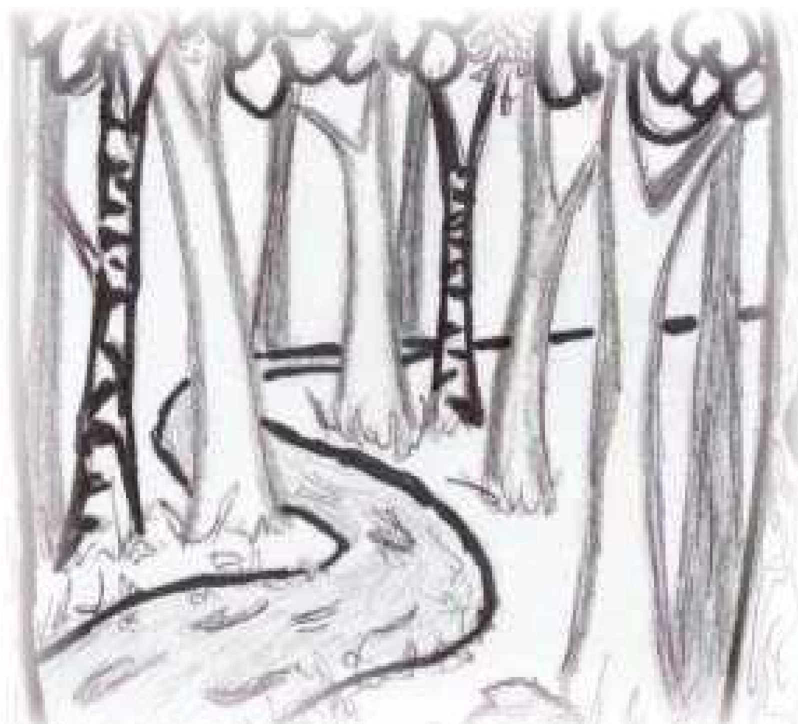
Ontario's Best Trails

Guidelines and Best Practices for the Design, Construction and Maintenance of Sustainable Trails for All Ontarians



Trails for All Ontarians Collaborative

2006

Acknowledgement

The construction and maintenance “best practices” for trails in Ontario were developed by the Trails for All Ontarians Collaborative. The Trails for All Ontarians Collaborative is a joint partnership of local, regional and provincial organizations involved in trails or representing people with disabilities.

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These “best practices” were made possible through the support received from the Ontario Trillium Foundation. The Ontario Trillium Foundation, an agency of the Ministry of Culture, receives annually $100 million of government funding generated through Ontario’s charity casino initiative.

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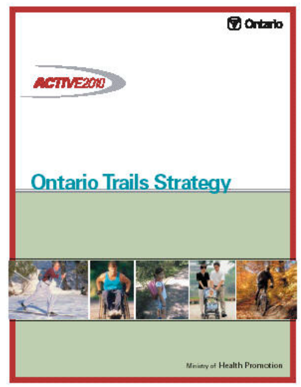
Introduction

"A world-class system of diversified trails,
planned and used in an environmentally responsible manner,
that enhances the health and prosperity of all Ontarians."[1, p.11]



The Ontario Trails Strategy[1] describes our vision for trails in Ontario. It recognizes the many benefits of trails for health and prosperity, and highlights the importance of environmental protection. Working towards this vision ensures that Ontario trails will encourage the preservation and appreciation of the widely varied environments found throughout our province. It also emphasizes the need for a diverse network of trails across Ontario so that trail users of all abilities and interests will have access to trail opportunities within their own community.

Why have trails?

Trails are critically important to the health and quality of life of the people of Ontario. Trails provide everyone, young children to older adults from all backgrounds and abilities, with the opportunity to be physically active. A physically active lifestyle improves physical and mental health and quality of life, while decreasing the risk of the most common health problems[2]. Trails also offer the opportunity to experience different environments. These experiences encourage greater understanding of our diverse province and the importance of protecting our outdoor environments. Working to provide trail opportunities strengthens our communities by encouraging partnerships, promoting stewardship and recognizing the generosity of landowners. Trails provide economic benefits as well. Trail users, both residents and visitors, contribute more than $2 billion per year to the provincial economy[3].

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[1] Ontario Ministry of Health Promotion. (2005) Active 2010: Ontario Trails Strategy. Toronto: Author.
[2] Public Health Agency of Canada, Physical Activity Unit. Physical Activity for Health: The Evidence. [On-line] Retrieved 31 July 2006 from http://www.phac-aspc.gc.ca/pau-uap/fitness/evidence.html.
[3] Trans Canada Trail Foundation. Trans Canada Trail Launches Economic Impact Study - Findings to Exceed $2 Billion. [On-line] Retrieved 31 July 2006 from http://www.tctrail.ca/index.php?section_id=7&lang=en&text_id=5946&.

Certainly, the health and quality of life benefits of trails are critically important. However, from an environmental perspective there is another key reason to have trails. **A carefully designed and constructed trail minimizes the impact that people have on surrounding or more sensitive terrain**. A well-constructed and maintained trail ensures that trail users stay on a tread that is suitable for their use. This protective function of a trail, through a concentration of use in appropriate terrain, is often overlooked but critically important.

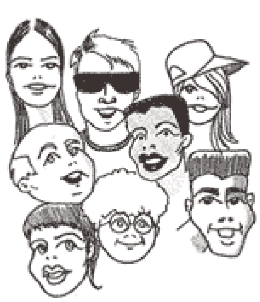
Why have guidelines and best practices?

The Ontario Trails Strategy provides a challenging and exciting vision. The **goal is to ensure that our outdoor environments are protected and preserved, while at the same time making it possible for all Ontarians to experience the joys of our great outdoors**. Historically, many groups focused primarily on one of these goals. That is, some groups focused on the protection and preservation of our outdoor environments, others worked to provide a variety of trail experiences in a community and still others worked to provide a specific type of trail experience in all areas of the province. **These guidelines, and the best practices for achieving them, are designed for trails that permit human-powered uses.** It is essential, that trail groups obtain all necessary permits and approvals before any work to design, construct or maintain a trail is undertaken. Permits and approvals will be required from the land owner, and may also be required from the Conservation Authority, local Ministry of Natural Resources Office or other land management agencies which have jurisdiction over the land where the trail will be located.

The guidelines and best practices outline in this resource encourage everyone involved in trails to reach for the vision of the Ontario Trails Strategy to ensure that our trails:

- **Follow the principles of sustainable design and development**.
- **Are universally designed to include people of diverse abilities**.

Additional information on these twin goals of sustainable and universal design can be found in the following section (Sustainable and Universal Design).



Ontario is recognized around the world for the cultural diversity of its population, particularly in the largest urban areas. The **diverse abilities that Ontarians have for using trails is recognized less often**. Our population is getting older. As the “baby boomers” reach retirement age, over 20% of our population will be older adults. As a group, these older adults will have better health and greater resources to remain actively involved in their community. However, ageing is often accompanied by a decrease in endurance, strength and balance that can make the use of some trails more difficult.

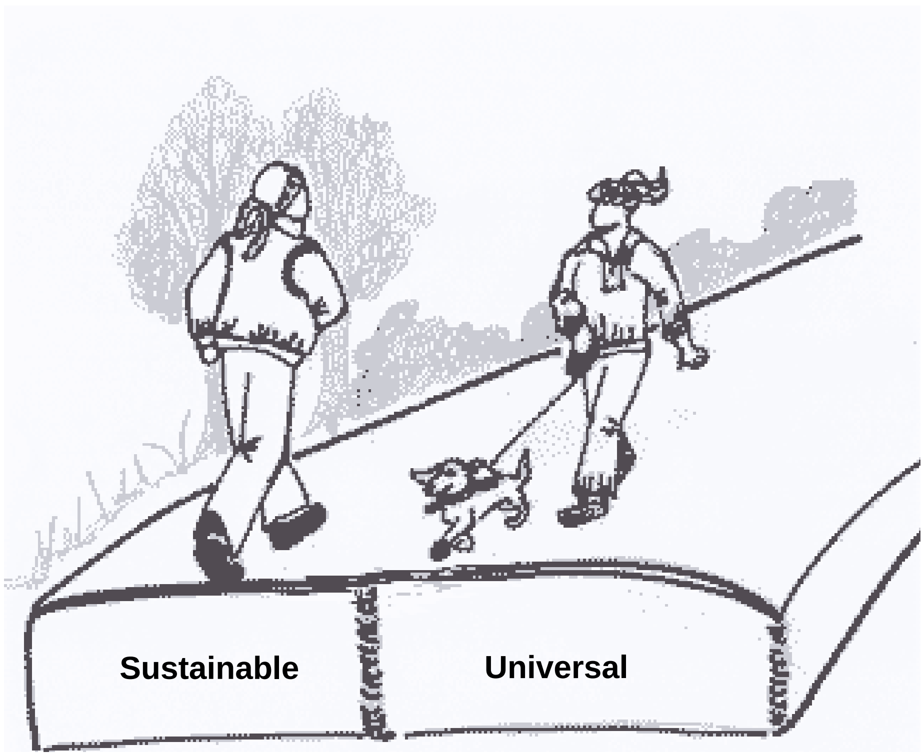
The proportion of our population that lives with a disability is also increasing. On average, over 40% of Ontario households include someone with a disability[4]. Clearly, if we are to reach the vision established through the Ontario Trails Strategy, **our trails must provide lifelong opportunities for people of all backgrounds, ages and abilities**.

Providing trail opportunities for people of all abilities is strategically important. **Our communities develop richer and more meaningful relationships when efforts are focused on providing trail opportunities to all citizens**. Trails are unique in that they provide a recreation opportunity that can be universally enjoyed with little or no per use cost. The more people who use trails, the greater will be public support for protecting and enhancing trail opportunities. Including a broad spectrum of people among trail users also greatly increases the pool of volunteers who have been, and will continue to be, the backbone of trails in Ontario.

The widespread availability of trail opportunities is also recognized as a key strategy for encouraging healthy, active lifestyles. The vision of Active 2010[5] is to create a culture of physical activity and sport participation for all Ontarians that contributes directly to their own health as well as the health of their communities. The goal is to enhance opportunities for daily physical activity and quality sport activities so that more Ontarians will value a healthy active lifestyle and participate on a regular basis. Of course, people who are more fit and physically active are much less likely to require medical treatment or have chronic conditions. Active people of all ages and abilities are also more likely to live independently and be involved in their community. Reducing health care costs and enabling people to live actively at home benefits us all.

[4] 4.5 million households that include 12.5 million people is an average of just under 3 people per household, and 1 in 7 people have a disability (data from Ontario government and Statistics Canada web sites - retrieved 31 July 2006).
[5] Government of Ontario. Active 2010. [On-line] Retrieved 31 July 2006 from http://www.active2010.ca.

The development of these guidelines and best practices for Ontario trail design, construction and maintenance provides **a common foundation for the creation of trails that are sustainable and universal**. Our hope is that trail groups will use these guidelines and best practices as the minimum standard for the construction of new trails and the maintenance of existing trails, so that all Ontarians can enjoy and support enhanced trail opportunities throughout our province.



A Trail is a Trail is a Trail . . . NOT in Ontario

Forests are the dominant characteristic of Ontario's landscape. There are four forest regions in Ontario[6]:

- Hudson Bay Lowlands.
- Boreal Forest.
- Great Lakes - St. Lawrence Forest.
- Deciduous Forest.

Each forest region is distinct in terms of the parent material (bedrock, glacial deposits, soil) found in the area, the type(s) of forest and other flora that grow in that environment, as well as the fauna that the area can support. Between the four regions, Ontario is home to more than 3,200 species of plants, 160 species of fish, 80 species of amphibians and reptiles, 400 species of birds, and some 85 species of mammals[6].

Each region has its own specific challenges for the design and construction of recreational trails. Understanding the forest type and the soils associated with each region will help the trail builder construct trails that are sustainable and universally designed.

Hudson Bay Lowlands

The **Hudson Bay Lowlands are a low relief wetland**. This area is primarily muskeg, with thousands of small lakes and ponds. It also contains all of Ontario's tundra[6]. Forest cover, generally tamarack and black spruce, is present on less than 20 percent of the land. The Hudson Bay Lowlands are home to woodland caribou, polar bear, arctic fox, arctic hare and millions of migratory birds and waterfowl.

The **terrain in this area is extremely sensitive** to human impact. Walking in the same place twice on sphagnum and mosses can leave a footprint that lasts for years. Wet areas and water will also be major concerns for trail builders. When a trail is provided, very careful attention will be required to ensure that it is in an appropriate location. Trail construction techniques such as boardwalks (post and deck or puncheon design) and turnpikes will be very commonly used. The need for long sections of constructed tread makes it more costly to build and maintain recreation trails in this region.

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[6] Ontario Ministry of Natural Resources. Overview of Ontario's Forests - Ontario's Landscape. [On-line] Retrieved 31 July 2006 from http://ontariosforests.mnr.gov.on.ca/forestoverview.cfm.

Boreal Forest

Ontario's boreal forest comprises the bulk of terrain in northern Ontario. Although relatively "young" in geological terms, it is **the largest forest region in Ontario**, stretching roughly from the shore of Lake Superior to the Hudson Bay Lowlands[6]. The boreal forest, which is a combination of coniferous and deciduous trees, contains 59% of Ontario's forests[6]. The most common tree species include white and black spruce, tamarack, balsam fir, jack pine, white birch and poplar. The boreal forest is home to a wide variety of flora and fauna. Jays and other songbirds, moose, black bear and beaver, and ferns, mosses, and shrubs are commonly found.

Large sections of the boreal forest are comprised of **exposed bedrock from the Canadian Shield covered by thin layers of soil and moss**. Smaller lowland peat bogs and fertile uplands can also be found. The typically sparse soil makes the mosses and ground vegetation extremely fragile. Trails must be very carefully located on appropriate terrain. The construction of trails in the boreal forest will require a variety of techniques due to the many changes in topography, soils and vegetation. Although not as wet as the Hudson Bay Lowlands, the boreal forest often requires the use of similar structures to cross wet areas (e.g., boardwalks, turnpikes). These structures are typically combined with other trail construction techniques, such as bridges and trail tread water drainage structures. In many areas, trail construction can be completed with the natural material, such as logs and rock, which is usually readily available.

Forest fires, floods, windstorms and insect damage play a prominent role in the ecology of the boreal forest[6]. These natural forces affect all of the trees in a specific area, opening large patches that are favourable for new growth. The result is a natural patchwork of even-aged forests that may be less pleasing to trail users.

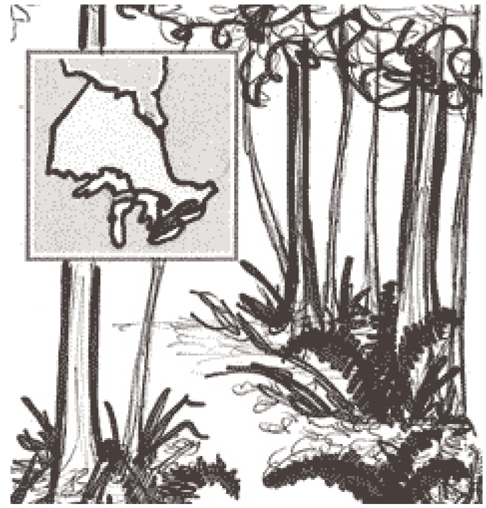
Great Lakes-St. Lawrence Forest

The Great Lakes-St. Lawrence forest extends across central Ontario from the St. Lawrence River in the east to Lake Huron and beyond Lake Superior in the west[6]. This area is **a transitional zone between the deciduous forests of the south and the coniferous forests of the north**. As a result, there are a wide variety of landscapes, plants and animals throughout this region. Many of Ontario's key geological features, such as the Oak Ridge Moraine and Niagara Escarpment, are found in this region.

The forest in **this region is widely varied**. Coniferous trees, such as pine, spruce, hemlock, aspen and cedar, combine with deciduous trees, such as birch, maple, and oak. Species more common in the boreal forest, such as white and black spruce, jack pine, aspen and white birch also exist here. Fungi, ferns, mosses and shrubs are also common[6]. The fauna of the Great Lakes-St. Lawrence region is also widely varied. Some of the most common species are deer, moose, black bear, beaver, coyotes, skunks, racoons, and porcupines. There are also a wide variety of birds, fish and insects.

The full range of trail construction techniques will be used in developing trails throughout the varied landscapes of this region. The physical landscape is very diverse, and each section should be fully evaluated to determine what type of trail and which construction techniques are best suited to the natural environment. The complexity of trail construction within such a varied environment is compounded by the relatively high population (both resident and visitor) that can be expected to use trails within this region. Trail designers and builders should expect high levels of trail use throughout this region which will require trails to be built to a higher standard to ensure sustainability.

Deciduous Forest



The deciduous forest region is located in south-western and south-central Ontario. It stretches primarily **along the shores of Lake Erie and Lake Ontario, extending up along the south-eastern shore of Lake Huron**. The trees found here are at the northern end of the deciduous forest regions common in the United States. Common tree species, such as maple, birch and oak combine with more “exotic” species such as walnut and sycamore.

The plants and animals found in the deciduous region are the most diverse in Ontario. Although most of the original deciduous forest was cleared by early settlers for agriculture, a patchwork of tree lots remain, primarily on lands that are not suitable for farming. Tree planting and forest restoration programs have also helped to increase the forest cover in the deciduous region, for the benefit of Ontario’s residents almost all (over 90%[6]) of whom live in this region.

Trail use in deciduous forest will be extremely heavy due to the proximity of densely populated urban areas. As a result, high standards of trail design, construction, and maintenance will always be required. For example, it will more commonly be necessary to install a sub-base of gravel to permit a high level of use in areas with wet soil conditions. Keeping users on the trail and using techniques to minimize environmental impacts will be a major focus for the trail builder. The terrain in this region is also more varied, making it more likely that trail designs will have to consider more changes in elevation than would be encountered in the lowland or boreal regions.

Ontario Soils

Understanding different soils and how they affect and are affected by trail use is extremely important for designing trails that are environmentally sustainable. Soils affect water drainage, erosion potential, and tread material. **Every type of tread material will react differently to the forces of trail use, such as compaction, displacement and erosion**. How different tread materials, such as soil, rock, sand, clay, etc., will respond to trail use in both wet and dry conditions needs to be clearly understood.

The best soils for constructing a trail are primarily clay-based with a significant amount of small, fractured rock pieces. These soils can be compacted during trail construction to provide a trail tread that is resistant to the forces applied by trail users and environmental conditions (e.g., rain). While clay provides for strong cohesion between the soil particles, too much clay can make for a very slippery surface when in wet conditions. **Designing the route for a trail should include careful consideration of what soils and other tread materials will be available or required**. Constructed tread surfaces, such as boardwalks, are often required on trails built on soils with high sand, silt or loam content.

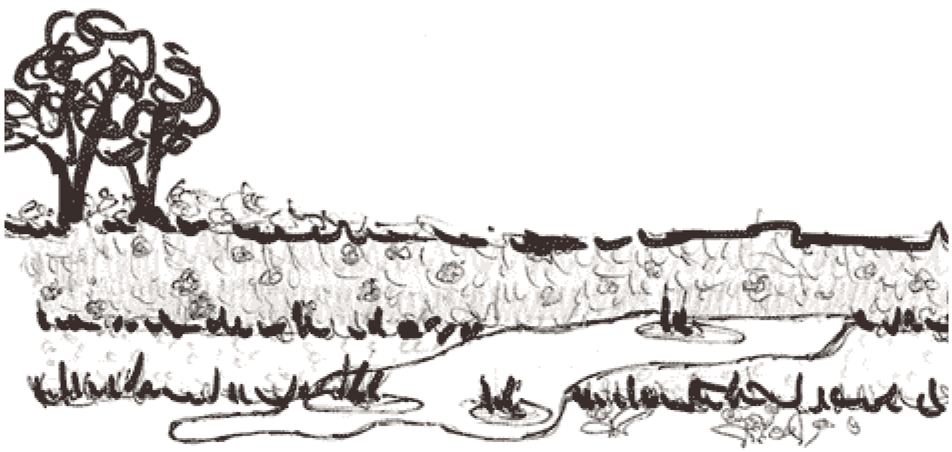
Local authorities, such as offices of the Ministry of Agriculture and Food, Ministry of Natural Resources or a Conservation Authority, can help you to evaluate the soils found along the trail route. Staff from these agencies can also be an excellent resource for information on recommended protective measures for the local soil conditions. If suitable soils for a trail tread cannot be found in your area, you will have to construct an alternate tread surface (e.g., boardwalk) or modify the soil composition by adding fractured rock (e.g., ¾ minus crushed aggregate) or clay[7] as necessary. Adding fractured rock pieces (e.g., mechanically crushed rock) can make natural soils much more stable, easier to compact and resistant to the forces of trail use. Keep in mind, **any material imported to the trail environment must be approved by the local Conservation Authority**. In some cases it may not be possible to build a trail if the soils and environmental conditions are too delicate.

In Ontario, **the type of tree growing on a site can help you to determine the type of soil found in that area**. For example, White Pine trees grow in sandy soil, White Birch is found in rocky soil and Cedar trees indicate wet soil. Soil types vary throughout the four regions of Ontario. Some soil types can be the same for hundreds of kilometres while others can change within metres of each other.

[7] The International Mountain Bicycling Association (IMBA) suggests that adding cat litter (which has a high clay content) can be an effective and inexpensive method for increasing the clay content of sandy soils. Refer to IMBA:Subaru/IMBA Trail Crews: 1999: Hello from the Sunshine State, March, 1998. [On-line] Retrieved 31 July 2006 from http://www.imba.com/tcc/1999/florida.html for additional information.

Use soil maps to accurately identify the location of soil types in your specific trail area and to determine their suitability for different trail uses and structures. Soil maps are available at most local Ontario government offices such as Ministry of Agriculture and Food or Ministry of Natural Resources and some libraries. However, **this information should be supplemented with an on-site examination of the area**.

In most soil conditions, **avoid placing a trail on flat, low-lying terrain or very steep grades**. Depending on site conditions and type of trail use, trails in these areas will usually have much more significant water drainage and erosion problems.



Soil surface and subsurface colour can be used to evaluate soil drainage. A uniform subsurface soil colour (yellow, brown, red) usually indicates adequate drainage. However, **if the soil is grey or olive coloured with some mottles** (spotted with concentrations of red, yellow, brown, or bluish-grey soil), **the soil drainage is more likely poor**. Poorly draining soils will rarely result in a sustainable trail tread.

Examine the trail area for excessive surface water during the spring thaw or after a heavy rain. At these times, drainage problems will be easiest to see. Avoid building trails in areas with poor drainage or a high water table, especially if the depth to the water table, bedrock, or hard clay is less than 40 cm (16 inches). **Shallow soils not only have drainage problems, but also tend to erode easily and may slide when walked on**. When choosing a trail site, favour locations that have a soil depth of at least 1 metre. **The Hudson Bay Lowland areas will normally have excessive water**[6]. Soil testing would not be useful in most of this region.

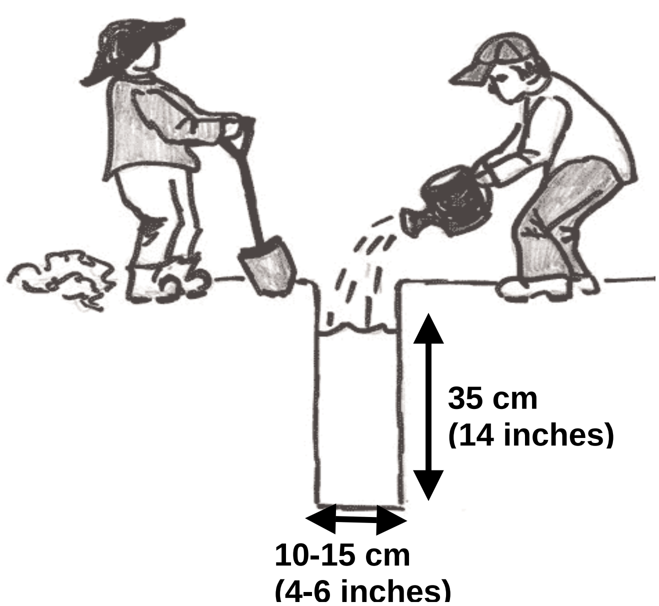
Soil texture also has a major influence on how well the soil drains and its ability to resist erosion. Texture refers to the sizes of individual soil particles. Clay and silt are the smallest particle sizes, and soils containing high amounts of these particles tend to be muddy when wet or cracked and dusty when dry. Clay and silt soils are more susceptible to compaction and are very likely to erode with trail use, especially on steep slopes. Likewise, soils composed mostly of sand, which has the largest particle sizes, are extremely unstable and should be avoided. Single-texture soils may be suitable for trail use if gravel-sized particles are embedded in the soil. To identify a soil's textural group, moisten a small amount of soil to the consistency of putty. Make a small ball of soil and squeeze it between your thumb and forefinger, pressing the thumb forward to form the sample into a ribbon. Table 1 describes each soil by textural class, and provides guidance on how to interpret the results of your soil texture test.

Table 1: Soil Texture Categories[8]

Soil Texture	Identification
Sand	Loose and gritty. Will not form a ball.
Loam	Smooth (flour-like), but slightly gritty. Forms a ball, but ribbon usually breaks easily.
Silt	Smooth like flour, not gritty. Forms ribbon that breaks under it's own weight.
Clay	Smooth and sticky when wet. Forms ribbon that is long and pliable.
Organics	High amount of decomposed material and water. Black to brown colour. Wetlands, low areas. Also referred to as peat or muck.

To test soil drainage in the other regions, dig a hole 35 cm (14 inches) deep and 10 to 15 cm (4 to 6 inches) wide, and fill it with water. Once the water has completely drained, fill it a second time. If the water fails to drain from the hole within 18 hours (2.5 cm (1 inch) per hour), the soil either is poorly drained or has a high water table.

This soil drainage test should not be performed when the ground is frozen or after a heavy rainfall. For example, if you walk the trail route after a heavy rain to observe problems, you will need to return at a later time when the excess water has dissipated in order to perform the soil drainage test.



[8] Parker, T.S. (2004) Natural Surface Trails by Design: Physical and Human Design Essentials of Sustainable, Enjoyable Trails. Boulder, CO: Natureshape.

Which trails should follow these guidelines and best practices?

The Trails for All Ontarians Collaborative was created to provide guidance related to **trails intended for human-powered use**. This includes trails for activities such as walking, hiking, jogging, running, cross country skiing, snowshoeing, and bicycling. It also includes trails that combine human-powered and other types of use. Trail groups should keep in mind that individuals using personal mobility devices (e.g., wheelchairs) are included among walkers, hikers, joggers and runners, that bicyclists may be using hand cycles or recumbent bikes and that winter trail users may also be in a seated rather than standing position (e.g., sit skis). Trails that are intended solely for other types of use (e.g., equestrian, ATV, motorbike, snowmobile trails) are not within the scope of this document.

These **guidelines and best practices are designed to apply to all trail settings, from highly developed urban paths, to suburban, rural and wilderness trails**. It is critically important that we provide a full range of trail opportunities to all Ontarians. People living in urban centres should have opportunities to experience nature and the “wilder” side of our province. Conversely, those living in rural and remote areas should have the choice to pursue recreational activities, such as in-line skating or casual walks with their family, that are more commonly associated with trails in developed areas.

There should also never be a question such as “should I build an accessible trail or an inaccessible trail?” The Ontario Trails Strategy makes it clear that **all types of trail opportunities should be available to all Ontarians**. That doesn’t mean that every piece of every trail must be open to use by everyone and all types of trail use. Rather, it means that the permitted users on every trail (as determined by the land managing entity) may be of any age, culture, or gender and may or may not have a disability.

Why were these guidelines and best practices developed?

These guidelines and the best practices for implementing them on Ontario trails were developed for a variety of reasons. Primarily, it was because **volunteers plan, design, build and maintain the vast majority of Ontario trails**. These volunteers willingly donate their time, experience and labour for the benefit of us all. Many of the larger trail organizations (e.g., Bruce Trail Association) provide extensive support, education and training to their volunteers. More typical, however, are the many volunteers who have great difficulty in obtaining specific information on how to build and maintain trails that are environmentally, economically and socially sustainable (see) as well as safe and enjoyable for all potential users (see Universal Design). **The primary goal for this project was to support the greatest asset that the trail community in Ontario has, our willing volunteers**, by providing a “one stop shop” for all of the best information related to trail design, construction and maintenance. In keeping with this goal, the design, construction and maintenance guidelines and techniques included in this document can be readily achieved, without the need for professional training or the use of heavy, mechanized equipment.

Our Greatest Trail Asset

It is also intended that these guidelines and best practices can be used as a source of education for trail managers, professional or volunteer, regarding the current state of knowledge for making trails sustainable and available to people of all abilities. These guidelines and the best practices for achieving them will ensure a common foundation for all trails. However, it is critically important to recognize that **a standardized approach does not mean that there will ever be a “standardized trail”**. It is a common misconception that the development of trail standards will make all trails exactly the same. In reality, nothing could be further from the truth. While it is true that the widespread implementation of these guidelines and best practices will enable all trail users to know what to expect from trail-to-trail in terms of minimum standards, **it is left to each individual trail designer to determine the ways in which each new trail will be unique**. It is up to each trail organization to go beyond the minimum standards in the direction that will create a unique trail experience of the highest quality (i.e., sustainable and universal).

Keep in mind that the **information in this resource are guidelines**. While they are the best practices based on sustainability and universal design, they are not a required or legally mandated minimum standard for trails. Trail groups are encouraged to comply with as many of these recommendations as possible to ensure that their trail is optimally designed for sustainability and use by all Ontarians.

Who was involved in developing these guidelines and best practices?

These guidelines and best practices for Ontario trails were developed through a collaborative partnership of local, regional, and provincial disability and trail organizations. The **Trails for All Ontarians Collaborative** was an alliance of existing organizations that was created to complete the development and evaluation of these guidelines and best practices.

The **partners of the Trails for All Ontarians Collaborative** were:

Abilities Centre

Active Living Alliance for Canadians with a Disability

Fitness Friends

Get Active Now - Active Living Resource Centre for Ontarians with a Disability

Go For Green

Haliburton Highlands Trails and Tours Network

Hike Ontario

Huronia Trails and Greenways

Kawartha Lakes Green Trails Alliance

Oak Ridges Trail Association

Ontario Trails Council

Township of Uxbridge

Trans Canada Trail Ontario

Variety Village

Wye Marsh Wildlife Centre

The success of this project was further enhanced by the contributions received from dozens of individuals, conservation authorities, municipalities, disability organizations and the following supporting organizations:

Active Living Coalition for Older Adults
Central Ontario Loop Trail (COLT)
City of Toronto
Pathways to Health Committee
Quetico Provincial Park

Financial support for this project was received from the Ontario Trillium Foundation as well as all of the partner organizations.

The Ontario Trillium Foundation
La Fondation Trillium de l'Ontario

One of the major goals of this project was to **consult widely with a broad range of trail groups and organizations representing potential trail users**. Draft versions of the project documents were circulated for review to all partner and supporting organizations. They, in turn, were encouraged to widely circulate the documents to obtain feedback from a broad spectrum of stakeholders. Many individuals, not connected to an organization, also chose to provide comments and feedback. We believe that their contributions have greatly enhanced the quality of this document. We also greatly appreciate the time and effort of the many organizations that were not partners in this project but nevertheless took the time to provide us with valuable feedback and recommendations (Appendix D). These organizations represent private, local, regional and provincial trail providers, both professional and volunteer, as well as a variety of groups representing potential trail users.

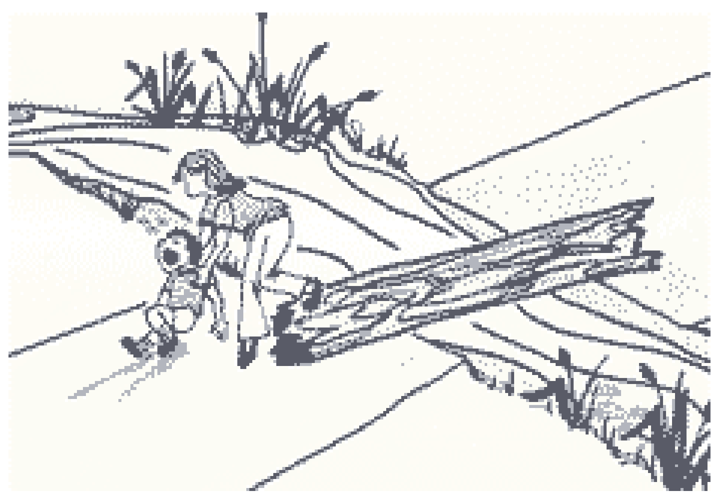
What if parts of my trail cannot meet these recommendations?

These **recommendations are designed to optimize the social, environmental and economic sustainability of recreation trails in Ontario** and to encourage a broad spectrum of trail opportunities for all Ontarians. In almost all cases, following these guidelines will ensure that trail construction and/or use do not compromise the natural environments that are so highly valued. **In urban and suburban environments, the highly constructed nature of the trail environment means that it would be extremely unusual that a trail could not fully comply with these recommendations. Experience to date has also shown that most trails in rural or remote environments can also comply, except in very specialized situations**.

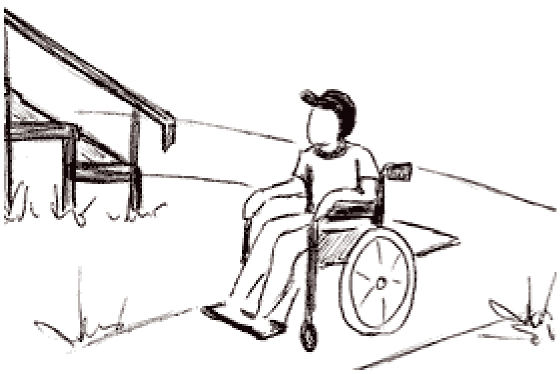
When considering the possibility of building a trail that does not comply, it is important to ask questions such as the following:

- If the environment is so sensitive that I cannot build the trail tread to a width of 1.0 m (3 feet), why would a width of 0.6 m (2 feet) not also have a significant, detrimental impact?
- If we only cut back the vegetation so people can walk more easily through the forest, what will the impact be of the trampled vegetation and compaction that will result from each user (and each user potentially stepping in a different place)?
- If the trail requires a grade exceeding 10%, how can I be sure that the high risk of environmental degradation on steep slopes will not occur?
- If the possibility of drainage along the trail tread is so high that a cross slope exceeding 8% is required, is the chosen route really the best alignment for the trail?
- If the trail tread will be soft or unstable, why do I want to risk substantial environmental damage from trail use?
- What will the true, long-term damage and cost to the environment be in relation to the possibility of increased short-term costs for construction to these recommendations?

Despite all of the issues raised by the above questions, and the detrimental effects on trail sustainability that result, it is recognized that **in relatively unusual circumstances** there will be short sections of a trail that cannot meet all of these recommendations. In these situations, the trail segment that is limited should be constructed as close to the recommendations as possible. **All sections of the trail that are not under the same constraints** (i.e., before and after the difficult section) **should be constructed to fully comply with the best practices**. The existence of, location and conditions found on the difficult section of trail should be clearly posted at all trail access points and made available in all trail information materials (e.g., web site, guidebook).



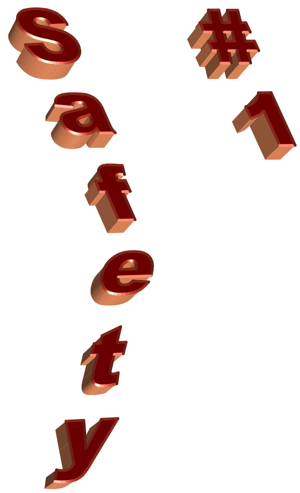
Will following these guidelines make a trail accessible to everyone?



The answer to this question is an emphatic "**NO**". **It is absolutely impossible to make a trail that is accessible to everyone**. There will always be some people who do not want to or cannot use a trail no matter how the trail is designed, constructed and maintained. For example, some people are allergic to sunlight and therefore could only use a trail that was safe to use in the middle of the night. Other people have fears of being outside, and would never choose to use an outdoor trail. There are also many trails that are intimidating to a wide range of potential users (e.g., women, older adults) because there is a strong perception of the trail being unsafe or that trail users may be unacceptably vulnerable to harm.

It must also be recognized that **the needs of different trail users often conflict**. By creating a trail that is designed to meet the needs of one group of trail users, the possibility for enjoyment of the trail by other potential users is decreased. For example, as stated earlier, it is a commonly held myth that trails must be paved in order to be accessible to people who use mobility devices, such as wheelchairs or scooters. Even if a trail is paved because of such "good intentions", a paved surface automatically makes the trail less appropriate for people who prefer an unpaved surface (e.g., runners, equestrians, or people who walk with an artificial leg). Each characteristic of a trail will encourage some users and discourage others. **The key to achieving "best practices" is to ensure that the full spectrum of trail opportunities is available to all members of the community within their local area**.

Safety and Best Practices for Trails



It almost goes without saying that safety on trails should always be of paramount concern. Almost, because **safety should be explicitly considered as well as implicitly encouraged**. Long before issues of insurance costs and liability were raised, the safety of people on trails (both trail users and trail workers) was the most important concern in relation to the design, construction and maintenance of trails. It is not possible to provide a comprehensive guide to trail safety within the current document. Readers are encouraged to use the information provided as a starting point, and to follow up on suggested references and use other information sources to ensure that they have the most up-to-date and appropriate safety knowledge for their trail.

Following recommended practices for trail design, construction and maintenance will enhance trail safety. The safety of trail workers will be enhanced because the techniques and equipment used to build and maintain the trail will be appropriate to the environment and the skills of the workers. Keeping tools sharp and in good repair, and using the correct tool for each job are key components of trail worker safety. Trail user safety will also be enhanced because the wide range of abilities among trail users will have been carefully considered within each phase of trail design, construction and maintenance.

In order to optimize trail safety and reduce the possibility of litigation, **organizations should have a risk management plan for their trail**.[9,10] Risk management affects the officers of trail organizations, volunteer trail workers, event leaders, trail users and landowners across whose land the trail may pass. There are several components of a risk management plan. Initially, **every effort should be made to reduce the possibility of injury** by identifying risk areas and limiting their effect. Signs, barriers, supervision, education programmes or regular trail inspections are just a few of the activities that will help to limit the effect of identified risk areas. Although **prevention should always be the primary method of reducing risk**, it is also important to minimize the effect of accidents that do occur through the availability and use of first aid posts and rescue equipment.

Trail users are most often put at risk when the demands of the trail environment exceed the skills they possess. Excessive demands from the trail environment can occur because of natural events (e.g., sudden changes in weather, catastrophic events such as landslides). However, they occur much more commonly because of changes in the trail environment that can be controlled and/or prevented.

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[9] Hike Ontario. Hike Ontario Risk Management Manual. [On-line] Retrieved 31 July 2006 from http://www.hikeontario.com/services/downloads/riskmgmt.pdf.
[10] Go for Green. Trail Monitor 3: Risk Management and Liability for Trails. [On-line] Retrieved 31 July 2006 from http://www.trailscanada.com/documents/Monitor_3_Final.pdf.

For example, a wide, paved trail that leads from a trailhead that is highly developed (i.e., has lots of amenities) establishes an expectation among trail users that the trail environment will also be highly developed and relatively easy to negotiate. If that same trail leads to a step-stone or log crossing of a fast moving river, users will be faced with an inappropriate choice: turn back without reaching the destination or attempt a crossing that is much more difficult than the trail itself. Trail builders can enhance the safety of trail users by ensuring that **the skills required for use of the trail are explicitly stated in trail information and implicitly conveyed through the trail conditions and environment at all trail access points**.

Trail users can also be put at risk when trail designers and builders do not consider the needs of all potential users. Most often, trails are designed for the “twenty-something fitness fanatic”, the “trail expert” or the “experienced back-country traveller”. However, in reality, **most trail users will not be highly fit, skilled and experienced**. In order to enhance the safety of trail users, trails should be designed and built in a way that considers that many trail users may be of average or lower fitness, inexperienced, or limited in the skills they can use to see, hear, understand and negotiate the trail environment. **Typically, trails are designed and built by people who have a lot of trail experience. Never assume that trail users will have the same level of skills, expertise or experience**.

Like trail users, the safety of trail workers can also be jeopardized by unusual weather or sudden changes in the trail environment. However, as is the case for trail users, **the primary hazards for trail workers are related to a mismatch between the skills and experience required for the task and the skills and experience of the trail worker**. Even though these trail construction and maintenance techniques focus primarily on methods appropriate for trail volunteers (rather than professionals), **it should never be assumed that a trail worker has the knowledge, skill or expertise to perform the desired task**. The safety of trail workers is equally important, whether the trail is being constructed by professionals using heavy equipment or by volunteers helping out on a weekend.

A detailed review of trail safety for both workers and trail users is far beyond the scope of this resource. Further information about trail safety issues can be obtained from many sources.[11] A limited amount of additional safety information is also provided in Appendix E.

[11] For example, Oak Ridges Trail Association. Oak Ridges Trail Association Safety Policy for Trail Workers. [On-line] Retrieved 31 July 2006 from http://www.oakridgestrail.org/Documents/Safety%20Policy.pdf.

Cost of Best Practice Trails

Money. It's always an important consideration in relation to trail design, construction and maintenance. **Money**, and usually lots of it, **is required before you build a trail** (e.g., permit or environmental assessment costs), **while you build the trail** (e.g., construction materials) **and after you build the trail** (e.g., maintenance tools, materials for the replacement of facilities). Money is also almost always in very short supply! However, **the "cost" of recreation trails does not refer only to monetary costs**. Trails also have substantial costs in relation to the time and effort required to design, build and maintain trail experiences.

Following the best practices for sustainability and universal design does not "cost more"[12]. In new trail design, construction or re-construction it will require similar resources (monetary and non-monetary) and can significantly increase the resources available to support a trail. For example, **environmental sustainability will minimize the on-going costs of trail maintenance and the use of environmental protection measures can often attract new sources of support for the trails** (e.g., grants, money from "enviro-friendly" companies). **Enhancing the social sustainability of the trail is a great way to increase the pool of potential trail workers, and the "capital" of community involvement, commitment and use can easily be translated into trail support** from the government, public and not-for-profit sectors. Ensuring broad community support and minimizing on-going maintenance costs through environmental sensitivity are the best ways to ensure the long-term economic sustainability of the trail. Appendix F: Dollars and Cents provides additional information on potential sources of trail support and funding.

[12] Wilderness Inquiry, Inc. (Sept. 24, 1999). Access Board Cost Analysis of Outdoor Developed Areas, U.S. Architectural and Transportation Barriers Compliance Board. [On-line] Retrieved 31 July 2006 from http://wi.wildernessinquiry.org/downloads/research/CAS%20Final%20Report.pdf.

What about backcountry or wilderness trails?

These recommendations apply equally to all trails in Ontario, regardless of where they are located. Backcountry or wilderness trails are distinguished by their location and the "wilderness experience" that they provide. **Nothing in these recommendations limits the location where trails can be built or the type of experience that they can provide**. The key to constructing a backcountry or wilderness trail is to ensure that the trail provides the "wilderness experience" that the user expects. Although we, in Ontario, are blessed with an enormous amount of wilderness (in comparison to most similarly-developed countries), our wilderness is nevertheless a very precious and quickly vanishing resource. **Most trail users perceive a trail to be a wilderness experience when the surface of the trail tread appears natural, the trail seems relatively narrow and close to surrounding vegetation, the trail follows the natural contours of the land, and encounters with other groups of users are relatively infrequent**. Assuming that the trail is in a location where the number of users will be relatively small, trail managers can create a more "wilderness feel" on the trail by:

- Carefully choosing the trail route to **ensure that the naturally occurring soils are suitable for the trail tread**. Where natural soils are not suitable, use short sections of acceptable alternate surfaces (e.g., boardwalk, soil mixed with a clear and colourless natural stabilizer).

- **Minimizing the size of the buffer zone** between the trail tread and the vegetation. Although this may require more regular maintenance, it also allows the trail user to feel closer to the natural environment. On trails where maintenance will be infrequent, the Ministry of Natural Resources recommends that the tread corridor be cleared to a wider standard so that the trail remains useable until the next maintenance period.

- **Follow the concepts of curvilinear trail design** so that the trail winds naturally through the environment. Trails that do not match the natural contours of the land give the impression that the trail has been "bulldozed" into the environment rather than following the natural terrain.

- Minimize the use of constructed facilities (e.g., benches, toilets) to only those required for environmental protection. **Design the trail so that users can make use of natural features instead of constructed facilities** (e.g., a fallen log or large rock for a resting area rather than a bench). When facilities are provided, ensure that they are constructed of materials that maintain the "back-country" feel.

What is NOT in these Guidelines?

All trail groups know that building and maintaining a trail involves much more than the skills used to actually design, construct and maintain the trail. These guidelines, and the best practices to achieve them, are intended to apply to Ontario trails that are intended for human-powered use. That includes trails in urban, suburban, rural, and wilderness areas as well as trails that share both human-powered and other uses.

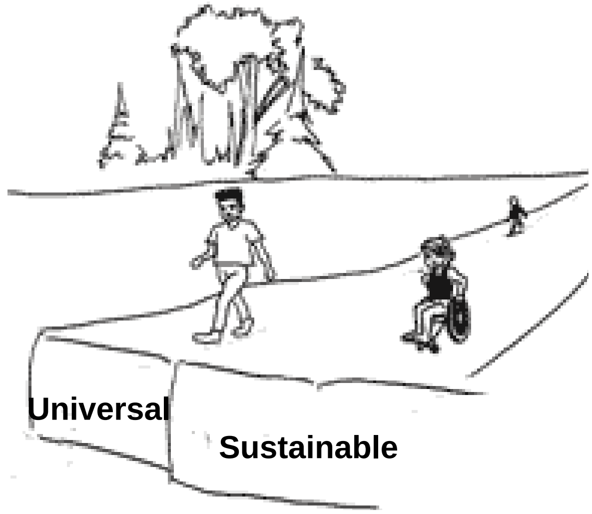
It must also be recognized that **the majority of Ontario trails were developed long before our current knowledge of sustainable trail design practices was available**. Many existing trails were created in order to get from Point A to Point B as quickly as possible. They developed as people and vehicles followed walking routes to the next town or to the views available at a high point, game trails, natural openings in the forest, logging roads, railroad corridors, unopened road allowances, etc. **Nothing in these guidelines suggests that we should abandon this vast network of existing trails**. These guidelines also do not require that existing trails be re-designed or re-constructed using these best practices. However, trail groups that manage existing trails that do not follow sustainable and universal design principles are strongly encouraged to **look for opportunities to bring existing trails closer to these recommendations** when maintenance activities are performed or trail re-construction is required for other reasons (e.g., flooding due to beaver activity).

Many of the aspects of developing and operating Ontario trails have not been included in this resource. In order to keep the scope of this project manageable, important topics that were determined to be outside of the scope of this resource include:

- Best practices for achieving the recommended design guidelines.
- Guidelines and best practices for trails intended solely for non-human powered use (e.g., equestrian trails, motorized trails).

- Guidelines and best practices for water trails.
- Guidelines and best practices for trail experiences based on extreme slopes (e.g., downhill ski trails, technical rock climbing routes) where complying with the recommended design guidelines would make it virtually impossible to provide the same trail experience.
- Recommendations for developing public support or the public planning processes related to trail development.
- Detailed information on trail safety, liability, insurance and risk management.

Sustainable and Universal Design



The vision put forth in the **Ontario Trails Strategy** clearly identifies what are **"best practices" for trails in Ontario**. It is **a system of trails that is "environmentally responsible" and available to "all Ontarians"**. **These two issues have been the guiding principles of this project**. The principles of sustainable design were used to ensure that the construction and maintenance information reflects the best practices for environmental responsibility and optimizing social and economic sustainability. Universal design principles guided the information provided in relation to enhancing access to trail opportunities for all Ontarians. Although information about trail design was not originally envisioned as part of the Trails for All Ontarians Collaborative project, the volume of questions and feedback received regarding trail design, rather than construction and maintenance, encouraged us to provide a very brief overview of the principles of sustainable and universal design as well as trail design guidelines.

Trails that are designed, constructed or maintained according to these guidelines should be promoted as sustainable and universally designed. Including a short statement on trail maps, trailhead signs or web sites such as "The Red Trail was designed to meet the Guidelines for Sustainable Trails for All Ontarians" will let all trail users, and potential users, know the minimum standard that can be expected on the trail. **For the majority of trail groups, ensuring that their trail meets these minimum guidelines and best practices will require little or no changes to their current practices**. For example, the Oak Ridges Trail is constructed with a clear tread width of 1.0 metre. That standard is the same as the minimum recommended width contained in these guidelines for hiking-only trails, so no change to current Oak Ridges Trail Association practices are required to meet that requirement. For other trail groups, such as those who are building steep trails, close to the fall line and using water bars to control on-trail drainage, meeting these recommended practices for sustainability and universal design may require the adoption of a newer approach to trail design and construction (curvilinear layout).

Many trail groups, including those involved in developing these guidelines, find it challenging to think of the wide range of abilities that may occur among the users of their trail. These guidelines encourage the development of the broadest range of trail opportunities, including extremely difficult and remote trails. **The key concept unique to this project is ”sustainable trails that all of us can use together”**. Trail groups that offer a difficult, back-country trail (e.g., the hiking trail in Pukaskwa National Park) should consider the needs of male and female users, users of different ages, users from different cultural backgrounds, users from different socio-economic backgrounds, users with varying levels of trail experience and users with different abilities or disabilities. The same broad range of trail users should be considered by trail groups that offer an easy walk in a local city park, a bicycle commuting trail, a cross-country ski trail or any other trail opportunity for human-powered use.

It’s really just a matter of the “mind set”. Do you think of “trails for us” and “other trails for them” (regardless of who “us” or “them” are) or do you think about **providing the wonderful experience offered on your trail to all of the potential users who have the necessary skills and experience**. No trail group consciously decides to exclude certain groups. However, spending a day watching who is using your trail can be very informative and highlight potential barriers that have not previously been recognized. Ask yourself whether women or older adults use your trail as much as men or younger adults or whether people who are deaf are ever seen on your trail. If these or other groups of potential users seldom use your trail, try to find out why. Trails that have the majority of users from only one or two demographic groups are seldom sustainable, either socially or economically. Ensuring that a broad spectrum of potential users can enjoy your trail is the best way to build support for your efforts within your local community.

Universal Design

What is universal design?

Universal design[13] is a philosophy that attempts to meet the needs of the widest possible range of potential users. It means **considering the needs, interests and abilities of everyone**, not just those "like us" or "most expected", from the very beginning of the design process. **Universally designed facilities can be enjoyed by people of all abilities**, without specialized, individualized or additional modifications.

When applied to trails, it means creating a trail that can be enjoyed by a broad spectrum of people (but always within the intended user groups). **Universal design does not mean making every trail available for use by every possible trail user**. **Hiking trails can be only for hikers, not cyclists or equestrians**. However, **a universally designed hiking trail is one that recognizes that all hikers have different abilities to use a trail**. Some trail users have a lot of experience, others are novices. Some are very fit, others are unfit. Some are co-ordinated and agile, others are less co-ordinated. Some hikers use a wheelchair or power scooter as a personal mobility device, while others use a walking stick or backpack to make their hike more enjoyable. A universal design approach to trail design means that the needs of all of these users are considered and accommodated, to the greatest extent possible.

The vision of the Ontario Trails Strategy is to make trail opportunities available to all Ontarians. "All" Ontarians includes people who often do not use trails, such as older adults, families with young children, people from different cultures and people with disabilities. Applying **a universal design philosophy to trail design is the most effective way to ensure that all of the users and potential users in your community can enjoy the benefits of your trail**. Keep in mind that individuals who use wheeled forms of mobility (e.g., manual or power wheelchair, power scooter) because of a disability are considered pedestrians, and must be permitted on hiking trails even if other trail users on wheels (e.g., cyclists) are not permitted. Similarly, working dogs (e.g., seeing eye dogs) are permitted on trails even if other dogs are not.

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[13] Center for Universal Design. (2005) What is universal design? [On-line] Retrieved 31 July 2006 from http://www.design.ncsu.edu/cud/about_ud/udprinciples.htm.

It is often assumed that the philosophy of universal design applies only to paved trails, trails in urban or suburban areas, or trails that are naturally easier to negotiate (e.g., rail trails). That assumption is incorrect. The philosophy of trying to offer your trail experience to a broad spectrum of potential users applies to all types of trails, from the wide, paved trails of our cities to the single-track hiking trails in remote areas of the province. Not everyone will want to use all types of trails, but trail groups should avoid creating barriers to trail use for some Ontarians through inappropriate design, construction or maintenance practices.

The seven principles of universal design[13] (see Appendix B: Principles of Universal Design Applied to Trails for examples for trails) are:

- **Equitable use**
  (same method of access for all users, avoid segregating or stigmatizing some users, make design appealing to all users).

- **Flexibility in use**
  (provide choice in methods of use, provide adaptability to the user's pace, facilitate the user's abilities).

- **Simple and intuitive in use**
  (correct use is easy to understand, be consistent with user intuition, arrange information based on importance, accommodate a wide range of literacy/language skills).

- **Perceptible information**
  (use different modes for essential information, contrast information and surroundings, maximize legibility).

- **Tolerance for error**
  (minimize hazards and errors, provide warnings of hazards and errors, provide fail safe features, discourage unconscious action when vigilance is required).

- **Low physical effort**
  (maintain neutral body position, use reasonable operating forces, minimize repetitive actions, minimize sustained effort).

- **Size and space for approach and use**
  (clear line of sight to important items for seated user, reach all components from standing or seated position, accommodate variations in hand and grip size, provide space for use of assistive devices or personal assistance).

What are the benefits of universally designed trails?

Applying the philosophy of universal design is an important part of the best practices for Ontario trails for many reasons. While it is true that the Canadian Charter of Rights and Freedoms and the Ontario Human Rights Code have prohibited discrimination in the provision of public facilities and services for several decades, it is more important to look beyond the legal requirements for maximizing access to all Ontarians. In linking the Ontario Trails Strategy to Active 2010, the government and trail organizations supporting the strategy have chosen to **support trails as an effective way of increasing opportunities for physical activity** as an avenue to physical and psychological health benefits.

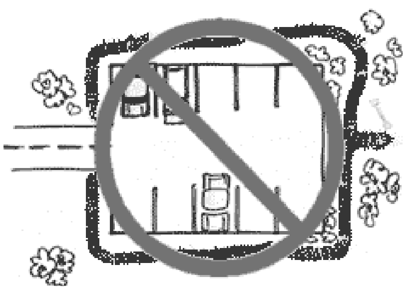
In the past, many groups of individuals in Ontario have been vastly under-represented among Ontario trail users. These groups include women, families with young children, older adults, people with disabilities, and certain cultural groups, to name just a few. Clearly, the way that trails have been traditionally developed, through formalized recognition of ad hoc travel pathways, does not address the needs of a large sector of our population. **It is essential that designers recognize the continuum of abilities among all trail users**. Trail design based on the philosophy of universal design will make future trail development a "best practice" for ensuring that all Ontarians have access to the many benefits of trail use. Trails, and associated facilities and services, which are developed using a universal design philosophy are much more successful in enabling all individuals to participate and ensuring the social and economic sustainability of the trail.

The benefits of universally designed trails include:

- Creation of diverse trail experiences, from wilderness to highly urbanized settings.
- Increased diversity among trail users.
- Increased trail use among people with different abilities for trails.
- Increased social sustainability of the trail because of more diverse use.
- Increased economic sustainability of the trail because of increased social sustainability.
- Protection of the trail environment by enabling all trail users to stay on the prepared tread.

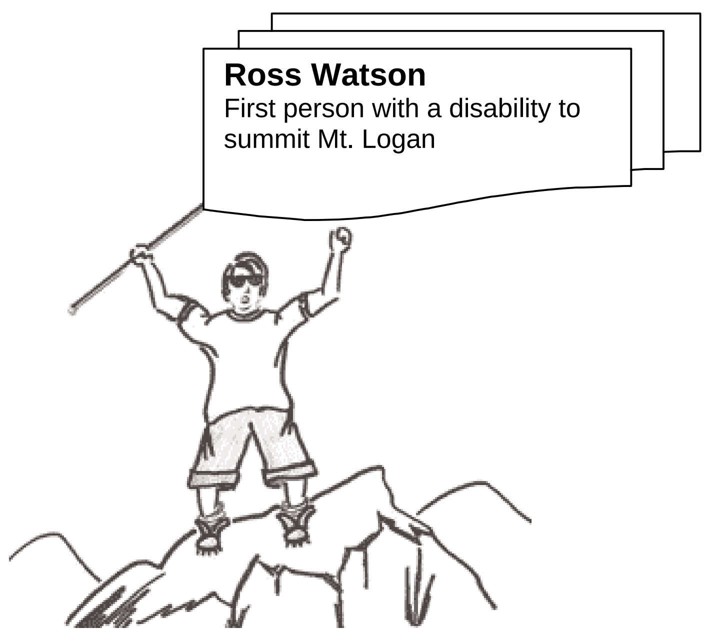
How does universal design apply to trails?

Recreation trails should provide all users with access to the same range of trail experiences. This means that trails should be designed to reach destinations or points of interest and travel through various environments. **Avoid developing "a trail with no reason"**, such as a very short trail suitable for very young children that doesn't have a destination or reason for the trail to exist. Providing access to a wide range of potential trail users is best achieved by providing trail information in multiple formats and by minimizing grade, cross slope, barriers, and the presence of surfaces that are soft or unstable.



In the past, many "accessible" recreation trails were either confined to urban areas or designed to be very short, and have little grade or cross slope and a wide, paved surface. Typically these trails made a loop around or near the parking lot or access point, or were adjacent to a picnic area or nature centre. In rural areas, individuals looking for a short, easy stroll, such as travellers who need to stretch after driving long distances, often enjoy these trails. In urban areas, these types of trails are often enjoyed at lunchtime by workers in the immediate area. Although these types of trails may meet the needs of some users, they usually do not provide the complete trail experience available in the area or over the total length of the trail. It is important that trails be designed so that all potential users can access and experience the full range of environments and experiences available.

It is critical that designers recognize that people with and without disabilities can and do use all types of trails. Some people, with and without disabilities, choose to travel on extreme trails, such as to the summit of Mt. Logan, Canada's highest peak. Others rarely, if ever, venture off of the sidewalk. Therefore, trail designers should keep in mind that some people with disabilities will always be able and interested in using a trail regardless of its exact design specifications.



Any trail intended for pedestrian or human-powered use should be designed, constructed and maintained using these guidelines and best practices. Ensuring that trails follow these guidelines will optimize trail sustainability and enable trail use by all those travelling under human power, including people of different ages or abilities, and those who use devices such as strollers, wagons, crutches or wheelchairs. Trails that are not designed for human-powered use, such as single-user mountain bicycling, horseback riding, or off highway vehicle trails, are not addressed by these guidelines. Nevertheless, they should be designed to provide access to permitted trail users of all abilities. For example, a horseback-riding trail should ensure that the trail and all provided facilities can be used by equestrians with and without disabilities.

Trail designers and builders should always strive to design, construct and maintain their trail according to the principles of universal and sustainable design. However, in situations where it is not feasible to meet all of these guidelines and best practices through the full length of a trail, the trail should be designed and constructed to comply to the greatest extent possible. Keep the sections that do not fully comply with these guidelines as short and infrequent as possible. **The more that trail conditions vary from these guidelines, the less sustainable the trail will be and the larger the proportion of people who will not have access to the trail experience**.

For example:

- The trail should be free of constructed barriers, and natural barriers should be removed if feasible (that is, if the barrier can be removed with the available resources and without damaging a significant natural element of the environment).
- If trail grade must exceed 10 percent, the steep segment should be as short as possible and the remainder of the trail should comply with the recommendations.
- If trail cross slope must exceed 5 percent, the steep segment should be as short as possible and the remainder of the trail should comply with the recommendations.
- Provide level rest intervals regularly (e.g., 30 metres or 100 feet) on sections of trail with a grade exceeding 5 percent.

- If the trail travels along a cliff, and a drop-off creates a tread width less than 1.0 metre (3 feet), the narrow section should be made as wide as possible and the length of the narrow section should be minimized.
- Soft surfaces on the trail tread should be stabilized, supplemented or replaced to enhance access for users of all abilities, discourage users from creating ad hoc trails on more stable surfaces and minimize the erosive damage resulting from trail use.

How do universal design trails differ?

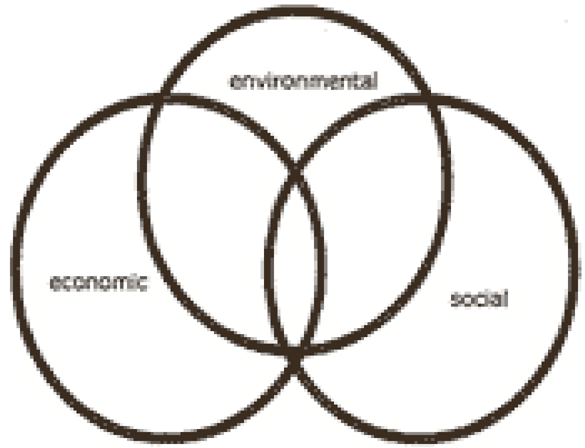
Universal design trails differ from other trails in many ways. In most cases, the difference is in the spectrum of users who enjoy the trail. A universal design trail can be used by a higher proportion of the population, which makes the benefits of trail use more broadly available. **Diversity among trail users is a hallmark of universal design trails**. Trail users represent a broad spectrum of people, from different age groups, both genders and a variety of cultures.

It is also important to recognize that **universal design trails differ from those that have traditionally been labelled "accessible" or "barrier free"**. An "accessible" trail is one that complies with legal standards for access by people with disabilities. The standards that will be developed for trails through the Accessibility for Ontarians with Disabilities Act (2005) are one example of legal standards against which a trail can be judged as either "accessible" or "not accessible".

Trails that are "barrier free" may or may not comply with accessibility standards but they are generally free of obstacles, barriers or changes in level that would make access difficult for those using crutches, canes or wheeled forms of mobility (e.g., strollers, wheelchairs, scooters). In contrast to "accessible" or "barrier free" trails, **a universal design trail recognizes that each trail user will have different abilities** and that some people (such as those who are unable to go outside) may not have access to the trail experience. **Universal design strives to minimize**, **to the greatest extent possible**, **the proportion of potential trail users who cannot access the trail**.

Sustainability

What is sustainability?



"Sustainability is an approach to decision making that incorporates the interconnections and impacts of economic, social and environmental factors on the quality of life of today's and future generations. It is a dynamic and evolving notion, and as a process, it strives to be participatory, transparent, equitable, informed, and accountable."[14]

There are **three key components of sustainability**:

- **Environmental sustainability**.
  Meeting the needs of the present, without compromising the ability of future generations to meet their needs[15]. Long-term maintenance of ecosystem components and functions for future generations[16]. For trails, providing trail users with access to the environment without compromising the ability of the environment to survive for the benefit and use of future generations. Your local Conservation Authority is a valuable resource for information about the environmental sustainability of your trail and the surrounding environment.

- **Economic sustainability**.
  Being able to meet current and future needs using only the "interest" on our investments. The original "capital" or resources are not consumed[17]. For trails, being able to maintain the trail using the resources readily available from or for the trail.

- **Social sustainability**.
  The ability of a community, through a combination of individual and community capacity, to maintain and build on its own resources and to prevent and/or address problems in the future. Social sustainability is built on the principles of equity, social inclusion and interaction, security, and adaptability[18]. Trails are socially sustainable when they are enjoyed and supported by a large, diverse proportion of the community.

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[14] Sustainable Toronto. Defining Sustainability. [On-line] Retrieved 31 July 2006 from http://www.utoronto.ca/envstudy/sustainabletoronto/whoweare.htm
[15] FAO/Netherlands International Conference. Water for Food and Ecosystems, Glossary. [On-line] Retrieved 31 July 2006 from http://www.fao.org/ag/wfe2005/glossary_en.htm
[16]ENTRIX. Glossary. [On-line] Retrieved 31 July 2006 from http://www.entrix.com/resources/glossary.aspx
[17] Government of Canada. Sustainable Development. [On-line] Retrieved 31 July 2006 http://canadianeconomy.gc.ca/english/economy/sustainable_development.html
[18] City of Vancouver. Definition of Social Sustainability. [On-line] Retrieved 31 July 2006 from http://vancouver.ca/ctyclerk/cclerk/20050524/documents/p1.pdf

The concept of **sustainability challenges us to think in new ways**. No longer can sustainability be considered only in terms of environmental impact. We must also think in terms of economic and social sustainability. Essentially, accepting **the goal of sustainability requires that we develop a new perspective on what we do and what we, as a community, want to achieve**. It requires us to think about our issues and challenges in **a new light, focusing first and foremost on the interconnectedness of environmental, economic and social issues**.

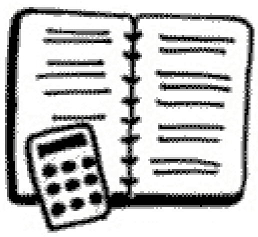
Efforts based on the concept of sustainability recognize that **environmental, economic and social issues are strongly intertwined** and that achieving any one without the others is not possible. We must consider not only how an issue will affect our environment, but also how it will affect us economically and how it will influence our society. **Sustainability stresses co-operation** rather than competition and the promotion of our personal "agenda". **Creating a truly sustainable community requires the co-operation and active involvement of all sectors of society**, including governments, leaders, businesses, not-for-profit organizations and community members.

How does sustainability apply to trails?

Based on the above definition, how does the concept of sustainability apply to trails? **Trail sustainability is a process of trail design, construction and maintenance that seeks to maximize the probability that the trail can be maintained over the long term**. Although it is often assumed that sustainable design relates to environmental sustainability, it is important to recognize that trails must also be sustainable from the economic and social perspectives.

An environmentally sustainable trail is one that will be compatible with the natural environment over the long term. Trails that experience on-going erosion are examples of trails that are not environmentally sustainable. The choice of construction and maintenance techniques can also influence the environmental sustainability of a trail. For example, a bridge built with pressure treated wood may leach toxic chemicals into the surrounding environment if the wood is not properly treated and physically separated from the adjacent soil.

Economic sustainability refers to the ability of a trail to support its own costs. For example, a cross-country ski trail that attracts a large number of fee-paying users will be able to generate the revenue necessary for trail maintenance and snow grooming. If the trail requires a constant infusion of significant funds, the long-term economic sustainability will be more difficult to predict. In general, **the economic sustainability of a trail is closely linked to its social sustainability**. Trails that are supported and used by a larger proportion of the population are generally more likely to generate sufficient revenue for on-going operations and maintenance. However, **economic sustainability is also linked to environmental sustainability because trails that are not compatible with the surrounding environment are more difficult, and therefore more costly, to maintain**.



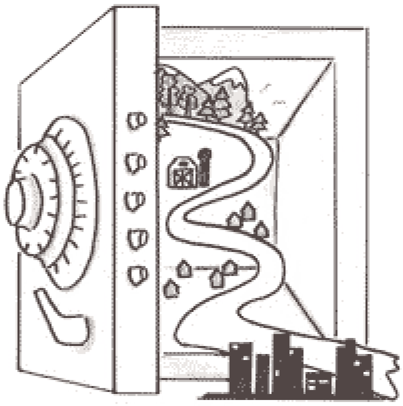
Social sustainability is determined by the community response to the trail. A trail that is championed by one dedicated person may be quickly abandoned if that person moves or loses interest. In contrast, trails that are enjoyed by a large proportion of the local population will likely have continued support over the long-term.

The type and scope of techniques that will be utilized in developing a sustainable trail will vary tremendously. Each trail will be located within a specific type of environment, have available specific economic resources and will be socially supported by a specific community. Based on these unique features, the sustainability strategy most suitable for each trail can be developed.

What are the benefits of trail sustainability?

Sustainability must be at the core of the Ontario trail system. Trails are costly to build and even more costly to maintain. **Only a small proportion of the "costs" associated with trails are monetary**. All of the resources needed to provide trail opportunities, such as land, volunteers, trail organizations, and maps or web sites, are extremely limited. **Trails that are not sustainable cost too much, in terms of damage to the environment, loss of community support and the waste of volunteer time, expertise and effort**. We cannot afford to invest our scarce resources in the creation of trails that are "here today and gone tomorrow".

Environmentally sustainable trails allow us to **use our scarce natural environments more effectively**. At first glance, it may seem that natural (particularly rural and remote) environments are plentiful in Ontario. While it is true that those environments cover much of Ontario, it is also true that they are relatively inaccessible to most residents and visitors, at least for use on a daily or weekly basis. Provincial legislation protecting areas such as the Bruce Trail, Oak Ridges Moraine, and southern Ontario "Greenbelt" will do much to preserve our most precious natural areas.



However, even paved trails in the heart of urban areas, such as Toronto's Martin Goodman Trail, are a scarce and precious resource that must be protected. Remember the reasons that trails are built. Trails are designed to bring us to or through an environment. **Whether the environment is remote and untouched or highly developed, the trail must not fundamentally alter the experience of the environment for trail users**. Environmentally sustainable trails allow us to experience all of our many unique and richly varied environments in a way that allows those environments to be preserved and protected for generations to come.

Socially sustainable trails allow communities to gain and maintain a vested interest in the health of the trail experience and trail environment. Communities that believe in the benefits of a trail will work harder to maintain, protect and enhance the opportunities that the trail provides. Research indicates that socially sustainable trails also have benefits for communities at large, beyond the immediate trail users. For example, the presence of a frequently used trail can enhance the safety of a neighbourhood[19] and crime can be prevented through appropriate design of the built environment[20]. Trails have also been shown to increase interaction between neighbours, promote acceptance of diversity and decrease social isolation.

Socially sustainable trails are also more likely to be economically sustainable. Broader community support translates into more volunteers helping with the trail, who spend more time and effort on trail activities, and more people donating more money to ensure the trail's long-term viability. The economic sustainability of a trail is also closely linked to its environmental sustainability. Trails that are designed to fit within and complement the surrounding environment require fewer resources for construction and maintenance. By minimizing the resources needed to provide trail opportunities, and maximizing the benefits of trails for all Ontarians, the network of trail opportunities across Ontario will be not only sustainable but also expandable into the future.

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[19] Hike Ontario. Benefits of Trails. [On-line] Retrieved 31 July 2006 from http://www.hikeontario.com/benefits/beneftisoftrails.htm

[20] Crime Prevention Through Environmental Design - Ontario. Welcome to CPTED Ontario. [On-line] Retrieved 31 July 2006 from http://www.cptedontario.ca.

Modification of Existing Trails

The majority of existing trails in Ontario were never designed or constructed for the purposes of sustainability and universal design. As stated earlier, most trails developed from historic paths of travel or routes opened for other purposes (e.g., logging). Despite the apparent lack of planning, many trails are sustainable and universally designed. The "trick" is to know which trail is which.

Is your trail environmentally sustainable?

Is your trail economically sustainable?

Is your trail socially sustainable?

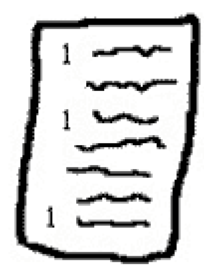
Is your trail universally designed?

In keeping with the vision of the Ontario Trails Strategy[21], over the long term (10 to 20 years) **the goal should be to maximize the sustainability and universal design of all trails in Ontario**. This can best be achieved by developing a realistic transition plan designed to start "where the trail is at" and move towards the desired goals for sustainability and universal design. The development of an effective and appropriate transition plan can be achieved through the following steps:

1. **Assess the existing trail conditions**.
   Determine whether the trail currently complies with the "best practices" for sustainability and universal design. Rely on objective measurements of the on-trail conditions, not the subjective opinions of key trail workers or trail users. Refer to Appendix G for additional information on trail assessment.

2. **Analyze the assessment data**.
   Systematically review the assessment data and compare it to the information provided in these "best practices". Identify areas where the trail already meets these "best practices" as well as those areas that have less sustainability or universal design than desired.

3. **Prioritize the desired changes**.
   Review all of the areas that have been identified as needing enhancements related to sustainability or universal design. Determine the priority order for making the changes based on:
   1) Ensuring environmental sustainability.
   2) Increasing universal design.
   3) Enhancing economic and social sustainability.



[21] Ontario Ministry of Health Promotion. (2005) Active 2010: Ontario Trails Strategy. Toronto: Author.

4. **Develop a transition plan**.
   Create a long-term plan (e.g., 10 to 20 years) for moving forward with all of the priority changes. Make sure that the plan is realistic in terms of the timeline and resources required. The plan should also be fairly detailed in relation to who will be responsible for overseeing the plan implementation. Include in the plan the efforts that will be required to acquire needed materials, resources or financial support.

The following are a few quick and easy “tricks of the trade” to enhance the sustainability or universal design of existing trails.

- **Provide trail users with accurate information about the on-trail conditions**.
  The social and economic sustainability of existing trails can be greatly enhanced by developing public support for the trail. The more people that are able to use and enjoy the trail, the more public support will grow. Encourage safe, responsible and enjoyable use of the trail by enabling all trail users to obtain accurate information about the existing conditions on the trail so that each user can make an informed decision about whether the trail, in its current condition, meet her/his interests and abilities.

- **Stabilize soft or eroded surfaces**.
  Mix needed components into the soil to balance the sand, silt and clay content or use “human-made” stabilization materials and techniques.

- **Clear vegetation from the trail corridor**.
  Clear foliage and vegetation from on and above the trail tread to the recommended buffer zone dimensions. Cut branches and stems at the collar and flush with the trail surface.

- **Look for opportunities to reroute trails that do not follow the contours of the land**.
  Rerouting a trail requires a major investment of time and effort and should not be undertaken lightly. However, look for naturally occurring opportunities to improve the trail alignment (e.g., flooding of the existing trail).

- **Improve through maintenance and repair**.
  When performing maintenance and repair activities, take every opportunity to enhance the sustainability and universal design of the trail, structure or facility.

Always construct or install structures and facilities designed to be accessible.
Experienced trail users of all abilities will have their own “tricks” for travelling along a trail, even if it doesn’t meet the standards of “accessibility” that will be required by the Accessibility for Ontarians with a Disability Act (AODA 2005). Ensure that when trail users arrive at a facility that it is available for their use, by replacing existing facilities that need to be replaced with a design that meets accessibility requirements.

Guidelines for Trail Design

"The ideal trail is . . .
seamless with the outdoor environment"[22].

Trail design is the foundation of all best practices related to trail development and operation. Ontario's best practices for trails are based on the principles of sustainable and universal design (Sustainable and Universal Design). **A well-designed trail can always be improved** if the quality of trail construction or maintenance is less than desired. In contrast, a poorly designed trail will forever be a nightmare of construction, maintenance and user concerns. **Although the time spent designing a trail is only a tiny, tiny fraction of the time that the trail will be used, it is by far and away the most critically important time.**

It is not possible to specify one set of design guidelines that would be optimal for every type of trail or even every trail of a particular type. For example, the appropriate design guidelines for a hiking trail will be different from a trail that provides hiking and cycling. Similarly, a hiking trail in an urban environment will be different from a hiking trail in a rural environment and both will differ from a hiking trail in a remote, wilderness environment. Two hiking trails may also be different from each other because one is more heavily used, even if they are both in the same environment. **Given the need for, and many benefits of, variation between trail experiences and environments, the design guidelines provided here are intended only as the recommended minimum**.

For most trails in Ontario, these guidelines will be sufficient on their own. **The purpose of these guidelines is to provide specific information on the minimum trail characteristics so that all Ontario trails will be based on the principles of sustainability and universal design**. There is no requirement for any trail to conform only to these guidelines. For many trails, other guidelines may apply or those involved in the trail may feel that additional guidelines are required. The guidelines specified here for trail design are provided within the following sections:

- Understanding the Trail.
- Trail Layout.
- Slope.
- Tread.
- Clear Corridor.

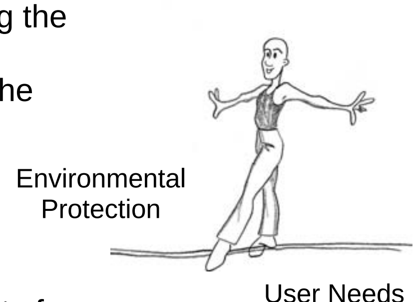
[22] Beers, D and Knapp, K. (In press). Best Management Practices for Trail Layout and Design. Sacramento: California Department of Parks and Recreation.

Understanding the Trail

In order to fully understand the trail that will be created, it is essential that the designer **understand both the environment** in which the trail will be located **and the users** who will be permitted on the trail. The guidelines for understanding the trail are:

1. **Design from an in-depth understanding of the natural environment**.
   Ensure that the trail designer has a very detailed understanding of the trail environment, throughout all seasons of the year. **Be sure that you know the landscape very well**. Look for viewpoints, water problems, steep terrain, etc. **A visit to the trail environment in the Spring is recommended**, because visibility (no leaves on the trees) and water flow (snow melt, Spring rain) are maximized, making it relatively easy to determine natural drainage patterns, control points and the contours of the land.

2. **Balance the demands of conservation, recreation and transportation**.
   Trails do not belong "just anywhere". Consider the need or desire for recreation or transportation in relation to preserving and protecting the natural environment. In some areas, it may not be possible to build a trail without significantly altering the natural environment. Changes from trail construction and use can be related to animal travel and behaviour patterns as well as the flora and natural features of the area. In some areas, the most sustainable course of action may be to not build a trail. Contact your local Conservation Authority for assistance when you first start to plan and designing your trail, particularly if the trail will be on property connected to a body of water (e.g., wetland, stream, shoreline) or prone to seasonal flooding.



3. **Encourage variation in the trail experience**.
   Create a trail that reflects the varied needs of users, the varied natural landscape underfoot and the widely shared desire for varied trail experiences.

4. **Protect the natural environment around the trail**.
   Ensure that the environment is protected to the greatest extent possible and that trail construction, maintenance and/or use will not have a permanent and substantial negative impact on the environment. **Done well, a trail disturbs the natural setting very little**. While it may seem intuitive to protect the "wilderness" when building "back-country" trails in remote areas, environmental protection is just as important for trails in urban, suburban or rural environments. Resources for building trails are precious and few.

5. **Preserve and promote important elements**.
   Preserve and promote natural elements including geologic, scenic, wildlife and historic features. The most important priority in new trail design involves selecting the **most suitable trail route that encompasses the important features of the site and yet minimizes environmental impacts** from trail use. Recognize that while important natural elements create great interest for trail users, in some cases they also need protection from trail use. Work closely with experts to select an appropriate and sustainable trail location. Use short side trails so that trail users can access important elements. Completely bypassing an important natural element but keeping the trail near to its location will only encourage trail users to bushwhack off the trail tread.

6. **Ensure that all necessary permissions are obtained**.
   Environmental permissions will be required from the landowner, Conservation Authority and often the local office of the Ministry of Natural Resources. Near watercourses, additional permits will be required. These groups should be brought into the trail planning process at the earliest stage and should be kept actively informed as plans for the trail progress.

7. **Consider the interests and abilities of all potential users**.
   From the earliest stages, consider the needs and abilities of all permitted trail users. For optimal economic and social sustainability, the experience that the trail will provide should be readily available to all potential trail users who have the knowledge, skill and expertise required by the trail environment. Involving all current and potential users early on in the planning and design phase is the key to designing a trail that can be enjoyed by a broad spectrum of people. **Understand how people will be moving on the trail and how their skill and experience may vary.** Trail users could be pedestrians, runners, joggers, hikers, cyclists (both mountain and road), skateboarders, equestrians, in-line skaters, cross-country skiers, snowshoers or people using baby movers (carriages, strollers, joggers, etc.), and many, many others. Some trail users will be experienced, others inexperienced. Some will be physically fit, others will be less fit. Some trail users want to enjoy the natural environment at a leisurely pace. Others want a good “work out”, and still others want to “get away from it all”. **Experienced trail designers will recognize the wide range of potential trail users and keep their needs in mind** throughout the design process. They will also pay particular attention to the needs of those who may be inexperienced or less skilled.

Table 2: Consider the Range of Abilities Among Hiking/Walking Trail Users

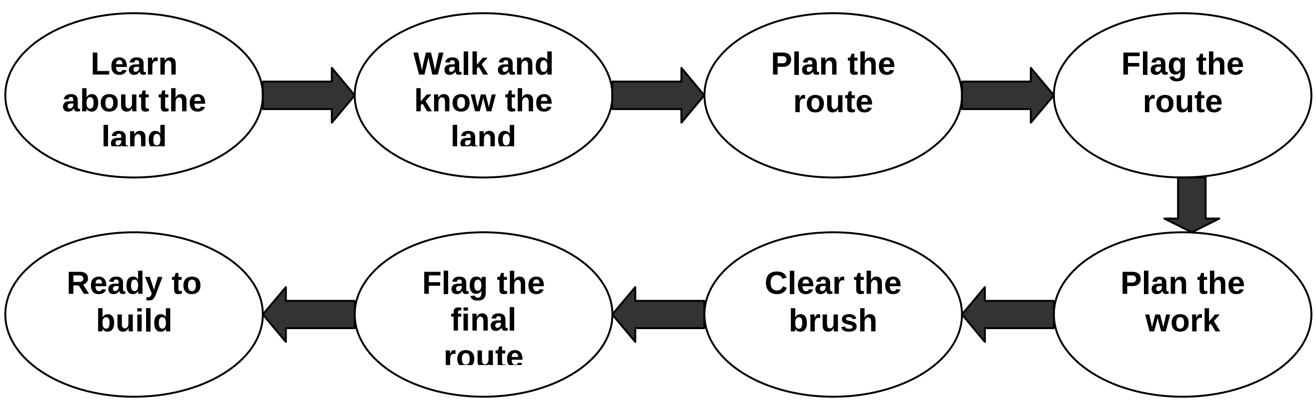
To understand the abilities of all potential trail users, consider how females within each box would be able to enjoy the trail. **Repeat the consideration for males**, and **then go on to look at other permitted users** (e.g., cyclists, in-line skaters, skiers).

	General Age Range					
Potential Differences in Ability	**< 5**	**5-12**	**13-19**	**20-45**	**46-65**	**> 65**
Normal weight / Overweight or obese						
Cultural background and beliefs						
Religious background and beliefs						
Written language / literacy						
Balance / Agility / Coordination						
Endurance (physical, psychological)						
Mobility with wheels (e.g., stroller, wheelchair, scooter)						
Hearing or Vision						
Behaviour consistency / Control						
Social skills / Interpersonal skills						
Thinking skills / Cognition / Memory						

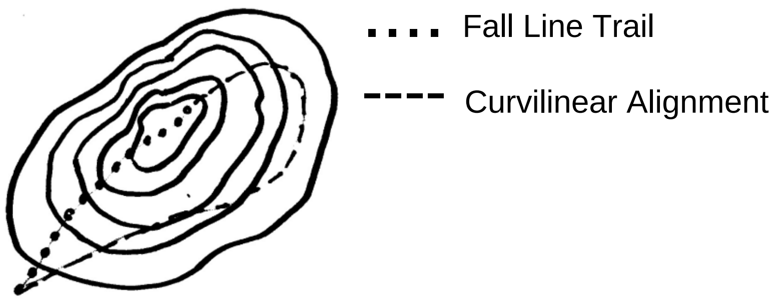
Trail Layout

8. **Design from knowledge and experience**.
Ensure that the trail designer has extensive knowledge and experience in trail, universal and sustainable design and construction. Trail designers and builders will look at the trail from different points of view. Make sure both the design and construction aspects are considered throughout the design process. Experience in sustainable trail design is particularly important.

9. **Follow the process of sustainable trail design**.
Each trail is unique, but the same steps are used to design all sustainable trails. Consider the unique aspects of each trail and environment as you complete the following steps:
Identify the need for a trail.
Know who the trail users will be.
Review of existing sources of environmental information.
Maintain the natural drainage patterns of the landscape.
Identify major control points.
Determine the maximum sustainable grade.
Complete field inspections "on the ground".
Identify minor and designed control points.
Determine the final trail grades.
Flag initial trail alignment.
Develop work logs and cost estimates.
Brush the general trail corridor and clear it of potential hazards.
Flag the final trail alignment.



10. **Follow a curvilinear alignment**.



Design the trail so that it closely follows each curve in the natural terrain. Natural drainage patterns should be maintained at all times. A curvilinear alignment (also called a contour-designed trail) allows water to sheet across the trail as part of the natural environment so that water does not accumulate in larger volumes or particular areas (which will cause erosion). If a curvilinear alignment is used, drainage structures to manage water flow on the trail tread (e.g., waterbars, swales, drain dips) will not be required. **Directing or concentrating water flow**, either on or off of the trail, **always has a significant negative impact** on the health of the surrounding environment.

11. **Maintain natural drainage patterns and avoid flat areas**.

Protecting natural drainage patterns, **ensuring that watercourses flow freely and maintaining sheet drainage across the trail tread must be a high priority** for all trails. Trail builders are often mistakenly attracted to flat terrain because it is often much easier to build trails in these locations. It is also mistakenly assumed that a trail in flat terrain will be more accessible to trail users of different abilities. Unfortunately, trails in flat terrain usually retain water making the tread difficult to sustain. Always choose a trail route that keeps the tread slightly higher than a portion of the surrounding terrain.

12. **Avoid "the way we've always done it"**.

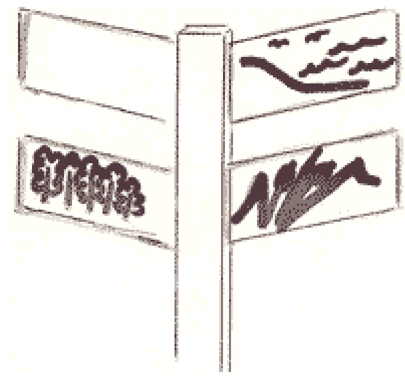
Many trail designers (both professional and volunteer) have "been doing this for 30 years". Unfortunately, our knowledge of sustainable trail design is relatively new (within the last 10 years or so). To a large extent we are still learning, but what we do know is that "**the way it was done before" is often not sustainable**. It is an unfortunate and well-documented fact that trails designed and built with methods developed in the 1970's and 1980's seldom create environmentally, economically and socially sustainable trails.

13. **Determine the location of the trail on the landscape through a careful examination of the trail environment**.
It is often difficult to determine how sensitive an environment will be in relation to trail development. These decisions should always be based upon expert knowledge, and where questions remain unanswered, the benefit of the doubt should be in favour of the environment. **A common mistake is to locate the trail where it is easiest to construct**. Unfortunately, the easiest path of construction is seldom the most appropriate location in terms of environmental sustainability. **Take advantage of sunny, south facing slopes** that more quickly lose their snow load and dry after heavy rains. Vegetation is often less dense on sunny, drier slopes, making construction and long-term maintenance easier. **When designing winter-use trails** (e.g., ski, snow machine), **take advantage of shaded, north facing slopes**. North-facing slopes and shaded areas are also desirable in areas that get really hot in the summer.

14. **Utilize the natural topography and geology of the land**.
Follow the natural contours of the land and respect surrounding landforms. Choose locations where the soil and parent geology are most suitable to trail sustainability. Use the topography to your advantage to minimize environmental impact and trail maintenance while enhancing the user experience. **Walk the trail route prior to construction**. This is a key step in creating a trail that is useful and sustainable over the long term. Before beginning construction, walk the trail in both directions; let the landscape guide key decisions such as the location of bridges, signage and any amenities. Read the landscape and "**let the earth tell you where the trail should be built**"[23.] Topographic maps and aerial photos are useful but they are no substitute for eyes on the ground.

15. **Build on "Crime Prevention Through Environmental Design" principles**.
CPTED[24] is a pro-active approach to crime prevention through appropriate environmental design. The four principles of CPTED are natural surveillance (maximizing natural visibility), natural access control (e.g., using landscaping to make access to out-of-bounds areas difficult), territorial reinforcement (clearly distinguishing public and private space), and maintenance (continue use of a space for its intended purpose).

[23] Parker, T.S. (2004) Natural Surface Trails by Design Physical and Human Design Essentials of Sustainable, Enjoyable Trails. Boulder, CO: Natureshape.
[24] Crime Prevention Through Environmental Design - Ontario. Welcome to CPTED Ontario. [On-line] Retrieved 31 July 2006 from http://www.cptedontario.ca.



16. **Identify major and minor control points**.
Control points are features of the natural environment that "control" or influence the movement of trail users. **All of the control points within the general environment of the trail must be clearly identified**. Control points may be features that attract trail users, such as a spectacular vista or other points of interest. They may also be features that trail users must avoid, such as a cliff or noxious or endangered plants or animals. Control points may also be created by construction issues, such as lakes, rivers, roads, or soils that will easily erode or are poorly drained. Control points act as the "anchors" for the general trail layout.

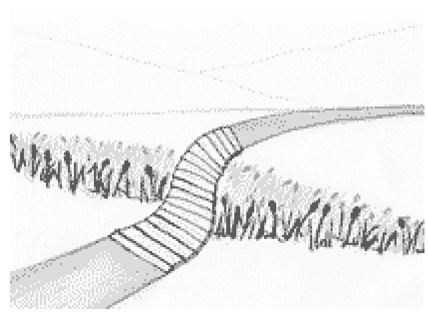
17. **Complete an environmental assessment**.
Whether a formal environmental assessment is required will vary greatly, depending on location and land ownership (public versus private). However, even where a formal assessment is not required, the organization developing the trail should complete an informal assessment. **The assessment should focus on identifying key features of the environment that should either be featured on or protected from the trail**. It is also important to note the type of environment on and around the proposed trail route in order to determine whether placement of the trail in that location is appropriate and sustainable.

18. **Work with the landowner to identify the trail corridor**.
Respect private property. Remember, the trail only exists through the grace and goodwill of the property owner. Work closely with the landowner to identify the corridor in which the trail can be located. The layout of the actual tread location within that larger corridor depends on the environmental control points.

19. **Focus activity within the desired trail corridor**.
Design and construct the trail to discourage the creation of side trails that widen the corridor of impact. Trail users who wander off the prepared tread will cause environmental damage (e.g., trampling of vegetation and soils). **Ensure that the trail corridor is designed, constructed and maintained for the type and number of trail user**s. For example, horses will cause more wear to trail surfaces than hikers, and experienced hikers often have less impact than the general public. Widen the trail tread at places where trail users are likely to gather (e.g., vistas, top of a steep hill). Trails that are too narrow for the number of users, have an undefined or unclear tread, bypass a feature of interest, are difficult to negotiate (e.g., muddy, eroded or blocked by deadfall) or appear to take a route that is more difficult than necessary will encourage users to move onto the surrounding terrain, greatly increasing the environmental impact of the trail.

20. **Plan for "traffic" patterns on and off the trail**.
Clearly separate trails from vehicle traffic to increase user safety, enhance the trail experience and decrease snow removal and maintenance costs. Trails should always approach intersections at a 90-degree angle. **Maintaining clear sight lines is also very important, particularly at trail intersections or when approaching a section of trail that may contain a hazard for the user** (e.g., sharp bend on a steep downhill). Keep in mind that some trail users (e.g., those with limited hearing) will be relying solely on what they can see in order to understand and detect the movement of other trail users.

21. **Don't follow paths created by people or animals**.
People (and animals, in the case of game trails) don't naturally take the route that is optimal for preservation of the environment, or even the easiest or safest route. People naturally take the shortest route between two points, even when it is more difficult or even hazardous. Their choice of route is intended to "get places" and is rarely the optimal alignment for environmental sustainability.

22. **Avoid putting the trail tread through a wet environment**.

Wetlands and shorelines are delicate environments that are important habitats for many species of plants, fish, birds, amphibians, reptiles and small and large mammals. They are also attractive to people. It is natural that trail designers will want to provide users with access to these interesting natural habitats. Indeed, people will likely make their own trail to the water if an official trail is not provided. Unfortunately, trails constructed through wet environments have a much greater impact on the natural environment. They also are typically more difficult and costly to construct and maintain. For these reasons, try to **design the trail so it goes along the edge, but not actually through, the wet environment**. If going through the wet environment is essential, it is critically important that the trail be designed with vegetated strips between the trail and water feature, to avoid foot contact with the natural soil in wetlands, to keep users on the trail tread, to maintain natural water flow, and with spur trails to allow users to access the water feature. "Wetland Trail Design and Construction" is an excellent resource that should be consulted for any wetland trail work. It is free of charge and available online[25].

[25] Robert T. Steinholtz. Wetland Trail Design and Construction. [On-line] Retrieved 31 July 2006 from http://www.fhwa.dot.gov/environment/fspubs/01232833/index.htm

23. **Include water access points in all trail designs**.
Access to water is a very important consideration for all trails. Trail users need water to drink as well as water to keep them cool or refresh themselves. Even people who don't want to go into the water are naturally attracted to water features, such as streams, lakes, and rivers. For the sake of the environment adjacent to the trail, be sure to provide access to water features along the trail or trail users will create their own path.

24. **Design and locate bridges for all water crossings**.
A well-designed bridge looks like it belongs at the site. A good bridge should be simple, understated and appear to fit well into the natural environment. It should also be the minimum length required, be situated on stable banks, provide a level crossing and tread that is the same width as the rest of the trail. A bridge can change an ordinary trail into a more interesting experience. People will pause on the bridge to watch the water flow by and to look for wildlife. **Any bridge on any trail will almost certainly become, regardless of its size, a trail feature, a focal point, and a destination**. Bridges are also expensive and must be designed with appropriate load capacities. When in doubt, ask a qualified professional to design the bridges on your trail. Avoid relying on step stone crossings, Gadbury bridges (a lot split in half) or water fords. These direct-water crossings are dangerous for many users and the wet crossings have a continuously detrimental impact on the water feature with every passing user.

25. **Create a construction log and final flag line**.
The final tread location or the location and type of structures (e.g., bridge, retaining wall) along the trail should be determined during trail design. The designer should create a detailed construction log that can be used to guide the work of the construction crew.

26. **Consider the construction resources to be used**.
Each trail will be constructed using different people, equipment and materials. The actual construction techniques and resources available must be considered throughout the design process. Keeping the required construction methods well within the resources available (e.g., materials, skills of workers) is the only way to ensure that the trail will be constructed as the designer intended.

27. **Design for minimal maintenance**.
Ultimately, the most important factor in trail maintenance is the original trail design and alignment. Trails that will require on-going maintenance (e.g., cleaning waterbars, replacing corduroy) are not sustainable. Do not risk damage to the environment by designing trails that will require on-going maintenance (that may or may not be performed as needed). A well-designed trail is not only more pleasant to use, but it will also be easier to maintain.

28. **Avoid designing for trail designers**.
Typically, trail designers have extensive trail experience and they use trails much more frequently than most people. That makes them a "somewhat different breed" than the majority of trail users. Experienced trail volunteers also tend to be more fit and skilled than the average trail user. Make sure you consider the trail for a variety of viewpoints, not just those of very skilled and experienced people.

29. **Plan for and manage waste disposal**.
Littering and ineffective garbage and sewage disposal are major environmental concerns. Design trail facilities so that they encourage the proper disposal of all waste. Trash receptacles and recycling containers should not be provided at trailheads or along a trail unless the group managing the trail has the resources to monitor and empty the containers as required. Once these receptacles are full, the extra waste will blow or be distributed by animals throughout the trail environment. The management of human excrement must also be considered. Always encourage trail users to pack out what they brought in. Providing adequate and attractive toilets (compost toilets) at trail access points, that are regularly and effectively supplied and maintained, is the best way to ensure that human excrement will not be found near the trail.

Tread

Surface characteristics are used to define **the requirements for the tread on which users walk or ride**. Interestingly, the **requirements based on universal and sustainable design are identical in this case**. That is, both require a surface that will support the user, without being eroded or deformed.

Slip-resistance should be clearly distinguished from stability or support of the tread. Slip-resistance is a measure of the "stickiness" of the top of the surface. That is, **how much friction there is between the trail user's shoe or wheel and the top layer of the surface**. While universal design guidelines for the built environment require a surface that is slip-resistant, there is no slip-resistance requirement for recreation trails from either a sustainability or universal design perspective. **All trail users must be aware that outdoor surfaces can be slippery under any condition, from water or rain, vegetation, snow or ice**.

The trail tread can be made from any type of natural or human-made material. Trails in natural settings should use a tread material that is compatible with the environment and trail experience. The material used for the trail tread should be carefully selected, regardless of whether it is imported or occurs naturally on the trail route. **The choice of tread material should be based primarily on issues of environmental sustainability in conjunction with the demands that will be imposed by trail users**. There are a wide variety of environmentally sustainable products that can be used to stabilize either constructed materials (e.g., wood chips) or naturally occurring soils. The National Center on Accessibility[26] has a large database of trail tread products on its web site. Trail managers should carefully investigate the appropriateness of these products for their own trail environment, as they can vary dramatically in effectiveness depending on the local climate and materials used.

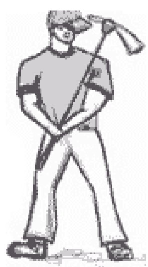
It is a commonly held myth that universal design standards require a paved trail surface. This is definitely not the case. Apart from high-use trails in urban areas, paved surfaces (e.g., asphalt, concrete, interlocking brick) have very limited use for Ontario trails. In fact, **paved trails in southern Ontario, where winter consists of almost continuous cycles of freeze and thaw, are particularly hard to maintain**. Under freeze-thaw conditions, paved surfaces quickly become inaccessible or unsafe due to cracks in the pavement, changes in level or excessive slopes.

[26] The National Center on Accessibility. Surfaces. [On-line] Retrieved 31 July 2006 from http://www.ncaonline.org/products/surfaces/index.shtml

In general, paved surfaces should not be considered compatible with rural or remote settings unless the purpose of the trail is to provide access for people using devices with small wheels (e.g., skateboards, in-line skates). If used in urban or suburban environments, **paved trails must be constructed in the same manner as roads and sidewalks** (i.e., excavated sub-base with drainage rock, compacted sub-surface materials) in order to ensure that they will be safe to use for more than a short period of time. Consider adding an unpaved shoulder beside paved trails to accommodate those trail users who prefer an unpaved surface.

30. **Plan to construct an appropriate trail tread**.

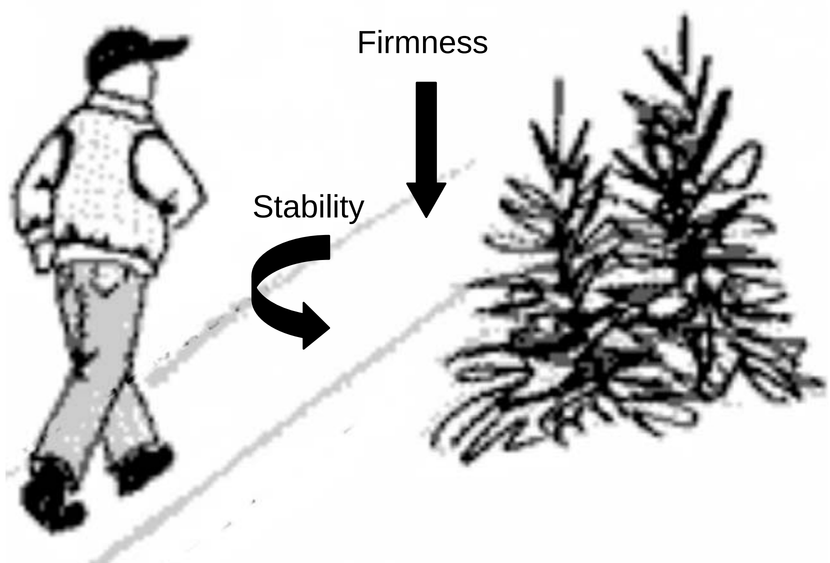
Every person or animal that moves through an environment will have an impact, positive and/or negative, on the natural ecosystem.



People often mistakenly believe that if they don't actually construct a trail tread, but instead just cut back a bit of vegetation so people can move more easily, that the trail will have minimal impact on the environment. In fact, quite the opposite is true. **The best way to have a trail "lie lightly on the land" is to ensure that the tread is designed and built to sustain the type and amount of intended use**. Trail users will go off the trail tread if it's too narrow or if the surface gets soft, muddy or is covered with obstacles. **Every single footprint off of a prepared trail tread increases the negative impact** of the trail on the surrounding natural environment.

31. **Ensure the tread will sustain the permitted use**.
Design the trail tread so that it will sustain both the type and amount of intended use. Each type of trail use (e.g., hiking, biking, equestrian, motorized) creates different challenges for tread sustainability. **Horses have a reputation for being "rototillers with stomachs"**, because they can easily "chew up" a wide variety of tread materials. However, hikers and trail users on wheels can also be responsible for tread degradation. When travelling downhill, the foot or wheel will compress and skid on the surface as the user works against gravity to control their descent. Carefully examine the existing material along the trail corridor to identify areas that can provide a sustainable tread. If the naturally occurring materials are not suitable, re-locate the tread or design a tread of imported materials. If existing soils are used, great care is required to determine the final trail route. Soil conditions can change dramatically and frequently, even within an environment that seems relatively homogeneous. **Soils that are ideally suited for a trail tread in one location, can be entirely different only 3 m or 5 m (10 or 16 feet) down the trail**. Have someone knowledgeable about local soil conditions identify the final trail route.

32. **Design a firm and stable surface**.
Firmness is the ability of a surface to resist downward pressure. A firm surface does not become pitted or indented under the weight of passing trail users. Paved surfaces are extremely firm, surfaces with a thick cover of organic material (duff) are moderately firm, and bog or unpacked snow surfaces are soft. **Stability is the ability of a surface to resist angled or rotating forces**. A stable surface does not shift or slide as trail users pass by. Wood chip, pea gravel and sand surfaces are notorious for being unstable. Where there are appropriate conditions, the naturally occurring soil may provide a firm and stable surface for trail users travelling on foot. It is more difficult to find naturally occurring surfaces that will be firm and stable for other human-powered trail users (e.g., bicyclists). **Ensuring the trail has a firm and stable surface will minimize the impact of trail use on the surrounding environment**. It will also promote the social sustainability of the trail, through enhanced user satisfaction, and enable users of different abilities to better access the trail.

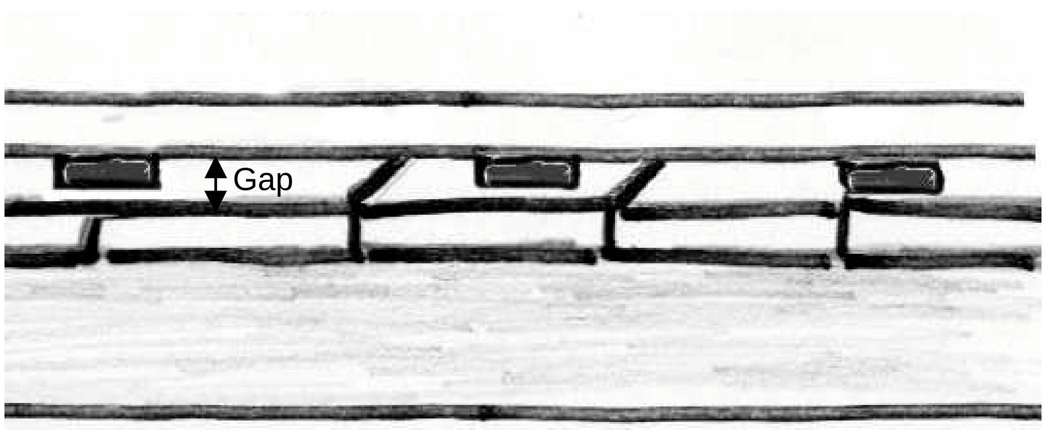


33. **Design a surface with minimal openings**.
Design the trail so that openings (e.g., gaps between wood planks, grates) are kept to a minimum. It is preferable to ensure sheet drainage across the tread rather than rely on openings for getting water flow off of the tread. Openings require more maintenance and are difficult for some trail users (e.g., those using crutches, canes or small wheels) to navigate. Minimize the number of openings in the trail tread. Where openings are required, place them in the buffer zone or design them to be no more than 1.5 cm (0.6 inches) in the direction of travel.

Table 3: Comparison of Trail Tread Guidelines to Other Recommendations

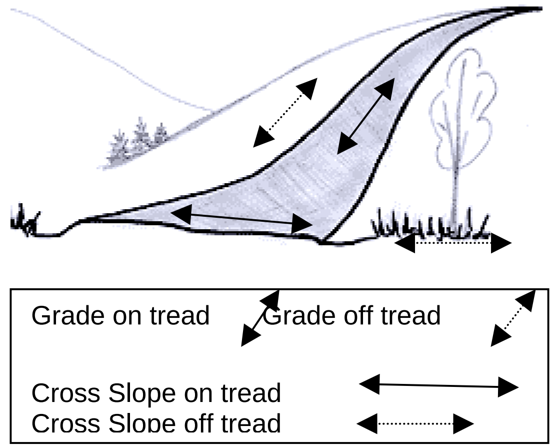
Characteristic[27]	Best Practice	Sustainable Design[28]	Universal Design[29]	Remote[30]
Surface				
Substance	**Firm & Stable**	Firm & Stable	Firm & Stable	---
Material	**Natural or Human-made**	Natural or Human-made	---	Natural
Openings (cm) (inches) [31]	**1.5 (0.6)**	---	1.25 (0.5)	---

34. **Provide edge protection where required for safety**.
Edge protection is neither a sustainability issue nor a universal design issue. **The decision to provide edge protection should be based on the safety of trail users**. Where edge protection is provided for safety purposes, the top of it should be at least 9 cm (3.5 inches or the width of one 2 x 4) above the trail tread. This is higher than what is often required in safety codes for the built environment, but it recognizes that many trail users ride on devices (e.g., mountain bikes) that are specifically designed to roll over small objects. If provided, **edge protection should be designed with gaps between the tread surface and edge protection** so that the drainage of water off the trail is not adversely affected.

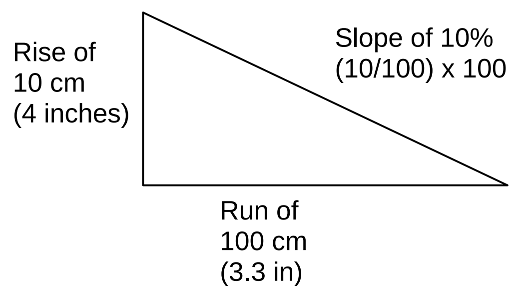


[27] Refer to Appendix A: Glossary of terms for definitions of each characteristic.
[28] British Columbia Ministry of Forests (2001). Recreation Trail Manual: Chapter 10.3 Trail Design. [On-line] Retrieved 31 july 2006 http://www.tsa.gov.bc.ca/publicrec/manual/chap10/chap10.htm
[29] Access Board. (1999). Final Report of the Outdoor Recreation Regulatory Negotiation Committee for Developed Outdoor Recreation Areas. Washington, DC: U.S. Architectural and Transportation Barriers Compliance Board. [On-line] Retrieved 31 July 2006 from www.access-board.gov.
[30] The Bruce Trail Association. (2001) Guide for Trail Workers. 3rd Edition. Hamilton: Author.
[31] Opening size is measured perpendicular or diagonal to the user's direction of travel.

Slope



What do you think of when you read the words "slope of the trail"? Most people immediately think of the uphill and downhill sections of the trail. However, there are actually two types of slope that are important for trails. **Grade is the slope of the trail parallel to the direction of user travel** (i.e., uphill and downhill), and **cross slope is the slope perpendicular to user travel** (i.e., from side to side). For each of the two slope directions there are also **two slope locations**; **on the tread and adjacent to the tread**. Altogether, there are a total of four slope components that will influence the sustainability and universality of the trail design. Many factors will influence the relationship between the four slope components. At the most extreme, the slope on the trail should not exceed one half of the slope on the terrain beside the tread[32]. However, in most environments the terrain, soils, climate and other factors will require the slope on the tread to be 1/3 or less of the slope that is found on the surrounding terrain.



The **percent slope is the ratio of the vertical change in the trail over a horizontal distance**. For example, a trail that rises 1 vertical metre for every 10 horizontal metres (33 feet) of trail would have a grade of 1/10 or 10%. Similarly, a trail tread that is 1 metre (3.3 feet) wide and has one side of the trail 3 cm (1.2 inches) higher than the other, would have a cross slope of 3%. For additional information on how to measure trail grade and cross slope, refer to Appendix G.

35. **Stay within the maximum slope for the trail**.
    The maximum slope for the trail will be determined by the maximum sustainable slope of the soil or parent material and the appropriate slope for trail users of all abilities. Each type of soil or parent material will be able to sustain a different maximum slope before environmental sustainability problems (e.g., erosion) occur. Over the length of the trail, the maximum sustainable slope may change many times, as soil or parent material composition changes. The maximum slope for the trail should never exceed the maximum sustainable slope of the soil. However, in some locations, the maximum slope of the trail will have to be less than the sustainable slope in order to create a trail that is safe for all permitted users.

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[32] International Mountain Bicycling Association. (2004) Trail Solutions: IMBA's Guide to Building Sweet Singletrack. Boulder, CO: Author.

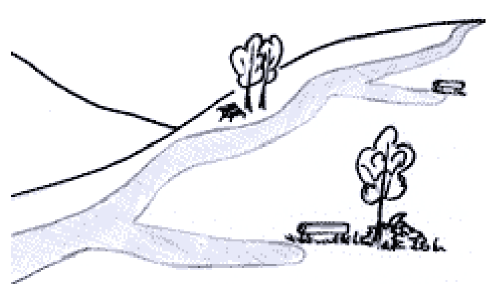
36. **Design for gradual slopes**.
Slopes (grade and cross slope) should be kept under 5% whenever possible. Slopes of up to 10% may be used when required by the topography or to maintain natural drainage patterns. Evaluate the impact on potential trail users of all abilities if a trail design with steeper slopes is being considered. Most trail users find slopes above 10% difficult, and many trail users find slopes above 5% that continue for long distances to be difficult. Steep or continuous cross slopes are particularly difficult for individuals using crutches and trail users who rely on wheels for mobility (e.g., children in wagons or strollers, in-line skaters, cyclists, people who use wheelchairs) because they are constantly pulled to the lower side of the tread.

Table 4: Perception of Trail Grades by Users with and without Disabilities

Percent Grade	People without Disabilities	People with Limited Mobility
0 to 2	Nearly level	Nearly level
3 to 5	Gently sloping	Sloping
5 to 8	Moderately sloping	Moderately steep
8 to 10	Moderately steep	Steep
10 to 15	Steep	Very steep
16 and greater	Very steep	Maximal effort required

37. **Design for the minimum tread cross slope required for drainage**.
The cross slope should be the minimum that ensures that water flows quickly off to the side of the tread. Typically, the **cross slope of the trail tread is an outslope** (i.e., the slope leads towards the downhill side of the trail). Cross slopes of **3% or less provide excellent drainage on paved surfaces**. **Most natural soil treads will drain properly with 5% to 8% cross slope**. Cross slopes of more than 8% are not recommended because they are very seldom required for drainage and they make use of the trail very difficult or unpleasant for most trail users.

38. **Provide level areas regularly when slopes are above 5%**.
Level areas, at least 2 metres (6.6 feet) in length and as wide as the trail, should be provide on or adjacent to the trail at intervals of no more than 20 metres (66 feet) whenever a trail tread slope (grade or cross slope) exceeds 5%. Long sections of trail that have continual, unchanging slopes greatly increase the physical stress of the trail on users. Design the tread so that there will be regular variations in grade and/or cross slope in areas where the slope(s) must exceed 5%.



39. **Design grades to be less than the tread cross slope**.
When the grade of the tread is steeper than the cross slope, sheet drainage across the tread will be re-directed along the trail tread. The greater the discrepancy between grade and cross slope, the greater the impact on natural drainage patterns.

40. **Avoid areas where there is minimal slope on the land adjacent to the tread**.
Trails through areas with minimal or no adjacent cross slope should be avoided whenever possible. In very flat areas it is extremely difficult to drain water off of the trail tread. **A water-saturated trail tread is highly susceptible to user impacts, soil compaction and erosion**.

41. **Minimize climbing turns and switchbacks**.
Climbing turns and switchbacks are most commonly used in steep terrain where the topography and lack of available land base does not permit more sustainable trail alignments. Whenever trail users can see that the trail abruptly reverses direction, there will be an almost irresistible temptation to "short cut". **Great care must be taken to camouflage the adjacent sections of trail** so they are not visible to trail users until they virtually arrive at the turn. This does not mean that climbing turns or switchbacks should never be built. However, revisions to the trail layout should be carefully considered and investigated as a first option, leaving the construction of a switchback (or climbing turn) as a much less attractive option to be pursued when other options are not available.

Table 5: Comparison of Slope Guidelines to Other Recommendations

Characteristic[33]	**Best Practice**	**Sustainable Design**[34]	**Universal Design**[35]	**Remote**[36]
Slope				
Grade (%: m[37]) on the tread	5 : any[37] 8 : 50 10 : 25	10 : any[37]	5 : any[37] 8 : 60 10 : 10	10 : any[37] 15 : with special[38]
Cross Slope (% : m) on the tread	5 : any[37] 8 : 10	5 : any[37] 8 : for drainage	2 : any[37] 5 : for drainage	Tread higher than side

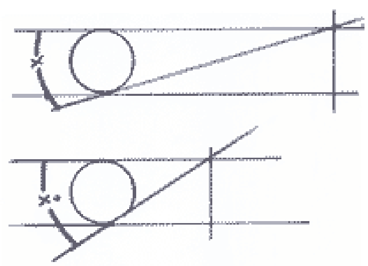
[33] Refer to Appendix A: Glossary of terms for definitions of each characteristic.
[34] British Columbia Ministry of Forests (2001). Recreation Trail Manual: Chapter 10.3 Trail Design. [On-line] Retrieved 31 july 2006 http://www.tsa.gov.bc.ca/publicrec/manual/chap10/chap10.htm
[35] Access Board. (1999). Final Report of the Outdoor Recreation Regulatory Negotiation Committee for Developed Outdoor Recreation Areas. Washington, DC: U.S. Architectural and Transportation Barriers Compliance Board. [On-line] Retrieved 31 July 2006 from www.access-board.gov.
[36] The Bruce Trail Association. (2001) Guide for Trail Workers. 3rd Edition. Hamilton: Author.
[37] Recommendations for grade and cross slope are given by the percentage slope and the length of continuous slope permitted. For example, "5 - any" indicates a grade of 5% can continue for any distance.
[38] Slopes above 10% are not recommended.

Changes in Level

Changes in level are locations where the height of the trail tread changes abruptly. Steps or a large, flat rock that trail users must step up onto are examples of changes in level that are commonly found on trails.

42. **Use sloped surfaces instead of changes in level**. Design trail treads to utilize gradually sloped or bevelled surfaces rather than abrupt changes in level with vertical surfaces. Abrupt changes in level are often a tripping hazard for those who are unable to see or are absorbed in the trail experience and not alert to the details of the tread.

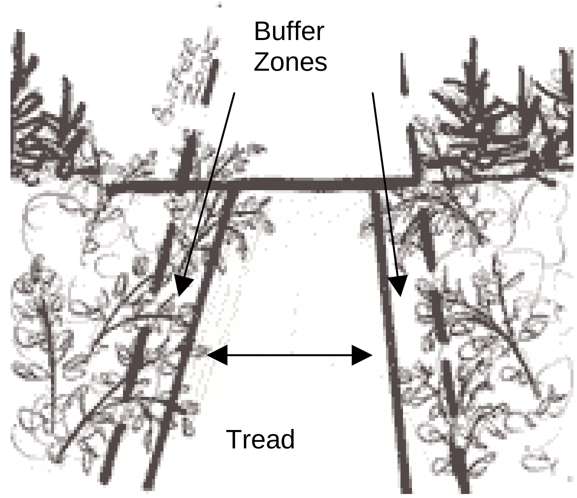
43. **Changes in level should comply with the tread slope requirements**. The slope created by a change in level is measured over a 0.6 m (2 feet) distance, which reflects the general size of the base of support for most trail users travelling by foot. The height of level changes should not require trail users to balance at an angle greater than the recommended tread slope when the base of support is straddled on and off of a change in level. For example, consider a rock in the trail tread that creates a change in level with a height of 6 cm (2.4 inches). If the rock is located on a level section of trail, the slope measured between on and off of the rock over a distance of 0.6 m would be equivalent to a grade of 10%. If an identical rock were located on a section of trail that had a prevailing grade of 5%, the angle that the trail user would have to negotiate would be 15% from the horizontal. Similarly, a rise in one side of the tread by 3 cm (1.2 inches) over the 0.6 m distance would be equivalent to a cross slope of 5%. That same change in level on a prevailing cross slope of 7% would require the trail user to negotiate a 12% cross slope.



44. **Design steps or ladders in the tread only where there is no other option**. Steps built to "traditional" standards require the user to balance on an angle of 25% (15 cm rise over 0.6 m distance). Such a dramatic tilt to the trail user's base of support is not recommended. Steps are also not recommended from a sustainability perspective, because they are expensive to construct and maintain. **According to the Bruce Trail Guide for Trail Workers, "Steps should only be considered after all other options have been evaluated."[39]**

[39] The Bruce Trail Association. (2001) Guide for Trail Workers. 3rd Edition. Hamilton: Author. pp. 39.

Clear Corridor



The clear trail corridor includes not only the trail tread, but also the space above the trail tread where trail users are expected to travel and an additional buffer zone that separates trail users from surrounding vegetation. **Ensuring that vegetation does not intrude on or above the trail tread is essential to the safety and enjoyment of trail users**. Keeping the vegetation away from trail users is also important for the health of the vegetation. Vegetation that hangs in the way or brushes the trail user is at risk of being arbitrary stripped or broken by annoyed trail users. This breaking of branches or stripping of foliage is rarely done in a way that is beneficial to the health of the vegetation. **Trails that are designed with an adequate buffer zone are rewarded with a healthier plant environment**.

45. **Design the trail corridor based on terrain and desired experience**.
    The optimal dimensions for the height and width of the tread and buffer zones will vary, depending on the environment in which the trail is located and the desired trail experience. Design the clear trail corridor so that users do not inadvertently contact the surrounding environment. Each type of terrain and experience (e.g., hiking, biking, equestrian, motorized) will have different width requirements.

46. **Ensure the tread is wide enough for all permitted users**.
    Unless a trail is rarely used or enforcement of one-way traffic is feasible, trails should be designed wide enough for two users to pass, without forcing people off of the prepared tread. **For a hiking trail, that means the constructed tread should be at least 1.0 m wide and the clear area above the tread should be at least 2 m high**. If narrower trails are built, wider passing spots should be provided at frequent intervals (50 m or less). A clear trail corridor of this size will be adequate for most trails that are maintained prior to each growing season. **Additional width should be provided as the speed of travel increases and on grades exceeding 5%** so that trail users will have adequate sight lines for their safety as well as the safety of others. **On trails that permit cross-country skiing, a minimum tread width of 3 m (10 feet)** should be provided so that skiers will be able to angle (herringbone, snowplow or side step) their skis as necessary for the terrain. Many trail volunteers think that clearing a wider tread is more damaging to the environment. That is definitely not true. People will walk side-by-side at every opportunity and vegetation will be damaged when they arbitrarily move or break branches to get through narrower corridors. Ensure that the vegetation in the trail environment stays as healthy as possible by appropriately trimming branches at the collar and removing vegetation within a corridor at least 1.0 m in width.

47. **Vary the corridor width**.
Variation in the size of the trail corridor provides more interest and can reduce trail construction costs. In rough terrain the corridor may be narrower, while in areas with fewer constraints, such as meadows or woods, a wider trail corridor may be appropriate.

Table 6: Comparison of Trail Corridor Guidelines to Other Recommendations

Characteristic[40]	**Best Practice**	**Sustainable Design**[41]	**Universal Design**[42]	**Remote**[43]
Clear Corridor				
Tread Width (m, (ft))	1.0 (3.3)	0.9 (3)	0.9 (3)	0.6 (2)
Tread Height (m, (ft))[44]	2.0 (6.6)	---	---	---
Buffer Width (m, (ft))[45]	1.6 (5.3)	1.5 (5)	---	1.5 (5)
Buffer Height (m, (ft))[44, 45]	2.5 (8)	2.5 (8)	---	2.5 (8)
Protruding Objects (cm, (in))[46]	0.0	---	10.0 (4)	0.0

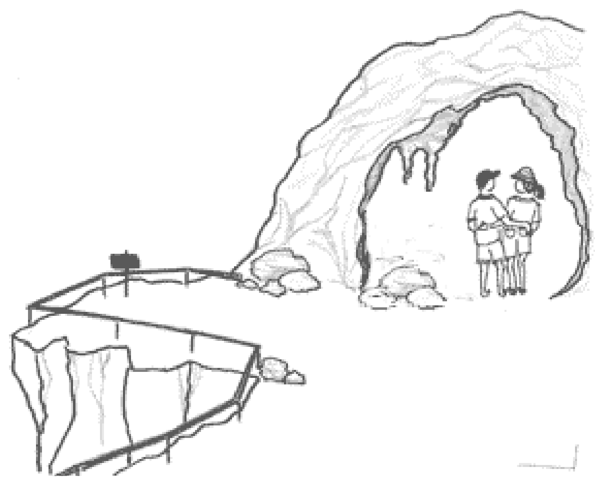
48. **Design a vegetation-free buffer zone on each side and above the tread area**.
The buffer zone provides a safety area for users who inadvertently go off the tread. Planned vegetation removal in this area also reduces maintenance, allows for longer sight lines, and keeps the trail passable through severe weather events. For hiking trails, a minimum buffer zone of 30 cm (12 inches) on each side and 50 cm (20 inches) above the trail tread corridor is recommended. However, on many trails, the buffer zone should be larger than these minimum guidelines. For example, the buffer zone should be larger (e.g., one metre (3.3 feet) on all sides) if

[40] Refer to Appendix A: Glossary of terms for definitions of each characteristic.
[41] Research in the Selway-Bitterroot Wilderness in Montana (1978-1989) demonstrated that trails built with a width less than 1.0 metres were trampled by users until the width increased to 1.1 metres (an increase in width of 47%. In contrast, more highly used trails that were constructed to a width of 1.2 metres were only slightly increased in width by users (up to 1.3 metres). These results demonstrate that even in wilderness areas, trail users require a tread of at least 1.0 metres or else they will step off of the prepared tread and create a wider trail (Cole, DN. (1991). Changes on Trails in the Selway-Bitterrooot Wilderness, Montana, 1978-89. US Department of Agriculture Forest Service, Intermountain Research Station, Research Paper INT-450.
[42] Access Board. (1999). Final Report of the Outdoor Recreation Regulatory Negotiation Committee for Developed Outdoor Recreation Areas. Washington, DC: U.S. Architectural and Transportation Barriers Compliance Board. [On-line] Retrieved 31 July 2006 from www.access-board.gov.
[43] The Bruce Trail Association. (2001) Guide for Trail Workers. 3rd Edition. Hamilton: Author.
[44] It is important to emphasize that **these clearance heights are above the trail tread, which is not necessarily the same as the ground**. In winter, as snow accumulates and is compacted from trail use, the location of the trail tread may be substantially higher than ground level.
[45] Specifications for the width and height of the additional buffer zone **include the width or height of the trail tread**.
[46] Distance that an object can protrude into the clear tread width or clear height.

the trail will not be regularly maintained, if the surrounding trail environment contains noxious plants (e.g., poison ivy), in areas where vegetation can be weighted down with snow, on trails that permit larger trail users (e.g., equestrians, ATVs) or if emergency or maintenance vehicle access is required. **Clearing a wider trail corridor can also be an effective method of environmental management** because different species of vegetation will thrive under more open or shaded conditions. A higher buffer zone can also reduce the "tunnel" effect that is often created when a trail is cut through dense bush. Although the tunnel effect can be attractive, design the trail so that the "tunnel" is broken at frequent intervals so that users do not feel trapped or unsafe. The social sustainability of a trail can be negatively affected if users do not feel safe or feel that they are blocked from being aware of their surroundings.

49. **Ensure that all decisions regarding vegetation removal are informed**.
Have a person who knows the local natural vegetation make the decisions about vegetation removal to create the trail tread. Rely on experts familiar with the area to identify any rare, dangerous or otherwise special vegetation. Be sure to confirm decisions about planned vegetation removal with the landowner. **It is usually best to leave as much of the natural vegetation as possible**. A well-designed trail minimizes the need for vegetation removal by taking advantage of naturally occurring clearings and not requiring the removal of larger trees. If a large tree is blocking the trail, re-align around the tree and outside of the tree rootlets. Saving the tree not only requires less work, it also maintains an environmental and aesthetic asset. That said, there may be circumstances where an old or diseased tree must be removed for safety reasons. In this situation, consult with local experts and authorities regarding the possibility of tree removal.

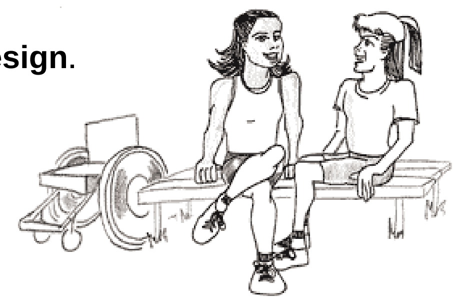
50. **Do not allow objects to protrude into the trail tread**.
A protruding object is any item that can be found within the area defined by the tread corridor (i.e., tread width and tread height). **All protruding objects should be considered a hazard to trail users**. Protruding objects on trails are most commonly caused by overgrown vegetation or a tree that has fallen across the trail. Protruding objects may also result unintentionally when signs or trail facilities (e.g., benches, trash receptacles) are mistakenly mounted in the trail tread. In very rare cases, it may be essential to allow objects to protrude into the clear trail corridor. Trails in caves or at the edge of overhanging rocks are two examples. If a trail is appropriate in these often sensitive environments, **trail users should be warned of the presence of the protruding object by a safety barrier**. The safety barrier should create a solid connection between the ground and the point on the object that the trail user would initially bump into.



User Amenities and Facilities

Trail user **amenities and facilities include all of the human-made structures found along the trail** route that are designed to **enhance the safety and/or enjoyment of trail users**. Some amenities, such as access to water suitable for drinking and emergency shelters, are critical to user safety. Amenities such as benches or picnic tables are primarily for user comfort, while facilities such as handrails can enhance both safety and satisfaction. The purpose of other types of amenities, such as toilets or trash receptacles, **can be for both user enjoyment and environmental protection**.

There is no overall requirement for the provision of trail amenities and facilities for "best practice" trails. The decision regarding what, if any, **amenities and facilities will be provided along a trail should be a balance of all of these issues (user safety, user comfort and enjoyment, environmental protection) in relation to the intended trail experience and permitted trail uses**. The guidelines for creating user amenities and facilities that are sustainable and universally designed are:



51. **Enhance social sustainability and universal design**. To enhance the social sustainability of the trail, amenities and facilities should be accessible to and useable by the broadest possible spectrum of potential trail users. **When trail amenities and facilities are provided, the structure itself should conform to accessibility requirements**. Minimum accessibility requirements that apply to the entire province of Ontario are under development through the Accessibility for Ontarians with Disabilities Act (2005). However, many municipalities and the Canadian Standards Association[47] already have accessibility requirements that govern the design of public amenities and facilities. Where municipal requirements are not available, the CSA standards should be used until the provincial standards have been developed. If municipal requirements exceed other standards, facilities on trails within that municipality are required to comply with the municipal regulations. **Amenities and facilities provided at trail access points should also comply with regulations regarding the surrounding surface and access routes**. Amenities and facilities located along the trail but not at an access point should meet the clear space requirement around the structure and be located on a route that is of the same standard as the trail itself.

[47] Canadian Standards Association. (2004). Accessible Design for the Built Environment. CSA Standard B651-04. Mississauga: Author.

52. **Enhance environmental sustainability**.
In order to maximize the environmental sustainability of a trail, amenities and facilities that provide trail users with access to drinking water, toilets, and garbage disposal should be provided. The facilities can be located along the trail, at access points, or in the vicinity of the trailhead (e.g., at the nearby general store or gas station), depending on factors such as amount of trail use, intended trail experience and resources of the trail managing organization. If the trail organization does not have the resources to manage waste disposal, clear information regarding the expected procedures (e.g., pack in/pack out, taking waste (including excrement) home, location of nearby facilities) should be provided for trail users. On longer trails where the distance between access points is large, drinking water, toilets and garbage disposal facilities should be provided at intervals approximately 2 hours apart for the average to slower than average trail user. If it is not feasible to provide these facilities at regular intervals (e.g., it would be difficult to pack-out garbage from the middle of a long distance trail), signs indicating the lack of on-trail facilities should be clearly posted at all trail access points.

53. **Carefully consider the need for access to health and safety facilities**.
Health and safety facilities include access to drinking water, toilets and emergency shelters and assistance. If it is considered reasonable to expect that trail users would have a need for these essential facilities and they are not provided, trail managers should recognize that **users will "make their own path" in order to meet these needs**. In terms of trail management, users should not be encouraged to go off of the designated trail because of a lack of trail amenities. Encouraging these types of unauthorized uses usually has a negative impact on the trail environment and can also jeopardize user safety. For example, if there are no facilities on or near the trail where users can obtain drinking water, they will be encouraged to go off of the designated trail to the edge of a nearby creek or stream. As each user makes their own trail to the edge of the creek, riparian habitat is damaged and trail users are exposed to additional hazards (e.g., slipping on an unstable bank and falling into the creek).

54. **Consider all permitted trail users**.
People usually travel on trails in a group of two or more people. Ensure that facilities and the path connecting the facility to the trail are suitable for use by more than one person and for people of different ages and abilities. For example, if a rest area is provided, ensure that there is seating for children and adults as well as space for someone using a wheelchair or power scooter to sit along side and among the group. Although it may or may not be appropriate to provide user amenities along a trail, **it is never appropriate to provide facilities or amenities that can be used by some people and not others** (e.g., provide an outhouse or toilet that is not of an accessible design).

55. **Provide a level, firm and stable surface to access the facility**.
The space in front of all operating side(s) of the facility should have a slope < 5% and be at least 1.0 m (3.3 feet) in diameter, and the size should be increased to a minimum of 1.5 m (5 feet) in diameter if users may want or have to change direction. For example, a 1.5 m (5 feet) diameter surface should be provided in front of a toilet or trash receptacle because the user will want to turn around when they are finished using the facility. The larger diameter of 1.5 m (5 feet) should also be used around all facilities that pose a potential hazard to the user (e.g., barbecue grill or fire pit).

56. **Connect the facility to the trail with a suitable path**.
The path leading from the trail to the facility should be of the same standard as the trail itself. That is, it should have similar width, tread and slopes as the trail used to get to that location.

57. **Provide rest areas at regular intervals**.
Rest areas are important because they provide trail users of all ages the opportunity to relax and enjoy the trail environment. **Rest areas need not be elaborate or human-made**. A large fallen tree, positioned so that a stable and relatively level sitting surface is provided approximately 45 cm (18 inches) above the ground, makes a suitable resting area on trails in natural or remote environments. At a minimum, resting areas should be provided at 30-minute intervals for the slower-than-average trail user. On trails that anticipate a high volume of use by young children, older adults, or inexperienced or unfit trail users, resting areas should be provided at more frequent intervals (e.g., 15 minutes apart).

58. **Inform trail users of access to electricity**.
The availability of electricity (via a regular plug outlet) at trail access points greatly enhances the ability of people who use power wheelchairs and scooters to access the trail. **Many powered mobility devices are designed for extended use** over several hours, however **the more difficult travel conditions on a trail can drain the power supply more quickly** (e.g., energy is wasted when the wheels slip on the surface) than during typical “city use”. Clearly inform trail users of the location(s) where access to electricity is available or if such access is not provided through information sources (e.g., brochure, web site) that trail users can access before going to the trail.

Access Points

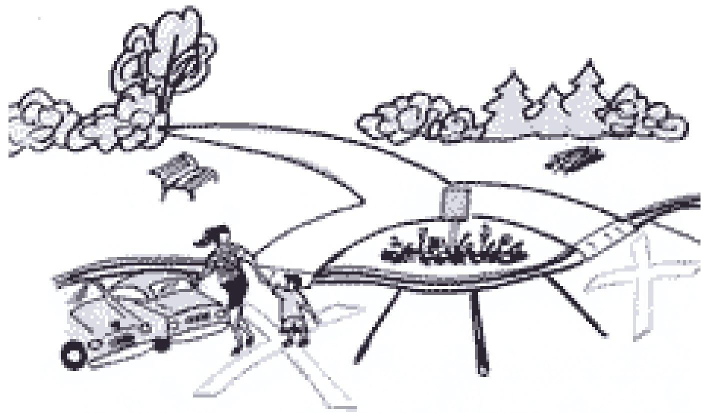
Access points include all of the locations where users can enter or exit from the trail. Typically, we think of access points as being at the trailhead. However, access points can also be at intersections, with roads or other trails, where trail users change from one path to the next.

59. **Make trailheads attractive and inviting**. Trailheads are often thought of as one of the most important aspects of a trail. They are usually the first thing that potential trail users encounter, and as such they create that "all important" first impression of the trail and trail experience. **Trailheads should be highly visible to potential users**. Increasing the attractiveness of trail use through appropriate trailhead design will have a positive impact on the social and economic sustainability of the trail. The size and scope of trailhead areas should match the intended trail experience and expected level of use. For safety and sustainability, **the practice of making trailheads inconspicuous to reduce or control use should be avoided**. The frustration experienced by trail users who have to search for the trailhead and the ad hoc access routes they may create will have significant negative impacts on the social and environmental sustainability of the trail. The safety of trail users and vehicular traffic can also be compromised if drivers are searching for the trailhead or trail users "appear from nowhere". If the trail environment is so sensitive that it would not tolerate the use it would receive with a clearly defined trailhead, then the location of the trail should be seriously re-considered.

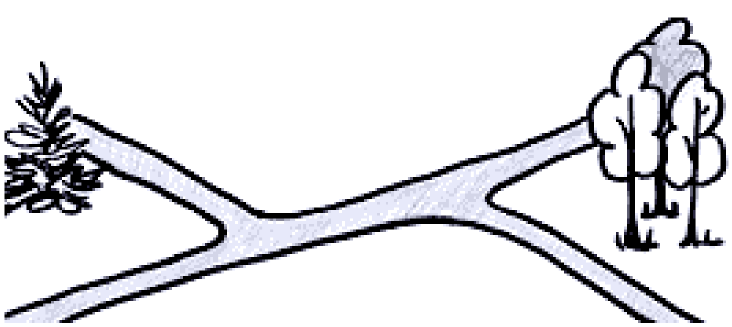
60. **Ensure everyone will understand they are entering a trail**. While this may seem self-evident, if you think about the wide range of people who may come to an access point it becomes apparent that achieving this goal can be quite complex. Consider whether the trail would be clearly understood by people moving at higher speeds (e.g., bicyclists, motor vehicle drivers), those who cannot see or read (e.g., people from other cultures or with learning disabilities), people who might not understand subtle signals (e.g., children, people with cognitive disabilities), those who view the trail from a low vantage point (e.g., children, people using wheelchairs) or trail users who are not permitted.

61. **Design trailheads to function as transfer points**. The trailhead should allow users to transfer between the trail and surrounding area in a way that is as natural, comfortable and "seamless" as possible. Design the access point so that it physically and visually ties the trail to the surrounding area, highlights entry into the trail environment, can be safely and effectively used by people of all abilities, and provides the information that trail users will require.

62. **Ensure that safe and effective parking can be provided**.
Parked cars will be found at all trail access points, whether or not parking facilities have been provided. Therefore, the choice of access point location should be based partly on its ability to provide for a safe and effective parking site. The number of parking spaces and the design of the parking area should represent the most appropriate balance between the intended trail experience and the expected level of trail use. All parking facilities must also conform to standards for accessibility. Using a curved layout for parking spaces can help to "soften" the visual impact of the parking area within the natural environment. Curved flow routes through the parking area, in conjunction with diagonal parking spaces, is a good design that is simple to understand and easy to use. . If there is no intention to provide parking space as part of the trailhead, trail managers should carefully consider the safety implications of that decision for those travelling on the trail and surrounding roads.

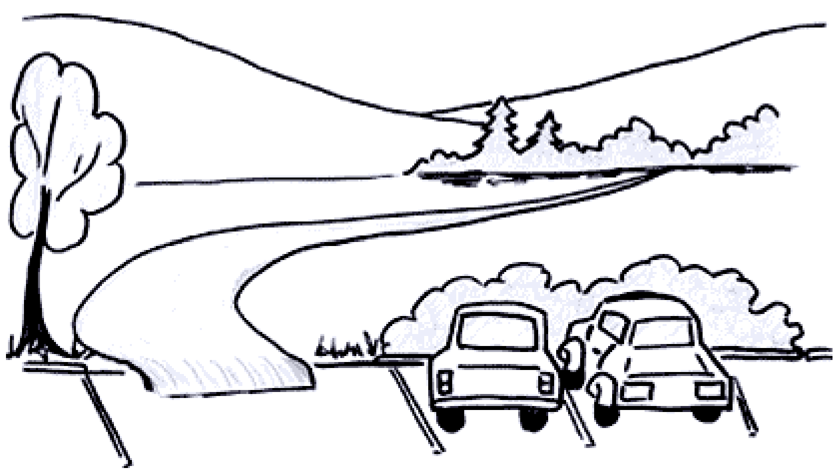


63. **Carefully design intersections for the safety of all trail users**.
Ensuring the safety of trail users, whether they are dispersing onto the road or crossing to the other side, should be the paramount consideration in the design of every trail to road intersection. In most cases, intersections (with either another trail or a road) should be designed so that **the intersection occurs at a 90-degree angle**. This perpendicular alignment offers the best opportunity for trail users to see, understand and negotiate the intersection. The size, layout and complexity of an intersection will be unique to each setting. The number and types of users, both on the trail and the intersecting travel path, must be considered. Design intersections so that all users (including those who have a low vantage point, rely solely on sight for information or travel at higher speeds) have adequate sight lines and there is enough tread width that users can safely congregate while waiting to proceed. The intersection should also be designed so that it matches the surrounding environment or trail "experience" to the greatest degree possible (within the bounds of safety requirements). Keep in mind that at every intersection, trail users may change direction. They may also encounter other users, such as other trail users or vehicular traffic.



64. **Plan for traffic flow through the intersection**.
It is important to consider how users from each trail or road will interact with each other. **Conflicts often result when the users on one trail "fly through" an intersection making it difficult or unsafe for users from the other trail to cross, merge or proceed**. Offsetting trail intersections, to create two 3-way intersections instead of one 4-way intersection, is a helpful design for minimizing user conflicts at intersections. It is also important to ensure that the **transitions between the trail surfaces and the intersection are smooth and free of obstacles**.

65. **Ensure transition areas are available to people of all abilities**.
Ensure that trail-to-road transition areas are smooth and barrier free, for the safety of trail users on wheels (e.g., bicyclists, people using wheelchairs). Conditions at the access point should be similar to the conditions found throughout the trail so that the initial impression of the trail environment is accurate.



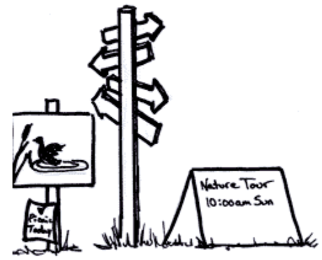
Designing Trail Signs and Information Sources

There are a wide variety of formats that can be used to convey information about a trail to potential users. Some formats (e.g., web site) are intended to provide information before the user arrives at the trail. Others (e.g., on-trail signs) provide information to users while they are on the trail. The guidelines for sustainable and universally designed trail signs and information are:

66. **Design user information so it is available to all**.
Signs should clearly **convey the desired information to all potential users, with and without disabilities**. Use standard symbols that are easy for people to understand, a matte finish and texture[48] (e.g., symbols carved into the sign or raised above the background of the sign by 0.8 mm to 1.5 mm (0.3 to 0.5 inches) to assist trail users of all abilities to understand the information provided. If text is required, it should be Grade 6 reading level or less (preferably Grade 4 or less). Short and simple messages are easier to understand. **Follow published guidelines[49] for accessible signage** and use colours and graphics consistently. Text should be a san serif font (e.g., Helvetica, Univers) and be written with upper- and lower-case letters. Avoid using all capital letters as it makes the text much harder to read. The size of text characters will depend on the viewing distance (how far trail users will be from the information source). Information sources that can be very close to the user's face (e.g., brochure, map, web site) can use text as small as 20 mm (0.8 inches) in height. Signs on the trail should have a minimum character height of 75 mm to 100 mm (3 to 4 inches) for viewing distances of 2.3 m to 2.5 metres (7.5 to 8.2 feet). Additional information about text requirements can be found in "Clearing Our Path"[49]. The contrast between the background colour and the colour used for the text or graphics should be at least 70%[50]. White/yellow lettering on a dark (black preferred) background is generally easier for people with visual impairments to read than dark letters on a white background. It is also helpful to have the sign background colour contrasted against the background surface. For example, a sign mounted on a light wall should have a black background and white lettering. Conversely, a sign mounted in dense green vegetation should have a white background and dark lettering.

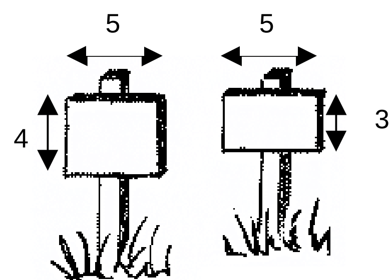
[48] Treasury Board of Canada Secretariat. Tactile Signage: Sign System and Installation Guide. [On-line] Retrieved 31 July 2006 from http://www.tbs-sct.gc.ca/fip-pcim/man_4_3b_e.asp
[49] Canadian National Institute for the Blind. (1998) Clearing Our Path. Toronto: Author.
[50] Contrast = [(B1-B2) / B1] x 100, where B1 = light reflectance value of the light area and B2 = light reflectance value of the dark area

67. **Match the information source to the trail environment**.
The material, colour and style of all signs and information sources should be compatible with the trail environment and intended experience. The number and size of on-trail signs should be a balance between maintaining the trail experience and providing users with the information that they need to know.



68. **Choose sign locations carefully**.
Choose the location of your signs and supports carefully. The sign panel can be created from a wide variety of materials, such as metal, fibreglass, wood, concrete, and plastic. Choose sign materials that are appropriate to the trail environment and have the required durability and aesthetics. Choose materials that are insect, salt and water resistant. Proper placement allows the message to be easily understood, without misinterpretation. Remember that **the message is conveyed not only by what is on the sign but also through its placement**, and its location relative to other signs and markings. Use common sense and judgement to determine sign locations and use as few signs as possible to convey the required information. **Avoid "sign pollution"**.

69. **Design sign panels to suit the trail environment**.
Avoid using inexpensive materials in large rectangles, such as a 4 feet by 8 feet sheet of plywood, as it will give the trail a "billboard appearance"[51]. Sign panels that use a 5 to 3 or 5 to 4 ratio for their dimensions are more visually appealing than square panels.

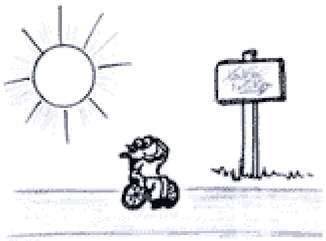


5 to 4 ratio 5 to 3 ratio

70. **Design sign supports for the trail environment**.
Supports do more than hold up a sign. The physical quality of supports should have a harmonious relationship with the natural environment and desired trail experience. Choose colours and materials that complement the site, such as a rock support for signs on a trail across exposed Shield. A roof over a trailhead or orientation sign provides trail users with an invitation to stop before they start along the trail. Supports for a sign can be made from lumber, logs or metal. **Cedar posts are recommended** if available. If pressure treated lumber is to be used, be certain that the preservative does not contain arsenic. To make a natural post, use a rot-resistant tree such as cedar, locust or hemlock. **Living trees should not be used as sign supports**.

[51] Trapp, S., Gross, M., and Zimmerman, R. (1994). Signs, Trails, and Wayside Exhibits: Connecting People and Places. UW-SP Foundation Press, Inc., Interpreter's Handbook Series, University of Wisconsin, Stevens Point, pp 18.

71. **Design for the conditions where the sign/information source will be installed**.



It is important to design information sources for the conditions that will occur once they are installed on the trail. While this may seem self-evident, this aspect of sign design is often overlooked. Ensure that sign visibility will be maintained under high sun, glare, or snowy conditions or if trail users have a low vantage point (e.g., children, recumbent cyclists, people using wheelchairs, people of short stature).

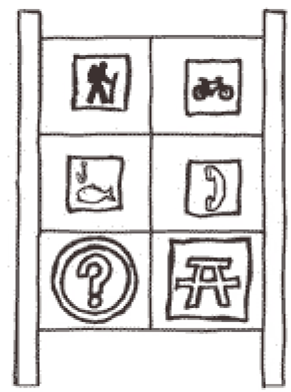
72. **Be consistent with and clearly identify sign/information source locations**. Signs should be located on one side of the tread. The signpost should be set back from the tread so that no part of the sign protrudes into the space above the tread. The sign should also be located so that trail users can easily get closer to the sign if necessary, in order to see or understand the information on the sign. Wherever possible, a short section (0.6 metres (2 feet)) in the direction of travel across the full width of the tread) of alternate surface should be installed in the trail tread to identify the location of information sources for people with vision impairments.

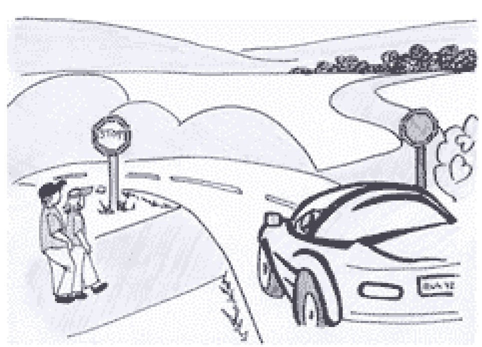
Identifying the location of information sources is particularly important for interpretive trails and when conveying information about trail hazards.

73. **Use universal symbols if possible**.
Use universal symbols to provide users with the direction to travel or information about where features (e.g., parking lot, washrooms, lookout) are located. They can also convey regulatory information, such as “do not enter”, or educate trail users about hazards (e.g., rock fall zone, steep slopes) found along a trail. Use **interdictory** (red ring with a diagonal red stroke) **and permissive** (round green ring) **symbols to indicate what is/is not prohibited on a trail**. **Virtually any universal symbol is available as ready-to-use clip-art**. Standard trail images can be purchased on CD-ROM or from on-line services[52]. Icons representing grade, cross slope, width and surface can also be obtained free of charge[53].

[52]INMAGINE. Illustrations Photos / Universal Symbols Images. [On-line] Retrieved 31 July 2006 from http://www.inmagine.com/universal-symbols-photos/imageclub-icv019
[53] Beneficial Designs, Inc. P.O. Box 69, Minden, NV 89423, 775-783-8822, www.beneficialdesigns.com.

74. **Abide by local or provincial sign regulations**.
Many trails, and particularly those within highway or railroad rights-of-way, will be subject to additional local or provincial standards for sign style, placement or content. Check with knowledgeable local sources to ensure that these requirements are clearly understood.

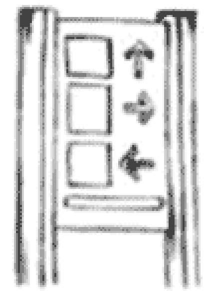
75. **Design an accurate and complete system of regulatory/warning signs**.

Regulatory signs display rules and regulations regarding trail use and primarily advise the trail user of trail restrictions. **Regulatory signs should clearly identify the permitted trail users**. Signs can also tell users where they should not or cannot travel. **Warning signs should be used to indicate upcoming hazards** (actual and potential) along a trail. Examples are steep slopes, railway crossings, rough tread or uneven pavement changes. It is helpful if they also provide users with clear directions or suitable precautions for dealing with adverse conditions. Graphic symbols used for regulatory signs for trail users are derived, for the most part, from the MTO Manual of Uniform Traffic Control Devices. Regulatory signs for railway crossings originate with Transport Canada. Graphics for regulatory signs relating to other trail use issues such as littering, parking, dogs, etc. are site specific and are derived from a variety of sources, such as Ontario Provincial Park sign plans or the Parks Canada signage manual. Regulatory signs should be 45 cm x 45 cm (18 x 18 inches)[54]. Use a **yellow background to indicate a hazard** or warning. Hazards should be indicated at least 30 metres (98 feet) in advance and at the point of hazard. Use **black text and graphics on a white background for all other signs, except for stop signs** which use white on red.



Text size should be at least 5.5 cm (192pt) font for the major message. Both the text and graphic should be centred. **Stop signs should be posted at all intersections where off-road sections of a trail cross roadways** with motor vehicle traffic. This includes all public roadways, as well as park roads, semi-public roads and parking lots. Yield signs should generally be avoided because of the ambiguity of assessing right-of way.

[54] Ontario Ministry of Transportation. (1995). Manual of Uniform Traffic Control Devices. Toronto: Author.

76. **Design a network of directional signs**.



Directional signs **give directions to users on the trail**, enabling them to easily find important locations such as trailheads, access points, facilities and important trail features. **Trail distances should**, at a minimum, **be indicated on major and secondary trailhead signs**. Directional signs can also include maps (i.e., "You are here"), trail length and the distance(s) to features, alternate access points or intersections. Use blazes or directional signs to clearly mark the route of the trail. Blazes should be at least **5 cm wide and 15 cm high** (2 x 6 inches). The tree or fence post should be larger than the blaze, so that a **contrasting border of at least 2 cm (0.8 inches) is visible on all sides**. Blazes should be **mounted about 1.5 metres (5 feet) above the trail tread** and should be visible to people sitting as well as standing. Higher mounting locations should be used on winter trails, the height being determined by the typical snow depth. Mount small directional signs 3 metres to 5 metres (10 to 16 feet) in advance of a change in direction or where there may be difficulty in following the route[55]. These signs should be approximately 30 cm by 30 cm (12 by 12 inch). Arrows of 30 cm x 15 cm (12 x 6 inches) are also useful, particularly in places with multiple trails. Place route markers with the name of the route and distance to the trailhead every 500 to 700 metres (1600 to 2300 feet).

77. **Consider the need for additional user information**.
Information sources should clearly identify the type of trail (e.g., hiking, interpretive) for all users. Signs indicating the location of rest stops, washroom facilities, and the availability of drinking water, for example, can also be very helpful. Additional information can remind users of trail etiquette (e.g., stay on the trail, downhill users have the right of way) and educate users about potentially hazardous or uncomfortable situations (e.g., poison ivy, bears nearby, or expert only trail). Provide additional information alone or with the appropriate directional sign at logical, high-visibility locations.

78. **Do not use the International Symbol of Accessibility (ISA)**.

The International Symbol of Accessibility (ISA) should not be used to describe the conditions on a trail unless the trail fully complies with all of the internationally accepted ISA standards. One of those standards is a slip-resistant surface. Clearly, there are very few, if any, trails in Ontario that can provide a slip-resistant surface at all times of the year. The ISA can be used on facilities provided along the trail (e.g., washrooms), if the facility complies with the standards dictated by the symbol.

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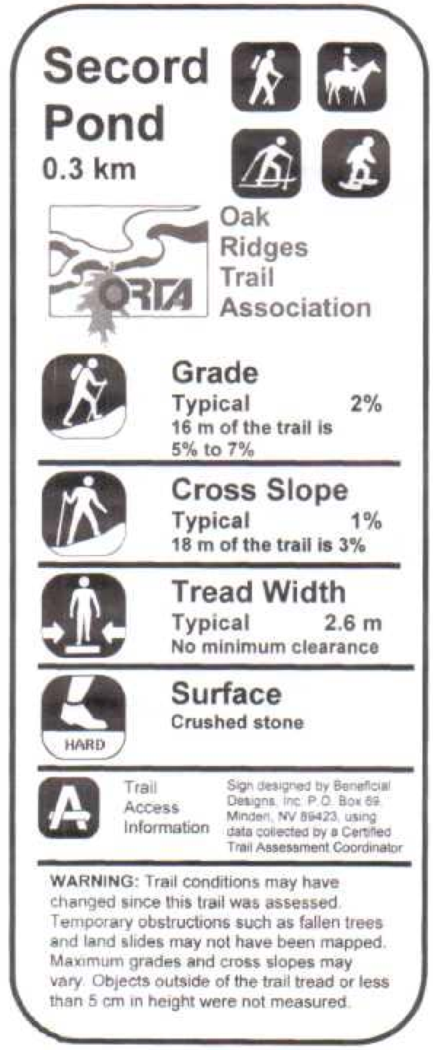
55 Victor Ford Associates Inc. (1997). Design, Signage and Maintenance Guidelines: Waterfront Trail. Waterfront Regeneration Trust. Toronto Ontario

79. **Provide information about the on-trail conditions**.
Ensure that trail users of all abilities have access to accurate information about the on-trail conditions that they will encounter. At a minimum, the information should include objective measurements of **trail length, tread, clear corridor, and slope**. Providing this information will enhance trail safety and social sustainability by enabling potential trail users to make informed decisions about whether the trail will suit their interests and abilities. Signs indicating the accessibility of built facilities (e.g., washrooms) should be provided on the facility and through other information sources (e.g., trail maps and brochures).



80. **Do not use trail ratings to convey trail conditions**.
Trail difficulty ratings are commonly provided on trails. The green circle, blue square, black diamond rating system developed by the ski industry is particularly well known. However, **trail difficulty rating systems are not recommended because they can significantly impact user safety**. Trail ratings are rarely accurate for any particular user, and can be dangerously inaccurate for people who are inexperienced, unfit or have different abilities. The key problem with difficulty ratings is that the **ratings are always subjective**. They represent the opinion of the person who applied the rating. As a trail manager or worker, that person is likely more fit and experienced than the average user. All experienced trail users can recall times when they have finished a "difficult" hike without breaking stride or when an "easy" hike was much more challenging than anticipated. **Trail difficulty ratings are also misleading because the same labels can represent very different trails at different sites**. Skiers know very well the dangers of assuming that you can ski the "black diamond" trail in Banff just because you can ski every "black diamond" trail in southern Ontario. Trail users assume difficulty ratings represent a standard set of trail conditions. This is not the case and users often get into difficulty on a trail because their expectations of the on-trail conditions have been mislead by the difficulty rating.

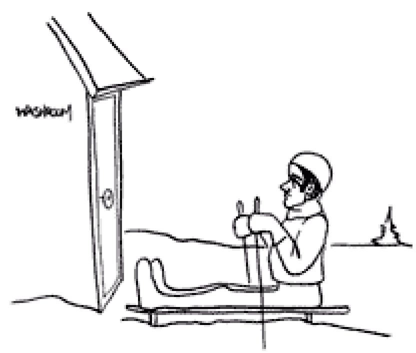
Designing for Year-Round Use

Best practices for trail design also involves **considering the different trail uses that occur at different times of the year**. For example, cross-country skiers generally require a much wider trail tread on slopes, so that they can angle their skis as they climb (i.e., herringbone) or descend (i.e., snowplow). For all trails that could be used year-round (even if the winter use is incidental or unintended), keep in mind the following guidelines:

81. **Anticipate that the trail tread may be much higher than the ground surface**.
    In areas that receive substantial amounts of snow, those travelling on the trail in the winter may be 1 metre (3.3 feet) or more above the ground. Even in areas where there is relatively little snow accumulation, trail users are likely to be at least 10 centimetres (4 inches) above the natural trail surface.

82. **Design vegetation that will not interfere with trail use in the winter**.
    The weight of snow and ice on tree branches and bushes can often make the vegetation surrounding the trail much lower to the ground. Standards for clearing the trail corridor should be adjusted according to the degree of change in the foliage during the winter months.

83. **Design for trail users who may not be able to stand or walk on their feet**.
    It is a common mistake of inexperienced users of cross-country skis or snowshoes to remove their equipment when they stop for a rest or to make adjustments. The result is a rapid reminder of how essential the skis or snowshoes are to enable us to "float" on top of the snow. Trails and associated facilities need to be designed so that trail users will be easily able to negotiate the trail and use the facilities even if they are unable to remove their equipment.



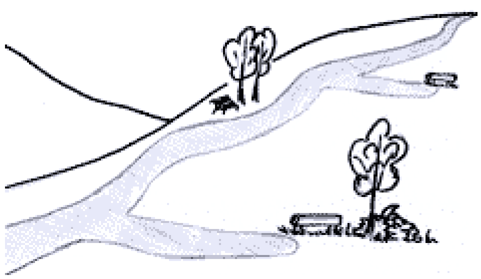
84. **Special considerations are required during times of freeze-up and thaw**.
    At these times, trail surfaces are often the most difficult to negotiate. There is typically a lot of water in and on the ground. As a result, trail surfaces can be slippery or even impassable and the risk of hypothermia is extremely high if trail users get wet. **In many areas of southern Ontario, the conditions that occur during freeze-up and thaw are predominant throughout the winter months**. Trails that cross water courses without the use of solid structures (e.g., ice crossings) and trail environments that accumulate substantial amounts of water during these times should be closed to use, for the safety of trail users and protection of the environment, until the trail conditions have stabilized.

Changing from Other Standards to these Guidelines

These design guidelines are based on current research for both trail sustainability and universal design. They **generally differ very little from existing guidelines** for trails designed for human-powered users. Where there are differences, in most cases the current guidelines are less restrictive and trail groups can follow more restrictive standards without modification.

Traditional guidelines for remote/wilderness trails are the one area where differences between the traditional and current guidelines will require trail designers to change “the way they do things”. However, trail designers are free to use their creativity to achieve the current guidelines while retaining the desired remote/wilderness trail experience. For trails that have traditionally been designed according to remote/wilderness trail standards, consider design changes such as the following:

Provide level areas on or at the side of the trail every 25 m to 50 m when tread slopes are above 5%.



Provide a trail tread that is firm and stable.

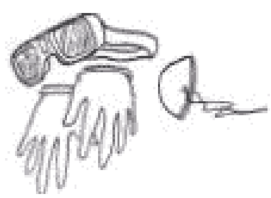
Provide a trail tread that is 15 cm wider on each side.

Guidelines for Trail Construction

1. **Build the trail based on a detailed construction log**.
   During the design phase, create a very detailed log describing all aspects of the trail design, location and construction. Include detailed information about all trail structures and facilities as well as specific information about the trail tread width, location and materials. The crew leader is responsible for ensuring that the trail is constructed as the designer intended.

2. **Construct the trail so that all permitted users have access to the trail**.
   
   Trail designers will have considered the abilities of all potential trail users in designing the trail and any barriers (e.g., fence, railing, gate, bollard) that will be found on the trail. All permitted trail users, including those with movement limitations, must have access to the trail. Barriers should not be installed if they would limit use of the trail by some permitted trail users (e.g., children, older adults, unfit individuals, people with disabilities).

Trail Safety

3. **Ensure the construction crew uses safety equipment and correct procedures**.
   
   All members of the construction crew should wear appropriate safety equipment and be trained in safe tool use and proper construction safety procedures. Choose the right tool for each job, and ensure a good grip and stable footing.

4. **Use proper lifting techniques**.
   
   Construction crews often move very large and heavy materials (e.g., bridge stringers, large rocks). Ensure that there is sufficient manpower to lift by hand and that everyone is trained in proper lifting techniques (e.g., back straight, lift with legs). If possible, use mechanical advantage (e.g., levers, winches, pulleys) to reduce the individual effort required.

5. **Use the right tools**.
   Make sure to use the correct tools for each task. Keep tools sharp and in good repair so that they assist rather than hinder your work.

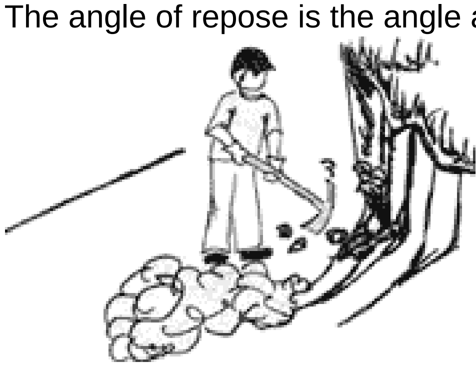
Environmental Protection

6. **Minimize environmental impacts during construction**.
   Trails constructed for sustainability will not result in on-going environmental damage because of trail use. **Ninety percent of all environmental impacts will occur during trail construction**. Construction crews that take care to minimize the impact of their construction work create the best opportunity to preserve the natural environment. Plan construction work so that each section of trail is completed as quickly as possible. Build the most difficult sections, install drainage structures and complete excavations first. This encourages proper hardening of fill soils, allows excavated material to be used in other areas and enables better trail finishing.

7. **Follow the natural contours and preserve natural drainage patterns**.
   Carefully follow the designed layout for the trail. Ensure that the constructed tread follows the natural contours (i.e., stays closer to the contours than the fall line) and pulls up and into every naturally occurring swale or drainage feature so that natural sheet drainage patterns are maintained.

8. **Preserve and rehabilitate the trail environment**.
   Actively seek to preserve the vegetation in the trail corridor to preserve the natural experience for trail users. During construction, look for opportunities to rehabilitate environmental damage and complete all rehabilitative work specified by the designer.

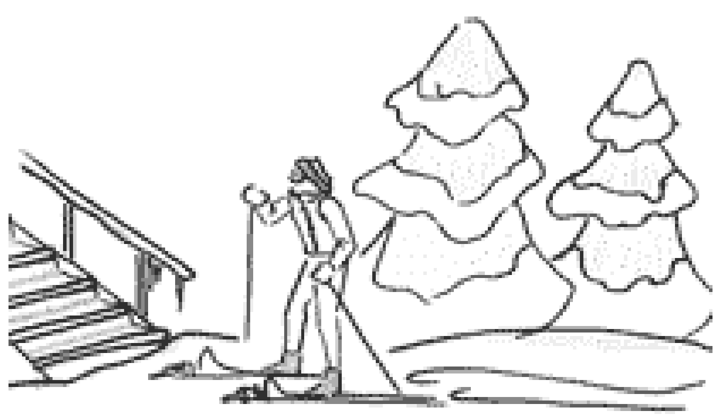
9. **Stay within the angle of repose**.
   The angle of repose is the angle at which the soil or natural parent material will remain stable without additional support. The terrain uphill of the tread should be shaped so that it is naturally stable and vegetated. Retaining walls, if required, should be used to support the trail tread at a level that allows the uphill terrain to remain at or below the angle of repose.



10. **Use climbing turns and switchbacks sparingly**.
    Climbing turns and switchbacks should only be used when there is very limited land area and very steep terrain. Trail designers who are unable to complete the trail layout using a sustainable, curvilinear alignment will incorporate climbing turns and/or switchbacks into the construction log. These tread structures must be very carefully designed and constructed in order to minimize the resulting environmental damage. When poorly designed or constructed, trail users will shortcut the turns causing significant environmental damage that will continually increase with trail use. Construction crews must carefully rehabilitate the trail environment to ensure that trail users will not be tempted to go off of the prepared tread.

11. **Construction is complete when rehabilitation work is finished**.
    Many construction crews focus on the structure or tread that they are assigned to build and pay little attention to the restoration of the environment after construction. The construction work should be considered “in progress” until all construction scars have been removed from the trail environment, the growth of native vegetation has been encouraged and any work that would reduce future maintenance and resource rehabilitation needs has been completed. The ideal trail is one that looks like it has “always been there” from the minute that construction is completed. There should be no signs of fresh saw or axe marks, freshly cut stumps, raw banks or freshly broken rock. Cut limbs and brush should be scattered out of sight, not stacked. Cover cut banks and new tread sections with natural topsoil and a thin layer of duff. Ensure that the details of the planned restoration work are included in and approved by the local Conservation Authority or other governing agency (e.g., municipality, local office of the Ministry of Natural Resources).

12. **Use steps and ladders only when absolutely necessary**.
    The use of steps and ladders are to be avoided and used only as a last alternative. Steps and ladders are costly, and require a great deal of effort, both during original construction and in on-going maintenance. Steps and ladders also make trail use very difficult for many trail users. Hikers, especially backpackers, will walk alongside steps at every opportunity. **Steps can also be significant barriers or hazards** for other trail users, such as cyclists, cross-country skiers, young children and people with limited mobility. Steps and ladders should only be considered when all other options are not suitable. If steps are required, try to also provide a ramped surface where strollers, wagons, wheelchairs or bicycles can be more easily pushed by those walking up the steps.



Construct a Sustainable Tread

13. **Compact a sustainable trail tread sized for all users**.

Constructing a compacted, sustainable trail tread is the best way to minimize impacts on the environment adjacent to the trail. Ensure that permitted trail users can stay on the tread that has been built for sustainability. Trails that are too narrow for users to pass or that have a tread that is soft or unstable encourage users to go off of the prepared tread, greatly increasing the trampling and compaction of areas adjacent to the tread. It is not necessary to use soil stabilizers or paving materials to create a hardened tread. In most areas of Ontario, the naturally occurring clay-based soils can be compacted into a sustainable tread without the need for any additional soil treatments.

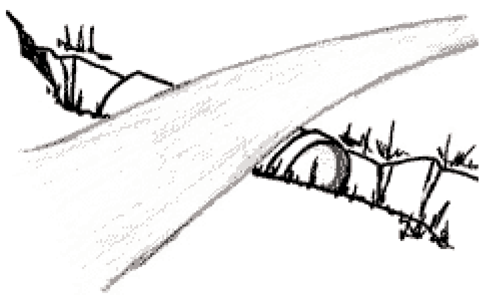
14. **Construct the tread with a consistent outslope**.
The side-to-side slope of the tread should allow water to drain quickly across the tread and then continue down the adjacent slope. The steepness of the outslope will be determined by the tread material and surrounding terrain. Follow the designer's instructions regarding the amount of outslope. The designed outslope will represent the best compromise between providing adequate drainage and enhancing access for all trail users.

15. **Remove organic material from in, on and over the trail tread**.
All organic material (leaf debris, vegetation, loose top soil) should be removed from the trail tread. Organic material left in the trail tread will eventually rot, leaving depressions that will alter drainage across the tread and make the tread more difficult to negotiate safely. Vegetation should also be removed from above the trail tread to create a clear, vegetation-free corridor for all trail users. Vegetation that is in the way of trail users is at risk of being broken or stripped in a way that will damage its health. In areas with deep layers of topsoil, only the loose soils should be removed.

16. **Remove obstructions from in, on and over the trail tread**.
All obstructions (e.g., rocks, stumps, branches) should be removed from the trail tread. Obstructions left in the trail tread are a tripping hazard, particularly for those trail users (e.g., older adults, children) who may be less agile. Obstructions should also be removed from above the trail tread to create a clear, obstruction-free corridor for all trail users. Obstructions that hang in the way of trail users are a hazard for those whose attention is focused on the trail environment or individuals who are unable to see clearly. Bollards and other barriers constructed to prevent unauthorized use are not considered obstructions.

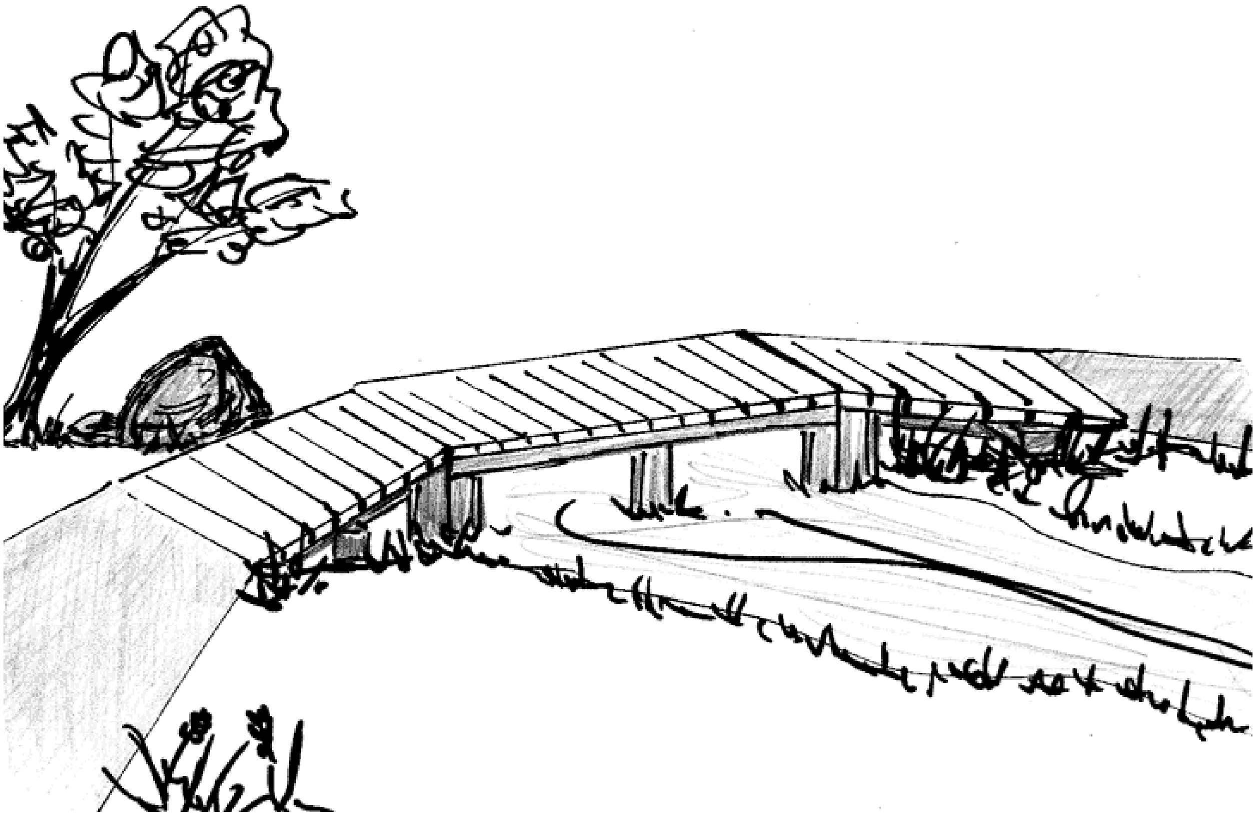
17. **Clear the trail tread area and the buffer zone**.
The designed tread area is determined by the width and height required by permitted trail users. It is the width of the tread up to a height above the tallest user. The buffer zone is outside of the trail tread area on both sides and above the top of the tread area. The buffer zone may contain soft foliage or ground cover but should be free of hazardous vegetation or substantial branches. The buffer zone should be at least 0.3 m (12 inches) on each side and at least 0.5 m (20 inches) above the tread corridor, with larger buffer zones required for larger trail users or on trails where maintenance is less frequent. The extent of vegetation removal should be developed by those knowledgeable about the local environmental and requirements of the landowner. Construction crews should follow the information specified in the construction log.

18. **Use drainage structures to separate the tread from natural drainage channels**.
Trails designed for sustainability will require few if any drainage structures (e.g., culverts). Drainage structures will only be required where it is necessary to separate the tread from a natural drainage channel. Drainage structures should always be aligned with the natural pattern of water flow. Drainage structures should never be used to collect or re-direct water flow within the environment. Within the trail tread, drainage structures should always be closed (i.e., the user cannot step into the structure). The proper construction of drainage structures is complex, so the crew should be lead by someone with the appropriate skills and experience. Construction of drainage structures must be approved by the land managing agency to ensure that it complies with requirements for construction within areas of water flow.



19. **Construct tread structures where the natural terrain is not sustainable**.
Tread structures, either intermittent or continuous contact, are used when the natural terrain cannot provide or should not be used for a sustainable tread. The structure raises the tread above the natural (i.e., difficult or sensitive) terrain. Typically, tread structures are built in areas with a lot of water (either visible water or saturated soil). Tread structures can also be used to protect areas with delicate plants or make the surface underfoot more even and stable. When constructing tread structures, work carefully to minimize the loosening of soil into bodies of water, trampling of wetland vegetation and the disturbance of habitat or bird/animal behaviour. Obtain all necessary approvals for the type, extent and timing of the work.

20. **Smoothly connect ground level and elevated treads**.
The approach to elevated trail treads should be ramped and free of steps or trip hazards. Approaches may be decked or built of earthen-gravel fill. If fill is used, a soil dam should be used to separate the approach material from any wood sections of the tread structure.

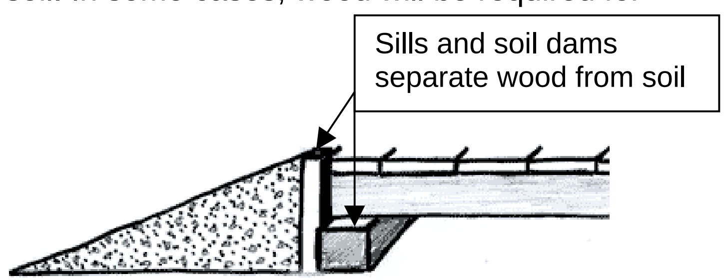


21. **Construct a firm, stable, dry and erosion-resistant tread**.
Soil that contains a significant amount of clay as well as a mixture of fractured rock (i.e., pieces with rough edges that vary in size) will generally provide the most sustainable trail tread. The naturally occurring materials along the trail route will have been considered by the designer in specifying the tread construction. Construction crews should follow the trail tread construction details as closely as possible because soil conditions (and therefore construction techniques) can change frequently within the trail corridor. If possible, the naturally occurring materials should be used in conjunction with stabilization materials or techniques to preserve the natural aesthetic of the tread.

Constructing with Wood

22. **Choose lumber carefully**.
Pressure treated wood is often the "building material of choice" because it is expected to last a long time. Until January 2004, wood was commonly treated with Chromated Copper Arsenate (CCA). CCA has been linked to health problems for many people. Since 2004, arsenic, a known cancer-causing agent, has been removed from the chemicals used to treat wood. However, building supply companies were, and still are, allowed to sell off existing stocks of CCA treated wood. Today pressure treated wood is typically created with chemicals such as amine copper quat (**ACQ**) or copper azole (**CA**). At the very least, these options are less toxic than CCA. However, some health concerns remain and it is still advisable to take precautionary measures when using wood treated with these chemicals.

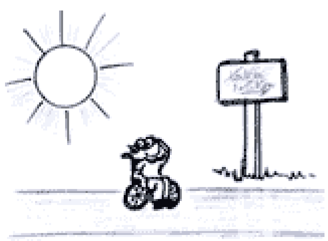
23. **Minimize wood contact with water and soil**.
Use concrete, rock or rustproof metal for support structures (e.g., sill, crib, soil dam) that will be in contact with water or soil. In some cases, wood will be required for these structures. If wood is required, try to use species of wood (e.g., cedar) that is less likely to rot. Avoid using pressure treated lumber in contact with water or soil because the chemicals will leach into the surrounding environment.



24. **Use timber rather than logs for tread construction**.
Lumber should be used to construct all wood trail treads (e.g., boardwalk, bridge decking). The use of logs for the tread surface is not recommended because the rounded surface can be very hazardous for many trail users. If logs must be used in remote areas, they must be securely attached to the underlying support structure and the top surface should be shaved with a chain saw to provide a relatively flat surface on which trail users will stand.

Construct the Trail Information System

25. **Inventory and co-ordinate trail signs and information**.
It is important that trail users have access to information regarding the trails that they wish to use. Trailhead signs, brochures, web sites guidebooks, on-trail signs and blazes are just a few examples of the ways in which trail users can obtain information. A detailed inventory of all trail information sources should be created during trail design and construction. The inventory should be regularly reviewed to ensure that information sources are co-ordinated, that trail users of all abilities will have access to the information (even if they cannot read) and that the content is accurate and complete. GPS can be very helpful in recording the precise location of signs along the trail. It is also helpful on general information sources and trailhead signs to provide the user with a web site or contact person for obtaining additional information about the trail.



26. **Use standard symbols and simple text for trail information**.
Use standard icons and graphics to convey trail information. When written text is required, it should be suitable for a Grade 4 reading level. Use a matte finish, non-serif fonts, colours with contrast of 70% or greater and ensure that character size is appropriate to the distance between the user and the information source.

Bear Safety

- Keep your area clean
- Put food in strong, sealed containers
- Keep dogs on a leash
- Put trash where it belongs

Best Practices for Trail Construction

There are many ways to build a trail. Detailed information about materials and construction techniques for the trail should be developed during the trail design phase. **The construction crew leader uses the detailed construction log created during trail design to ensure that the trail is constructed as intended**. The specific construction techniques on each trail will vary, depending on many factors (e.g., intended trail experience, type and volume of trail users). The trail designer will have considered the range of abilities among trail users as well as environmental factors in order to determine the final trail design. The designer will also have worked closely with the landowner to ensure that the final trail design will be supported and accepted. **It is important that the construction crew follow the construction log details as closely as possible**, so that "as built" will be virtually the same as "as designed".

The construction techniques described in **this "best practice" document are intended for use by volunteers who will be building trails without using heavy machinery**. They are the recommended minimum standard for trail design, construction and maintenance. Volunteer labour and hand tools are the source of most Ontario trails. Trails professional unfamiliar with sustainable trail design will also find these "best practices" informative. It is essential that **the person leading the trail construction work be thoroughly familiar with all of the design and construction standards that apply to the trail**. Trail designers and construction crew leaders should strive to ensure that every trail meets not only these minimum guidelines, but also any additional guidelines that may apply to specific trails or managed lands. Otherwise, the volunteer labour used to construct the trail may be for nought if, after construction, sections of the trail do not meet required standards and have to be re-done.

Once the route is final, **trail construction usually proceeds in five broad steps**. The order of completion will vary depending on the specific site conditions. The steps are:

- Clearing obstacles and vegetation from the trail corridor.
- Constructing drainage structures (e.g., drainage lens, culvert).
- Constructing trail tread structures (e.g., boardwalk, bridge).
- Establishing or constructing the trail tread.
- Building the structures required for trail users (e.g., access to water, toilets).

Each of these steps (described in subsequent sections) requires various materials and tools. It is important that the materials and tools be carefully chosen to ensure that they are suited to the specific task and local conditions. **Making good choices of material and tools will save time and costs.**

Minimizing Environmental Damage

It is important that every trail be constructed in a manner that respects the natural surroundings. People use trails to make contact with the natural environment, and research clearly shows that **90% of the environmental impacts caused by sustainable trails occur during construction** and initial use. It is a misconception that the environmental damage from a trail results primarily from ongoing trail use. However, if a trail is constructed using these "best practices" for sustainability and universal design, only minimal environmental impacts will occur after the first year of trail use.[56] **Your challenge, as a trail builder, is to limit the environmental damage during trail construction as much as possible**.

Erosion and compaction of the soil adjacent to the trail tread are the two largest problems faced by trail builders. Erosion and compaction modify the trail's local environment by changing the way that water, soil and nutrients move about. It is a common misconception that erosion and compaction are "unavoidable", as if they inevitably and naturally result from trail construction and use. This need not be the case. **By constructing a sustainable trail tread**, that is itself properly compacted and suitable for the type and amount of trail users, **the erosion and compaction of areas adjacent to the trail tread can be largely avoided**. If compaction of the trail tread will potentially damage sensitive plants or trees, the design of the trail should be re-considered to ensure that the tread is located in more appropriate soils and vegetation.

Fall line
Direction water flows down a hill (path of least resistance). Constructing a trail on the fall line encourages water to run down the trail tread.

Contours or Contour lines
Lines on a topographic or orthophoto map that join points at the same elevation to illustrate altitudes, slopes, and other terrain properties.

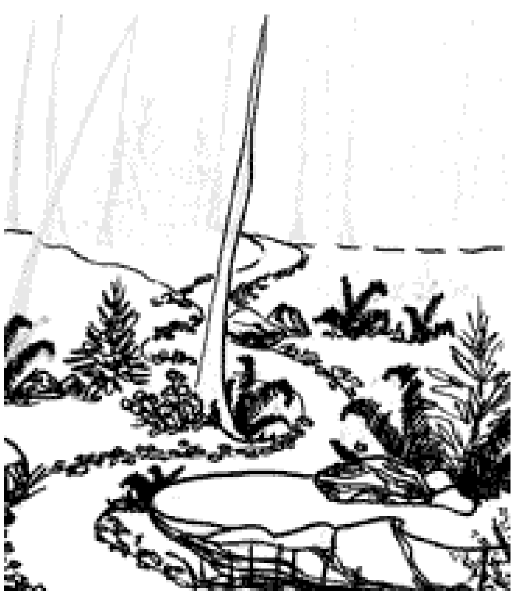
Curvilinear or Contour-design trail
Trail constructed so that it crosses the contours of the landform at a shallow or oblique angle.

[56] Cole, D.N. (1990). Ecological impacts of wilderness recreation and their management. In J.C. Hendee, G.H. Stankey, and R.C. Lucas, Wilderness Management (2nd ed.), North American Press, Golden, CO. pp. 425-466.

To minimize soil erosion and compaction on areas adjacent to the trail tread, design and construct your trail so that:

- The trail follows the natural contours (i.e., stays closer to the contours that the fall line) of the land.
- The slope of the trail should not exceed the maximum sustainable grade of the natural terrain (refer to Guidelines for Trail Design for additional information).
- Steps, water bars and check dams are not needed to control erosion on the trail tread. The need for these techniques indicates that the trail layout is not sustainable, and their use will dramatically increase the erosion and water damage to areas adjacent to the tread.

- The trail takes advantage of (i.e., pulls into and out of) naturally occurring swales and drainage features in order to ensure that the natural sheet drainage patterns of the landform are maintained.
- The tread has a consistent "outslope" so that the natural, sheet drainage patterns can continue easily across the trail tread.



In addition to minimizing the erosion and compaction of soil adjacent to the trail, **the uniqueness and sensitivity of trailside vegetation must also be carefully considered and appropriately managed**. The aesthetic appeal of a trail is enhanced if it takes the trail user through a variety of vegetation. Vegetation can be used to protect privacy, provide vistas, and enhance public safety. Close to the trail edge, leave vegetation so that it looks undisturbed. This will discourage users from going off of the trail tread and the foliage can help to reduce the impact of rainfall on the surrounding soil. If vegetation adjacent to the trail is damaged or must be removed during trail construction, ensure that the area is re-planted with native species as soon as the damaging construction work has been completed.

The construction of a trail often also provides opportunities to carry out habitat restoration or enhancement projects. **Actively look for opportunities to improve or restore the trail environment** as part of your trail construction project. Within urban areas especially, there may be funding available to encourage schools to be involved in naturalization projects or for the planting of native species. Similarly, the construction of a stream crossing can often offer opportunities for projects that will stabilize rapidly eroding banks or streams with pools and riffles.

When planning an environmental restoration or rehabilitation project, be sure to obtain all of the necessary permits and approvals. Wetland projects will require approval from the Ministry of Natural Resources. Conservation Authority approval may also be required, and the staff can provide detailed information about species at risk or other special considerations that may apply to the trail environment.

Clearing the Trail Corridor

The first step in constructing a trail is to complete the clearing of the trail corridor. With the initial brushing and clearing of the trail corridor completed during the design phase (see Guidelines for Trail Design - Clear Corridor), some of the clearing work will already be done. At this stage, the crew follows along the final flag line for the tread alignment, ensuring that all vegetation and obstacles (e.g., rocks) have been removed. There are three goals for this clearing work:

- Remove all obstacles or vegetation and other organic material (e.g., duff) that will hamper construction or the sustainability of the trail tread. Ideally, the topsoil (which is organic material) is removed so that the trail tread is built on compacted mineral soil. However, if the layer of topsoil is relatively thick, excavating down to the compacted mineral soil is not appropriate. In this case, only the loose soil should be removed along with the vegetation. This material should be carefully removed and stored during construction. After construction is complete the topsoil and vegetation can be used to restore the trail tread and adjacent areas.

- Remove restrictions and obstacles along the trail route so that it will be safe for all permitted trail users. Obstacles and restrictions that are potential safety hazards should be removed from on and above the trail tread as well as from the buffer zone.

- Remove the brush and vegetation from the cut bank and fill slope that will be created by the side slope adjacent to the tread. As the side slope gets steeper, the area that must be cleared gets larger because the top of the cut bank and the bottom of the fill slope get further apart. It is important to ensure that fill is not placed on top of existing vegetation because the filled area will become unstable and irregular (causing drainage problems) when the vegetation underneath the fill eventually rots.

In most places, especially in southern Ontario, clearing the trail corridor will require removal of the existing vegetation. **On the trail tread, all organic material must be removed** in order to optimize the sustainability of the constructed tread over time. **Adjacent to the trail tread, it is usually best to leave as much of the natural vegetation as possible**. A well-designed trail will minimize the need for vegetation removal by taking advantage of naturally occurring clearings and not requiring the removal of larger trees (which are an important environmental and aesthetic asset).

It is also important to **remove all objects that protrude into the trail tread area**. Rocks protruding from the trail tread are a tripping hazard for trail users, particularly those who are less agile (e.g., older adults) and those who may be inattentive (e.g., children). Objects that overhang the trail tread above the ground are also hazardous. Bumped heads or "whacks" on the body are not a component of a "safe trail experience". Objects overhanging the trail tread are particularly hazardous for people with limited sight and those who may be inattentive (e.g., children).

In certain special situations (e.g., tundra and riparian areas), existing vegetation must be left as untouched and undisturbed as possible to maintain environmental quality. In these special circumstances, the trail tread must be built above and around existing vegetation (refer to Tread Structures Above the Surrounding Terrain for additional information). Contact your local Conservation Authority and office of the Ministry of Natural Resources for detailed information about what, if any, work can be undertaken in these environments.

Occasionally it may be desirable, or even necessary, to make additional small openings in the vegetation along the trail. There are a number of reasons that additional openings may be desirable (e.g., provide a view, allow a rest area, provide a break in the "tunnel effect" of continuous canopy, management of species growth by altering sun penetration). The location of these areas and the work required should be specified in the trail construction log. It is important that **all decisions regarding vegetation removal be informed and approved**. In areas where the clearing limits are increased above the minimum, it is helpful to include a brief note about the reason(s) for the decision in the construction log. **Trail volunteers often equate the removal of vegetation with environmental damage**. Therefore, it is important for the construction crew leader to carefully monitor the work to ensure that the intended clearing limits are achieved throughout the trail.

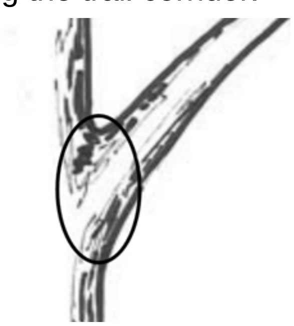
The specific methods and extent of clearing will vary, depending on the type of tread surface to be constructed. If an elevated tread surface (e.g., boardwalk, causeway) will be constructed, the initial steps to remove existing vegetation will likely not be required. However, to clear the trail corridor for safe and sustainable construction and use of a ground-level trail tread, complete the following steps:

1. **Ensure all members of the trail crew know and practice safety procedures**.
Clearing work on a trail typically involves people swinging tools that are heavy and sharp. Therefore, it is essential that appropriate safety practices be implemented. Before work on the trail begins, **ensure that all crewmembers are aware of the importance of basic safety practices**, such as:

a) Wear appropriate safety equipment (e.g., glasses, hat, leg guards).
b) Have a good grip on the tool handle (no wet or muddy gloves) and stable and secure footing.
c) Maintain constant awareness of other people in the area (workers and trail users).
d) Ensure that the work area, including areas overhead, are free of hazards (e.g., wires) or obstacles to correct tool use.
e) Choose the right tool for the job (see Tools Used for Clearing) and keeping the tool sharp and in optimal condition for use (e.g., no loose bolts).
f) Place tools not in use in a specific location (so others can find them when needed but people will not trip on them).
g) Carry tools safely (down at your side, blade guards on) to and from the work site.

2. **Remove all organic material from the trail tread**.
Organic material includes all vegetation, such as small plants, tree trunks and small bushes, and the root systems that support them. Root systems that are left in the trail tread will eventually rot, leaving a depression or "soft spot" that will encourage water to pool and may become a hazard for trail users. Vegetation on the trail tread also impedes water movement (sheet flow) across the trail tread. Any vegetation, organic matter or topsoil that must be removed from the trail tread should be kept for use in making repairs along the trail edges and elsewhere along the trail corridor.

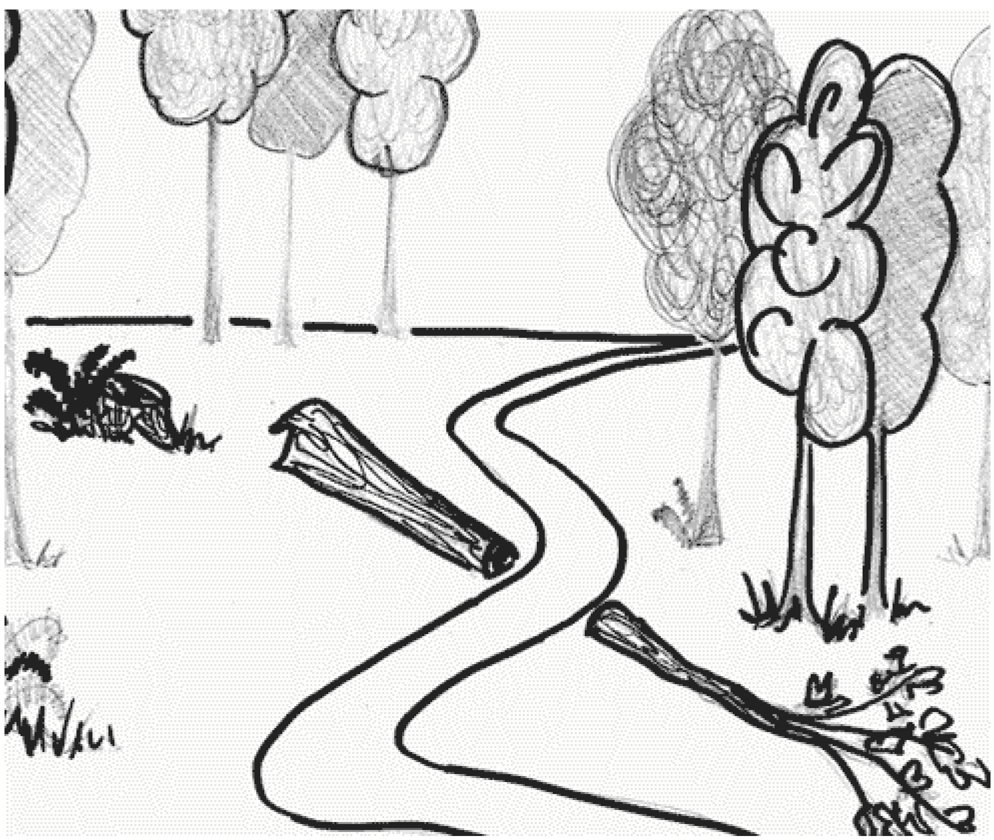
3. **Remove vegetation overhanging the trail tread**.
Overhanging branches are a commonly forgotten "item" during trail construction. The problems that they create for trail users are particularly acute on trails that are used during the winter season, when branches may be heavily laden with snow. **When removing stems and branches, always cut through the collar of the limb**, to decrease the risk of infection and promote healing in the living tree.



4. **Remove rocks and any other obstacles from the trail tread**.
All rocks or other obstacles (e.g., signs, tree stumps) must be removed from the trail tread area. The trail tread area is the area covered by the design width and design height of the trail (see Clearing Limits). The safety and enjoyment of all trail users is critical for the trail's economic and social sustainability. All trail users should have the opportunity to move along the trail without the risk of injury. For trails that are constructed on a bedrock surface, the trail design should choose a route that reduces, to the greatest extent possible, the hazards from protrusions into the trail tread area.

5. **Clear vegetation from the buffer zone**.
The buffer zone is the area of cleared vegetation outside of the trail tread. All vegetation that could injure trail users who veer off of the tread should be removed. Vegetation should be cut level with the ground to prevent potential injuries to trail users who may lose their balance or fall. Innocuous vegetation (e.g., existing small plants, turf, soft ground cover) should be maintained for aesthetic reasons and to minimize the erosive impact of rainfall on the surrounding environment. Noxious vegetation (e.g., hawthorn, poison ivy) should be cleared well back (at least 1 year's growth beyond all areas where trail users may be found) from the entire trail corridor (trail tread and buffer zone). Expect the unexpected. Not all trail users will be able to stay on the trail tread all of the time.

6. **Remove large branches and trees as specified in the construction log**.
   Often, the removal of larger branches or trees is not completed during the design phase brushing and clearing. In most cases, the removal of large trees or branches will be for safety reasons. Trail volunteers can remove large branches or trees that have already fallen, if they have the appropriate training and equipment. **Great care is required at all times when working with large branches or trees**. As the tree is cut, segments can shift suddenly and injuries often result. In general, it is best to cut a notch in the bottom side of large limbs before starting to cut down from above. The notch will decrease the risk of equipment binding or getting caught as the cut is made. A notch will also decrease the probability of uncontrolled cracking of the limb, which may result in damage to the remaining tree (e.g., stripping of the bark). The notch should be 1/2 to 2/3 of the thickness of the limb. A notch from below may not be possible if the limb is on or close to the ground. **The felling of trees (either dead or alive) requires specific expertise, so professional assistance is recommended**. If the tree is in the trail tread, the tree should be felled at a height (1.5 metres) above the ground, so that the remaining trunk can provide leverage that will assist in removing the root system as well. If there is any question that the tree or branch being removed is diseased, professional advice should be sought to determine whether the pieces from the felled tree should remain in, or be removed from the trail environment.

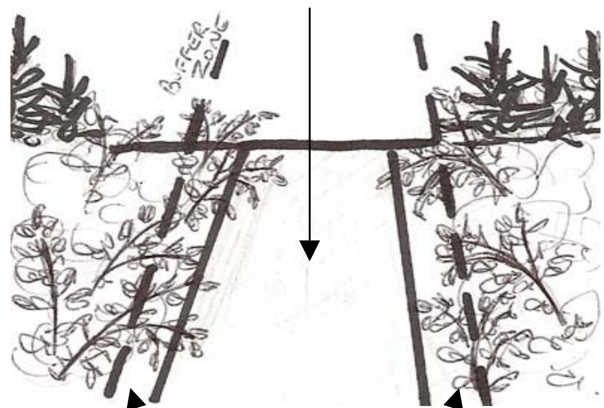


Clearing Limits

The clearing limits for the trail corridor should be specified in the construction log. **Decisions regarding the size of the trail tread area and buffer zone are made during the design phase**, and are typically based on input from local environmental experts and the landowner in addition to the needs of trail users.

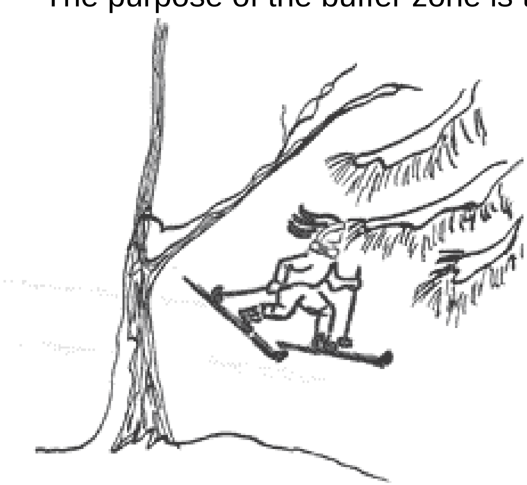
The clearing limits for the trail corridor will be determined by two factors:

- Designed trail tread area.
- Buffer zone.



The **designed trail tread area is the width and height of clear space required by permitted trail users**. For a hiking trail, the designed width should be 1.0 metre (3 feet) or more and the designed height should be 2.0 metres (6.6 feet) or more. For trails that permit other user groups, the design width and height may be increased.

The **buffer zone is the area on both sides and above the designed trail tread area**. The purpose of the buffer zone is to establish the sight lines required for safe trail use, minimize the damage to trailside vegetation from users who stray off of the tread, and ensure that vegetation does not encroach onto the trail tread between the times for scheduled maintenance. The **buffer zone should be at least 0.3 metres (12 inches) wide on each side of the trail and at least 0.5 metres (20 inches) above the top** of the designated trail tread area. Many trail managers and landowners require larger buffer zones, particularly on more remote trails where maintenance is infrequent, on trails where users may be travelling at higher speeds, or where the position of vegetation is routinely affected by heavy ice, rain or snow conditions.

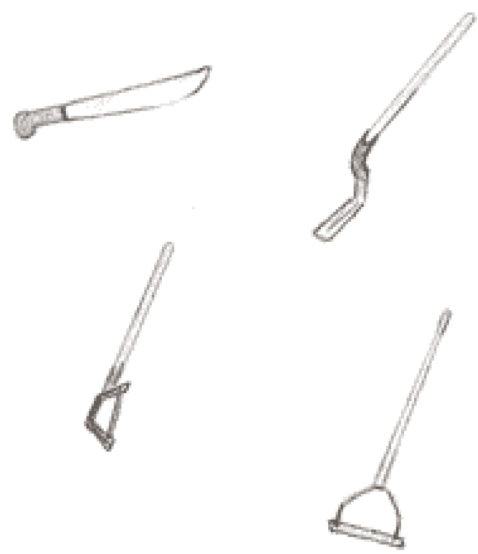


Construction crews should not make changes to the plans for vegetation removal described in the construction log. If additional vegetation removal seems to be required, the trail designer, a person who knows the local natural vegetation and the landowner should be involved in making and approving any changes. Trail workers should also make sure to clear the corridor to the width specified in the construction log. Many trail volunteers may mistakenly believe that clearing less vegetation will result in less environmental impact. However, trail impact research has clearly demonstrated that the vegetation loss and vegetation impact is much greater if the vegetation removed during construction is not wide enough for two trail users to walk the trail side by side. If vegetation is not carefully cut by trail workers so that the tread and buffer zone are free of vegetation, inevitably trail users will bend or break the vegetation to get it out of their way. Broken branches often result in stripped sections of bark which leave the vegetation at much greater risk for infection. In some cases, the stripped bark may actually kill small saplings.

Tools Used for Clearing

A wide variety of hand tools can be used for trail clearing. Specific tool choices will depend upon the type and diameter of the vegetation to be removed. **Make sure that all trail workers have the training and experience to use tools appropriately and safely**.

<u>Clearing Weeds and Dense Vegetation</u>



Powered mowers (e.g., string mower[57]) and **weed cutters** (often called "weed whip", "swizzle" or "weed whacker") can be used to quickly clear fields of grassy vegetation. If powered equipment will be used, the work crew should make a "first pass" to remove the larger saplings before the weed clearing work begins. Often, alternating passes of removing saplings and weeding are required. The saplings are difficult to see before the weeds are cleared, but the weeds are more difficult to clear when they surround more substantial vegetation. For particularly dense vegetation, a **Swedish brush axe** (also known as a Sandvik) can be used. It functions similar to a machete, but the shorter blade and long handle make it much safer to use.

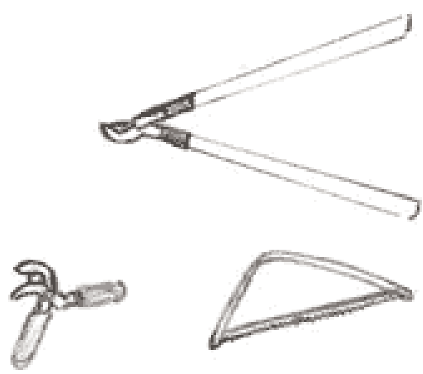
[57] Bruce Trail Association. (March 2005) How to cut tall grass. <u>Treadway</u>, pp 11.

Safety first!

Cutting and digging tools are sharp and care must be taken in their use. Chainsaws are extremely dangerous and should only be used by properly trained individuals. Tools that bounce or glance off tree trunks or stumps when swung are a common cause of injury among trail volunteers. Keep your tools sharp, and ensure volunteers know how to use them correctly before letting them on the trail. Everyone using these tools must have access to and use the necessary safety equipment (e.g., glasses, safety boots, gloves and leg guards).

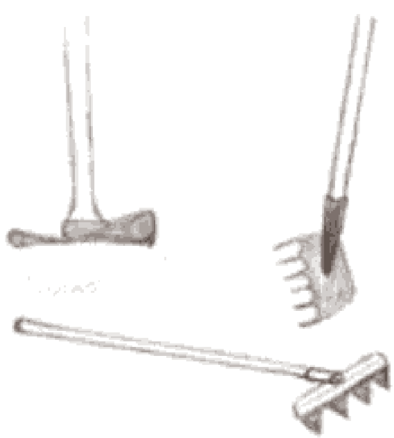
Cutting Small Saplings and Twigs

Hand-held **pruning shears** and **secateurs** are effective tools for snipping through small twigs (less than 2 cm (0.8 inches) in diameter). Long handled **by-pass pruners**, **anvil clippers**, **loppers**, or **folding handsaws** can be used for larger saplings and twigs. Pruners and loppers are generally preferred, because they give a clean cut (allowing the bark to heal more quickly) and are safer to use and carry. Models with ratchet or power assist features can effectively cut vegetation up to 5 cm (2 inches) in diameter. Long handled tools and tools with telescopic handles are particularly important for trimming small branches from mature trees. The long handles ensure that the worker can reach into the tree and make a clean cut through the collar of the branch, adjacent to the tree trunk.



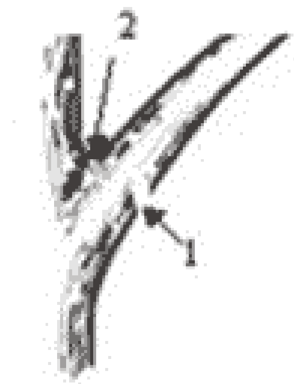
Cutting Large Branches and Tree Trunks

For larger branches and tree trunks of more than 5 cm (2 inches) in diameter, saws are usually the “tool of choice”. Saws provide a smoother cut, are generally more efficient, and are easy and reasonably safe for volunteers to use. Handsaws are available in a variety of sizes and styles. **Pruning, bow or crosscut saws** are most commonly used by trail volunteers. **Pole saws** are useful for cutting limbs that otherwise would be out-of-reach during trail maintenance sessions (e.g., those limbs that are out of reach in the summer but in the face of skiers in the winter).



While chainsaws may be the fastest and most efficient way to clear large trees, stumps or logs, they are heavy to carry over distances and dangerous for inexperienced users. **Chainsaws should only be used by individuals who are thoroughly and properly trained**.

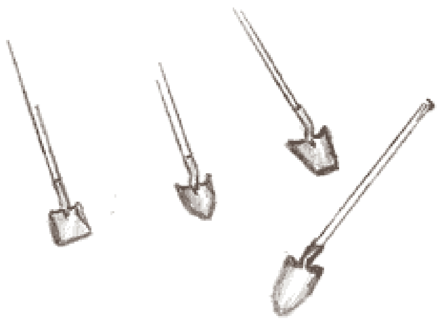
Training courses in the use of chainsaws are available through many schools and organizations. If chain saws are to be used on a trail, the work should be done by an experienced crew (the person cutting plus two assistants) at a time when other trail workers and trail users are not in the area (i.e., either before or after the other trail work in the area has been completed).



Cut large branches through the collar. If the branch is large, make the first cut up from the bottom a short distance from the collar. The second cut is made through the collar, cutting down from the top.

<u>Digging and Rock Moving Tools</u>

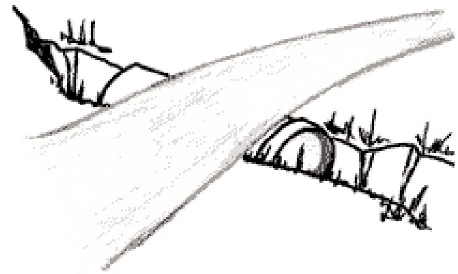
Grubbing tools, such as a **Pulaski**, **McLeod**, **grub hoe**, **fire rake** or **mattock**, are used to loosen dirt, cut through roots and remove ground cover vegetation. Workers using a Pulaski, McLeod or mattock must be constantly aware of the position of the cutting blade (which is opposite the digging tool).



Shovels are the primary tool used for digging and moving earth or rock. They are available in a wide variety of sizes and shapes. Square or flat shovels are suitable for moving loose earth and for shaping the trail tread. Round-point shovels are best for digging. Longer handles will reduce the amount of bending required but many people find a short-handle shovel better for carrying heavy loads. The optimal style and size of shovel for each trail task will depend on both the type of work being performed and the preferences of the trail workers. The pick end of a Pulaski or mattock can also be used to loosen compacted soil.

The removal of large rocks from the trail tread should be a relatively infrequent work task. In most cases, it is preferable to design the trail so that is bypasses the large rock. Bypassing the rock will have less environmental impact, and it is also less work. If the removal or relocation of a large rock is specified in the construction log, tools such as a **pry bar**, **rock bar**, **digging bar**, or **wrecking bar** will be used. In some cases, a **winch** or **grip hoist** may also be required. The person in charge of the trail crew is responsible for ensuring that the workers have the appropriate training and experience before any specialized techniques or equipment are used. Seek assistance from experienced personnel if there is any concern regarding the trail crew's ability to complete the required work.

Trail Drainage Structures



Trail drainage structures can be used to separate the trail tread and buffer zone from natural drainage channels that contain concentrations of flowing water. The installation of any type of drainage structure will require permits or approvals from the Ministry of Natural Resources or the Conservation Authority because changes to water flow patterns in the trail environment can have significant impacts on ground on water-based habitats. The construction methods and materials must also be approved to ensure that sediment or construction debris does not adversely affect fish habitat. The permits will provide detailed information about how and when the work can be completed as well as the size and configuration of the approved drainage structure.

Drainage structures within the trail tread or buffer zone should always be of a "closed" design (e.g., culvert, drainage lens). A closed drainage structure is an alternative to building a tread surface above the water flow (e.g., boardwalk). Either a drainage structure or an elevated tread is necessary to prevent the trail tread from having a significant impact on natural drainage channels that either intermittently or continuously contain a reasonably large volume of water.

Drainage structures can be made of many materials including plastic, metal, wood and stone. Each has advantages and will influence construction work in different ways.

- Plastic is light, easy to carry to the trail location and easy to cut with a hacksaw or sharp knife. Choose a dull, neutral colour so the culvert will be less conspicuous.

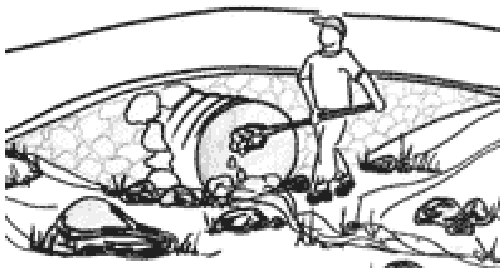
- A wooden culvert may be a number of logs buried under the trail. The tread material is placed on top and the logs are positioned to allow water to pass between them.

- Where large, well-shaped rocks are available, a rock culvert or closed French drain can be built as a durable and beautiful drainage solution. However, each stone must be carefully fitted against the others for the structure to function properly. Rock culverts are not practical if rocks must be carried in to the site.

The size of the drainage structure, and the materials used to construct them, depend on the location of the natural drainage channel and the volume, continuity and dispersion of the water flow. The aesthetics of the trail environment are also considered during the design of trail drainage structures. The **design of the drainage structure is crucial if it is to function in a sustainable manner** with a minimum of maintenance. For this reason, the size, material, location and grade of the drainage structure specified in the **construction log must be closely followed**. The person responsible for the construction crew must assume overall responsibility for ensuring that the constructed drainage structure conforms to the specified design. **The construction of a drainage structure is complex, and the steps involved vary each design**. Ensure that the trail designer and crew have the knowledge required for the proper construction or installation of the drainage structure.

Culverts

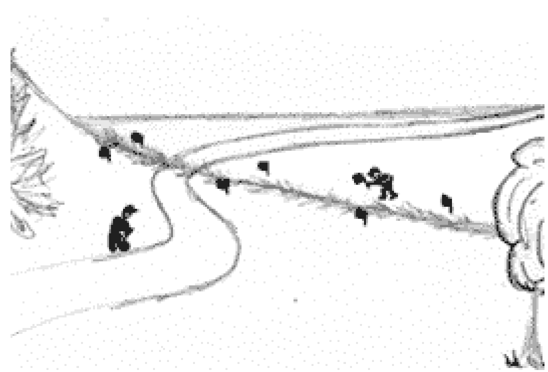
Culverts support the trail tread so that it does not interfere with a natural drainage channel. They are deceptively “simple-looking” drainage structures. Nothing would seem easier than to dig a trench, lay in a pipe, and put the earth back on top. However, experienced trail volunteers know that **careful installation and attention to detail is required to install a culvert that will continue to function effectively with little maintenance**. Whenever possible, have someone with experience (i.e., they have previously installed several culverts that worked well for more than one year) involved in the culvert installation.



In recent years, culverts have typically been plastic or galvanized metal pipes that are purchased “ready to go”. Corrugated metal culverts are typically used for larger water volumes. It is also possible to build culverts using rocks or logs, but these structures require a lot more work and significantly more expertise. All **culverts should have a diameter of at least 30 cm** (12 inches) so that maintenance of water flow through the culvert will be easier (e.g., a shovel can be used to clear material blocking water flow).

The trail designer will have specified the size and type of culvert required in the construction log, based on the volume and frequency of water flow. From a sustainability perspective, it is essential that **culverts are used to protect and maintain naturally occurring drainage channels** so that they are not blocked by the construction of the trail tread. Efforts to force water through a culvert that is not in the natural drainage channel cause substantial damage to the natural environment and are rarely effective. Construction crews must be careful to position the culvert in the correct position. The construction crew leader must also **ensure that all necessary permits for the use of a culvert have been obtained before the construction work begins**.

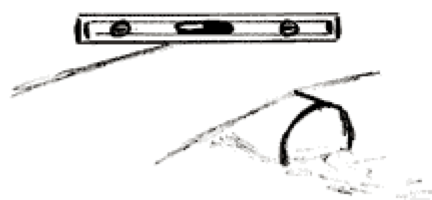
The steps to install a plastic or metal culvert are:



1. **Mark the natural drainage channel**. Examine the natural drainage channel before starting construction. Use pin flags, environmentally safe marking chalk or flagging tape to record the precise location of the natural drainage channel on the landscape. Make sure that the markings are outside the construction area so that they will remain clear and available for referencing even after excavation has started.

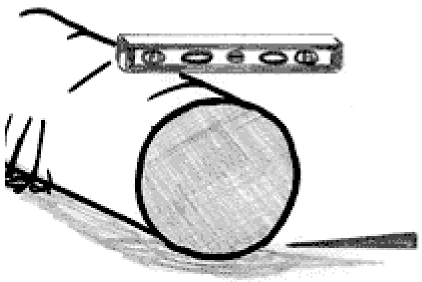
2. **Remove the vegetation and topsoil**.
   Carefully remove the organic material (vegetation, roots, stems) and topsoil from the site where the culvert will be installed. If possible, preserve these materials for use in rehabilitating the site after construction of the culvert has been completed.

3. **Dig a trench at the location of the culvert**.
   
   The mineral soil is excavated at the location of the culvert. The amount of excavation will depend on the size and position of culvert. As a general "rule of thumb", the trench should be at least 20 cm (8 inches) deeper than the vertical height of the culvert, although different designs may vary this depth requirement. The trench (and the culvert it will contain) should extend at least 30 cm (12 inches) beyond each side of the trail tread. Take care to check the position of the trench frequently during excavation, using the reference marks on the landscape (Step #1).

4. **Establish the grade of the drainage structure**.
   
   The grade within the drainage structure is critical for proper function. Without proper grade placement, the movement of sediments through the drainage structure will be compromised. Follow the grade specifications for the culvert in the construction log carefully. **The culvert should drop at least 6 cm for every 100 cm of horizontal distance** to maintain adequate water flow. Utilize a digital level to measure the grade of the surface on which the culvert will sit as well as at 3 or more locations on the culvert itself (once it is installed).

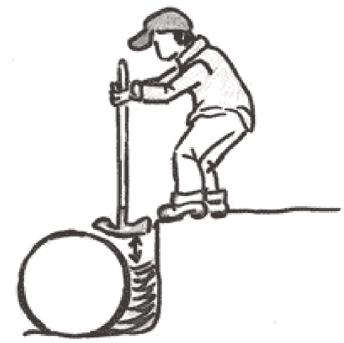
5. **Size and shape the culvert**.
   In most cases the culvert will already be cut and shaped to the correct size before it is delivered to the site. Make sure that the top of the culvert extends at least 30 cm (12 inches) beyond each side of the trail tread. Cutting the ends of the culvert at a 45-degree angle (down and away from the tread) will improve the aesthetics of the culvert in the trail environment.

6. **Position the culvert**.



If a plastic or metal culvert is used, the structure is placed into the trench and then shimmed and stabilized as necessary to ensure proper positioning. If a wood or stone culvert is desired, it must be constructed within the trench. The culvert must be aligned so that the natural path of water flow can enter the culvert without a forced change in direction. The culvert must also be wide enough and deep enough so that water will flow through and out of the finished structure without a significant change in water speed or direction. Changes to water speed or direction will cause sediment to fall out of the water flow and accumulate in the culvert.

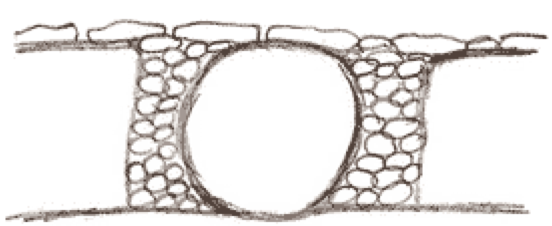
7. **Backfill around the culvert**.



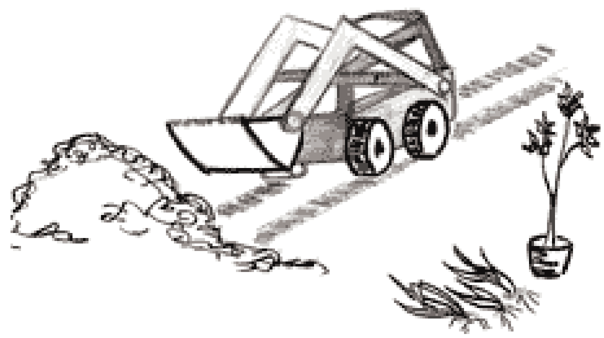
After setting the culvert in position, backfill around the culvert with the material previously removed from the trench. Add fill until it is halfway up the side of the culvert and then compact the fill firmly using a flat shovel, McLeod or tamping bar. Continue to alternate layers of fill (up to 15 cm (6 inches) in height) with tamping and compacting until the culvert is completely buried. Compacting the material around the culvert will add strength to the pipe and ensure that correct positioning is maintained. Check the position of the culvert frequently during this step (against the reference marks created in Step #1) to ensure that the tamping and compaction does not shift the culvert position. When the back filling has been completed, the area on top of the culvert should still be 20 cm to 30 cm (8 to 12 inches) below the level of the adjacent trail tread.

8. **Cover the structure with tread material**.
The culvert should be covered with at least 20 cm (8 inches), and preferably 30 cm (12 inches) of tread surface material. The height of tread surface material above the culvert should match the adjacent trail tread so that the finished trail tread has a consistent height and surface. The tread material above the culvert should be installed using the same techniques used throughout the trail.

9. **Stabilize soil and tread material near the inflow and outflow**.
Set large rocks around each end of the culvert to stabilize the fill or soils adjacent to the intake and outflow and to hide the ends of the pipe.



Drainage Lenses

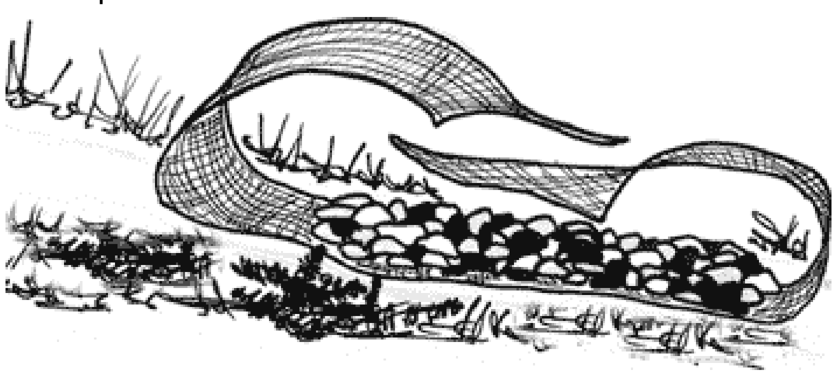


A drainage lens is constructed below grade to allow for water movement underneath the trail tread. It is typically used instead of a culvert where the flow of water is smaller in volume or more dispersed across the terrain. A “French drain” is a term often used to refer to a very similar structure that is built into, rather than below, the trail tread. A drainage lens should be used instead of a French drain so that trail users of all abilities will be able to safely negotiate the trail.

The steps for constructing a drainage lens are:

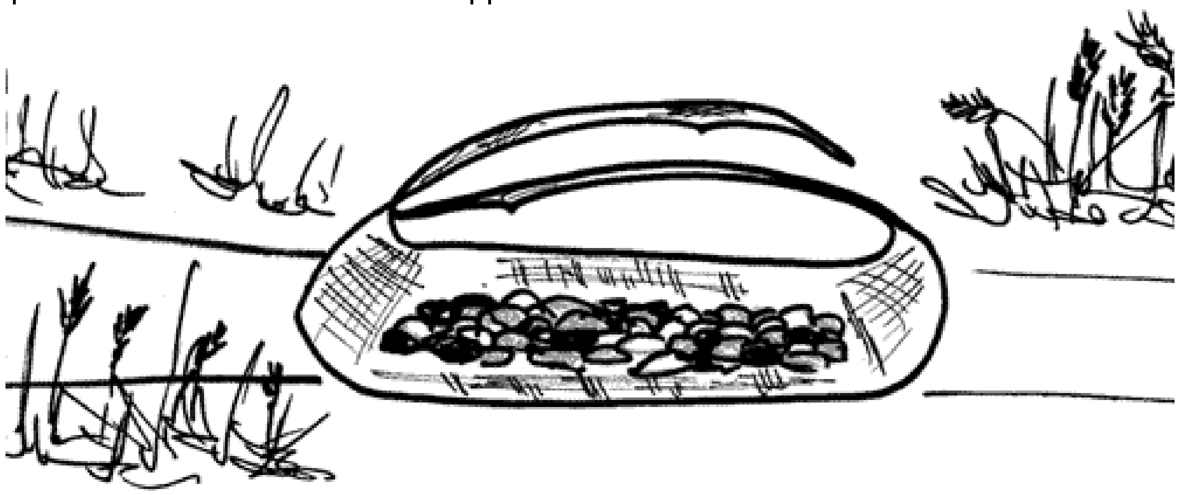
1. **Prepare the site.**
   Carefully remove the organic material (vegetation, roots, stems) and topsoil from the site. If possible, preserve these materials for use in rehabilitating the site after construction of the drainage lens has been completed. Make the clearing wide enough for the trail tread plus the buffer zone on both sides of the tread.

2. **Install landscape fabric**.
   Lay down a layer of landscape fabric along the trail tread. The fabric should be long enough to completely cover the site where the drainage lens will be plus have enough additional material to fold back over the top of the drain rock with a 30cm (1 foot) overlap.



3. **Install the drain rock**.
   Place 15 cm (6 inches) to 25 cm (10 inches) of drain rock on top of the bottom layer of landscape fabric. Drain rock is large (5 cm to 15 cm (2 to 6 inches), irregular pieces of gravel or crushed rock that provides open spaces for water flow even when the rocks are firmly compacted.

4. **Position the top layer of landscape fabric**.
   Fold the ends of the landscape fabric that are lying on the adjacent trail tread back over the top of the drain rock like a “sausage” or “burrito”. Make sure that the ends of the landscape fabric overlap each other by at least 30 cm (12 inches) and that the open ends of the “burrito are on opposite sides of the tread.



5. **Install the tread surface material**.
   Put the tread surface material on top of the “burrito” of drain rock. Layers of material 10 cm to 15 cm (4 to 6 inches) thick are added and then compacted. Continue to alternate fill layers and compacting activities until the tread surface reaches the desired height. The surface material should now match the tread of the rest of the trail.

6. **Rehabilitate the buffer zone**.
   Use the topsoil and organic materials removed from the tread to re-establish a natural surface in the buffer zone. Make sure to provide enough depth of topsoil on top of the landscape fabric (at least 15 cm or 6 inches) to allow for adequate growth of ground cover vegetation.

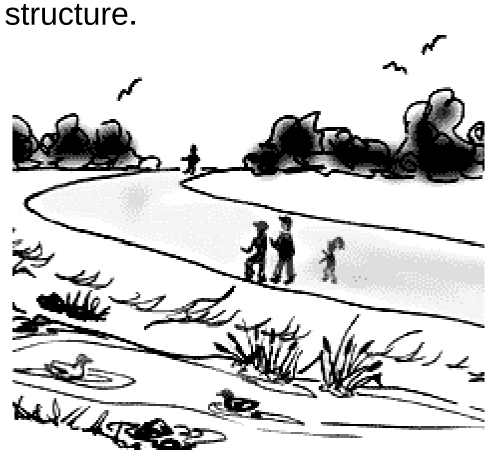
Open Drainage Structures

Open drainage structures, such as ditches, French drains or bleeders, have traditionally been used to channel water in trail environments. However, **using open drainage structures within the trail tread creates a trip hazard** and many trail users find it difficult to navigate the water-filled channel or the uneven surface of drain rock. For these reasons, **open drainage structures should not be constructed within the trail tread or buffer zone** (i.e., anywhere that users may be expected to travel).

The trail designer should carefully consider the environmental impact of an open drainage structure before including it in the construction log. The advantage of open drainage structures is that they often require fewer materials (i.e., less expensive) and with little maintenance or observation they may be less likely to clog. Therefore, the construction of open drainage structures can be considered in areas away from the trail tread and buffer zone. For example, they can be used to contain water flow within a natural drainage channel that connects to a closed drainage structure (e.g., culvert) that crosses the trail.

To construct an open drainage structure:

1. **Identify the natural drainage channel**, outside of the trail tread and buffer zone, that needs to be enhanced with an open drainage structure.
2. **Dig a trench** along the natural drainage channel extending from the water source(s) to the optimal discharge point. If possible, use natural discharge points (such as creeks) as the end point for the trench. The trench must be wide enough and deep enough to allow water to flow through and out of the trench without significant changes in water speed or direction. The size and location of the trench will be determined by the volume of water and local terrain.



3. For a French drain or bleeder, fill the trench with large pieces of rock. The rock pieces should be large enough that water can easily flow in between the rocks. Filling the trench with rock keeps the “surface” of the open drainage structure at a level similar to the surrounding terrain. The flowing water must be reasonably clear of dirt and debris for this type of construction. Otherwise, the drain will quickly be filled with silt and the water will no longer pass through. In areas where the flowing water contains a moderate or high amount of sediment, the trench should be left completely open.

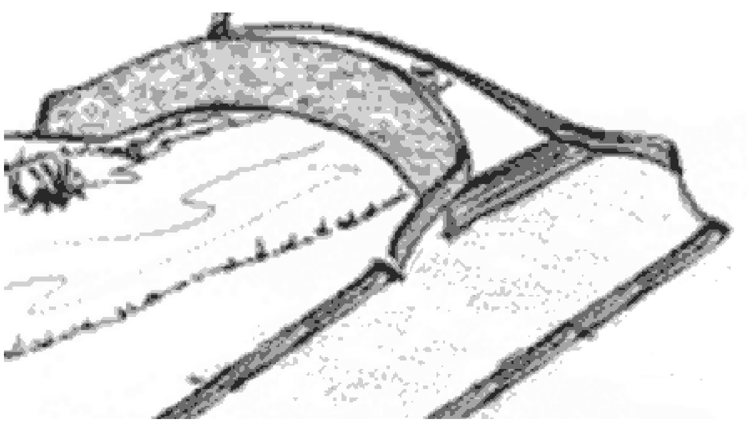
Constructing Trail Tread Structures

Tread structures are used when the natural terrain cannot provide or should not be used for a sustainable tread. The structure raises the tread above the natural (i.e., difficult or sensitive) terrain. Typically, tread structures are built in areas with a lot of water (either visible water or saturated soil). Tread structures can also be used to protect areas with delicate plants (e.g., tundra) or make the surface underfoot more even and stable (e.g., crossing a rock slide).

The terminology and construction methods used in relation to tread structures varies dramatically. The feedback on initial drafts of this resource was extremely diverse, polarized and variable from trail group to trail group. Opposing and strongly held views were difficult (and in some cases impossible) to reconcile. However, there was agreement on two general categories for trail tread structures:

- **Intermittent contact structures**.
  Boardwalk, puncheon and bridges are examples of structures that are built so that contact with the terrain is intermittent (e.g., contact with the natural terrain occurs only at support structures such as cribs, abutments, or sills).

- **Continuous contact structures**.
  Causeway and turnpike are examples of tread surfaces that are built up from a base that is in constant contact with the natural terrain. The ramps onto and off of intermittent contact structures are also typically built as continuous contact structures.



Intermittent contact structures are preferred for areas where water is a dominant feature of the landscape. Even if water is not visible, the construction of a continuous contact structure can significantly damage the natural drainage patterns. **Continuous contact structures cannot be used in areas where delicate plants must be protected**. Although continuous contact structures have historically been used extensively to construct trail tread, from a sustainability perspective they have limited use. They should be used primarily, in select locations not affected by surface water flow, when providing a more consistent tread surface is a priority.

The trail designer will consider a wide range of factors (e.g., environmental impact, permitted trail users) in deciding on the type of tread structure required. The construction of tread structures requires substantial labour, but it is often the “activity of choice” for volunteers who can easily see the results of their efforts. The primary responsibility of the construction crew is to **ensure that “as built” is the same as “as designed”** (i.e., the constructed structure complies with the specified design as closely as possible) **and that there is as little impact on the surrounding environment from the construction activities as possible**.

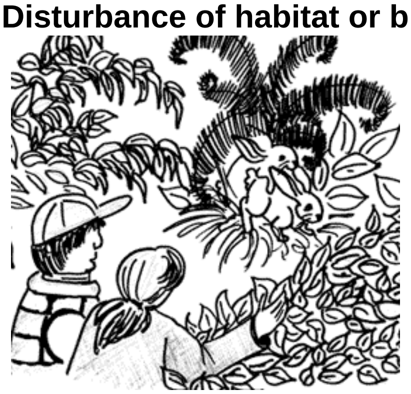
As previously stated, 90% of the environmental damage related to a recreation trail will occur during construction and initial use. If the trail is constructed for sustainability, the environmental impact will be almost entirely related to the initial trail construction. As a result, **construction crews have almost total control over the environmental impacts that will occur**. Negative environmental impacts that can result from trail structure construction typically include:

- **Erosion of loosened soil into nearby bodies of water**.
  Sedimentation of water channels affects many plants and aquatic species and can easily damage fish breeding sites.

- **Trampling of delicate wetland vegetation**.
  Trampling can occur not only as workers move around the construction site, but also as materials or tools are put aside when not in use.

- **Contamination of the trail environment with construction debris**.
  It goes without saying that all unused or replaced construction materials should be removed from the trail environment for proper disposal. In addition, it is also necessary to consider the removal or appropriate disposal of construction debris that has blended with the environment (e.g., sawdust that has fallen on or under vegetation), small chunks of wood that have been pressed into the soil.

- **Disturbance of habitat or bird/animal behaviour**.



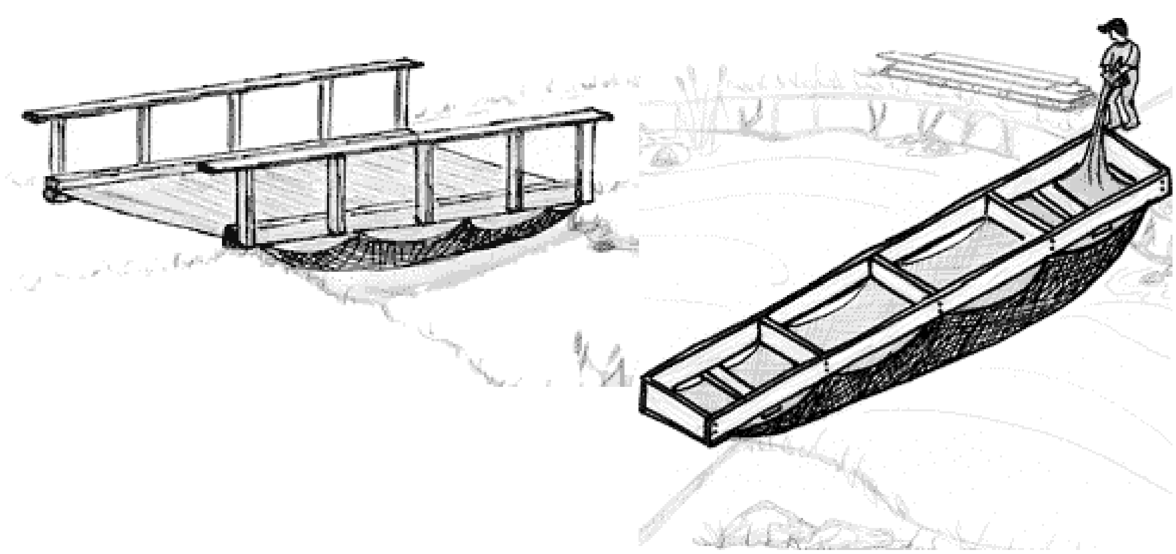
  Particularly near bodies of water, the natural habitat is crucial for fish, birds and other wildlife. Even if permanent damage (e.g., trampling) does not occur, construction work must be done with consideration of breeding patterns. Just having people nearby during a crucial breeding period can significantly impact some species. Ensure that work plans take into consideration the fauna that will be affected by the construction activities.

In order **to minimize the environmental impact of trail structure construction, work crews should**:

- **Carefully control the loosening and movement of soil**. Place a silt fence or weed-free straw bales immediately downslope of excavation areas and downstream of bridge crossings. If silt fences will be placed within a body of water, the planned work must be approved by the local office of the Ministry of Natural Resources before any construction activities begin. Carefully remove the silt fence when construction is complete, making sure that the collected materials are not released into the environment. Recover the soil and vegetative materials trapped by the silt fence or straw bales and use them to restore the construction area or rehabilitate other areas of the trail environment.

- **Be constantly vigilant about where people walk and where tools and materials are placed**. Work crews must always be conscious of where they are walking or placing tools and materials in order to minimize the trampling of vegetation that will occur. If possible, walk and store materials on the existing trail tread. If that is not possible, try to choose areas devoid of vegetation (e.g., granite outcrop) or areas with primarily invasive species for the placement of tools and materials and the completion of construction activities (e.g., sawing wood). When construction is complete, rehabilitate the construction area by replacing any trampled vegetation with native species, firmly compacting and shaping loosened soils to match the natural terrain and covering excavated areas with a small layer of duff.

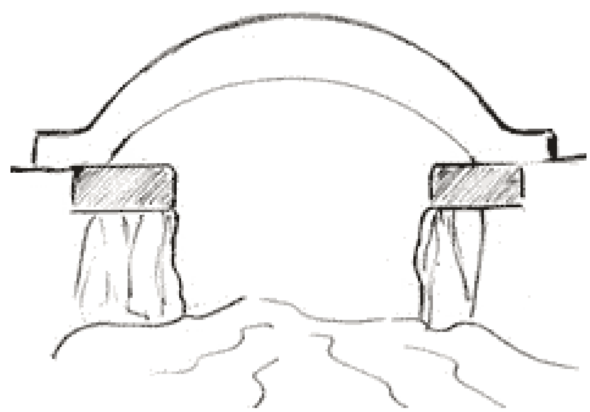
- **Shield the surrounding environment from construction debris**. Cover the trail tread or construction area with a tarp so that all of the sawdust, small wood pieces and other construction debris can be easily collected and removed from the environment. If a bridge or other intermittent contact structure is being built, attach a piece of geotextile fabric to the stringers or cribs so that it hangs just below the structure being constructed. The fabric (often referred to as a "bridge diaper") will act as a drop cloth to not only catch the construction debris but also the oil and gas residues produced by gas-powered tools and equipment.



- **Protect trees and boulders used for anchors**. When rigging or winches are being used to move heavy materials (e.g., bridge stringers), great care should be taken in how the rigging or winches are attached to the tree(s) or boulder(s) that will be used as anchors. Use wide nylon webbing as the straps around the anchor point. The wide straps will disperse the forces on the anchor and help to prevent damage to the rock surface or the bark and sap channels of the trees. Select anchors carefully to ensure that they will not be uprooted or displaced by the forces that will be exerted on them.

- **Construct structures that do not alter existing water channels or natural drainage patterns**. Structures constructed adjacent to water channels (e.g., bridge abutments, cribs) must be built within the natural embankment so that they blend seamlessly with the natural contours of the terrain. Built structures should not alter the existing stream channel or protrude into the water course. Alteration of the stream channel will result in bank erosion opposite the structure and downstream erosion on both sides of the water course.

Prior to the start of construction, it is essential that all necessary approvals and permits have been obtained. Confirm that the local Conservation Authority and any other relevant government offices or organizations have reviewed and approved all aspects of the proposed work. Approval must be obtained not only for what will be constructed, but also the timing of construction. Exactly who will need to approve the project will vary, depending on factors such as land ownership, type of environment, natural habitat, presence of water bodies, etc. The land management agency should be able to provide the names and contact information for the relevant agencies and organizations.

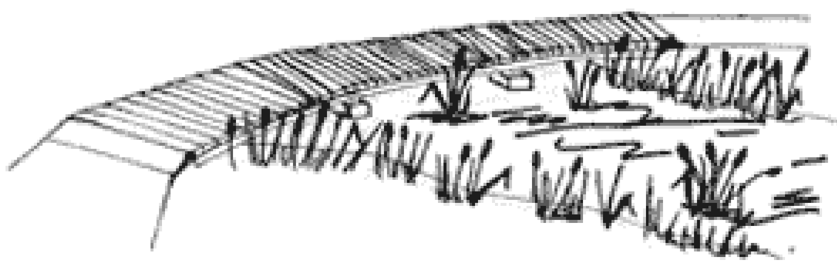


Elevated tread structures are the most costly and labour-intensive aspect of trail construction. For bridges, there are additional liability concerns because the trail user is elevated above the surrounding terrain. Regardless of size, all components of an elevated tread structure must be constructed to appropriate standards for load carrying capacity. **Trail designers must ensure that the structure specifications in the construction log conform to all required safety and engineering standards**.

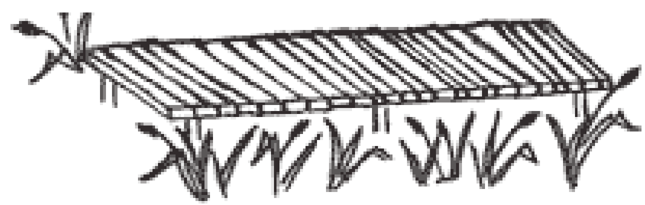
Tread Structures Above the Surrounding Terrain

Trail volunteers use a wide variety of terminology to describe the tread structures that they build to elevate the trail tread above the surrounding terrain. For the purposes of this resource, the following terms are used:

<u>Boardwalk (Puncheon Design)</u>
A walkway that is **close to the ground** (i.e., less than 0.3 metres or 1 foot above surrounding terrain) and is **constructed on sills** that sit on the natural terrain.



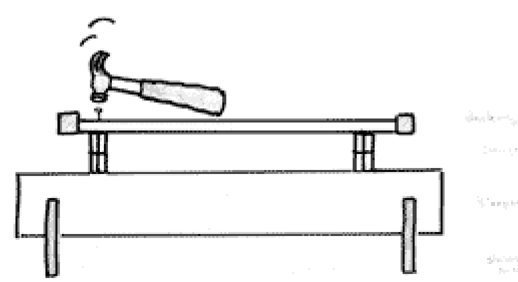
<u>Boardwalk (Post Design)</u>
A walkway that is **close to the ground** (i.e., less than 0.3 metres or 1 foot above surrounding terrain) and is **constructed on posts** drilled or dug deep into the ground.



<u>Bridge</u>
A walkway that is **elevated above the ground** and is **constructed on anchor posts, cribs or abutments** that are drilled or dug deep into the ground.

Regardless of which anchoring technique is used, the height of the walking surface above the terrain, or the stability of the soil, the same general steps are used:

- Install the anchor system (sills, posts, or abutments).
- Level the height of adjacent anchors.
- Attach stringers to the anchors.
- Attach decking to the stringers.
- Construct the approaches.
- Attach handrails or deck edging (if required).



More detailed information on each of these steps is provided in the following sections.

Choose construction materials carefully!

It is critically important that the construction materials used for elevated tread structures are carefully selected based on the demands of the environment and the safety of trail users. **Some types of wood (e.g., cedar) are less likely to rot**, particularly if the weather allows them to dry out intermittently. An oil-based stain is suitable for lengthening the durability of natural wood structures in some natural environments. Plastic lumber products can also be used, but they will require much more extensive support structures. Regular maintenance will also be required to prevent the growth of algae which makes the plastic lumber surface extremely slippery when it is wet.

Pressure treated wood is often the "building material of choice" for tread structures because it is expected to last a long time. Until January 2004, wood was commonly treated with Chromated Copper Arsenate (CCA). CCA has been linked to health problems for many people. Since 2004, arsenic, a known cancer-causing agent, has been removed from the chemicals used to treat wood. However, building supply companies were, and still are, allowed to sell off existing stocks of CCA treated wood. Today pressure treated wood is typically created with chemicals such as amine copper quat (**ACQ**) or copper azole (**CA**). At the very least, these options are less toxic than CCA. However, some health concerns remain and it is still advisable to take precautionary measures when using wood treated with these chemicals. Lumber companies continue to develop non-toxic wood preservatives. Products using sodium silicate[58] are promising, but when this resource was created they were not yet available in Ontario.

Always use safety equipment when cutting and using treated wood, such as gloves, glasses, and a dust mask.

[58] Timber Treatment Technologies. TimberSIL: Locked in for life. [On-line] Retrieved 31 July 2006 from www.timbersil.com

Installation of Anchor Sills

Anchor sills (also called mud sills) **provide support for the stringers and are the only part of the elevated tread structure that contacts the ground**. Sills can be made from a variety of materials, including logs, lumber and concrete. The size and number of sills will be determined by the required load carrying capacity and the type of terrain. If the natural soils are stable, a smaller sill will be required. In areas where soils are unstable, larger sills will be required. Parking lot curb blocks make excellent sills, although they can be very difficult to transport.

The vertical dimension of the sill should ensure that **the top of the sill is at least 15 cm (6 inches) above the adjacent terrain** to separate the stringers from the ground. If one sill is not high enough, a small crib can be built. To build a crib, put two logs parallel to each other on the bottom row and then add a second row of logs that is perpendicular to the first row. Additional rows can be added as necessary, each perpendicular to the last, to achieve the desired change in height. Ensure that the top row of logs is perpendicular to the boardwalk stringers. A small gabion basket can also be used in place of an anchor sill. Sills, cribs and gabion baskets should never be located within a watercourse where they would interfere with the natural water flow patterns. Refer to Construction of Abutments for additional information about cribs and gabion baskets.

To install anchor sills:

1. **Remove the organic material**.
   Remove all vegetation and organic material (e.g., roots, loose top soil) from the ground that will be under the sill. Organic material left under the sill will eventually rot, and soft spots may develop causing the sill to shift. Take care not to remove organic material or vegetation from the areas beside the sill. Removing too much vegetation can encourage erosion and it also detracts from the aesthetics of the trail environment. In areas with shallow topsoil, the topsoil should also be removed so that the sill is placed directly on a base of mineral soil. However, in areas where the topsoil layer is quite thick, this may not be practical.

Research in Alaska suggests that cellular containment panels can be used for trails in areas saturated with water (e.g., muskeg)[59]. The existing soil and organic material is not removed and the panels are placed on top of the existing terrain. The sills are mounted on top of the panels. The weight of the sills keeps the panels in place and, with time, vegetation will grow through the panels to restore a more natural appearance. Refer to Binding or Stabilization Materials for additional information on panel installation.

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[59]Meyer, K.G. (2002). Managing Degraded Off-Highway Vehile Trails in Wet, Unstable, and Sensitive Environments. Washington, DC: US Department of Agriculture and Federal Highway Administration. Monlux, S. and Vachowski, B. (2000). Geosynthetics for Trails in Wet Areas. Washington, DC: US Department of Agriculture and Federal Highway Administration.

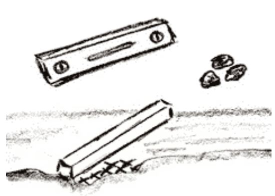
2. **Compact the soil**.
Shape and compact the soil to provide a firm surface for the sill. A flat, square shovel or McLeod can be used to tamp the soil in place. Small matrices of broken rock can also be mixed into the soil to create a more solid surface.

3. **Create a rock "bed" for the sill**.
Any wood that is in contact with the ground will be more likely to rot. Place large, flat rocks on top of the compacted soil so that the sill will not be in contact with the ground. If concrete sills are used, this step is not required.

4. **Position lifting straps**.
Lifting straps are strong lengths of webbing, typically 5 metres to 6 metres (16 to 20 feet) in length. Lift one end of the sill slightly off the ground and slide the straps, evenly spaced, underneath. You need one lifting strap for every two people involved in carrying the sill. Workers each drape one end of one strap over their shoulders with the knees slightly bent, hands anchoring the end of the lifting strap. On the lift command, workers extend their legs to lift the sill off of the ground.

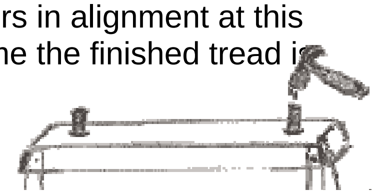
5. **Place the sill**.
Carefully lift and position the sill on the prepared ground. It is very important for all members of the work crew to be attentive to the directions from the leader. For safety reasons, the work crew must stop, start and move in unison. It is also important to ensure that all members of the work crew **use proper lifting techniques**. The use of lifting straps will encourage workers to lift and carry with the large muscles in the legs (rather than the back or arms). If the sills are particularly heavy or the number of workers is limited, the use of a grip hoist should be considered. Do not allow workers to risk injury by straining to perform a task.

6. **Level the sill**.



Use a level to check that the sill level. Shim under the sill as needed to ensure the sill is level from end to end. Shimming with pieces of rock is preferred as small pieces of wood are more likely to rot. **Do not rely on "eyeballing".** Any errors in alignment at this step will be magnified several times by the time the finished tread is installed.

7. **Stabilize the sill**.
Sills MUST be solidly anchored to the ground. Put 1.5 cm (5/8 inch) rebar through holes drilled in the sill is a simple and inexpensive stabilization technique (be sure the drill holes are not above rock sections of the bed). Large rocks or setting the sill in concrete are other stabilization options suitable for some trail environments.



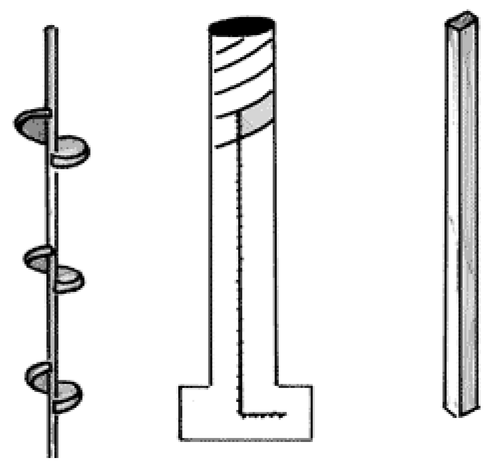
Installation of Anchor Posts

Anchor posts are used instead of sills when greater stability of the support structure is required. In Ontario, the use of anchor posts for the construction of trail tread structures is relatively unusual. Bedrock, sand and muskeg areas are just a few examples of the types of terrain that are not suitable for anchor posts. If anchor posts are to be used, **engineering expertise should be obtained** to determine the size, depth and location of anchor posts. Because of the complexity of installation, **anchor posts are seldom installed by trail volunteers**. The **assistance of an experienced construction professional is recommended** when anchor posts are required to support an elevated tread structure.

There are three types of anchor posts that are commonly used for trail tread structures:

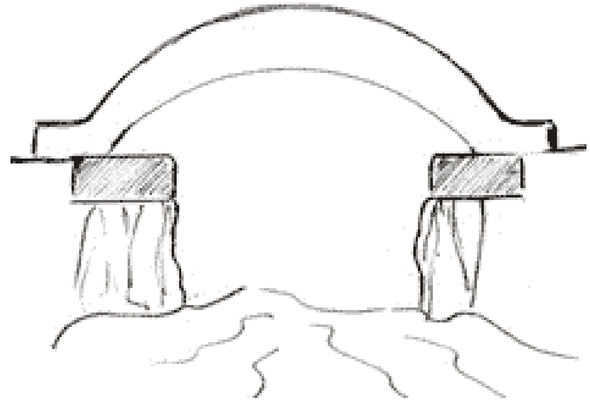
- **Wood posts encased in concrete**.
  Postholes larger than the required posts are excavated down to the frost line. The bottom of the each hole is filled with a layer of drain rock. A wood post is placed into the hole and a level is used to ensure that it is completely vertical. The hole is filled with concrete and the vertical position of the post is confirmed (or adjusted as necessary). The wood post is supported with bracing so that it maintains the correct position until the concrete has set.

- **Concrete posts**.
  Postholes larger than the required posts are excavated down to the frost line. The bottom of the each hole is filled with a layer of drain rock. A sonotube (heavy cardboard mould) is placed into the hole and a level is used to ensure that it is completely vertical. The hole is filled with concrete and the vertical position of the sonotube is confirmed (or adjusted as necessary). The sonotube is supported with bracing so that it maintains the correct position until the concrete has set.



- **Helical piers**.
  Helical piers are metal piers with a pointed tip that is “threaded” so that it can be “screwed” into the ground with a motorized “driver”. They are available in a wide variety of sizes and have a metal bracket on the top which attaches to the stringers. Helical piers have a minimal impact on wetland environments or natural drainage patterns but they require extensive and specialized equipment for installation.

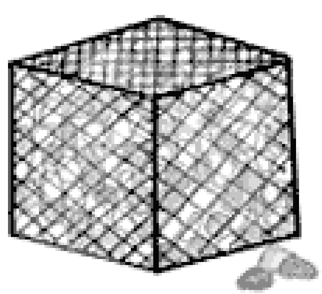
Construction of Abutments

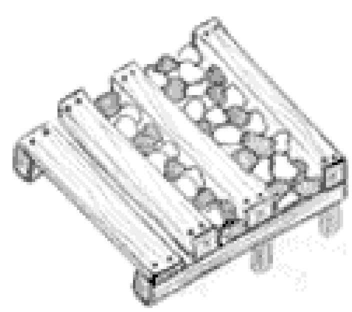


Abutments are structures anchored into the terrain that support the stringers. Typically they are used to anchor a bridge when the banks are quite steep, or when the stringers need to be supported at a height off the ground. **Permits will be required for any abutment construction that is in the vicinity of a body of water** (e.g., creek). Depending on the ownership and management of the land and environmental factors, permits may be required from a number of different sources. The landowner should be able to provide the list of agencies and organizations that must be contacted regarding permits.

Constructing an abutment into an embankment makes it easier to construct the elevated tread at the same height as the surrounding terrain. However, construction on the banks of water bodies is extremely complex and can cause significant environmental damage if done in correctly. **Professional expertise is required for the design and construction of abutments**.

Cribs and gabion baskets are commonly used techniques for constructing abutments with volunteer labour. In both cases, a containment structure is built and then the structure is filled with rock to ensure its stability. In the case of gabion baskets, the containment structure is wire mesh[60]. For cribs, the containment structure is typically made of wood. Cribs are built with a series of layers, each perpendicular to the layers above and below. **Engineering expertise is required to determine the location, size, materials, construction methods and anchoring systems for all abutments**. The footing of abutments must be on ground that is solid and dry. Abutments on flat terrain can sit on compacted mineral soil. Abutments on steep terrain must be tied into the slope. Before constructing any type of abutment, the plans and details of the construction methods and timing must be approved by the local Conservation Authority and/or office of the Ministry of Natural Resources. Gabion and cribs should never be constructed within the water flow channel.

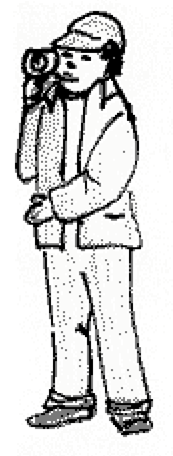




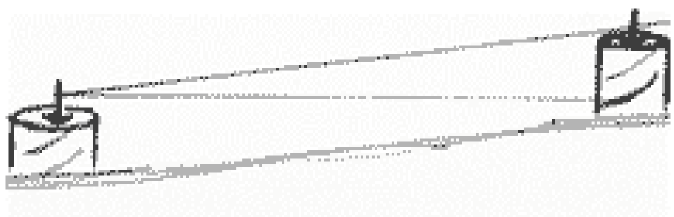
[60] The Bruce Trail Association. (2001) Guide for Trail Workers. 3rd Edition. Hamilton: Author.

Ensuring Adjacent Anchors are Level

Just as it is important for each anchor to be level from side to side, it is equally important that adjacent anchors be relatively level to each other. If adjacent anchors differ significantly in height, the finished tread structure will be sloped and difficult to navigate. Sloped stringers can also be more difficult to stabilize.

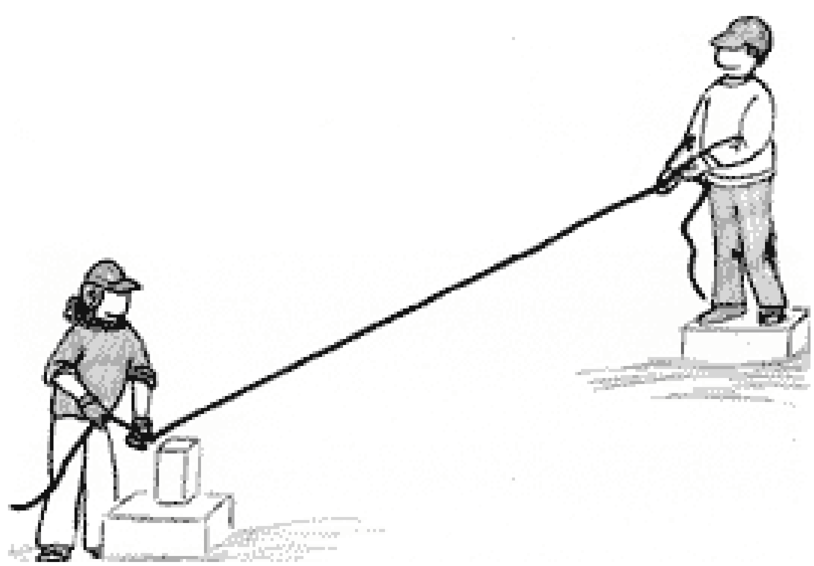


Use a laser level or clinometer (refer to Appendix G for details) to determine the slope between adjacent anchors. If the slope is more than 4% (i.e., a height difference of more than 4 cm for every 1 metre of horizontal length or 1 inch for every 25 inches of horizontal length) the height of the lower anchor point should be increased.



To increase the height of the lower anchor point, complete the following steps:

1. **Determine the height increase required**.
   Stand on the higher anchor, facing the lower anchor. Have a second person hold a vertical object on the top of the lower anchor. Use the clinometer, string level or laser level to determine the point on the vertical object that is level with the higher anchor. Measure the height from the top of the lower anchor to the level point on the vertical object. The height difference is the height increase required.



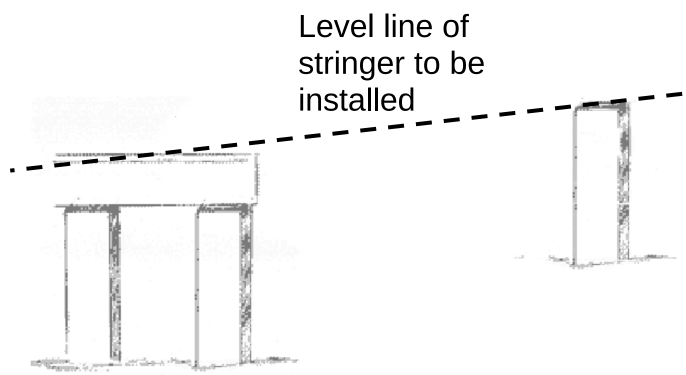
2. **Determine the thickness of anchor layers**.
   The height of the lower anchor must be increased using an even number of "layers". Otherwise, the final layer (that directly supports the stringer) will not be perpendicular to the stringer. For optimal support structure stability, the stringer should always be perpendicular to the anchor. Divide the measured height increase in half to determine the height of each "layer". Unless the difference in height between adjacent anchors is extreme, building the lower anchor up by two layers will be sufficient. For more extreme height differences, continue to divide the height of each layer in half, until the height of one layer is similar to the vertical dimension of the materials that will be used.

   Height Increase Needed = 19 cm

   19 ÷ 2 = 9.5

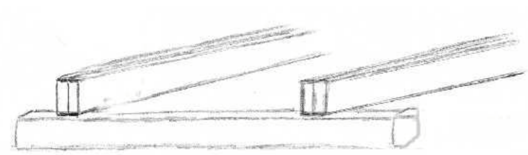
   Height of each layer = 9.5 cm

3. **Install a "twin" for the lower anchor**.
   Using the same procedures described for installing an anchor, install a second anchor close to and parallel to the lower anchor. The "twin" anchor may be either closer to or farther from the higher anchor, as long as the stringer will span the entire distance, across both lower anchors and the higher anchor. Typically the "twin" anchor is approximately 0.75 metres from the first.



4. **Install additional layers**.
   For each additional layer, install two new anchors across the space between the two original anchors. The anchors in each layer are parallel to each other and perpendicular to the layers above and below. Place and stabilize each anchor piece as if it were a small stringer (i.e., using the instructions for stabilizing a stringer). Continue to add anchor layers until the required change in height is achieved.

Attaching Stringers to Anchors



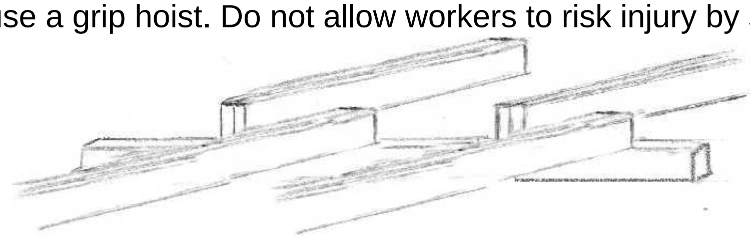
Stringers are the long spans, parallel with the direction of trail travel, which **connect adjacent anchors and support the tread**. Typically, they are made of wood, either log or lumber. For some projects, steel beams may be used as stringers.

The length of a stringer should not exceed 5 metres (16 feet). That is, **the distance spanned between adjacent anchors should be no more than 4 metres (13 feet)**. If longer spans are required, professional expertise assistance should be obtained because the diameter and strength of the stringers will need to be carefully calculated.

The stringers are installed after the construction of adjacent anchors is complete. The installation of stringers is similar to the positioning of sills. The steps are:

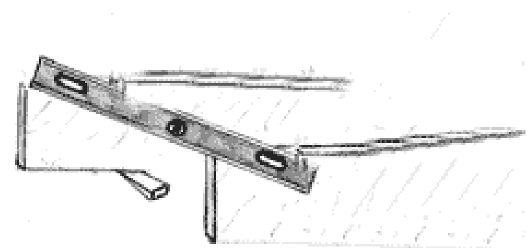
1. **Position the lifting straps**.
   Lifting straps are very strong lengths of webbing that will support substantial amounts of weight. They are typically 5 metres (16 feet) to 6 metres (20 feet) in length. Lift one end of the stringer slightly off the ground and slide the lifting straps underneath. There should be one lifting strap for every two people involved in carrying the stringer. Space the lifting straps evenly under the length of the stringer. Each worker drapes one end of the strap across the shoulders with the knees slightly bent. The hands are used to anchor the end of the lifting strap. On the lift command, workers extend their legs so that the stringer is lifted off of the ground.

2. **Place the stringer**.
   Carefully lift and position the stringer onto the anchors. The stringer should be perpendicular to (rather than parallel to) the anchor on which it rests. Remember that stringers from adjacent sections must overlap on each anchor. In general, it is best to alternate the stringers from different directions on each anchor. The number of stringers required for each section of tread will be determined by the required load carrying capacity. Ensure that all members of the work crew **use proper lifting techniques**. Always lift and carry with the large muscles in the legs (rather than the back or arms). Since most stringers are extremely heavy, ensure that you have a large work crew or use a grip hoist. Do not allow workers to risk injury by straining to perform this task.



3. **Level the stringer**.
Ensuring that each stringer is level is critically important. **Use a level** to check the alignment. Do not rely on "eyeballing". If care has been taken in ensuring the anchors are level, and constructed materials (e.g., lumber, steel) are being used for the stringers the alignment will be relatively simple. However, if logs are used as stringers, natural variations in the diameter of the log mean that great care will be required to ensure that a level and consistent surface for the trail tread is provided over the full length of the stringers. It is also important to ensure that all parallel stringers connecting the same anchors are level with each other.

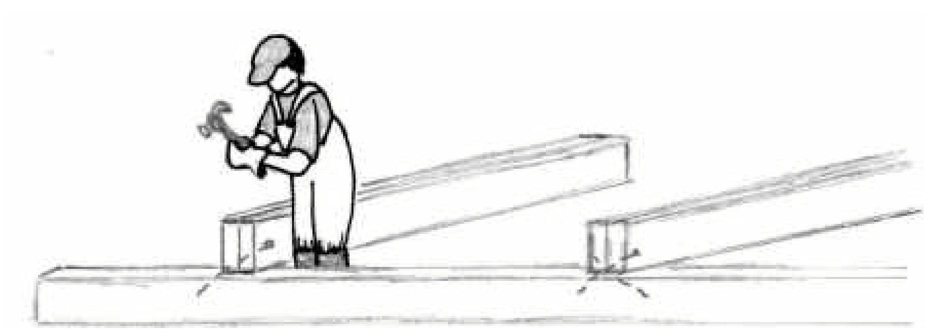
Shim under one or both ends of each stringer as necessary to ensure that each stringer is level:



- From one end to the other.
- With parallel stringers connecting the same anchors.
- With the stringers that support the adjacent sections of tread.

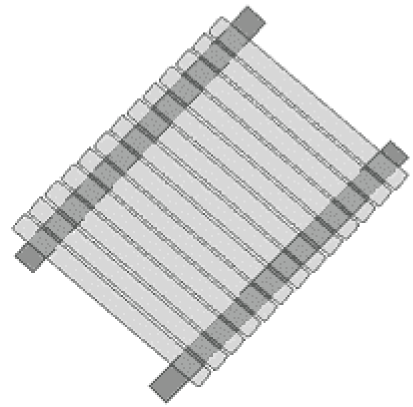
Shimming with small pieces of wood is commonplace and effective. Since the wood pieces are elevated above the soil, they are not particularly prone to rot.

4. **Stabilize the stringer**.
Stringers MUST be solidly positioned on the anchors. Putting 1.5 cm (5/8 inch) rebar through holes drilled in the stringer and anchor is a simple and inexpensive stabilization technique. Wood stringers and anchors can be securely nailed together by driving several large spikes through the stringer and into the anchor. The spikes should be at different angles (i.e., toe-nailed) to prevent them from working loose. Bolts can also be used to attach wood stringers as well as to secure steel stringers. In wood, the bolts should be countersunk and covered with plugs or wood putty to discourage vandalism.



Attaching Decking to Stringers

Decking is the term used for the walking surface of elevated tread structures. Typically, 2 x 4, 2 x 6 or 2 x 8 lumber is used for decking. **Use rough sawn lumber for decking** as it provides a tread with more "grip". Thicker lumber (3" or 4" boards) should be used if the distance between stringers is more than 0.75 metres (2.5 feet) or if heavier load bearing (e.g., equestrians, stock, motorized trail users) is required. Avoid the use of tree branches for decking because the rounded walking surface can be hazardous for many trail users. Plastic planks are also used by some trail organizations. However, they require additional support (i.e., more stringers placed closely together) and maintenance (to prevent the growth of algae that makes the surface very slippery), so the choice of this material must be carefully considered. Pressure treaded lumber can also be very slippery when wet so its use is not recommended for decking.



To install lumber decking:

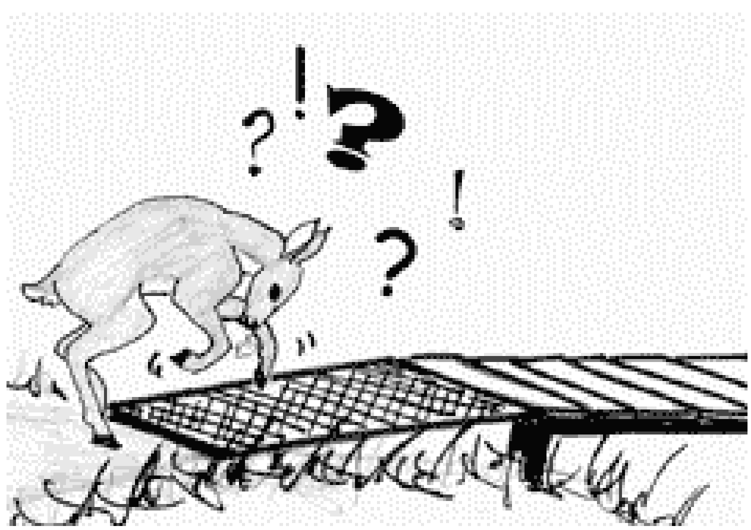
1. **Cut decking pieces to the required length**.
   The width of the decking should match or exceed the tread width for the rest of the trail. The minimum deck width is 1.0 metre (3.3 feet) for hikers and 1.5 metres (5 feet) on trails that are used by cross-country skiers. The decking should not extend beyond the outside edge of the stringers by more than 0.3 metres (1 foot).

2. **Lay the decking on the stringers**.
   Lay the decking so that the long side of each plank is perpendicular to the user's direction of travel. This will ensure that bicycle and other wheels do not get caught between the planks. Use rough-sawn (milled) planks as they usually provide more grip, particularly when they are wet. Place the decking with the tree growth rings facing down so the boards are less likely to warp. Leave a gap of up to 15 mm (0.6 inches) between boards to allow water to drain off of the tread. Keeping the tread dry will make the wood last longer and be safer for trail users. Unfortunately, the accumulation of organic material in the gaps and on top of the stringers promotes the rot of the underlying structure. The 15 mm (0.6 inches) gap size is a compromise between: a) the space required for drainage and the expansion and contraction of the lumber with changes in temperature, b) the need for a large gap to discourage the accumulation of organic material, and c) the need for a smaller gap to ensure that the decking is safe for users of all abilities. Many trail users have difficulty crossing elevated treads if they can easily see between the planks or have to step carefully onto pieces of decking that are spaced far apart. Lay all of the decking in place before nailing it to the stringers.

3. **Attach the decking to the stringers**.
   Screw or nail the planks to the outermost stringer on each side. In general, two nails or one screw on each end of each plank should be sufficient. Galvanized nails or screws should be used. Longer nails or screws (e.g., 10 cm or 4 inch) will deter vandals from pulling up the planks. If there are more than two stringers, do not attach the decking to the centre stringers because, over time, the nails will lift and create a tripping hazard.

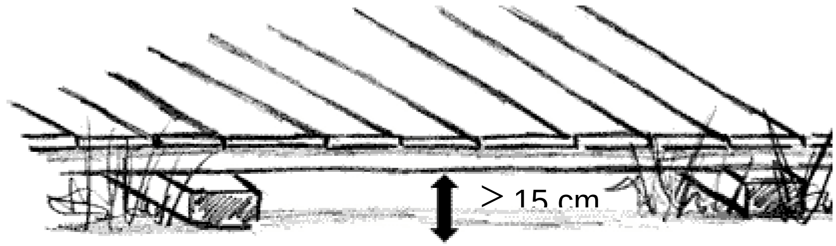
The use of logs for decking is not appropriate except in very remote areas where lumber is not available. If logs must be used, the topside of each log should be "shaved" with a chain saw to create a flat surface for trail users to stand on. Spaces between the round log edges should be filled with compacted crushed rock, soil or wood chips so that trail users have a consistently firm, level and stable tread. Remember, putting soil or wood chips on top of the logs will encourage them to rot more quickly.

In areas where the decking will be almost continuously wet (e.g., in the spray from a waterfall or shoreline), expanded metal (flat, metal lattice or grid) or tensar netting[61] can be added to the top surface of the wood deck to make it less slippery under wet conditions. However, **care must be taken to ensure that the metal or netting sits flat and tight on the wood surface**. Even small sections of metal or netting that are not flat and tight to the wood surface can be a tripping hazard, particularly for children and people who use walking sticks, crutches or canes.

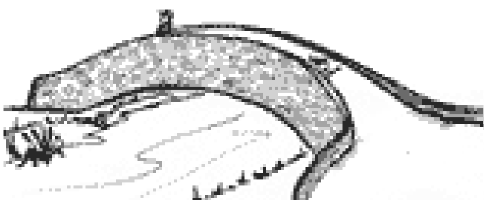


[61] Tensar netting is a black plastic square mesh used extensively in New Zealand (www.maccaferri.co.nz).

Constructing the Approach



A key component of the design of elevated tread structures is that the parts are separated from contact with the ground to decrease the speed of rot in the wood components. Even though the top of the sill is relatively close to the ground (gap of at least 15 cm or 6 inches), the trail user walking on top of the elevated structure, which is mounted on stringers, will usually be elevated above the remaining trail surface by at least 0.5 metres. The **approach structures at each end of the elevated tread enable trail users to navigate the difference in height between the two tread surfaces**.



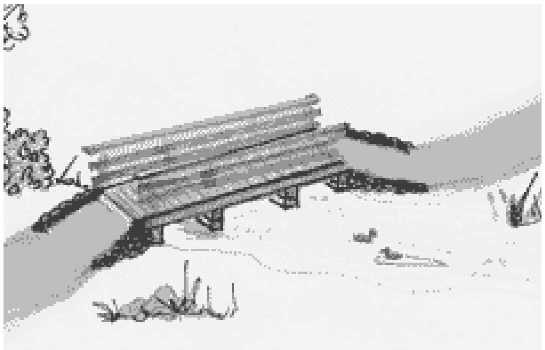
The design and construction of the approach is critical to ensuring that trail users of all abilities can access the elevated tread structure easily and safely. The approach structure should always provide a continuously ramped surface that smoothly connects the ground level and elevated tread surfaces. The slope up the ramp should not exceed 10%, and ramps below 5% slope are recommended. Steps onto the elevated surface can also be provided, and may be helpful to some trail users or if the height differential is substantial, but **a ramped surface is always required**. Ensuring ramped access will also discourage cyclists from by-passing the elevated tread when water levels are low, in order to avoid dismounting.

An approach structure is not required if the elevated tread structure is constructed on top of abutments that are excavated into the ground so that the elevated tread structure begins level with the ground level trail tread. The excavation and construction of these types of abutments is complex, and professional assistance is recommended.

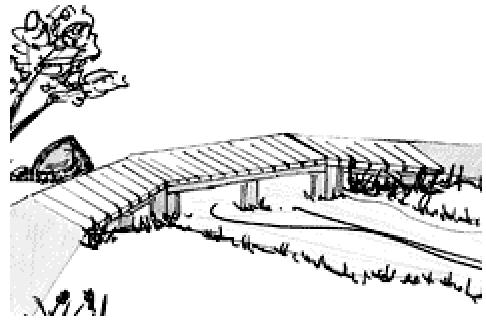
The construction log will provide detailed information on the length and slope for the access ramp surfaces. Because the access ramps are typically designed to have the steepest acceptable grade, **it is critically important that construction crews build the access ramps exactly as designed**. Changing a ramp designed as 3 metres (10 feet) in length to be a ramp of 2.8 metres (9.2 feet) in length can mean the difference between a safe and accessible elevated tread and a trail that encourages trail users of different abilities to navigate an uncomfortable and potentially unsafe situation.

There are essentially two types of approach structures:

- Earthen-gravel fill approaches.



- Decked approaches.

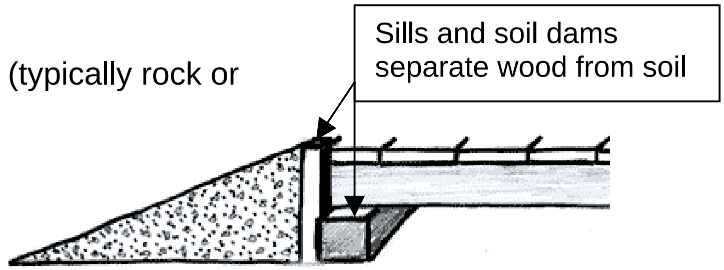


The construction log will specify the design to be used. The two types of structure are relatively similar. The primary difference is whether the elevated tread decking is extended onto the approach (and then earthen-gravel fill is used only for the final connection to the lower trail tread) or whether the entire approach surface is constructed from earthen-gravel fill. The following **instructions are for a ramped approach structure**. If an earthen-gravel fill approach is required, begin at Step #3.

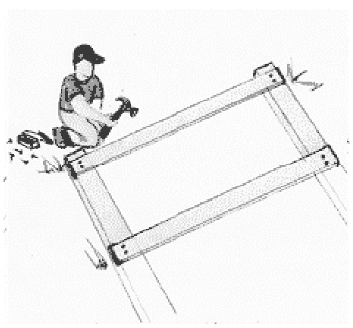
1. **Create the foundation**.
   The foundation is the area where the approach structure will connect with the ground level tread. The foundation is used to separate the approach structure from the damp ground below. Rocks or concrete are the preferred materials for the foundation. Place flat rocks, concrete slabs, or patio stones on the ground level tread at the point where the approach structure will start. Anchor the foundation using the techniques described for stabilizing the anchor sills. If the ground level tread is a paved surface (i.e., asphalt, concrete, interlocking brick), then a foundation is not required.

2. **Install the stringers**.
   The stringers for the approach structure are constructed, sized and installed using the steps described above for the elevated tread structure. Ensure that the stringers are level with each other and the stringers on the elevated tread structure. The ends of each stringer must be cut on an angle so that the stringer fits smoothly against the elevated tread stringers and sits firmly on the foundation. Make sure that the ground-level end of each stringer has a vertical face so that it will sit snugly against the soil dam. Anchor the approach stringers to the foundation using the techniques described for the anchor sills.

3. **Create a soil dam**.
A soil dam is a surface that will not rot (typically rock or concrete) that physically separates the stringers from contact with damp soil, or earthen-gravel fill. Flat rocks, patio stones, or bricks can be placed at the end of the stringer to act as a soil dam. The size of the soil dam should match or exceed the vertical dimension of the stringer above the foundation to ensure a smooth transition between the earthen-gravel and decked surfaces. A soil dam thickness of at least 5 cm (2 inches) will provide adequate separation.



4. **Construct the containment structure for earthen-gravel fill**.
The containment structure creates the “walls” that are filled with earthen-gravel material. It is usually made of skinned logs. Place two logs on the ground so that the surface that will eventually be on the bottom of the containment structure is on the top (i.e., the logs are upside down). The logs should be the same width apart as the width of the ground level trail tread. Place a plank 1/3 of the distance from each end of the logs and fasten it to the logs with nails or screws. The planks are cross-braces that physically connect the logs that will be on opposite sides of the tread. This stabilizes the position of the retainer logs. Place a third log across the opening at one end and nail or screw it in place. The third log will be placed against the soil dam(s) to help retain the earthen-gravel fill.



5. **Position the containment structure**.
Turn the containment structure right side up and move it into position at the bottom of the approach. When positioned correctly, the end log should be perpendicular to the direction of travel and abutted against the soil dams. The two side logs should be aligned with the edge of the ground level trail tread. The cross-bracing planks should now be on the bottom of the structure, against the ground.

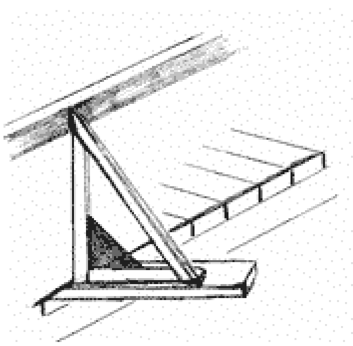
6. **Fill and compact the earthen-gravel**.
Fill the containment structure will layers of earthen-gravel or crushed rock. Add up to 15 cm (6 inches) of fill and then compact the material solidly using a flat shovel, McLeod or mechanical compactor. Continue to alternate the addition of a layer of fill and compaction work until the containment structure is filled to the required height. The height of the compacted fill adjacent to the soil dams should be at the same level as the elevated tread. Shape the fill material so that it slopes continuously from the level of the elevated tread to make a smooth connection to the ground-level tread. The fill should also be shaped with adequate cross slope so that rain falling on the ramp will flow off the side of the ramp (rather than down the centre of the tread). At ground level, the level of fill will be lower than the walls of the containment structure.

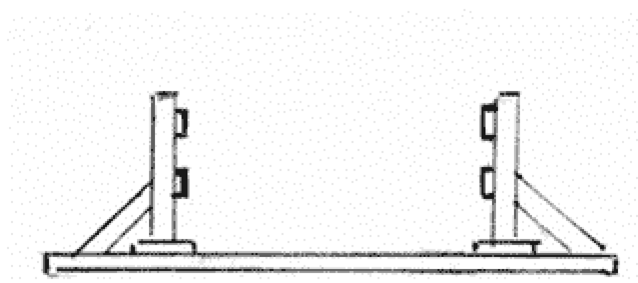
Attaching Handrails

The trail designer will determine the need for handrails based on a variety of factors, such as the height of the elevated tread above the surrounding terrain, the anticipated range of abilities among trail users and safety codes and regulations. The Ontario Building Code specifies that “guards” (i.e., railing, wall) are required if the walking surface is more than 60 cm (2 feet) above the surrounding ground surface[62]. Handrails are not required on trails because of changes in the grade of the trail. For example, if the grade on the trail exceeds 5% (1:20), handrails are not required on the trail. Trail designers must ensure that trail complies with all safety codes related to the provision of handrails. The trail designer may also require one or more railings in other situations, depending on what is required for the safety of trail users and to assist them in making a steady crossing.

There are a wide variety of handrail designs and materials that can be used. The choices made will depend on the aesthetics of the trail environment and required safety codes. Details of the size and design of handrails to be constructed will be provided by the trail designer in the construction log. Important points to keep in mind during the construction of handrails are:

- Handrails should not decrease the usable tread to less than 1.0 metres (3.3 feet) or the width of the ground-level trail tread (whichever is larger).
- Handrails should be mounted so that there is no **continuous** barrier along the edge of the elevated tread that might prevent water from draining (see Attaching Deck Edging for details). For added safety, handrails can be combined with deck edging.
- The handrail should be free of sharp edges and provide a continuous gripping surface.
- The perimeter (i.e., circumference) of the gripping surface should be between 10 cm (4 inches) and 15 cm (6 inches) in total length.





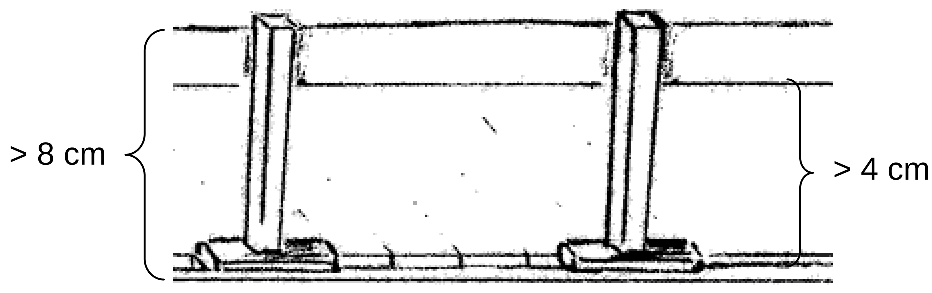
[62] Ministry of Municipal Affairs and Housing, Building and Development Branch. (2005). Ontario Building Code 1997. July 1, 2005 update.

Attaching Deck Edging

Edge protection may be desirable on elevated tread structures that do not have handrails. Trail designers are not required to provide edge protection on elevated tread structures, except where required by local trail standards or safety regulations. Edge protection (also called a “bull rail”) is often included on elevated tread structures that are used by horses. Handrails, rather than edge protection, are preferred for trails that permit cyclists.

If desired, edge protection can be constructed from either logs or lumber. If provided:

- The top of the edge protection rail should be at least 8 cm (3 inches) above the elevated tread (8 cm is the height of two 2” pieces of lumber) so that it will be more effective for trail users with “outdoor” tires (e.g., jogging baby strollers, mountain bike wheelchairs).



- The edge protection rail should be mounted on intermittent spacers at least 4 cm (the height of one 2” piece of lumber) in height, rather than being fastened directly to the elevated tread (this allows water and debris to drain more easily off of the sides of the elevated tread).

- Bracing for the handrail should not create a tripping hazard or step in the trail tread (bracing should be level with, outside of or under the tread).

Constructing Docks

Docks and floating bridges are most commonly used on water trails (e.g., canoe or kayak routes). However, floating bridges can also be appropriate for crossing small bodies of water. The use of a floating bridge rather than an elevated tread structure must be determined in conjunction with the land managing organization. **Permits will be required for all construction work because it occurs within a body of water**. The local conservation authority should be contacted so that the proposed work can be reviewed and approved. The landowner should be able to provide the contact information for any additional agencies or organizations whose permission will be required.

The U.S. Forest Service has developed a good resource for the construction of floating trail bridges and docks[63]. It is available, free of charge, on the recreation trail resources web site of the U.S. Federal Highway Administration: http://wwwcf.fhwa.dot.gov/environment/rectrails/trailpub.htm.

The U.S. National Park Service has also recently published an excellent resource[64] on floating docks, launches and landings, which contains suggestions on how to design these facilities so that they are easier for people with disabilities to use. The design considerations recommended in that resource include:

- Make the surfaces at and around the launch as even, level, and free of gaps as possible.
- Provide a level area adjacent to the loading area that is at least 1.5 x 1.5 metres (5 x 5 feet) in size.
- Consider putting the level area in water up to 0.3 metres (12 inches) deep. As long as the surface is not slippery, it makes the transfer from the level area into the canoe much easier because it requires very little change in the height of the person's torso.
- Make a transfer step 0.2 to 0.3 metres in height (8 to 12 inches) so that people can lower themselves gradually to and from the ground surface.
- Provide a transfer board that slides out from the launch over top of the canoe. This will allow a person to slide out over the canoe and then transfer into the centre of the canoe (more stable than trying to step in from the side). If the transfer board is barely above the level of the gunwales, the board will not only support the person's weight but will also help to stabilize the boat.

[63] Floating Trail Bridges and Docks. U.S. Forest Service. FHWA Publication #0023-2838-MTDC.
[64] US Department of the Interior. (2004). Logical Lasting Launches: Design Guidane for Canoe and Kayak Launches. Washington, DC: National Park Service Rivers, Trails and Conservation Assistance Program.

Elevated Tread Structures in Constant Contact with the Terrain

Continuous contact tread structures are controversial in the trails community. Many people oppose the use of continuous contact tread structures because the design creates a continuous barrier that can substantially alter the natural drainage patterns of the trail environment. In general, **the use of intermittent contact tread structures is recommended and the use of continuous contact structures should be limited** to situations where intermittent contact structures are not feasible.

There is a wide variety of continuous contact tread structures that are used to build elevated trail tread. The terminology used to refer to these different types of structures also varies tremendously, based on the feedback received on the first draft of this resource. For the purposes of this resource, the following terms are used:

<u>Turnpike</u>

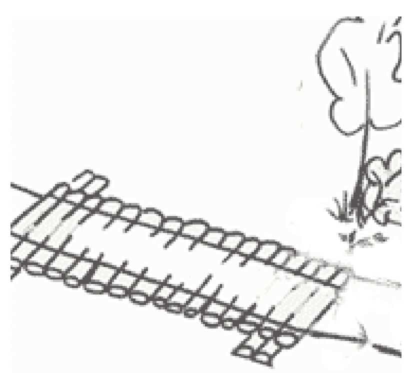
An elevated walkway that uses wood borders (i.e., log, lumber) or no borders to retain the fill.

<u>Causeway</u>

An elevated walkway that uses rock borders to retain the fill.

<u>Corduroy</u>

Logs, placed perpendicular to the direction of travel, that are laid side-by-side along the trail tread in order to elevate the trail tread above muddy or wet ground.



Choose construction materials carefully!

By design, the materials used for the construction of continuous contact elevated tread structures will be in "continuous contact" with the soils that occur naturally in the trail environment. This makes the materials more likely to rot, and increases the risk that contaminates from the materials will leach into the soil and impact the local habitat. Therefore, it is critically important that the construction materials used for these tread structures are carefully selected based on their potential impact on the environment as well as the safety of trail users. **The use of rock or untreated types of wood that are less likely to rot (e.g., cedar) is strongly recommended**. Refer to the Tread Structures Above the Surrounding Terrain section for additional information about the importance of material selection.

Always use safety equipment when cutting and using treated wood, such as gloves, glasses, and a dust mask.

Causeway and Turnpike

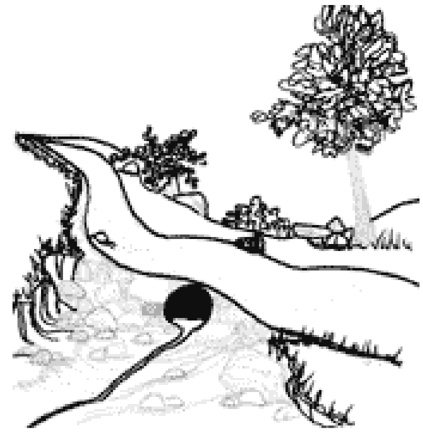
The length, height, location and construction techniques for the causeway or turnpike will be determined by the trail designer. Factors such as environmental conditions, natural drainage patterns and trail user information will be combined to determine the type of elevated structure required. **The location of causeways and turnpikes is critical** to their success (or failure). Areas of very low or imperceptible water flow, or very intermittent drainage channels can easily be dammed by a causeway or turnpike that is constructed in the wrong location. **Causeways and turnpikes should never be constructed in areas with visible, ground level water flow or areas with intermittent flooding**. If construction crews arrive at the site and find evidence of surface water flow, construction should not begin until the plans for the elevated tread structure are reviewed.

Turnpike and causeway surfaces are long lasting, and low maintenance. Even if the sidewalls are constructed with logs, the rotted log will eventually be replaced by a duff berm that will still retain the drain rock and tread material. The crushed aggregate and other tread surface materials that can be used last longer and require less maintenance than wood plank surfaces. After the initial construction labour and expense, a turnpike will stay "high and dry" in all types of weather. Users will be able to travel through wet environments under enjoyable conditions without making a significant impact on the environment. **The main drawbacks for turnpike or causeway use are the high potential for negative environmental impacts and the substantial amount of labour required** during initial construction. Building a turnpike or causeway of any length requires an energetic trail crew that is not afraid of hard work.

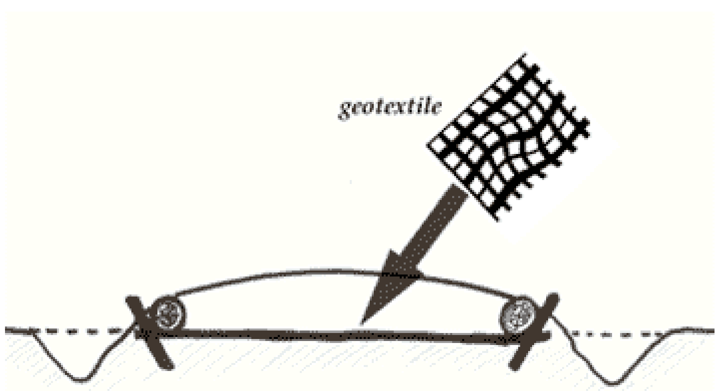
The steps for constructing a turnpike or causeway are:

1. **Prepare the site.**
   Clear the site of organic material (vegetation, roots, stems). Make the clearing wide enough for the trail tread plus the space required by the retaining structure (if constructed). If retainer logs or rocks are used on either side of the trail tread they must be located in the buffer zone so that the width of the trail tread is not reduced.

2. **Install drainage structures**.
   Drainage structures, such as culverts and drainage lenses, can be incorporated into the turnpike or causeway if the elevated tread structure crosses through established and well-defined natural drainage channels (i.e., not dispersed, sheet-flow drainage). These drainage structures are constructed in the same manner as in other trail locations (see Trail Drainage Structures).

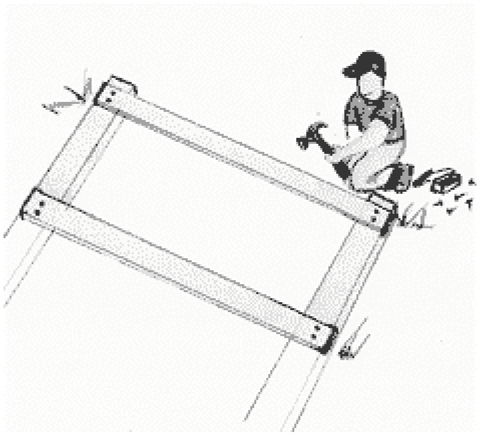


3. **Install a geotextile base**.
   The water and drainage patterns that occur below the surface should not be disturbed. Lay a geotextile grid on top of the natural surface as a base that will support the turnpike so that it "floats" over the natural drainage patterns[65]. Sheets of geotextile grid are usually about 1 metre by 3 metres (3.3 by 10 feet) in size. They are relatively lightweight and can be fastened together with plastic ties after they have been installed in the correct location. The plastic grid can be easily cut with a utility knife if a different size or shape of panel is required.

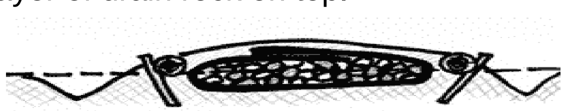


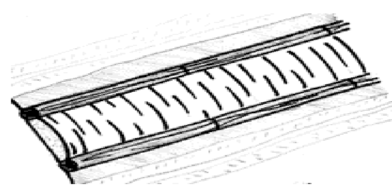
[65] Meyer, K.G. (2002). Managing Degraded Off-Highway Vehile Trails in Wet, Unstable, and Sensitive Environments. Washington, DC: US Department of Agriculture and Federal Highway Administration. Monlux, S. and Vachowski, B. (2000). Geosynthetics for Trails in Wet Areas. Washington, DC: US Department of Agriculture and Federal Highway Administration.

4. **Construct the retainer structure**.
The retainer structure creates a trough that is filled with a layer of drain rock and then the tread surface material. For a turnpike, it is usually made of skinned logs. The skinned logs on each side of the tread are connected by lumber planks or smaller logs, which act as cross-braces, at regular intervals. The cross-braces stabilize the position of the logs by physically connecting the logs on either side of the tread, underneath the tread material. Galvanized wire can also be used for cross-bracing the logs. For a causeway, the retainer structure is built with rocks or boulders and cross bracing is not required. End caps (logs or stones across the end of the retainer structure) can also be used if necessary to retain the fill in the intended location. Care must be taken to ensure that the end caps will not become a tripping hazard if the tread surface compacts unevenly.



5. **Install the drain rock**.
Lay down a layer of landscape fabric the length of the turnpike or causeway. Place 15 cm (6 in) to 25 cm (10 in) of drain rock on top of the bottom layer of landscape fabric, in between the walls of the retaining structure. Drain rock is large (5 cm to 15 cm or 2 to 6 inches) pieces of gravel or crushed rock that provides open spaces for water flow even when it is firmly compacted. If you need to keep the tread material from clogging the spaces within the drain rock, a second layer of fabric can be placed on top of the drain rock. If landscape fabric is not available or is not desired, it is also possible to fill the retaining structure with a base layer of large rocks and then a layer of drain rock on top.





6. **Install the tread surface material**.
Put the tread surface material on top of the landscape fabric or drain rock. Layers of material 10 cm to 15 cm (4 to 6 inches) thick are added and then compacted. Continue to alternate layers of fill and compacting activities until the tread surface reaches the desired height. Be sure to install at least 10 cm of tread material on top of landscape fabric so that the fabric does not become exposed over time. The surface material should, ideally, match the tread of the rest of the trail. Using similar material and construction techniques throughout the trail surface will improve the aesthetics of the trail by making the turnpike less obvious to trail users. It is important that the tread surface above the turnpike be shaped so that water flows naturally off the tread surface.

Corduroy

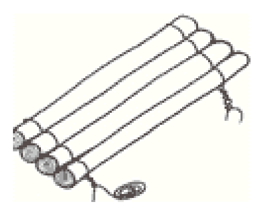
Corduroy is a technique that, in the past, was often used to construct a trail across wet terrain. Typically, it consisted of logs laid side-by-side across the tread, although some trail construction guides recommend that the logs be anchored together. However, **corduroy is the source of many sustainability and access problems**. The logs in corduroy will eventually rot and require replacement, increasing trail maintenance demands. **Corduroy has a negative impact on healthy natural environments** because of:

- Destruction of the underlying vegetation.
- Disruption of the natural drainage patterns.
- Disruption of the migration and movement patterns of reptiles.
- Increased vegetation trampling and destruction off of the trail tread.

Trail users and wildlife are seldom comfortable walking on top of the corduroy. As a result, the environmental impact of trail use continues to increase as they go further and further off of the trail tread in order to find dry, firm and stable ground. For many trail users, stock and wildlife, trying to balance on corduroy, especially under wet conditions, can be dangerous. For all of these reasons, **corduroy is not recommended**.

The use of corduroy may be considered in very remote areas where other methods of elevated tread construction are not feasible. Corduroy may also be used on trails that are open for winter use only (e.g., cross country ski trails). If corduroy is used, the following methods of construction are essential:

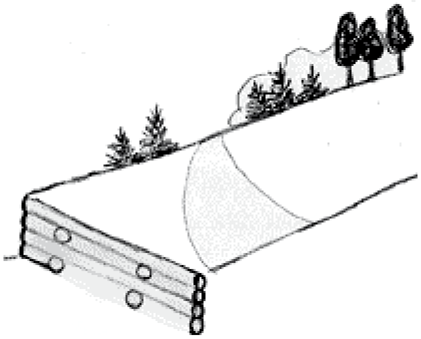
- Securely fasten logs together and to support structure so that they will not lift, shift or turn. Relying on the surrounding soil to stabilize the logs is not sufficient. Wrapping galvanized wire around each log is an effective way to fasten the logs.



- Scrape the top surface of the logs with a chain saw to create a relatively flat walking surface at least 0.8 metres (2.75 feet) in width. The notches between adjacent logs (where the rounded log surfaces abut each other) must be filled with a compacted material to provide a solid, continuous tread. Crushed rock is recommended for this purpose as soil or organic materials (e.g., wood chips) will encourage the underlying logs to rot.

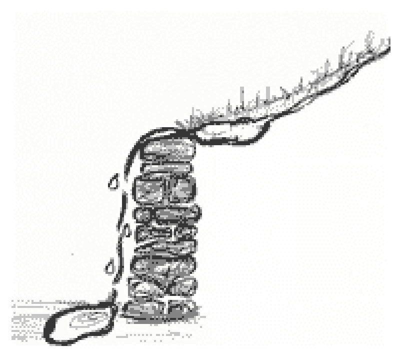
Retaining Walls

A retaining wall is used to support the trail bench when the natural soil does not have the stability required for a trail tread. **The retaining wall is built on the downhill side of the tread** and then the trail bench is constructed between the retaining wall and the uphill slope. Some trail groups also use retaining walls to control sloughing of uphill material onto the trail tread. However, this is not recommended. **Always construct the uphill slope so that it is at or below the angle of repose**, this will allow the slope to naturally stabilize itself through re-vegetation. **Retaining walls can also be used on very steep slopes, even if the natural soil is suitable** for a trail tread. Constructing a retaining wall on the downhill side of a very steep slope decreases the size of the excavated trail bench and lowers the height of the back slope. For these reasons, retaining walls are often used to construct the landing of a switchback.



Retaining walls can be difficult to build and **if the wall required will be more than 1 metre in height, experienced or professional help should be obtained**. In general, the best option is to build the trail so that retaining walls are not required. **The need for a retaining wall suggests that the natural soil or landform cannot support the trail tread**. When that is the case, it invariably means much higher construction costs and more on-going trail maintenance. Before deciding to build a retaining wall, try to find a more suitable, alternative route for the trail.

Retaining walls can be built with a wide variety of materials, such as rocks, gabion baskets, logs, lumber, concrete and interlocking bricks. The choice of materials will depend on aesthetics, and the availability and suitability of materials in and for the trail environment. **Building a safe and effective retaining wall involves more than just stacking materials**. The slope of a retaining wall (the distance or angle that each row is set back on the previous row) should be determined by the steepness and stability of the slope as well as the performance characteristics of the material being used[66]. Design of the retaining wall must also consider drainage patterns, and how water will flow around and through the finished wall. **When in doubt, seek professional advice**.



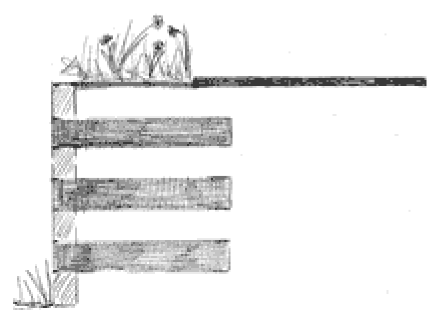
[66] Robert T. Steinholtz. Wetland Trail Design and Construction. [On-line] Retrieved 31 July 2006 from http://www.fhwa.dot.gov/environment/fspubs/00232839/toc.htm

The construction log will specify the materials to be used to construct the retaining wall. The materials are typically log, lumber, rock or interlocking stone. Once the drainage issues have been resolved, and the need for drainage pipes within the retaining wall has been determined, building a retaining wall will require the following steps:

1. **Excavate the footing trench**. Dig a trench at least 45 cm (18 inches) deep. Make sure that the bottom of the trench is solid mineral soil, so that the retaining wall will have a solid and secure base.

2. **Install the drain rock**. Put a 15 cm (6 inch) layer of drain rock in the bottom of the trench. This will allow water uphill of the retaining wall to flow underneath the wall and continue downhill. Ensure that the drain rock is firmly compacted so that it provides a solid surface for the retaining wall.

3. **Install the footing**. The footing is constructed on top of the drain rock layer. The bottom of the footing should be at least 30 cm below the surface. The depth of the footing will be specified in the construction log and is determined by a variety of factors (e.g., soil type, slope, height of the retaining wall). The footing should be constructed from concrete, rock or interlocking stone. Wood footings are not recommended because they will rot over time, significantly affecting the stability of the retaining wall. The footing should be high enough so that the top of the footing is at least 10 cm (4 inches) above the surrounding terrain.

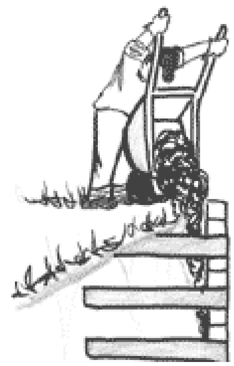


4. **Anchor the wall**. Anchors are critically important for the stability of the retaining wall. For log retaining walls, the anchors will be "sill logs" placed at right angles to the face. For rock walls, the anchors will be longer rocks that extend deeper into the filled area than the face rocks. The length of the anchors (rock or log) will be specified in the construction log, depending on the steepness of the slope and the stability of the fill material.

5. **Ensure that the anchors are stable**. **Do not use shims or chinking** or other materials to stabilize an anchor. If an anchor is not stable under its own weight (e.g., it shifts or rocks when force is applied) it should not be used. For a log, ensure that it sits flush on the material below. For rocks, choose rocks that will have at least three solid points of contact with the supporting material.

6. **Lay one row of material along the face** (the side of the wall that is parallel to the trail tread) of the wall. The face material should fit tightly around the ends of each anchor.

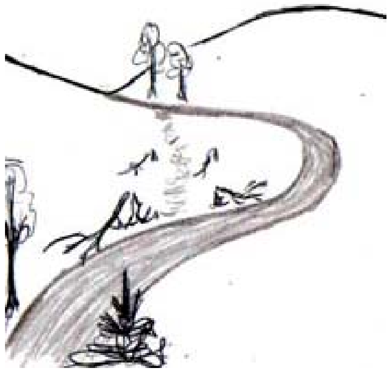
7. **Ensure that the face material is stable**. **Do not use shims or chinking** or other materials to stabilize the face material. If the face material is not stable under its own weight (e.g., it shifts or rocks when force is applied) it should not be used. For round logs, flatten the opposite sides of each log with a chain saw so that each row of logs will sit flush on the material below. For rocks, choose each rock so that it has at least three solid points of contact with the supporting material.



8. **Fill and compact behind the wall**. Fill behind the wall with 10 cm (4 inch) layers of soil. Compact the soil firmly by tamping it in place. Continue to add fill in 10 cm (4 inch) layers and compact the soil until the entire area behind the row of face material has been filled. At this point, the anchors should also be firmly buried in the compacted fill material. For log walls, a filler log or landscape fabric may be placed behind the face logs to prevent soil from escaping through spaces between the face logs.

9. **Repeat from #4**. Continue to add anchors in each additional row of face material and then fill and compact behind each layer until the retaining wall reaches the desired height. Remember that any drainage pipes or structures must also be incorporated as you build. **Place each face layer so that it sits slightly behind the supporting face layer**. The amount of setback for each layer (the "batter" of the wall) will be specified in the construction log. It is determined by a variety of factors, such as the steepness and stability of the slope. In general, each layer of a retaining wall should be set back at least 1 cm (0.4 inch) for every 2 to 4 cm (0.8 to 1.6 inches) in height[66].

Climbing Turns and Switchbacks

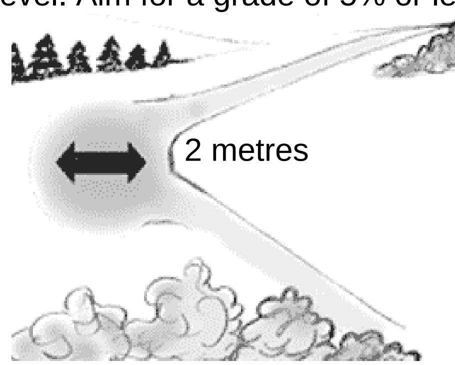


When trails are located in steep terrain and the topography and available land will not allow the use of the more sustainable curvilinear trail alignment, a climbing turn or switchback may be required. **Switchbacks and climbing turns allow a trail to reverse direction** so that most of the tread can follow the natural contours of the terrain. A switchback will have a relatively level turning area. This ensures that trail users do not have to negotiate the fall line of the hill while on a steep slope. A climbing turn does not have one turning area, but gradually climbs and changes direction throughout the turn. Since trail users will be on a slope on the fall line in a climbing turn, climbing turns are best suited to gentler slopes.

Climbing turns and switchbacks must be built with the utmost care. Whenever trail users can see that the trail abruptly reverses direction, there will be an almost irresistible temptation to “short cut”. Trail users going off the trail tread to take a shorter route will significantly impact vegetation and drainage patterns in the trail environment. Damage or removal of vegetation leaves the underlying soil, which is not compacted to be a trail tread, at high risk for erosion. **Great care must be taken to camouflage the adjacent sections of trail** so they are not visible to trail users until they virtually arrive at the turn. Installing handrails at knee and torso height on the trail tread as it approaches the switchback landing from uphill can be an effective method of encouraging trail users to follow the tread through the switchback. In some types of terrain, vegetation or natural rock outcroppings can also be used to camouflage the adjacent sections of trail tread.

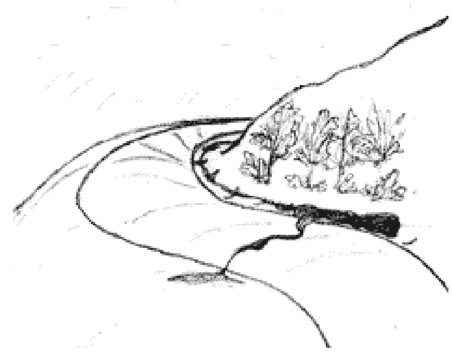
To construct a climbing turn or switchback, perform the following steps:

1. **Cut or create the turning area** (this step is not performed for a climbing turn). The turning area for a switchback should be relatively level. Aim for a grade of 5% or less on the turning area (that doesn’t apply to the sections of trail before and after the turning area). If the switchback is located on a natural knoll, construct the turning area in the same way you would construct the rest of the trail tread. Otherwise, construct a retaining wall on the downhill side of the tread to create the level turning area. The compacted trail tread of the turning area should be a minimum of 2 metres (6.6 feet) in width. It must be wider than the adjacent sections of trail so that trail users, particularly cyclists or cross-country skiers, have adequate room to make the required turn.



2. **Link the adjacent trail treads to the turning area**. Continue to construct the uphill and downhill sections of the tread so that they smoothly connect throughout the turn. In some cases, the natural landform will allow the turn and approaches to be constructed in the same manner as the rest of the trail tread. However, if a retaining wall has been used or in situations where the natural terrain is not suitable, it will be necessary to build approach sections that are raised above the natural terrain. The raised sections of tread are constructed using the techniques described for building turnpike or causeway (see Elevated Tread Structures in Constant Contact with the Terrain) or an approach to a bridge (see Constructing the Approach). The downhill approach to the turn (or the downhill half of the climbing turn) should have sufficient outslope to ensure that water drains easily off the trail tread. The amount of outslope required will be determined by the grade of the tread as well as the type of surface material.

3. **Sculpt the surface of the turn**. The surface throughout a climbing turn or switchback should be carefully sculpted and compacted to provide proper drainage. **On the uphill portion of a turn, the tread should have an inslope** so water drains to the uphill side of the tread. The surface of the buffer zone on the uphill side of the turn should be sculpted so that it directs water past the end of the turn. This will prevent water from running across the turn and further down the trail. As the turn continues, the sculpting of the surface is gradually changed so that **on the downhill end of the turn a typical outslope is restored** and water drains to the downhill side of the tread.



4. **Shape the uphill approach to the turn so it has an inslope**. The section of trail tread immediately uphill of the turn (or the uphill half of a climbing turn) should be sculpted so that it drains to the uphill side of the tread. The surface of the buffer zone is sculpted so that water is directed past the end of the turn before continuing downhill. The amount of inslope required will depend on the grade of the trail and the surface material used. If possible, mix crushed rock into the natural soil or harden the tread material so that the amount of inslope required is minimized. Inslopes of more than 5% are very difficult for many trail users. Depending on the size of the climbing turn or switchback, it may be necessary to inslope the approach for a distance of up to 30 metres (98 feet).

5. **Restore the environment around the switchback or climbing turn**. When you finish construction, trail users should not be able to tell the climbing turn or switchback was recently constructed. Widely distribute unused soil so that it does not alter the natural drainage patterns and disperse any cut vegetation. Plant vegetation or place fallen trees or large rocks in between the uphill and downhill approaches, to camouflage the next section of trail and to discourage users from taking a shortcut.

Constructing the Trail Surface

After the trail route has been cleared, construction of the trail surface can begin. If the tread is to be the **naturally occurring ground surface, it must be firm, stable, resistant to erosion and dry***.* Soils that contain small pieces of fractured rock (i.e., rock matrix with a variety of sizes of rock pieces) generally provide the most sustainable tread. If the trail alignment is optimal but the natural soils are not suitable, the use of tread stabilization techniques (e.g., soil hardening) or a constructed tread (e.g., boardwalk) will be required. **It is inappropriate to construct the trail tread on sub-standard soils that cannot provide a sustainable tread**.

Soil types change dramatically throughout every landscape. The trail designer will have considered the naturally occurring ground surface in making the tread material and construction decisions specified in the construction log. **Good trail design will locate the trail on the most sustainable soils with appropriate grades**, thus minimizing potential erosion. If substantial tread construction is specified in the construction log, it reflects the fact that the optimal trail alignment must cross an area with poor quality natural soils. The constructed tread provides a "structural solution" to the poor quality of the natural soil. **The trail construction person needs to always "read the ground" for changes of soil type that may have been missed in the trail design phase**. Construction crews should not alter the trail tread work specified in the construction log. If sub-standard soils are encountered during construction, the work should stop until the issue can be re-considered from a design perspective (i.e., consideration of a change in the trail alignment).

To determine if the naturally occurring soil is not suitable for constructing a sustainable tread:

1. Take a clump of soil and add a few drops of water so that you can form it into a small ball.

2. Shape the ball into oblong shape so that it looks like a sausage that is fat in the middle and narrower at each end.

3. A good soil matrix that is suitable for a sustainable tread will stay together when you break the "sausage" in half. If the soil sausage crumbles when you break it into two pieces, the soil will likely not form a sustainable tread.

Building trail tread is often “back-breaking” work. Natural environments rely on delicate patterns of water movement. Trails are not a part of the natural environment, and even the most sustainable trails will alter the natural patterns of water movement. **It is almost impossible to underestimate the importance of maintaining natural drainage patterns** both during trail construction and on-going trail use. Sustainable trails often require more work to construct, because they pull in and out of every natural drainage channel. However, this work is necessary to ensure that the impact of the tread on the natural drainage patterns is minimized, the tread will have the proper outslope for good drainage, and it will be level enough for safe and comfortable use.

The specific steps for constructing the trail tread will vary, depending on the quality of the natural soils, the terrain, and the type of tread material. In general, the steps will be:

- Prepare the ground.
- Cut the bench.
- Install the tread material.
- Restore the tread environment.

Each of the steps used to create a natural surface trail is described in detail in the following sub-sections. Information on constructing hardened or constructed trail surfaces is provided in the section titled Constructed Trail Surfaces.

Prepare the Ground

To prepare the ground for a natural surface tread:

1. **Mark the location of the tread**.
   Before starting construction, use pin flags, environmentally safe marking chalk or flagging tape to record the intended location of the finished trail tread on the landscape. Make sure that the markings are outside the construction area so that they will remain clear and available for referencing even after excavation has started.

2. **Remove the organic material**.
   Remove all vegetation and organic material (e.g., roots) from the construction area (tread and back slope). Organic material left on or under the tread will eventually rot, and soft spots in the tread will develop. As the soft spots compact, swales will be created that will encourage water to sit on the trail tread. Take care not to remove organic material or vegetation from the areas beside the tread. Removing too much vegetation can encourage erosion and it also detracts from the aesthetics of the trail environment. Preserve the removed vegetation so that it can be used to rehabilitate the site or for repairs to other sections of the tread.

3. **Remove the topsoil**.
   Rake the loose topsoil off of the trail tread. The material should be raked far enough off the tread so that it is outside of the area where the bench and back slope will be constructed. Top soil and organics raked to downhill of the tread will act as a silt “fence”, helping to minimize spread of the mineral soil loosened during construction to the surrounding environment. The topsoil removed from the tread should be preserved so that it can be used to rehabilitate the finished tread.

4. **Mark the tread location**.
   After the topsoil is removed, scratch deep lines in the dirt to mark the exact location of the finished tread. **It is essential that the tread curve in and out of every natural swale and drainage channel on the landscape**. The shaping of the tread onto the natural contours of the land is critical to its sustainability. The downhill side of the tread can also be marked with pin flags to make it easier to identify. The pin flags should carefully follow the tread alignment specified in the construction log.

Cut the Bench

The bench refers to the land on which the tread material rests. A “full bench tread” is one that is constructed by cutting the full width of the trail tread into the hillside. Although many people believe that “cutting a bench” is damaging to the trail environment, in fact a full bench tread provides the most sustainable design. Properly constructed, **a full bench tread should last “forever” with virtually no maintenance**.

A “partial bench” refers to a tread that is partly dug into the hillside and partly supported by fill that is contained with log edging or a retaining wall on the downhill side. Many trail crews prefer to build partial bench treads because a lot less excavation work is required. Unfortunately, **partial bench trails provide a less sustainable tread and are more expensive to construct**. It is very difficult to construct the filled portion of the tread with the same degree of compaction as the bench cut section. As a result, the filled section compacts more with trail use and eventually forms a rut on the trail tread that diverts or traps water and increases erosion.

If drainage structures are required along the tread they should be installed after the bench is cut. Refer to Trail Drainage Structures for additional information.

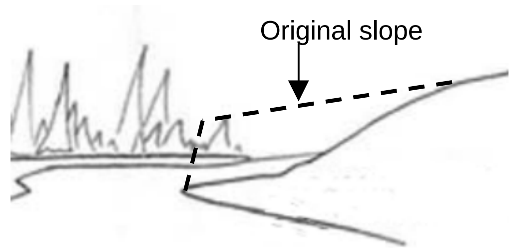
The location where the first cut will be initiated can be identified during trail design or determined on-site by an experienced construction crew leader. **The trail bench and back slope are cut “from the top down”**. That is, the first cut is made at the top of the back slope (i.e., the edge of the back slope that is furthest from the tread). The back slope is excavated initially, and then the tread is gradually included when the excavation work reaches the level of the finished tread. To cut the bench for the tread, the following steps are repeated in sequence as the excavation work is completed:

1. **Loosen the mineral soil**.
   Use grubbing tools (see Tools Used for Clearing) to loosen the compacted mineral soil. Initially, the soil will only be loosened to a depth of 5 cm (2 inches) to 10 cm (4 inches). The depth of the cuts into the mineral soil will increase as the excavation work gets closer to the finished tread grade.

2. **Remove the mineral soil**.
   Use shovels, rakes and McLeods to remove the loosened soil from the site. Mineral soil removed from the site can be used to repair the tread in other locations. If the soil cannot be re-used, distribute the soil downhill of the constructed tread. The soil should be distributed widely so that it is naturally dispersed in the environment. Ensure that the distributed soil does not alter the natural drainage patterns of the landscape.

3. **Repeat the loosening and removal steps**.
   Continue to alternate the steps to loosen and remove the mineral soil until the tread is excavated to the desired level.

4. **Shape the back slope**.
Carefully shape the back slope as you excavate towards the finished grade of the tread. A properly shaped back slope is critically important to the sustainability of the trail tread.The amount of excavation required to create a good back slope will depend on the natural soils and the contours of the land. At all points, the back slope should not exceed the angle of repose[67]. If the back slope can be significantly less than the angle of repose it will be more stable and will more quickly collect duff and re-establish a protective cover of vegetation. **Be sure that every point on the back slope is above the height of the finished tread**. Do not allow the back slope to be excavated or compacted lower than the tread or water will not be able to drain easily across the trail. Careful excavation of the back slope so that it blends seamlessly with the trail tread will ensure that water can sheet drain easily across the finished tread. Remember, if additional tread materials will be installed, the final shaping of the backslope will be done after the tread has been completed.



5. **Compact the bench**.
After the soil has been removed, shape and compact the remaining soil to provide a firm surface on which the tread material can be installed. A flat, square shovel or McLeod can be used to tamp the soil in place. Rock and fill can also be mixed into the natural soil, if necessary, to create a solid surface. It is important to carefully inspect the finished bench. **The finished bench must follow the natural drainage patterns and contours of the land**. It is essential that the constructed tread pull up and into every natural drainage channel encountered in order to maintain natural, sheet drainage patterns. Follow the layout and tread location information in the construction log exactly in order to optimize the long-term sustainability of the trail.

[67] The angle of repose is the angle at which the natural soil, when it is not compacted, is stable.

Install the Tread Material

The **optimal tread material is natural soil mixed with crushed rock**. “Road base” gravel (“3/4 minus”) is easy to obtain and ideally suited for a firm, stable and sustainable soil tread. Mechanically crushed rock (not river gravel) is best because the pieces have jagged edges that will not shift on each other. The proportion of soil and rock will vary with the desired aesthetics (e.g., a tread that looks more like soil or crushed rock) and the natural conditions. In some cases, substantial amounts of crushed rock will be required. In other areas, the natural soil will contain enough rock particles that additional material will not required. **Ensure that at least some rock particles are mixed into the trail tread** to enhance the tread durability and sheet flow drainage while keeping the outslope at 8% or less. The construction crew leader should be constantly alert for micro-changes in the soil conditions that were not specified in the construction log.

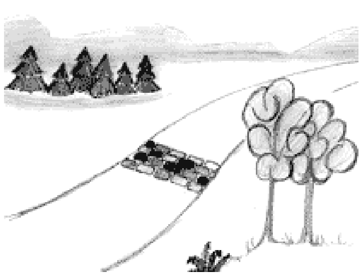
If the trail tread will be constructed from manufactured products (Constructed Trail Surfaces), the materials should be installed according to the manufacturer’s instructions. **If a natural soil tread is desired**, and the naturally occurring soil is not suitable for a sustainable trail tread, **it can be improved through the following steps**:

1. Loosen the natural soil along the trail tread to a depth of 15 cm (about 6 inches) and turn the material loosely along the trail tread.

2. Add the crushed rock on top of the loosened soil and thoroughly mix the two materials together. When the mixing is complete, all of the soil should look alike. There should be no visible layers or sections made of only one type of material.

3. Compact and shape the modified soil to form the trail tread (see Compact and Shape the Tread).

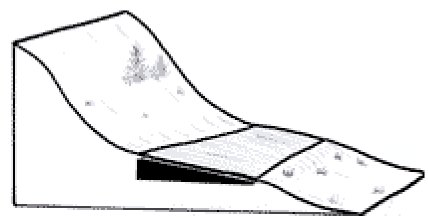
After you add new material, the total amount of soil on the tread will be larger. As a result, even after compacting, the trail tread may be higher than the intended tread height. If excess material remains after compaction and shaping of the trail tread, it should be used to repair other sections of the trail or it can be disposed of by spreading and distributing it in the surrounding area. **Be careful to not damage the natural drainage patterns or any vegetation when distributing excess material**.



Flagstones, wood or pavers can be embedded into the tread to identify points of interest or facilities (e.g., bench, washroom). For people with vision or cognitive limitations and inexperienced trail users, consistent changes in tread texture can be very helpful in signaling facilities and features, such as pathways to washrooms, interpretive features, trail intersections and trailheads. Changes in tread texture that provide information to trail users should be placed across the full width of the tread and should extend for a distance of 0.6 m in the direction of travel. It is important that any changes in the tread surface do not present a tripping hazard.

Compact and Shape the Tread

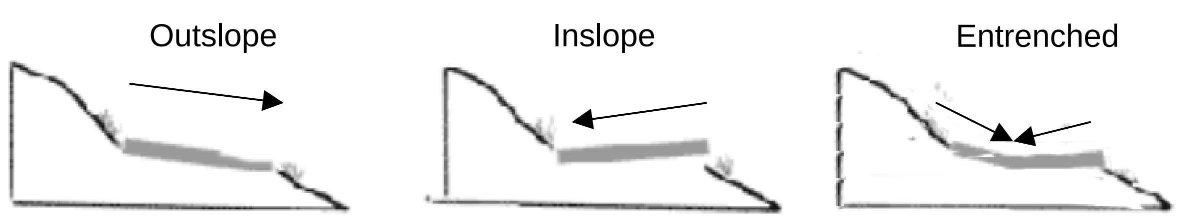
Proper compaction and shaping of the tread is the key to sustainability. The trail designer will have considered the impact of a trail tread compaction in determining where the tread will be located. Although many people know that soil compaction can have a negative effect on delicate root systems, **compaction of the trail tread is critically important**. The tread alignment specified in the construction log will be designed to ensure that the vegetation in the surrounding environment will not be adversely impacted by compaction of the trail tread. Compaction of the trail tread allows water to sheet quickly over the trail, protecting and preserving the trail surface. When trail users have a firm and comfortable surface, they will not roam "off the trail" to find a better path (causing more environmental damage in the process).



For optimal sustainability and minimal impact on the surrounding environment, the trail **tread should be very firmly compacted so that it has an even and consistent outslope**. Shovels or a McLeod can be used to shape and compact the tread. In more developed areas, the tread can be mechanically compacted with rollers or vibrating plates. Make sure that the finished trail tread has a smooth and even surface so that water flows easily in sheets across the trail and puddles or pools of water do not develop.

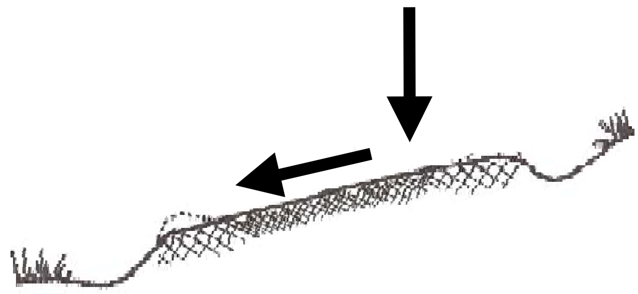
Do not leave the job of compacting the tread to user traffic.

The worst thing for the sustainability of your tread is to have some areas compacted more solidly than others. Not only will users avoid the softer areas (and therefore magnify the difference in compaction), but the compacted areas will be lower, trapping water on the trail tread. Eventually, the compacted area becomes a rut in the centre of the tread, and a flow of water down the trail soon follows. **A properly constructed trail tread should be fully compacted** so that even the first trail user does not imprint the tread as they pass.



Constructing the Tread Outslope

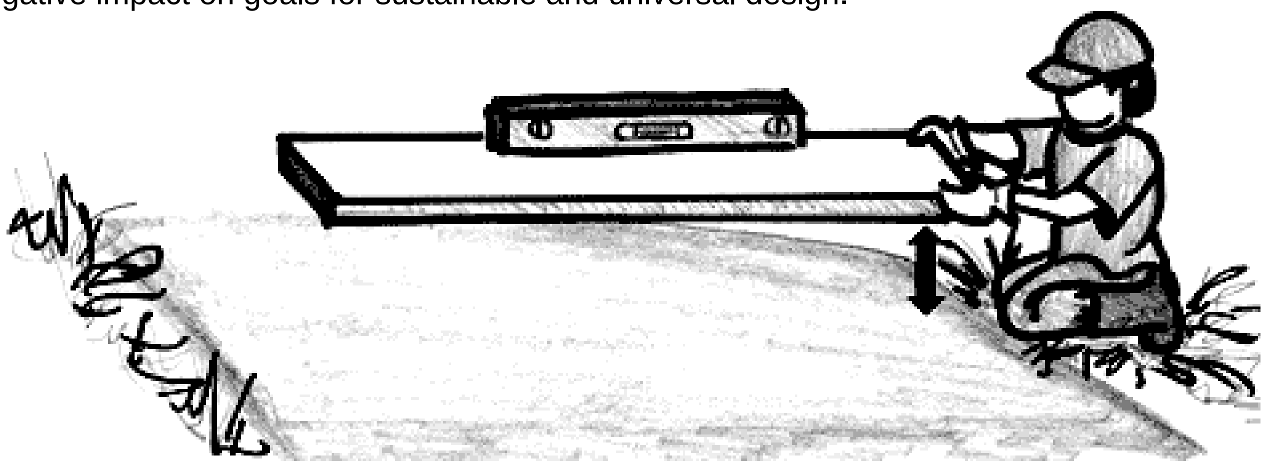
Outslope refers to the shape or angle of the trail tread so that **water on the trail surface naturally drains off of the downhill edge** of the tread. It is created by cutting and shaping the trail bench (see Cut the Bench). Continuous tread outslope allows water to flow across a trail at any point, avoiding the erosive force that occurs when water is concentrated at a selected point. Use of continuous outslope along the full length of the trail tread is the preferred method for maintaining the natural drainage patterns in the trail environment.



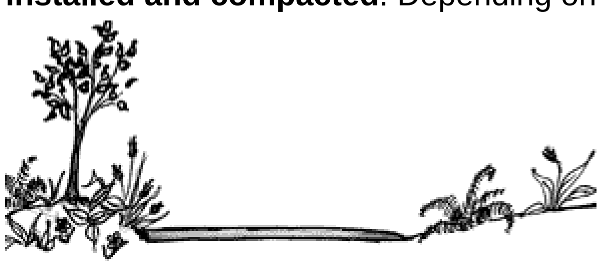
The **amount of outslope required will depend on the grade of the trail and the type of tread material**. As the linear grade of the trail increases, the outslope must also increase to prevent water from being directed down the trail. In general, paved treads will require 3% outslope or less on a level grade. Hardened treads with limited grade are usually sustainable with 5% outslope. Natural surface trails will require 5% to 8% outslope when the linear grade is relatively level.

The trail tread should always be constructed according to the outslope specified in the construction log. Construction **crews should measure the outslope, using a digital level or clinometer** (see Appendix F), throughout the tread surface to ensure that "as built" is the same as "as designed". The trail designer will have carefully considered the conflicting needs for sustainability and universal design in determining the tread material used and the outslope required.

The need for outslope of the trail tread to ensure proper drainage creates the only significant conflict between sustainable and universal design principles. As the amount of outslope increases, many users will find the trail increasingly difficult. Trail users "on wheels", such as children riding bikes, stroller, in-line skaters or people using wheelchairs, will tend to drift to the downhill side of the trail. People who are obese and those who use walking sticks, canes and crutches also find outsloped surfaces more difficult. Cross-country ski poles that are adjustable in length are another clear indicator of how many trail users are uncomfortable if the outslope is too severe. The outslope specified in the construction log will have been determined by the trail designer through the careful consideration of the needs of the environment and trail users. **Construction crews must be careful to construct the tread to the specifications provided**. Increasing or decreasing the outslope by even one or two degrees can have a very negative impact on goals for sustainable and universal design.



To measure the outslope of the trail tread, place a 2" x 4" or similar object, one metre (3.3 feet) in length, across the tread and perpendicular to the direction of travel. Put a level on the wood and then lift the downhill end of the wood until the whole piece is level. Measure the distance from the trail tread to the bottom of the piece of wood. If a one metre (3.3 foot) object is used, the height of the object above the ground (in centimetres) will be equal to the percent outslope (i.e., a height of 5 cm is equal to 5% outslope). Remember, the outslope of a trail tread must always be **measured after surface material is fully installed and compacted**. Depending on the degree of tread surface compaction during construction and the amount of on-going trail use, the outslope may need to be re-established at regular intervals in order to prevent a berm from developing on the downhill side of the tread. Refer to Restoring the Tread Outslope in "Best Practices for Trail Maintenance" for information on restoring tread outslope.



Restore the Tread Environment

The final step in tread construction is to restore the trail environment so that it closely matches the "pre-construction" state. This is where you get to **re-use the vegetation, organic material (e.g., duff) and topsoil that was carefully removed** and stored at the beginning of your work. A thin layer of duff (e.g., 1 cm or 0.4 inches) on top of the finished trail tread will not only improve the aesthetics of the trail, but it will cushion user traffic, help to retain soil moisture and protect the underlying soil from rainfall impacts. The construction work is incomplete until all "scars" from the work have been removed from the trail environment. Trail users should not be able to tell that work was recently done on the trail.

Vegetation should be restored to the back slope to the greatest extent possible. If sufficient material was not preserved during excavation, try to selectively transplant material from small patches near by. Quickly re-establishing the cover of vegetation will help to ensure that the back slope remains stable and significantly improves the aesthetics of the trail environment.

Restoration of the trail environment also extends to the removal or distribution of any natural materials that cannot be re-used. Wherever possible, the material excavated during construction of the bench should be preserved and re-used for repairs at other locations (e.g., to fill a swale on the tread). **If materials cannot be re-used, they should be broadcast away from downhill edge**. Be sure to move the material several metres away from the edge of the tread. Materials left near the end of the tread often form a berm that prevents water from draining naturally downhill but rather forces it down the trail tread. Leaves and branches removed originally from the tread can be used to cover the broadcast soil and re-establish a more natural aesthetic.

The final step in restoring the environment is to remove the tread location markers, pin flags and flagging tape that you originally installed. If the trail environment is properly restored, **before you leave the trail will "look like it's been there forever"**.

Constructed Trail Surfaces

It is often best to build a hardened trail tread in areas where poor soil conditions cannot be avoided or modified. It may be necessary to use a constructed trail surface in areas where the environment is particularly sensitive or for trails that will have a high volume of users.

There are **four kinds of constructed trail surfaces**:

1. **Solid materials** that are applied over the terrain, such as wood or plastic planking or flagstones.

2. **Hardened treads** that mix binding or stabilization materials (e.g., products made from tree sap or seed hulls) into the natural soil.

3. **Stabilized treads** that use a cellular containment system to provide support for the tread and minimize the dispersion of tread material.

4. **Crushed aggregate treads** that are constructed by mechanically compacted crushed rock that contains a range of particle sizes (typically 2 cm (0.8 inches) or less, including a proportion of crushed fines).

In many locations you will also see trails constructed with pieces of material. Typically, the “pieces” are either wood chips or shredded rubber. **The use of pieced materials on trails is not recommended**. These materials have been developed primarily for playground surfaces because when they are placed on top of a compacted natural surface they provide additional resilience (i.e., cushioning). Wood chips are also used to raise the height of the trail tread on wet or muddy sections. People responsible for maintaining these trails will tell you that **these types of materials are rarely sustainable over time**. The pieces quickly “migrate” off of the trail tread, or accumulate at the sides of the tread if a border is constructed to contain the material. In addition, the surfaces that they create are often soft or unstable which means they require a lot more energy to walk on.

Recent research[68] has demonstrated that it is possible to stabilize these materials by adding binding or stabilization materials. Some manufacturers also produce wood chip products that come “ready made” with their own stabilization material (e.g., engineered wood fibre). However, if a hardened tread is going to be constructed, the **sustainability and aesthetics of the finished tread are usually much better if the stabilization products are mixed with the natural soil**.

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[68] Bergmann, R. (2000). Soil Stabilizers on Universally Accessible Trails. Washington, DC: US Department of Agriculture and Federal Highway Administration.

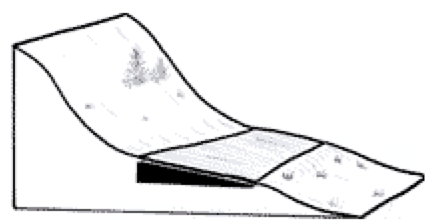
Solid Materials

Solid materials used for trail treads include wood (wood planks or decks), plastic (artificial "wood"), rubber (mats), rock (rip rap[69]), stone (flag stone), brick or concrete pavers or slabs, or porous pavement panels. Most of these materials are best used for highly developed, heavily used trails in urban settings. However, lumber and rock can be used in a wide variety of urban and rural trail environments where the natural soil does not make a suitable tread. Solid materials work best in areas where the natural soils are saturated with water or there are ephemeral (i.e., intermittent) springs or water flows. Lumber and plastic plank treads are constructed using the techniques described in Tread Structures Above the Surrounding Terrain.

Each specific trail situation requires a site appropriate choice of material and installation method. The installation procedures for similar products from different manufactures may be very different. Ensure that the people installing the surface material accurately understand the specific installation procedures for the product being used. Both the product and the installation method must be suitable for the trail type and environment. Therefore, decisions regarding tread surfaces should be made during the trail planning stages and the installation procedures detailed in the construction log.

To build a trail tread using solid materials, initially the Prepare the Ground and Cut the Bench steps are completed as previously described. The solid materials are then installed according to the manufacturer's instructions. In general, the steps will be:

1. **Shape and compact the bench**.
   Establish the outslope (generally 3% for solid surfaces) required for the final tread by shaping and compacting the mineral soil using the procedures described in Compact and Shape the Tread.



2. **Place the solid materials on the prepared bench**.
   The compacted trail bench should already be shaped to suit the application of the tread materials. It is much easier to establish the required outslope using the compacted mineral soil than to try to shim the solid materials to provide a sloped surface.

[69] Rip rap is constructed from large rocks (one cubic foot installed below trail grade so the surface of the rock is at grade). The rocks are installed tightly together to create a surface similar to cobblestone. The Incas used this technique over one thousand years ago to build trails that are still in use.

3. **Fill and compact between the solid panels**.
Solid materials generally should not be installed so that they abut solidly against adjacent pieces. As the materials expand and contract with changes in temperature, it is necessary to have some "wiggle room" available to prevent the solid panels from lifting (e.g., frost heaves). Often, natural soil will be used to back fill around the solid materials, however finely crushed aggregate can also be used if a more "paved" appearance is desired. Wherever possible, **the space to be filled between adjacent solid panels should be no more than 15 mm (0.6 inches) in width**. This will ensure that trip hazards will not be created if the fill material settles below the level of the solid surfaces. Add fill material in small layers (e.g., 10 cm (4 inches) or less) and then compact the material before adding more fill. The filling and compacting activities should be continued until the fill material is at the same level as the solid panels.

4. **Restore the tread environment**.
The construction of solid surfaces generally produces the desired finished tread. However, the areas adjacent to the tread should be restored as previously described (Restore the Tread Environment).

Crushed Aggregate/Crusher Fines

Mechanically crushed rock is often used to provide a firm and stable trail tread. Many trail users feel that crushed aggregate trails are more aesthetically pleasing than trails using solid materials. In southern Ontario, the use of crushed limestone is particularly common. If crushed aggregates are used, they should be "3/4 minus" (pieces 2 cm (0.8 inches) or smaller) and contain a range of sieve sizes, with about 25% of the content being crushed fines. The crushed aggregate should contain fractured rock with irregular edges so that it compacts solidly. The crushed aggregate should also be free of vegetative material to ensure that rot of organic material over time does not result in soft spots or uneven surfaces. **It is critically important that crushed aggregate surfaces be mechanically compacted during tread construction**. In the past, the aggregate was often spread on the trail without compaction. While eventually the tread will compact with use (over 3 to 5 years), the years of initial use will be very difficult for many trail users. In addition, outslope of the tread will be inconsistent and the migration of the non-compacted materials into the surrounding environment will have a substantial negative impact on adjacent vegetation.

To construct a tread using crushed aggregate:

1. **Shape and compact the bench**.
   Establish the outslope (generally 5% for crushed aggregate surfaces) required for the final tread by shaping and compacting the mineral soil using the procedures described in Compact and Shape the Tread. The trail bench should be mechanically compacted, with a vibratory plate or roller compactor, to ensure that the outslope of the bench will be retained once final compaction of the crushed aggregate has been completed. If the natural soil of the bench cannot provide a suitable surface for compacting, the entire tread bench should be covered with landscape fabric.

2. **Place the crushed aggregate on the tread**.
   The crushed aggregate should be placed evenly across the bench to a depth of 7 cm to 10 cm (2.8 inches to 4 inches). Shape the material to re-establish the desired grade and cross-slope, ensuring that the surface is consistent and without depressions that might trap water. The aggregate should be kept moist to assist with shaping and compacting.

3. **Compact the crushed aggregate**.
   Keeping the crushed aggregate moist, mechanically compact the crushed aggregate with a vibratory plate or roller compactor. A minimum of 4 to 5 passes should be completed so that the finished surface smooth, free of depressions and provides the required outslope and grade.

4. **Place and compact a second layer of aggregate**.
   Repeat Steps #2 and #3 with a second 7 cm to 10 cm (3 to 4 inch) layer of aggregate. Additional layers can be added if desired, but a minimum total aggregate depth of 15 cm (6 inches) should achieved when the tread construction has been completed.

5. **Restore the tread environment**.
   The finished crushed aggregate tread will be suitable for immediate use. Areas adjacent to the tread should be restored as previously described (Restore the Tread Environment).

Binding or Stabilization Materials

Binding or stabilization materials include bonding agents, landscape fabrics and cellular containment materials. Binding agents are typically made from natural materials, such as tree sap or seed hulls. They create a solid and unified surface when mixed with natural soil or crushed aggregate[70]. Binding agents should be carefully selected, based on the climate and other characteristics of the trail environment, because most will work best under particular conditions. Landscape fabrics (e.g., filter fabric) and cellular containment materials (e.g., solgrid, geoweb) are made from environmentally inert substances. They create a semi-rigid structure that prevents soil particles or pieced materials from shifting due to trail use.

It is critically important that the manufacturer's instructions be followed precisely when using a binding agent to create a trail tread. Each product will have specific instructions. Failure to follow the product instructions often results in a tread surface that is difficult or impossible to use without extensive re-construction and maintenance.

While the installation procedures for each binding agent will differ, in general, the following steps will be needed:

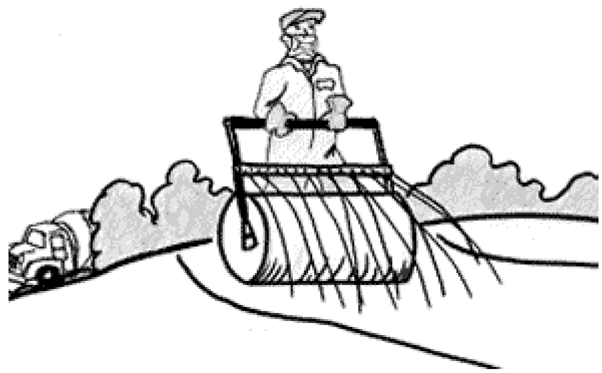
1. **Shape and compact the bench**.
   Establish the outslope (generally 5% for hardened surfaces) required for the final tread by shaping and compacting the mineral soil using the procedures described in Compact and Shape the Tread. The trail bench should be mechanically compacted, with a vibratory plate or roller compactor, to ensure that the outslope of the bench will be retained once final compaction of the hardened surface has been completed. If the natural soil of the bench cannot provide a suitable surface for compacting, the entire tread bench should be covered with landscape fabric.

2. **Place the base material on the tread**.
   a) **Stabilization Materials**
   Place the stabilization material/grid onto the prepared bench according to the manufacturer's instructions. Stabilize the material on the bench and then follow the manufacturer's specifications to fill the stabilization material with the tread material. For optimal aesthetics, ensure that there is sufficient tread material so that the compacted, finished tread shows no evidence of the stabilization material. It is often helpful to use a bonding agent with the top 2 cm to 3 cm (0.8 to 1.2 inch) of the tread material to ensure that the stabilization material will not be gradually exposed through trail use.

[70] Many companies promote the use of binding and stabilization materials with wood chips or shredded rubber. Stabilization of these materials improves the sustainability of the constructed tread, but information on these uses is not provided because they create a relatively soft surface that many people find difficult to cross. Aesthetically, the stabilization of the natural soil or crushed aggregate is preferred.

b) **Binding Agents**

If binding agents will be used, specific soils or crushed aggregate will have to be imported for the tread material because most binding agents require specific soil/material conditions for successful performance. Occasionally the natural soils may be suitable. Place the base material evenly across the bench to a depth of 7 cm to 10 cm (3 to 4 inches). Shape the material to re-establish the desired grade and cross-slope, ensuring that the surface is consistent and without depressions that might trap water. Apply or mix the binding agent with the tread materials according to the manufacturer's specifications.



3. **Compact the tread material**.
   Mechanically compact the tread material with a vibratory plate or roller compactor. A minimum of 4 to 5 passes should be completed so that the finished surface smooth, free of depressions and provides the required outslope and grade. If stabilization materials have been used, ensure that there is sufficient tread material so that the stabilization panels will not be damaged or distorted during compaction.

4. **Restore the tread environment**.
   The finished tread will be suitable for immediate use. Areas adjacent to the tread should be restored as previously described (Restore the Tread Environment).

Steps and Ladders

The use of steps and ladders are to be avoided and used only as a last alternative on trails. Steps and ladders are costly, and require a great deal of effort, both during original construction and in on-going maintenance. Steps and ladders also make trail use very difficult for many trail users. “Hikers, especially backpackers, generally don't like steps and will walk alongside them if there is any opportunity.[71]” **Steps can be significant barriers or hazards** for other trail users, such as cyclists, cross-country skiers, young children and people with limited mobility. Steps should only be considered when all other options are not suitable[72].

Despite all the limitations, there are some trails that will require steps or ladders as part of the trail tread. For example, the trails that lead to the many fire towers in Ontario would be pointless if a ladder to climb the tower and see the view was not available. **Steps and ladders may be considered in very steep terrain, where other trail layouts are not possible or would not adequately protect the natural environment**. In these situations, steps can help to retain soil and stabilize the slope, which makes them less damaging to the environment than having users “slip sliding” as they climb or going off of the trail tread. Steps also provide trail users with relatively “level ground” to stand on, which can be a welcome relief from the constant effort of balancing and stabilizing oneself on very steep terrain.

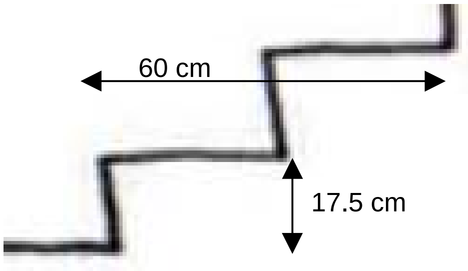
When it is necessary to install steps on a trail, the riser height of each step should be as consistent as possible. Handrails should be provided for all flights of stairs, in accordance with local safety codes. A detectable warning surface must be installed at the top of the steps to warn trail users with visual impairments and those who may not be paying attention (i.e., children). The detectable warning surface should be a different texture than the trail tread and should extend across the full width of the tread and for a distance of 0.9 m in the direction of travel. That is, the trail user moving towards the stairs would encounter the start of the detectable warning surface 0.9 m before he/she arrived at the top of the steps. A detectable warning surface is not required on the downhill side of the steps.

[71] US Department of Agriculture Forest Service. (2000). Trail Construction and Maintenance Notebook: Special Structures: Steps. Washington, DC: US Department of Transportation. [On-line] Retrieved 31 July 2006 from http://www.fhwa.dot.gov/environment/fspubs/00232839/page10a.htm#steps
[72] The Bruce Trail Association. (2001) Guide for Trail Workers. 3rd Edition. Hamilton: Author.

When steps must be installed on a trail, consider the following adaptations to make the trail more accessible:

- Provide sloped spaces beside or within the steps so that people pushing strollers, pulling wagons, or using a wheelchair can roll up or down the surface if they have sufficient strength.
- Provide handrails on one or both sides of the steps that users can use for support if needed.
- Mark the edge of each step with a contrasting colour or texture so that it is more easily seen by trail users, particularly those with vision impairments.
- Ensure that trail information sources (e.g., web sites, guide books, signs) indicate that there are steps on the trail.
- Add a bench or other sitting surface 40 to 45 cm (16 to 18 inches) in height at the top and bottom of the steps. The bench at the bottom may be connected to a step tread of equal height to help people who use wheelchairs to transfer to the staircase so they can use the stairs. Similarly, additional tiered surfaces that extend up to 40 to 45 cm (16 to 18 inches) above the top step can be provided.

- Provide landings or rest areas where trail users can stop and rest in the middle of a long series of steps.



Steps provide a way to climb or descend a steep slope and help to protect the local environment from erosion, but the safety of the trail user must be the prime consideration. Stairs in houses and buildings are typically 17.5 cm (7 inches) high with a 32.5 cm (13 inches) run (the distance from the front of one step to the back of the next step). **On trails, the steps should be deeper** (run of 60 cm (2 feet) or more), so that trail users can place their entire foot on the step for support. Wide and deep steps also appear less steep and intimidating to users. **Each step should be as wide as the location permits**, and steps should never be narrower than the rest of the trail tread. **Steps on trails should have riser heights of 15 cm** (6 inches) wherever possible, with maximum riser heights of 20 cm (about 8 inches) used only when necessary. Remember as riser height increases, many trail users, including children, elderly walkers, hikers with heavy packs and people with disabilities, find it increasingly difficult to negotiate steps safely. High riser heights are also difficult for descending hikers and may be dangerous for people who are tired (e.g., the end of a long hike).

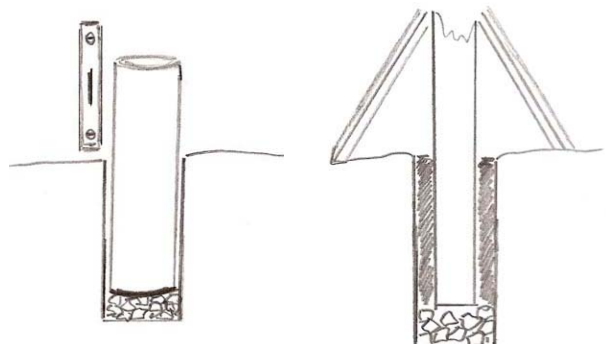
Steps should follow the contour of the land to minimize site disturbance. The location, spacing, number and rise of the steps will be determined during trail design, based on the existing terrain and type of trail user, and specified in the construction log. Key points to remember when building steps are:

- Work from the bottom and then go up the hill.
- Ensure that the base of the steps is on a level grade. Otherwise, the trail tread below the steps will tend to erode.
- Excavate the bottom stair into a solid footing.
- Ensure that the steps allow water to drain to the side to minimize the deterioration of wood surfaces and retain the fill material.

Stringer Steps

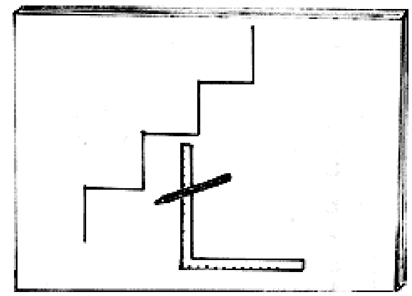
Steps on stringers are more difficult and expensive to construct and maintain. However, they are the only option for areas, such as exposed bedrock, where surface conditions make it too difficult (or ill-advised) to set steps into the ground. Steps on stringers may also be considered for trails in steep terrain with very high levels of use in order to minimize soil compaction and user impacts. **Aligning and anchoring the vertical support posts required for these types of steps makes it less likely that stringer steps will be constructed using only hand tools**. Where anchoring the steps is difficult (e.g., connecting to granite) or requires mechanized equipment, professional assistance should be obtained.

To construct steps on stringers:

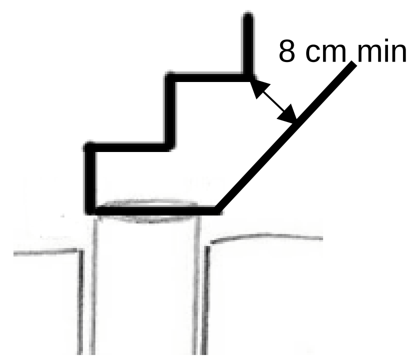


1. **Install support posts**.
   Vertical support posts are used to mount and stabilize the stringers. They can also be used as an anchor for the base of a handrail. The vertical posts are set into the ground as deeply as possible, at least 1 or more metres (3.3 feet) below grade. The posthole should be twice the diameter of the post it is to hold. The bottom of the hole should be lined with gravel. Insert the post and fill with concrete for maximum stability. Allow the concrete to cure according to the manufacturer's instructions. If concrete is not used, backfill holes with material removed during digging. When backfilling, do the work in small stages (10 cm (4 inches) of material at a time). For each layer, add the required material and then compact it firmly before adding more fill.

2. **Design the stringers**.
   Stringers are typically made from lumber. The required width and thickness of the lumber will be determined by the type of trail users and the number and size of the steps. Commonly used lumber sizes for stringers on hiking trails are 2 x 8, 2 x 10 and 2 x 12. The difficulty of steps increases as the rise (vertical height) increases or the depth (horizontal space for placing your foot) decreases. Make sure that the steps you design match the skills and experience of all potential trail users. Ideally, the depth of each step should be at least 30 cm (12 inches) with a rise of no more than 15 cm (6 inches) per step. Always try to keep the rise as low as possible and the depth as large as possible. If essential because of the terrain, the depth may be reduced down to 20 cm (8 inches) or the rise increased up to 18 cm (7 inches). Measure the vertical change in elevation that the steps must cover. Divide the total change in elevation by the desired rise for each step, ensuring that both numbers use the same measurement unit (e.g., 100 cm elevation change ÷ 10 cm rise = 10 steps), in order to determine the number of steps required.

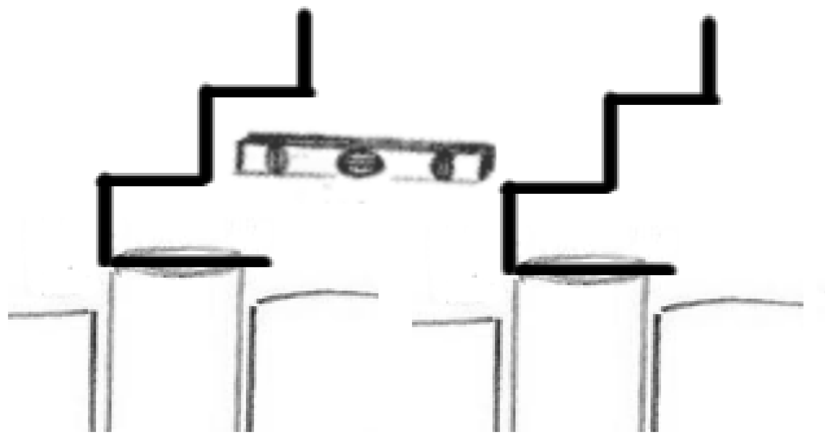
3. **Measure the stringers**.
   
   Use a framing square to draw the rise and run for each step on the lumber that will be used for the stringer to ensure that the rise and run of each step are perpendicular to each other. After the cut lines have been completed for the full length of the stringer, closely examine the stringer to ensure that the remaining depth of wood is sufficiently strong for the intended trail users. The thinnest part of a stringer should be at least 8 cm (3 inches) thick for trails that will have only one or two hikers on the steps at one time. The thinnest part of the stringer must be substantially thicker if heavier trail users (e.g., equestrians) or a larger number of hikers will be using the steps.

4. **Cut the stringers**.
   Use a saw (hand or power) to cut the stringers and remove excess material as indicated by the cut lines. Before cutting the stringer, closely examine the cut lines to double-check that after the cutting is complete, the remaining depth of wood will be sufficiently strong for the intended trail users. Purchasing stringers that are pre-cut or cutting the stringers before the material is hauled to the trail site will minimize lumber debris in the trail environment and decrease the weight of materials being transported. However, be sure that the cut is correct, remember, **measure twice and cut once**!

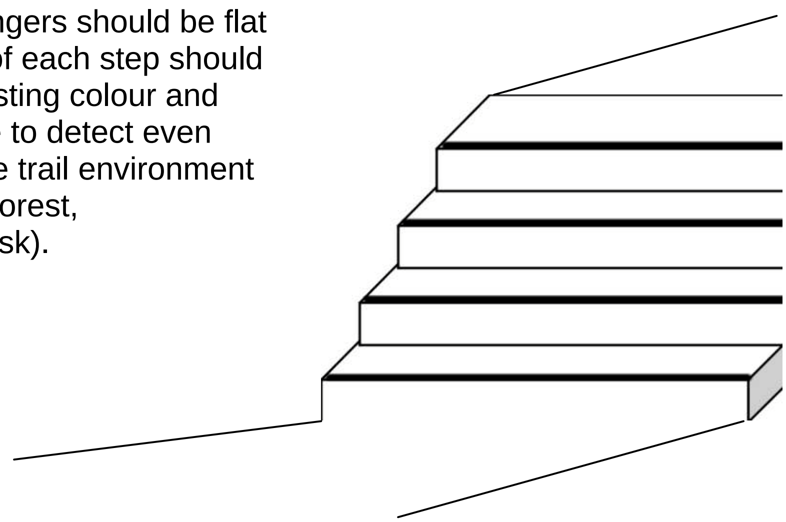
5. **Mount the stringers**.
   

   The stringers are anchored to the support posts. **Use galvanized bolts and washers** to prevent hardware from rusting (zinc plated can also be used if galvanized hardware is not available). Drill the boltholes at each end of the stringer so that they align with the centre of each support post. Hold the first stringer in the proper position, **making sure that the tread surfaces will be almost level** (2% slope from back to front on the step tread or less), and mark the location of the boltholes on the support posts. Drill holes through the support posts that are large enough for the mounting hardware. Mount the stringer on the inside of the support posts using the mounting hardware. If possible, use locking nuts and countersink the bolts and then cover the tops with wooden plugs or wood putty to discourage theft and vandalism.

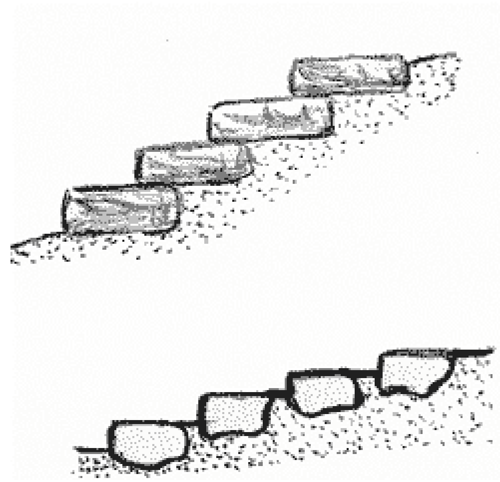
6. After the first stringer has been secured in the proper position, hold the second stringer in position on the opposite side of the step tread. Make sure that the tread surfaces will be almost level. The finished step treads (which are firmly mounted on the stringers) should have a slope of 2% or less from back to front on each step tread and 2% or less from one side of the tread to the other in order to allow water to drain off of the step treads. When the second stringer is positioned so that the step treads will be properly sloped, mark the drill holes for the second stringer on the support posts. Drill the support posts and mount the second stringer on the inside of the support post with the mounting hardware.



7. **Mount the treads**.
   The treads applied to the stringers should be flat and slip-resistant. The edge of each step should be clearly marked in a contrasting colour and texture that is easy for people to detect even if their vision is limited or if the trail environment has limited light (e.g., dense forest, heavy overcast, dawn and dusk).



Rock Steps



Rock steps last longer and trail users find them more natural looking, particularly if they are placed carefully. However, **building rock steps requires more skill and experience** to ensure that the finished steps will be stable and safe.

Rock steps can be built in two basic designs:

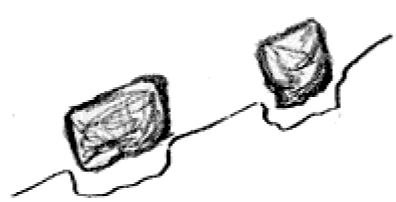
- Risers can be set into the slope and then backfilled to create a level tread surface.

- Tread rocks can be overlapped, with support from smaller rocks and fill.

To construct rock steps:

1. **Carefully select the rock surface for the tread**.
   Use the flattest surface of the rock for the tread, as this will provide the safest tread for trail users.

2. **Dig a hole for the rock**.
   Dig a hole that matches the shape and size of the portion of rock to be buried below the ground surface. Make certain that the rock will not move with use.



3. **Backfill around the rock**.
   Fill any extra spaces in the excavated hole with well-compacted crushed rock. Do not use organic material or soil for back filling as it is more likely to settle over time. If you are constructing the steps with rock risers, continue to backfill behind each riser to the base of the adjacent uphill riser.

4. **Immobilize the rock**.
   Place the riser end of the next rock on top of the back of the previous rock. This allows the weight of subsequent rocks to immobilize the lower rocks against the forces from passing trail users. If a single step is being built, or the steps are spaced too far apart to allow for overlap, the top of the rock should be level with the compacted trail tread that is uphill of the step.

Wood Steps

Wood steps are simple to build and are less expensive than steps supported by stringers. Wood steps can be made from either timber or logs. **Timber steps are generally easier to build**, with 4 x 4 or 6 x 6 "railway ties" being particularly popular. Remember, if the timber has been pressured treated, **make sure that Chromated Copper Arsenate (CCA) has not be used** as a wood preservative.

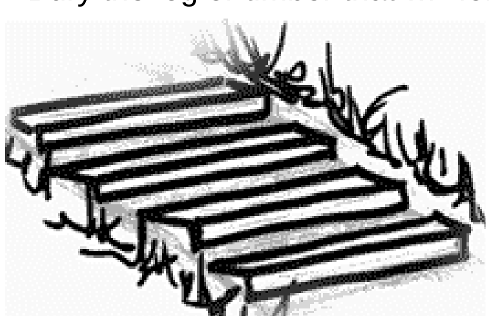
If logs are used, the **logs should be cut in half lengthwise, or shaved with a chain saw, to ensure that the top of each step is flat**. Rounded logs should not be used for steps because they are unsafe for many trail users. Try to use the largest diameter log possible so that trail users have a relatively large step surface.

To construct log or timber steps:

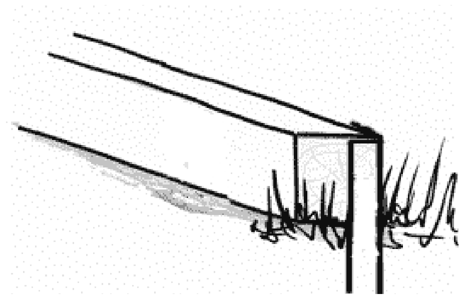
1. **Mark the natural slope**.
   Draw a line on the ground (using lime or environmentally safe marking chalk) to show the natural curve of the terrain. Draw one line on each side to show the outside edges of the step treads.

2. **Excavate the step gully**.
   Dig into the ground between the lines marking the natural slope to create a gully that is the same size or slightly larger than the log or timber that will be used for the riser. For example, if a log 15 cm (6 inches) in diameter will be used for the riser, the gully should be 15 to 17 cm (6 to 6.7 inches) wide. As excavation is completed for each step, it will create a series of terraces that approximate the planned stair treads.

3. **Embed and anchor the risers**.
   Bury the log or timber that will form the riser into the ground. The height of the timber or diameter of the log should be 1/3 larger than the height of the planned step riser. For example, if the step riser will be 15 cm (6 inches) in height, a log 20 cm (8 inches) in diameter should be used. Dig the step gully deeper so that 1/3 of the riser will be buried below the tread. After the riser is buried, back fill on the uphill side of the riser until the tread is level with the top of the riser. As you back fill, be sure to compact the material tightly to create a solid and stable tread.



4. **Anchor and bury the ends of the risers**.
   Both ends of the riser should be completely buried in the surrounding terrain. Large rocks can also be placed at each end of the riser to provide additional stability and to encourage trail users to stay on the tread. If it is not possible to bury both ends of the riser, anchor the steps with two pieces of 1" x 1" angle iron. Each piece of angle iron should be 30 cm (12 inches) longer than the diameter of the riser and have two holes drilled through one end. Pound the two pieces of angle iron vertically into the ground on the downhill side and at opposite ends of the riser so that they sit tightly against the wood. Anchor the angle iron to the riser with galvanized nails or screws through each of the drilled holes.



5. **Restore the environment**.
   Use plantings to restore the construction site and soften the edge of the steps. Use the excavated materials to restore other sections of the trail tread or disperse it throughout the surrounding environment so that aesthetics are maintained and natural drainage patterns are not affected.

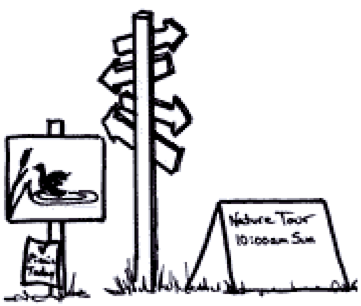
Ladders

As previously indicated, **ladders should be used only when absolutely necessary**. Ladders will limit use of the trail to only a small, agile proportion of hikers. Ladders also entail a high degree of maintenance to ensure they remain safe. Liability warning labels found on ladders sold for household use make it very clear that ladders on trails are a significant liability risk. **Consider installing a ladder on a trail only when all other options for re-routing the trail have been considered and the prevailing grade of the terrain is more than 100%** (i.e., more than 10 cm (4 inches) rise for every 10 cm (4 inches) of horizontal distance). If a ladder must be installed on a trail, design it so that it provides comfortable hand holds for each rung. This will allow more users to stabilize themselves, and some individuals may "climb" the ladder with minimal or no use of their legs.

Trail Signs

It is important that trail users have access to information regarding the trails that they wish to use. Trail information can be provided in a wide variety of formats. Trailhead signs, brochures, web sites guidebooks, on-trail signs and blazes are just a few examples of the ways in which trail users can obtain information. Even with good trail guides available, **trail signage is indispensable**.

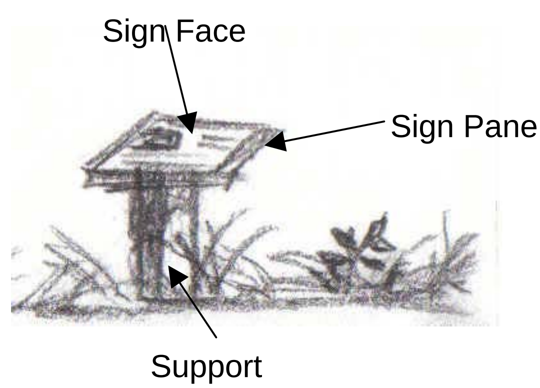
With the provision of trail signs, comes a responsibility for long-term management. Land managers should **ensure that trail signs are maintained in good order** and that trails continue to be suitable for roadway and trail signage. In addition, **all trails should have a detailed, written sign plan** prepared and approved by the club, agency, or organization that is responsible for the trail. The sign plan should provide specific and detailed information about the fabrication and installation of signs on the trail. It should also ensure that signs do not "overwhelm" the trail, either in complexity or number.



Care is needed to ensure that trail signs are harmonious with the nature of a trail environment. Although no one wants "sign pollution" (when there are so many signs that you can hardly notice the environment), **adequate signs and quality maps are what enable trail users to stay on a trail**. If trail users are uncertain about trail location or direction, they may create new trails that damage the environment and become maintenance and rehabilitation headaches.

Signs consist of three main components:

- **Sign Face**
  The information conveyed on a sign's surface.
- **Sign Panel**
  Physical backboard on which a sign face is attached or inscribed.
- **Supports**
  Post(s) or structure(s) that physically and visually anchor a sign to the site.



Sign Face

The **sign face is the surface on which the sign information is found**. Effective **sign faces are designed to meet the specific needs of permitted trail users**. They must be deliberately planned to serve the needs of all visitors. A sign on a bicycle route or downhill ski trail may only have a number, name or a symbol, because it must communicate essential information in a glance. As the visitor's pace slows, signs can become more complex (if desired) and subtle.

On trails, the sign face is typically made from a sheet of wood, metal or hard plastic. Regardless of the material used, **the sign face must be resistant to the damaging effects of weather** (e.g., wind, rain, ice, snow) **and ultra-violet radiation**. A quality sign should stand up to vandalism, rain, sun, snow and ice for at least 10 years. Funding permitting, trail managers should opt for durable, high quality signs, especially in the case of interpretive or trail head signs. If lower quality signs must be used because of funding limitations, regular inspections will be required to ensure that the information on the signs remains clearly visible (e.g., not faded, peeling or with damage from insects or mildew under the waterproof layer).

Blazes are another type of sign face that is commonly used on trails in Ontario. Paint blazes are typically used because they are low cost, easy to install and maintain, with little to no environmental damage. Latex rather than oil-based paint is recommended. Semi-gloss paint is durable and creates less glare than high gloss paints.

Trail signs must convey information in a way that all potential trail users can easily understand. This is true for all signs, regardless of the purpose, size or type of construction. To enhance the ability of a trail sign to accurately convey the intended information to all trail users, **construct the sign face using the following guidelines**:

- Use standard icons and graphics to convey information.
- Include a text descriptor below pictograms. Pictograms (i.e., icons) should have a minimum height of 15 cm (6 inches) (excluding text).
- Characters and background should be contrasting colours. In general, white or light-coloured lettering on a dark background is easier for people to read. Use dark letters on a white background for signs that are mounted in a "dark" environment (e.g., dark stone or dense vegetation). Avoid using the following colour combinations: yellow/grey, yellow/white, blue/green, red/green, black/violet, and red/black.

- Use a non-glare finish for characters (i.e., letters, images, icons) and background. Glossy finishes reflect light and make reading difficult.

- Text should be suitable for a Grade 4 reading level.

Grade 12 Reading Level	**Grade 4 Reading Level**
The Larkspur Meadow is an excellent example of environmental restoration.	The Larkspur Meadow shows that we can take care of the plants and animals that live in this area.

- Maximize the contrast as much as possible. The contrast should be at least 70%[73]. Contrast can be increased by surrounding the character or sign with contrasting trim (e.g., black rectangle around white blaze increases the contrast between the white blaze and a grey concrete post[74]).

- Use different textures for characters and background, if possible.

- Use uppercase or lowercase or a combination of both. Do not use italic, oblique, script or highly decorative characters.

- Choose “sans serif” fonts (the width of the uppercase letter “O” should be 50% to 100% of the height of the uppercase letter “I”).

- Characters on signs at eye level (approximately) should be at least 20 mm (0.8 inches) high (based on the size of the uppercase letter “I”) if they can be viewed from a distance of 1.5 metres (5 feet) or less. For each additional 1.0 metre (3.3 feet) of viewing distance, the size of the characters should be increased by 10 mm (0.4 inches). A person who doesn’t wear glasses should be able to clearly read the sign from at least 30 metres away.

- Spacing between adjacent characters should be 10% to 35% of the character height.

- Line spacing should be approximately 150% of character height (135% to 170%).

- Text indicating the name and length of the trail should be “tactile” (i.e., raised above the background of the sign by at least 10 mm (0.4 inches). The two typefaces most easily read by touch are Helvetica and Times Roman.

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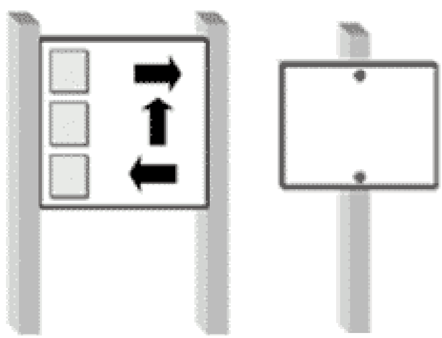
[73] Contrast = [(B1 – B2) / B1) x 100] (Canadian National Institute for the Blind. (1998) Clearing Our Path. Toronto: Author.
[74] The Bruce Trail Association. (2001) Guide for Trail Workers. 3rd Edition. Hamilton: Author.

Specific Types of Signs

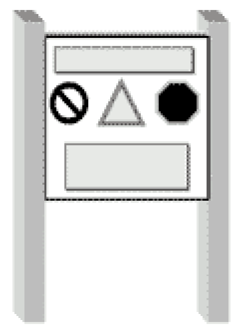
From entrance signs to interpretive signs, each type should serve a specific purpose. The **construction log will provide specific details** on the sign face to be constructed. The **key points for sign faces** found at the trailhead or on the trail are summarized below. If the construction log differs from this summary, the details in the construction log take precedence because the trail designer will have considered a wide variety of factors in order to determine the most appropriate sign face.

Directional



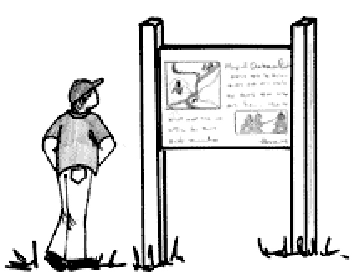
- Mount 3 m (10 feet) to 5 m (16.5 feet) before direction change.
- Each sign face 30 cm x 30 cm (12 x 12 inches) (approx.) or 30 cm x 15 cm (12 x 6 inch) arrows.
- Route markers every 500 m to 700 m (1640 to 2297 feet) along trail.
- Mount 1.5 m (5 feet) above tread or so sign can be easily seen from both seated and standing positions.
- Blazes 5 cm x 15 cm (2 x 6 inches) with contrasting 2 cm (0.8 inch) border on all sides.

Regulatory / Warning



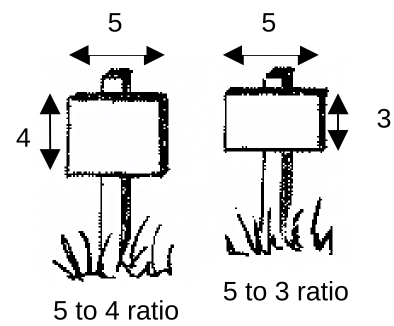
- Graphics from MTO Manual of Uniform Traffic Control Devices.
- Identify permitted users.
- Provide warning of hazards.
- Size as legally required[75].
- Black text on white background. Stop sign is white on red. Yellow background for hazard.
- Minimum text size of 55 mm (2 inches) for major message.

Educational / Informational / Interpretive



- Provide objective information about on-trail conditions.
- Educate users about trail environment and etiquette.
- Mount in logical and high visibility locations.

Sign Panel



The sign panel can be constructed from a wide variety of materials, such as metal, fibreglass, wood, concrete, and plastic. The trail designer will have considered durability (long-term maintenance requirements and vandalism risk), aesthetics and budget when selecting the sign panel material. Sign panels that use a 5 to 3 or 5 to 4 ratio for their dimensions are more visually appealing than square panels. Avoid using inexpensive materials in large rectangles, such as a 4 ft by 8 ft sheet of plywood, as it will give the trail a "billboard appearance"[76].

Sign Supports

Supports for a sign can be made from lumber, logs or metal. Large boulders can also be used as sign supports. The trail designer will have chosen the support colours and materials to complement the site. **Cedar posts are recommended** if available. To make a natural post, use a rot-resistant tree such as cedar, locust or hemlock. Peel the bark off to discourage insects and prevent moisture retention. If you can't get a natural post, use a squared post from a lumberyard. Living trees should not be used as sign supports.

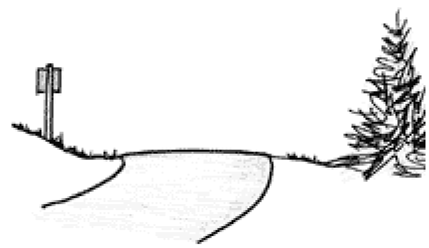
If pressure treated lumber is to be used, be certain that the preservative does not contain arsenic. Coat the pressure treated lumber with an oil based stain to reduce the potential that chemicals from the wood will leach into the soil. Use extra precautions to minimize skin contact with chemicals and **always wear a dust mask when cutting pressure treated lumber**.

[75] Ontario Ministry of Transportation. (1985). Manual of Uniform Traffic Control Devices. Toronto: Queen's Printer.
[76] Trapp, S., Gross, M., and Zimmerman, R. (1991). Signs, Trails, and Wayside Exhibits: Connecting People and Places. Stevens Point, WI: University of wisconsin Stevens Point, pp. 18.

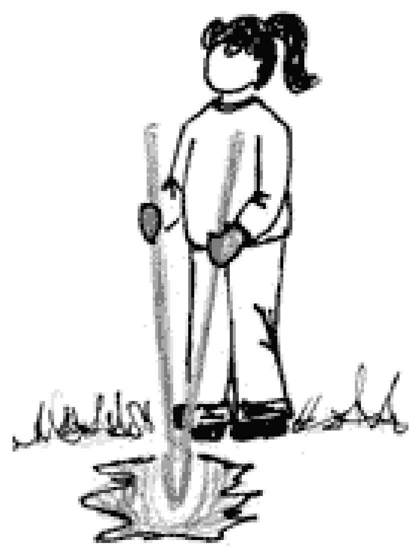
Sign Installation

Exact post installation specifications vary depending upon the type of sign, location and message. For example, regulatory signs need to comply with provincial and municipal regulations. If signs need to be placed on highways, such as a trail crossing warning to motorists, a series of guidelines must be respected. It is important to **consult with the local road authorities and/or the Ontario Ministry of Transportation regarding placement of signs on or near roads and highways**. Because of the equipment involved, very large signs require professional installation.

In general, when **installing supports for a sign**:



- **Determine the support location**.
  Install the support in the location specified in the construction log. Supports should be on the right hand side of the trail tread, except if they are mounted in road allowances (where signs on the left can be used to encourage trail users to travel on the left side of the road if desired). The support location must be far enough off the tread to ensure that the sign panel will not overhang the trail tread.



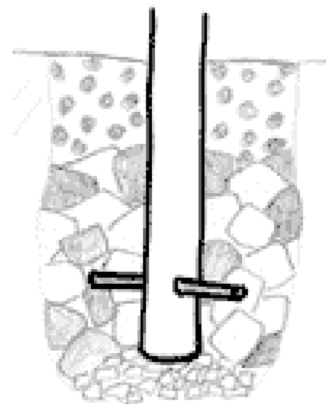
- **Identify the support location within the trail tread**.
  Change the surface of the trail treads to a distinctly different material (e.g., flat stone instead of soil) at the precise location of the signpost. This will encourage trail users, even those who have limited vision, to be alert to the presence of the sign. The alternate surface should extend across the entire width of the tread and be at least 0.6 metres (2 feet) long in the direction of travel.

- **Use a post digger to excavate the posthole**.
  The hole for the support should be 15 to 20 cm (6 to 10 inches) in diameter. For proper support, and to avoid movement of the post from frost, the posthole should be 1.2 to 1.4 metres (4 to 4.5 feet) deep.

- **Fill the bottom of the hole with 15 cm (6 inches) of gravel** or other granular fill for drainage.

- **Place the post into the hole and backfill**.
  Centre the post in the hold so that it sits firmly on the drainage gravel. Add 15 cm (6 inches) layers of backfill material and then compact the layer firmly before adding more fill. Continue to compact and fill until the area around the post is slightly above the surrounding terrain. A slight elevation discourages rot because water will not pool around the post.

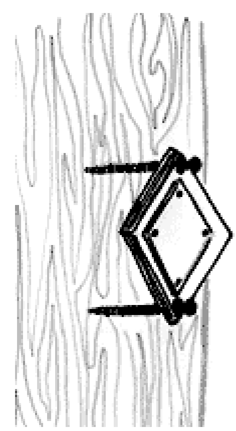
- To prevent turning or removal of a support, place one or two large, **horizontal spikes into or through the bottom of the support** before it is buried. Alternatively, surround the post with concrete, particularly in unstable soil.



If concrete will be poured to stabilize the post, it will be necessary to brace the post firmly in the proper position until the concrete has completely cured. In areas where bedrock is in close proximity to the surface, pinning may be required. If a metal post is used, it should be galvanized steel (38 x 38 mm or 1.5 x 1.5 inches) and the hardware should be 9 mm (0.4 inch) or 12 mm (0.5 inch) galvanized or cadmium-plated bolts (carriage bolts) and nuts with washers. Another choice is to anchor the post with pieces of rebar or wood inside stone cairns[77].

In some trail environments, it may be appropriate to attach the sign panel to a tree. Great care should be taken if this approach is selected to ensure that the selected tree will not be damaged by the sign. Signs should not be attached to fine tree specimens. To mount a sign on a living tree:

- Mount the sign on a plywood backboard that is 2 cm to 3 cm (0.8 to 1.2 inches) thick. This prevents the tree from easily growing out around the sign. Pressure treated wood may be used for the backboard since the wood will not be in contact with the soil.



- Attach the sign to the tree using #10 Robertson head wood screws or coated deck screws. The screws should be 2-1/2" or longer, depending on the size of the sign. The screws should be put into the tree one above the other (not side-by-side), along the axis of tree growth[78]. For hardwood trees, it may be necessary to drill small pilot holes before attaching the sign with the screws. Larger screws (e.g., 3" long #12 Robertson) and washers may be used in areas where vandalism is a concern.

- Leave the head of the screw at least 2 cm (0.8 inch) out from the bark of the tree to allow for tree growth. Establish a regular inspection schedule, based on the age and expected growth of the tree, to monitor the position of the screw. The screws should be "unscrewed" a few turns as needed to ensure adequate separation of the tree and sign.

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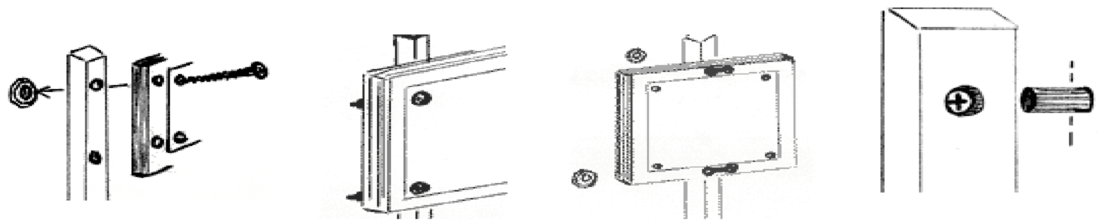
[77] Demrow, C. and Salisbury, D. (1998). The Complete Guide to Trail Building and Maintenance. 3rd edition. Boston: Appalachian Mountain Club, pp. 91-92.
[78] The Bruce Trail Association. (2001) Guide for Trail Workers. 3rd Edition. Hamilton: Author.

Sign Panel Installation Hints

The following hints can be helpful in increasing the likelihood that a sign and signpost will remain legible and in place for an extended period of time.

- Mount the sign panel (typically < 2cm (0.8 inches) thick) on a plywood backboard, 2 cm to 3 cm (0.8 to 1.2 inches) thick. Lag bolt the backboard to the post through at least two predrilled, countersunk holes. **A backboard mount is more secure** and protects the sign from splitting.



- Bolt the sign to a flattened surface of the support.

- **Use only galvanized**, or at least zinc plated bolts, washers, and nails. Standard ones will rust, leaving an unsightly stain[79].

- **Countersink bolts and cover the tops** with wooden plugs or wood putty. To prevent theft, mount signs with nuts and bolts that require special tools for removal or coat the back of the sign with axle grease[80].

- **Cut the upper end of the post** at an angle to shed rain.

Painting Blazes

Use a semi-gloss, latex paint for blazes on trees or fence and blaze posts. The blaze shape and colour will be specified by the trail designer according to the trail club's sign plan. Blazes should be at least **5 cm (2 inches) wide and 15 cm (6 inches) high**. After the blaze is painted, a 2 cm (0.8 inches) border on all sides of the blaze should be visible. The border can be created by the tree, post or panel that provides the surface for the paint blaze if it is a suitably contrasting colour. Otherwise, the border can be painted around the blaze with a high contrast colour.

Blazes should be **painted 1.5 metres (5 feet) above the trail tread**, or in a location that is easily visible to people who are either standing or seated. Higher mounting locations should be used on winter trails, the height being determined by the typical snow depth. Blazes should not be mounted on rocks or boulders, because they will have limited visibility and will be more easily covered by snow or dirt.

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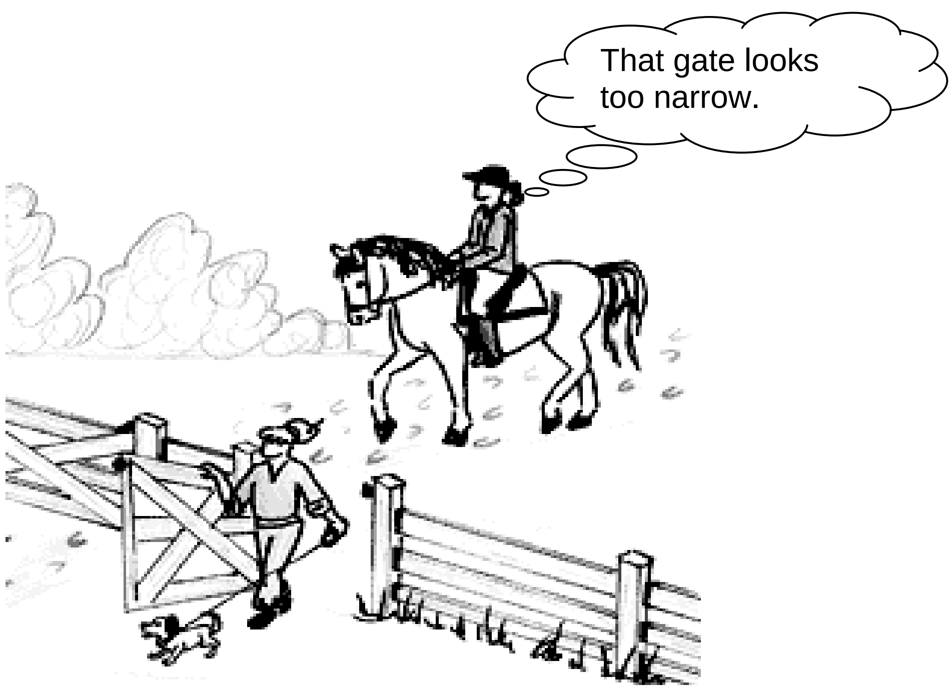
[79] The Bruce Trail Association. (2001) Guide for Trail Workers. 3rd Edition. Hamilton: Author.

Trail Barriers

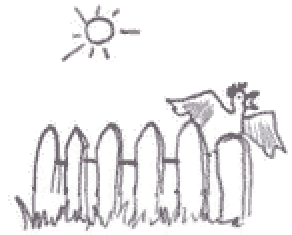
Trail barriers are installed to prevent unauthorized use of the trail and to prevent trail users from accessing adjacent properties and fragile or hazardous areas. For example, some trails install barriers to keep out motorized users, horse riders, or bicycles. On other trails, the barriers keep livestock in their pastures and off of the trail or adjacent roads. The choice of **trail barrier must be a balance between the prevention of unauthorized activity, enabling permitted trail users and the aesthetics of the trail environment**.

Barriers can be constructed of a variety of materials including rock, timber or steel. Care must be taken to **ensure that all barriers comply with all safety requirements** while still being able to blend into the natural landscape. Barriers, whether fences, railings, bollards or plantings, should extend at least 1.0 metre on either side of the trail bed. This will discourage trail users from going off the trail tread to get around the barrier.

Whenever barriers are installed on a trail, **care must be taken to ensure that the barrier design does not limit use of the trail by permitted users**. For example, people pushing strollers or using wheelchairs should have access to trails that allow people travelling on foot, even when barriers are installed to prevent motorized vehicles from accessing the trail. Carefully consider the need for, and design of, trail barriers. In many cases, such as restrictions on cyclists, the intent of the barrier cannot reasonably be achieved. **An ineffective barrier may result in more environmental damage than no barrier at all**, because it will encourage “determined” individuals to go off the trail tread to get around the “barrier”. Before erecting a trail barrier, consider whether the desired restriction could be achieved through other means, such as signage and user education.



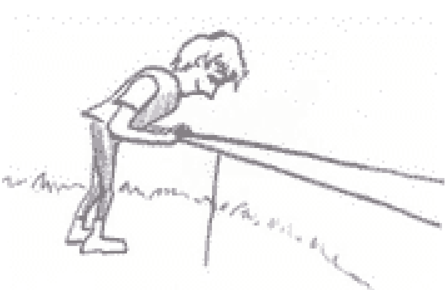
Fences and Railings



Fences and railings include all barriers that restrict the movement of people or animals. They are installed primarily for the protection of trail users or sensitive environments. Fences separate trail users from hazards such as traffic lanes, bodies of water, drops offs, railways and steep slopes. In southern Ontario, fences built to corral livestock are also frequently encountered on trails. **Fences and railings can also contribute to the aesthetics of the trail**, by focusing the user's attention and providing a visual connection between the trail and surrounding environment. Fencing may also be installed to delineate property boundaries, for privacy, or to control user circulation on trails.

Railings and fences that protect trail users from a dangerous situation should be constructed in accordance with local building codes. Log, timber or stone construction is usually best in rural areas and natural environments. In urban, heavy use areas, metal or a combination of wood, metal, and stone may be appropriate. **The security factor of a fence should be proportional to the amount of hazard**. A chain-link or barbed wire fence is required for extreme hazards, even in a wilderness environment. **If trail users are allowed to pass through the fence, an opening in the fence that can be safely used by all permitted trail users must be constructed**.

Railings are required in all areas, such as many scenic lookouts, **where trail users are elevated more than 60 cm (2 feet) above the surrounding terrain**[81]. Be sure to check safety codes and legal requirements specific to the trail location for additional restrictions or requirements related to safety railings. The use of native logs for railings provides a rustic appearance that is appropriate for many natural and forested settings. **Synthetic fasteners**, used to secure the logs into position, **should not be immediately obvious** to people on the trail. This is both an aesthetic issue and a maintenance issue. Trail users should not feel like they are "jailed" on the trail. However, it is equally important to "disguise" the methods used to construct a fence so that people, particularly curious young children, cannot easily bypass or dismantle the fence.



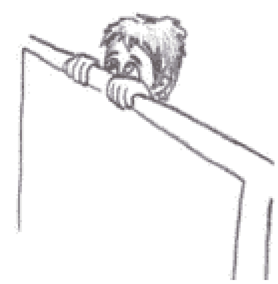
[81] Ministry of Municipal Affairs and Housing, Building and Development Branch. (2005). Ontario Building Code 1997. July 1, 2005 update.

The safety and effectiveness of fences and railings is determined by the security of the anchor posts and the design of the connecting material. **Anchor posts must be constructed and installed to withstand the expected natural and human forces**. This means more than just keeping the posts upright when people hang on or lean on the fence or railing. Anchor posts must hold firm even if a group of people were to apply force or if a large animal pushed against one.

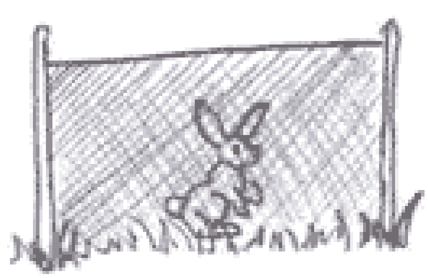
The **connecting material between anchor posts must be selected based on the purpose of the fence or railing**. There are an infinite number of styles that can be used for the connecting material. The limits relate only to creativity and availability of materials. It is recommended that the connecting material blend with the aesthetics of the trail environment. **It is critically important that the choice of connecting material consider the needs of all trail users**, including young children, people of short stature (less than 1.2 metres (4 feet) in height) and people who use wheelchairs or other types of mobility devices (e.g., recumbent bicycles). These individuals will see things from a very different perspective than a standing adult, so make sure that you consider their safety and the view from their vantage point.

Some examples of the connecting materials that can be used for fences and railings include:

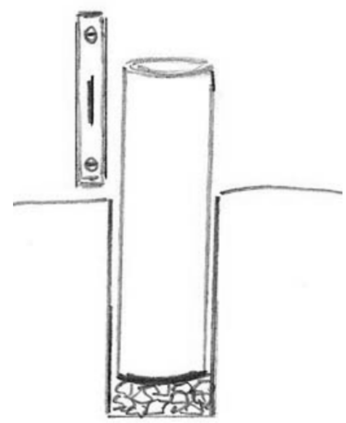
- Privacy fencing, with overlapping slats, for hiding facilities such as trash disposal and to visually separate trail users from surrounding properties.

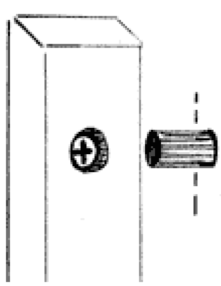


- High-tensile wire, often with rows of barbed wire on top, for fences that will control cattle and discourage them from pushing on the fence.
- Wire mesh for controlling the movement of small animals.
- A short two-rail or one-rail split-rail fence to control the circulation of trail users.

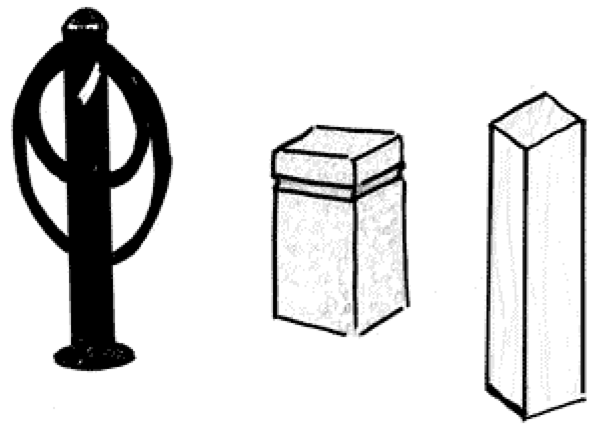


The exact procedures for constructing a fence or railing are determined by the materials used and the intended function. In general, two steps are required:

1. **Install anchor posts**.
   
   Stability of the fence or railing is largely determined by the methods used to construct and install the anchor posts. Anchor posts should be set into solid ground. In situations where that is not possible, more advanced techniques will be required and professional assistance should be obtained. Anchor posts should be installed as deeply as possible, at least 1 metre or more below grade to prevent frost from shifting or loosening the posts. Postholes should be twice the diameter of the post it is to hold. The bottom of the hole should be lined with gravel. Add large, horizontal bolts or pieces of rebar to the bottom of the post to make it more difficult for the post to twist or be removed. Insert the post and fill the hole with concrete for maximum stability. Allow the concrete to cure according to the manufacturer's instructions. If concrete is not used, backfill the hole with the material removed during digging. When backfilling, do the work in small layers (10 cm of material at a time). For each layer, compact the material firmly before adding more fill.

2. **Mount the connecting material**.
   
   The method of mounting the connecting material onto the anchor posts will vary with the type and design of material used. If metal fasteners are used, choose a material that will not rust or degrade with exposure to the elements, such as zinc plated or galvanized bolts. **Countersink the fasteners and cover the tops** with wooden plugs or wood putty. This will help prevent theft as well as improve the aesthetics of the fence or railing. When using solid connecting material (e.g., wood railing), mount the connecting material onto a flat surface on the anchor post for increased stability.

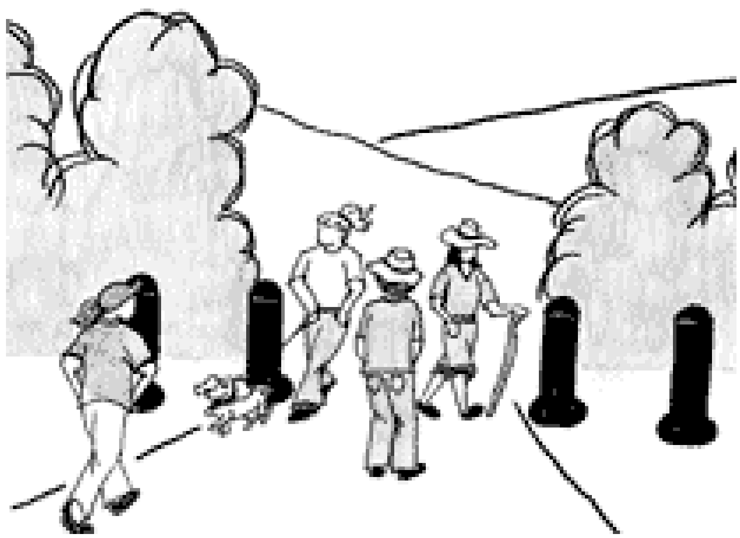
Bollards



Bollards are solid obstacles installed on a trail tread to control the movement of people and/or vehicles on the trail. They can be made of lumber, log, metal or stone. In urban settings, bollards are typically purchased and installed according to the manufacturer's instructions. In more remote areas, bollards can be constructed using timber, logs or large boulders.

Bollards can either be permanent or removable, depending on the trail requirements. Removable bollards are typically used to prevent unauthorized cars and trucks from accessing the trail. These types of bollards are designed to be removed, usually by unlocking them, when trail access is required for service or emergency vehicles.

Bollards should always be installed in odd numbers. For example, put one bollard in the centre of the tread or place three bollards at intervals across the tread. Installing an even number of bollards can encourage collisions between trail users because users coming from both directions will naturally head toward the central open space. If more than one bollard is used, **the space between must be at least 1 metre**. Bollards spaced less than 1 metre (3.3 feet) apart can be a hazard for cyclists and in-line skaters and may block trail access by people who use wheelchairs or other mobility devices.



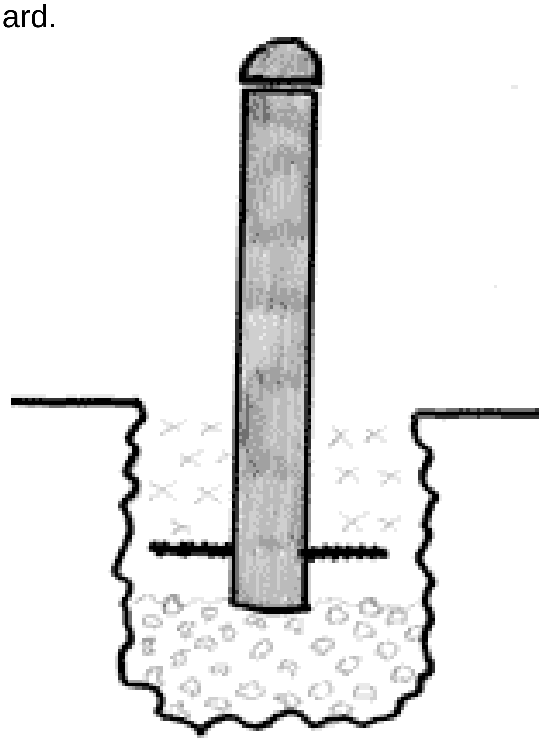
Bollards must be highly visible, even at night. Trail users must be able to detect the bollard far enough in advance to avoid it. As the speed of travel increases for trail users (e.g., bicyclists compared to hikers), the sight lines to the bollard and the spacing between the bollards should increase. Put reflectors onto the bollard to enhance visibility. Bollards should generally be at least 0.7 metres (2.3 feet) high. On trails where cyclists are permitted, the bollards should be a minimum height of 1.2 metres (4 feet).

Bollards should be set into or onto solid ground. If large boulders are used, the bollard should be set onto compacted mineral soil (see Compact and Shape the Tread). If possible, excavate the compacted soil to match the shape of the bottom of the boulder. Bury at least 1/3 of the height of the boulder below the adjacent ground surface. This will increase the stability of the boulder and make it more difficult to re-position.

Post bollards (typically timber, log or metal posts) should be installed as deeply as possible. Having at least 1 metre (3.3 feet) of the bollard below grade will prevent frost from shifting or loosening the bollard. In situations where it is not possible to bury a post bollard, such as on exposed bedrock, more advanced techniques will be required and professional assistance should be obtained. Bollards

To install a post bollard:

1. Dig a posthole that is twice as wide as the bollard.



2. If desired, add two large, horizontal bolts or pieces of rebar to the bottom of the bollard so the bollard will be difficult to twist or remove after the installation has been completed.

3. Line the bottom of the hole with gravel.

4. Insert the bollard into the hole and then fill the hole with concrete. Allow the concrete to cure according to the manufacturer's instructions. If concrete is not used, backfill the hole with the material removed during digging. When backfilling, do the work in small layers (10 cm (4 inches) of material at a time). For each layer, compact the material firmly before adding the next layer.

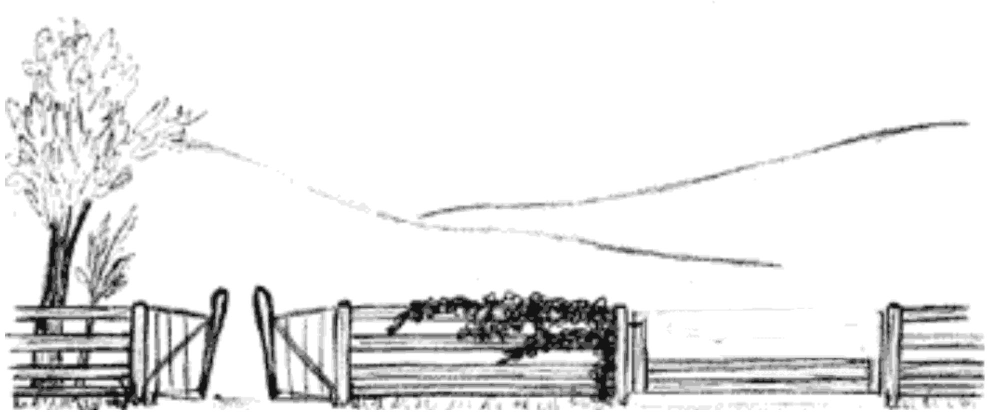
Fencing Openings

Any time that people are allowed to pass through a fence or railing, an appropriate "opening" must be installed. In many situations, **a simple opening in the fence may be appropriate**. In other situations, **a cattle guard may be required** within the opening to ensure that livestock cannot pass through. In still other situations it may be appropriate to install some type of gate, although these must be carefully designed to ensure that they can be operated by all trail users and they will continue to function properly in all seasons.

The design and construction of any fence opening must be done in collaboration with the landowner. It must be **based on a clear understanding of all uses for adjacent lands and the purpose of the fence** (e.g., crops, livestock, barrier to motor vehicles). Where there are concerns about the movement of animals (either wild or livestock), the fence opening must also be approved by the Ministry of Natural Resources and/or the owner of the livestock. The construction of fence openings in the vicinity of livestock must be done with particular care because the time and cost of retrieving uncontrolled animals can be substantial.

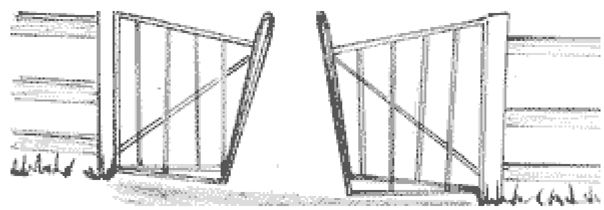
For people travelling on foot, the opening in the fence should be at least 1 metre (3.3 feet) in width. The size and configuration of the opening can vary, depending on the permitted and prohibited uses of the trail. The width of the opening can be reduced to 0.8 metres (2.75 feet) if necessary to prevent large users (e.g., ATV, horse) from accessing the trail.

Sometimes a combination of openings is required in order to allow all trail users to pass through the fence and prevent access by prohibited users or animals. If the fence opening will be less than 0.8 metres (2.75 feet) in width, an alternate opening is required so that people who use mobility devices (e.g., wheelchairs) will continue to have access to the trail. The combination of fence opening designs that can be used is limited only by the creativity of the designer.



Research is currently being funded by the US Department of Agriculture to evaluate the effectiveness of a variety of fence opening designs[82]. When designing and constructing fence openings, it is essential that the needs of the landowner and all permitted trail users be considered at all times. Consult with your local Conservation Authority to ensure that plans for fence openings will not result in negative impacts on the local plant and animal communities. The following are just a few examples of the type of opening designs and technologies that are being used on trails to limit access by prohibited trail users:

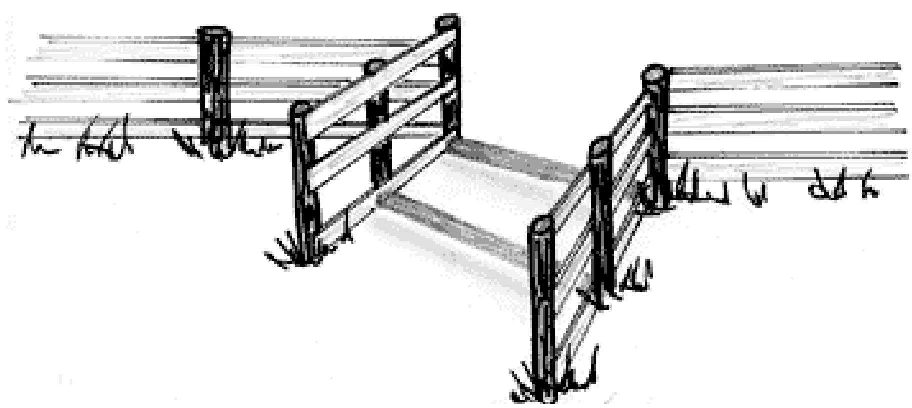
- Openings that are wider at ground level and narrower at the top are recommended for allowing access by people who use wheelchairs and preventing access by motorcycles and ATVs[83].



- Two offset 1-metre (39 inches) wide openings that require a 90° or 180° turn often make it very difficult for motorized vehicles to access the trail. Caution is required with the use of this design where cyclists are permitted on the trail because people using recumbent or hand cycles will also not have access to the trail.

Top view, 1 m openings

- A wide and tall opening is required to permit equestrians on the trail. If the equestrian opening has parallel logs, mounted 0.4 to 0.5 metres (1.3 to 1.6 feet) above the ground across the full width of the opening, that are horizontally spaced at 1 metre (3.3 foot) intervals, access to the trail by motorized vehicles will be very difficult.



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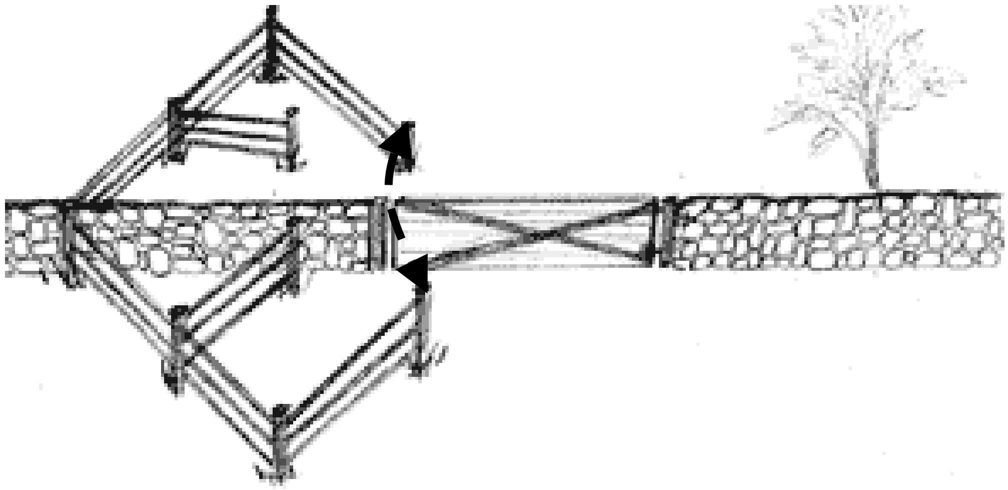
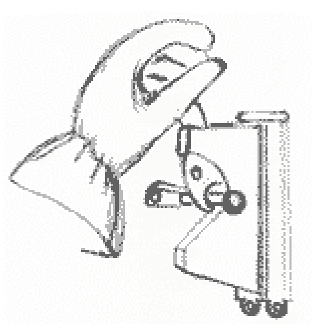
[82] Recreation Trail Vehicle Barrier: Providing Access to Personal Mobility Devices. Contact Beneficial Designs, Inc. (www.beneficialdesigns.com) for specific information about this research project.
[83] Scottish Natural Heritage. Countryside Access Design Guide. [On-line] Retrieved 31 July 2006 from: http://www.snh.org.uk/publications/on-line/accessguide/gates.asp.

- A self-closing gate with a restricted area for the user to wait while the gate moves can limit the size of trail user permitted while preventing animals from passing through the fence.



In some trail environments, cameras triggered by motion or exhaust sensors are being used to identify and prohibited users who enter a trail environment. Although they do not prevent physical access to the trail, camera systems can be very inconspicuous (maintaining the aesthetics of the trail environment) and they effectively deter repeat offences as long as the vehicle has a visible license plate for identification of the owner.

Unfortunately, none of the fence opening designs developed to date will allow access by all users travelling on foot, including people who use mobility devices, but prevent bicycles from being brought onto the trail. Many bicycles have quick release wheels (so that the front wheel can be removed when locking the bike in a public place) which means that the dimensions of the bicycle can easily be made very small. The light weight of most bicycles, even those for mountain bicycling, also means that bicycles can easily be lifted over fences or gates.

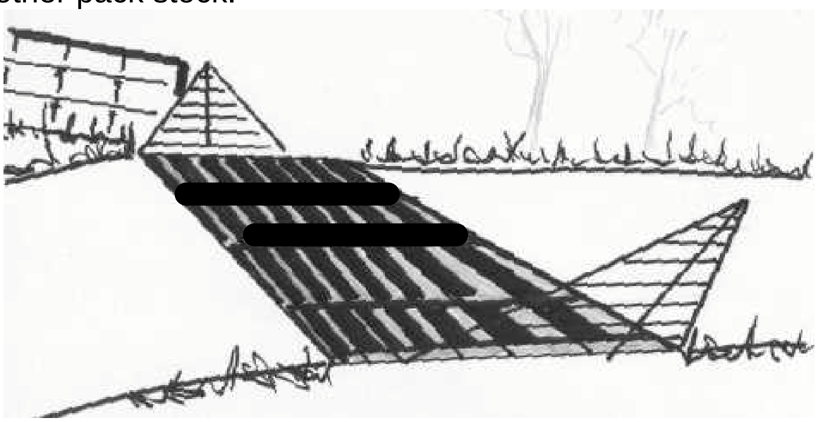


Lockable gates that limit use of the trail by permitted trail users should not be installed on trails. Lockable gates are suitable for installation across service and emergency vehicle access routes, as long as all permitted trail users can access the trail without opening the lock. **It is inappropriate to require some trail users**, such as people who use wheelchairs, **to arrange in advance to obtain a key or lock combination, when other trail users on foot have unlimited access to a trail**.

If at all possible, post information about fence openings, gates or potential problems with trail access on the trail web site and at key access points or trailhead locations.

Controlling Livestock or Animal Movement

The **most effective method for preventing the movement of animals, including livestock, through a trail fence opening is the installation of a ground-level cattle guard** (often referred to as a “Texas Gate”). A cattle guard is essentially a grate that is placed over an excavated pit. Livestock will not cross the grate because they can see it is not a solid surface. For this reason, cattle guards are not appropriate on trails that permit horses or other pack stock.



The design of the grate must be carefully developed to ensure that it provides safe and secure access for all permitted trail users. Traditionally, these grates were installed on farm roads and driveways. As a result, the design of many commercially available cattle guards are not appropriate for trails where people will be travelling on foot. While a car or truck can easily drive across the round metal cylinders often used to create the grate surface, many trail users will find this type of crossing hazardous. To ensure that a trail can be safely used by all trail users, including children, older adults, people with disabilities, and individuals who are inexperienced or unfit, the grate should be constructed with solid walking surfaces across it’s full length. Two solid walking surfaces should be applied on top of the grate or integrated into its design. Each solid walking surface must be 0.3 to 0.4 metres (12 to 16 inches) in width and the space between the two walking surfaces should be no more than 20 cm (8 inches). The walking surface should be too narrow for livestock but enable permitted trail users to cross the grate on a solid surface.

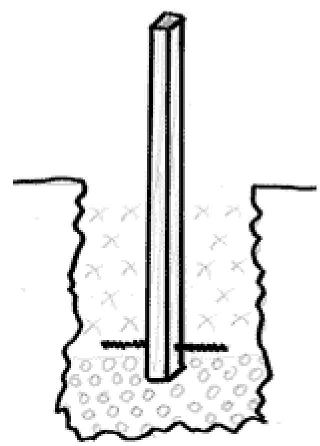
Self-closing gates can also be used to prevent the movement of livestock through a fence opening. If a gate is installed on a trail, the design and operation must carefully consider the abilities or all trail users. To be suitable for use on a trail, **self-closing gates should be simple and intuitive**. A **maximum of 3 kg of force** should be required to move the gate and the **latch mechanism should be suitable for opening with a closed fist**. The top of the **latch mechanism should be mounted 1 metre above the ground**, or no more than 1.2 metres (4 feet) above ground in areas with both summer and winter use. Gates that require more than 3 kg of force to open may inadvertently trap weaker or less fit trail users. People with limited hand function and winter trail users wearing thick gloves will think you’re wonderful when they can operate the gate with a closed fist.

Constructing a Fence Opening

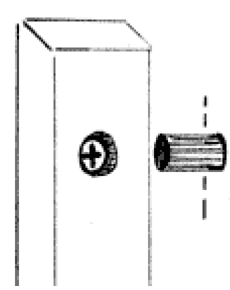
The methods used to construct and install a fence opening for a trail will vary tremendously depending on the type of opening, the intended function of the fence, and the terrain in which it will be located. The construction of the opening will be similar to the construction of the fence itself. There are typically three main steps.

1. **Layout the fence opening on the ground**.
   The type and size of fence opening required will be specified by the trail designer in the construction log. Construction crews should follow the information provided in detail so that the fence opening will function as intended. Use environmentally-friendly spray chalk or a stick to mark the location of the anchor posts on the ground.

2. **Prepare the ground within the opening**.
   It is important that the ground within the opening be properly prepared so that trail users can move effectively and impacts on the surrounding environment are minimized. All areas of ground that users may be expected to travel on within and around the fence opening should be prepared in the same manner as the trail tread (see Constructing the Trail Surface).

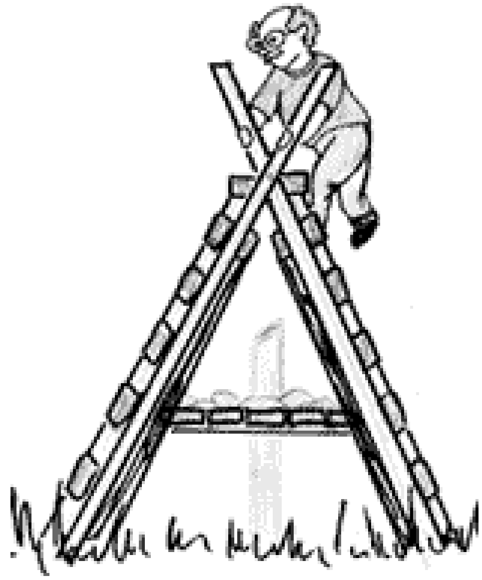


3. **Install the anchor posts**.
   The stability of the fence adjacent to the opening(s) is determined by the methods used to construct and install the anchor posts. Anchor posts should be set into solid ground. In situations where that is not possible, more advanced techniques will be required and professional assistance should be obtained. Anchor posts should be installed as deeply as possible, at least 1 metre (3.3 feet) or more below grade to prevent frost from shifting or loosening the post. The posthole should be twice the diameter of the post it is to hold. The bottom of the hole should be lined with gravel. Add large, horizontal bolts or pieces of rebar to the bottom of the post to make it difficult for the post to twist or be removed. Insert the post and fill the hole with concrete for maximum stability. Allow the concrete to cure according to the manufacturer’s instructions. If concrete is not used, backfill the hole with the material removed during digging. When backfilling, do the work in small layers (10 cm of material at a time). For each layer, compact the material firmly before adding more fill.



4. **Mount the fence and/or gate onto the posts**.
   The fencing or gate and the method of mounting on the anchor posts will be determined by the gate design and type of hardware (e.g., hinge and latch) desired. If metal hardware is used, choose a material that will not rust or degrade with exposure to the elements. If the hardware can be countersunk into the anchor post and covered with wooden plugs or wood putty, it will help reduce risk of theft.

Stiles

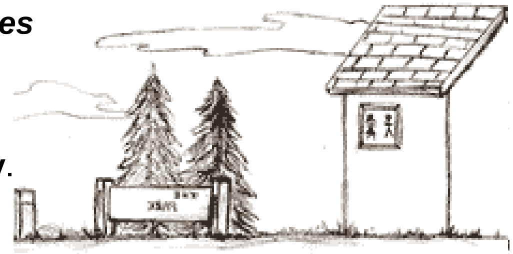


A stile consists of, usually two, linked staircases. They allow someone walking on a trail to climb up and over a fence. Stiles are often used on farms to provide access to fields that contain livestock. However, stiles pose a significant safety hazard for many trail users and are not recommended for use on trail.

Many landowners believe that stiles are the only effective way to allow trail users to pass through a fence without creating an opportunity for livestock to roam freely. Typically, their primary concern is that gates can be left open, which would allow their livestock to escape. They may also be concerned that a gate would allow access to their property by prohibited users (e.g., motorized vehicles).

If a land owner indicates that only a stile is acceptable and no other type of fence opening will be allowed, the impact of stiles in terms of discrimination against certain trail users (e.g., children, older adults, people with disabilities, people who are less fit or less experienced) and the limitations of stiles related to user safety should be clearly explained. In most cases, landowners will be willing to consider an alternative fence opening design, instead of a stile, once the reasons for the recommendation are clearly understood. If the landowner adamantly refuses to consider anything other than a stile, the trail should be re-routed as necessary. If stiles are already installed on a trail that is newly acquired, a plan should be developed to replace the stiles with appropriate fence openings or to re-align the trail corridor.

Construction of Trail Facilities and User Amenities



Trail facilities encompass a wide variety of built structures. Some, like access to drinking water or emergency shelter, are related to **health and safety**. Other facilities, such as benches or picnic tables, can be provided for the **enjoyment** of trail users. Still others, such as toilets or trash disposal, are primarily intended for **protection of the environment**. Full compliance with these best practices does not require the construction of facilities on a trail or at a trailhead. The decision to construct facilities, and the type of facilities to construct, should be determined by the trail managing agency **based on the need for environmental protection and the intended trail experience**. Typically, facilities constructed on urban or highly developed trails will be more substantial and more numerous than facilities provided in remote areas or on seldom-used trails. However, **trails that receive a very high level of use should have all of the facilities required to manage user impacts on the environment**, even if the trail is located in a rural or wilderness area.

Although the construction of facilities is not required on a trail, unless specified by the land owner or local managing agency, **if facilities are constructed they must be accessible to all permitted trail users**, including people with disabilities. Never fall into the trap of assuming “someone in a wheelchair will never come here” or that everyone on skis or on horseback will be able to walk when they dismount. **Facility construction techniques must always comply with local building codes and safety and accessibility regulations**. In general, construction techniques used to create accessible facilities are the same as those used for all facilities. The primary difference is in design rather than construction. Information about the design of sustainable and accessible facilities is widely available through published resources such as:

Canadian Standards Association. (2004). Accessible Design for the Built Environment. CSA Standard B651-04. Mississauga: Author

Canadian National Institute for the Blind. (1998) Clearing Our Path. Toronto: Author.

Ontario Ministry of Community and Social Services. (2006). Accessibility for Ontarians with Disabilities. [On-line] Retrieved 31 July 2006 from: http://www.mcss.gov.on.ca/mcss/english/pillars/accessibilityOntario

US Department of Agriculture Forest Service. (2006). Forest Service Outdoor Recreation Accessibility Guidelines (FSORAG). [On-line] Retrieved 31 July 2006 from: http://www.fs.fed.us/recreation/programs/accessibility

US Access Board. (1999). Outdoor Developed Areas Regulatory Negotiation Committee Final Report. [On-line] Retrieved 31 July 2006 from: http://www.access-board.gov/outdoor.

Guidelines for Trail Maintenance

Trail maintenance includes a wide variety of **activities designed to return the trail tread and environment to its original or intended condition**. Typically, trail maintenance activities include restoration of the trail tread (filling eroded sections, restoring outslope), removal of debris (branches, garbage), repair of facilities (replacement of bridge or boardwalk decking, benches, picnic tables) and the control of vegetation (brushing, clearing, removal of dead limbs). **Maintenance activities are work that is required on an on-going basis**. In contrast, restoration or re-construction work typically includes re-alignment, re-routing or upgrading of trails/trail sections and/or facilities to higher standards. The guidelines presented here address only trail and trail facility maintenance (i.e., keeping the trail or facility in its original or intended condition). The maintenance guidelines are presented under the following sub-headings:

- Planning maintenance activities.
- Maintaining drainage.
- Maintaining the trail tread.
- Maintaining trail structures and facilities.
- Restoring the trail environment.

Planning Maintenance Activities

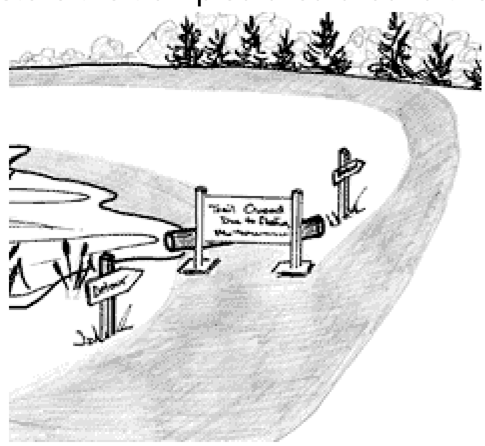
1. **Create a maintenance plan during trail design and construction**.
   A maintenance plan for the trail should be developed as the trail is designed and constructed. Take the time to anticipate maintenance needs and plan and construct the trail to minimize the work required. The initial trail inventory, completed before the trail is open for public use, should be used to finalize the planned maintenance activities.

2. **Consider all aspects of trail maintenance**.
   Maintaining the trail tread and environment typically involves completing trail inspections, maintaining proper drainage, restoration of the tread, removal of debris, controlling vegetation and the repair of facilities.

3. **Protect species that are at risk**.
   Work closely with the Ministry of Natural Resources, Ontario Parks and any other organizations responsible for protecting species that are of special concern, threatened or endangered. The timing, extent, methods and materials of all maintenance activities that may influence protected flora and fauna must be carefully considered and approved by all relevant organizations.

4. **Complete maintenance work promptly**.
   Virtually all major trail repair projects start out as small maintenance tasks. Plan maintenance activities so that the work is completed promptly, before small problems grow into major concerns. If major work is required on the trail, provide that information to trail users so that the more difficult trail conditions in the interim do not affect the social sustainability of the trail.

5. **Organize work so that each trail section is completed as quickly as possible**.
   When planning trail maintenance work, organize the work activities so that each section of trail is completed as quickly as possible. For example, plan to remove a downed tree, repair the damaged tread and restore the trampled area around the tree before sending crews to work on a downed tree in another area.



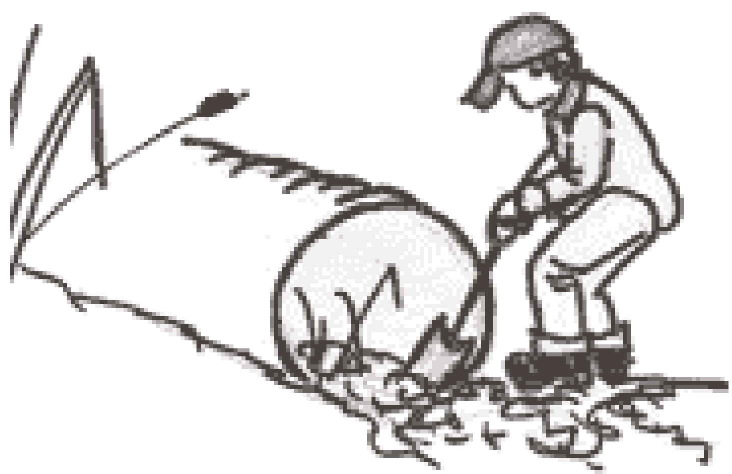
6. **Plan for and provide an alternative to a closed trail**.
   If a trail or trail segment is to be closed, either temporarily or permanently, try to have an alternate route available for use before the trail section is closed. Use trail information sources to educate users about the reason for the closure, the location of the alternate route and any changes to trail use.

7. **Complete regular trail inspections and evaluations**.
   Unless trails are very remote, formal evaluations should be completed at least once per year (or more often if required for insurance or risk management purposes), preferably prior to the busiest season of use and shortly after spring thaw or bad weather. Identify one contact person to collate maintenance information obtained from informal inspections and user comments. Ensure evaluation personnel are properly trained and knowledgeable about the needs of all permitted trail users. Base each evaluation on the results of previous assessments. Let users know about assessment results that are relative to their safety or enjoyment. Keep the assessment results on file as required for risk management purposes (typically at least 7 years).

Maintaining Drainage

8. **Plan maintenance work to match the natural drainage patterns**.
When trail maintenance activities are being planned and completed, design them so that the trail drainage matches the natural drainage patterns of the environment as closely as possible. Even trails that were not designed for sustainability can often be significantly improved through a series of planned maintenance work that re-establishes natural sheet drainage.

9. **Inspect and maintain drainage structures frequently**.
Drainage structures are used on trails that do not preserve the natural sheet drainage patterns of the environment. When drainage patterns are altered, there is an increased risk of erosion and deposition around the drainage structure. Monitor all drainage structures frequently and clear debris and repair the source of the erosion or deposition as quickly as possible.



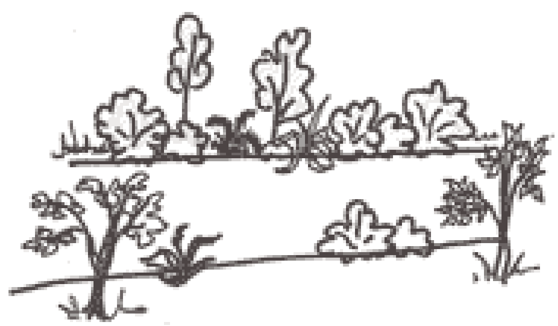
10. **Minimize the need for drainage maintenance on existing trails**.
For existing trails that are not sustainably designed, minimize the need for drainage maintenance by re-routing sections of tread to drier ground or using drain dips to direct water off the tread.

Maintaining the Trail Tread

11. **Maintain the tread outslope**.
Outslope of the trail tread, so that sheet drainage flows naturally across and off the tread, is critically important for environmental sustainability. Mechanical compaction of the tread to the required outslope and regular monitoring and removal of material if a berm develops at the edge of the tread will prevent water, and therefore erosion, from occurring along the tread.

12. **Remove obstructions from the trail tread**.
Obstructions are items in the tread that could cause a trail user to trip or lose their balance. Maintain the trail tread so that it is free from rocks, ruts, or sharply irregular surfaces so that trail users do not have to concentrate all of their attention on negotiating the tread. The social sustainability and safety of the trail is enhanced if trail users, especially children, can safely negotiate the trail even when the primary focus of their attention is the trail environment.

13. **Clear vegetation from the trail tread corridor and buffer zone**.
Leafy vegetation should be removed from the trail tread corridor as well as from the buffer zone on each side and above the tread. For a hiking only trail, the buffer zone should be at least 0.3 m on each side and at least 0.5 m above the tread corridor. Vegetation that hangs in the way of trail users may be broken or stripped in a way that damages its health. The weight of rain or snow can put at risk vegetation that was well clear of the trail during maintenance work. Prune to the collar of any branch or stem to provide a clear, natural looking corridor for trail users.



Maintaining Trail Structures and Facilities

14. **Regularly inspect and maintain trail structures and facilities**.
    Prompt maintenance of trail structures and facilities is essential not only for safety and liability, but also to maintain a high-quality public image. Monitor all structures and facilities on a regular basis. Make small surface repairs promptly and remove or replace structures or facilities with significant damage.

15. **Remove litter and repair vandalism promptly**.
    Remove all litter and repair all vandalism as quickly as possible. Litter or vandalism damages the social sustainability of a trail because it makes the trail look like "no one cares".

Restoring the Trail Environment

16. **Utilize material removed from the trail in other areas**.
    Soil and other materials removed from the trail in one location should be retained and used in areas that require tread repair or structures that require fill. Removal of the material from the trail environment or dispersion of excess material within the environment should be a tactic of last resort.

17. **Disguise removed vegetation**.
    Make the effort to dispose of debris properly. Each cut branch should be touching the ground to encourage decomposition. Conceal debris by dragging branches under and around shrubs. Do not randomly toss debris into the surrounding environment or create piles of brush. If debris cannot be properly distributed through the environment, remove it for composting in an appropriate location.

18. **Repair environmental damage from trail use**.
    Monitor the environment around the trail regularly to identify unanticipated negative impacts that may result from trail use (or inappropriate trail use). The risk of damage is highest for trails that were not initially designed for sustainability. Be sure to identify the underlying cause of the damage before developing plans for repair. Carefully plan to restore the damage through seeding, planting or transplanting vegetation. Re-design or close severely damaged trails as required.

Best Practices for Trail Maintenance

Trail maintenance. It's an idea that makes some people cringe while others rub their hands in anticipation. **But what is "maintenance"?** Trail maintenance includes a wide variety of **activities that return the trail tread and environment to its original or intended condition**. Typically, trail maintenance activities include restoration of the trail tread (filling eroded sections, restoring outslope), removal of debris (branches, garbage), repair of facilities (replacement of bridge or boardwalk decking, benches, picnic tables) and the control of vegetation (brushing, clearing, removal of dead limbs). **Maintenance activities are work that is required on an on-going basis**. In contrast, restoration or re-construction work typically includes activities such as the re-alignment or re-routing of sections of trail or the upgrading of the trail and/or facilities to higher standards (e.g., widening and redesigning a hiking trail so that it is also suitable for cross-country skiing). The information in this section focuses on trail maintenance activities. Refer to Guidelines for Trail Construction for additional information about the techniques and procedures recommended for trail re-construction. Of course, it goes without saying that the safety of trail workers and trail users must be a primary concern for all maintenance activities. Refer to Safety and Best Practices for Trails and Appendix E: Trail Safety for more detailed information about trail safety issues.

Regardless of your personal thoughts about trail **maintenance**, **it is an absolutely essential component for every trail**. Certain features, such as wetlands, river banks or waterfalls, are often the reason that trails are developed but these features are also very susceptible to destruction or damage from inappropriate trail construction or use. Even after the trail has been constructed, it will be necessary to monitor the trail environment to identify negative impacts that may occur from inappropriate trail use or changes to the trail conditions. Examples of potential negative impacts include damage to existing soils and geological features (e.g., from compaction or erosion when trail users go off of the trail tread or water accumulates and flows on the trail tread), the impact of trail use at different times of the year (e.g., use during or just after Spring thaw when the trail is officially closed), or the types of trail activity (e.g., horses have a greater impact than hikers). Remember, **if the trail damages the natural environment the effect may be to destroy the very reasons that originally made the area attractive** for trail development.

Perhaps the most important concept in trail maintenance is the saying "A stitch in time saves nine". **Detect and fix problems while they're small**. Nearly every major problem on a trail was, at one time, a small problem that went uncorrected.

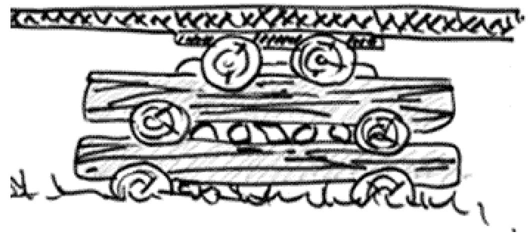
Unfortunately, the scarce resources available to support trail construction are even more difficult to acquire for on-going maintenance. As a result, **virtually all trails have volunteers involved in some aspect of their trail maintenance activities**. The purpose of this chapter is to help trail managers, decision-makers and volunteers to maintain Ontario's trails in a way that enhances the safety, sustainability and enjoyment of trails for all potential users.

It is essential that **trail maintenance be considered as just one part of the overall trail management programme**. The maintenance plan for the trail is developed on the basis of the initial trail inventory (after construction and before the trail was opened to public use) combined with information about the intended standards for user safety and enjoyment. **Detailed trail assessment systems, such as the Trails Canada assessment or the Universal Trail Assessment Process, should have been used to complete the initial trail inventory**. These detailed trail assessment systems collect all of the required trail-related information in one assessment (maintenance information, information for user safety and satisfaction, interpretive and mapping information, information for planning and budgeting trail work.). For more detailed information about trail assessment, refer to Appendix G.

In most cases, trails will require routine maintenance such as clearing brush or making repairs to the trail tread. With the proper tools and techniques, **basic trail maintenance tasks can be done by people of almost any skill or energy level**. Where trails have been neglected for a long time, or in places where floods, fires or other natural and unnatural acts have caused havoc, even the most experienced trail builder can find challenge and satisfaction in the work of restoring the tread to a safe, usable condition.

The best practices for trail maintenance include the following steps:

- Completing trail inspections and evaluations.
- Establishing a maintenance plan for the trail.
- Maintaining proper drainage.
- Maintaining the trail tread.
- Maintaining trail vegetation.
- Maintaining trail structures and facilities.



Design for Easy Maintenance

Making trail maintenance easy begins with trail routing and design. Even before a trail is built, the maintenance requirements of the trail will largely be determined. All aspects of trail design and construction will influence the required maintenance. Whenever possible, take the time to **anticipate and minimize potential problems through appropriate trail design and quality trail construction**. On existing trails that require a high level of maintenance, use inspection and evaluation information to consider whether changes to the design or construction of trail facilities and structures or the re-routing of sections of trail could help to reduce on-going maintenance to a more manageable level. Refer to Guidelines for Trail Design for detailed information about sustainable trail planning and design.

Choices made at the planning and construction stages will significantly influence the maintenance demands of a trail. The type of tread material, trail route, or materials used for constructed facilities will influence trail maintenance. Clearly some materials are more resistant to wear and environmental impacts than others. Unfortunately, often the materials that are the most durable are also more expensive to buy and require more skills or equipment to use or install. Similarly, some landscapes are also more able to withstand the unavoidable impacts of trail use. When building a trail in a more sensitive or unstable environment, a plan for ensuring the on-going maintenance of the trail environment is essential. Some factors to consider include:

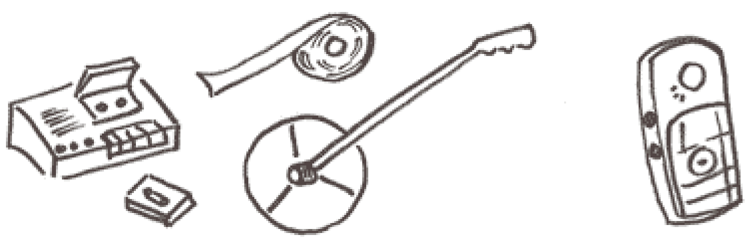
- Sun exposure (sunny, south-facing slopes will dry more quickly), annual rain and snow fall, number of freeze/thaw cycles and speed of Spring thaw.
- Slope of the tread and adjacent land (stay within the angle of repose, low or flat areas are difficult to drain).
- Native vegetation and indigenous soil (mature forests have less ground cover, some soils are more resilient or better suited for a compacted tread).
- Type of environment (e.g., forest, wetland).
- Natural drainage patterns around the trail (dispersed sheet drainage, location of water courses, beaver activity) and user access to drinking water sources.
- Desired number and style of constructed facilities and structures, as well as the preferred construction materials (affecting treatment, repair or replacement needs).
- Availability and suitability of trees for blazes and sign posts (signs on live trees will need to be re-positioned as the tree grows).

Inspection and Evaluation

For existing trails, the **most important factor affecting trail maintenance is the completion of regular maintenance evaluations and trail inspections**. A **maintenance evaluation is a formal inspection** that requires a complete walk through of the entire trail. Trail **inspections can be done by combining the information gathered through informal walks along the trail with feedback provided by trail users**. The purpose of the inspection or evaluation is to:

- Identify the features and facilities that are found throughout the trail.
- Specify the current condition of the features and facilities.
- Detail the work required to bring them up to, or maintain them at the intended standard.

Regular trail inspections and evaluations should be completed and properly documented in order to reduce the liability exposure of the trail managing group or agency. For most trails, evaluations should be completed at least once per year, or more often if required for insurance or risk management purposes. Results from all trail evaluations, including how the issues identified were addressed, should be retained along with other records for the trail as required for risk management purposes (typically a period of at least 7 years). Document not only the trail tread, but the entire trail corridor and all associated structures (e.g., bridges) and facilities (e.g., parking, washrooms). If trail inspections cannot be completed on a regular basis because of the remote location of the trail, ensure that information about the limited maintenance and evaluation activities is available to all trail users.



Regular monitoring of the on-trail conditions, structures and facilities provides the data needed to identify required maintenance work in a timely and cost-effective manner. By identifying a problem as soon as it starts to develop, inspections will provide advance warnings of potential safety issues and costly repairs to major structures. More importantly, regular monitoring and quick repairs of small problems can prevent expensive and dangerous problems from arising at all. Virtually **all big trail maintenance problems started out as a small problem that was either not recognized or was ignored**. Regular monitoring over time can also enhance the effectiveness of trail planning and budgeting for trail maintenance, as well as assist land managers in identifying those sections of trail that require more frequent monitoring.

A good maintenance survey can be done easily by one person. However, having a second person involved in the assessment is highly recommended. An assessment crew of two people can make the work more enjoyable, reduce the total assessment time, provide for discussions or alternative ideas about identified problems, and enable the sharing of expertise. Traditionally, a maintenance survey was completed using a measuring wheel, flagging tape or pin flags, grease pencils and a handheld tape recorder. These methods can still be used, but the use of a GPS recorder integrated with a GIS mapping system is usually more accurate and often more time efficient. GPS units can often be obtained from the local municipality, Conservation Authority or Ministry of Natural Resources if the trail group does not have its own.

It is important that everyone involved in conducting a trail inspection or evaluation uses the same terminology, for trail features and required actions, as well as the same units of measurement. **Consistency in all aspects of the trail inventory process will make it much easier to use the inspection/evaluation results** to develop an effective trail maintenance plan. Any problems uncovered during trail evaluations or inspections should be corrected as quickly as possible, given the resources and skills of the trail managing organization.

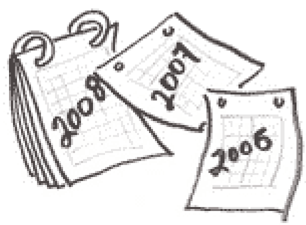
Each maintenance survey should be based on the results from a previous assessment. A copy of the assessment results (detailed log of the previous trail conditions) should be carried during the assessment so that any changes to the expected conditions can be easily identified and recorded. If a GPS recorder or handheld computer is used, previous assessment results should be pre-loaded so that data entry during the maintenance survey is limited to those areas or facilities where changes have occurred. Record any deficiencies or changes noted during the maintenance assessment in the trail or data log with sufficient detail to allow for accurate estimates of the required labour, tools, and materials needed for the work.

Evaluations and inspections can also be combined with repair or maintenance work on the trail if the people doing the inspections have the necessary time, skills and tools.

Combining trail monitoring and maintenance activities usually works best when the trail is relatively short, because the completion of maintenance activities can usually be accomplished without limiting the completion of the evaluation/inspection. Combining activities is also important for sections of trail in more remote locations that take a significant amount of time to reach. It is always a good idea to have trail inspectors carry a couple of simple tools, such as anvil clippers to cut back small limbs, a hammer to pound in raised nails and a bag for collecting litter. Of course a trail map and notebook (preferably a waterproof surveyors book) should be carried to note the location of problems and the work required to make repairs. When monitoring is done on a regular basis, the maintenance activities are more likely to remain small in scope so that they can be easily completed by only one or two people.

To plan and conduct formal maintenance evaluations, consider these key points:

- **Schedule at least one formal maintenance evaluation each year**.



Ideally, the maintenance evaluation should be scheduled so that required maintenance work can be identified and addressed before the busiest season of use. During the evaluation, a checklist or log of the trail conditions and facilities should be used to guide the evaluation so that important factors or information is not missed or forgotten. The formal maintenance evaluation should also include a review of public comments received about the trail conditions and the results of informal inspections completed since the last formal evaluation. For wilderness trails in remote areas, formal maintenance evaluations will be much less frequent, or even limited to the initial assessment after construction and before the trail is opened for public use.

- **Ensure that the trail inspector performing the evaluation has the required skill, knowledge, qualifications and expertise.** Formal maintenance evaluations should not be conducted by untrained personnel. The individual responsible for the evaluation must be properly trained, have detailed knowledge of trail construction techniques, be skilled at recognizing current and potential maintenance issues (e.g., not only erosion on the trail tread but dead limbs or trees a distance away from the tread that may be a potential safety hazard), and be capable of conducting an impartial examination of the trail (i.e., one that is not biased for or against the needs of any one trail user group). It is helpful if the person doing the evaluation has knowledge of the trail's design and construction. On trails that include built structures with a designated load bearing capacity (e.g., bridge, boardwalk, tower), it is recommended that the inspection be completed by a structural engineer or someone similarly qualified.

- **Have individuals representing permitted trail users and the group(s) responsible for maintenance and trail management accompany the trail inspector**. Representatives from other involved groups (user groups, individuals, adjacent landowners, etc) can also be invited, if applicable. **The evaluation will be most effective if it considers the abilities of all permitted trail users**. Someone who rides a horse or bicycle on a trail will "see" different potential problems than the avid backpacker, and the backpacker's ideas will be different from those of a family with young children, older adults or people with disabilities. If possible, **have two or three people who use the trail in different ways go with the trail inspector** during the maintenance evaluation. Having different perspectives available will help to ensure a more complete and comprehensive evaluation.

- Each section and structure of **a new trail should be fully inspected upon completion, before the trail or structure is open for use**. A formal maintenance evaluation should also be completed after 6 and 12-months of trail use. After the first 12-month period, the on-going maintenance evaluation cycle will be determined on the basis of the work performed to date, anticipated changes to the trail conditions over time and the time and resources required.

To plan and conduct informal trail inspections, consider the following key points:

- **Identify an inspection coordinator**. Designate one person who will be the point-of-contact for trail users and others who identify maintenance concerns or wish to convey information about on-trail conditions. Make the contact information for the inspection coordinator available to trail users through trail brochures, signs or other information formats. Having one person designated as the inspection coordinator helps to ensure that information reporting is not misplaced or delayed.

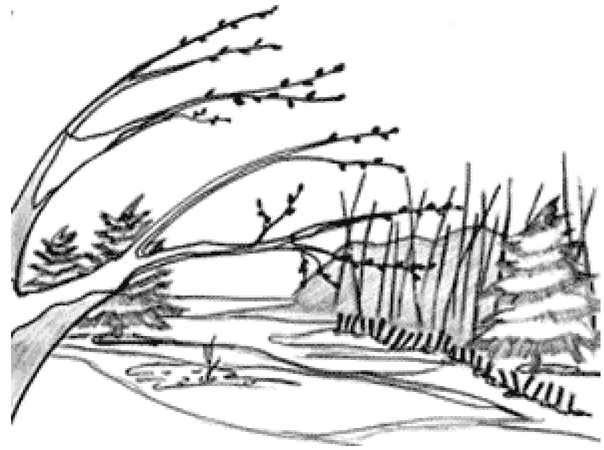
- Complete **less formal inspections regularly throughout the season(s) of use** for the trail. For trails that are open to year-round use, at least one informal inspection should be completed in each season. Informal inspections are most easily accomplished by having a group of trail users take responsibility for monitoring specific sections of the trail on a regular basis.

- Trail organizations should establish a simple and obvious way for all trail users to report potential problems that they may observe on the trail. **Public comments received by emails, letters, telephone calls, etc. should be reviewed** as they arrive to identify any significant safety issues on the trail.

- **Trail inspections should be completed after any severe weather event**, especially if there is heavy rain or snow and/or high winds. These inspections should focus not only on the trail tread, but also on potential safety concerns (e.g., trees and limbs that have been partially blown over, landslides and washouts, bridge or support structures that have been shifted or loosened).

- Public comments and results of the less formal inspections should be recorded and then reviewed in conjunction with the next formal maintenance evaluation if the issues raised are not time-sensitive or related to a safety issue on the trail.

Timing the Trail Inspection or Evaluation



The **best time to do maintenance evaluations and trail inspections is after bad weather or during Spring thaw** because:

- Frost, erosion and water flow are more easily identified.
- The extra water from snow melt and early rains will make drainage problems much more prominent.
- Features of the trail environment are easier to see before the leaves are out on the trees.
- The early Spring is just before the season of heaviest use for most Ontario trails (except snowmobile trails) so that any essential work can be identified and completed before there are large numbers of users on the trail.

Be sure to investigate and document the source of the problem, not just the result.

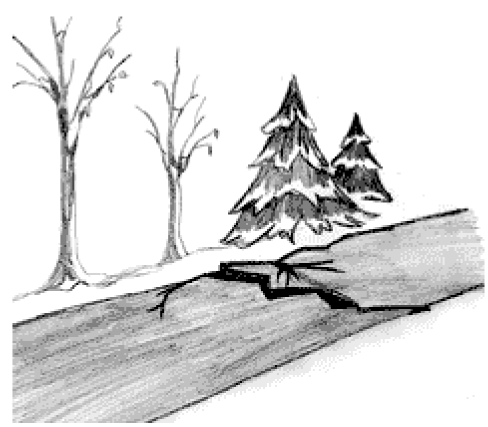
When assessing water problems on the trail, the most important questions to ask are:

Where and what is the source of the water?

Where is the water going?

How can I keep or quickly get the water off the trail?

Spring is also a good time to identify damage to the trail tread, structures or facilities from freeze/thaw cycles. Trails in southern Ontario are particularly prone to damage because of the frequent temperature fluctuations above and below freezing. As the temperature drops below freezing, water droplets turn to ice which makes them get larger. The force of the ice creates small cracks that fill with water as the temperature rises only to re-freeze with even more ice the next time the temperature drops.



Providing Inspection Results to Trail Users

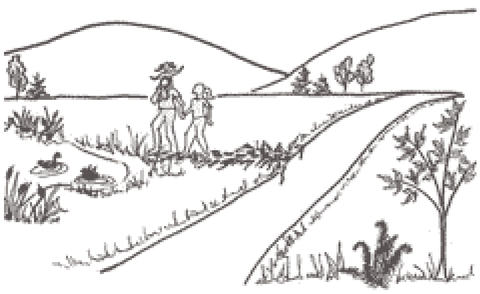
When maintenance evaluations or trail inspections identify work that needs to be done on a trail, it is very important that trail users are made aware of the results. **Nothing will destroy the social sustainability of a trail more quickly than having users arrive at or start out on a trail that is not safe and enjoyable to use**. There are an almost endless number of methods that can be used to provide inspection results to trail users. Notice boards at trail access points, web sites, email lists of trail members, trail newsletters, local newspapers, and community information sources (e.g., library, recreation centre or store information boards) are just a few examples of the options available.

The resources available to, and the type of use for each trail will determine the most appropriate method of providing inspection results to trail users. For example, posting inspection information on a trail web site is often appropriate for trails that attract a large number of users who do not live adjacent to the trail. For trails that function primarily for the use of residents in the immediate vicinity, it may be more appropriate to provide information at trail access points or through local sources of information (e.g., local newspaper, store bulletin boards, membership email list). Regardless of the format used, providing trail users with accurate information about maintenance issues on the trail is a proactive approach to proper trail management. When providing information to trail users, be sure to include:

- What the problem is.
- Where it is located on the trail.
- When it is expected to be corrected.
- Who to contact for more detailed information about the problem.

Closing a Trail

Trails may be closed, either temporarily or permanently, for a variety of reasons. Temporary closures typically occur because the maintenance work required on a trail is extensive or the trail may be hazardous or difficult to use until the required work is completed. **Trails that are not appropriate in terms of their location or environmental impact**, either from a sustainability or universal design perspective, **should be decommissioned** (i.e., permanently closed). It is important to recognize that **many volunteer trail groups will not have the resources or expertise to return a badly damaged trail to a safe and usable condition** when large-scale problems have occurred (e.g., forest fire).



Social trails are unplanned, unofficial trails that are created when users take a short cut or go off of the trail tread. As soon as it is recognized, the development of a social trail should be noted in trail inspection reports. It is important to investigate why the social trail is developing. It may be that the public is telling you with their feet where a trail should be constructed. **Before closing a social trail, find out why the trail is occurring** and determine whether it should become an official trail or whether it should be closed. If the trail becomes official, make sure that it gets developed according to the recommended guidelines for trail design and construction (see Guidelines for Trail Design and Guidelines for Trail Construction) and is of a similar standard as the rest of the trail(s) in the area. Of course, obtaining permission from the land owner as well as any other groups with jurisdiction over the land (e.g., Conservation Authority) is essential before changing a social trail to an official trail is even considered.

Consider closing a trail or trail segment, either temporarily or permanently, when[84,85]:

- There is a significant negative impact on the ecology/wildlife or cultural/historic aspects of the trail environment.

- There is a hazardous condition or situation on the trail.

- Conditions cannot be made safe for permitted trail users, particularly those who are less experienced or less skilled.

- Continued use of the trail, prior to the completion of repairs, will result in additional damage to the trail or trail environment.

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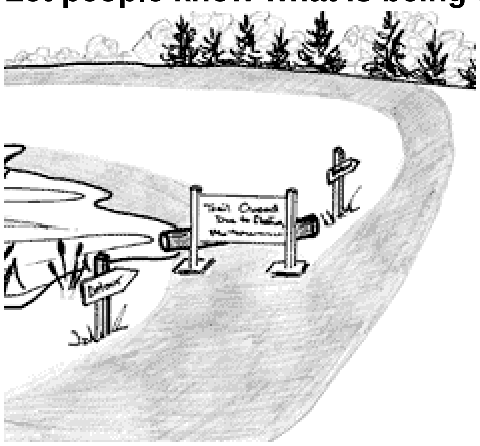
[84] International Mountain Bicycling Association. (2004) Trail Solutions: IMBA's Guide to Building Sweet Singletrack. Boulder, CO: Author.

[85] Grand Concourse Authority. (2004) Grand Concourse Walkway Maintenance Manual. St. John's, Newfoundland: Author. [On-line] Retrieved from http://www.grandconcourse.ca/noflash2004/manual.htm.

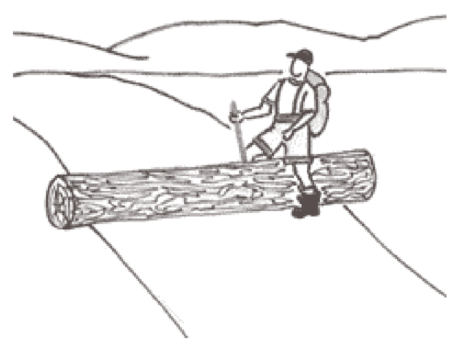
- The tread is consistently wet or muddy even with proper drainage and outslope.
- The grade exceeds the angle of repose (where the soil is naturally stable) and/or significant erosion problems are evident.
- Inappropriate use of the trail is occurring and cannot be prevented.
- A catastrophic event has caused severe damage.
- The nesting behaviour of important species will be disrupted.
- Trail users cannot be brought into or through a sensitive environment without causing permanent damage to that environment.



Let people know what is being done to the trail and why the trail or trail segment is closed. The most difficult part of closing a trail or trail segment is ensuring that trail users stop using the route. In most cases, trail users will readily comply if they are educated about the reason(s) for the closure and provided with an alternative trail that connects with adjacent sections and intersecting trails. Fences and signs often will not deter trail users from continuing along a well-established route unless a clear, attractive and well-marked alternative is provided. Long closures of a trail (e.g., half of one season of use or more) will encourage users to find other trails of interest and, therefore, may have a negative impact on the longer-term social and economic sustainability of the trail.

When a trail or trail segment must be **closed temporarily**:

1. **Erect barrier(s)** at all access point(s) for the trail.
2. **Provide information** at each barrier about why the trail has been closed, when it is expected to re-open and who to contact for additional information.
3. **Provide an alternate route** if the route is safe and appropriate for both trail users and the environment and all needed permissions have been obtained.



When a trail or segment must be permanently closed, the tread must be removed and rehabilitated. It is not sufficient to make the trail "unusable", such as felling a large tree across the trail or removing a bridge. Attempts to discourage use by creating "barriers", will only draw attention to the closed area and/or encourage users to find an alternate path around the obstruction. For the same reason, fences, gates and other barricades should not be used to enforce a permanent trail closure.

To permanently close a section of trail:

1. **Construct the new trail or reroute before the original trail is closed**. Having the new route established and open for use will enable the environmental rehabilitation work to proceed without limiting trail use and will discourage trail users from continuing on the original trail once that section is closed. The new trail construction will also generate interest from trail users so that the need for the trail closure can be clearly explained. Ensure that all needed permissions (e.g., Conservation Authority, land owner) have been obtained before construction of the new route begins.

2. **Update trail information sources**.
   Remove all signs from trail access points and update all trail literature. Replace information about the trail on web sites and in brochures with information about why the trail has been closed.

3. **Remove the trail tread and cut bank**.
   Remove all of the trail tread and cut bank and aerate the soils to promote revegetation. Organic materials and loose rocks on the tread should be saved for later use. Constructed surfaces should be completely dismantled and all materials removed. The compacted soil on natural-surface trails should be tilled to a depth of at least 5 cm (2 inches) so that new plants can grow.

4. **Recreate the natural drainage patterns**.
   Remove all material from the fill slope (downhill side of the tread) and use it to re-construct the original drainage contours within the trail corridor. Shape the material so that the original slopes and drainages are restored. If additional materials are required, try to acquire materials from the newly constructed trail rather than importing materials from another environment. Ruts and rills from erosion of the old tread should be tilled to loosen the densely compacted soils. The ruts are then filled with local soils and materials to re-create the original shape and contours of the land. If gullies are too large to be filled, install check dams at 3 cm, 5 m or 10 m intervals (for slopes of >30, 20 to 30, or <20 degrees respectively). Filling the gully between check dams with brush cuttings will further slow the flow of water and encourage natural sedimentation.

5. **Remove all trail access points**.
   Remove all signs, sign posts and constructed facilities from closed trail access points. Remove all paving materials from parking areas. Till the compacted soil of the parking area to a depth of at least 5 cm (2 inches) so that new plants can grow.

6. **Re-plant the trail tread and access points**.
   Plant native vegetation (plants, grasses, small trees) to cover and camouflage the tilled areas. Tilled soil that is left to naturally regenerate will be highly susceptible to invasive species. The choice of vegetation for planting is extremely important and requires expert knowledge of the local environment. If a re-route is being constructed, transplant the vegetation from the new route is the optimal method of ensuring that the new vegetation is genetically matched to the trail environment. Always plant vegetation in a random fashion for a natural aesthetic (rather than rows).

7. **Disguise the trail corridor**.
   Make the trail corridor look like it was never there. Rake leaves and organic material onto the tread, put rocks on the tread or drag logs and branches across the tread. Remember to "plant" deadfall at eye level, as well as on the ground, to eliminate the air space above the original tread. Large rocks or logs can be winched across the access point to further discourage use of the closed section. However, this must be done in a way that makes these obstructions look as if they naturally occurred and the placement of large barriers should not be done until all other steps have been completed (i.e., the original tread has been obliterated).

Easy Trail Maintenance – It's All in the Plan

Planning is the most important aspect of trail maintenance. Planning allows you to:

- Design and construct a trail that will require less maintenance.
- Establish a system for identifying required maintenance.
- Complete trail work quickly and effectively.

Designing and constructing a trail with maintenance in mind will enable you to create a trail that requires minimal, or at least a manageable amount of maintenance. Unfortunately, the majority of trails in Ontario were never formally "planned". It is much more common for Ontario trails to follow routes that were established long ago (e.g., traditional travel routes or game trails) or for other purposes (e.g., rail lines, logging or mining roads). On these "inherited" trails, evaluation can help to minimize maintenance requirements by establishing a system for identifying and repairing small problems before they become significant, and by making efficient and effective use of the time and skills of the hundreds of trail volunteers who provide their labour.

Assuming a good trail design, quality construction, a clear understanding of the environmental conditions of the site, and an understanding of the needs of trail users and the amount and type of trail use, **it's possible to estimate maintenance needs long into the future**. Future maintenance needs should be calculated at 6-month, 1-year, 5-year and 20-year intervals. To a large degree maintenance activities are predictable. However, the results from trail inspections/evaluations should be used to dictate the actual maintenance activities performed.

Trail maintenance plans should identify projects within categories such as public health and safety, resource protection, preservation of investment, visitor convenience and new construction or re-construction. The trail maintenance plan should establish frequent (i.e., weekly or monthly activities), seasonal, annual and longer-term schedules for regular trail maintenance activities. It should also indicate who is responsible for performing the planned maintenance activities. Depending on the type of trail, the maintenance plan can include everything from the stocking and cleaning of toilet facilities to the replacement of trail infrastructure (e.g., bridges, signs).

To **create a trail maintenance plan**, complete the following steps:

1. **Document and describe the trail tread and trail corridor in detail**.
   The entire trail tread and trail corridor must be described as fully as possible so that the maintenance needs of each section can be anticipated. A detailed description of the trail tread and trail corridor should be available from the results of the initial trail inventory (completed after construction and before the trail is opened for use). If an initial inventory is not available, use the information compiled during trail design and development along with trail maps to clearly identify each section of the trail. Use a number or symbol reference system to indicate where each described section of the trail is located on the map. Provide as much detail about the on-trail conditions as possible for each section. For example where the trail tread is made from the natural soil, describe the type of soil, slopes on and adjacent to the tread, and the type of vegetation on and around the trail. Detailed information about the trail and trail corridor can be used to anticipate the maintenance demands within each section of the trail (e.g., a section through dense, fast-growing vegetation will need more frequent maintenance than a section on bedrock or through a mature forest with little ground cover). Similarly, areas with sandy soil or steeper grades are typically more prone to damage from erosion. The known or potential maintenance concerns for each trail section should also be included in the documentation.

Table 7: Example of Trail Tread Assessment Information

Distance	Tread Material	Tread Width	Tread Grade	Tread XSlope	Off-Tread Slopes	Off-Tread Veg.	Comments/ Concerns
0-57m (0-187 ft)	Clay soil	0.7m (2.3 ft)	+3.0%	5.0%	10-15%	Meadow	Weeding required
57-123m (187-404 ft)	Clay soil	0.65m (2.1 ft)	+1.0%	5.0%	10-15%	Meadow	Weeding required
123-196m (404-643 ft)	Clay soil & crush rock	0.8m (2.6 ft)	-5.0%	5.0%	10-15%	Mature forest	
196-254m (643-833 ft)	Clay soil & crush rock	0.7m (2.3 ft)	0.0%	5.0%	10-15%	Mature forest	Monitor foliage near trail
254-299m (833-980 ft)	Board – Spruce 2x4	1.2m (4 ft)	0.0%	5.0%	0%	Creek	
299-387m (980-1270 ft)	Crushed rock	0.75m (2.5 ft)	1.5%	5.0%	10-15%	Mature forest	
387-460m (1270-1509 ft)	Crushed rock	0.75m (2.5 ft)	1.0%	5.0%	10-15%	Mature forest	Monitor foliage
460-525m (1509-1722 ft)	Crushed rock	0.75m (2.5 ft)	2.0%	5.0%	10-15%	Meadow	
525-613m (1722-2011 ft)	Crushed rock	0.75m (2.5 ft)	7.0%	5.0%	10-15%	Meadow	
613-750m (2011-2460 ft)	Crushed rock	0.75m (2.5 ft)	5.5%	5.0%	10-15%	Immature forest	

2. **Inventory the trail structures and facilities**.
   Create an inventory of all trail structures (e.g., bridge, culvert, boardwalk) and facilities (e.g., washroom, parking, potable water) from the information collected during the initial trail inventory. The facility and structure inventory should be as detailed as possible so that the anticipated maintenance for each structure or facility can be determined. Each built structure should be described in terms of the materials used, the size and shape of the structure, and any paint or coating used. The known or potential maintenance concerns for each structure should also be recorded. If data from the initial trail inventory is not available, an inventory of trail structures and facilities should be created during the next trail evaluation.

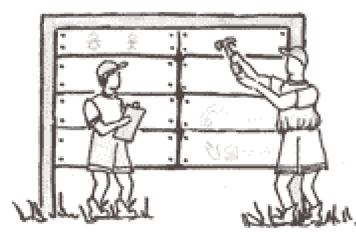
Table 8: Sample Maintenance Schedule

Month	Weekly/Monthly Tasks	Seasonal Tasks
May	Empty trash containers Stock washrooms Stock trail information boxes Weed meadow	Remove down trees Repair benches
June	Empty trash containers Stock washrooms Stock trail information boxes Weed meadow	Install benches and picnic tables Install campsite pay stations
July	Empty trash containers Stock washrooms Stock trail information boxes Weed meadow	
August	Empty trash containers Stock washrooms Stock trail information boxes Weed meadow	Replace bridge #2
September	Empty trash containers Stock washrooms Stock trail information boxes Weed meadow	Re-deck boardwalk Remove benches and picnic tables Remove campsite pay stations

3. **Schedule and delegate maintenance tasks**.
   Develop a maintenance work plan that includes a detailed list of the maintenance activities to be performed, who is responsible for the completion of each activity and when the work must be done (e.g., ASAP, within one month, next Fall). There should also be a system for recording the date that work is completed and the names of the people who are responsible for doing the work. The list of maintenance activities should include anticipated maintenance work (based on the trail description and facility/structure inventory) as well as additional tasks identified through trail inspections. When determining the schedule of maintenance tasks, a wide variety of factors must be considered. These include weather conditions, soil moisture conditions, trail use patterns, trail worker skill levels, logistics, availability of tools and materials, presence of threatened and endangered species, etc.

Maintenance actions should be scheduled under headings such as the following:
Daily/Weekly - tasks done very frequently on higher-use trails
Monthly - tasks done frequently on lower-use trails
Seasonally - tasks done for each season of use
Annually - tasks done very infrequently
Special Case - Immediate - tasks requiring urgent attention due to safety concerns
Special Case - Short or Medium-Term - additional tasks that are not done at regular intervals.

4. **Develop inventories of trail facilities**.
Utilize the detailed trail information to create inventories of on-trail facilities. In general, inventories should be created for the following categories:
Signs – trailhead signs, on-trail signs, blazes, etc.
Load-Bearing Facilities – bridges, boardwalks, ladders, etc.
User Health and Safety Facilities – water sources, toilets, emergency shelters, etc.
User Amenities – benches, picnic tables, fire pits, etc.



Comprehensive facility inventories make it much easier to record needed maintenance work as it is observed and reported by trail users. Inventories of all facilities within each section of trail should be provided to all trail work parties. In this way, people working on the trail can monitor the availability and condition of trail facilities on an on-going basis. The facility inventories should be updated whenever a new facility is constructed or installed. It is often helpful to identify each facility with a unique identification number. The ID number can be used to clearly identify each facility and match it to its description in the trail inventory. In this way, if a facility is damaged or missing it can be more easily replaced.

5. **Calculate maintenance costs and resources**.
The costs (labour, tools, materials) should be determined for all maintenance work scheduled in the plan. Costs are calculated based on labour rates, expected labour production, material costs, and facility life expectancies. If work is identified that exceeds the maintenance resources available, the work required should be transferred to trail construction/reconstruction costs so that additional resources can be acquired.

Maintaining Proper Trail Drainage

Ensuring proper drainage and water flow in the trail environment is critical to long-term environmental and social sustainability (i.e., the provision of a safe and enjoyable trail experience for all users). The frequency of drainage-related maintenance activities will depend on many factors, including the trail environment, layout/design of the trail, type of use, natural drainage patterns and the types of drainage control measures.

From a broad perspective, maintenance activities to ensure proper trail drainage should focus on the following activities:

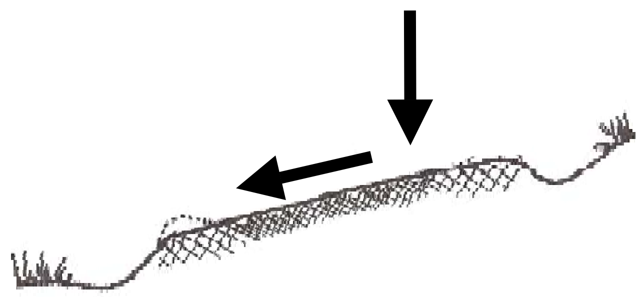
- Maintaining the outslope of the trail tread.
- Ensuring that drainage structures function as intended.
- Replacing or repairing trail tread or structures that have been moved by water flow.

Trails that are properly designed and constructed to be sustainable will require little or no maintenance related to water flow and trail drainage. If maintenance work is frequent or drainage structures are required, it suggests that the trail was not designed for sustainability. Whenever possible, maintenance activities should bring the tread closer to a match with the natural drainage patterns. The closer the match between the natural drainage pattern and the constructed trail drainage facilities, the less maintenance that will be required.

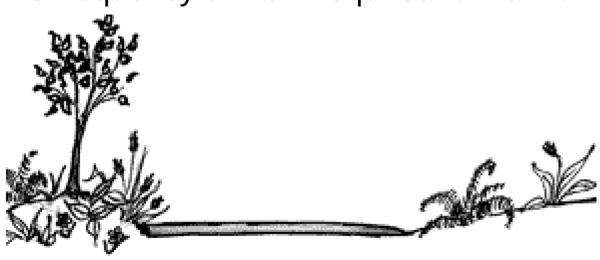
Restoring the Tread Outslope

Maintaining the desired outslope of the trail tread is the “first order of business” in the maintenance of trails with natural surfaces. It is **the simplest, but most important and most labour-intensive trail maintenance task**.

Trail surfaces that are not compacted, firm and stable enough for permitted trail users may build up a berm along the outside (downhill) edge of the trail. The berm results from a combination of compaction in the centre of the tread (because of higher use in that area of the trail) and the displacement of loose material towards the downhill side of the tread. Whether the “berm” on the edge of the trail is created by the accumulation of loose material or the compaction of the centre of the tread, the result is the same. Water gets trapped on the trail tread creating puddles of water or areas of soft tread material. If not repaired, eventually the water will drain down the tread, increasing erosion, and trail users will venture off the trail tread in search of a solid trail surface, increasing environmental impact.

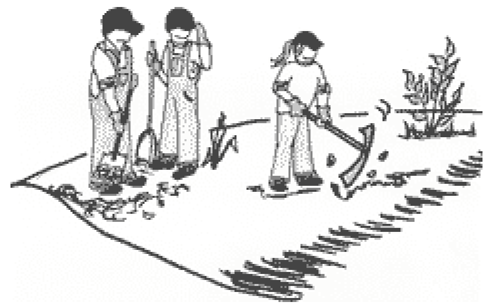


The frequency of work required to maintain the tread outslope will vary, depending on how the trail was originally designed and constructed. Soils that are firm and stable and trails that are used by fewer people will require less work. In contrast, trails in areas with high precipitation, unstable soils or with certain types of trail use (e.g., high levels of equestrian use) will likely need more frequent maintenance.



Like most trail maintenance projects, the **work of maintaining the outslope will be much easier if it is done before the tread deteriorates significantly**. If the berm is allowed to increase in size, damage to the trail tread will be much more significant and more effort will be required to dismantle the berm and re-establish the required outslope. The **key to maintaining tread outslope is to do the required work on a regular basis** so that a berm, if it occurs at all, is never more than a minimal size (10 cm (4 inches) or less in height with no vegetation).

To restore the tread outslope:

1. **Remove vegetation from the berm**.
   
   If the berm has been stable for an extended period of time, or if the trail is located in an area with fast vegetation re-growth, the berm may be partly or completely covered in vegetation. If the vegetation is an invasive species, it should be removed from the area. If the vegetation is native to the area, it should be carefully removed and replanted to restore the trail tread or surrounding environment. Use shovels, picks and other tools to remove or transplant the vegetation[86].

2. **Till the berm and tread to loosen the material**.
   Use hoes, picks and other tools to loosen and till the material that forms the berm. Areas of the tread where the berm material will be placed (e.g., entrenched, compacted and depressed areas of the tread) should also be tilled or scarified so that the original and additional material will mix and bond well. Loosening of the material should be done carefully so that the material is kept on the trail tread.

3. **Move the material to the uphill side of the tread**.
   
   Use rakes, shovels and McLeod tools to move the loose material to the uphill side of the tread. Distribute the loose material in a layer up to 10 cm (4 inches) thick. Shape the loose material so that it provides a consistent outslope from the uphill to the downhill side of the trail tread. The soil must be moist to achieve proper shaping and compaction.

4. **Compact the material**.
   
   The trail tread should be mechanically compacted using a roller or vibratory plate. Make sure that the soil or tread material is moist. Dry materials do not adhere or compact well. Mechanically compacting the material decreases the likelihood of the material shifting back to the downhill side of the tread. It also provides a tread surface that is less likely to further compact under the weight of trail users. If mechanized compaction is not available, tamping tools or the flat side/end of many trail tools can be used to compact the loose material into it's new location. However, compaction by hand is labour intensive and the treads usually continue to change shape with trail use (and therefore require more maintenance).

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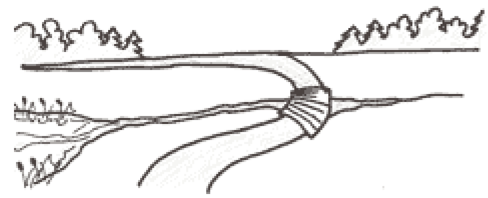
[86] U.S. Forest Service. 2004. Trail Construction and Maintenance Notebook. [On-line] Retrieved 31 July 2006 from: http://www.fhwa.dot.gov/environment/fspubs/00232839/page13.htm

5. **Repeat tread shaping and compaction**.
   Continue to move material to the uphill side of the tread and then compact the material in 10 cm (4 inch) layers until the desired tread outslope is restored.

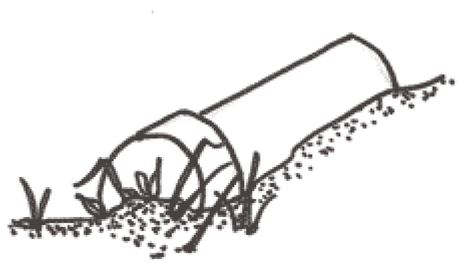
6. **Remove remaining berm material**.
   
   If the desired outslope has been restored but not all of the berm material has been removed, continue to loosen the berm material until the downhill edge of the trail provides a clear path for water to drain quickly off of the side of the tread. Unused berm material can be used to repair the trail tread in other locations. Alternatively, it may be possible to carefully distribute the extra material through the surrounding terrain, being careful not to disturb natural drainage patterns or native vegetation.

7. **Encourage vegetation in the buffer zones beside the tread**.
   Vegetation removed from the berm can be replanted in the buffer zones adjacent to the trail tread. Replanting helps to disguise the recent maintenance work. If portions of the buffer zones are not vegetated and replanting is not possible, rake a shallow top layer of soil in the buffer zone to encourage the natural regeneration of vegetation.
   

Maintaining Drainage Structure Function



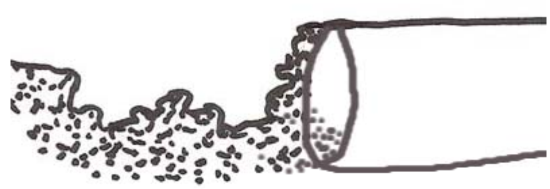
Properly designed drainage structures should require little to no maintenance in order for them to function properly. Culverts and other drainage structures that become clogged with debris, silt or leaves provide evidence that the structure is less than optimal for the environmental sustainability of the trail. If trails are designed and constructed using a curvilinear layout, very few drainage structures will be required. **The drainage structures needed for a curvilinear trail are only those that serve to separate the trail tread from natural drainage channels** (e.g., provide a trail surface above a deep or fast-moving natural drainage). On existing or inherited trails that do not follow a curvilinear alignment, additional drainage structures may be required.



Drainage structures should be inspected regularly as part of the trail maintenance plan. Additional inspections should be completed after major weather events (e.g., storms, rain, snow, wind). Look for signs of water damage, erosion, settling of the structure or sedimentation. If these changes are evident, examine the surrounding area to determine the source of the problem and then make appropriate repairs.

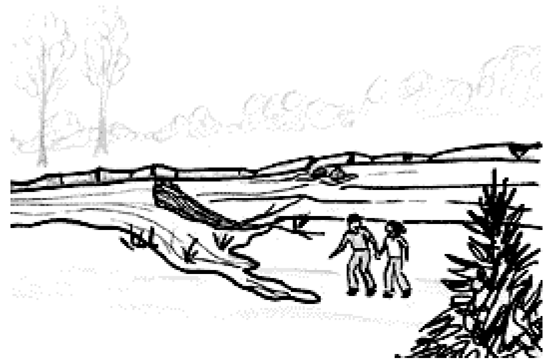
To maintain drainage structures, including culverts, swales, and trenches:

1. **Inspect the drainage structure**.
   Examine the drainage structure for evidence of erosion or deposition in or near the drainage structure. Erosion may result from water flow or trail use (e.g., unstable surfaces at the edge of the tread that are collapsing toward a culvert). Deposits are the accumulation of water, sediment or other debris. Also check for signs that the drainage structure has changed position (e.g., was moved by water flow, has settled into sub-soil).



2. **Determine the source of the problem**.
   Follow the "trail" of the water flow to determine the cause of the erosion or the source of the deposits. Verify that all water flow is within the intended drainage channel. If there is a problem with the control of water flow it is usually because the trail design or structure is forcing water flow out of the natural drainage channel.

3. **Repair the source of the problem**.
   Stabilizing the trail environment so that water does not reposition materials is the most sustainable way to deal with problems of erosion and deposition. Failing to properly stabilize the source of the problem will result in the need for continual maintenance to clear deposits from the drainage structure so that it continues to function properly. **The source of the erosion or deposition must be identified and repaired** before the drainage structure itself is maintained.

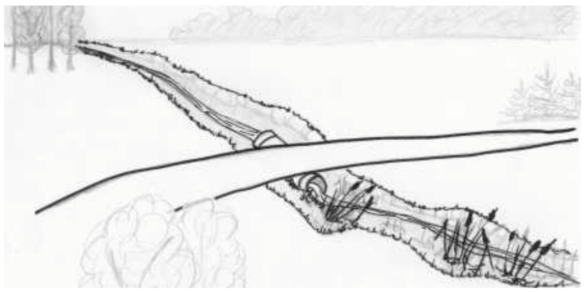


A clear understanding of the flow of water and the forces causing the erosion and deposition is required in order to make an effective repair. **In most cases, the poor alignment or design of the trail, or a drainage structure that is not properly sized or positioned, will be the cause of the erosion and deposition problems**. Before trying to "fix" or reinforce an imposed drainage pattern, carefully examine the trail and surrounding environment to identify the natural drainage channel. The drainage structure installed must be appropriate to the natural volume and patterns of water flow and the type of trail and trail user. Always choose a drainage structure design that will enable all permitted trail users to use the trail in a safe and enjoyable manner.

Maintenance efforts should be focused on returning water flow within the trail environment to the natural drainage pattern. The exact method of repair will be determined by conditions in the surrounding environment. In general, use rock (e.g., riprap) or vegetation to stabilize eroding surfaces so that material cannot be moved or deposited by water flow through the drainage structure. If the source of the erosion is outside of the trail environment, then the erosion is a natural process and the trail drainage structures must be designed to accommodate the sediment-filled water flow.

4. **Clear the drainage structure**.
   After the source of the problem has been repaired, clear the accumulated debris from the drainage structure. In most cases, this can best be done using shovels, rakes and other hand tools. If there is only a small amount of debris, water can be used to flush debris out of enclosed drainage structures (e.g., culvert).

5. **Ensure that the drainage structure is properly positioned**.



   Water flow, settling of soil or user traffic may change the position of drainage structures over time. Examine the structure to determine whether water is flowing freely through the structure, without eroding areas around the inlet or outlet of the structure. If water does not flow freely, it will deposit additional material as it is forced to slow or change direction.

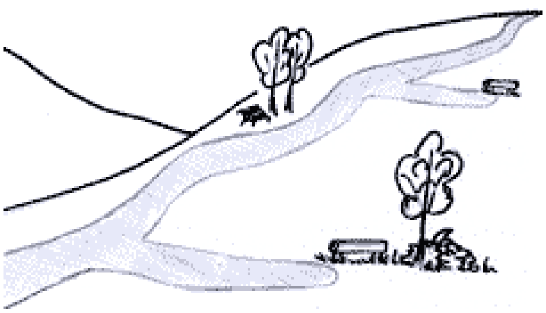
6. **Stabilize the banks around the drainage structure**.
   Ensure that the ground around the inlet and outlet of the drainage structure is stable. Use rocks and vegetation to reinforce or stabilize loose material as required. Use different sizes of rocks and native vegetation to create a more natural appearance.

7. **Repair the tread over a closed drainage structure**.
   If a closed drainage structure (e.g., culvert) is used, ensure that the tread material is replaced and compacted over top of the structure once the other repairs are complete. If maintenance of the drainage structure has been neglected for a length of time so that the structure was completely blocked, the tread material may have been eroded by water flow over the trail. In this case, repair the tread as indicated in the following section by gathering material from the erosion path and supplementing with additional material as required.

Drain Dips / Grade Reversals

Drain dips are wide, shallow depressions that are sloped toward the downhill side of a trail tread. Drain dips are also called grade reversals because the tread goes downhill and then “reverses” uphill. Drain dips / grade reversals use changes in the slope of the trail tread to direct water off of the trail. They take advantage of water’s tendency to flow downhill. Essentially, they use the slope of the tread to collect water and channel it to the downhill side of a trail.

Constructing the trail route to take advantage of naturally occurring swales, drainages and grade changes can minimize the need for constructed drainage features. **Drain dips / grade reversals should never be included in newly designed trails**. Allowing water to collect and flow along the trail tread, even for short distances, increases the probability of erosion and water saturation of the trail tread. These factors have significant negative impacts on the environmental and social sustainability of a trail. The need to direct flowing water off of the trail tread, which is the purpose of drain dips / grade reversals, is a clear indication that the trail was not developed for sustainability using a curvilinear alignment. Although never recommended for new trail construction, drain dips / grade reversals can be used to control erosion, water flow and the maintenance required on existing or inherited trails. **Drain dips / grade reversals should always be used instead of waterbars to rehabilitate or maintain trails that disrupt natural drainage patterns** (i.e., are not sustainably designed). The use of drain dips / grade reversals rather than waterbars is particularly important on trails used by cyclists or people who use other wheeled forms of mobility because they can channel water flow while keeping the trail tread barrier-free for users.

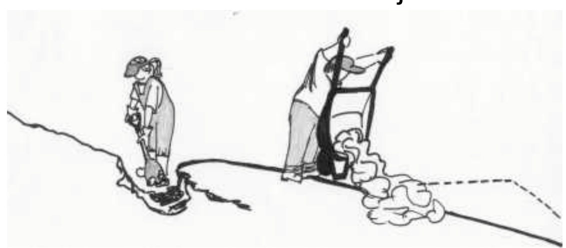


To construct a drain dip / grade reversal:

1. **Plan gradual changes in grade and cross slope**. The downhill and uphill sections of the drain dip / grade reversal must be designed and constructed so that all changes in slope are gradual. Sudden changes in slope will dramatically alter the flow of water, causing sediment deposits on the trail tread. Make sure that the size of the drain dip / grade reversal is adequate for the maximum expected water flow.

2. **Construct a large outflow area**.
   The outflow is the area at the lowest point of the drain dip / grade reversal where the water flows off of the tread. It should have sufficient cross slope so that the sediment-filled **water flows easily off and well away from the trail tread**. Ensure there is no berm on the downhill edge of the tread. Slope the buffer zone at the outflow steeply away from the tread. The outflow should be slightly lower level than, and have a length that is twice the width of the adjacent tread.

3. **Excavate the drain dip / grade reversal**.
   In most terrain, the drain drip / grade reversal can be constructed with hand tools (e.g., pick, shovel). Excavate the required downslope (if the tread is not steep enough) and use the excavated material to create the upslope / grade reversal material beyond the outflow. If the excavated material is not sufficient to create the required grade reversal, additional material should be brought to the site from other areas along the trail (e.g., where a berm has been removed from the edge of the trail tread). Excess material should be used for tread repair at other locations on the trail or widely dispersed in the adjacent environment. Make sure that any dispersed material cannot migrate onto the trail tread or alter the function of the drain drip / grade reversal.

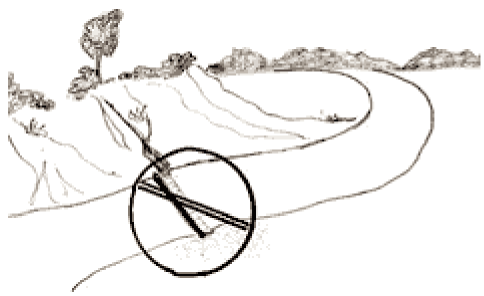


4. **Sculpt and compact the tread**.
   Use mechanical compactors (e.g., vibratory plate) to sculpt and solidly compact the tread material into the required shape. The top of the upslope should be at least 30 cm (12 inches) above the lowest point on the tread. If mechanical compactors are not available, rakes, hoes and tamping tools (e.g., McLeod) can also be used but generally do not provide enough compacting force to prevent further movement and compaction through regular trail use. **Compaction of the tread throughout the drain dip / grade reversal is critical**. The tread must be fully compacted during construction so that there is no change to the slope or contours of the tread within the drain dip / grade reversal even with heavy trail use. If use of the trail or water flow on the tread results in shifting, pitting or rutting of the tread surface, the function of the drain dip / grade reversal may be compromised

5. **Clear the outflow**.
   Remove all vegetation (other than ground cover), loose soil and debris from the area of the outflow. The cleared area should be large enough that water will flow 1 metre (3.3 feet) or more off of the tread before it stops moving.

Waterbars

Waterbars are wood, stone or rubber surfaces that are placed across the tread at an angle so that water running down the tread is directed off to the side of the trail. **Waterbars are always a problem on trails**. Although intended to control erosion and trap sediment, they often create more severe erosion problems. As water flow is slowed by a waterbar, sediment is deposited on the tread immediately uphill. When the sediment accumulates to the height of the waterbar, water flows over it, increasing the erosive force of the water as it falls over the waterbar and continues unimpeded down the tread. In addition, waterbars create a tripping hazard for all trail users, even if they only extend an inch or two above the tread surface. Trail users on wheels (e.g., cyclists, people using wheelchairs) will go off of the tread to go around the waterbar, increasing damage to the local environment.



The need for waterbars on a trail is a clear signal that the trail has not been designed and constructed for sustainability. Although this is a factual statement based on the latest trail impact research, it is probably the statement that created the most controversy during the development of this resource. Many veteran trail workers and users pointed out, and rightly so, that many existing trails have waterbars and that without the waterbars the erosion on the trail would be even greater. Unfortunately, trail users often consider only the changes to the trail tread that result from waterbars. Relatively few people recognize the negative environmental factors that waterbars represent.

While it is true that the treads of many long-established trails could not exist without the installation of waterbars to limit the quantity and speed of water flow on the tread, that does not mean that waterbars have a positive impact on the environment. The benefits from waterbars for the trail tread can also be obtained from a tread that incorporates drain dips / grade reversals (which will not force users on wheels (e.g., cyclists, people using wheelchairs) off of the tread and require less maintenance).

From the perspective of environmental sustainability, both waterbars and drain dips / grade reversals are fundamentally flawed because:

- Waterbars and drain dips / grade reversals are only required on a trail that is close to the fall line or so significantly entrenched that water flows down the tread rather than throughout the adjacent environment.
- Although there is no doubt that the erosion on fall-line trails would be much worse without some form of diversion, re-directing volumes of water (first down the entrenched or fall line trail and then off of the tread via waterbars) causes environmental damage throughout the trail environment.
- Plants near the waterbar outlet are deluged with unnaturally large volumes of water and sediment.
- Vegetation uphill of the waterbar outlet are starved for precipitation.
- Waterbars require frequent maintenance in order to function properly and not become filled with sediment
- Water cascading over the top of a sediment-filled waterbar accelerates the erosion of the tread immediately downhill of the waterbar.
- Vegetation adjacent to waterbars (i.e., off of the tread) also experiences a high rate of trampling and damage from trail users who do not want to or are unable to step over the waterbars (e.g., cyclists, people who use wheelchairs).

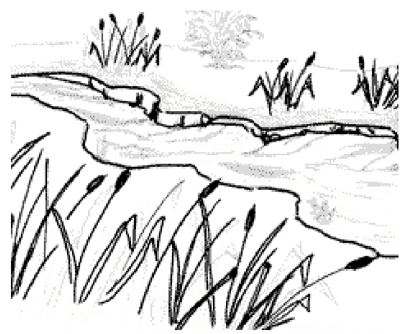
Trails that are built so that natural, sheet drainage patterns are maintained will not have to depend on waterbars or drainage dips to manage unnaturally large accumulations of water. Whenever possible, construct a trail so that it maintains the natural sheet drainage patterns. **If a poorly designed trail cannot be reconstructed, install drain dips / grade reversals rather than waterbars**. Drain dips / grade reversals perform the same function as waterbars, but they require virtually no maintenance (e.g., removal of accumulated sediment) and do not negatively impact use of the trail (e.g., cyclists).

Recreating Trail Structures Moved by Water Flow

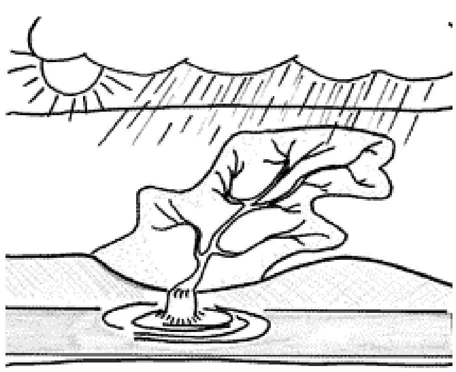
At times it will be necessary to recreate trail structures and facilities that have moved as a result of water flow. Obviously, **if water flow in the area is continuous and significant, the trail structure must be re-designed before it is reinstalled.** The structure must be appropriately sized, and positioned in order to maintain the natural drainage patterns in the environment. Very rarely, trail structures will be shifted by a truly unique weather or other type of event (e.g., catastrophic failure of an upstream dam). In this case, the trail environment should be carefully examined to determine whether or not the drainage structure should be re-established in the original position. The emphasis here is on "should". In many cases it will be possible to return the structure to its original condition, but **the primary question will always be whether that is appropriate for the local trail environment**. Putting drainage structures back in locations where they have previously failed, without altering their size or design, is usually a waste of precious trail resources (i.e., time, labour).

In most cases, if a trail structure or facility has been moved by water it is a clear indication that the structure or facility was not sized or located appropriately. In order to install a new drainage structure or facility:

1. **Determine the source of the problem**
   Examine the area where the structure was originally constructed. Determine the conditions that caused the structure to move. Thick vegetation matted from water flow suggests that flooding of the area is a relatively unusual event. In contrast, if there is evidence of erosion, a lack of vegetation or a concentration of water-tolerant vegetation (e.g., mosses, cattails, reeds), water flow in the area is likely to recur.



2. **Establish the natural drainage patterns**.
   The most accurate way to establish the natural drainage patterns in a trail environment is to complete a detailed observation and assessment of the entire



   watershed. Runoff and flood data are usually not sufficient to predict the peak runoff levels that the drainage structure will be required to accommodate. Remember, the water in the small creek that trickles under your trail may come from a watershed that is hundreds of square kilometres in size. In the spring melt or when there is heavy rain, that small creek can become a raging river as the water from the entire watershed accumulates at lower elevations. Only when the natural drainage patterns within the trail environment and surrounding watershed have been established can an appropriate style and size of drainage structure be determined.

3. **Construct an appropriate structure or facility**.
   Construct or re-construct an appropriate structure or facility at the site dictated by the natural drainage patterns. Follow the same procedures that would be used during original construction (see Trail Drainage Structures). If the structure was not damaged by the water movement, it may be possible to re-use the original structure if it is of a suitable design. However, the decision to re-use a structure or facility should be made carefully and only after a careful inspection of the structure/facility has been completed to ensure that it is appropriate, safe and functional. If the structure cannot be re-used, it should be dismantled and the materials removed from the trail environment.

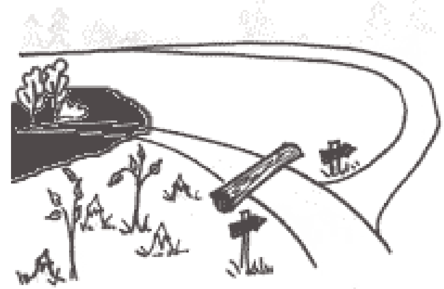
4. **Repair the original and destination sites for the structure**.

   The destination site of the structure or facility is the area where the structure ended up after it was moved by the water. Once the new structure has been constructed in the proper position, the original and destination sites for the previous structure should be fully restored to their natural condition. Remove all broken debris from the site and replant native vegetation so that the original and destination sites are no longer visible to trail users.

Seasonal Wet and Muddy Areas

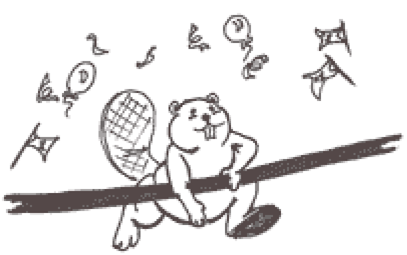
Ideally, the proposed route for a trail will be inspected in all four seasons before the trail is constructed. If that effort is made, the likelihood of dealing with the high maintenance demands of seasonally wet or muddy areas will be virtually eliminated. The best option for dealing with seasonally wet areas is to relocate the trail to “dry ground”. However, if relocating the trail is not an option, the trail tread in seasonally wet areas should be constructed in the same manner as trails in permanently wet environments (see Tread Structures Above the Surrounding Terrain). **Trail users should not be left to “fend for themselves” through seasonally wet areas** because, in doing so, they will go off of the trail tread and greatly increase the environmental impact of trail use.

Drainage Problems from Animals



Many Ontario animals can significantly alter the drainage within a trail environment. The beaver is perhaps the most widely recognized "cause" of a trail that has been wonderful for years and then the next year is completely flooded. The pointed, freshly gnawed stumps of trees adjacent to a body of water are a sure sign that beavers have just moved into the area. However, many other animals can also flood trails as they make their "homes" or obtain "food" from the surrounding environment.

The optimal approach for dealing with trail flooding from animal activities is to re-locate the trail. This can be extremely frustrating if, a couple of years later, the animal leaves and the original trail alignment is once again "high and dry". However, ultimately **the trail will be more sustainable if it is positioned in an area that is not prone to the "vagaries" of animal behaviour**. Areas close to water bodies that could be flooded by animal activity are also prone to drainage problems and often have soils that are not suitable for a sustainable trail tread. For all of these reasons, **re-locating the trail is the only option for long-term sustainability**. Constantly changing the trail alignment can negatively impact the social sustainability of the trail, not to mention the environmental impact and work of repeatedly relocating portions of the trail.



A common "mistake" among trail organizations is to assume that the beaver dam or other animal structure that is causing the flooding can be dismantled so that the body of water will return to its historical level and location. **Beware, the phrase "eager beaver"**. In the lore of trail maintenance and construction, it has always been the beaver that comes out "on top" when there is a contest over who has the most energy and resolve. From a practical sense, most trail volunteers lead "other lives" for most of the week. They go to jobs during the day or take care of family. By comparison, the beaver is almost totally focused on creating the habitat needed for survival. Even if you spend 4 or 5 hours each day dismantling the beaver dam, the beaver has about 20 hours per day to thwart your efforts. It's not worth it.

Maintaining the Trail Tread: Solid Surfaces

Solid trail surfaces are those that are constructed of hard materials that are installed in sections or relatively large pieces. Primarily, the materials used are asphalt, concrete or wood. However, other solid surface materials can also be used (e.g., interlocking brick, rubber panels). Asphalt and concrete surfaces are used primarily for urban trails and to reinforce trail surfaces that have very high levels of use or are intended for people travelling on small wheels (e.g., skateboards, inline skates).

The maintenance of solid trail surfaces in Ontario is a function of three key factors:

- **Durability** of the material used.
- Impact of frost and cycles of **freeze-thaw** on the position and base of support for the tread material.
- Impact of **environmental influences** (e.g., sun, precipitation) on the material.

Solid surfaces generally do not need regular "maintenance" in that the surface will remain suitable for trail users on a day-to-day basis. However, for solid trail surfaces to function effectively they must be properly constructed to withstand winter cycles of freezing and thawing. In general, that means that the base of support for the trail tread must be constructed so that it is either below the frost line (e.g., supports for a boardwalk) or flexible enough to accommodate changes in ground position due to frost (e.g., gravel sub-base similar to a road).

Small repairs to solid surfaces will inevitably be required. These repairs usually result from small-scale damage because of freeze-thaw cycles or the degradation of the material over time from exposure to climactic factors (e.g., sun, rain). Trails constructed from solid surfaces should be checked regularly (e.g., weekly or monthly depending on level of use) for needed repairs, particularly at the end of the winter season. If very substantial repairs are required, or if the continuous small repairs required become an onerous burden, consideration should be given to replacing the solid surface with a different material that is easier to maintain.

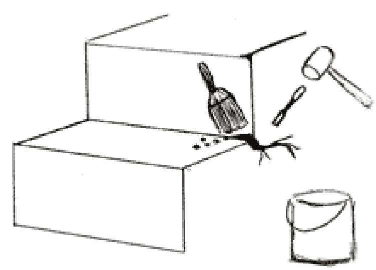
Trail workers will often observe evidence of erosion adjacent to and under a solid trail surface or the accumulation of water in pools on top of the surface. Correcting these problems on solid surfaces follows the same process as other trail surfaces. Erosion problems result from problems with either water flow or trail users. Water pooling on a solid surface is a clear indication that the appropriate outslope of the tread has not been maintained. **The only effective way to deal with these problems is to re-construct or relocate the trail surface** so that the source of the problem is effectively addressed. **Patching of a solid surface trail without addressing the source of the problem usually just pushes the problem to a different section of the tread**.

While there are many good reasons for constructing a trail from a solid surface (e.g., in-line skating), **it is not appropriate to require that a trail be built from a solid surface (e.g., asphalt, concrete) in order to "make it accessible to people with disabilities"**. Solid trail treads will only provide an accessible surface if they are properly constructed to withstand the freeze-thaw cycles of a typical Ontario winter. Asphalt and concrete are just as likely to have accessibility problems as any other tread material. The choice of a solid surface must be made based on the demands of trail users (e.g., in-line skating), the typical weather and environmental conditions, and the resources available for construction and maintenance.

Concrete Trail Surfaces

In general, if concrete surfaces are properly constructed (i.e., proper sub-base, reinforced for stress) they will require very little routine maintenance throughout the life of the trail. If concrete trail surfaces are extensively damaged (e.g., large or very numerous cracks) or concrete sections have dramatically heaved or settled, trail workers should replace the section of trail rather than trying to make extensive repairs.

Small cracks (less than 1 cm (0.4 inch)) should be joint sealed as soon as possible to prevent moisture from reaching the base foundation. Small gaps in the surface or degradation of the original tread surface should be repaired using concrete patching compound. Concrete patching compounds are a combination of cement and adhesive that adheres to established concrete surfaces. Concrete patching and sealing compounds are available at most hardware and building supply stores. Purchasing materials rated for use in repairing wells or septic tanks will ensure that the material is inert and will not leach chemicals into the surrounding environment.



When minor damage to a concrete trail tread is suitable for sealing or patching, the following methods can be used to return the tread to a safe and usable condition or extend the life of the tread a little longer prior to replacement:

1. Prepare the crack or damaged area. **Remove any loose material** from the damaged area using a stiff wire brush. Make sure that all pieces of concrete that are not solidly attached are loosened and removed.

2. Use a mallet and chisel to **shape the edges of the crack so that they are "undercut".** This will provide a more secure attachment between the original concrete and the patching compound or sealer. For deep cracks or gaps, construct a compacted, sandy base in the damaged area before applying the patching compound. Everyone working with mallet and chisel should wear safety goggles for eye protection.

3. **Clean the area** to be patched with a cleaning agent that will remove dust and other concrete particles.

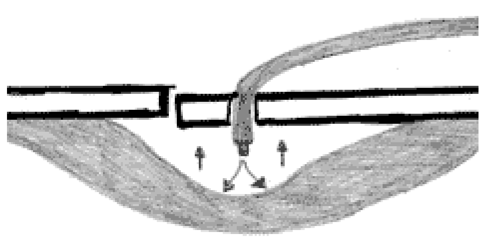
4. **Apply the sealer or patching compound** to the crack according to the manufacturer's instructions. Be careful to ensure that the required temperature will be maintained throughout the time needed for the material to dry and cure.

Remove trip hazards

Trip hazards are caused either by erosion under the concrete surface or heaving of the surface upward from frost. When adjacent concrete surfaces are not at the same level, the probability of tripping injuries is greatly increased. Solid trail surfaces, such as concrete, should not be used in areas where freeze-thaw cycles will cause buckling and heaving of the surface unless there are sufficient resources to construct the trail to the standards required by the environmental conditions.

Traditionally, the repair of trip hazards in concrete surfaces was done by grinding the higher-level surface down to match the lower level surface. This type of work typically requires equipment that is best operated by individuals with the proper training and experience. A newer option for these types of repairs is to lift up the lower section so that it comes to match the higher section. If the sections of concrete are very small (e.g., patio stones), this can be done relatively easily. If the concrete sections are too large to be lifted by hand, trail workers may want to obtain professional assistance.

A new product[87] made of polymer resins offers the possibility of drilling a small hole through the concrete and injecting the flexible, inert material under the concrete. The inert material fills any available space below the concrete and then as more material is added under pressure, the polymer resin lifts the concrete into position. However, this product is relatively new and long-term data on the durability of the repair or the suitability of the product for different environments are not yet available. Care must also be taken to ensure that the repaired/lifted surface maintains the correct grade and cross slope for proper drainage.



[87] The polymer resin product is called uretek. More information on sidewalk and trail repair using uretek can be found at www.uretek.ca.

Asphalt Trail Surfaces

Asphalt trail surfaces are extremely common, particularly in the urban areas of Ontario. Asphalt is often thought of as an easy and inexpensive method for creating a trail surface that is suitable for people of all abilities. Unfortunately, the climate in most areas of Ontario makes it difficult to maintain an asphalt trail in a safe and useable condition. Only rarely, are asphalt trails properly constructed to provide a safe trail tread beyond the first one or two winters. Every Ontarian knows how our asphalt roads, which have a very substantial sub-base, are affected by winter weather. Therefore, it's not surprising that most asphalt trails, which are usually constructed by laying asphalt onto the mineral soil or with only a small sub-base, quickly deteriorate even though the weight of trail users is not comparable to the vehicles on our roads.

After proper construction with a full sub-base, **asphalt trails must be regularly sealed and maintained in order to provide a safe and usable tread** for trail users of all abilities. On trails with mechanical snow removal, sealing and repairs to asphalt are particularly prone to damage. When machinery is used to remove snow from the trail, the maintenance demands of the trail will be substantially increased. Extensively damaged sections of trail tread should always be replaced, rather than repaired, by skilled professionals using the appropriate equipment.

All of this is not to suggest that asphalt should not be used for trails. Indeed, there are many good reasons to provide asphalt trails and for some types of use (e.g., in-line skating) it is virtually essential. These warnings are simply intended to make trail groups aware that constructing an asphalt trail will not mean that the trail can be ignored for years after the initial construction work. Like all trails, asphalt trails require regular maintenance so that they continue to provide a safe and enjoyable trail experience.

<u>Sealing Asphalt</u>

When a new asphalt trail is constructed the entire asphalt surface needs to be sealed. Sealing is expensive but the life span of the asphalt will easy double or triple if this work is completed. Sealing with a slurry mixture will provide a more skid-resistant trail tread.

Sealing keeps out moisture and prevents the surface from drying out. Sealing also helps to reduce the loss of rock material that is embedded in the asphalt. If the asphalt surface dries to the point where rocks are lost from the surface of the trail tread, the asphalt should be removed and replaced.

After initial construction, the asphalt trails should be re-sealed every 3 to 5 years. Any cracks that form in the asphalt should be sealed before winter and in the early spring. Prompt sealing of cracks will prevent moisture from reaching the sub-base under the trail and will extend the life of the trail by several years.

Trails that do not have regular vehicle traffic may need to be re-sealed more often. On roads, vehicular traffic compacts the asphalt and forces oil up to the surface (sort of a "self-sealing" mechanism). However, there is not enough heavy compaction on most trails intended for human-powered use to allow this to happen so regular sealing of asphalt trails is recommended.

To seal an asphalt trail:

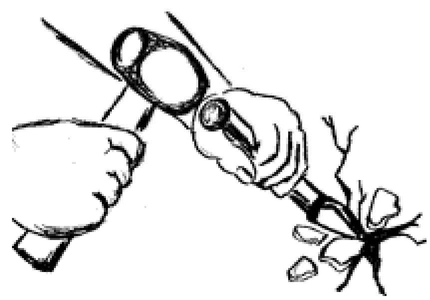
1. Use a broom or wash the trail surface to **remove any dust and debris** from the surface of the asphalt. The use of an asphalt-cleaning compound is recommended.

2. Follow the manufacturer's instructions for **applying the asphalt-sealing compound**. In general, the compound will be of a paint or watery consistency and can be applied using a paint roller or sprayer.

3. **Block user access to the trail until the sealant has completely dried** or cured. The time required will depend on the product used and the temperature and humidity at the site.

Repairing Cracks and Holes in Asphalt

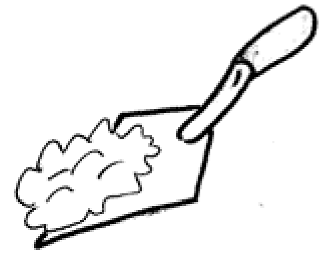
Repairs to asphalt trail treads should be limited to small cracks and potholes that occur on an isolated basis. If more extensive repairs are required, professional assistance should be obtained. Small cracks and potholes can be repaired using these steps:



1. Prepare the crack or damaged area. **Remove any loose material** from the damaged area using a stiff wire brush or broom.

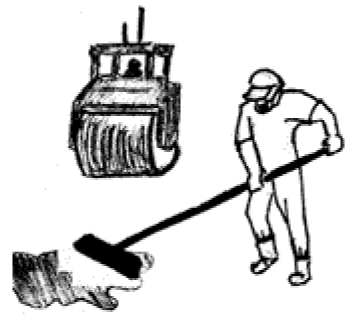
2. Use a mallet and chisel to **shape the edges of the crack so that they are "undercut"**. This will provide a more secure attachment between the original asphalt and the patching compound. For deep cracks or gaps, construct a compacted, sandy base in the damaged area before applying the patching compound. Wear safety goggles to protect your eyes from flying debris.

3. **Clean the area** to be patched with an asphalt-cleaning compound to remove dust and other particles that may affect the bonding of the patch.



4. **Apply asphalt-patching compound** to the crack according to the manufacturer's instructions. Be careful to ensure that the required temperature will be maintained throughout the time needed for the material to dry and cure.

5. When the asphalt-patching compound has cured, **apply one or more coats of asphalt sealing compound** over the repaired section.



A number of potholes in a single area or crumbling of the asphalt at the edge of the trail tread is evidence that the sub-base is damaged. Repairs should not be completed over a damaged sub-base. Instead, cut out the affected area and reconstruct that section of the tread. Reconstruction will require that the base be properly compacted before the asphalt is replaced. In some situations, it may be helpful to install a geotextile underlay on top of the sub-base to increase the stability of the new asphalt layer.

Wooden Tread Structures

Wood trail tread structures require regular maintenance in order to ensure a safe and enjoyable trail experience for all users. In general, the maintenance issues related to trail treads made of wood fall within these categories:

- Deterioration of the wood from environmental factors (e.g., sun, rain).
- Loose, raised or missing hardware (e.g., nails, screws, bolts).
- Erosion of adjacent natural trail surfaces.
- Shifting of the support structure (e.g., due to frost, erosion or water flow).

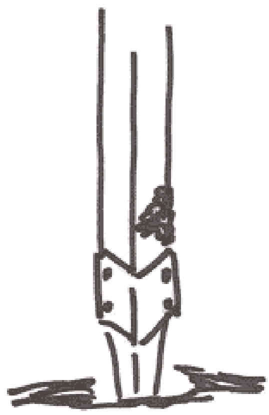
Wood should be fully dried before being used for trail construction. In Ontario, most lumber will be kiln-dried when purchased. However, lumber obtained from discount sources, directly from a mill or designated as lower quality and wood cut from trees near the trail may shrink substantially as it dries. **Frequent inspections should be completed during the first year after construction** to identify and repair any warped or loose pieces of wooden tread structures.

Replacing Cracked, Rotten or Damaged Wood

Wood trail treads should be inspected carefully and regularly to ensure that the wood is not cracked, damaged or starting to rot. **Any wood pieces that are damaged or show signs of rot should be removed and replaced**. Use cedar or other types of wood that are less likely to rot for all replacement materials. Pressure-treated lumber can also be used as long as the wood will not be in contact with the ground (ground contact can cause the preservatives to leach into the surrounding environment). When purchasing pressure-treated lumber be sure to obtain newly manufactured materials that has not been treated with Chromated Copper Arsenate (CCA). CCA has been linked to health problems for many people. Since 2004, arsenic, a known cancer-causing agent, has been removed from the chemicals used to treat wood. However, building supply companies were, and still are, allowed to sell off existing stocks of CCA treated wood. Today pressure treated wood is typically created with chemicals such as amine copper quat (**ACQ**) or copper azole (**CA**). At the very least, these options are less toxic than CCA. However, some health concerns remain and it is still advisable to take precautionary measures when using wood treated with these chemicals. Lumber companies continue to develop non-toxic wood preservatives. Products using sodium silicate[88] are promising, but not yet available in Ontario.

[88] Timber Treatment Technologies. TimberSIL: Locked in for life. [On-line] Retrieved 31 July 2006 from www.timbersil.com

All of the damaged materials removed from the trail tread should be properly disposed of away from the trail site. Never dispose of pressure treated, painted or treated lumber in the trail environment. The chemicals used to preserve or paint/treat the wood will leach into the environment as the wood rots. Always remove materials from broken wood structures and properly dispose of the material at an authorized site.



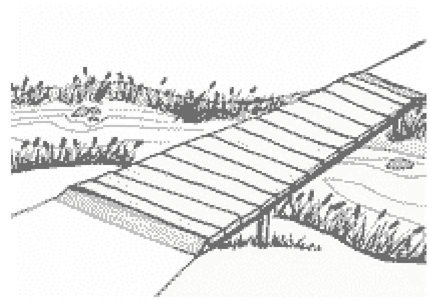
While it is usually easy to get trail volunteers to replace broken or rotting pieces of wood decking, it can be much more difficult to generate support for completely replacing damaged support structures (e.g., cracked or rotting bridge stringer). However, **it is essential that rotting support structures be removed and replaced**. It is not acceptable to “patch” a rotting support structure by anchoring a new support onto the rotting beam. Even if the additional support is anchored well beyond the area that appears rotten, trail workers should remember that wood rots from the inside out. That means, **the rot you see is never as extensive as the rot that actually exists**. Once a piece of wood starts to rot, there is virtually no way to prevent it from rotting further. Attaching additional supports to a rotting beam will only result in more work when the rot inevitably extends into the area where the new support is anchored. Although it seems like a lot of work, any wood support structures that are damaged or show evidence of rot must be replaced. **Remove all of the decking, remove the damaged support, install a new support and then replace the decking**.

<u>Replacing or Repositioning Hardware</u>

All hardware used for trail structures should be galvanized so that the hardware does not rust or deteriorate with exposure to the natural elements. The hardware used to join pieces of wood together or to attach wood to other surfaces can loosen with time and trail use. Inspect all hardware regularly to ensure that pieces are not lost or broken. Whenever possible, secure bolts with locking nuts or recess hardware into the wood surface and cover the ends of the screws or nails with wood plugs or putty. Camouflaged hardware is aesthetically pleasing and decreases the risk of vandalism or loss.

Nails often gradually lift over time as pressure is applied to different areas of the wood surface. Straight nails should never be used for trail structures. Galvanized, Ardox nails are less likely to lift because the wood fibres tend to cling to the spiral curves of the nail. Another alternative is to connect the wood pieces with screws rather than nails (although screws are much more expensive). If screws are not threaded on the section of screw that will sit within the wood plank, the screws will be less likely to lift or loosen over time. Ceramic-coated deck screws can also be used to attach decking boards to timber supports.

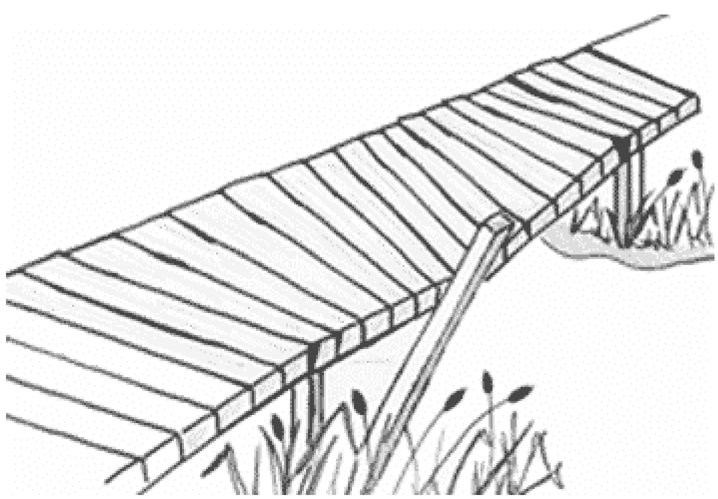
Transitioning to Adjacent Surfaces



Wooden trail treads must be carefully constructed so that **access onto and off of the wood surface is free of steps or tripping hazards**. The adjacent surface should be shaped to provide a smooth connection to and from the wood tread. A soil dam is required to separate the wood from the surrounding soils and moisture. Asphalt, crushed rock and soil are the materials most commonly used to create the transition onto or off of a wood surface. Details regarding the construction of approaches to wooden trail structures can be found in Tread Structures Above the Surrounding Terrain. Refer to Guidelines for Trail Design - Tread) for detailed information on the maximum height between adjacent surfaces and the maximum slope on transition areas.

Shifting Support Structures

Shifting support structures are the most difficult maintenance task on wooden trail treads. Movement of the earth from freezing and thawing is the most common cause of shifts in the support structures for wood trail treads. Anchor posts that are set into solid mineral soil below the frost line should not shift significantly over time or because of frost. In contrast, support posts in wet soil or anchored in fairly shallow soil (less than 1 metre) can shift significantly when temperatures change. There are only two options for support structures that have shifted: a) leave the support in the shifted position, or b) remove the support and reset the post. In general, small amounts of movement in support structures do not need to be addressed as long as support for the trail tread remains solid. However, if shifting of the support structure causes the cross slope of the wooden trail tread to exceed 5%, the slanted tread will be difficult for many trail users to cross and the support post should be removed and reset. If a support post needs to be reset, the new support post should be installed as if it is new construction (see Tread Structures Above the Surrounding Terrain).



Maintaining the Trail Tread: Pieced Surfaces

The maintenance needed to ensure an appropriate tread surface will vary tremendously, depending on the type of pieced surface material used and the permitted users on the trail. **Trail surfaces constructed with mechanically crushed rock with a variety of piece sizes are usually less costly to maintain**. The key to minimizing maintenance is to ensure that there is adequate soil moisture content for cohesion and that the pieces are mechanically compacted during construction.

Pieced surface materials are **generally easier to maintain or repair than solid surfaces**. The most significant factor is the availability of additional pieced material to match what is already on the trail. For natural surfaces, additional material may be found on other areas of the trail (e.g., where a downhill berm has been removed) or taken from inconspicuous sites adjacent to the trail corridor. Additional constructed pieced materials and additional natural materials not available on site will have to be transported by trail workers. The **transportation of surface materials can significantly increase the amount of work** required to maintain a trail tread that is enjoyable and safe to use.

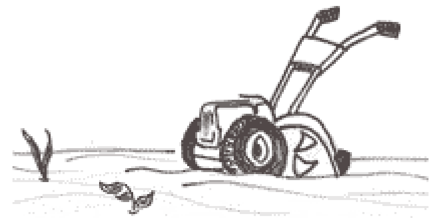
Filling is typically used to repair damage to trail treads made from pieced materials. Pieced materials that are composed of "pieces" that vary in size and have straight or jagged edges (i.e., that have been mechanically crushed or broken) should always be used for the fill material. Mechanically crushed rock with a variety of sieve sizes will compact to a solid surface because the jagged edges "stick" together and the smaller pieces fill the "holes" around the larger pieces. In general, pieced materials should have pieces no larger than 2 cm (0.8 inches) to provide a smooth and sustainable tread surface.

The filling of swales in the trail tread can also be an effective, proactive method of altering drainage to reduce erosion on the tread. However, extreme care is required to ensure that changes to natural drainage patterns do not negatively impact the trail environment. If pieced material is "missing" from eroded sections of the tread or is found at a "wash out" or drainage outlet, determine the source of the water flow and make the necessary changes to restore the natural drainage patterns before repairing the damage to the trail tread.

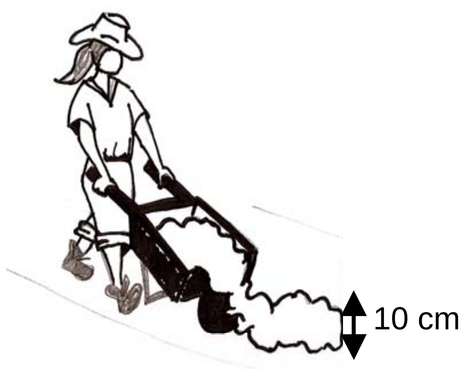
Naturally occurring pieced materials are less likely to form a firm and stable tread and will require more maintenance because the rounded shape of the pieces makes it much more difficult to properly compact the material into a solid trail tread. For example, “river gravel” is known for providing a trail surface that is “like walking on glass marbles”

To fill a depression in the trail tread:

1. **Till tread to loosen the existing material**.
   Use hoes, picks and other tools to loosen and till the material that forms the trail tread. This will allow the new material to mix and bond well with the existing material. Loosening of the material should be done carefully so that the material is kept on the trail tread.



2. **Place additional material into the damaged area**.
   Use rakes and shovels to move the loose, pieced material into the damaged area of the tread. Distribute the pieced material evenly, mixing it thoroughly with the loosed tread material, in a layer up to 10 cm (4 inches) thick. Shape the loose material so that it blends smoothly with the undamaged sections of the trail tread. Remember, if the original material was altered to improve the stability of the surface it will be necessary to treat the additional material to be added in the same manner. Deliberately compacting the material in 10 cm (4 inches) layers will provide a tread surface that is less likely to further compact under the weight of trail users.



3. **Compact the material**.
   Use mechanical compactors (e.g., vibratory plate) to solidly compact the material. Mechanical compaction is the best way to ensure that the tread maintains its intended shape even with heavy trail use. If mechanical compaction is not feasible, tamping tools or the flat side/end of many trail tools can be used to compact the pieced material solidly into the repair area. Trail treads compacted by hand must be monitored on a regular basis to ensure that the required shape of the tread is maintained.

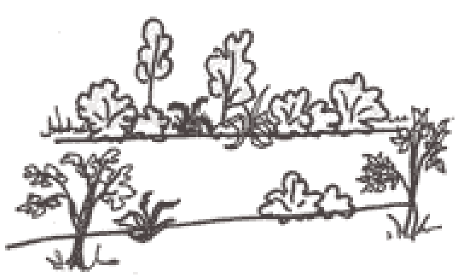
4. **Repeat addition, shaping and compaction of tread material**.
   Continue to add material to the repair area, shape it and then compact the material in 10 cm (4 inches) layers until the repaired area is level with the surrounding tread and the desired tread surface slope is restored.

Maintaining Trail Vegetation

Vegetation on and adjacent to the trail tread plays a vital role in the protection of the trail environment. When vegetation, either canopy or ground cover, is removed from the trail corridor, there is an increased risk of negative environmental impacts (e.g., invasive species, soil erosion, wind damage). However, leaving vegetation to grow naturally across the trail can also result in significant environmental damage as trail users push, break or strip small branches and foliage in order to clear a more enjoyable path.

Trimming and Removing Vegetation

Pruning and brushing vegetation to keep it off of the trail tread is an essential and regular part of trail maintenance, especially in the brushy boreal and mixed wood plains of Ontario. **Leafy vegetation should be cleared, not just from the trail tread, but also from an additional buffer zone on either side and above the trail corridor**. For hiking only trails, the buffer zone should be a minimum of 0.3 metres (1 foot) in width on both sides and 0.5 metres (1.6 feet) above the trail corridor (i.e., 0.6 metres (2 feet) in addition to the width and height of the trail tread corridor). For trails with uses other than hiking, the size of the vegetation-free buffer will increase, with the minimize size determined by the permitted trail uses. For example, multi-use, non-motorized trails should have a total of at least 3.5 metres (11.5 feet) of vertical and 2.5 metres (8 feet) of horizontal clearance.



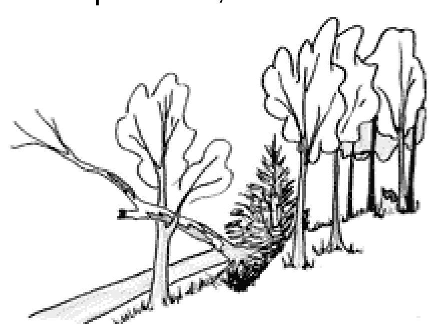
The buffer zone is necessary to keep growing vegetation away from trail users even when it is bent down by the weight of rain or snow. In addition, **when openings in the foliage are only large enough for the trail user, the surrounding foliage will obstruct the vision of trail users travelling downhill or around a bend**. Safe use of the trail requires that trail users have adequate sight lines in front of them so that they can see people they are approaching. Adequate sight lines are particularly important for trail users moving at faster speeds and for the safety of trail users with limited hearing. If necessary, the vegetation-free buffer zone can be made smaller for a short distance in order to protect a specific tree or to skirt around a large boulder. However, whenever possible it is better to design the trail, either initially or through re-alignment, so that the vegetation-free buffer can be maintained through the length of the trail.

The goal in maintaining the vegetation-free zone is to **maintain the trail environment so that it appears as natural as possible**. A pruning or brushing job done quickly may deal with restoring the function of the trail, but it does not usually provide an aesthetically pleasing result. Avoid the temptation to quickly lop off an intruding branch and throw the debris aside. Grass and other succulent plants can be cut back with weeding tools. Use loppers or pruners to nip brushes and saplings. Make sure that your tools are sharp. Sharp tools are safer to use (i.e., they are less likely to bounce or deflect off the vegetation) and a clean cut is also better for the health of the vegetation.

It is best to maintain vegetation in the spring. Additional maintenance may be required in the summer (if vegetation grows quickly) or fall (if the trail will be used during the winter months). Monitor the growth of new plants to ensure they are not stunted or delayed relative to normal growth conditions. Delays in plant growth can be the first sign of increasing environmental impacts from trail use. In general, saplings less than 10 cm (4 inches) in diameter should be removed from the trail tread and buffer zone. Protect trail users from tripping by cutting stumps flush with the earth.

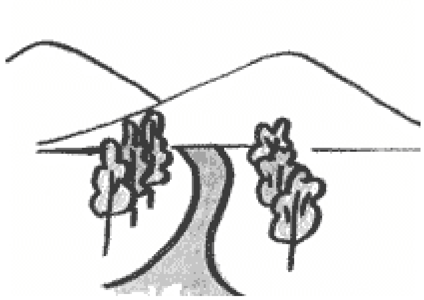
Trees along the trail will also need to be inspected to ensure that they are healthy and sound. If possible, avoid removing trees from the trail environment. However, diseased or rotting trees have the potential of falling across the trail. If any live or dead tree has the likelihood of falling on the trail it should be removed. Branches that are likely to fall on the trail should also be removed. **Felling and removing live trees requires special equipment and skill**. Volunteers should utilize appropriately trained personnel if the removal of a tree is required. Similarly, large trees that have fallen across the trail may require the use of a chain saw. Only people certified in the proper use of a chainsaw should perform these tasks. Regardless of your training and experience, **never fell trees or operate a chainsaw alone**. Always get help.

Watch out for "hazard trees", snags that are leaning toward the trail and that may fall across the tread. Since dead trees are often home to many forest animals, you should **remove them only if they present an immediate danger to trail users**, or if maintenance is so infrequent that trees that do fall will cause considerable problems for trail users until someone is able to return. Since trails do not encourage people to stay in one location (like they would at a campsite or picnic area), the probably of a trail user being hit by a falling tree is relatively small. That being said, the recent case of the trail user who was killed at the Royal Botanical Garden has heightened awareness of the danger posed by hazard trees and the importance of optimizing the safety of the trail environment.

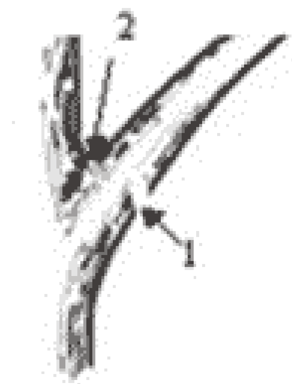


There are **three basic elements for brushing or pruning trail vegetation** in a manner that is most compatible with the natural environment. Each of these elements makes pruning a more tedious maintenance task, but the results in terms of the social sustainability of the trail are worth the extra effort. The three key points for clearing vegetation are:

1. **Carefully consider what vegetation needs to be cleared**.
   Pruning and brushing should be done sensitively so that the trail appears natural. No one wants to use a trail that looks like the site of “a chain saw massacre”. Where there are large, mature trees, maintain the canopy over the trail to discourage the growth of underbrush. When you are finished your work, trail users should not be able to tell that maintenance work has been done. Trim back vegetation that is growing over wooden trail structures to prevent early decay of the wooden elements. In some places in Ontario there may be rare or endangered plants on or near the trail. Check to be sure you know what plants are growing on or along your trail.



2. **Prune to the collar of any branch or stem**.
   Pruning to the collar is optimal for the health of the tree or shrub and it also provides a more natural looking result. At the base of any branch there is a wide section that contains a plant's natural healing agents. Any pruning performed away from this collar will expose the plant to a greater risk of infection. A cut at the collar will naturally heal. For large branches over 5 cm (2 inches) in diameter, cut halfway through the branch from the bottom a short distance away from the collar (cut #1 in the illustration) and then cut down from the top of the branch through the collar (cut #2). This prevents tearing of the bark, again reducing the risk of infection.



3. **Properly place and conceal debris**.
   Place debris out of view, remove it from the trail environment or compost it in an appropriate location. Dealing with debris properly requires extra effort, but the result is well worth it. Each cut branch should be touching the ground to promote decomposition. Brush piles are not appropriate. They are not only unsightly, they encourage pests and can become a fire hazard. If debris cannot be removed or composted in an appropriate location, conceal it by dragging branches under and around shrubs. If the debris cannot be completely concealed, place the butt (cut) end of the debris away from the trail as this will help to disguise the debris. Do not toss debris! Branches that are randomly discarded usually end up hanging in adjacent shrubs or trees.

Dealing with Noxious Vegetation

Noxious vegetation, such as poison ivy, stinging nettles or Hawthorne bushes, can have a negative impact on the social sustainability of a trail. For the safety and enjoyment of trail users, **noxious vegetation should be removed from the trail corridor and surrounding buffer zone**. Every reasonable effort should be made so that trail users, particularly young children and those who might inadvertently go off of the trail (e.g., novice cyclists or in-line skaters), will not come into contact with noxious vegetation. **Education should always be the trail user's first defence against noxious vegetation**. Ensure that trail information sources (e.g., maps, web sites, guide books, on-trail signs) provide all trail users with accurate information about the potential for contact with noxious vegetation on the trail.

The **optimal method of removal will depend on the type of vegetation, the environment in which the trail is located, and local regulations regarding the removal of plant species**[89]. When dealing with noxious vegetation, it is **essential that trail workers wear proper clothing and safety gear**. Tyvek coveralls and cotton gloves under rubber gloves (either alone may lead to inadvertent exposure) are helpful when dealing with irritants, such as poison ivy or water hemlock. Protective gloves are essentially for stinging or thorned plants, such as nettles or hawthorn. **Keep first aid materials handy at the trail work site**.

General guidelines for removing Ontario's most common noxious plants are:

Nettles
Trim the plant back to the base of the stem twice a year.

Hawthorne
Trim this plant back from the trail and buffer zone. The long spikes are a safety issue for trail users, so make sure that people on or falling beside the trail will not be injured. It is not necessary to remove the entire plant. Hawthorne can continue to grow away from the trail as it has many environmental benefits.

[89] Information on dealing with noxious vegetation was provided by the Wye Marsh Wildlife Centre, Midland, Ontario, tel: 705-526-7809, email: wye1@csolve.net, http://www.wyemarsh.com

Poison Ivy, Poison Oak, Poison Sumac[90]

An herbicide should be applied by qualified, experienced personnel. **Never burn poison ivy plants**, as the irritant will be carried in the smoke to everyone in the area. If you don't want to use chemicals, manual removal of the plants will be effective only if you remove every bit of the plant (leaves, vines, roots). Check with your municipality regarding proper disposal of plants. The urushiol (sap that causes the itch) can remain active for years even after the plant is dead.

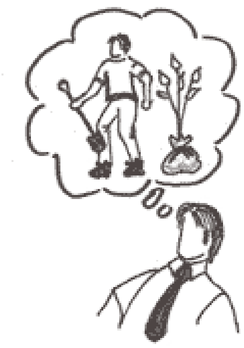
Water Hemlock

Consider water hemlock to be extremely toxic. Some books say even contact with the juices can be lethal. The pretty flowers can be attractive to children and inexperienced trail users. **All plants that can be seen from the trail should be removed**. Experienced workers wearing cotton gloves under rubber gloves and safety coveralls should remove the entire plant (including the roots) and burn it. Research has also shown that repeated flaming of the plants on site can be effective in eradicating water hemlock[91].

[90] US Food and Drug Administration. Outsmarting Poison Ivy and Its Cousins. [On-line] Retrieved 31 July 2006 from http://www.fda.gov/fdac/features/796_ivy.html

[91] California Invasive Plant Council. A Test of Repeat-Flaming as a Control for Poison Hemlock, Cape Ivy and Periwinkle. [On-line] Retrieved 31 July 2006 from http://www.cal-ipc.org/symposia/archive/pdf/Bossard_Moore.pdf

Restoring Vegetation to the Trail Environment



People who volunteer to maintain a trail usually think about the work needed to remove vegetation from the trail corridor. The need to add vegetation to the trail environment is less likely to immediately "spring to mind". However, properly maintaining the vegetation within the trail corridor **must always be a balance between removal and restoration**.

Restoration is about repairing damage to the trail environment that results from trail construction or use. The goal is to improve wildlife habitat and the cleanliness and clarity of water sources, and to restore a healthy ecosystem. The restoration of vegetation can occur for a wide variety of reasons. Most typically, it is used to repair eroded or compacted areas within the trail corridor, to replace invasive species that have been removed or to remove and restore "social trails" or other closed trail segments.

Restoration projects require careful planning, a clear grasp of the breadth of the task, and a strong commitment to achieve the intended goals despite the long time frame that may be involved. The effectiveness of the **methods used for restoration may take years to produce results**. Trail crews must be satisfied with knowing that they have created the conditions to allow a meadow or a portion of a forest to re-establish itself.

Understanding what has caused the damage is the critical first step in restoring the trail environment and preventing the damage from recurring. If, for example, a trail to a favourite lake is to be closed and restored, learn from the old trail what problems need to be resolved in creating a new trail to the lake.

The timing of work to restore vegetation, relative to the growth cycle, is also critically important. Erosion control blankets or weed free straw or hay bales can be used to stabilize the soil in eroded areas until the new vegetation has been planted and become well anchored. In general, planting should be done in the spring and fall when there is no risk of frost (after risk of frost ends in spring or 30 days before risk of frost in fall) and the soil is naturally wet so the need for watering is minimal.

It is helpful to **include information on the state of trail vegetation when maintenance evaluations are completed**. Information on the types of plants that grow well along each section of trail can be very useful information when restorative work is being planned.

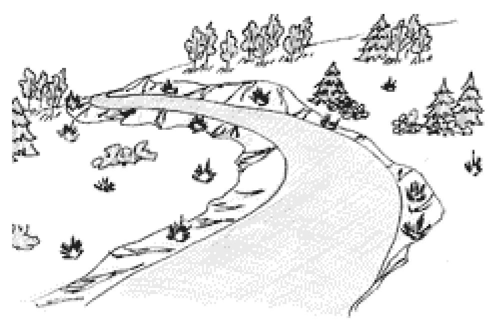
Depending upon the type and scope of restoration work required, it may be necessary to develop a professional restoration plan. An effective and comprehensive restoration plan will optimize the use of materials and resources and measure the progress and success of the work. **Contact your local Ontario Stewardship Council, Conservation Authority or Ministry of Natural Resources District Office for additional information about developing a detailed restoration plan**. If the trail is located in an area that is close to a college or university with an environmental program, you may be able to get students to do the restoration plan for your trail as part of their course work.

Site Preparation

Proper site preparation is the key to the success of your restoration effort. Regardless of the overall restoration plan or the extent of the work, the first step in trail environment restoration is to properly prepare the site. To prepare the restoration site:

1. **Identify areas of erosion**.
   Begin by examining the site for any signs of erosion. Severely compacted soil is often so hard that water runs off, carrying precious soil particles. If there is erosion on the site, the source of the problem needs to be identified and every effort should be made to **restore the water flow to the natural drainage channel**. Once the natural drainage pattern has been restored, site restoration can begin (see *Maintaining Proper Trail Drainage*).

2. **Install visual barriers to hide the restoration area**.
   Once you have controlled the erosion problems at the site, install visual barriers to hide the area and deter further human impacts. Rocks, logs and snags can be used to create the visual barriers. The placement of the visual barriers should be deliberate to allow for in filling of the area by other plants. Large rocks, which match the area landscape and cannot be easily moved, can be embedded in the restoration site to deter people from walking through the site. The rocks will also lessen the effects of sun, wind, snow and rain. Logs that are decaying are ideal for restoration projects. Firmly set in restoration sites they can provide a barrier to trampling and an inviting environment for new plants starting to grow. A larger log standing upright in the earth can be an effective method of creating a visual barrier in the airspace above the restoration site. The snag (i.e., large log or fake stump) must be very solidly embedded in the ground to ensure that it cannot be moved by the forces of wind, snow or human "ingenuity".



Soil Preparation

Once the restoration site has been properly prepared and “hidden” from view by visual barriers, the next step is to prepare the soil for the renewed vegetation. The two key issues for soil preparation are soil compaction and soil composition.

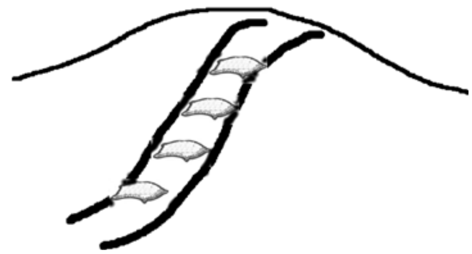
1. **Soil Compaction**.
   Soil that is compacted will not absorb water or air. Roots will be unable to penetrate into it and seeds will not be able to germinate. Compacted soil must be loosened so that the new vegetation can take root. Using a pick, mattock or shovel, dig into the compacted soil so that it becomes loose and open to a depth of approximately 15 cm (6 inches). **Do not turn the soil over**. The topsoil must be kept intact at the surface in order for plants to grow.

2. **Soil Composition**.
   To improve soil composition it may be necessary to add more soil. During trail construction, save any excess soil by stock piling it for re-use at restoration sites. Be careful to ensure that this transferred or re-used soil is of similar composition to the soil that naturally occurs in the restoration area. Stock piled soil should be used within six months. Adding fertile soil to a restoration site can quickly erase the scar of construction/rehabilitation and provide an environment for new growth to take root. If wildlife has left deposits of well-aged tailings or castings from burrowing activities near the restoration site, this material can also be spread over the site where additional soil is needed in order for vegetation to grow.

Check dams are a popular, though generally ineffective, instrument of trail maintenance. In theory, a check dam (a barrier across the trail such as a bale of hay or a large log or rock) is intended to slow the velocity of water flowing down the trail, thereby reducing erosion. In reality, check dams only halt erosion in a very small area (less than 1 metre or 3.3 feet) uphill of the check dam and they usually accelerate erosion immediately below and beside the dam. Although **check dams should never be used to control trail drainage**, they can be used to increase soil deposition at restoration sites where it is difficult or impossible to find or import the required material. Using a large burlap bag filled with moist topsoil, as a check dam can be an effective method of increasing soil deposition. By cutting an “X” into the top of the bag, a local shrub can also be planted in the soil[92].

[92] International Mountain Bicycling Association. (2004) Trail Solutions: IMBA’s Guide to Building Sweet Singletrack. Boulder, CO: Author.

If soil preparation requires the use of check dams:



- Install them at intervals of less than 1 metre (3.3 feet) so that the flow of water across the site is stalled momentarily at each check dam. This will allow the sediment carried in the water to be deposited on the uphill side of the check dam.
- Make sure they are tall enough to trap sediment and securely anchored so they cannot be shifted by water flow.
- Remove the check dams once there is sufficient deposition of soil on the restoration site. As the check dam is removed, great care must be taken to stabilize the soil deposits so that the erosion will not re-occur.

Planting, Transplanting and Seeding

The final step in restoring vegetation to a trail environment is the actual planting, transplanting or seeding of the new vegetation. Seeding and transplanting are the most common methods of re-vegetation. Consider the growing cycle of the plants in the trail environment in order to determine the best time for planting, transplanting and seeding to be completed.

Experts familiar with the local site conditions should be used to determine the native species to be planted and the best methods for planting, transplanting or seeding effectively. Whenever possible, **use plant material growing in the area for re-vegetation**. Plants already growing in the area will have adapted to the local environment and, therefore, have a much greater chance of successfully establishing themselves in the new location. Be aware that some land management agencies will have specific requirements for new vegetation, including that species are genetically consistent.

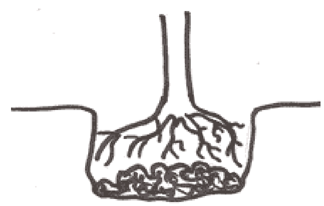
Planting

Planting techniques are used to introduce new vegetation that has been purchased from a commercial supplier. Typically there are **two types of plants: those that have bare roots and those that have their roots buried in soil** (e.g., root ball, container plants). The steps for planting differ slightly between the two types.

To plant new vegetation:

1. **Dig a hole** that is twice as wide and at least as deep as the root system or 15 cm (6 inches) deeper than the root ball. When using bare rootstock, also loosen the soil surrounding the hole so that roots can penetrate more easily.

2. **Add organic matter** (e.g., peat, compost) to the soil in the bottom of the hole to improve the soil condition. An organic fertilizer (e.g., bone meal) can also be added if desired. If the plant has bare rootstock, shape the organic matter into a mound in the bottom of the hole.



3. **Prepare the roots**. Gently remove the container (if needed) and loosen any exposed roots. Ensure that the root ball doesn't break. If the plant is bare rootstock, soak the root in water for several hours before planting.

4. **Place the plant into the hole** so that the top of the root ball is level with the surrounding grade. If using bare rootstock, spread the roots carefully on top of the mound of organic material.

5. **Add soil** to the hole in small layers and **compact each layer firmly to eliminate air pockets**. Continue to backfill and compact the soil until the hole is filled.

6. Shape the soil around the plant to direct water towards the roots. **Water the plant** generously. After watering, add additional soil as necessary.

7. If needed, **stake the plant and apply a layer of mulch** to the planted area. Staking the plant will help to ensure stability, deter theft and discourage animals from digging up the new vegetation. Applying mulch will help the soil to retain moisture and discourage the growth of ground cover around the plant.

8. **Remove any dead or diseased portions of the plant** and ensure that it is watered (by rain or by hand) regularly until the plant is well established.

Transplanting

In general, grasses, sedges, mat-forming plants and plants with runners have the highest level of success for transplantation. Woody plants of moderate size may also be transplanted as long as they are not brittle, do not have long horizontal roots and are not found on dry sites. Plants with tap roots are more difficult to transplant, and therefore are not typically used.

To transplant vegetation:

1. **Prepare the vegetation for transplanting.** Small plants should be cut back to 1/3 of their size. Larger trees should have the branches tied back with twine.

2. Mark a circle on the ground around the plant to indicate the size of the root ball. The larger the root ball, the better. At a minimum, **the root ball should be 2/3 the size of the plant's "canopy"** or area covered with vegetation.

3. Using a shovel, **cut straight down into the soil** around the entire circle. The cut should be at least 30 cm (12 inches) deep (45 cm (18 inches) is preferred).

4. **Dig out the area outside of the circle** so that a second undercut can be made to sever all roots under the root ball.

5. **Gently lift the plant and root ball** into a container or onto a tarp or burlap for transportation to the new site. Try to keep as much of the woodland soil around the plant's roots as possible.

6. **Keep the plant moist and shaded** until it is replanted. Refer to the previous section on planting for details of how to plant the vegetation at the new location.

Seeding

Seedlings can be collected within the trail area and then broadcast directly onto the prepared soil or restoration site. However, manual seeding is slow and requires more labour (collection, sewing). It is also limited to a relatively small number of plant species that can be used. **Seeding is also less visually obvious than transplanting**, so it may be longer before the area starts to look rehabilitated and trail crews can see the impact of their work.

Once the site and soil has been prepared:

1. **Rake the topsoil** to loosen it and prepare it for the seeds.

2. Mix a fertilizer into the topsoil (if desired).

3. **Distribute the seeds evenly** throughout the planting area.

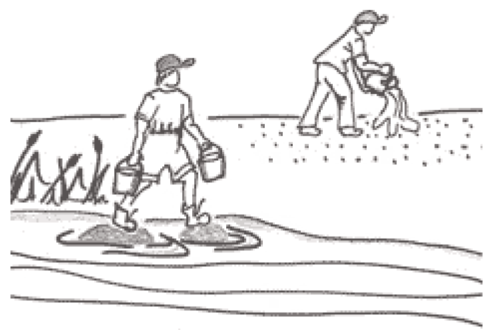
4. Rake the topsoil so that the seeds are covered with at least 1 cm of soil.

5. **Water the seeded area generously** immediately after seeding and keep the seeded area moist and well watered until the plants are well established.

Maintaining the Restoration Site

The success of the re-vegetation effort will require a long-term commitment to maintaining the restoration site[93]. **Watering and mulching will be necessary on an on-going basis until the new vegetation has been solidly established**. Trail volunteers should know that the job of restoring a former trail site does not end once the new vegetation is planted.

1. **Watering**.
   Plants that are well watered are better able to resist insects and disease. Water generously and often, depending upon weather. Unless the restoration site is very close to an urban water supply (e.g., tap, hose), watering will be done by carrying buckets of water from nearby streams or lakes. Avoid pouring large volumes of water from large buckets directly onto newly planted vegetation. Transfer the water to watering cans or pour water from the bucket through a colander (two-person operation) to reduce the impact of large volumes of water falling from a height. In hot and dry weather, most vegetation will need to be watered every other day.



2. **Mulching**.
   Mulch will inhibit erosion, retain moisture, protect plants and seeds, shelter insects and microorganisms, and provide organic matter for the development of soil. The use of **leafy material such as duff, decomposing logs or other material found nearby is the ideal mulch** for a trail restoration site. Bark, sawdust and wood chips can also be used in light concentrations (heavy concentrations will absorb soil nitrogen and negatively affect plant growth). **Spread mulch 5 cm to 10 cm (2 inches to 4 inches) deep around the base of the plants**. The mulch material should be loose, to allow for air circulation. This will help to prevent fungus growth and suffocation of the plant. A commercial alternative is the use of a mulch mat. The mulch mat contains a layer of sterile organic material that will disintegrate over time. Although more expensive, mulch mats are helpful in discouraging trail users from walking through restoration sites.

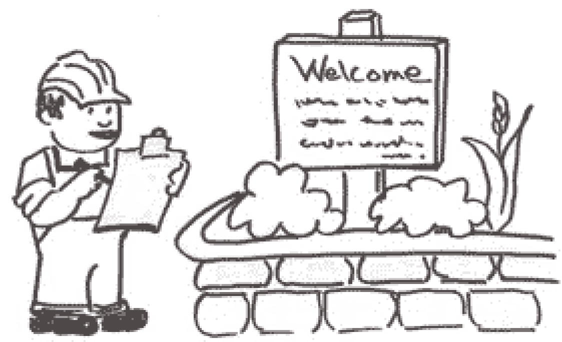
[93] Student Conservation Association. (1996). Lightly on the Land: The SCA Trail-Building and Maintenance Manual. 1996. Seattle, Washington: Author.

Maintaining Trail Structures and Facilities

As trail structures and facilities age, they will require more maintenance. Maintenance is particularly important for structures and facilities that impact the safety of trail users, such as signs, support structures (e.g., cribs, bridges), retaining walls and fences, drainage structures, and safety railings. Maintenance to trail structures and facilities should be done as quickly as possible for safety reasons and to maintain a high-quality public image. Any damage that compromises the functionality or aesthetics should also be repaired.

The maintenance of trail structures and facilities typically involves three components:

1. **Monitoring the state of repair**.
   Major support structures, such as bridges, retaining walls and railings, should be inspected by someone with the expertise and experience needed to evaluate the safety and function of the structure. A comprehensive maintenance inspection of support structures should be completed at least every 3 years[94]. Depending on the construction techniques, environment, materials used, or insurance/risk management requirements, more frequent inspections may be required. Additional information about conducting maintenance evaluations and trail inspections is provided in Inspection and Evaluation.



2. **Replacing structures and facilities with significant damage**.
   Structures and facilities that sustain more than minor surface damage should be replaced with new construction. Refer to Best Practices for Trail Construction for more detailed information.

3. **Making small surface repairs**.
   Small surface repairs are those that do not affect the structural components of the structure or facility. Typically, it involves sanding or treatment of rough surfaces or the removal of graffiti. Additional information on making small surface repairs and dealing with vandalism is provided below.

[94] US Department of Interior, National Park Service. Trail Structures. [On-line] Retrieved 31 July 2006 from http://www.nps.gov/noco/parkmgmt/upload/NCT_CH5.pdf

Making Small Surface Repairs

Small surface repairs are those that are limited to surface damage or hardware adjustments on the trail structure or facility. Most trail structures or facilities are made of wood, metal, or stone/concrete. Information on making repairs to stone and concrete surfaces can be found in Solid Materials. Hardware adjustments, such as tightening loose screws, should be made with the appropriate tools. Below are suggested methods for making surface repairs to wood or metal surfaces. The most appropriate methods for repairing trail structures and facilities will ultimately be determined by the type of structure/facility, the type of damage, the source of damage, and the conditions in the local trail environment.

To repair metal surfaces:

1. **Clean the surface** with a stiff brush and a metal cleaning agent (annual cleaning of metal surfaces is also a good way to prevent corrosive damage).

2. **Sand all rusted or corroded areas** with a hard grit sandpaper for metal surfaces.

3. Ensure that all dust and debris from sanding is removed from the surface.

4. **Apply a primer and then topcoat of paint** to sanded surfaces. Place a “wet paint” sign on the area until it is completely dry to keep people from using the facility. Remove the “wet paint” sign when the facility is ready for use.

To repair wood surfaces:

1. Remove splinters of wood and **sand all rough edges** and cracks.

2. Thoroughly clean the area of dirt and debris.

3. **Fill small cracks and holes** with wood filler, according to the manufacturer’s directions.

4. **Cover the repaired area with paint or a preservative** to prevent moisture from getting into the repaired section. Place a “wet paint” sign on the area until it is completely dry to keep people from using the facility. Remove the “wet paint” sign when the facility is ready for use.

Replace all areas where the damage affects the structural integrity of the tread and severely cracked or damaged sections with new material. Ensure that the sections adjacent to the new material are structurally sound.

Sign Maintenance

Although signs should be designed and built with longevity in mind, maintenance will be required on a regular basis. All signs should be inspected, at least every two years, to ensure that they are intact and undamaged. Each sign represents a link in the network of signs directing trail users to the trailhead, and up the trail. A damaged sign will break the link and, therefore, should be replaced as quickly as possible to avoid trail user confusion.

The most common maintenance tasks for signs include:

- **Cleaning**, especially for signs close to roads, because dirt and grime can be detrimental to the quality and longevity of the sign.

- **Trimming of encroaching foliage**, done as necessary depending on the local environmental conditions.

- **Replacement** of signs can be very frequent, depending on the type of trail and surrounding environment. A detailed sign inventory, which includes GPS data and a trail map for the sign location, exact dimensions for the sign and mounting hardware as well as the sign panel content, can make the replacement of damaged signs a simple task.

Litter and Vandalism

All litter, no matter how small, needs to be removed from the trail environment. It is often helpful to provide trash and recycling containers at trail access points to encourage trail users to properly dispose of their items. Litter left along the trail inevitably encourages more people to do the same.

Any **vandalism or graffiti should be removed or repaired as quickly as possible**. Damage and graffiti from vandalism makes the trail environment look like “no one cares”, ultimately damaging social sustainability.

Maintenance in Sensitive Environments

Wetland and Riparian areas

In ecologically sensitive areas, alterations to the land or vegetation must be done with extreme care. It is recommended that volunteer trail workers not undertake this work, except under the direct supervision of expert personnel who are knowledgeable about the unique demands of the local environment. Trail groups should contact local offices of the Ministry of Natural Resources or the Ministry of the Environment to obtain more specific information on the protection of wetland and riparian trail environments.

"At Risk" Species

"At risk" species include **all animal and plant species in Ontario that are considered to be of special interest, threatened by or vulnerable to extinction**. Details on the flora and fauna identified within these categories can be obtained from the Ministry of Natural Resources and Ontario Parks[95]. It must be recognized that often the presence of "at risk" species is the reason that a trail is created. However, the fact that people want to see "Tree X" or "Animal Y" does not, in and of itself, justify the construction or maintenance of a trail. **Great care is needed in order to ensure that the presence of the trail or trail users does not further endanger the flora and fauna**. Trail groups should contact local offices of the Ministry of Natural Resources or Ontario Parks to obtain expert assistance and advice on any trail work that may impact "at risk" species.

[95] Ministry of Natural Resources. Species at Risk: Act today so they have a tomorrow. [On-line] Retrieved 31 July 2006 from http://www.mnr.gov.on.ca/mnr/speciesatrisk

Appendix A: Glossary of terms

The terms listed and described in this glossary were identified through a review of this resource document. Definitions and/or descriptions of the meaning of these terms were developed from a combination of our understanding of how they are used in this document and accepted definitions of terms within the trails community[96].

Abutment
A foundation under both ends of a bridge to support the load of the bridge structure and the weight of loads travelling across it (i.e., people, recreation vehicles, horses, maintenance vehicles, etc.) and to make the bridge level.

Access point
Designated areas and passageways that allow the public to reach a trail from adjacent streets, trails or community facilities.

Accessible
A term used to describe a site, building, facility, or trail that can be approached, entered, and used by people with disabilities.

Accessible trail
A trail that complies with legal standards for access by people with disabilities. The standards that will be developed for trails through the Accessibility for Ontarians with Disabilities Act (2005) are one example of legal standards against which the accessibility of a trail can be judged.

Anchor sills
Supports laid on the ground under the stringers of a bridge or boardwalk. The sills are placed perpendicular to the stringers. The purpose of the sills is to provide a solid and stable surface of support for the stringers. The sills also prevent the stringers from contacting soil or moisture in the ground, which can promote decay of the wood.

Backcountry
An area where there are no maintained roads or permanent buildings – just primitive roads and trails.

Barrier free trail
A trail design that promotes the elimination of physical barriers that reduce access by people with disabilities. Trails free of obstacles, barriers or changes in level that would make access difficult for those using crutches, canes, or wheeled forms of mobility.

[96] Schmid, J. (n.d.) Trails, Greenway, and Outdoor Recreation Terms. Retrieved 1 February 2006 from: http://americantrails.org/glossary.html.

Bench cut
A relatively flat, stable surface (tread) on a hillside occurring naturally or by excavation. When excavated, the bench is often referred to as a full, half, or partial bench depending on what proportion of the tread is located on excavated terrain.

Berm
The ridge of material formed on the outer edge of the trail that projects higher than the centre of the trail tread.

Best practices
The specific methods used to design, construct or maintain trails that are sustainable (environmentally, socially and economically) and universally designed.

Binding or stabilization materials
Binding or stabilization materials include bonding agents, landscape fabrics and cellular containment systems. Binding agents are typically made from natural materials, such as tree sap or seed hulls. They are designed to create a more solid and unified surface when mixed with natural soil or crushed aggregate

Blaze or blazing
Marking the route of a trail using readily identified symbols such as paint marks, symbols posted on trees, marking posts, or marking cairns.

Boardwalk
A fixed planked structure that is close to the ground (i.e., less than 0.3 metres above surrounding terrain). It is built on sills or pilings (posts), in areas of wet soil or water. The planks provide a dry tread for users crossing through the area.

Boardwalk (puncheon design)
A boardwalk that is constructed on sills that sit on the natural terrain.

Boardwalk (post design)
A boardwalk that is constructed on posts or pilings that have been drilled or dug deep into the ground.

Bollards
Bollards are solid obstacles installed on a trail tread to control the movement of people and/or vehicles on the trail

Bridge
A structure, including supports, erected over a depression (stream, river, chasm, canyon, or road) and having a deck for carrying trail traffic. Because most bridges are elevated a significant distance above the surrounding terrain, handrails are typically provided on both sides of the tread.

Buffer
Any type of natural or constructed barrier (trees, shrubs, or wooden fences) used between the trail and adjacent lands to minimize impacts (physical or visual). Buffers also provide a transition between adjacent land uses.

Buffer height
The maximum height to which the buffer extends above the trail tread. The buffer height includes the clear height over the trail tread plus the additional height of the buffer above the heads of trail users. For trails intended for human-powered users the buffer height should be at least 0.5 metres (20 inches) more than the height of the tread corridor.

Buffer width
The maximum width from the outside of the buffer on one side of the trail tread to the outside of the buffer on the opposite side of the trail tread. The buffer width includes the width of the clear trail tread (1.0 metres (3.3 feet) for hiking-only trails) plus the additional width of the buffer on each side of the trail (at least 0.3 metres on each side).

Buffer Zone
The vertical area that is free of obstructions or potential hazards. The buffer zone is determined by the buffer width and buffer height.

Burrito
Type of Mexican food made from a tortilla wrapped around the filling. The term “burrito” is often used to describe the construction of drainage structures when landscape fabric is wrapped around drainage rock.

Carrying capacity
Carrying capacity is the amount of use that an area can withstand without undue environmental degradation.

Causeway
Elevated section of trail contained by rock, usually through permanent or seasonally wet areas.

Clay
Clay is smooth and sticky when wet. When molded by hand it forms a ribbon that is long and pliable.

Clear height
The vertical dimension, which must be cleared of all tree branches and other obstructions that would otherwise interfere or influence movement along the trail.

Clear span
The distance across a stream or wet area required to prevent damage to the stream or edge habitat. In terms of the stringers of a bridge, it is the measurement used to calculate the thickness of the beam being used to support the bridge.

Clear trail corridor
The clear trail corridor includes the trail tread, and also the space above the trail tread where trail users are expected to travel and an additional buffer zone that separates trail users from surrounding vegetation.

Climbing turn
A turn which is constructed on a grade of 20% or less when measured between the exterior boundaries of the turn, and which follows the grade as it changes the direction of the trail 120 to 180 degrees.

Compaction
The consolidation of earth and/or aggregate material by tamping with hand tools or machinery (e.g., preparing the trail tread).

Construction log
A detailed log (i.e., notes) containing the specifications for the construction of the trail tread, structures and facilities. The construction log is typically developed during the trail design process.

Contours or Contour lines
Lines on a topographic or orthophoto map that join points at the same elevation to illustrate altitudes, slopes, and other terrain properties.

Contour-design trail
Trail constructed such that it more closely follows the contours of the natural land rather than climbing the fall line (perpendicular to the contours).

Control point
A control point is a feature of the natural environment that "controls "or influences the movement of trail users.

Corduroy
A primitive type of boardwalk (puncheon design) made with native logs instead of wood planks. Corduroy is a technique that, in the past, was often used to construct a trail across wet terrain. Typically, it consisted of logs laid side-by-side across the tread, although some trail construction guides recommend that the logs be anchored together. The installation of corduroy has a negative impact on the trail environment. Most users (any many animals) will walk or ride around the corduroy, trampling and stripping adjacent vegetation, ultimately increasing the size of the wet and muddy area. The collection of trees (either living or dead) from the surrounding environment also substantially alters the life cycle of the natural environment. The difficulty of travelling on corduroy will also negatively impact the social sustainability of the trail, and therefore its use is not recommended. Corduroy can be considered for trails only used in the winter (e.g., cross country ski trails) and in very remote areas where there is no feasible alternative as long as the logs are securely anchored and covered with compacted soil or crushed rock. Covering the logs will make the logs rot faster but is necessary to create a firm tread that trail users will actually use (rather than avoid).

Crib
A type of abutment: a timber or log box filled with rock used as a foundation to support a bridge

Cross slope
The slope from one side of the trail across to the other side, measured at a right angle to the direction of travel, expressed in percentage, degree, or ratio.

Crushed aggregate tread
A tread that is constructed from mechanically compacted crushed rock that contains a range of particle sizes (typically 2 cm or less, including a proportion of crushed fines).

Culvert
A drainage structure made of wood, metal, plastic, or rock that is placed perpendicularly under the trail to channel water from one side of the trail to the other.

Decking
Decking is the term used for the planks that create the walking surface on an elevated tread structure.

Difficulty rating or difficulty level
A subjective rating of the degree of challenge a trail presents, theoretically based on an average user with average physical abilities and skills. Difficulty is a function of trail condition and route location factors such as alignment, steepness of grades, gain and loss of elevation, and amount and kind of natural barriers that must be crossed. Snow, ice, rain, and other weather conditions may increase the level of difficulty. Although widely used, trail difficulty ratings are not recommended because they are subjective interpretations that may or may not relate to the abilities or interests of each trail user.

Drainage
The natural flow of water in the trail environment.

Drainage dip
A reverse in the grade of the tread combined with an outslope that is used to direct water off the tread surface.

Drainage lens
A drainage lens is constructed below grade to allow for water movement underneath the trail tread. It is typically used instead of a culvert where the flow of water is smaller in volume or more dispersed across the terrain.

Edge protection
Edge protection is a barrier at the side of the trail, such as a curb or handrail, designed to prevent users from going off of the trail tread. The provision of, and design used for edge protection on a trail is based on the safety or impact of trail users.

Erosion
Natural processes (water, wind, ice, or other physical processes) by which soil particles are detached from the ground surface and moved downslope, principally by the actions of running water (gully, rill, or sheet erosion) or trail users. The combination of water falling on the trail, running down the trail, and freezing and thawing, and the wear and tear from traffic create significant erosion problems on trails.

Erosion control
Techniques intended to reduce and mitigate soil movement from water, wind, and trail user traffic.

Exotic species
A plant introduced from another country or geographic region outside its natural range.

Fall line
Direction water flows down a hill (path of least resistance). A line that runs perpendicular to the contours of the land. Constructing a trail on the fall line encourages water to run down the trail.

Firmness
The degree to which a surface resists deformation by indentation when, for instance, a person walks or wheels across it. A firm surface would not compress significantly under the forces exerted as a trail user walked or wheeled on it.

French drain
Stone filled ditches that can have a porous pipe laid along the base to collect the water and carry it away from the site. The top must be kept clear of the surfacing material; allowing water to run freely into the drain. Not recommended for use within the trail tread because of the uneven surface of the stones.

Gabion basket
Gabion baskets are a commonly used technique for constructing abutments with volunteer labour. A containment structure is built with wire mesh and then the structure is filled with rock to ensure its stability.

Gap
An opening in the tread surface of the trail.

Gate
Structure that can be swung, drawn, or lowered to block an entrance or passageway.

Geotextile
A semi-impervious, non-woven fabric cloth that provides a stable base for the application of soil or gravel.

Grade or Gradient
The degree of rise (ascent) or fall (descent) of a slope of a tread, calculated in percentage as vertical distance ÷ horizontal distance = percentage grade.

Grade reversal
A short rise in the trail, as it traverses a slope, that forces any water on the trail to drain off to the side. See also drainage dip.

Grate
A framework of latticed or parallel bars that prevents large objects from falling through a drainage inlet, while permitting water and some sediment to fall through the slots.

Inclusive recreation trail
Trails that are designed according to universal design and sustainable design principles, so that the trail can exist over the long term and which allows for greater participation by persons of diverse abilities and lifelong use for those who are ageing.

Inslope
Cross slope of the trail tread that forces water to flow to the uphill side of the tread.

Linear trail
A trail that follows a single line from point of origin to destination.

Loop trail
A trail that forms a single circle that begins and ends at one point of origin.

Load-Bearing Facilities
Constructed structures on the trail that support the weight of trail users. Examples are bridges, boardwalks, and ladders. Engineering expertise is required to determine whether the load-bearing facility is strong enough for the type and number of permitted trail users.

Loam
Loam is a type of soil that is smooth (flour-like), but slightly gritty. When molded by hand it forms a ball, but a ribbon usually breaks easily.

Maintenance
Work that is carried out to keep a trail in its originally constructed serviceable condition. Usually limited to minor repair or improvements that do not significantly change the trail location, width, surface, or structures.

Maze trail
A maze is a network of linear and/or loop trails that criss-cross each other between the point of origin and the destination.

Natural trail surface
A tread made from clearing and grading the native soil, with no additional surfacing materials.

Obstacle or Tread obstacle
Physical objects that impede or slow travel on a trail. Logs, rocks, roots and ruts are common obstacles.

Ontario Trails Strategy
The Ontario Trails Strategy is a long-term plan that establishes the strategic direction for the planning, management, promotion and use of quality, diverse, safe, accessible and environmentally sensitive urban, rural and wilderness trails for recreational enjoyment, active living and tourism development. The vision is a "world-class system of trails that captures the uniqueness and beauty of Ontario's vast open spaces, and natural and built cultural and heritage resources"[97].

Outslope
A method of tread grading that leaves the outside edge of a hillside trail lower than the inside so that water runs to the downhill side and off the tread. The outslope should be barely noticeable (i.e., 5% or less).

Organic soil
Organic soil (e.g., peat, muck) contains a high amount of decomposed material and water. Black to brown in colour, it is typically found in wetlands, and other low-lying areas.

Protected specie
This encompasses any plant or animal that is legally protected because it is endangered, threatened to become endangered, or one of special concern.

Protruding object
A protruding object is any item protruding into the clear trail corridor.

Puncheon
A low-lying wooden trail tread that is used to cross wet, boggy ground or small creeks. Puncheon is a type of boardwalk that is built on sills so that contact with the terrain is intermittent.

Recreation trail
A trail that is designed to provide a recreational experience.

Rehabilitation
All work to bring an existing trail up to its classification standard, including necessary relocation of minor portions of the trail.

Retaining wall
Structure used to provide stability and strength to the downhill edge of the trail tread and to support the trail tread at the edge of lead-bearing structures (e.g., bridges). Can also be used at a grade change, when it is not possible to stay within the angle of repose, to prevent the soil from slumping, sliding, or falling onto the tread from the up-hill side. It is usually made of log or stone.

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[97] Ontario Ministry of Health Promotion. (2005) Active 2010: Ontario Trails Strategy. Toronto: Author.

Right-of-way
A linear corridor of land held in free simple title, or an easement over another's land, for use as a public utility (highway, road, railroad, trail, utilities, etc.) for a public purpose. Usually includes a designated amount of land on either side that serves as a buffer for adjacent land uses.

Riparian
A habitat that is strongly influenced by water and that occurs adjacent to streams, shorelines, and wetlands.

Sand
Sand is a type of soil that is loose and gritty and will not form a ball when molded by hand.

Satellite loop trail
A trail that is based on one central loop trail which begins and ends at the point of origin. Additional loop trails begin at various points along the central loop trail or lead off from the central loop via short linear spurs.

Silt
Silt is a type of soil that appears smooth like flour, not gritty. When molded by hand it will form a ribbon that breaks under its own weight.

Sill or sleeper
The bed or support that the crib or stringers are placed on.

Slip
The downslope movement of a mass of soil under wet or saturated conditions. A micro-landslide that produces micro relief in soils.

Slip resistance
Slip resistance is a measure of the "stickiness" of the top of the surface. That is, how much friction there is between the trail user's shoe or wheel and the top layer of the surface.

Slope
The incline/decline of terrain. It is mostly measured in percentage, calculated as the vertical distance divided by the horizontal distance, multiplied by 100. It can also be expressed as a ratio or in degrees.

Spoked loop trail
A trail that has the point of origin in the centre of the trail network, with trails radiating out in different directions to join with the perimeter loop trail.

Soil Dam
A soil dam is a surface that will not rot (typically rock or concrete) that physically separates the stringers from contact with damp soil, or earthen-gravel fill.

Stabilization or soil stabilization
Measures that protect soil from the erosive forces of trail use, raindrop impact and flowing water. They include, but are not limited to, vegetative establishment, mulching, and the application of soil stabilizers to the trail tread.

Stacked loop trail
A trail that has one point of origin and has two or more loops stacked on top of each other.

Stile
A step or set of steps used to pass over a fence or wall. Historically used on trails instead of an opening or gate. The installation of stiles on a trail is not recommended because many trail users find them difficult to negotiate and many new designs for gates and fence openings are now available which are equally effective.

Stringer
Stringers are the main members or beams, parallel with the direction of trail travel, which connect adjacent anchors and support an elevated tread (e.g., boardwalk, bridge). Typically, they are made of wood, either log or lumber. For some projects, steel beams may be used as stringers.

Surface
Material on top of the trail bed or base course that provides the desired tread. Construction of the surface is designed to lessen trampling and compaction of adjacent terrain, provide a dry surface for users, and prevent potential erosion and abrasion. In addition to concrete and asphalt, trails can be surfaced with a wide variety of materials, such as soil, rock, wood, snow, or grass.

Sustainable design or sustainable development
Development that maintains or enhances economic opportunity and community well-being while protecting and restoring the natural environment upon which people and economies depend. Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainable designs are those that can be maintained over the long-term from environmental, economic and social perspectives.

Switchback
A trail alignment crossing back and forth (zigzagging) across a steep slope to make it easier for the user to traverse up or down the slope.

Trail
Route on land or water with protected status and public access for recreation or transportation purposes. Activities that are typically performed along a trail can include walking, jogging, motorcycling, hiking, bicycling, horseback riding, mountain biking, canoeing, kayaking, snowmobile or ATV driving, bird watching, nature observation or backpacking[98].

Trail layout
The overall design or pattern of trails on the land. Transportation trails are most often linear. Recreation trails may be linear, loop, stacked loop, satellite loop, spoked loop or a maze.

Tread or Trail tread or User tread
The surface of the trail or the portion of the trail corridor on which users travel.

Trailhead
The beginning or ending point of a trail or trail segment. A trailhead is more than an access point. A trailhead typically offers some combination of additional facilities, such as restrooms, water, trail information (e.g., signage), or parking.

Turnpike
Technique of raising the trail bed above wet, boggy areas by placing mineral soil over fabric between parallel side logs or rocks (along edge of tread). The tread must be "crowned" and ditches dug alongside the logs or rocks to provide drainage.

Universal design
A philosophy that attempts to meet the needs of the widest possible range of potential users without individualized or additional modifications. A design philosophy that promotes equitable opportunities for people of all abilities.

Waterbar
A log or a series of rocks partially buried across the trail designed to divert groundwater to the downhill side of the tread. Requires significant maintenance to maintain proper function and minimize environmental impact.

Wetland area
A lowland area, such as a marsh, bog, fen or swamp, which is saturated with water, creating a unique, naturally occurring habitat for plants and wildlife.

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[98] March, J. :Trent University Trails Study Unit (2005).Trail Definitions. [On-line] Retrieved 31 July 2006 from http://www.trentu.ca/academic/trailstudies/TrailDefinitions.html.

Appendix B: Principles of Universal Design Applied to Trails

Universal Design Principle	Application to Trails
Equitable use (same method of access for all users, avoid segregating or stigmatizing some users, make design appealing to all users).	All permitted trail users should be able to access the same sections of trail and have a similar trail experience.
Flexibility in use (provide choice in methods of use, provide adaptability to the user's pace, facilitate the user's abilities).	Offer areas for trail users to rest and options for shorter or longer on-trail adventures so users can choose the experience most suited to them.
Simple and intuitive in use (correct use is easy to understand, be consistent with user intuition, arrange information based on importance, accommodate a wide range of literacy/language skills).	Convey trail information in standard icons, graphics and simple text. Design trail systems so that users can easily follow the trail and how to return to the starting point can be easily understood.
Perceptible information (use different modes for essential information, contrast information and surroundings, maximize legibility).	Make signs legible and easy to see/read. Provide trail information in different formats (e.g., maps, web site, signs).
Tolerance for error (minimize hazards and errors, provide warnings of hazards and errors, provide fail safe features, discourage unconscious action when vigilance is required).	Minimize trail hazards. Anticipate trail user errors (e.g., loss of direction) and design trails and information systems accordingly. Make access to difficult trails a conscious choice (not an accidental turn).
Low physical effort (maintain neutral body position, use reasonable operating forces, minimize repetitive actions, minimize sustained effort).	Facilities (e.g., water taps, gate latches) should be easy to operate with a closed fist/gloved hand. Provide frequent grade breaks and rest areas in steep terrain.
Size and space for approach and use (clear line of sight to important items for seated user, reach all components from standing or seated position, accommodate variations in hand and grip size, provide space for use of assistive devices or personal assistance).	Ensure the access path onto the trail from parking/road/transit is accessible to all permitted users. Keep lines of sight clear for standing and seated trail users as well as those who cannot hear. Provide adequate tread width for those using assistive devices or requiring assistance.

Appendix C: Additional Resources

Listing a resource in this section does not imply that the organization or individual(s) who authored the resource endorse the content of this document or that the authors and partners in this document endorse the content of listed resource

Canadian Internet Sites

Abilities Centre[P][99]
http://www.abilitiescentre.com
The goal of the Abilities Centre is to become an internationally renowned facility for services to persons with special needs and the communities in which they live. The centre will provide a full range of barrier free recreation, rehabilitation and sports programmes. It will also provide the expertise for programmes and facilities across the country to maximize their inclusiveness and eliminate barriers to participation. The Board of Directors of the Abilities Centre has raised approximately two-thirds of the capital required to build the facility. Architectural drawings and user groups' needs analysis studies have been completed, and partnership agreements have been established with independent associations and groups committed to using the Abilities Centre upon completion of construction.

Active Living Alliance for Canadians with a Disability[P]
http://www.ala.ca
The Active Living Alliance for Canadians with a Disability (ALACD) promotes, supports and enables Canadians with disabilities to lead active, healthy lives. ALACD provides nationally co-ordinated leadership, support, encouragement, promotion and information that facilitates healthy, active living opportunities for Canadians of all abilities across all settings and environments. There are thousands of programs and events happening across the country that are accessible for people with disabilities. The important part is knowing where to find them. The ALACD has engaged in a process to gather information about ongoing programs and events in all provinces and territories. The collection may be searched on line for programs or events in different areas.

[99] Partners involved in the Trails for All Ontarians Collaborative, who developed this resource, are denoted by a superscript letter “P”.

Active Living Coalition for Older Adults
http://www.alcoa.ca
The Active Living Coalition for Older Adults (ALCOA), in partnership with its member organizations, encourages older Canadians to maintain and enhance their well-being and independence through a lifestyle that embraces physical activity and active living. ALCOA receives financial support from Health Canada, and the Public Health Agency of Canada. The web site gives information on the organization and its programmes. ALCOA regularly publishes "Research Updates" that take cutting edge and practical research results in the field of physical activity and older adults and present them in plain language for health practitioners, leaders and older adults.

Get Active Now – Active Living Resource Centre for Ontarians with a Disability[P]
http://www.getactivenow.ca or phone 800-311-9565
Get Active Now offers a one-stop source for facts on active living, practical resources, programs in your communities and "how to" materials that enable Ontarians with disabilities, families, caregivers, and professionals within the field to access information. We are committed to making a difference in the lives of Ontarians with a Disability, and their communities, by promoting healthy active living opportunities through Get Active Now. We also provide a variety of inclusion resource materials geared towards the disability community including Get Active Now tools; inclusion resources; activity fact sheets; books such as Leisure, Integration and Community (2nd Edition); and Get Active Now Adapted Equipment Bags for children, youth and seniors.

Bruce Trail Association
http://www.brucetrail.org
The Bruce Trail Association is a charitable organization committed to establishing a conservation corridor with a public footpath along the Niagara Escarpment, in order to protect its natural ecosystems and promote environmentally responsible public access to this UNESCO World Biosphere Reserve. It is a charitable, membership based, volunteer organization. A Board of Directors governs the BTA and volunteers from 9 Bruce Trail Clubs are responsible for maintaining, stewarding and promoting the Trail.

Central Ontario Loop Trail
http://www.looptrail.com
The Central Ontario Loop Trail (COLT) is a marketing partnership promoting a shared-use regional trail system passing through five counties in Central Ontario, Canada. This system is a unique 450 km loop of publicly owned trails. Two thirds of this loop are rail trails connected by scenic secondary roads. The web site includes information on different parts of the trail and instructions for obtaining trail maps.

City of Toronto
http://www.toronto.ca
The City of Toronto's web site includes a wealth of information about the city in general, but also about the walking trails which encompass parks, heritage sites, lost rivers and ravines, interesting Toronto neighbourhoods and streets, and waterfront locations. Discovery Walks is a programme of 9 self-guided walks that link city ravines, parks, gardens, beaches and neighbourhoods. There are also 2 maps available to be downloaded, Toronto Parks and Trails, and 2005 Cycling Map.

Fitness Friends[P]
http://www.energizemotivatetrain.com or phone 905 666-8179
The "Fitness Friends" programme aims to increase the activity levels of children with special needs. Fitness Friends is a project of EMT – Energize, Motivate, Train and was developed, in 1999, in co-operation with the Durham Catholic District School Board and Durham District School Board. Teams consisting of a child with a special need, a peer, and a staff member participate in as many active living opportunities as they can outside of the school curriculum and physical education classes. The program culminates in a year end sports activity day, where all the Fitness Friends are invited to a region-wide Fitness Friends Festival. There are also opportunities for participating schools to arrange special presentations on topics such as: Living with a Disability; Canes, Crutches and Chairs with Wheels; Communicating Without Words; Paralympic Performances (also includes Special Olympics and Silent Sport).

Go for Green - Trails Canada[P]
www.trailscanada.com, sentierscanada.com
Go for Green is a national non-profit, charitable organization encouraging Canadians to pursue healthy, outdoor physical activities while being good environmental citizens. Go for Green's Trails Canada / Sentiers Canada Program promotes community trail initiatives across Canada through a sustainable Web-based resource centre. Trails Canada / Sentiers Canada features an array of information for the trail builder and the trail user, including an inventory of more than 4,200 Canadian recreational path listings in every province and territory. Other online resources include an event calendar, highlighting trail activities across the country, Trail Monitor fact sheets, the Pathfinder newsletter, and Trail T@lk, a discussion forum for trail-related issues. The site can also be searched for trails that have been designated for wheelchair use.

Haliburton Highlands Trails and Tours Network[P]
http://www.trailsandtours.com
The Haliburton Highlands Trails and Tours Network is an organization dedicated to the development and promotion of trails and tours in Haliburton County. It strives to provide quality recreational trail and tour opportunities for visitors and residents, protect the health and beauty of the natural environment, enhance the local economy, promote healthy lifestyles and foster community pride and participation. The web site includes links to all season outdoor activities, including hiking, biking, horseback riding, ATV, 4 X 4 off road, canoeing, kayaking, dog sledding and cross-country skiing. There is also an on-line Trail Development Template, which has information on trail inspection, maintenance and record management, trail signing, and some trail building.

Hike Ontario[P]
http://www.hikeontario.com
Hike Ontario is a non-profit organization which represents the interests of walkers and hikers in the province of Ontario. Membership includes over 1,800 individual members and 25 hiking clubs with a combined membership of over 13,000 individuals. It is a member of the Ontario Trails Council, a body that co-ordinates trail organizations such as equestrian trails, snowmobile trails, bicycle trails, motocross trails, etc. Hike Ontario has developed standards and training programs for hike leaders that are used for course delivery by community colleges, universities, hiking clubs and outdoor training organizations. The web site includes lists of Ontario hiking trails and clubs, a Resource and Services section which includes fact sheets on various subjects, the Hike Ontario Trail Mail E-Zine, and information on the Hike Leader Certification program.

Huronia Trails and Greenways[P]
http://www.simcoecountytrails.net
Huronia Trails and Greenways (HTG) is a registered not-for-profit charitable corporation dedicated to promoting and enabling the development of a sustainable network of trails and greenways in Simcoe County, Ontario and is locally coordinating the development of the Trans Canada Trail in Simcoe County. In partnership with the Simcoe Muskoka District Health Unit, and with funding from the Communities in Action and Trillium Foundations, Huronia Trails and Greenways has several programs underway to promote physical activity on Simcoe County trails, as part of the Active 2010 initiatives. The web site includes trail maps, user guidelines, local news and events, and links to many trail and recreation organizations.

International Mountain Biking Association Canada
http://www.imba.com/canada/welcome.html
IMBA Canada's mission is to create, enhance, and preserve trail opportunities for mountain bikers throughout Canada. The first Canadian IMBA office was opened in the summer of 2004. The web site includes news, calendar of events, resources, and information on programs.

Kawartha Lakes Green Trails Alliance[P]
c/o 3-232 Kent Street West, Lindsay, ON K9V 6A4 or klgta@hotmail.com
The Kawartha Lakes Green Trails Alliance is comprised of a volunteer membership of individuals and community organizations and managed by a Board of Directors who are permanent / seasonal residents of the City of Kawartha Lakes. The Kawartha Lakes Green Trails Alliance advocates for the sustainability of a safe non-motorized system of trails for the benefit of all residents and visitors to the City of Kawartha Lakes. They support a system of trails that offer recreational opportunities for a variety of users that will be managed with consideration for environmental, social and economical concerns.

Ministry of Health Promotion – Ontario Trails Strategy
http://www.mhp.gov.on.ca/english/sportandrec/A2010_TrailStrategy.pdf
The full document of the Ontario Trails Strategy is found on this web site. This long-term plan establishes a strategic direction for government and stakeholders on the planning, management, promotion and use of trails, toward a healthier and more prosperous Ontario.

Oak Ridges Trail Association[P]
http://www.oakridgestrail.org
The Oak Ridges Trail Association (ORTA) is an incorporated volunteer body with charitable status that builds and manages the Oak Ridges Trail. The Oak Ridges Trail extends for approximately 250 km along the Oak Ridges Moraine. The trail starts with a link to the Caledon Trailway near Palgrave in the west and continues to the town of Gores Landing on Rice Lake in the east. The Board includes directors responsible for the Oak Ridges Trail, membership, newsletters and organized outings. The newsletter, Trail Talk, appears quarterly and contains listings of all organized hikes. The Oak Ridges Trail web site home page features an overview of the Oak Ridges Trail Association, the Oak Ridges Moraine and an 'ORTA News' board. Some of the 'hot-links' from this page provide details on how to join ORTA, volunteer opportunities and ORTA products including the Trail Guidebook. The 'Hikes' button provides a schedule of guided hikes plus ORTA-related events. A 'Photo Gallery', featuring photos of the trail, special events and wildlife, can be enjoyed by all visitors to the web site. Access to the on-line version of Trail Talk is available to ORTA members.

Ontario Parks Association
http://www.opassoc.on.ca
The Ontario Parks Association (OPA) is committed to civic beautification, and the advancement, protection and conservation of parks, open space and the natural environment. It is a non-profit, charitable organization and offers services emphasizing quality and accessible education and professional development, networking, information, communication and advocacy for persons participating in park services.

Ontario Trails Council[P]
http://www.ontariotrails.on.ca
The Ontario Trails Council (OTC) - Conseil des Sentiers de l'Ontario - is a volunteer based, charitable organization that promotes the creation, preservation, management and use of recreational trails in Ontario. Established in 1988 as a coalition of trail user and management groups (e.g., hikers, cyclists, snowmobilers, equestrians), it now includes a wide variety of members who share an interest in trails (e.g., Conservation Authorities, Provincial Parks, Health Units, Municipal Park and Recreation Departments, Forestry organizations). The OTC is actively involved in the Co-ordinating Committee for the Ontario Trails Strategy. The goals of the Ontario Trails Council are to encourage the creation of a provincial trail network ("Trillium Trails"), increase the number of trails, enhance trail safety and responsible use, and provide an informed, credible voice in support of trails and the resolution of trail-related issues. The OTC web site contains a wide variety of trail information, such as digital trail maps, event notices, information on the OTC trail insurance programme, links to other trail organizations and information on funding and government programmes for trails.

Parks and Recreation Ontario
http://216.13.76.142/PROntario/index.htm
As indicated on it's web site, Parks and Recreation Ontario (PRO) is an all-inclusive, not-for-profit corporation dedicated to enhancing the quality of life of the people of Ontario. It promotes the value of parks and recreation in living an active, healthy lifestyle throughout the province.

Paths to Equal Opportunity
http://www.equalopportunity.on.ca/eng_g/index.asp
This site is maintained by the **Accessibility Directorate of Ontario**, part of the Ontario Ministry of Community and Social Services. The Directorate works for a more accessible and inclusive Ontario for people with disabilities.

Pathways to Health Committee
http://www.trailsforhealth.ca
The Pathways to Health Committee works to encourage healthy lifestyles among residents of and visitors to the City of Kawartha Lakes, by encouraging four-season non-motorized use of the many recreational trails found in the region. In an effort to achieve the goal of increased physical activity levels in the City of Kawartha Lakes, the Committee has created a comprehensive inventory of public trails, developed a communication strategy encouraging the general public to access trail and healthy lifestyle information through the web site, and developed and implemented a media campaign for trail-related events promoting the benefits of being physically active. The web site features a searchable trails inventory, trail tips, a photo gallery of local trails, a trails discussion forum, a real-time weather forecast, and an events calendar. It also outlines the health benefits of being active.

Quetico Provincial Park
http://www.ontarioparks.com/english/quet.html
Quetico is a protected, pristine wilderness retreat of international acclaim west of Lake Superior on the Canada-U.S. border. It is primarily the destination of experienced canoeists seeking solitude and rare glimpses of wildlife. The park is accessible at four points by canoe and two by car (Dawson Trail Campground and Lac la Croix Ranger Station). There are 7 hiking trails that are all accessed via the Dawson Trail Campground.

Sustainable Toronto
http://www.utoronto.ca/envstudy/sustainabletoronto/whoweare.htm
Sustainable Toronto is a consortium of the Environmental Studies Program of Innis College, University of Toronto and the York Centre for Applied Sustainability, York University. It is also linked with the City of Toronto, the Canadian Institute for Environmental Law and Policy (CIELAP) and the Toronto Environmental Alliance (TEA) and several non-profit groups. It is a unique and innovative partnership to promote community sustainability.

Township of Uxbridge[P]
http://www.town.uxbridge.on.ca
The Township of Uxbridge has two trail initiatives. One is the Trans Canada Trail, which enters Uxbridge at Durham #23, travels through Uxbridge to Durham #21 and into the Regional Forest. The second initiative is the Uxbridge Town Trails Project, which will continue the building of a network of 9 trails for the entire Township of Uxbridge. The recently acquired 140-acre Countryside Preserve will be part of the "linking communities through trails" program. The Parks, Recreation and Culture Department works extensively with the various partners including the Region of Durham, TRCA, private landowners and business owners to create this extensive trail network in Uxbridge.

Trans Canada Trail Ontario[P]
http://www.tctrail.ca or Dan Andrews, General Manager, 705-743-0826
Trans Canada Trail Ontario (TCTO), is a not-for-profit organization, whose primary purpose is to collaborate with and financially support local trail groups in their quest to build a multi-use recreational trail across the province. As the provincial agent of the Trans Canada Trail Foundation, TCTO is committed to completing the Ontario link of the Trans Canada Trail by 2010. The Ontario section of the Trans Canada Trail will be 4000 kilometres in length, the longest of any province and territory. When complete the Trans Canada Trail will wind its way through every province and territory in Canada, linking hundreds of communities along its route of 18 000km. More information about the Trans Canada Trail can be found on the web site, including trail builder information, donor programs and a Trail Locator which gives the length of a specific trail segment, the local environment, nearest city, access points, seasons of use, and permitted uses on the trail.

Trent University Trail Studies Unit
http://www.trentu.ca/academic/trailstudies
The web site provides a comprehensive listing of the 3503 trail references available in the Trail Studies Unit Library. The centre is located in the Environmental Sciences Building, Trent University. Additional resources are available in the libraries of Trent University and Fleming College, Lindsay.

Variety Village[P]
http://varietyontario.ca/html/Village.htm
Variety Village is a sport, training and fitness centre dedicated to promoting inclusive opportunities for people of all ages / abilities. It is the flagship project of Variety – The Children's Charity. Variety Village is recognized as a leader in adapted sport, training and fitness. Programs / services promote community involvement, educational training and awareness, integrated participation, and recreational-competitive coaching. There are many ways to get active and get involved (volunteering, membership, outreach, educational programs, introduction to inclusion courses and much more).

Waterfront Regeneration Trust
http://www.waterfronttrail.org/index.html
The Waterfront Trail is a 740 km long multipurpose trail along the Canadian side of Lake Ontario. The web site includes information about the history of the trail, suggested itineraries, and events occurring along the trail.

Wye Marsh Wildlife Centre[P]
http://www.wyemarsh.com
The Wye Marsh Wildlife Centre is in a 3,000-acre wildlife area in an environmentally endowed location in southern Georgian Bay. Wye Marsh is the steward of this property consisting of both a Provincial and National Wildlife Area. Its mission is to spark a commitment to conserving wetlands, woodlands and wildlife by creating exciting learning opportunities in a natural setting. Anchored by its Visitor Centre, the Wye Marsh Wildlife Centre is open year-round and provides educational programs and excursions; maintains a 30km trail system and a multitude of canoe channels; conducts research in partnership with University of Guelph, Severn Sound Environmental Association, Environment Canada, Ducks Unlimited and the Ontario Ministry of Natural Resources, and acts as protector for its IBA (Important Bird Area). Wye Marsh is also a nationally significant wetland and an ANSI (Area of Natural Scientific Interest). Wye Marsh receives support from the private sector; however the majority of funding is self-generated through admissions, memberships, fundraising events and gift shop sales.

Foreign Internet Sites

Listing a resource in this section does not imply that the organization or individual who authored the resource endorses the content of this document or that the authors and partners in this document endorse the content of listed resource

American Trails
http://www.americantrails.org
American Trails is a national, not-for-profit organization working on behalf of all trail interests (e.g., hiking, bicycling, mountain biking, horseback riding, water trails, snowshoeing, cross-country skiing, trail motorcycling, ATVs, snowmobiling, four-wheeling). The extensive web site includes lists of trails and trail organizations in North America, news items and newsletters, and calendar of events for training, workshops and conferences. The Resources and Library section contains an extensive online bibliography of resources.

By All Reasonable Means: Inclusive Access to the Outdoors for Disabled People
http://www.countryside.gov.uk/Index.asp
http://www.countryside.gov.uk/LAR/ByAllReasonableMeans.asp
The Countryside Agency has established a framework for good practice in the United Kingdom for working with people with disabilities to improve and increase their access to the outdoors. The aim is to provide clear and detailed advice for countryside managers on how to improve the accessibility of the opportunities that they provide.

Countryside Access Design Guide (British Site)
http://www.snh.org.uk/publications/on-line/accessguide/index.asp
“This guide provides advice and guidance on design principles which will help practitioners to make informed decisions. Consideration of each site's circumstances and the opportunities to make it as accessible to as wide a range of visitors as possible will help users of the Guide to find the appropriate design solution. It provides Information Sheets on structures frequently used by land managers to assist and manage public access to the countryside, including: gaps & barriers; gates; stiles; steps & ramps; fences; boardwalks; seats and picnic tables.”(Countryside Access Design Guide)

Federal Highway Administration - US Department of Transportation
http://www.fhwa.dot.gov/environment/rectrails
The Recreational Trails Program (RTP) is a programme of the U.S. Department of Transportation's Federal Highway Administration (FHWA) that provides funds to State governments for the development and maintenance of nonmotorized and motorized recreational trails and trail-related facilities. The web site includes links to documents that provide best practices for trail accessibility, and trail design, construction, and maintenance, other publications and resources to trail references. A list of publications is available at http://www.fhwa.dot.gov/environment/fspubs/index.htm.

National Center on Accessibility
http://www.ncaonline.org
The National Center on Accessibility, a program of Indiana University and the National Park Service in the USA, promotes recreation access for people with disabilities. The web site gives information on research initiatives, provides technical assistance, and describes relevant publications and products. Of particular interest to the trails community is the ongoing National Trails Surface Study, which is evaluating trail surfacing products for creating accessible trail surfaces (details at http://www.ncaonline.org/products/surfaces/index.shtml).

National Center on Physical Activity and Disability (NCPAD)
http://www.ncpad.org
The National Center on Physical Activity and Disability is an information center concerned with all aspects of physical activity and disability. The web site contains comprehensive information about various disabilities, the importance of physical activity in everyday life, and activities and sports that can be adapted for individuals with specific disabilities. It is possible to search the database for a wide range of information and programme contacts.

National Trails Training Partnership
http://www.nttp.net
A wide variety of agencies and organizations in the USA have joined together to promote opportunities for training in trail planning, design, development, maintenance, and volunteer management. The web site gives information on the member agencies and a calendar and description of training opportunities.

Professional Trailbuilders Association
http://www.trailbuilders.org/index.html
The Professional Trailbuilders Association (PTBA) is a private sector group of trail specialists, professional trail contractors, designers, and consultants. The activities of PTBA support quality trail design, construction, and maintenance for all types of trails in all types of locations. The web site includes information on member contractors, PTBA and related conferences, links to online trail resources, publications on trail planning, design, construction and maintenance, and trail training resources.

Trail Explorer
http://www.trailexplorer.org
Trail Explorer provides objective Trail Access Information (TAI) describing the conditions on selected trails in the United States and Canada. It summarizes information about a trail - grade, cross-slope, surface, width, length, obstructions and features. TAI allows trail users to choose a trail that suit their abilities and interests based on accurate and reliable information. Trail Access Information is generated by using the Universal Trail Assessment Process (UTAP).

United States Access Board
http://www.access-board.gov
The United States Access Board is an independent Federal agency devoted to accessibility for people with disabilities. It is legally responsible for establishing the standards used to assess compliance of public facilities with the Americans with Disabilities Act. The publications available on the web site include a recommendation for trail accessibility standards: US Access Board - Outdoor Developed Areas Regulatory Negotiation Committee Report http://www.access-board.gov/outdoor/outdoor-rec-rpt.htm.

United States Department of Agriculture Forest Service
http://www.fs.fed.us
The U.S. Department of Agriculture Forest Service is the Federal agency that manages the public lands in US national forests and grasslands. The web site provides a variety of trail-related research and resources (e.g., Guidelines for Selecting Trail Bridge Sites and Structures, http://www.fs.fed.us/na/wit/WITPages/trailbridge_info.html).

United States Department of Agriculture Forest Service Trail Accessibility Guidelines
http://www.fs.fed.us/recreation/programs/accessibility/FSTAG.doc
In May 2006, the U.S. Department of Agriculture Forest Service finalized legal standards for the accessibility of trails (FSTAG) and developed outdoor recreation facilities (FSORAG). The legal standards that apply to all Forest Service properties are available on the web site. The standards are very similar to the proposed accessibility guidelines that were developed by the US Access Board (Outdoor Regulatory Negotiation Committee Final Report, 1999).

University of Minnesota, Forest Library
http://forestry.lib.umn.edu/bib/trls.phtml
This web site indexes publications relating to the planning, design, construction, and maintenance of all types of trails from 1984 to the present. It also includes trail use studies and may be searched by author, title, or keyword.

Wilderness Inquiry
http://www.wildernessinquiry.org
Wilderness Inquiry provides wilderness activities to people of all ages and abilities. The web site includes descriptions of trips available throughout the world and a description of the wide range of research that has been done by and about Wilderness Inquiry. One of the links is to Minnesota’s Accessibility Guidebook, http://wi.wildernessinquiry.org/mnparks/index.html, which includes accessibility information for 50 recreation areas based on the utilization of universal design principles.

Print and Electronic Documents

Listing a resource in this section does not imply that the organization or individual who authored the resource endorses the content of this document or that the authors and partners in this document endorse the content of listed resource

Beneficial Designs Inc. (2001) Designing Sidewalks and Trails for Access - Part II: Best Practices Design Guide. Washington, DC: US Department of Transportation, Federal Highway Administration. [On-line] Retrieved 31 July 2006 from http://www.fhwa.dot.gov/environment/sidewalk2/pdf.htm
This document “addresses the general benefits of sidewalks and trails, the history behind disability rights legislation, and the needs and abilities of sidewalk and trail users.” It “provides a comprehensive approach to creating accessible sidewalk networks and addresses a broad array of sidewalk topics including planning, design, and maintenance.”

Birchard Jr., W., Proudman, R., and the Appalachian Trail Conference. (2000) Appalachian Trail Design, Construction and Maintenance, 2nd Edition Harpers Ferry WV: Appalachian Trail Conference.
This is the second edition of the definitive handbook on trail work for the Appalachian Trail Conference. It includes standards and technical details of trail design, construction and maintenance.

Birkby, R., and The Student Conservation Association (2006). Lightly on the Land: The SCA Trail Building and Maintenance Manual, 2nd Edition: Seattle: The Mountaineers Books.
In addition to conservation crew leadership and risk management, Lightly on the Land presents the “nuts and bolts” of trail construction and maintenance. It covers topics such as building with rock or timber, bridge construction, and environmental restoration. Included is detailed information about tools, knots, and rigging. The emphasis is on how to build pathways and reshape existing routes so that they can be sustained with a minimum amount of maintenance.

British Columbia Ministry of Forests. (2001). BC Recreational Trail Management. [On-line] Retrieved 31 July 2006 from http://www.tsa.gov.bc.ca/publicrec/ manual/chap10/chap10.htm .
Developed by the Ministry of Forests, this trail management manual is very detailed and includes trail planning, design, construction, monitoring and maintenance information, as well as detailed drawings.

Bruce Trail Association. (2001) Guide for Trail Workers, 3rd Edition, Hamilton: Author. .
This guide provides people working on the Bruce Trail with information on expected construction and maintenance techniques (e.g., bridges, blazing, slope control). It also identifies safety and environmental issues.

California State Parks and Recreation. (no date). A Cursory Look at Trail Maintenance. [On-line] Retrieved 31 July 2006 from http://foothill.net/fta/work/maintnotes.html.
This document focuses on wilderness trails only and is intended to be used as a reference by trail maintenance crews. It provides information on the prevention of trail deterioration under the headings of Designing for Trail Maintenance and Key Elements of Trail Maintenance.

Canadian Standards Association. (2004). Canadian Standards Association (CSA) Accessibility Guidelines. Author
The CSA recently updated its accessibility standards (previously called barrier free standards) to better reflect the goal of full participation by people with disabilities. The new standards (CSA B651-04) can be purchased on the web site in a variety of formats. Additional resources that are available free of charge include:
a) Customer Service for People with Disabilities Suite of Training Products, and
b) CSA and Ontario Government Work Together to Improve Accessibility for Ontarians with Disabilities. [On-line] Retrieved 31 July 2006 from http://www.csa.ca/Default.asp?language=english.

Demrow C., and Salisbury D. (1998) The Complete Guide to Trail Building and Maintenance, 3rd Edition Boston: Appalachian Mountain Club.
This book was developed by the Appalachian Mountain Club for use by its trail workers and volunteers on the Appalachian Trail. However, it has also been widely used by builders of natural surface trails in many other locations.

Flink, C.A., Olka, K., and Searns, R.M. (2001) Trails for the Twenty-First Century: Planning, Design, and Management Manual for Multi-Use Trails, 2nd Edition. Washington: Island Press.
This book is a step-by-step guide to all aspects of planning, designing and managing multi-use trails. It was sponsored by the Rails-to-Trails Conservancy.

Go for Green. (2001). Canadian Trail Bibliography and Resource List. [On-line] Retrieved 31 July 2006 from:
http://www.trailpaq.ca/english/03_builders_e/03_builders_e.cfm.
The Canadian Trail Bibliography and Resource List is a comprehensive listing of Canadian only sources, intended to assist individuals and groups involved or interested in trail development in Canada. It includes reports, manuals, books, videos and web sites relating to rail/trail development in Canada. A brief description and source is given for most items. The bibliography is alphabetical by author and is indexed under areas such as: legislation, maps and location of Canadian rail/trails, the benefits of rail/ trail development, trail construction and design, feasibility and management of trails, and other miscellaneous topics.

Grand Concourse Authority. (2004) Grand Concourse Walkway Maintenance Manual. St. John's, Newfoundland: Author. Information about this resource found at [On-line] Retrieved 31 July 2006 from:
http://www.grandconcourse.ca/noflash2004/manual.htm.
The Walkway Maintenance Manual addresses maintenance tasks, maintenance schedules and the expected standard of maintenance for the walkway network constructed by the Grand Concourse Authority. This manual describes appropriate walkway maintenance procedures using a step-by-step approach. The labour, equipment, materials and safety equipment required to undertake each task is also identified.

International Mountain Bicycling Association. (2004) Trail Solutions: IMBA's Guide to Building Sweet Singletrack. Boulder, CO: Author. Trail Solutions is the primary trail building resource published by the International Mountain Bicycling Association. It contains eight sections that guide readers through the essential steps of trail planning, design, tool selection, construction and maintenance. There is also information on how to secure funding and volunteer support for trail work.

Metropolitan Toronto and Region Conservation Authority. (1993) Trail Planning and Design Guidelines - A Handbook for an Inter-Regional Trail System in the Greater Toronto Area. Toronto: Author.
This trail planning and design guide discusses the steps related to the development of a regional trail system. The chapters in this manual are: General Planning and Design, Trail Types, Construction, Maintenance and Signage.

Neese, J., Eriksson, M., and Vachowski, B. (2002). Floating Trail Bridges and Docks. [On-line] Washington: US Department of Agriculture Forest Service. [On-line] Retrieved 31 July 2006 from: http://www.fhwa.dot.gov/environment/Fspubs/02232812/index.htm
This report outlines the basic designs of floating structures. It includes information about floating boat docks, floating bridge designs, anchorage systems, and devices that allow the dock to adjust itself to varying water levels.

New Brunswick Trails Council Inc. (2001). The Sign Manual and Trail Building Specifications. [On-line] Retrieved 31 July 2006 from: http://www.sentiernbtrail.com.
The Sign Manual and Trail Building Specifications are available free of charge to member organizations in New Brunswick and at discounted rates for out of province member organizations.

New Hampshire Department of Resources and Economic Development. (2004). Best Management Practices For Erosion Control During Trail Maintenance and Construction. [On-line] Retrieved 31 July 2006 from: www.nhtrails.org/Trailspages/ BMPmanual2004.pdf
This publication attempts to create an understanding of the trail construction and maintenance impacts on wetlands and other natural resources. It also describes methods that can be used to minimize these impacts.

Newfoundland and Labrador Provincial Parks. (1993) Trail Planning and Design Manual. St. Johns: Government Newfoundland and Labrador. Department of Tourism and Culture.
This resource summarizes the trail planning and design guidelines recommended for the development of trails in the provincial parks of Newfoundland and Labrador.

Oak Ridges Trail Association (2003). Oak Ridges Trail Association (ORTA) Guidelines for Trail Maintenance. [On-line] Retrieved 31 July 2006 from: http://www.oakridgestrail.org/Documents/ ORTA%20Trail%20Standards.pdf
This document provides guidelines for trail workers about trail appearance, blazes, signage and stiles. It also has a sample trail condition report.

Oak Ridges Trail Association (2003). Oak Ridges Trail Association (ORTA) Safety Policy for Trail Workers. [On-line] Retrieved 31 July 2006 from: http://www.oakridgestrail.org/Documents/Safety%20Policy.pdf
The purpose of this document is to ensure that volunteers and employees working either in construction or maintenance on the Oak Ridges Trail do so in a safe manner.

Ontario Parks. (1996). Barrier Free Design Guidelines Design Manual. Toronto: Author.
This resource describes the design guidelines that are to be used for facilities in Ontario's provincial parks that are intended to be "barrier-free".

Parker, T.S. (1994) Trails Design and Management Handbook. Aspen, CO: Pitkin County Open Space and Trails Program.
This publication contains detailed information about widely applicable specifications for multiple use concrete, asphalt and crushed stone trails.

Parker, T.S. (2004) Natural Surface Trails by Design: Physical and Human Design Essentials of Sustainable, Enjoyable Trails. Boulder, CO: Natureshape. http://www.natureshape.com/pubs/nstbd.html
This is the first of three books in the Trails by Design series published by Natureshape LLC. This book advances the art and science of natural surface trail design by comprehensively describing the physical and human forces and relationships acting on natural surface trails. Two additional books are planned for the series: Shaping Natural Surface Trails by Design: Key Patterns for Forming Sustainable, Enjoyable Trails and Managing Trails by Design: Integrating Stewardship, Sustainability and the Trail Experience.

Parks Canada (Architecture and Engineering for Parks Canada, Public Works and Government Services Canada) and Canadian Paraplegia Association. (1994). Guide for Accessible Outdoor Recreation Spaces: Design Guidelines for Accessible Outdoor Recreation Facilities. Ottawa: Canada Paraplegic Association.
This resource provides diagrams and design guidelines for developing accessible outdoor recreation facilities. It may be obtained from: Canadian Paraplegic Association, National Office, 1101 Prince of Wales Drive, Suite 320, Ottawa, Ontario K2C 3W7, Telephone: (613) 723-1033, Fax: (613) 723-1060.

Parks Canada. (1985) Parks Canada Trail Manual. Ottawa: Minister of Supply and Services.
This manual has chapters covering: General Planning and Design Guidelines, Planning and Design Process, Construction and Maintenance Guidelines and Guidelines for Particular Trail Types.

Rathke, D.M. and Baughman, M.J. (1997) University of Minnesota - Recreation Trail Design and Construction. [On-line] Retrieved 31 July 2006 from: http://www.extension.umn.edu/distribution/naturalresources/DD6371.html
This publication describes step-by-step construction methods, ways to handle trail obstacles, and recommended standards for the most common types of trails. It is designed for private woodland owners, organizations, and businesses (including nature centres, youth groups, schools, conservation clubs, and resorts) that are interested in designing and constructing trails.

Smiley, G. (1999). Canoeing for Disabled People. United Kingdom: British Canoe Union.
This document summarizes adaptations and modifications that enable people with disabilities to participate in “canoeing” activities. Note that because of the British origin of the document, the term “canoeing” includes primarily kayaks as well as canoes.

Steinholtz, R.T. (2004). Wetland Trail Design and Construction. Washington, DC: Recreational Trails Program, Federal Highway Administration, U.S. Department of Transportation. [On-line] Retrieved 31 July 2006 from http://www.fhwa.dot.gov/environment/fspubs/01232833/index.htm.
This manual describes the common techniques for building a wetland trail. It is intended for those inexperienced with wetland environments and included information for a wide range of situations.

United States Access Board. (1999). Final Report of the Outdoor Recreation Regulatory Negotiation Committee for Developed Outdoor Recreation Areas. Washington, DC: U.S. Architectural and Transportation Barriers Compliance Board. [On-line] Retrieved 31 July 2006 from http://www.access-board.gov/outdoor/outdoor-rec-rpt.htm.

US Department of Agriculture Forest Service (2005). Stabilized Engineered Wood Fiber for Accessible Trails. Washington, DC: Author. [On-line] Retrieved 31 July 2006 from: http://www.access-board.gov/research&training/play-surfaces/report-trails.htm
This project summarizes the results of a research project that examined the use of stabilized engineered wood fibre products to create surfaces for accessible trails. The report summarizes the installation and serviceability results for the project.

US Department of Agriculture Forest Service. (2004). Trail Construction and Maintenance Notebook: Special Structures: Steps. Washington, DC: US Department of Transportation. [On-line] Retrieved 31 July 2006 from: http://www.fhwa.dot.gov/environment/fspubs/00232839/
This resource provides detailed information for the construction of steps as part of the trail tread. The Missoula Technology and Development Center (MTDC) of the USDA Forest Service produced this manual of basic trail construction and maintenance information. They have attempted to keep it simple, and short enough to be used in the field.

US Department of Agriculture Forest Service. (annual). National Survey of Recreation and the Environment - People With Disabilities. [On-line] Retrieved 31 July 2006 from: http://www.ncaonline.org/rec-leisure/nsre.shtml.
The National Survey on Recreation and the Environment (NSRE) is the most up-to-date resource about the outdoor recreation interests and activities of the US population. It is conducted regularly by the US Forest Service and each survey contains information from over 15,000 Americans over the age of 15. In 1994/95, all respondents were asked if they had a disability and over 1,200 people answering the survey identified that they had a disability. This report presents summary information on the characteristics, outdoor activity participation, and attitudes of people with disabilities in the NSRE survey.

US Department of Agriculture Forest Service. (2006) Trails Accessibility Guidelines (FSTAG). Retrieved 31 July 2006 from http://www.fs.fed.us/recreation/programs/accessibility/FSTAG.doc
The Forest Service Trail Accessibility Guidelines (FSTAG) are intended to maximize the accessibility of trails in the National Forest System, while recognizing and protecting the unique characteristics of their natural setting.

US Department of the Interior. (2004). Logical Lasting Launches: Design Guidance for Canoe and Kayak Launches. Washington, DC: National Park Service Rivers, Trails and Conservation Assistance Program.
This resource describes the design and construction of canoe and kayak launches. The resource also includes a short section on addressing accessibility issues for people with disabilities.

USDA Forest Service, Engineering Staff. (1996) Standard Specifications for Construction and Maintenance of Trails. Washington, DC: Government Printing Office. EM-7720-103 and EM-7720-104. [On-line] Retrieved 31 July 2006 from: http://www.fs.fed.us/r1/helena/contracting/96_Trail_Specs_English.pdf
This is a technical document developed to provide guidance to USFS employees, its contractors and co-operating federal and state government agencies on the standards and specifications that apply to the construction and maintenance of recreation trails.

Victor Ford Associates Inc. (1997). Design, Signage and Maintenance Guidelines: Waterfront Trail. [On-line] Retrieved 31 July 2006 from: http://www.waterfronttrail.org/library-publications.html
This resource was developed to assist in constructing and signing new Waterfront Trail sections, and managing existing sections. In addition to guidelines for design, signage and maintenance, the document includes information on risk management and liability issues and appendices which include subjects such as definition of terms and codes of ethics. The book is available in PDF format on the web site.

Virginia Greenways and Trails. (2000). Virginia Greenways and Trails Toolbox. [On-line] Retrieved 31 July 2006 from: http://www.dcr.virginia.gov/prr/docs/toolbox.pdf
This guide provides comprehensive information on the organization, planning and development of Virginia's local greenways and trails.

Warren, N. (no date). Developing Recreational Trails in Nova Scotia: Planning, Design, Construction, Maintenance and Management. Halifax: Nova Scotia Sport and Recreation Commission, the Department of Economic Development and Tourism, and the Department of Natural Resources. [On-line] Retrieved 31 July 2006 from: http://www.novascotiatrails.com/page.cfm?pid=1052&tid=6&hid=99. This resource was produced for community-based trail building groups. The cost of a printed version is $75 plus HST for Nova Scotia groups, and $125 plus HST for out-of-province groups. However, an up-to-date version of the manual is available, free of charge, in a PDF format on the website.

Wilderness Inquiry, Inc. (1999). Access Board Cost Analysis of Outdoor Developed Areas. Washington, DC: U.S. Architectural and Transportation Barriers Compliance Board. [On-line] Retrieved 31 July 2006 from http://wi.wildernessinquiry.org/research.html (scroll down to "Research Performed by Wilderness Inquiry").
The purpose of this report was to identify the scope of trails, picnic areas, camping areas, and beaches that are anticipated to be built or significantly altered per year in the U.S., and to determine the economic impact of the proposed accessibility standards on agencies that construct these outdoor developed areas. The U.S. Bureau of Public Debt contracted with Wilderness Inquiry, Inc., to conduct the study requested. A 501(c)(3) organization, Wilderness Inquiry provides activities that integrate people with and without disabilities into the outdoor environment, including many that take place in the outdoor developed areas being discussed for inclusion in the American's with Disabilities Act Accessibility Guidelines (ADAAG). The cost analysis report is based on proposed scoping and technical provisions developed by the Regulatory Negotiation Committee. The most recent material developed by the Committee is available for review through the Access Board.

Sources for Specialized Equipment for Trail Access

The Fitness Friends Equipment Loan Program
www.energizemotivatetrain.com or Joe Millage, joe@energizemotivatetrain.com,
Phone: 905 666-8179, Fax : 905 666-8794
Storage is currently located in Whitby, Ontario. Available equipment for loan includes: 6 ice sledges, 2 arm bikes, 1 DUET (it is a bike and wheelchair in tandem that puts the w/c occupant in the lead you can it see at http://www.frankmobility.com/duet.htm), and 2 sport wheelchairs. Future plans (Summer 2006) include a storage space for donated equipment and refurbishing of that equipment. We also accept donations of equipment for re-cycling. This equipment will be gladly lent to individuals, schools, and community groups.

Wye Marsh Wildlife Centre
http://www.wyemarsh.com/about_access.html
A 6-seater golf cart enables visitors with disabilities to experience the marsh with fewer restrictions. The golf cart is electric, very quiet, and fits down the Return Trail and out on the main walking berms. Additional adaptive equipment includes: 2 sit-skis, another all-terrain wheelchair, Landeeze and Rolleeze bubble tire wheelchairs, an all-terrain walker, and 2 Kicksleds.

The Tetra Society - Mississauga Branch
http:// www.tetrasociety.org
The purpose of Tetra is to recruit skilled volunteer engineers and technicians to create assistive devices for people with disabilities. This unique program was developed in response to difficulties that people with disabilities experience in their search for greater independence and integration within their communities. The individualized solutions provided are often simple but can significantly change someone's life.

Bloorview MacMillan Centre - Adapted Recreation Equipment Loan Service
http://bloorview.tdc.on.ca/loan.cfm or Arnold Lopez, 416- 425-6220, ext. 3541 or e-mail: alopez@bloorviewmacmillan.on.ca
The Recreation Equipment Loan service is available to Bloorview MacMillan Centre families free of charge. This service invites families to borrow adapted recreation equipment on a trial basis to help determine whether or not they want to purchase an item for their child. Families pick up and return equipment at the MacMillan site (or pay to have item shipped each way) and may keep equipment for a maximum of 21 days. The equipment available includes adapted bikes, hand cycles, sleds, cross country kick-sleds and baby joggers (the web site has pictures of equipment available).

TrailRider
http://www.disabilityfoundation.org/bcmos/equipt.htm
The TrailRider was designed specifically to allow people with significant disabilities to gain access to the wilderness. Built using lightweight aluminium, the vehicle resembles a wheelbarrow with two handles at the front and two at the back. A large pneumatic tire allows the TrailRider to roll easily over rocky, rough terrain, tree roots and through streams. The vehicle is also equipped with a hand-operated, lightweight disc brake system located on the rear handles of the TrailRider. Mobility depends on having two or more people without disabilities push/pull the TrailRider.

Ontario Provincial Parks
The Friends of Killbear have an all-terrain wheelchair (the Landeez) for use by visitors to Killbear Provincial Park. The all-terrain wheelchair can be used on the Park's beaches and one of the recreational trails. Similar wheelchairs are also available at Sandbanks, Awenda and Rondeau and other provincial parks. Check directly with each provincial park as equipment availability is expanding but varies from park to park.

Appendix D: Organizations that Provided Feedback During the Project

In response to requests for input to the project, we received feedback from a very wide variety of organizations. **In addition to the project partner organizations** (as listed in the section Who was involved in developing these guidelines and best practices?), the following organizations contributed their time and expertise to the improvement of these guidelines and best practices.

Listing of organizations or individuals in this section does not indicate their endorsement of the contents of this document

Municipalities

City of Kingston, Cultural Services Division, Department of Community Services

City of Orillia, Parks and Recreation Department

City of Toronto, Parks, Forestry & Recreation Division

City of Waterloo, Services Centre

Corporation of the City of Quinte West, Community and Leisure Services Department

Huntsville Parks and Trails Advisory Committee

Municipality of Machin, Pine Tree Pathways

Open Space Development and Park Planning Section, City of Hamilton

Saugeen Shores

The City of Niagara Falls, Park, Recreation and Culture

The Corporation of the City of Brantford, Park and Recreation

Town of Essex, Parks and Recreation

Conservation Authorities

Central Lake Ontario Conservation

Conservation Halton, Watershed Lands and Resources Services

Credit Valley Conservation, Conservation Land Management

Lower Thames Valley Conservation Authority

Mattagami Region Conservation Authority

Niagara Peninsula Conservation Authority

Ontario Government Land Management Groups

Charlestown Lake Provincial Park

Killarney Provincial Park

Quetico Provincial Park

Turkey Point Provincial Park

Ministry of Natural Resources

Ministry of Health Promotion

Professional and Volunteer Groups Providing Trail Opportunities

Ganaraska Hiking Trail Association

Haliburton Highlands Stewardship Council

Thames Valley Trail Association

NPA –Trails 2000, Kirkland Lake

Kinark Outdoor Centre

Disability and Accessibility Organizations

Huntsville Accessibility Advisory Committee

SPH Planning & Consulting Ltd.

Appendix E: Trail Safety

The concept of trail safety encompasses a diverse range of factors. Some of the most widely recognized factors are:

- Legal considerations.
- Safe trail work practices and safe methods of trail operation.
- User etiquette.

These factors are briefly described in the following sections.

Legal Considerations

In Ontario, the majority of trails are built and maintained by volunteers. The trail organizations that manage our trails have a "duty of care" to create a trail opportunity that optimizes the probability of a safe trail experience for everyone who is permitted to use the trail. Trail organizations also need an understanding of the legalities that affect their trails in the event of an accident.

Unfortunately, in our increasingly "litigious" world, it is also important for trail organizations to consider their options for insurance coverage and the potential benefits of using disclaimers.[1,2, 100] Some trail networks, such as the Trans Canada Trail[101], require local trail organizations to have adequate third party liability insurance for their trail. Smaller trail organizations may wish to consider purchasing insurance through larger trail organizations such as Ontario Federation of Snowmobile Clubs or the Ontario Trails Council. Further information on current trail insurance issues may be obtained on the Ontario Trails Council web site[102, 103]

When considering the use of these best practices, it is important to note that the use of a sustainable or universal design philosophy should have no impact on the insurance requirements or liability issues for a trail. Insurance companies cannot discriminate against people with disabilities by charging them, or the organizations that provide services to them, for additional insurance. Organizations that have adopted a universal design approach to trails have clearly established that such an approach actually reduces liability concerns because the trail organization is making a "good faith" effort to

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[100] Hike Ontario.(2002). Risk Management Manual. [On-line] Retrieved 31 July 2006 from: http://www.hikeontario.com/bulletin/factsheets/fact17_risk_mngt%20.pdf

[101] Trans Canada Trail. (no date) Liability Insurance. [On-line] Retrieved 31 July 2006 from: http://www.tctrail.ca/index.php?section_id=51&lang=en&PHPSESSID=886e863c900cef73c3004f47b3a0bb5a

[102] Ontario Trails Council. (no date) Ontario Trails Council Insurance Program. [On-line] Retrieved 31 July 2006 from: http://www.ontariotrails.on.ca/otc_orec2.htm.

[103] Ontario Trails Council.(2006). Insurance Review: Understanding and Dealing with the challenges of insuring trails in Ontario. [On-line] Retrieved 31 July 2006 from: http://www.trailscanada.com/english/03_builders_e/03_builders_e.cfm

consider the safety of all trail users. Trail user safety can be further increased by ensuring that trail information provides all users with objective information about the on-trail conditions[104]. The **use of objective information, rather than subjective difficulty ratings, enables each potential trail user to be responsible for their own, informed decision** regarding the suitability and safety of her/his own use of the trail.

In a similar fashion, trail safety practices are seldom influenced by accessibility or environmental protection legislation. For example, if safety standards require a bridge railing that is 1.1 m high, that standard must be met regardless of the accessibility or environmental protection requirements. In unique situations where the safety, accessibility and environmental standards are conflicting, an alternate trail alignment will be required. Similarly, if building a trail conflicts with environmental protection legislation that applies to the trail environment, the trail should not be built (regardless of whether it can be universally designed).

In Ontario, the legal requirement to provide trail opportunities that do not discriminate against specific segments of the population (e.g., based on gender, religion, culture, age, disability) was originally mandated by the provincial human rights code. With passage of the Canadian Charter of Rights and Freedoms, that code was updated to reflect the new national standards. The Ontarians with Disabilities Act (2001) and the Accessibility for Ontarians with Disabilities Act (2005) do not alter the "prevention of discrimination" obligations of trail providers contained in the Canadian Charter of Rights and Freedoms. The Ontarians with Disabilities Act (2001) mandates municipal and provincial government agencies to prepare annual accessibility plans for altering existing facilities that are not accessible. The Accessibility for Ontarians with Disabilities Act (2005) extends the requirement for accessibility planning to the private sector and will, over a 20-year time frame, develop minimum accessibility standards that will apply to all sectors. Eventually, the AODA (2005) standards will include legally required, specific minimum standards for the construction of recreation and transportation trails. Although our knowledge may change in the future, the guidelines included in this resource are based on our current understanding of the optimal minimum standards for trail accessibility.

Safe Practices for Trail Work and Trail Operation

Trail safety applies not only to trail users, but also to those who work on and operate the trail. One of the most important practices to enhance the safety of trail work and operation is to conduct regular inspections of the on-trail conditions. Trail inspections should be done at least annually, and more often if required for insurance or risk management purposes. There should also be a clear system for trail users to report any safety issues that might arise along the trail. A clear understanding of the conditions on the trail will not only identify potential risk areas for trail users, but it will also inform trail workers about the conditions that will be encountered and can enable proper planning

[104] Beneficial Designs, Inc. (2001). Designing Sidewalks and Trails for Access Part II of II: Best Practices Design Guide. Washington, DC: US Department of Transportation, Federal Highway Administration, Publication #FHWA-EP-01-027.

for completing the required trail work in a safe and effective manner. A trail inspection plan and a plan for evacuating injured or stranded trail users should be a routine part of the trail risk management plan.

The safety of trail workers should always be a high priority. Individuals who volunteer their time to improve the trail or trail conditions should have the skills, equipment and resources needed to do the work safely and effectively. Trail managers must ensure that they have accurate, up-to-date and detailed information about the trail work, the skills and experience of the volunteers and the on-trail conditions during the planned work period before they put together a trail work plan or work crew. As part of the work planning process it is important to visit the work site to become familiar with its features. For example, the presence of plants such as poison ivy or other types of noxious flora or fauna can seldom be identified from general area maps. Areas at the work site or on the route to the work site that may pose a hazard to trail workers should be clearly marked and the information provided to all trail crewmembers before the workers go out on the trail.

Important considerations in maintaining a safe environment while workers are out on the trail[105] include:

- Spacing, Awareness and Communication
  Ensure that there is appropriate space between workers so that they can effectively communicate as well as do their tasks (e.g., swing tools) safely. A 3.4 m separation between workers should be sufficient for most volunteer trail workers. When the construction tasks require the workers to be closer together (e.g., building a retaining wall), awareness and communication become the key to safe trail building. All trail workers should be instructed to clearly communicate their intentions with other workers, and to receive acknowledgement of those intentions before proceeding, if their work will require them to enter into the separation space of another worker.

- Body Position
  A correct body position is a key component of reducing the risk of injury to volunteers working on a trail. Body position includes where the body is positioned as well as the movements that it is required to make. In terms of position, loose rocks or other material underfoot can be hazardous especially if trail work is being done in steep terrain. Similarly, tree branches or objects to the side of the trail or overhead pose a similar risk. How the body moves is equally important. Trail workers should be taught proper techniques for lifting or moving rocks, logs and other trail materials safely. Ensure that workers check their body position before and during each trail task to ensure that a proper body position is maintained. When crews are working on a lifting or carrying task, ensure that clear signals are established for each phase of the work.

[105] Student Conservation Association. (1996). Lightly on the Land: The SCA trail-building and maintenance manual. Seattle Washington.USA.

- Distractions for Trail Workers

  The safety of trail workers can be compromised more easily whenever trail workers are distracted from the task at hand. The distraction does not need to be significant, and in some cases may not even be seen by others on the trail. Trail crews should be educated about the importance of focusing on the task at hand, and the importance of stopping work when distractions occur should be emphasized before and throughout the construction project. Common distractions for trail workers include the time of day, the need for a change of activity, environmental influences (e.g., weather, insects), boredom with a repeated task and hunger or thirst. More accidents happen just after lunch than any other time of day. Workers also need to be aware that when they have taken a break, their muscles may be somewhat stiff and they will need to refocus their mind on the task at hand. Trail workers should also be strongly encouraged to drink liquids (i.e., water) and eat nutritious meals both before and during the workday. Late afternoon is also a more risky time because workers will begin to tire, their attention may not be as sharp and often they will “push themselves” to finish a project even as day light fades. Taking regular breaks, ensuring adequate nutrition (fluids as well as food) and “calling it a day” before distractions become difficult to manage will help to improve safety by keeping trail workers more focused.

- Weather

  Watch local weather forecasts so that you can plan to minimize the effects of bad weather on trail workers. Once out on the trail, it is equally important to be aware of changes in the weather conditions because forecasts can often change over the course of a day and trail work is often done in locations where shelter from the elements is limited. Trail workers should also be educated about the symptoms of thermal injury (e.g., hypo or hyperthermia) and what procedures to follow should a thermal injury occur to either themselves or other workers. If rain is forecast, trail work should be re-scheduled if at all possible. Trail work done in the rain becomes more hazardous because the site may be slippery, bulky rain gear can limit worker movements, water on glasses or safety goggles can restrict visibility, and workers may find it harder to hold onto tools. Trail work should never be scheduled if there is the possibility of an electrical storm. If lightening develops while the crew is out on the trail, evacuate the area in advance of the storm. Move to lower elevations or seek shelter in the vehicles used to transport the workers (the rubber tires will provide additional protection to those inside the vehicle in case the vehicle is struck by lightening).

User Etiquette and Responsibility

User behaviour is probably the most significant factor in trail safety. Rarely do accidents occur when trail users are being 100% responsible in their actions relative to the on-trail conditions and their own skills and experience. Trail providers must operate from the knowledge that trail users cannot be relied upon to act appropriately and responsibly, and must design, construct and maintain their trail based on that knowledge.

Practically every trail and trail user organization has a “code of conduct” for members or trail users. Although the type of trail user can vary widely, the core components within these codes of conduct vary little between organizations. During the first year of the Trails for Life grants programme, the Trails Study Unit at Trent University received funding to develop a common “Trail Users Code of Ethics” that would form the minimum guideline for all types of trail user groups. The result of that project was the following trail user code of ethics[106]:

Ontario Trail Users Code of Ethics

- Expect and respect other users
- Know and obey rules and laws
- Stay on the trail
- Do not disturb plants or animals
- Do not litter
- Respect private property and local residents
- Be prepared, to ensure your safety and the safety of others
- Stay on the right, pass on the left
- Travel slow while approaching other travelers
- Be courteous and communicate with other trail users

Prior to completion of the Trent University project, the Trails for All Ontarians Collaborative had summarized the codes of ethics from a wide variety of trail user groups. Table 9 summarizes the common points of user etiquette that apply to all trail users. Check marks in Table 9 indicate that the point of etiquette was specifically cited for that trail user group. Conversely, the absence of a check mark indicates only that the point of etiquette was not specifically stated within the cited document. **Boxes without a check mark do not indicate that the point of etiquette does not apply**. Table 10 summarizes additional codes of conduct or points of trail etiquette that apply primarily to only one or two user groups.

[106] Marsh J., MacPherson A., and Murray. C. (2006). Ontario Trails Ethics. Report for Ontario Ministry of Health Promotion. Peterborough: Trent University.

The references used to compile the trail user code information were:

Hike

Hike Ontario. (2000).The Trail User's Code.[On-line] Retrieved 31 July 2006 from: http://www.hikeontario.com/bulletin/factsheets/fact02.htm; Brown, C., Cooper, W. and Gosselin, P. (no date) Discover your Routes: A Guide to Trails in Peterborough County. Peterborough: Hearts Alive Peterborough & Trail Studies Unit. [On-line] Retrieved 31 July 2006 from: http://www.trentu.ca/academic/trailstudies/ethics.html; Central Ontario Loop Trail. (2001-2005). Trail Etiquette . Retrieved 31 July 2006 from: www.looptrail.com; Huronia Trails and Greenways. (2005). User Guidelines. [On-line] Retrieved 31 July 2006 from: http://www.simcoecountytrails.net/user_guidelines.htm; Bruce Trail Association. (no date). Bruce Trail Users' Code. [On-line] Retrieved 31 July 2006 from: http://www.brucetrail.org/explorethetrail.asp?id=%7B233D4F6B-545E-48B4-9C6B-3880A3592847%7D; Kawartha Lakes Pathways to Health Committee. (2006). Trail Etiquette and Responsible Use. [On-line] Retrieved 31 July 2006 from: http://trailsforhealth.ca/trail+etiquette+and+responsible+use.aspx;

Bike

International Mountain Biking Association. (2003). Off Road Rules of the Trail. Retrieved 31 July 2006 from http://www.bicyclesource.com/you/trail/etiquette; Central Ontario Loop Trail. (2001-2005). Trail Etiquette . Retrieved 31 July 2006 from: www.looptrail.com; Huronia Trails and Greenways. (2005). User Guidelines. [On-line] Retrieved 31 July 2006 from: http://www.simcoecountytrails.net/user_guidelines.htm; Kawartha Lakes Pathways to Health Committee. (2006). Trail Etiquette and Responsible Use. [On-line] Retrieved 31 July 2006 from: http://trailsforhealth.ca/trail+etiquette+and+responsible+use.aspx

Horse

Ontario Trail Riders Association. (no date). A Trail Riders Code of Ethics. [On-line] Retrieved 31 July 2006 from: http://www.trentu.ca/academic/trailstudies/ethics.html; Huronia Trails and Greenways. (2005). User Guidelines. [On-line] Retrieved 31 July 2006 from: http://www.simcoecountytrails.net/user_guidelines.htm; Kawartha Lakes Pathways to Health Committee. (2006). Trail Etiquette and Responsible Use. [On-line] Retrieved 31 July 2006 from: http://trailsforhealth.ca/trail+etiquette+and+responsible+use.aspx.

Ski

Cross-country skier; Huronia Trails and Greenways. (2005). User Guidelines. [On-line] Retrieved 31 July 2006 from: http://www.simcoecountytrails.net/user_guidelines.htm.

Snow

Winter motorized. Huronia Trails and Greenways. (2005). User Guidelines. [On-line] Retrieved 31 July 2006 from: http://www.simcoecountytrails.net/user_guidelines.htm.

Motor

Non-winter motorized;Ontario Federation of Trail Riders. (no date). Code of Conduct. [On-line] Retrieved 31 July 2006 from:http://www.trentu.ca/academic/ trailstudies/ethics.html; Huronia Trails and Greenways. (2005). User Guidelines. [On-line] Retrieved 31 July 2006 from: http://www.simcoecountytrails.net/user_guidelines.htm.

Table 9: Codes of Conduct that Apply to Multiple Types of Trail Use

	Hike	Bike	Horse	Ski	Snow	Motor
Respect and be courteous to others permitted trail users.	✓	✓	✓	✓	✓	✓
Stay on existing trails.	✓	✓	✓		✓	✓
Leave no trace, do not litter, leave a place better than you found it	✓	✓	✓	✓	✓	✓
Ride/walk/ski only where permitted. Respect trail closures.	✓	✓	✓	✓	✓	✓
Know your limits. Control yourself and your ride. Be prepared to stop.	✓	✓	✓	✓	✓	✓
Respect private property. Do not trespass. Close gates behind you.	✓	✓	✓	✓	✓	✓
Ensure trail conditions are suitable. Don't use the trail if you leave tracks more than ½" in depth.	✓	✓	✓	✓	✓	✓
Pay trail fees, even when it is an honour system.	✓	✓	✓	✓	✓	✓
Yield the trail to other users, give them room and pass slowly and with care.	✓	✓	✓	✓	✓	✓
Always wear your safety gear (hat, helmet, sunscreen, etc.)	✓					✓
Keep dogs on a leash.	✓	✓	✓	✓	✓	✓
Stoop and scoop manure off the trail for all animals.	✓	✓	✓	✓	✓	✓
Trail providers do a lot of work – respect their efforts.			✓			✓
Avoid sudden stops, starts, direction changes or accelerations.					✓	✓
Comply with all legislation, bylaws and insurance requirements.					✓	✓
Park to the side of the trail. Turn off any motor.				✓	✓	✓

(Table 9 continues on next page)

	Hike	Bike	Horse	Ski	Snow	Motor
Camp only in designated areas.	✓		✓			
Let others know your route.	✓			✓		
Always use bridges to cross waterways.		✓	✓			
Respect nature. Do not disturb vegetation, wildlife, crops or farm animals.	✓		✓		✓	✓
Don’t walk or ride in groomed ski tracks.	✓		✓		✓	✓
Slow down when your vision of the trail ahead is restricted.		✓	✓	✓	✓	✓
Stop when you see a horse. Never spook animals. Pass with care.	✓	✓		✓	✓	✓
Do not travel alone on remote trails	✓	✓	✓			
Dress in layers suitable for the weather.	✓	✓	✓			
Carry a first aid kit, a guide book, map and compass, a whistle, trail snack and water and insect repellent.	✓	✓	✓			

Table 10: Additional Codes of Conduct for Specific Trail Users

				Motorized	
Hike[43]	Bike[44]	Horse[45]	Ski[46]	Winter[47]	Non-Winter[48]
Do not smoke on the trail.	Limit group to 6 riders.	Respect the authority of trail group leaders.	Do not ski late in the day or after dusk	Keep your motor quiet and rpm's low.	Keep your motor quiet and rpm's low.
Go around the edge of crop fields, not across the middle.	Use caution at road crossings	Train your horse to accept varied experiences & other users.	Carry wax, food & supplies for the un-expected.	Park, dismount & walk to sensitive areas.	Park, dismount & walk to sensitive areas.
Limit group size to 20.		Do not drink alcohol while on the trail.	Yield to users downhill.		Do not ride during hunting season.
Carry a map and identifica-tion.		Use a walking pace unless safety is certain & you have good ground conditions			
Bring and drink lots of water.		Move slowly around other trail users.			
		Never leave horses unattended			
		Help others who need assistance.			
		Limit group size to 6 or fewer			

[43] Brown, C., Cooper, W. and Gosselin, P. (no date) Discover your Routes: A Guide to Trails in Peterborough County. Peterborough: Hearts Alive Peterborough & Trail Studies Unit. [On-line] Retrieved 31 July 2006 from: http://www.trentu.ca/academic/trailstudies/ethics.html; Huronia Trails and Greenways. (2005). User Guidelines. [On-line] Retrieved 31 July 2006 from: http://www.simcoecountytrails.net/user_guidelines.htm

[44] Huronia Trails and Greenways. (2005). User Guidelines. [On-line] Retrieved 31 July 2006 from: http://www.simcoecountytrails.net/user_guidelines.htm

[45] Ontario Trail Riders Association. (no date). A Trail Riders Code of Ethics. [On-line] Retrieved 31 July 2006 from: http://www.trentu.ca/academic/trailstudies/ethics.html: Huronia Trails and Greenways. (2005). User Guidelines. [On-line] Retrieved 31 July 2006 from: http://www.simcoecountytrails.net/user_guidelines.htm

[46] Huronia Trails and Greenways. (2005). User Guidelines. [On-line] Retrieved 31 July 2006 from: http://www.simcoecountytrails.net/user_guidelines.htm

[47] Huronia Trails and Greenways. (2005). User Guidelines. [On-line] Retrieved 31 July 2006 from: http://www.simcoecountytrails.net/user_guidelines.htm

Appendix F: Dollars and Cents

The Cost of "Best Practices"

Like it or not, money is a significant factor that influences trail construction and maintenance. Building and maintaining a trail requires dollars, and usually it is the same volunteers who are building and maintaining the trail that also must dedicate time to obtaining the necessary financial support. **Trails that follow the "best practices" for universal and sustainable design are the easiest to support**. Sustainable design practices help to minimize construction and maintenance costs by integrating the trail within the existing natural environment. Trails that are universally designed can be used and supported by a very broad spectrum of the population. As such, they are optimally positioned to take advantage of a wide variety of funding sources.

There is virtually no difference in cost between a trail built according to the "best practices" and trails built in a more traditional manner. Where there are significant additional costs associated with the "best practices" is when a project is re-constructing an existing trail in order to bring it in line with the current "best practices". "Doing it right in the first place" is always much, much cheaper than trying to re-do a trail that was not originally designed to be universal and sustainable. There is currently no research that specifically evaluates the impact of the "best practices" for Ontario trails on the construction and maintenance expenses or the funding and support received. However, in 1999, Wilderness Inquiry, a US organization that provides activities that integrate people with and without disabilities in outdoor environments, received funding from the US government to investigate the potential impact of the proposed trail accessibility guidelines under the Americans with Disabilities Act. The proposed American guidelines[107] have similar or more extensive standards than those described in this manual (see Guidelines for Trail Design). The Wilderness Inquiry project[108] conducted a survey of land managers on their actual and perceived cost increases for complying with the proposed standards. The results showed that during the late 1990's, the cost of building a trail that would meet the proposed standards was 9.2% higher than the cost of building a trail that would not comply.

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[49] Access Board. (1999). Final report of the Outdoor Developed Areas Regulatory Negotiation Committee. [On-line] Retrieved 31 July 2006 from: http://www.access-board.gov/outdoor/outdoor-rec-rpt.htm.

[50] Wilderness Inquiry, Inc. (Sept. 24, 1999). Access Board Cost Analysis of Outdoor Developed Areas, U.S. Architectural and Transportation Barriers Compliance Board. [On-line] Retrieved 31 July 2006 from http://wi.wildernessinquiry.org/downloads/research/CAS%20Final%20Report.pdf.

When asked to explain the reasons for any increase in costs, land managers indicated that the increased costs were primarily due to:

- The need to install a constructed surface when the natural surface was not suitable.
- The construction of additional trail length when the natural topography included steep grades.
- The need to provide facilities (e.g., water source, picnic table, bench, toilet) that were of an accessible design.

In the intervening years, the proposed guidelines have been used as the “de facto” standard for trails in the US and similar standards have been adopted by other government agencies (e.g., US Forest Service). As a result, the cost of the “accessible” facilities that are often provided on a trail (e.g., accessible toilets, benches or picnic tables) have significantly decreased so that they are now virtually equivalent in price with traditional designs. Given this dramatic decrease is costs, it is also recognized that any increase in cost associated with the “best practices” (e.g., building a bridge deck 1.0 m wide instead of 0.7 m wide) would now be virtually negligible. The Wilderness Inquiry study also demonstrated that the cost variation for implementing the proposed guidelines did not differ for different locations, as all regions can contain areas of extreme topography. Further, it was determined that the costs associated with trail construction are primarily determined by the topography of the area and the type of trail being constructed (i.e., paved bike/pedestrian trails are much more costly than backcountry foot paths).

Estimating Costs

It is virtually impossible to provide a formula to calculate the costs of trail work. The cost of materials, labour, tools and other resources will vary tremendously, depending on the location, trail environment and desired type of trail experience. Trail groups should contact experienced people in their local community, particularly those who have built similar types of trails, in order to obtain a more accurate estimate of the resources required for trail design, construction and maintenance. The trail planning and design guidelines available from the Metropolitan Toronto and Region Conservation Authority[109] can also be used to identify the range of costs that will be associated with trails that are part of that inter-regional trail system.

[109] Metropolitan Toronto and Region Conservation Authority. (1993) Trail Planning and Design Guidelines - A Handbook for an Inter-Regional Trail System in the Greater Toronto Area. Toronto: Author.

In general, estimates of the costs of trail design, construction and maintenance should include factors such as:

- **Planning**
  - research materials, maps, aerial photos, testing fees

- **Design**
  - survey fees, architect's fees, administration (e.g., permits, documentation)
  - determine cost implications of the total length of each type of proposed trail tread (e.g., sections may need minimal work to create a sustainable, compacted tread surface while others may require boardwalk construction) and all proposed structures (e.g., drainage, erosion control, weight-bearing) and facilities (e.g., benches, bathrooms)
  - determine costs for surfacing and facilities for trailheads and access points
  - need for and type of erosion control structures (e.g., retaining wall)

- **Construction**
  - site preparation, staking, clearing, grading or excavating
  - tools and equipment (purchase or rental)
  - materials for trail tread (type, quantity and transport to trail site)
  - type, quantity and transport to trail site of materials for structures (e.g., bridge, boardwalk)
  - labour for one foreperson plus crew of at least 2 or 3 people (skill, quantity, transport to trail site, food, accommodation)
  - re-vegetation and rehabilitation of trail environment after construction (e.g., topsoil, seeds or plants)
  - signage
  - facilities provided along the trail (e.g., benches, bicycle racks, washrooms)
  - allow for delays due to weather and administrative costs for construction management

- **Maintenance**
  - maintenance work because of trail design and construction techniques
  - labour (type and quantity)
  - tools and equipment
  - creation, distribution and updating of trail information sources (e.g., brochures, maps, web site)

Potential Sources of Support

This section has been created to provide general information about and examples of potential sources of financial and “in-kind” support for ”best practices” trails. As with any funding application, there is no guarantee that requests to these sources will receive an enthusiastic response, but these ideas and connections have been found to be worthwhile in other outdoor projects.

The Ontario Trails Strategy identifies many potential partners that will be the key to moving forward with trails initiatives that are environmentally sustainable and available to all Ontarians. The partners identified through the stakeholder workshops of the Ontario Trails Strategy include:

- Ministry of Community and Social Services (Ontario Disability Support Program).
- Ministry of Health and Long Term Care.
- Municipalities / Parks and Recreation Departments.
- Unions.
- Employee Assistance Program Administrators.
- United Way.
- Schools / Universities / Researchers.
- Corporate Sector (e.g., recreation equipment manufacturers, homebuilders, banks and realty companies, business improvement associations, Chambers of Commerce).
- Tourism Industry / Community Trail Festivals.
- Service Organizations and Clubs
- Foundations
- Marketing Programs / Alternative marketing / Social Marketing
- Trail Clubs
- Special Needs Groups (e.g., CARD program in North York where people with disabilities can learn to ride horses)
- Seniors Groups
- Health Groups / Professionals
- Women’s Groups
- Environmental Clubs
- Conservation Authorities
- Aboriginal Groups
- Media

Each of these sectors, and undoubtedly many more not mentioned in the Ontario Trails Strategy reports, are potential sources of support for trails that follow the “best practices” of universal and environmentally sustainable design.

Government Grants

Government Grants exist at the federal, provincial, regional and municipal level. Emphasis at any level can change fairly quickly so it is imperative to keep your finger on the pulse of government initiatives. In Ontario, the Ontario Trillium Foundation, which disburses the proceeds of provincial lotteries, has been one of the funding agencies that has most consistently supported trail projects. The Ontario Trillium Foundation will accept proposals for local, regional and provincial initiatives. Additional information about the application process and criteria for support is available on the Foundation’s web site (www.trilliumfoundation.org).

Municipal governments will vary in the support that they can provide. Some offer start-up funding for special projects that increase accessibility, while others support projects that support the municipality’s long-term vision. Depending on the interests of the municipal government, they may offer monetary support or in-kind contributions that can include trail maintenance. Many municipalities, along with Conservation Authorities and local offices of the Ministry of Natural Resources, provide in-kind support for trails through access to their trained staff or information that they collect. For example, many communities have detailed GIS mapping information that can be used for trail planning, maps and promotional brochures. The use of GPS and other types of assessment equipment can also often be arranged through these governmental organizations.

Corporate Sponsorship

There is a very high level of competition for corporate funding. One President of a medium-sized company said that, on an average day, he sees between 4 and 6 requests for support. Large corporations get so many requests (sometimes hundreds every day) that they often have several people who work full-time on reviewing the applications and creating package presentations so that time required for grant views at meetings of the company board is minimized.

Many corporations have established corporate giving guidelines that allow them to focus on a particular sector. For large and medium companies, the giving guidelines are often available on the company’s web site. In general, most companies will support causes that fit within their spectrum of business. For example, Home Depot is a very good example of the current corporate mindset. They will contribute materials and/or volunteer labour to building projects. This support could be used for pathways and trails, especially if shelters or boardwalk surfaces were required and if Home Depot volunteers could do the work. In a case such as this it is important to make sure that professional supervision and safety concerns are answered. The Home Depot Foundation web site succinctly outlines their corporate giving guidelines (www.homedepotfoundation.org).

Although giving guidelines are often based on company related factors, that does not mean that support will be limited to the company's own services. For example, corporate giving-guidelines often also include:

- Causes where company staff volunteer (consider all the volunteers you have working on your trail and follow up on the companies that they work for to determine whether additional support is available).

- Events that enhance corporate profile (can you offer naming opportunities for your trail, are you having a grand opening where a company's support could be promoted).

- Causes that are viewed as close to their hearts, that is issues that have a personal impact on a staff member or close relative (if you are making changes to enhance trail access for people who are blind, for example, look for companies where there is a personal connection to someone who is blind).

- Causes that are cool, newsworthy and of high profile. We have witnessed much of this in the past few years with international relief efforts. The 9-11 New York City relief was one of the biggest, but the Tsunami and Katrina efforts also attracted a lot of non-planned corporate donations. This type of giving is sincere and from the heart, it does however have a very significant impact on the company's ability to support other worthwhile initiatives.

DO NOT GIVE UP IF YOUR REQUEST IS TURNED DOWN. BE PERSISTENT

Because of the very high level of competition for corporate support, it is important that you do not get discouraged if your initial request is refused. Be persistent in making a similar request to other companies, but use the experience of each company approached to improve your chances on the next application. Whenever a request for support is rejected, try to obtain as much information regarding the reasons for the decision as possible. Potential questions to ask or consider are:

- Was the presentation (written or oral) about your project lacking in any particular area?

- Was the support you requested within the range of grants typically provided by the company?

- Was the support requested reasonable in relation to the recognition that the company would receive?

- What types of recognition are preferred by the company and did the proposal match those preferences?

- If support was requested for a building project, did you clearly explain how the possibility of vandalism would be minimized so that the facility linked to the company's support will continue to be seen in a positive light?

- Was it clear how you would ensure that the company's generosity would be recognized and appreciated by the users on an on-going basis?

Local Support

Often our best resources are those that are closest to the cause. Local businesses, bank branches, service clubs, the chamber of commerce, community leaders and schools can all offer significant support. Service clubs are particularly important because they are volunteer organizations whose primary purpose is to make their community a better place. Often service clubs are the most active in the smaller rural communities where many trails are located. There are a very large number of service clubs, such as Rotary, Kiwanis, Lions, Optimist, The Independent Order of Odd Fellows (I.O.O.F.), and Loyal Order of Moose, so it is important to know which ones are active in each community. It is also worth noting that the success rate for applications to service clubs is generally much higher if a member(s) of the club is involved in your project.

Local banks are often a good source of funding for smaller projects. While large applications generally have to be reviewed through the bank's head office, local branches often have some discretionary funds available for projects within their local community. Local businesses may also be able to support your trail, but often their support is easier to achieve if you "think outside the box". That is, consider requesting their support in ways other than financial contributions. For example, if you are having a volunteer work day on your trail, ask the local coffee shop to provide coffee and baked goods in the morning or the local sandwich shop to provide lunch. Local newspapers are often looking for local stories which can be a good source of publicity for your project.

Students of all ages are also a great source of support, and involving them in your project can be a good opportunity to nurture their passion for the outdoors. Their time is valuable. Often, the volunteer student time can be matched "in kind" for financial support from other organizations. Student volunteers can also save thousands of dollars in labour costs. When thinking about volunteers, don't forget older adults or adults living in assisted housing developments. These adults often have significant amounts of time that they can contribute to a project that catches their interest. They are also stakeholders in your project to create a "best practices" trail, which will often further their interest and motivation.

It is important to carefully match the support request to the skills of the students or volunteers. For example, high school students often make great trail building volunteers, but the same would not be true for most young children. Keep in mind that students also have to do class projects. If their volunteer work for the trail can double as a class project, it creates a win-win situation.

Foundations

Most foundations have clear application procedures that range from very simple (a letter to which they will respond if more information is required) to quite complex. The Ontario Trillium Foundation, which is responsible for much of the support required for this project, provides shared-cost grants to non-profit organizations. Very clear application guidelines and dates can be found at www.Trilliumfoundation.org. The Ontario Trillium Foundation financially supports the capacity of organizations and communities to provide universal access to employment, volunteer and employment-bridging opportunities, and improved access to community services for people with disabilities.

Table 11: Internet Sources of Funding and Grant Writing Information

Organization	**URL**
Funds Net Services	www.fundsnetservices.com
The Foundation Center	www.fdncenter.org
Revisions Grants Services	www.revisions-grants.com
DOE/Westinghouse Free Home Grant-Writing Courses	www.apa.org/science/freegrantclass.html
Education Place On-line Grant Writing Courses	www.eduplace.com/grants/help/courses.html
Research Associates	www.grantexperts.com/national_grant_directories.htm
Home Depot	http://www.homedepotfoundation.org
Kiwanis	www.kiwanis.org
The Lions Club	www.lionsclubs.org
Rotary International	www.rotary.org/support/clubs
Telecom Pioneers	www.telecompioneers.org

Electronic searches via the Internet are a great way to identify the types of projects that charitable foundations have funded in recent years. Investigate charities involved in similar projects in other communities and look for potential partners with kindred interests. There are also private companies who, for a fee, can assist with the fundraising efforts for your project. Companies such as EMT (www.energizemotivatetrain.com) can help to cultivate partnerships. Other companies, such as Foundation Search, are designed to assist you in identifying private foundations where your application is more likely to be successful.

For example, a few quick searches[110] of the Foundation Search database (www.foundationsearch.ca) identified hundreds of foundations in Ontario that have previously funded trails, environmental or accessibility projects. Additional information about potential funding sources and how to write grant applications for accessibility[111] or trail[112] projects is also available on the Internet (Table 11). Although most of these funding agencies are specific to organizations in the United States, reviewing these suggested sources can identify parallel agencies or organizations in Ontario (e.g., State department of transportation may fund similar initiatives to the Ontario Ministry of Transportation).

In-Kind Donations

In-kind donations are any source of non-monetary support that your project receives. In-kind donations can include products (e.g., a loan of equipment, signage, gifts for auctions, refreshments for events, construction materials) or services (e.g., printing, special expertise such as trail design, landscaping or architectural services). However, probably the most significant source of in-kind donations is volunteer time. Time and labour costs are always significant aspects of trail construction and maintenance. If you count the number of volunteer hours your project has received this month, you will realize that the value of that time quickly adds up. In 2003, the standard value for time contributed by your volunteers was $12.50 per hour. The value of your volunteer time and other in-kind donations can often be used as part of your organization's contribution towards any matching funds that may be required for a grant application.

Putting Together a Funding Presentation or Grant Application

Case for Support

It is critical to illustrate the value of your project to the funding organization. While it may also be necessary to provide other types of information in your application, unless your project is highly valued by the organization it is likely that it will not even get a second look. The outline of your project in the case for support should be concise and clear. For each project, it is important to show how the funding organization's initial investment will pay future dividends.

Highlight your plans for incorporating universal and sustainable design at the earliest stages of your project. This type of thoughtful planning demonstrates insight and understanding, concepts that impress today's consumer conscious business leaders. It also shows that you are actively working to expand the usefulness and usability of your trail, beyond the legal accessibility requirements that will be introduced over the next few years.

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[110] For more information on these searches, contact Joe Millage (joe@energizemotivatetrain.com)
[111] Shrake, A. (2005) Funding Accessibility Projects: In Search of the Money Tree. National Center on Accessibility. [On-line] Retrieved 31 July 2006 from: http://www.ncaonline.org/monographs/11funding.shtml.
[112] Ontario Ministry of Health Promotion. (2005). Report on Stakeholder Workshop – Ontario Trails Strategy. [On-line] Retrieved 31 July 2006 from: www.mhp.gov.on.ca/english/sportandrec/accessibility-workshop-e.doc .

Handicapitalism
www.sistersspeakingout.com/handicapitalism2.htm

Jeff Adams, Accessibility Committee co-chair for Toronto's last Olympic/Paralympic bid, refers to "Handi-capitalism" as a clear statement that large groups, with perhaps a few members with accessibility issues, are welcome in the facility. He cites one example of a banquet facility that was asked about washrooms that would accommodate an electric scooter. When they said "no", the facility lost not only the business of that individual but also a large, 4-day conference that she was organizing. The term is now more broadly applied to recognize the many services that reach out and welcome persons with special needs.

It is also important to clearly illustrate that universal design is not just for individuals with special needs. Highlight the benefits of universal design for a wide range of trail users (e.g., older adults, families with young children, people with disabilities) to promote the importance of your project for families, classes, or community groups. You can also briefly allude to the fact that initially building for universal access is much cheaper than renovating to increase accessibility at a later date. In fact, following the "best practices" for universal and sustainable trail design will probably be no more expensive than traditional design and build costs.

Finally, recognize that everyone's time is precious so keep you're "Case for Support" simple, forthright and to the point. You don't have to oversell worthwhile projects, they will sell themselves. Once you've made your case, get the agreement of support and then do what you said you would do within a reasonable timeframe.

Sponsorable Items

Tangible materials, equipment and supplies are excellent as sponsored items. It is usually easier to get items donated than to obtain the funds required for purchase. As you plan your project, make a complete list of all of the items that you will need. As your project moves forward, keep the list going and make regular updates so that you are always ready to identify your needs should a potential supporter be found.

Similarly, it is also a good practice to keep a list of opportunities where individuals or organizations can be recognized for their contribution. With a little thought, it is certain that you could identify a large number of opportunities to recognize your supporters. To get you started, think of examples such as:

- As you walk your trail, you remark on a unique cluster of trees and think that a small sign on the side of the trail could bring attention to the uniqueness of the grove and be a good way to recognize a partner or remember someone who loved nature.
- Your newsletter may have additional space to bring to light the support of a partner or a donation.
- A school maintains a portion of the trail and you realize that there is no cost to submit an article to the school newspaper outlining their contribution, recognizing your volunteers and highlighting the corporate sponsor who donated lunches for the volunteer trail work crews.

Identifying Partners for a Specific Project

When looking for partners to involve in your project, it is worth reading the publications that support the interest groups who will benefit from your efforts. The benefits of trails that are universal and sustainable in design, such as enhanced physical, social and emotional well being, will be widespread. Magazines for older adults are a place to start your reading, but many different speciality publications and e-newsletters can bring to light many potential partners. These publications will highlight sponsors with a proven track record of supporting accessibility and active living for persons of all abilities. Sources for publications that could suggest potential partners include older adult organizations (e.g., Canadian Snowbird Association, Canadian Association of Retired Persons), disability organizations (e.g., Ontario March of Dimes, Ontario Federation for Cerebral Palsy, Ontario Paraplegic Association, Canadian National Institute for the Blind, Canadian Hearing Society), inclusive active living organizations (e.g., Paralympics Ontario, Ontario Special Olympics, Ontario Active Living Resource Centre), and magazines that promote active living opportunities that include people with disabilities (e.g., Sports and Spokes, Active Living, Palaestra).

In addition to stakeholder partner groups, also look for potential partners among companies whose products are used on your trail. Retail vendors, product manufacturers, sign companies, outdoor adventure suppliers, cycling shops, ski shops, and speciality footwear stores are just a few examples of places to look for partner organizations. Partners can also be found among local retailers. Great Canadian Superstore, Home Depot, Rona, CIBC, BMO, RBC, Scotiabank, Wal-Mart and Costco are just a few of the bigger chains that have a reputation for making significant contributions to projects in their local community.

Recruiting Volunteers

Volunteers are the backbone of most trail projects. In each community, the potential sources of volunteers will differ, so doing “your homework” and discovering what is available in communities near the trail will give you the best chance of recruiting the volunteers that you need. In general, the following are potential sources of volunteers that are common in most communities:

- Service clubs (e.g., Rotary Club, Kiwanis, Lions, Optimist, The Independent Order of Odd Fellows (I.O.O.F.), Loyal Order of Moose).
- Company retirees (e.g., Telecom Pioneers (www.telecompioneers.org)).
- Students (e.g., elementary schools, high schools (high school students in Ontario must do 40 hours of volunteer community service to graduate), colleges and universities (many post-secondary courses have required volunteer experience or internships) and the Katimavik programme for youth.
- Private companies.
- Senior centres and residences.
- Workshops and day programs for adults with cognitive, developmental, psychiatric or physical disabilities.
- Youth organizations (e.g., Scouts, Guides, 4-H clubs, Boys and Girls clubs).
- Parks and Recreation departments (some municipalities offer credit for programme registration to youths who volunteer in other community programmes).
- Police associations and the court system (at times they can refer people who are motivated to complete worthwhile community service hours).

Appendix G: Trail Assessment

Accurate trail assessments that are based on objective measurements, rather than subjective opinions, should be the foundation of all trail design, construction and maintenance activities. One only needs to go out on a trail and ask trail workers to guess the slope of the land, and then compare the wide range of guesses with the actual measurement to know that our perceptions of the environment can be significantly affected by the environment itself. Subjective opinions (e.g., the surface is hard, the cross slope is not steep enough for drainage) cannot be relied upon, even if the person expressing the opinion is highly skilled and experienced. Ensuring that assessments of the trail or trail environment are based on simple but objective measurements is the most effective way to ensure that the information provided accurately reflects the on-trail conditions. The information collected through objective assessments can be used for a wide variety of purposes, such as trail planning, construction or maintenance, alteration of a trail to enhance its suitability for people of different abilities, or monitoring of environmental conditions.

There are several excellent sources of information for completing trail assessments that will gather the information required to follow the principles of universal and sustainable design. The Trails Canada assessment procedures[113] offer specific instructions for either a basic or more in-depth assessment of the on-trail conditions. The Trails Canada assessments were developed in conjunction with Scouts Canada, so trail groups can make use of the “people power” offered through Scouts Canada groups in their local community. Details of the Trails Canada assessment procedures, including the instructions for completing the assessments, can be found at www.trailscanada.com or www.sentierscanada.com.

American Trails (www.americantrails.org) also offers training in trail assessment based on the Universal Trail Assessment Process (UTAP). The UTAP was developed by US trail agencies as a primary means of documenting on-trail conditions. Workshops to learn the UTAP are typically 2 days in length, and include 5 or more hours of practical, “on-trail” experience. The UTAP Training Guide and information about an automated trail assessment system that is currently under development (referred to as the High Efficiency Trail Assessment Process) are available from Beneficial Designs Inc. (www.beneficialdesigns.com).

Although there are a number of different trail assessment systems available, the Trails Canada and UTAP assessments are the only ones that are based on relevant research results. Research has established the accuracy and repeatability of these measurement systems as well as the ability of the collected information to accurately convey the on-trail conditions to trail users and land managers.

[113] Go for Green. (no date). Scouts Canada Manual. Ottawa: Author. [On-line] Retrieved July 31, 2006 from http://www.trailscanada.com/documents/Scouts_Canada_Manual.pdf.

Regardless of the specific procedures used, objective trail measurements should include the assessment of:

- Length of the trail
- Location and information about trail work sites, obstructions, features, intersections and facilities.
- Slope of the trail tread (grade and cross slope) as well as slopes on surfaces adjacent to the trail that may impact the trail environment or the safety of trail users.
- Surface firmness and stability relative to environmental and user impacts.

A brief overview of each of these measurements is provided in the following subsections. Readers are encouraged to access the Trails Canada or UTAP resources (cited above) for detailed information about accurate and objective trail measurement procedures. When completing assessments on a trail, the information can be recorded in a variety of formats (e.g., pen and paper, Dictaphone, videotape). The format used for recording the assessment information will depend on the resources available to the assessment team. Regardless of the format used, it is important that the team be prepared to record assessment information in the wide variety of conditions (e.g., rain, hot sun) that may occur out on the trail. Depending on the remoteness of the trail, the use of battery-powered devices may or may not be appropriate.

Length and Location

The length of the trail and the location of work sites, features and facilities should be recorded according to their distance from the designated trail access point. At the start of the assessment, while the crew is still at the trail access point, set the odometer on the measuring wheel to zero. At each location of interest, record the distance from the trail access point as the reference location for that work site, feature or facility. Details about the location and any work that is required should also be recorded. Mark the location of all trail work sites with flagging tape or a wire pin so that the returning work crew can more easily find the correct location. Do not reset the measuring wheel until each segment of the trail has been completed. A trail segment is the section of trail between two access points or trail intersections.

Slope

Grade is the slope of the trail tread in the direction that is parallel to the trail users path of travel. Cross slope is the slope perpendicular to the trail users path of travel. Both grade and cross slope should be recorded throughout the length of the trail. Regardless of whether the slope measurements are for grade or cross slope, the measurement should be recorded over a distance of 0.75 metres. This distance will most accurately represent the base of support of most trail users travelling by foot. The goal for measuring slopes should be to determine the grade and cross slope that trail users will have to traverse and that water will flow across. An electronic level, that provides digital output of the angle of the surface, is the most easiest and most accurate method of assessing grade and cross slope. However, electronic levels can be quite expensive to purchase. A piece of coving, a ruler and a marble (as described in the Trails Canada assessment, www.trailscanada.com) offers a low cost alternative but requires the user to make their own calculations. The use of levels or sighting equipment (e.g., clinometer, abney, laser level) is also appropriate although these can be difficult to use accurately over the short 0.75 metre distance of the measurements.

Measuring the grade and cross slope over a distance of 0.75 metres does not mean that these measurements are done every 0.75 metres along the trail. Measurements of grade and cross slope should be made wherever there appears to be a visual change in the slope. That is, if you can see that one section is more sloped than another, the slope should be measured once in each section on an area that is typical for that segment of trail. Each time there is a visual change in the trail grade or cross slope, a new measurement should be recorded. The length of steep sections should also be recorded for grades above 8% and cross slopes above 5%.

Surface Firmness and Stability

The most accurate method for measuring the firmness and stability of trail surfaces is the rotational penetrometer developed by Beneficial Designs Inc. (www.beneficialdesigns.com). Unfortunately, the cost of the penetrometer (approximately $2,000 US) is well beyond the resources of most volunteer trail organizations. A somewhat less accurate alternative, that is still suitable for use on most trails, is the “foot and heel test” described in the Trails Canada and Universal Trail Assessment Process resources.

The surface assessment requires that an average-sized adult (about 70 kg in weight) perform two tests of the surface. The first test assesses the firmness of the surface. The person stands on the surface with all of their weight on one foot. After pushing on the surface for 5 seconds, the person steps away and examines the imprint that has been made. If there is no imprint on the surface (apart from the marks or pattern on the sole of the shoe or movement of leaves or duff on the trail surface), the surface is considered firm. If the test has created a footprint that is indented into the most solid section of the surface, the tread is recorded as soft. A very soft surface is recorded if the person continues to sink into the surface the longer they stand in one place.

The assessment of surface stability is completed in a similar manner, except that the person twists the foot left and right on the surface a minimum of four times. If the foot penetrates deeper into the surface material with each twist, the surface is not stable.