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Recreation Trail Design



Figure 15-1. Pedestrians of all abilities enjoy the opportunity to be out in nature, which recreation trails provide.

Recreation trails are designed to provide a recreational experience. Use of a recreation trail is a choice made by those individuals who desire the experience that the trail provides. Recreation trails should provide users with disabilities with access to the same range of trail experiences offered to other users at the site. This means that trails should be designed to reach destinations or points of interest and travel through various environments. Providing

access to people with disabilities 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.

Any trail that is specifically designed for pedestrian use should also be designed to provide access to people with disabilities. Trails that are not designed to provide access for pedestrians, such as single-user mountain bicycling, horseback riding, or off highway vehicle trails, do not need to be designed to provide access to pedestrians with disabilities. However, these trails should be designed to provide access to people with disabilities who will be using the equipment associated with the intended trail use, such as a mounting area or platform for equestrians who use

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wheelchairs, and amenities such as parking and restrooms should also be accessible.

15.1 Background information

In the past, many “accessible” recreation trails were designed with a length less than a quarter mile, no grade or cross slope, and with a wide, paved surface that made a loop around or near the parking lot, picnic area, or nature center. Individuals looking for a short, easy stroll, such as travelers who need to stretch after driving long distances, often enjoy these trails. Although these types of trails may meet the needs of some users, they usually do not provide a complete experience of the environment or elements available at the site. Therefore, it is not desirable to design all trails to these same standards. Trails that are intended to provide access to people with disabilities should be designed to provide a range of opportunities so that all trail users can experience the various environments offered at the site.

The design recommendations presented here primarily reflect the work of the Regulatory Negotiation Committee on Accessibility Guidelines for Outdoor Developed Areas (U.S. Access Board, 1999b). These recommendations, or a slightly modified version, will form the basis of a proposed rule that will be published by the Access Board for public comment. Although no trail can provide access to all individuals, trails that meet the Committee’s recommendations are considered accessible under the ADA.

It is critical that designers recognize that these specifications do not represent an exact point, beyond which the trail will be completely inaccessible to all individuals with disabilities. People with 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. Everest or the South Pole. Others rarely, if ever, venture off of the sidewalk, or some people have disabilities that prevent them from even going outdoors. Therefore, designers should keep in mind that some people

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with disabilities will always be able and interested in using a trail regardless of its exact design specifications. Furthermore, more people are able to enjoy different trail experiences because of advances in adaptive equipment.

Trail designers and builders should strive for maximum accessibility. However, in situations where it is not possible to fully comply with the recommended specifications for trails, designers are encouraged to comply with the recommendations to the greatest extent possible. It is essential that designers recognize the continuum of abilities among recreation trail users. The more the trail conditions vary from the recommended specifications, the larger the proportion of people who will not be able to access the trail. On trails where it is not possible to fully comply with the design recommendations, designers should ensure that the non-compliant sections are minimized in length and severity. For example:

- The trail should be free of constructed barriers, and natural

barriers should be removed if feasible.

- If the steepest grade on the trail cannot be less than 20 percent, the segment should be as short as possible and the remainder of the trail should comply with the recommendations;
- If there is a segment of trail that has a 10 percent grade for more than 9.14 m (30 ft), a level rest interval should be provided as soon as possible, and the remainder of the trail should be designed according to the recommendations;
- If there is a segment of trail that has a cross slope of more than 5 percent, the segment should be as short as possible and the remainder of the trail should follow the recommended specifications; or
- If the trail travels along a cliff, and a drop-off creates a tread width less than 915 mm (36 in), the narrow

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section should be made as wide as possible and the trail on either side of the narrow section should be designed according to the recommendations.

The proposed Accessibility Guidelines for Outdoor Developed Areas would require newly designed or newly constructed and altered portions of existing trails connecting to designated trailheads or accessible trails to comply with the proposed guidelines. The guidelines recognize that the natural environment often will prevent full compliance with certain technical provisions. Departures are permitted from certain technical provisions where at least one of four conditions is present:

- Where compliance would cause substantial harm to cultural, historic, religious, or significant natural features or characteristics;
- Where compliance would substantially alter the nature of

the setting or the purpose of the facility, or portion of the facility;

- Where compliance would require construction methods or materials that are prohibited by Federal, State, or local regulations or statutes; or
- Where compliance would not be feasible due to terrain or the prevailing construction practices.

15.2 Outdoor recreation access routes

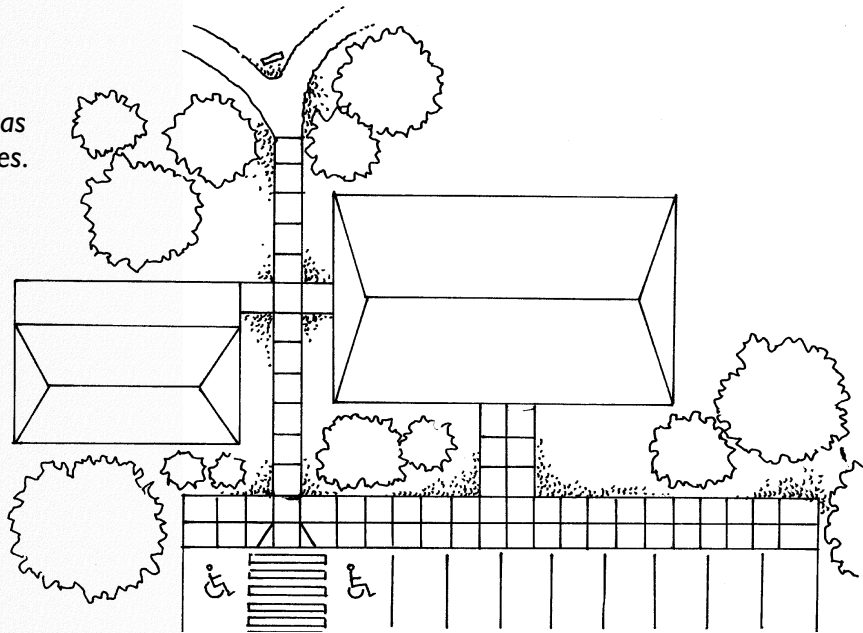
Outdoor Recreation Access Routes (ORARs) are paths that connect accessible elements within a picnic area, campground, or designated trailhead. These paths provide a means of access for people with disabilities to reach built elements that are part of the recreation experience. For example, the paths leading from the parking lot to the visitor center or to a picnic area from a campground would be considered ORARs.

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Figure 15-2. Outdoor Recreation Access Routes (ORARs) link together accessible elements, such as picnic areas and camp sites.



The U.S. Access Board has addressed design considerations for ORARs through the work completed by the Regulatory Negotiation Committee on Accessibility Guidelines for Outdoor Developed Areas. According to the Committee, ORARs should be designed within the following specifications:

- **Surface** — Firm and stable;
- **Clear tread width** — Minimum of 915 mm (36 in);
- **Openings** — Do not permit the passage of a 13 mm (0.5 in) diameter sphere. Elongated openings should be placed so that the long dimension is perpendicular or diagonal to the dominant direction of travel;
- **Tread obstacles** — Maximum height of 25 mm (1 in);
- **Protruding objects** — Objects between 685 mm (27 in) and 2.030 m (80 in) above the surface may not protrude into the route more than 101 mm (4 in);
- **Passing space** — 1.525 m x 1.525 m (60 in x 60 in) provided at maximum intervals of 61 m (200 ft) whenever the clear tread width is less than 1.525 m (60 in);
- **Cross slope** — Maximum of 3 percent;

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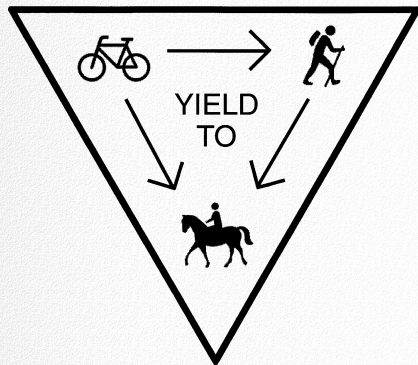


Figure 15-3. Recreation trails attract a variety of user groups. Providing signs that clearly indicate which users have the right of way will help mitigate conflict. Motorized recreation vehicles should be required to yield to other users.

- **Running grade** — 5 percent or less for any distance; 8.33 percent for a maximum of 15.24 m (50 ft); and 10 percent for a maximum of 9.14 m (30 ft). If the running grade exceeds 5 percent, resting intervals should be provided before and after the maximum grade segment;
- **Resting intervals** — 1.525 m (60 in) minimum in length and at least as wide as the widest portion of the trail segment leading to the resting interval with a cross slope that does not exceed 3 percent in any direction; and
- **Edge protection** — Where provided, should be a minimum of 75 mm (3 in).

15.3 Trail conflicts between multiple user groups

Many recreation trails attract a variety of user groups. Some trails are designed for multiple user groups; others attract a variety of users in addition to those for

whom the trail was designed. Each trail group has specific interests and needs in terms of trail design. Therefore, whenever there are multiple users on the same trail, there is the potential for conflict.

People with disabilities may be particularly affected by trail conflicts if they do not have the ability to quickly detect or react to hazards or sudden changes in the environment. To improve the trail experience for all users, including people with disabilities, designers and planners should be aware of potential trail conflicts and attempt to minimize the probability that conflicts will occur by employing innovative trail solutions. Basic conflicts can be reduced by:

- Providing information, including signage, in multiple formats that clearly indicates permitted trail users and rules;
- Ensuring that the trail provides sufficient width and an appropriate surface for all users, or providing alternate trails for some user groups,

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such as equestrians, who may have specific needs;

- Providing sufficient separation for users traveling at different speeds. For example, if volume and space permits, bicyclists and pedestrians should have different lanes or areas;
- Providing the necessary amenities for all trail users. For example, bicyclists require bicycle parking or lockers, equestrians require hitching posts and water troughs, and off highway vehicle (OHV) users require a testing circle or “landing” at the trailhead to determine if their equipment is operating correctly; and
- Considering the needs of people with disabilities within all of the user groups that are permitted on the trail. For example, individuals with disabilities may use a hand cycle or tricycle design that may not be compatible with some bicycle parking or lockers of limited width.

Similarly, an individual who uses a wheelchair may ride a horse but may be unable to dismount in order to go around or under obstacles.

15.4 Trail surfaces

In many situations, the condition of the surface is the most important factor in determining how easily a person with a disability can travel along a recreation trail. Surfaces that are very soft or filled with obstacles are difficult for all trail users and often exclude people with disabilities. The accessibility of the trail surface is determined by a variety of factors including:

- Surface material;
- Surface firmness and stability;
- Surface slip resistance;
- Changes in level and tread obstacles; and
- Size and design of openings.

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15.4.1 Surface material

There are various surface materials that can be used in outdoor environments. Recreation trail surfaces are most commonly composed of naturally occurring materials such as packed soil, grass, or rock. Some trails may use crushed stone or native soils mixed with soil stabilizing agents. However, surfaces ranging from concrete to sand may be used depending on the designated user types, the anticipated volume of traffic, the climate, and the conditions in the surrounding environment. High use trails passing through developed areas or fragile environments are commonly surfaced with asphalt, concrete, or soils mixed with stabilizing agents to maximize the longevity of the trail surface, minimize the maintenance requirements, and limit the environmental impact of the trail.

Selection of a trail surface material should be based on the type of user groups, the distance of the trail, the type of setting or experience desired, and the

characteristics of the natural environment. The surfacing material on the trail significantly affects which user groups will be capable of negotiating the terrain. Soft surfaces, such as dry sand or pea gravel, are more difficult for all users to negotiate and present particular hazards for those using wheeled devices including road bicycles, walkers, and wheelchairs not designed for rugged terrain. In contrast, other users, such as equestrians, joggers, and some people who walk with assistive devices, prefer surfaces that are not paved or very hard. Ultimately, trail designers must consider the needs of users in conjunction with the local conditions in order to determine the most appropriate surface material(s) for a trail.

15.4.2 Surface firmness, stability, and slip resistance

The firmness, stability, and slip resistance of the trail surface affects all users, but it is particularly important for people using mobility devices such as canes, crutches, wheelchairs or walkers.

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- **Firmness** is the degree to which the surface resists deformation by indentation when, in this case, a person walks or wheels across it. A firm surface would not compress significantly under the forces exerted as a person walks or wheels on it.
- **Stability** is the degree to which the surface remains unchanged by contaminants or applied force, so when the contaminant or force is removed, the surface returns to its original condition. A stable surface would not be significantly altered by a person walking or maneuvering a wheelchair on it.
- **Slip resistance** is based on the frictional force necessary to permit a person to ambulate without slipping. A slip resistant surface does not allow a shoe heel, wheelchair tires, or a crutch tip to slip when ambulating on the surface.

All recreation trails should be surfaced with a material that is firm and stable.

When a person walks or wheels across a surface that is not firm and stable, energy that would normally cause forward motion instead deforms or displaces the surface, so the energy is lost through slipping. Providing a firm and stable surface does not mean that only paved trails are acceptable. Crushed stone or fines, packed soil, and other natural materials can provide surfaces that are firm and stable (Table 15-1). To provide a firm and stable surface, the base material should be laid over a geotextile fabric to prevent vegetation growth. The base material must be compacted with the correct moisture content similar to the preparation of a roadbed. Finally, the proper trail surfacing material should be used. Depending on the distribution of particle sizes and the clay content of the material, a surface stabilizer may be needed to create a firm and stable surface.

Providing a slip resistant surface is also desirable, although not always possible to achieve on recreation trails. Brushed concrete and asphalt are slip resistant under dry conditions. Many soil

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Table 15-1. Firmness, Stability, and Slip Resistance for a Variety of Common Trail Surfacing Materials

Surface Material	Firmness	Stability	Slip Resistance (dry conditions)
Asphalt	firm	stable	slip resistant
Concrete	firm	stable	slip resistant*
Soil with Stabilizer	firm	stable	slip resistant
Packed Soil without Stabilizer	firm	stable	not slip resistant
Soil with High Organic Content	soft	unstable	not slip resistant
Crushed rock (3/4" minus) with Stabilizer	firm	stable	slip resistant
Crushed rock without Stabilizer	firm	stable	not slip resistant
Wood Planks	firm	stable	slip resistant
Engineered Wood Fibers that comply with ASTM F1951	moderately firm	moderately stable	not slip resistant
Grass or Vegetative Ground Cover	moderately firm	moderately stable	not slip resistant
Engineered Wood Fibers that do not comply with ASTM F1951	soft	unstable	not slip resistant
Wood Chips (bark, cedar, generic)	moderately firm to soft	moderately stable to unstable	not slip resistant
Pea Gravel or 1-1/2" Minus Aggregate	soft	unstable	not slip resistant
Sand	soft	unstable	not slip resistant

*A broom finish significantly improves the slip resistance of concrete.

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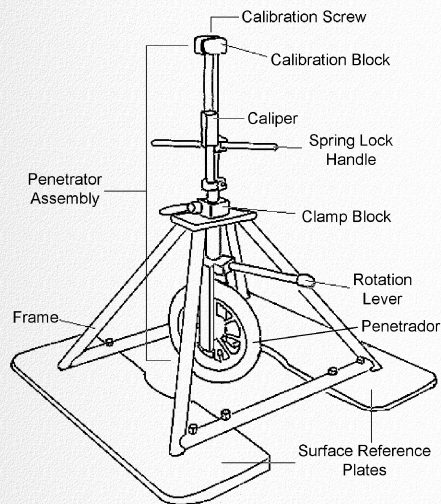


Figure 15-4. A rotational penetrometer is a portable measurement device for determining firmness and stability of trail surfaces.



Figure 15-5. This rotational penetrometer is testing the firmness and stability of sand.

stabilization products that are mixed with natural surfacing materials will also create a surface that is slip resistant under typical weather conditions. The U.S. Access Board (1994a) Technical Bulletin #4 addresses slip resistance in further detail.

If a firm and stable surface cannot be provided throughout the trail, the following recommendations should be considered for short distances:

- For travel over a very limited distance [less than 0.16 km (0.1 miles)] on a relatively level trail (less than 5 percent slope), a moderately firm surface may be used; and
- For travel that is primarily linear [less than 0.8 km (0.5 miles) in length], and relatively level (less than 5 percent slope), a firm but moderately stable surface may be used.

Until recently, there was not a simple, objective method for measuring trail surface firmness and stability in the field.

To address this issue, the National Institutes of Health funded a research project to develop a portable surface measurement tool. This device, the rotational penetrometer, measures surface firmness by pressing an indenter into the surface with a specified amount of force and recording the amount of displacement into the surface.

The device measures the stability of the surface by then rotating the indenter back and forth while the force is applied and recording the total amount of displacement of the indenter into the surface. The U.S. Access Board funded additional research to determine the physiological effects of surface firmness and stability on trail users. The studies led to recommendations for an objective definition of trail surface firmness (Table 15-2) and stability (Table 15-3) (Axelson, P.W. & Chesney, D., 1999). For more information about the rotational penetrometer, contact Beneficial Designs, Inc.

Ideally, all surfaces should be firm and stable under most weather conditions.

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Table 15-2. Recommendations for Surface Firmness

Surface Rating for Firmness	Displacement of Caster on Portable Wheelchair Measuring Device
Firm	0.3 in or less
Moderately firm	0.4 in to 0.5 in
Not firm	greater than 0.5 in

Table 15-3. Recommendations for Surface Stability

Surface Rating for Firmness	Displacement of Caster on Portable Wheelchair Measuring Device
Stable	0.5 in or less
Moderately stable	0.6 in to 1.0 in
Not stable	greater than 1.0 in

In general, paved recreation trail surfaces, such as asphalt, concrete, or soils or aggregates with stabilizing agents, will be firm and stable in both wet and dry conditions. Natural materials can also be bonded with synthetic materials to provide a firm and stable surface in most weather conditions. If the natural surface of the trail is not firm and stable even under dry conditions (e.g., sand, bog), the use of soil stabilizers or the construction of an imported or artificial trail surface is needed to create a more accessible surface.

In extreme climates, surfaces should provide a firm and stable surface under the predominant conditions. For example:

- Environments that are predominantly dry, such as the Sonoran Desert, should be firm and stable under dry conditions; or
- Environments that are predominantly wet, such as the rain forests of the Pacific Northwest, should provide a firm and stable surface under wet conditions.

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Soft trail surfaces should be avoided whenever possible. Not only do they limit the accessibility of the trail, but they generally require more maintenance and create a greater impact on the environment. Existing surfaces that are not firm and stable can be improved through the following recommendations:

- Improve the design of trail surfaces so that water quickly runs off to the side of the trail rather than being absorbed into the trail surface;
- If it is possible to excavate the natural trail surface, install a layer of drain rock under the surface material;
- Use a soil stabilizer or construct a raised rock surface, such as riprap or turnpike, to maintain the firmness and stability of wet areas;
- Construct a raised surface such as a boardwalk or puncheon; or
- If possible, avoid dry, sandy soils. As an alternative, consider maintaining

vegetative ground cover or building a boardwalk over the sandy surface. If trails are located on beaches, provide a beach access route and make tide information available to users so that they can travel at lower tides and make use of the firmer surface below the high water mark (see Section 17.2).

15.4.3 Changes in level and tread obstacles

Changes in level and tread obstacles are a safety hazard for people who use assistive devices, such as crutches, canes, scooters, bicycles, inline skates, wheelchairs, or walkers. Abrupt changes in level can cause people to trip and fall. The risk is particularly acute for individuals who have difficulty lifting their feet up off the ground, or for those who have limited vision and may be unable to detect the change in level. Catching a wheel on an obstacle or change in level can easily tip over wheeled devices as the individual's momentum continues even though the



Figure 15-6. This recreation trail contains many tread obstacles including tree roots and rocks.

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wheel has suddenly stopped. Minimizing or eliminating changes in level and tread obstacles will greatly improve trail safety for all users.

If changes in level or tread obstacles cannot be removed, they should be conveyed to trail users through signs, maps, or other information formats. The information should be provided at all trail access points, and should include the size, type, and location of the obstacles and any changes in level that will be encountered. Making this information available at trail entrances enables users to determine, prior to using the trail, whether they have the interest or ability to contend with the difficult environment created by the obstructions.

- Differences in the height of adjacent planks on a boardwalk;
- Uneven transitions from the trail surface to a bridge or walkway; and
- A sudden change in the natural ground level (often caused by rock outcroppings, earthquakes, or frost heaves).

Traditionally, changes in level have only been addressed when they extend across the full width of the trail so that the user is required to negotiate the change. However, any change in level is problematic for people with vision impairments because they may not detect the change in time to avoid it.

For recreation trails that have surfaces of concrete or asphalt, the changes in level should meet the recommendations used for shared-use paths. These include:

- Changes in level should not be incorporated in new construction;

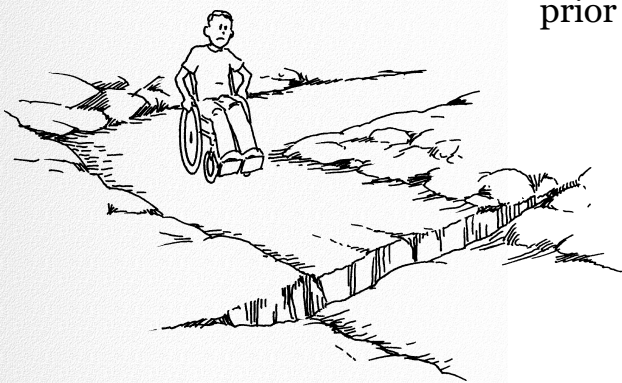


Figure 15-7. This sudden change in the natural ground level is a potential safety hazard for hikers and other trail users.

15.4.3.1 Changes in level

Changes in level are defined as a difference in vertical elevation between adjacent surfaces. Examples of changes in level commonly seen on unpaved recreation trails include:

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- Small changes in level up to 6 mm (0.25 in) may remain vertical and without edge treatment;
- A beveled surface with a maximum slope of 50 percent should be added to small changes in level between 6 mm (0.25 in) and 13 mm (0.5 in); and
- Changes in level such as curbs that exceed 13 mm (0.5 in) should be ramped or removed.

where a maximum height of 51 mm (2 in) cannot be attained, and the slope of the trail is 5 percent or less in any direction.

15.4.3.2 Tread obstacles

Tread obstacles are objects within the trail tread, such as rocks, roots, or ruts. They differ from changes in level (e.g., stairs) in that the surfaces around the obstacle may not differ in vertical elevation. Most obstacles do not extend across the full width of the trail tread. Trail users who can move onto, over, or around the obstacle will be able to continue down the trail.

Tread obstacles on the trail surface pose a significant barrier to access. All tread obstacles are potentially hazardous for people with vision impairments who may not be able to detect the obstacle or may be unsure of the most appropriate way to avoid the obstacle. Even if an obstacle can be avoided, the maneuvering that is required means that some trail users will have to expend significantly more energy

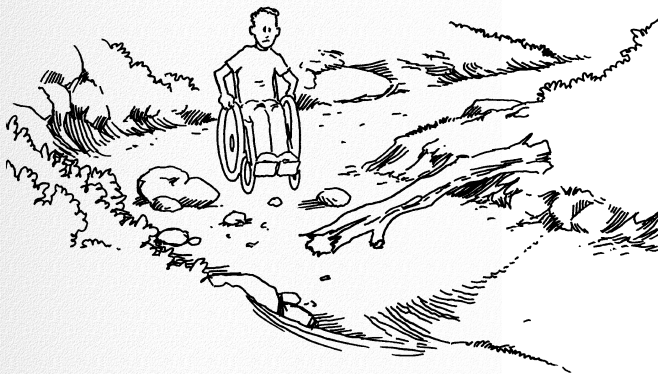


Figure 15-8. The tread obstacles on this trail surface do not allow this hiker to continue travel on the trail. Even when obstacles are avoidable, maneuvering around them requires trail users to expend more energy and time.

For unpaved recreation trails, changes in level:

- Should not be created during new development or construction;
- Should not exceed 51 mm (2 in) in height on existing trails; and
- May be up to a maximum of 76 mm (3 in) in areas

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and time. The problems associated with multiple obstacles are magnified on narrow trails because the maneuvering room and clear path of travel are significantly reduced.

Most obstacles on a trail, such as rocks, occur naturally. They often develop into access barriers as a result of the soil compaction and erosion that accompanies continued trail use. Proper trail layout and alignment, with particular attention to natural drainage patterns, can minimize the development of obstacles such as ruts, entrenchments, and exposed roots and rocks. Removal of existing obstacles should be accomplished through a regular maintenance program.

Paved recreation trails should not have obstacles within the trail tread. On unpaved recreation trails, the trail tread should be maintained to provide a minimum clear (i.e., obstacle free) path of travel at least 915 mm (36 in) in width. For short distances, a minimum clear width of 815 mm (32 in) is acceptable. Obstacles over 51 mm (2 in) in height should be removed.

15.4.4 Openings

Openings are spaces or holes in the tread surface. Openings may occur naturally such as a crack in a rock surface, or they may be created during construction such as spaces between the planks of a boardwalk to allow water to drain from the surface. A grate is an example of an opening that is a framework of latticed or parallel bars that prevents large obstacles from falling through a drainage inlet but permits water and some sediment to pass through. Another example of an opening is the flangeway gap at a railroad crossing.

Whenever possible, openings should not be located within the trail tread because wheelchair casters, cane tips, inline skate wheels, and bicycle tires can all get caught in trail openings. When placing openings in the trail tread is unavoidable, they should be designed according to the following recommendations:

- Opening width — The size of the open space should not permit a

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13 mm (0.5 in) diameter sphere to pass through the opening. When the size of an opening must exceed 13 mm (0.5 in), a slightly wider gap may be created. The size of the gap should not exceed 19 mm (0.75 in.) under any circumstances.

- Opening orientation — If the open space is elongated, it should be oriented so that the long dimension is perpendicular or diagonal to the dominant direction of travel. An elongated opening may be parallel to the dominant direction of travel if the opening does not permit the passage of a 6 mm (0.25 in) diameter sphere.

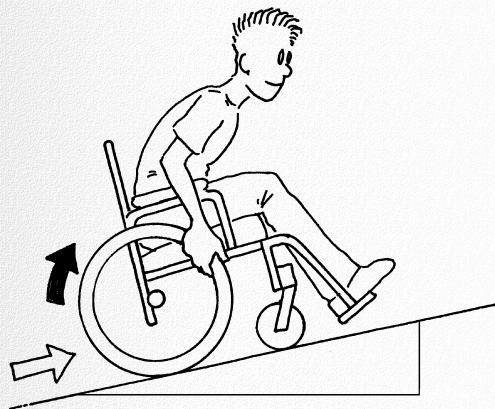


Figure 15-9. Steep trail grades are a significant barrier to access for many pedestrians with mobility impairments.

15.5 Trail grades and cross slopes

All individuals, with and without disabilities, must exert more energy to traverse upward on sloped surfaces than on level surfaces. For some individuals, such as those who use manual wheelchairs,

the difference in energy for sloped versus level surfaces is significant. In contrast, powered wheelchair users do not exert more energy on sloped surfaces; however, they do use more battery power on steep grades and end up with reduced travel range as a result. In addition, many individuals with mobility impairments, including both powered and manual wheelchair users, are less stable on sloped surfaces.

15.5.1 Grade

People with mobility impairments have a difficult time negotiating steep grades because of the additional effort required for mobility. Manual wheelchair users may travel very rapidly on downhill pathways, but will be significantly slower on uphill segments. Steep running grades are particularly difficult for users with mobility impairments when resting opportunities are not provided. Furthermore, less severe grades that extend over longer distances may tire users as much as shorter, steeper grades.

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15.5.1.1 Recommended grade specifications

In general, running grades on recreation trails should not exceed 5 percent, and the most gradual slope possible should be used at all times. When trails must be built with steeper grades, it is essential that the lengths of the maximum grade segments are minimized to enhance accessibility and grade segments are free of other access barriers. Users should not be required to expend additional efforts to simultaneously deal with factors such as soft surfaces, steep cross slopes, narrow tread widths, or obstacles.

When it is not possible to have running grades that are 5 percent or less, the following recommended guidelines should be used for designing maximum grades over short intervals:

- 8.3 percent for a maximum of 61.0 m (200 ft);
- 10 percent for a maximum of 9.14 m (30 ft); and

- 12.5 percent for a maximum of 3.05 m (10 ft).

On recreation trails, a 14 percent maximum grade is acceptable for open drains when resting intervals are provided every 1.525 m (5 ft), and the maximum cross slope is 5 percent. Furthermore, the total running slope should not exceed 8.3 percent for 30 percent or more of the trail.

15.5.1.2 Grades that do not meet accessibility recommendations

Research evaluating the impact of grade on trail accessibility is extremely limited. The National Center on Accessibility supported a pilot study to examine the slopes that people with disabilities are capable of negotiating and those slopes perceived as easy to moderate (Axelson, Chesney, and Longmuir, 1995). Results of the study must be interpreted with caution because of the wide range of disabilities (none, vision impairment, ambulatory with mobility impairments,

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manual wheelchair user) among the small group of 12 participants.

Results of this research showed that participants were capable of negotiating grades of 20 percent or more for a short distance of 2.5 m (8 ft). However, while it may be possible for individuals with disabilities to negotiate a 20 percent grade with an “all out” effort, it is inappropriate for a trail to be designed with such a steep slope.

In designing trails where it is not possible to comply with the recommendations for average and maximum grade, consideration should be given to grades that the largest proportion of users will be able to negotiate. The 1995 pilot research project by Axelson, Chesney, and Longmuir was conducted over a distance of 2.5 m (8 ft) on a firm and stable (plywood) surface. The results indicated that slopes over a short distance of 2.5 m (8 ft) were rated as easy if they had a:

- Grade of 10 percent or less with no cross slope;

- Grade of 8 percent or less with a cross slope of 5 percent or less; or
- Grade of 5 percent or less with a cross slope of 8 percent or less.

Slopes over a short distance of 2.5 m (8 ft) were rated as moderate if they had a:

- Grade of 14 percent or less with a cross slope of 8 percent or less; or
- Grade of 10 percent or less with a cross slope of 12 percent or less.

Based on this information, it is clear that an 8 percent grade with a 5 percent cross slope would be considered “easy” over a very short distance [2.5 m (8 ft)]. The proposed design guidelines from the Regulatory Negotiation Committee on Accessibility Guidelines for Outdoor Developed Areas (U.S. Access Board, 1999b) allow this combination of slopes for a much longer distance [maximum of 61.0 m (200 ft)]. The perceived difficulty would be expected to increase as the distance increased.

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To further examine the effects of trail length with grade and cross slope, additional research was completed with support from the National Institutes of Health (Axelson, et al, 1998). 38 volunteers with disabilities (7 manual wheelchairs, 3 power wheelchairs, 2 crutches/canes, 8 vision impairments) and 18 volunteers without disabilities hiked sections of trail that were between 213 m and 305 m (700 ft and 1000 ft) in length. The trail sections were selected because they had relatively consistent grade and cross slope conditions. All trail sections had a non-paved but relatively firm and stable surface. The results of this research indicate that:

- Trail sections were rated as easy if they had a grade of 5 percent or less with cross slope less than 1 percent;
- Trail sections were rated as moderate if they had a grade of 8 percent or less with a cross slope of 2 percent or less; and

- Grades of 8 percent or less with a cross slope of 6 percent or less were considered moderate by most trail users, but difficult by individuals using a manual wheelchair; and
- Grades exceeding 15 percent were considered difficult by all trail users.

Comparing the results from these two studies indicates that trails designed within the proposed U.S. Access Board recommendations [i.e., grades of up to 8 percent with cross slopes of up to 5 percent for up to 61.0 m (200 ft)] would be considered moderate to difficult for most trail users. These results also indicate that the same grade and cross slope is perceived as more difficult if it continues over a long distance.

In designing trails where it is not possible to comply with the recommendations for average and maximum grade, consideration should be given to grades that the largest proportion of users will be able to comfortably negotiate.

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15.5.1.3 Grade transitions and rest intervals

Before and after segments of steep grades, within 7.62 m (25 ft) of the top or bottom of a maximum grade segment, a rest interval should be provided where the running grade gradually transitions to a slope of less than 5 percent. The rest interval is not expected to be located immediately adjacent to the maximum grade segment to avoid an abrupt or rapid change in grade (see Section 15.5.1.5). Rest intervals may overlap the trail tread, but a preferable design is to have the rest interval located adjacent to the trail to enhance the safety and convenience of all trail users. A rest interval should be designed as follows:

- With a slope not exceeding 5 percent in any direction;
- On a firm and stable surface;
- With a width equal to or greater than the width of the trail segment leading to and from the rest interval;

- With a minimum length of 1.525 m (60 in); and
- With a gradual change of grade and cross slope on the segment connecting the rest interval with the trail.

15.5.1.4 Trails through steep terrain

Switchbacks are commonly used in steep terrain to minimize the trail grade by increasing the length of the trail. To enhance access, the trail grades should be designed using the recommendations for maximum grade (see Section 15.5.1.1) and the turning area should have a slope not greater than 5 percent in any direction. Switchbacks should be designed to work with the natural drainage patterns of the terrain. If a switchback does not drain well, the surface will become soft or eroded, and the efforts intended to reduce the grade will actually create additional access barriers.

When long switchbacks are installed, natural barriers, such as rocks or thick

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Figure 15-10. POTENTIAL PROBLEM: This switchback will result in difficult travel for wheelchair users because the slope is greater than 5 percent at the turning area.

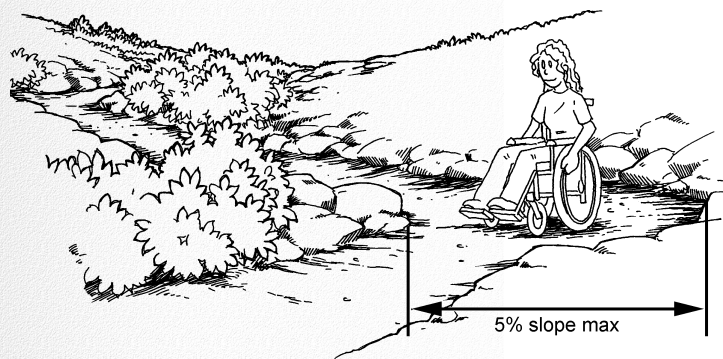


Figure 15-11. GOOD DESIGN: A turning area with a slope equal to or less than 5 percent in any direction enhances access on a trail with switchbacks.

vegetation, should be strategically located to prevent users who do not have difficulties with steep grades from carving a shorter path. If natural barriers are not available, installing landscaping, such as shrubs, along switchbacks is also an effective method to prevent hikers from creating way trails. A way trail is an informal path created by users that allows them to travel a shorter distance by cutting across the land between the switchbacks. Short switchbacks should be avoided because they encourage users to create way trails to avoid traversing the entire switchback. Way trails between switchbacks hasten soil erosion and destroy the surrounding vegetation.

On narrow switchbacks where bicycles are not permitted, edge protection should be provided wherever there is a severe drop off adjacent to the trail. Edge protection should be replaced with a railing if the recreation trail serves high-speed users such as mountain bicyclists. A smooth transition and a gradual change of grade from the trail grade to the switchback will also benefit users traveling at faster speeds.

15.5.1.5 Change of grade

A change of grade is an abrupt difference between the grades of two adjacent surfaces. When considering the needs of pedestrians, change of grade can be evaluated over a 610 mm (2 ft) interval, which represents the approximate length of a single walking pace and the base of support of assistive devices, such as a wheelchair or walker. The design recommendations for change of grade specify the relationship between two adjacent surfaces — not the actual grade of either surface.

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The exact change of grade that will be problematic varies between wheelchair users and is dependent on a variety of factors including the wheelchair design and the user's speed. Additional research is needed to provide a more comprehensive evaluation of the impact of change of grade on wheelchair users. Until more research is completed, the recommended maximum for change of grade is 11 percent. This value corresponds to the maximum change of grade permitted for the transition from the curb ramp through the gutter and onto the street (Section 7.3.7).

In the trail environment, a good understanding of the change of grade can be determined by:

- Adding the two grades together if the pre- and post-transition grades are in opposite directions (e.g., one uphill and one downhill). For example, if the first segment of trail is 8 percent and the second segment of trail is 6 percent, the change of grade would be 14 percent ($8 + 6 = 14$); or
- Subtracting one grade from the other if the pre- and post-transition grades are in the same direction (e.g., an uphill followed by a significantly steeper uphill). For example, if a trail segment with an 8 percent grade leads up to a trail segment with a 15 percent grade, the change of grade would be 7 percent ($15 - 8 = 7$).

A rapid change of grade may be difficult to negotiate because the footrests or anti-tip devices of a wheelchair cannot clear the ground surface. In general, wheelchair footrests are positioned low to the ground and extend beyond the front casters. Anti-tip devices are placed behind the rear axle of some wheelchairs to prevent the wheelchair from tipping over backwards. Both devices limit the clearance height of the wheelchair. At an abrupt change of grade, the footrests or anti-tip devices may contact the surface causing the wheelchair to stop suddenly or the rear wheels may lose contact with the ground.

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A further complication associated with severe changes in grade is the increased risk of tipping if the wheelchair user is traveling fast. If the footrests catch on the ground while the user is traveling fast, the momentum of the individual and wheelchair may cause the wheelchair to tip forward.

If the user moves quickly through the change in grade, the dynamic stability of the wheelchair may be compromised. Dynamic stability can be compromised because the momentum of the wheelchair will rotate backwards as the wheelchair climbs uphill. If there is a severe change in grade, this could cause the wheelchair to tip over backwards. Any amount of height difference between the two graded segments can further contribute to the stability problems experienced by wheelchair users.

An abrupt change of grade from an uphill to a downhill surface is also potentially hazardous. Although in this situation there is little or no risk of inadequate ground clearance for the footrests or anti-tip devices, an uphill

to downhill grade transition can also compromise the dynamic stability of the wheelchair. For example, when an individual travels up a steep slope, their weight is pushed back onto the rear wheels of the wheelchair. As the wheelchair transitions to the downhill slope, the weight and momentum shifts forward and down onto the smaller front caster wheels. The more abrupt the change of grade, the more sudden and forceful the transfer of momentum. If the transition is too severe, the wheelchair could tip forward.

The actual change of grade that will become problematic or potentially hazardous for any given user will depend on a number of factors including the type and setup of the wheelchair. Mountain-bike wheelchairs have a longer wheelbase and higher ground clearance resulting in greater stability and a lower probability of the footrests contacting the ground on changing surfaces. In contrast, movement of a sports wheelchair with a short wheelbase, small front caster wheels, and anti-tip devices may be compromised even when the change of grade is less than 13 percent.

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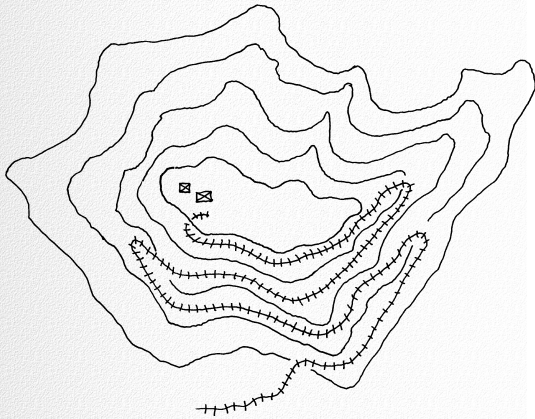


Figure 15-12. GOOD DESIGN: Curvilinear trails, such as converted railbeds to railtrails, follow the natural path of the environment and generally have more gradual grades.

15.5.1.6 Curvilinear trails

Trails should be designed so that they cross contour lines at a small angle. A curvilinear trail is one aligned to follow the natural contours of the environment. A curvilinear trail alignment will allow the trail to gain elevation gradually in conjunction with the natural contours of the terrain. This type of design generally:

- Minimizes maintenance;
- Preserves the natural resource; and
- Makes use of natural drainage patterns.

In contrast to trails that cut across natural contours, curvilinear trails usually feature natural and gradual changes in trail grade and direction. A curvilinear trail alignment is usually the best path for access.

15.5.1.7 Trails with steps

Steps are used in areas where the trail gains elevation quickly. A series of steps allows the remainder of the trail to have a less steep grade and reduces the risk of trail erosion or washouts. Steps may be preferred to steeply graded trail sections by individuals who use crutches or canes. However, steps create a significant barrier to individuals who use wheelchairs and should be used minimally, if at all. Steps must not be included in new construction. If steps are already incorporated into the design of existing trails, the following best practices should be implemented:

- Install a switchback or alternate side trail to allow users to avoid the steps;
- Provide signage indicating the size, number, and location of the steps along the trail at the trail entrance or trailhead; and

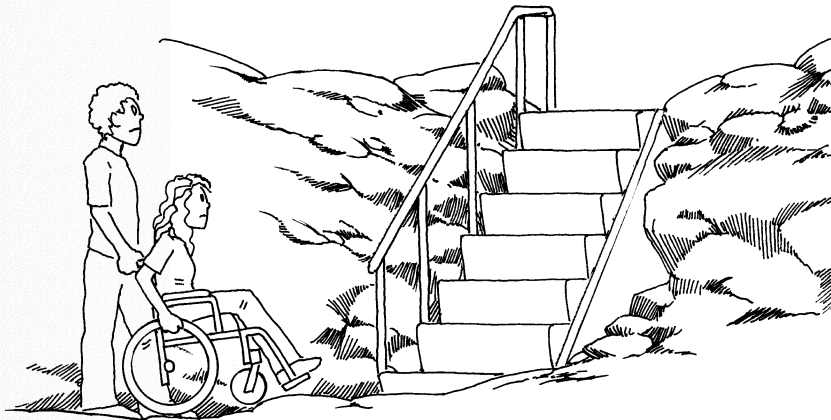
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Figure 15-13.

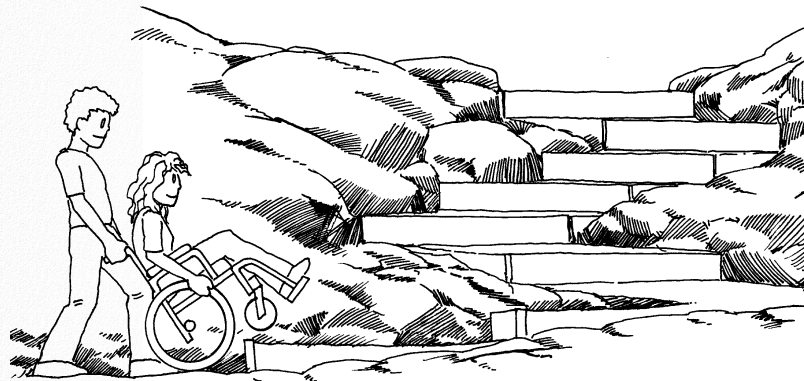
PROBLEM: While steps enhance access for some users, they are an access barrier for wheelchair users. If stairs are used, an alternative accessible route should be provided. A bike track should be added to stairs on multi-use paths.



- Install barriers or brush at the edge of the trail to ensure that trail users travel over the steps. If the trail is not designed to require people to use the steps, some trail users, such as bicyclists, may find ways to travel around the steps. A wheel track along the side of the stairs will encourage bicyclists to use the stairs. If many people travel around the steps, it will increase erosion, increase trail width, and decrease drainage efficiency, all of which may reduce the accessibility of the trail over the long term.

Figure 15-14.

ACCEPTABLE DESIGN: Stairs should only be installed if they serve a vital trail requirement and no alternative design will work. If stairs are installed on the trail, designers should try to minimize the height of steps and placing steps far apart. Wheelchair users will rarely be able to negotiate steps without assistance.



Most wheelchair users will not be able to traverse steps independently. Powered wheelchairs are significantly heavier than manual wheelchairs, which makes step negotiation almost impossible, even with assistance. Although all steps are problematic for wheelchair users, the design of the steps can improve access for other trail users. While stairs should not be incorporated into the design of new trails, if stairs do exist it is recommended that

they be redesigned to increase usability. Stair access can be maximized for wheelchair users by:

- Minimizing the height of each riser; and
- Spacing risers at least 1.525 m (60 in) apart so wheelchair users and others only need to negotiate one step at a time.

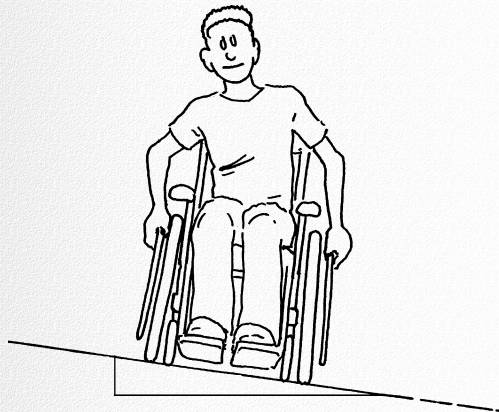


Figure 15-15. Wheelchair users traveling on a trail with a cross slope have to use more energy to travel in a straight line to offset the force of gravity that directs them sideways.

15.5.2 Cross slope and drainage

Severe cross slopes can make it difficult for wheelchair users and other hikers to maintain their lateral balance because they must work against the force of gravity. Cross slopes can also cause wheelchairs to veer downhill. In addition, individuals using crutches often cannot compensate for the height differential created by severe cross slopes.

15.5.2.1 Recommended cross slope specifications

Designers must balance the negative effect cross slope has on pedestrian

mobility against the necessity of including cross slope to provide adequate drainage. On most paved surfaces, 2 percent is adequate for drainage. However, cross slopes up to 5 percent may be necessary for drainage on non-paved surfaces, such as crushed limestone. Particular attention should be paid to drainage in steep terrain because the velocity of the water flow will be significant and more cross slope will be required to direct the water to the side of the trail rather than down the center of the path. If water cannot be adequately routed off an unpaved trail using a 5 percent cross slope, a more significant cross slope may be needed. Cross slopes may increase to 10 percent at the bottom of an open drain if the trail path width is a minimum of 1.065 m (42 in).

15.5.2.2 Cross slopes that do not meet accessibility recommendations

Research evaluating the impact of cross slope on trail accessibility is extremely limited. Results of the pilot research supported by the National Center

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on Accessibility indicate that some people with disabilities are capable of negotiating cross slopes of 15 percent or more for distances of 2.5 m (8 ft) or less depending on the type of mobility impairment and assistive device used (Axelson, Chesney, and Longmuir, 1995). Recreation trails are seldom designed with cross slopes as steep as 15 percent. Therefore, designers should expect that people with disabilities will utilize every trail that they design. However, while it may be possible for some individuals with disabilities to negotiate a 15 percent cross slope over a short distance with an “all out” effort, it is inappropriate for a trail to be designed to such a standard.

In designing trails where it is not possible to comply with the recommended standards for cross slope, consideration should be given to cross slopes that the largest proportion of users will be able to comfortably negotiate. The 1995 pilot research project by Axelson, Chesney, and Longmuir was conducted over a distance of 2.5 m (8 ft) on a firm and stable (plywood) surface. The results indicated the following:

Slopes for a distance of 2.5 m (8 ft) were rated as easy if they had a:

- Cross slope of 8 percent or less with a grade of 5 percent or less;
- Cross slope of 5 percent or less with a grade of 8 percent or less; or
- Cross slope of 3 percent or less with a grade of 10 percent or less.

Slopes for a distance of 2.5 m (8 ft) were rated as moderate if they had a:

- Cross slope of 12 percent or less with a grade of 10 percent or less; or
- Cross slope of 8 percent or less with a grade of 14 percent or less.

Based on this information, a 5 percent cross slope with an 8 percent grade would be considered “easy” over a very short distance [2.5 m (8 ft)]. The proposed design guidelines from the Regulatory Negotiation Committee on Accessibility Guidelines for Outdoor Developed Areas

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(U.S. Access Board, 1999b) allow this combination of slopes for a much longer distance [maximum of 61 m (200 ft)]. The perceived difficulty would be expected to increase as the distance increased.

15.5.2.3 Change of cross slope

A change of cross slope is an abrupt difference between the cross slope of two adjacent surfaces. When considering the needs of pedestrians, change of cross slope is evaluated over a 610 mm (2 ft) interval, which represents the approximate length of a single walking pace and the base of support of assistive devices such as a wheelchair or walker. The design recommendations for change of cross slope specify the relationship between two adjacent surfaces, not the actual cross slope of either surface.

The exact change of cross slope that will be problematic varies between wheelchair users and is dependent on a variety of factors, including the wheelchair design and the user's speed. Additional research is needed to provide a more

comprehensive evaluation of the impact of change of cross slope on wheelchair users. Until more research is completed, the change of cross slope should not exceed 5 percent. This means that a cross slope that changed from 2 percent to 8 percent over an interval shorter than 610 mm (2 ft) would not be acceptable. For open drains with cross slopes up to 10 percent, the change should happen gradually so that no 610 mm (2 ft) interval changes more than 5 percent.

When the change of cross slope is severe, one wheel of a wheelchair or one leg of a walker may lose contact with the ground causing the user to fall. Other walking pedestrians are also more prone to stumbling or falling on surfaces with rapidly changing cross slopes. An example of a situation where the change of cross slope might exceed 5 percent occurs at a washed out trail segment where the outslope of the trail has significantly increased due to erosion. As the wheelchair moves from the level surface of the trail to the outsloped surface, it will first balance on the two rear wheels and

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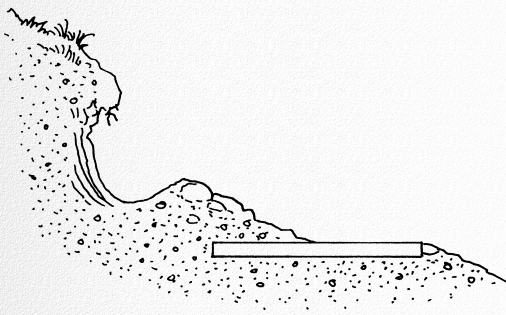


Figure 15-16. Erosion reduces the clear tread width of a trail limiting access for all users.

one front caster. As the wheelchair moves forward, it then tips onto both front casters and one rear wheel. During the transition, the wheelchair is only on one front wheel and one rear wheel. This transition may cause the wheelchair user to lose directional control because both rear wheels are not on the ground. This is especially dangerous at a drop-off, where the user may be at risk of falling off the edge of the trail.

15.5.2.4 Minimizing erosion through natural drainage patterns

Natural drainage paths should be maintained and encouraged whenever possible. Trails should be designed to incorporate natural drainage patterns rather than trying to construct drainage channels. Trails that limit natural drainage patterns will quickly become the drainage channel, as water always seeks the path of least resistance. The trail surface provides an excellent channel for drainage because the soil is often compacted so that the trail surface is lower than the surrounding

terrain. In addition, the trail surface is relatively free of obstacles providing a clear path of travel for surface water. For these reasons, when the natural drainage channel is obstructed, the trail is where the water channels. The resulting erosion, surface saturation, and high frequency of water flow on the trail will significantly limit trail access for all users.

Erosion on a trail is usually a function of poor trail design or construction. Inaccurate consideration of soil types and natural drainage patterns are the most common causes of trail erosion. Erosion and drainage problems create barriers for all users but may be particularly hazardous for people with disabilities, who may have more difficulty avoiding the problem area. Trail designs that ensure adequate drainage and the installation of appropriate drainage control mechanisms are the most effective means of maximizing trail access.

In many instances, trail managers are left to minimize the impact of poor trail designs if there is not an opportunity to reconstruct or redesign the trail.

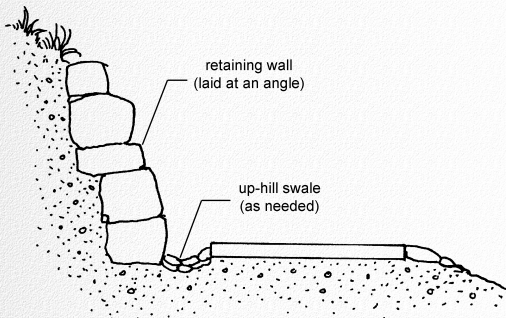


Figure 15-17. Retaining walls prevent debris from building up on the trail surface and stabilize the width of the trail.

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Accumulated soil or other debris on the trail poses a hazard for all users and significantly reduces the accessibility of the trail. The use of retaining walls and planting vegetation to stabilize the affected area can help to reduce the build up of debris.

Retaining walls are an effective means of preventing trail degradation. To meet the needs of people with disabilities, retaining walls should be located outside of the trail tread. Retaining walls inherently limit the ability of the trail user to move off of the beaten path. The combination of a retaining wall with a large obstacle on the opposite side of the trail bed (e.g., drop off, tree) will create a minimum passage space and may restrict access for people who require a wider trail tread, such as those who use wheelchairs. Whenever possible, the usable trail tread should be at least 915 mm (36 in) for a pedestrian trail (see Section 15.6). If the minimum passage space cannot be modified and is less than 915 mm (36 in),

information about the size and location of the minimum clear width should be provided to potential trail users so that they can avoid this frustrating or hazardous situation. The trail width information should be made available to users before they access the trail and may be provided in a variety of formats, such as signage or maps (see Section 15.8).

15.5.2.5 Waterbars

Waterbars are drainage structures that stretch across the width of the trail and direct water to the edge of the path. Traditionally, they have been built using a log or a piece of wood. Other designs use materials such as rocks or flexible rubber. With the exception of the rubber material, water bars tend to be obstacles for people using wheeled devices, such as bicycles or wheelchairs, because they are raised as much as 152 mm (6 in) above the tread and extend across the full width of the path. A need for waterbars indicates that the natural drainage of the terrain was not adequately considered during trail design, layout, and construction. The use of

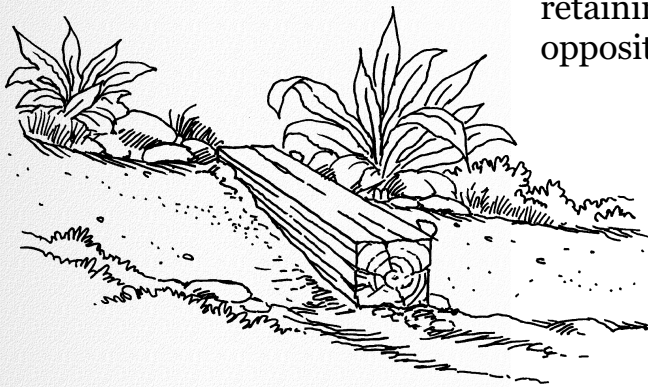


Figure 15-18. Non-flexible waterbars, such as a piece of wood or a log, are barriers for people with mobility impairments.

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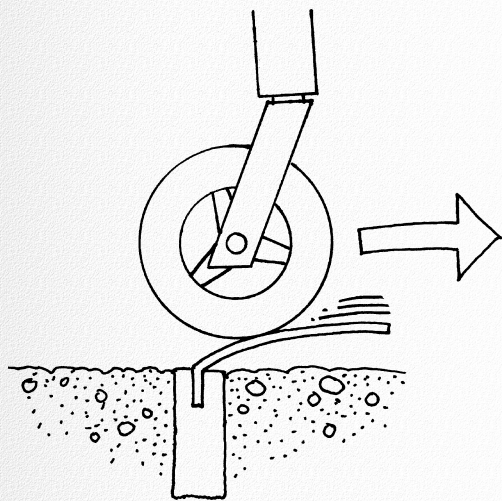


Figure 15-19. Flexible waterbars control drainage on a trail and are easier for wheelchair users to travel over.

waterbars to control drainage on a trail should be minimized whenever possible with the following alternatives:

- Redesign the trail with strategic increases in grades and cross slopes to direct or sheet the water off of the trail;
- Realign the trail to take advantage of natural drainage patterns; and
- Install drainage swales or mounds (see Figure 15-22) to channel water off the trail.

At best, waterbars are a temporary solution to drainage problems. Most users will choose to travel around waterbars whenever possible, particularly if their stability or mobility is limited. Once

enough users have cut around both sides of the waterbar, it will no longer effectively drain water off the trail. In addition, all waterbars require significant maintenance to function properly. Without appropriate maintenance, deposits of sediment on the uphill side of the waterbar will increase until water can flow over the waterbar. When this occurs, water running over the bar will actually increase erosion on the downhill side.

If a waterbar is installed, the best waterbar design, from an access perspective, is the rubber waterbar. This waterbar deflects water off the trail in the same way as other waterbars, but when a user encounters it, the bar is flexible enough to collapse. Waterbars made of flexible rubber will bend under the user's weight and therefore provide greater accessibility. Rather than having to travel over a 152 mm (6 in) obstacle, a pedestrian or cyclist can travel over a nearly flattened rubber surface. To be effective, rubber water bars must be flexible enough to be pushed down easily by all users from either direction of travel.

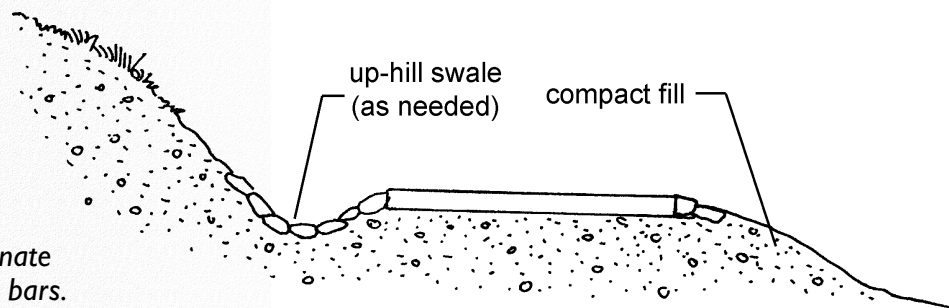


Figure 15-20. Swales can control drainage and eliminate the need for water bars.

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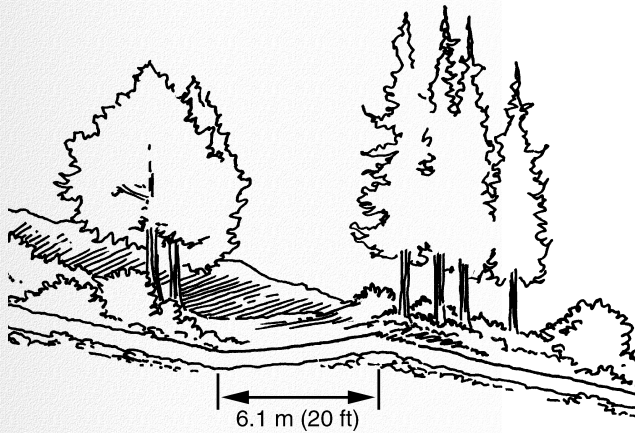


Figure 15-21. When included in new construction or alterations, drainage dips can significantly improve drainage without placing an obstacle, such as waterbars, in the trail tread.

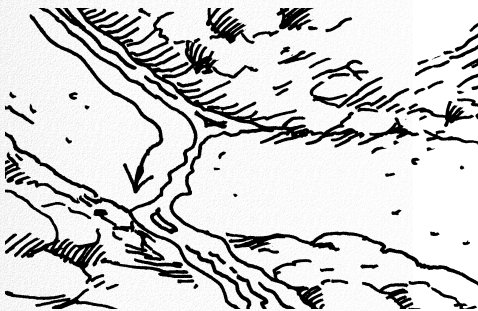


Figure 15-22. Drainage dips on recreation trails act as open drains. The cross slope of the open drain should not exceed 10 percent, and the clear tread width should be at least 1.065 m (42 in) minimum.

15.5.2.6 Trails in regions with heavy rain

Although drainage is a critical issue for the design and maintenance of all trails, it is particularly important in areas that receive high amounts of precipitation. Of greatest concern are areas that receive heavy rain events, although the effects of the spring melt in regions with significant snow accumulation can create similar problems. The following techniques can improve the accessibility of trails that receive heavy rain events:

- Installing drainage structures, such as culverts or bridges;
- Using drainage dips;
- Using swales;
- Elevating the trail on a boardwalk to ensure that

users have access to a firm and stable surface under all conditions; and

- Incorporating maximum cross slopes (no greater than 10 percent) for short distances at open drains, provided that the clear tread width is at least 1.065 m (42 in) wide.

It is vital that areas that receive large amounts of water address drainage issues during the development stage of a trail to avoid having to make retrofit improvements.

15.5.3 Rest areas

Periodic rest areas are beneficial for all recreation trail users, particularly for people with mobility impairments who expend more effort to walk than other pedestrians. Rest areas are especially crucial when grade or cross slope demands increase. The frequency of rest areas should vary depending on the terrain and intended use. For example, heavily used recreation trails should have more frequent opportunities for rest than

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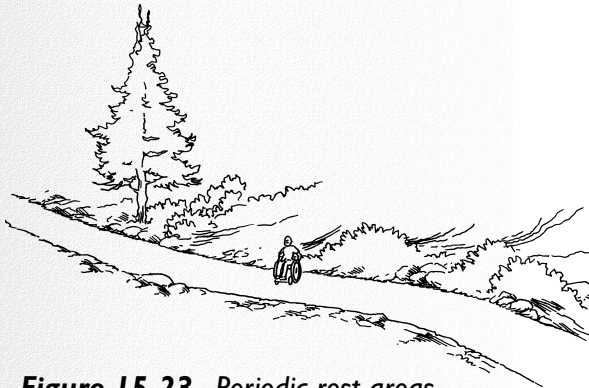


Figure 15-23. Periodic rest areas are particularly beneficial to people with mobility impairments who expend more effort to walk than other pedestrians. Rest areas should be created where there is an increase in grade or cross slope.

backcountry trails with fewer users. Rest areas provide an opportunity for users to move off the trail in order to stop and rest. If a rest area is only provided on one side of the trail, it should be on the uphill side. However, separate rest areas on both sides of the trail is preferred when there is a higher volume or speed of traffic. This discourages users from crossing in front of users moving in the opposite direction.

A rest area will have many of the same characteristics as a rest interval (see 15.5.1.3), however the additional space allows for more amenities. In general, rest areas should have the following design characteristics:

- Grades that do not exceed 5 percent;
- Cross slopes on paved surfaces that do not exceed 2 percent and cross slopes on unpaved surfaces that do not exceed 5 percent;
- A firm and stable surface;

- A width equal to or greater than the width of the trail segment leading to and from the rest area;
- A minimum length of 1.525 m (60 in);
- A minimal change of grade and cross slope on the segment connecting the rest area with the main pathway; and
- Accessible designs for amenities such as benches, where provided.

Benches can be particularly important for people with disabilities, who may have difficulty getting up from a seated position on the ground. Some benches should have backrests to provide support when resting, and at least one armrest to provide support as the user resumes a standing position. Accessible seating should have the same benefits as seating for users without disabilities. For example, providing a wheelchair space facing away from the intended view would not be appropriate.

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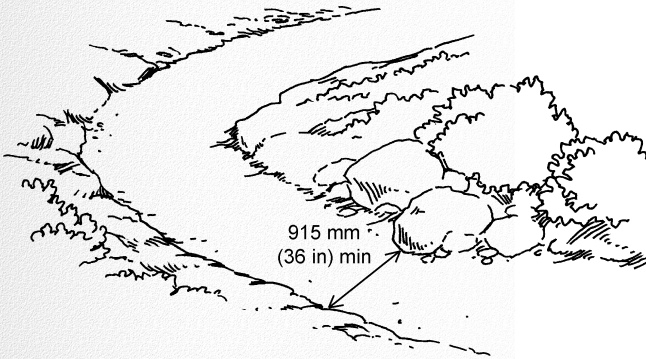


Figure 15-24. If an object must protrude into the travel space, it must not extend past the minimum 915 mm (36 in) clear tread width.

15.6 Trail tread width

The width of the trail tread not only affects pedestrian usability but also determines the types of users that will have access. Recreation trails designed for pedestrian use should have a minimum tread width of 915 mm (36 in).

However, it is recommended that the tread width be at least 1.525 m (60 in) wide when possible. This allows space for people using assistive devices, such as a wheelchair, stroller, or walker, to easily pass one another. If a narrower passage space is unavoidable, for example between two rock beds, the trail width may be reduced to 815 mm (32 in) for short distances.

In addition to providing for clear passage, designers should also consider that most pedestrians tend to avoid path edges. They chose to travel in the center of the trail to avoid drop-offs and untrimmed vegetation. The tendency of pedestrians

to avoid the edges of a path increases the width required for a given path to be usable. In contrast, individuals with limited vision who use a cane for guidance tend to travel primarily along the edge of the trail surface, using the difference between the trail and the surrounding brush to provide direction. The movement patterns of other designated user groups should also be considered when designing the width of a trail. For example, cross-country skiers may use a lateral foot motion for propulsion that is wider than the stride of most pedestrians. The width required to accommodate this motion increases when skiers ascend grades or pick up speed. As a result, trails permitting these users should be wider than trails that are designated solely for pedestrians.

15.6.1 Trails with vegetation

For all trails, the section cleared on either side of the tread width should be wide enough to prevent vegetation from encroaching on the trail between periods

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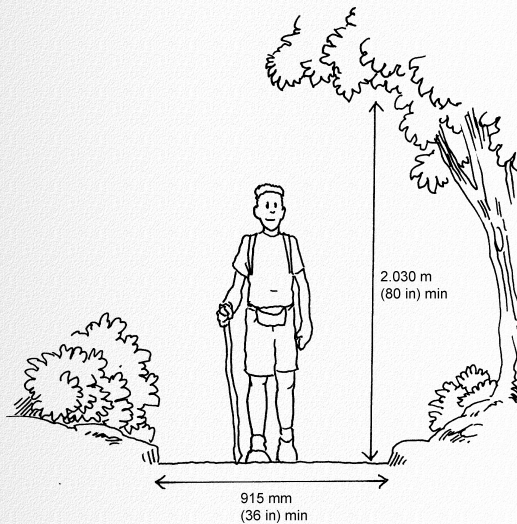


Figure 15-25. A clear area that is wider and taller than the trail tread width should be created to prevent vegetation, such as tree limbs, from encroaching into the trail and creating protruding objects.

of scheduled maintenance. Trails in areas with heavy vegetation require additional width on either side of the trail tread to prevent the growth of grasses or ground cover from significantly increasing the energy required to traverse the trail. Overgrowth can also hinder a user's ability to see other trail users, increasing the possibility of collisions. Overgrowth also limits a user's awareness of minor changes in the ground surface, increasing the risk of falls.

Although the extent of vegetation that must be cleared will depend on the type of vegetation, frequency of maintenance, and permitted trail user groups, the following recommendations should be considered:

- Whenever possible, the path should be cleared beyond the trail tread and above the required vertical clearance height to reduce maintenance requirements;
- At a minimum, vegetation should be cleared to the width of the beaten path and the height of the tallest user group; and

- On trails that accumulate a significant amount of snow in the winter, the clearance height should be measured from the height of the maximum snow level rather than from ground level to accommodate cross country skiers and other winter trail users.

15.6.2 Passing space

Periodic passing spaces allow trail users to pass one another and provide wheelchair users enough maneuvering room to turn around. Slower pedestrians benefit from passing spaces because faster users can travel by them with less disruption. On recreation trails that are narrower than 1.525 m (60 in), passing spaces should be at least 1.525 m x 1.525 m (60 in x 60 in) and should be provided at least every 305 m (1000 ft). Passing spaces should be provided more frequently if the terrain is challenging and there is no space to pull off of the trail to allow others to pass. Passing spaces should also be provided more frequently if the trail is

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Figure 15-26. Objects, such as tree limbs, that protrude into the recreation trail tread more than 101 mm (4 in) should be removed.

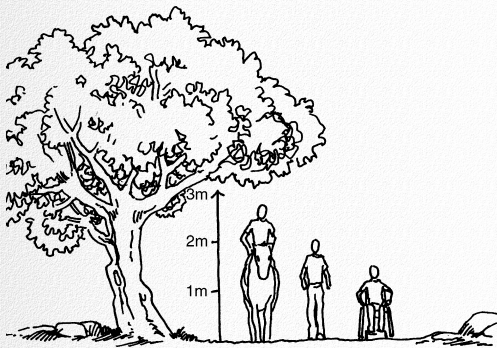


Figure 15-27. Overhead branches should be maintained to a height that is sufficient for all expected users of a recreation trail.

narrow and sight distances are restricted enough that a trail user may unexpectedly encounter somebody traveling in the opposite direction in an area where passing is not possible.

15.6.3 Protruding objects and vertical obstructions

Protruding objects are anything that overhangs or protrudes into the shared-use path tread, whether or not the object touches the surface. Examples of protruding objects include rock overhangs and tree limbs. People with vision impairments who use dog guides for navigation are able to avoid obstacles in the trail up to 2.030 m (80 in). Objects that protrude into a recreation trail but are higher than 2.030 m (80 in) tend to go unnoticed, because most pedestrians require less than 2.030 m (80 in) of headroom. People with vision impairments who use long white canes to navigate can easily detect objects on the trail that are below 685 mm (27 in). However, objects that protrude into the

pathway between 685 mm (27 in) and 2.030 m (80 in) are more difficult to detect because the cane will not always come in contact with the object before the pedestrian comes in contact with the object.

Ideally, objects should not protrude into any portion of the clear tread width of a recreation trail. If an object must protrude into the travel space, it should not extend more than 101 mm (4 in).

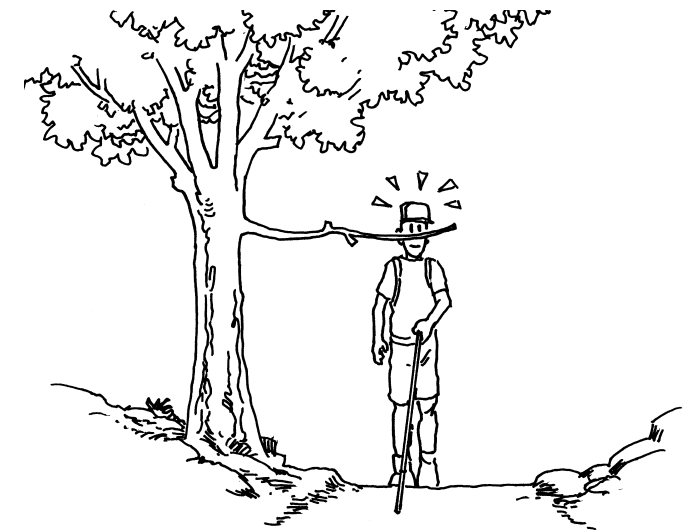


Figure 15-28. Objects that protrude into the pathway at a height greater than 685 mm (27 in) are difficult for pedestrians who use long white canes to detect.

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Because pedestrians with vision impairments do not always travel in the center of the trail tread, protruding objects should be eliminated from the entire tread width, as well as the clear trail width. If a protruding object cannot be removed, information about the size and location of the object should be conveyed to potential trail users before they access the trail. In addition, a barrier should be provided around the object so users will know to avoid the area. An example of a protruding object that cannot be removed would be a rock outcropping that overhangs the trail tread when the surrounding terrain does not permit the trail alignment to be changed.

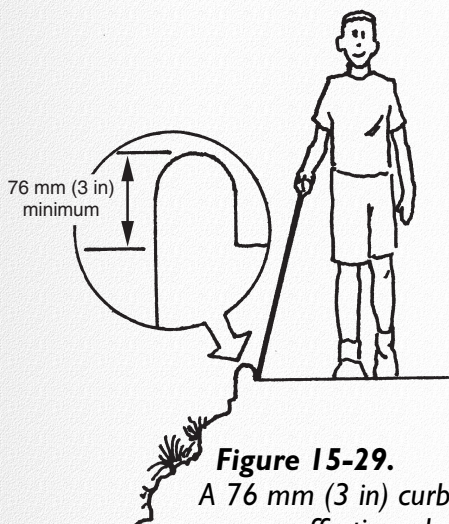


Figure 15-29.
A 76 mm (3 in) curb serves as effective edge protection on narrow trails and is more detectable by people with vision impairments than a shorter edge.

Trails should be built and maintained to an overhead clear height that is sufficient for all expected users of a trail. For example, equestrians require much higher clearances than pedestrians. Design of the trail clear height should also consider the user's location during all seasons and trail conditions. For example, cross country skiers may be on a "surface" that is several

feet above the same ground level that is used by hikers in the summer. A height of at least 2.5 m (96 in) should be provided for bicyclists and pedestrians, and at least 3.05 m (120 in) should be provided if equestrians or ATV riders use the path. Cross country skiers and snow machine users should have at least 2.5 m (96 in) above the average snow level. At the very minimum, recreation trails for pedestrian use only should provide 2.030 m (80 in) of headroom to protect trail users from vertical obstructions. On trails where there is the potential for emergency vehicles to gain access to areas, it is necessary to provide 3.05 m (10 ft) vertical clearance.

15.7 Edge protection

Edge protection serves as a barrier between the trail and the surrounding environment. Edge protection is installed to protect all trail users from a variety of elements including drop-offs and hazardous situations, such as poison oak or thermal areas. It is not necessary to

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install edge protection just because people with disabilities may be using the trail.

If bicyclists will be users of the trail, then edge protection should be a minimum of 1.066 m (42 in) high. Bicyclists are typically traveling more rapidly than other users and their center of gravity is higher. If they unexpectedly hit an edge protection that is less than 1.066 m (42 in), they are likely to flip forward into the hazardous situation.

On trails that do not permit bicycles, a variety of edge protection designs may be used; however, edge protection should generally be at least 76 mm (3 in) high. This is higher than standards for edge protection in built facilities because environments with a natural surface frequently contain small obstacles of 25 mm to 51 mm (1 in to 2 in) in height. As a result, individuals with vision impairments must adjust their obstacle detection to a slightly higher level. In addition, many wheelchairs designed for outdoor environments are capable of rolling over small obstacles, and, therefore, higher edge protection is required to ensure that it functions as intended.

15.8 Signs

Signs that clearly describe the recreation trail conditions are an essential component to enhance pedestrian access. Signs should be provided in an easy to understand format with limited text and graphics that are understood by all users. Providing accurate, objective information about actual recreation trail conditions will allow people to assess their own interests, experience, and skills in order to determine whether a particular recreation trail is appropriate or provides access to them with their assistive devices. Providing information about the condition of the recreation trail to users is strongly recommended for the following reasons:

- Users are less likely to find themselves in unsafe situations if they understand the demands of the recreation trail before beginning;
- Frustration is reduced and people are less likely to have to turn around on a recreation trail because they can identify impassible situations, such as steep grades, before they begin;

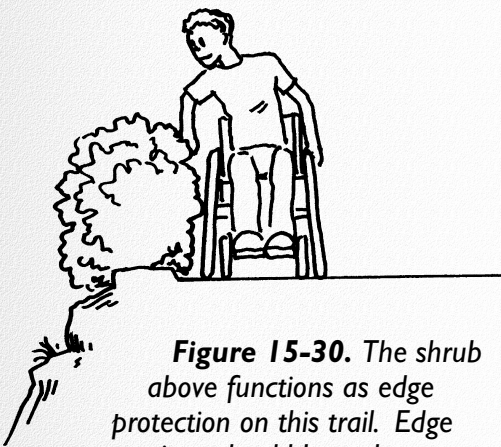


Figure 15-30. The shrub above functions as edge protection on this trail. Edge protections should be at least 76 mm (3 in) high.

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Figure 15-31. The symbols above have been included in the report of the Regulatory Negotiation Committee on Accessibility Guidelines for Outdoor Developed Areas. One of these symbols or a similar symbol will be selected to indicate a trail that meets the accessibility provisions for trails (U.S. Access Board, 1999b).



These are symbols that could be used to represent a trail that fully complies with Section 16.

- Users can select recreation trails that meet their skill level and desired experience;
- The level of satisfaction increases because the user is able to select a

recreation trail that meets his or her expectations; and

- If more difficult conditions will be encountered, users can prepare for the skill level and equipment required.

The Regulatory Negotiation Committee on Accessibility Guidelines for Outdoor Developed Areas specifies that a trail that meets accessibility provisions be designated with a universally understood symbol for “accessible trail.” The exact design of the symbol has yet to be developed, but several possible designs were included in their report.

In addition to the universal symbol, objective information about the trail conditions (e.g., grade, cross slope, surface, width, obstacles) should be provided. This information is needed regardless of whether or not the trail is accessible. Objective information is preferable to subjective trail difficulty ratings (e.g., easier, most difficult) because subjective ratings of difficulty typically

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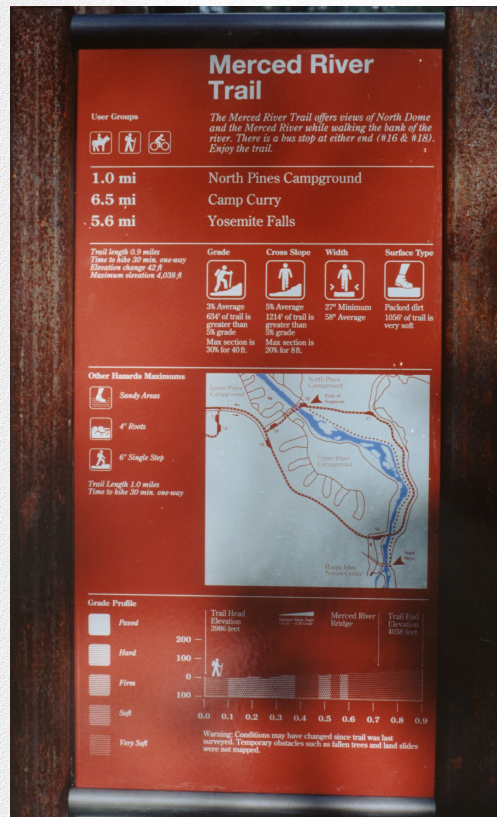


Figure 15-32. This sign at the Merced River Trailhead in Yosemite National Park allows users to assess whether or not the trail will meet their personal interests, experience, and skills by providing objective trail access information.

represent the perceptions of the person making the assessment and cannot be accurate or appropriate for the range of trail users. Individuals with respiratory or heart conditions as well as individuals with mobility impairments in particular are more likely to have different interpretations of trail difficulty than other users.

A variety of information formats may be used to convey objective trail information. The type of format should conform to the policy of the land management agency. For example, one agency may choose to provide trail information at the trailhead, while another may provide trail information at their visitor center. Written information should also be provided in alternative formats, such as Braille, large print, or an audible format. For example, the text of a trailhead sign made available on audiocassette or a digital voice recorder can be used to play the message with the touch of a button. In addition, simplified text and reliance on universal graphic symbols greatly enhances the comprehension of individuals with limited reading abilities.

The type and extent of the information provided will vary depending on the trail, environmental conditions, and expected users. For example, trails that attract predominantly experienced users and located in areas with few safety considerations may require fewer signs containing less detailed information than trails likely to be used by inexperienced people located in areas that will expose users to potential hazards. It is recommended that the following information should be objectively measured and conveyed to the trail user through appropriate information formats:

- Trail name;
- Permitted users;
- Trail length;
- Change in elevation over the total trail length and maximum elevation obtained;

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- Average running grade and maximum grades that will be encountered;
- Average and maximum cross slopes;
- Average tread width and minimum clear width;
- Type of surface;
- Location and length of any soft or unstable surfaces; and
- Size, location, and frequency of obstacles.