Natural Surface Trail Building

Common Structures and Techniques

About the New York-New Jersey Trail Conference

The New York-New Jersey Trail Conference is a volunteer-powered organization that builds, maintains, and protects public trails. Together with our partners, we strive to ensure that the trails and natural areas we share are sustainable and accessible for all to enjoy for generations to come.

The Trail Conference has partnered with parks to create, protect, and promote a network of over 2,100 miles of public trails in the New York-New Jersey metropolitan region. This work is supported by a membership of 10,000 individuals and 100 clubs, with a combined membership of over 100,000 active, outdoor-loving people.

The Trail Conference organizes volunteer service projects that keep these trails open, safe, and enjoyable for the public. We also publish maps and books that guide public use of these trails. Learn more at www.nynjtc.org.

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About This Document

There are numerous excellent resources which already exist to guide the construction of natural surface trails. The United States Forest Service has detailed Trail Plans and Specifications, along with the very useful Trail Construction and Maintenance Notebook. The Appalachian Mountain Club publishes a Field Guide to Trail Building and Maintenance, the Student Conservation Association has the famous book Lightly on the Land, and countless other trail organizations have excellent resources to draw from. Why, then, does the world need another trail construction document?

The need for this document became apparent not when *building* trails, but when trying to *explain* trail structures to people unfamiliar with them. These people often work in permit or compliance roles, and are used to dealing with industrial projects like buildings or roadworks – many have never visited a natural surface trail in their life, let alone become familiar with trail industry lingo.

As a result, permit applications for "culverts," crush fill," "drains," "turnpikes," or the dreaded "bridges" in the middle of preserved forests usually set off compliance alarm bells. In reality, when done correctly, adding trail structures does not *cause* significant damage to the environment – **it actually *prevents* it.** A major goal of this document is to equip trail advocates with resources to help land managers understand this.

Showing photographs of trail structures is often the quickest and easiest way to explain them. With that in mind, this document was created to be:

- **Visual:** Relying on full-color photographs, rather than words, to act as a catalog of common trail structures and techniques.

- **Varied:** Representative of the flexibility and creativity possible with trail building, showing various ways a structure could be implemented rather than presenting a single authoritative black-and white drawing or blueprint.

- **Digital:** A free PDF available to everyone, able to be shared as an attachment or link with partners and compliance agencies alongside your project applications.

- **Conservation-Minded:** While most trail building resources focus on *how* to build structures, we wanted to emphasize *why* structures need to be built. Someday we hope that environmental review processes will encourage the use of structures to minimize the impact of people moving through nature – not put regulations in place to discourage them.

We hope that this document is something that you can use to clarify trail building practices when talking to people who are just learning about the subject for the first time. Bring it to pre-application meetings, send screenshots to land management partners when proposing projects, and refer to the "Additional Resources" section at the end when you are ready for more detailed construction guidance.

Happy hiking!

What are Natural Surface Trails?

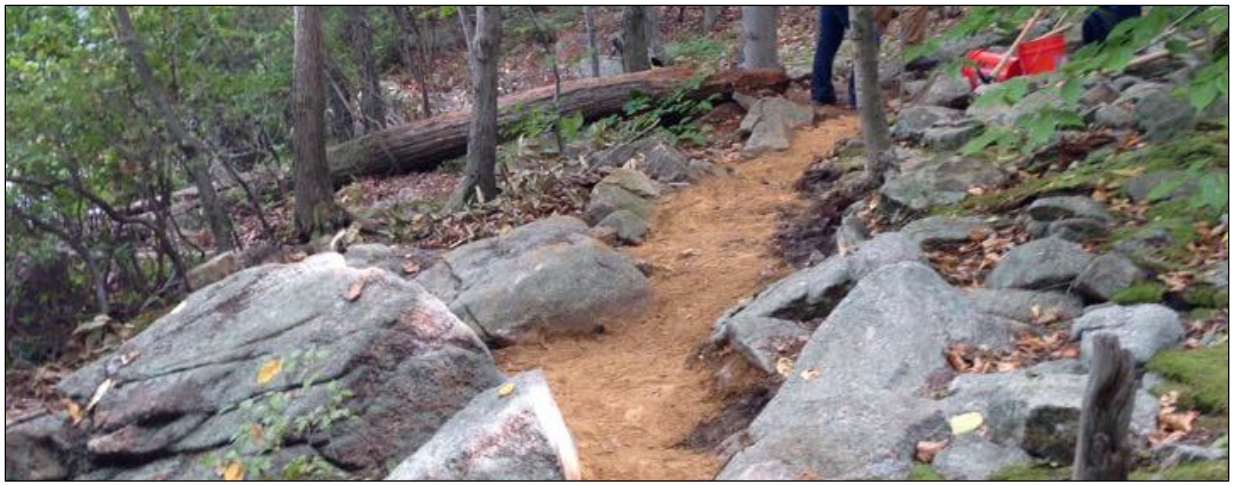
A trail, at its core, is simply a route leading from one point to another. Beyond that simplest of definitions, however, the term "trail" can quickly take on very different meanings to different people.

Trails can be as diverse as raked dirt paths, multi-million-dollar railroad conversions, three-lane urban commuter bikeways, sandy equestrian horse routes, "water trails" down the center of a river, seasonal snowmobile roads, designated lanes in a high-traffic paved street, or purely virtual mapped routes with no physical infrastructure.

A natural surface trail is made without pavement, typically by clearing and grading soil before surfacing with crushed stone if needed. Some trails are also referred to as "native surface trails," meaning that their construction relies exclusively upon local materials such as soil, stone, and timber sourced from the trail's immediate environment. Construction on natural surface trails is traditionally done with handheld tools, though small vehicles and specialized mechanized equipment are increasingly used to speed up construction – especially if stone crush surfacing is used, as is often required when a trail seeks to meet federal accessibility standards.

The intention of a natural surface trail is to **mitigate impacts on the surrounding environment and preserve the natural setting as much as possible while still creating a durable, sustainable surface** that is easy to maintain and provides a user experience that feels like "connecting with nature." Many trail builders consider it a great compliment when visitors believe the trail was always there, due to its natural appearance, rather than being built by people.

Constructed trail features, or trail structures, on a natural surface trail exist to facilitate these objectives where trail design and layout are either inadequate and/or insufficient. Structures are usually an essential part of long-term sustainability, as is described in more detail in the next section of this document.



A natural-surface trail, with the "peanut-butter" color of the trail tread coming from local mineral soil compacted into a firm walking surface.

Natural surface trail passing a glacial erratic.

A narrow single-track multi-use trail, with a tread surface roughly 18" wide.

Local mineral soil is often used to provide a stable and durable surface.

Timber and stone structures are compatible with natural surface trails.

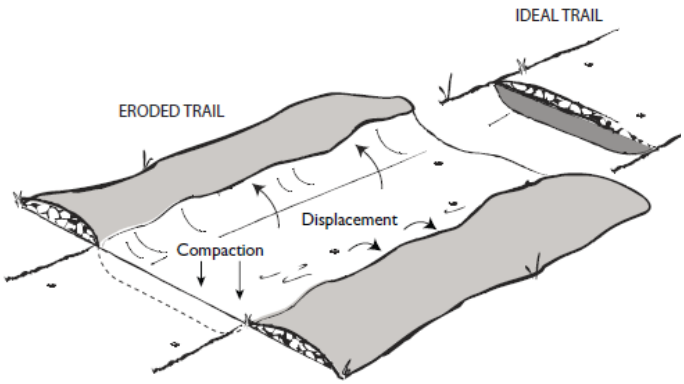
Why We Build Structures

The word "structure" can be intimidating: it brings to mind buildings, bridges, and engineers. For the purposes of this document, we are using the word in its simplest form: **a "structure" is anything that has been constructed**. This can be as simple as a few feet of smoothed and graded soil, used as a drain to direct water flow off a trail.

The intent of a natural surface trail is to sustainably meet the needs of users with minimal impact on the surrounding environment. **Structures are almost always a necessary part of ensuring that trails resist erosion and hold up to expected use without degrading.** Structures also provide a safe experience for the intended audience, and accessible structures and surfacing are absolutely essential when a trail aims to serve people of all physical abilities.

Land managers are sometimes reluctant to allow the installation of trail structures, believing that the additional disturbance will trigger environmental concerns. In reality, the opposite is true. **Failing to incorporate necessary structures into trail design and construction will often lead to significant erosion and environmental damage in the long term.** For this reason, land managers should encourage and expedite the construction and maintenance of these structures – not oppose them.

Trail structures, whether earthen, stone, and/or wooden, exist to mitigate erosion and drainage issues due to the twin factors of compaction and displacement. When walking, boots push down and compress soil (compaction) while kicking aside loose material (displacement). Over time, on most surfaces, this causes the trail itself to become lower than the surrounding area. As a result, the trail can form a depression in which water flows or pools. Water flowing down the trail causes further erosion, and water pooling causes hikers to skirt the wet spot – thus widening the area of impact.



Ideally, we want the reverse to be true – trails on flat ground should be convex or elevated, not concave, so that they stay dry and firm instead of wet and mucky. On slopes we want trails to gently slope out, which allows water to flow naturally downslope instead of catching in trail troughs. The correct solution when dealing with wet spots can vary widely depending on trail users, soil types, local materials, etc., but the intent is the same: **undertake some work in advance, which may minimally disturb the ground, in order to offset more severe long-term erosion consequences**.

Land managers are often concerned that building trail structures will impact the environment, but the opposite is true – well-built structures prevent more damage than they cause. When permit or compliance obstacles prevent necessary trail structures from being built, the resulting damage from erosion can be severe.

Responsible and sustainable trail construction requires that land managers weigh the short-term and minor disturbance of building new structures, with the long-term and much more significant damage that can result from their absence.

Accessibility Considerations in Trail Construction

Defining "Accessibility"

Some people use the term "accessibility" to describe how people can reach a trail. Is it accessible via public transit from nearby cities? Does it have adequate parking to accommodate people during peak hours? Is it easy to find on a map? While this is a valid use of the term "accessibility," in this document we will be using another definition.

For our purposes, **trail accessibility refers to the presence or absence of physical barriers along the trail, impacting who can or cannot recreate along it**. By reducing the barriers present, we increase accessibility and ensure that more people are able to use the trail.

Even when used in this way, people often treat accessibility as a stark binary – a trail either "*is*" or "*is not*" accessible. This simple view of accessibility is usually determined by whether or not a trail meets all of the standards outlined in the Forest Service Trail Accessibility Guidelines (FSTAG) document. Some people use the term "trails for all" to refer to trails that meet or exceed all of these standards.

In reality, all trails are accessible to some people and inaccessible to others. The factors that impact accessibility are unique to each individual, and even then can vary from one day to the next. Building stable and level stone steps may make a trail much easier and safer for a person with impaired balance, but present new barriers to a person using a wheelchair. Replacing a steep trail section with a more gradual route may still fail to meet FSTAG standards, but it may allow someone who uses hiking crutches to enjoy that trail for the first time. For this reason, even the FSTAG itself discourages use of the term "accessible trail" (section 7.3).

In recognition of accessibility being unique to each individual, **this document offers guidance on how to remove barriers and improve accessibility wherever possible, even if the trail in question will never be able to fully comply with all FSTAG standards**.

Crushed stone surfacing is an absolutely essential part of many accessible trails.

Removing Barriers to Access

In many areas, natural surface trail construction will not be able to meet all accessibility standards outlined in the FSTAG. A combination of rugged topography, funding limitations, construction by volunteers using hand tools, and stringent environmental review and compliance processes will often make it impossible to build a truly accessible "trail for all" in a rugged natural area.

The FSTAG identifies the following obstacles to accessible trail construction, with an example given below each listed obstacle.

- Not practicable due to terrain.
  - *Public access might be limited to a narrow strip of land on a steep slope, with no possible way to ascend while meeting accessible grades.*

- Would fundamentally alter the function or purpose of the facility, trail, or the setting.
  - *A trail might be popular because it utilizes metal rungs in a cliff face, and to comply with accessibility standards would have to be reinvented.*

- Cannot be accomplished with the prevailing construction practices.
  - *A section of narrow ledge along a stone face might need to be widened to meet accessibility standards, but to do so would require extreme, innovative, and prohibitively expensive engineering.*

- Cultural, historic, or significant natural features are eligible for protection under Federal, State, or local law.
  - *A historic site might not be able be made accessible without the installation of new structures, which would not be allowed due to its preservation status.*

That does not mean that accessibility should not be a consideration in every trail project. **Wherever possible, trail builders can remove barriers to access so that as many people as possible can enjoy their work** – even if full FSTAG "trails for all" standards cannot be met.

Accessible Layout and Design

Note that the most important elements of accessibility come during trail layout and design. The more a trail is designed to follow a route that meets accessible grades and utilizes firm surfaces, the less ultimate reliance it will have on built structures. This usually means the trail will also be easier and cheaper to maintain in the long term.

Trail designers should strive to lay out and design their trails in a way that minimizes reliance on structures like bog bridges, stepping stones, timber check steps, or waterbars, all of which require long-term maintenance and can serve as barriers that impact the ability of some people to access the trail in its entirety.

Construction Specifications and Drawings Index

The structures and techniques shown in this document are meant to be used in combination with trail work plans by an experienced trail builder, or by volunteers trained and supervised by a trail professional, and undertaken with the full knowledge and permission of all pertinent land managers.

This document assigns numbers to each structure and technique for ease of reference, with each structure included in one of four categories:

1.0 Tread Drainage

These structures are designed to address specific problem areas where water needs to flow off a trail, shedding it downslope before accumulating sufficient velocity and volume to damage the tread surface.

2.0 Tread Construction

These structures shape the surface of a trail, allowing it to rise over obstacles or gain elevation in a sustainable manner.

3.0 Tread Hardening

These structures use stone or timber to prove a highly durable surface which is still compatible with a "natural surface" trail setting.

4.0 Water Crossing

These structures allow visitors to pass over streams and small water bodies with minimal disturbance or obstruction to their natural flow.

Accessibility Implications: *Each structure has a box labeled "accessibility implications" to explain whether it can be designed to meet FSTAG standards. Where you see numbers (such as "7.4.2"), these correspond to relevant sections of the FSTAG document. If you instead see a page number (such as "pg. 73"), this corresponds to the Accessibility Guidebook for Outdoor Recreation and Trails. And if you see a section heading (such as "Grade and Cross Slope for Trails"), it refers to the website version of the Guidebook. All such references are linked for convenience.*

1.0 Tread Drainage

1.1 - Drainage Dip 1.1

A drainage dip is a simple depression that helps guide water off a trail. These are generally subtle ups-and-downs that the casual trail user would not even notice, and while freshly-defined dips can be visible they will often blend perfectly into the existing trail after several months of oxidation, rainfall, and leaf litter deposition. While several styles of drainage dip exist – knick, rolling grade, punch-out, etc. – they all operate on the same simple principle.

This "knick"-style drainage dip shows how a subtle drop in trail level, in this instance combined with a rolling grade "hump," is enough to direct water to flow off a trail.

Intent: To help shed water off the trail, particularly in stretches with prolonged constant grades. By guiding water off the trail downslope, regular drainage dips help keep water velocity low and reduce the amount of erosion that the trail undergoes.
How it Works: Water flows down the trail. When it hits a drainage dip, it naturally flows down the dip and off the trail instead of continuing to flow down the trail in a prolonged sluice.
Impact: By getting water off the trail before it accumulates volume and velocity, drainage dips help prevent trails from being carved into ditches or gullies. This reduces the sediment that water can displace, reducing overall erosion.

Accessibility Implications: Drainage dips can comply with FSTAG standards via special exceptions to typical grade and cross-slope rules: "*1:7 (14 percent) into and out of drain dips for up to 5 feet (1.5 meters) where the cross slope does not exceed 1:10 (10 percent, figure 110)*" (Grade and Cross Slope for Trails).
Accessible Alternatives: Structures that facilitate drainage underneath the trail (closed culverts, drainage lenses, etc.) or realigning the trail to better facilitate natural drainage while maintaining accessibility.
New York Permits Required: *TBD*
New Jersey Permits Required: *TBD*

Photographs - Drainage Dip 1.1

There are many nuances to the creation of drainage dips, elaborated upon in more technical construction documents, but all operate in fundamentally the same way – by creating a subtle drop in the trail surface, which causes water to gently flow off the trail at strategic locations.

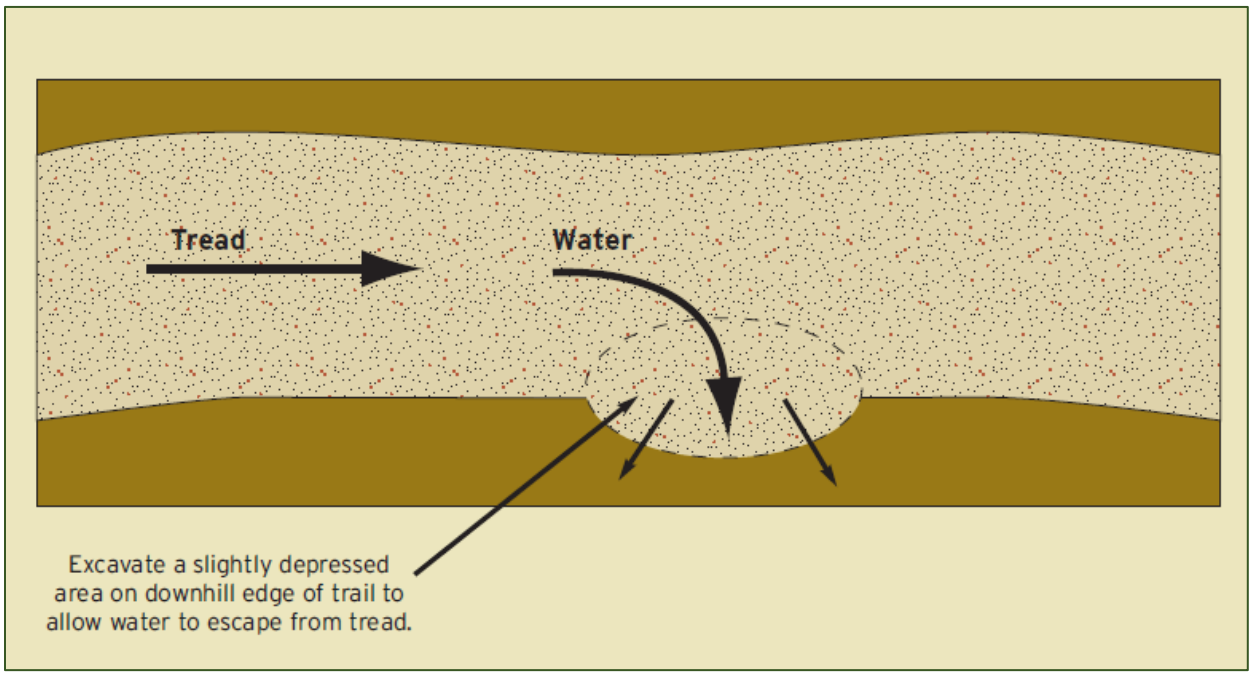
"Punch-Out" Drainage Dip

Full Drainage Dip

Knick

Rolling Grade Dip

Diagrams - Drainage Dip 1.1



1.2 - De-Berm 1.2

A "berm" is a mound of material that forms at the outside edge of a trail, typically as a result of compaction and displacement along the trail itself. Berms prevent water from flowing across and off a trail, instead trapping and funneling it down the trail. De-berming is the simple process of removing any material along the outer edge of a trail, which would otherwise trap water.

Volunteers de-berming the outer edge of a trail by dragging away accumulated material.

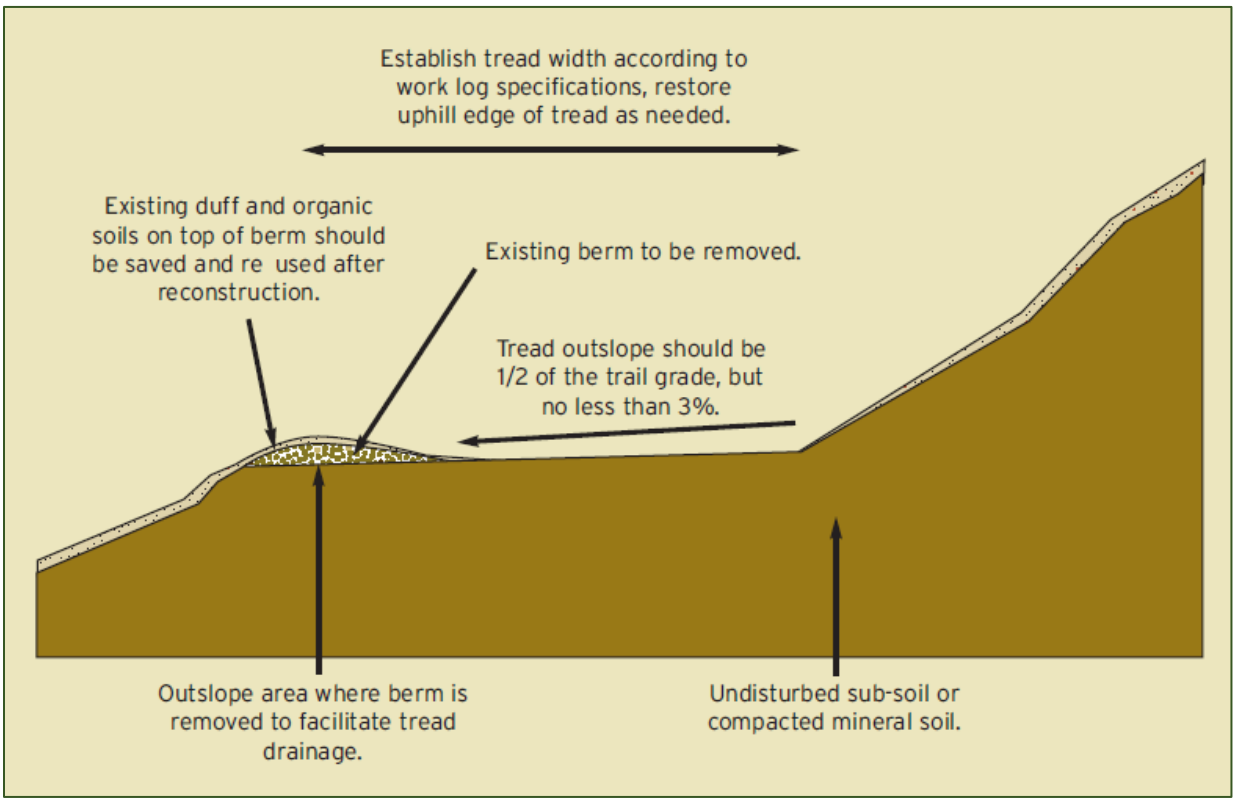
Intent: To keep water from being trapped on the trail and funneling down it – instead, to allow water to flow across the trail and continue downslope on its natural course.
How it Works: Berms can be formed either by natural compaction, displacement, and erosion or by improper construction. When the berm is cut down with a tool and the sediment spread thinly across the environment, water can again freely flow across the outsloped trail.
Impact: Restoring laminar (or sheet) flow across the trail keeps turbulent water from channeling down the trail and causing severe erosion.

Accessibility Implications: No conflict with FSTAG standards as long as re-established cross slope is kept to 5% or less (7.4.3.2), and clear tread width is at least 36 inches (7.4.2).
Accessible Alternatives: N/A
New York Permits Required: *TBD*
New Jersey Permits Required: *TBD*

Photographs - De-Berm 1.2

The outer edge of the trail has been marked with blue pin flags, and the darker disturbed soil to the left shows where a previous berm of humped soil was broken down and dragged downslope. As a result, water can flow over and across the trail without becoming trapped.

Diagrams - De-Berm 1.2



1.3 - Waterbar 1.3

Waterbars derive their name from the setting of a "bar" into the trail tread surface, typically composed of either a single piece of timber or a line of interlocking stones. Water moving down the trail encounters this bar and is guided off the trail. For this reason, waterbars need to be carefully built at the correct angle and outslope to redirect moving water without being damaged or undercut by it. Where a protruding structure presents concerns as a barrier to users, stone waterbars can be covered with mounded soil to present less of an obstacle.

A simple timber waterbar directs water off to the left of the trail. Piles of stones help slow water flow to prevent downslope erosion. Photo Credit: Acton Wakefield Watersheds Alliance (awwatersheds.org).

Intent: To shed water off the trail, particularly in stretches with prolonged constant grades. Waterbars are often used on steeper grades and/or more unstable soils. Because of their stone or timber construction, waterbars are very durable.
How it Works: Water flows down the trail. When it encounters a waterbar, the water is diverted along the drain and off the trail instead of continuing to flow down the trail.
Impact: By getting water off the trail before it accumulates volume and velocity, waterbars help prevent trails from being carved into ditches or gullies. This reduces the sediment that water can displace, reducing overall erosion.

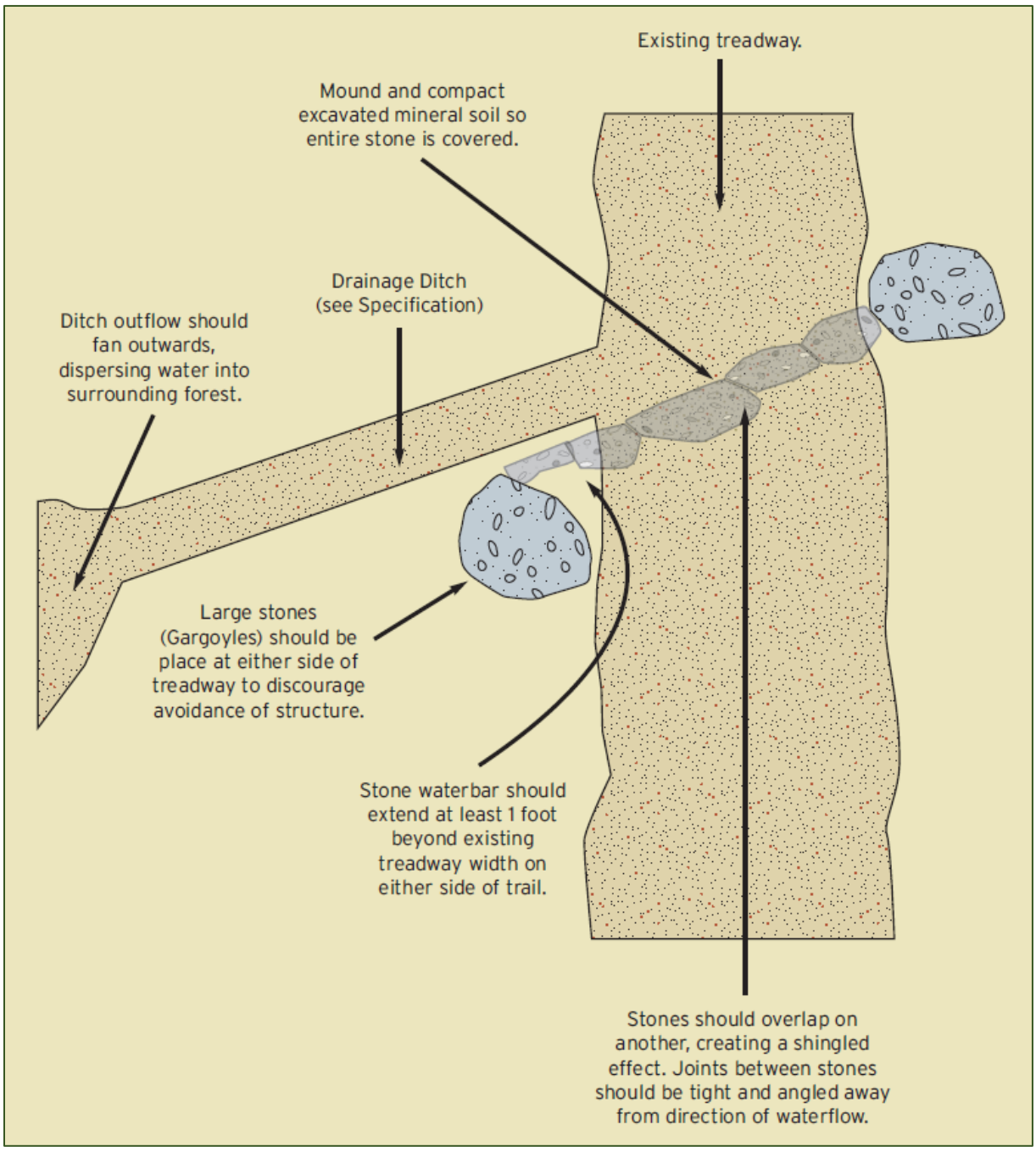
Accessibility Implications: Generally non-compliant – the tread obstacle presented by an exposed bar is generally above the 2 inches permissible (7.4.6).
Accessible Alternatives: Installing rolling grade dips, realigning the trail to reduce grades and eliminate need for water bars, or covering the protruding bar with mounded mineral soil to provide a ramped "hump" that presents an obstacle under 2". Must comply with all rules for drainage dips (Grade and Cross Slope for Trails).
New York Permits Required: *TBD*
New Jersey Permits Required: *TBD*

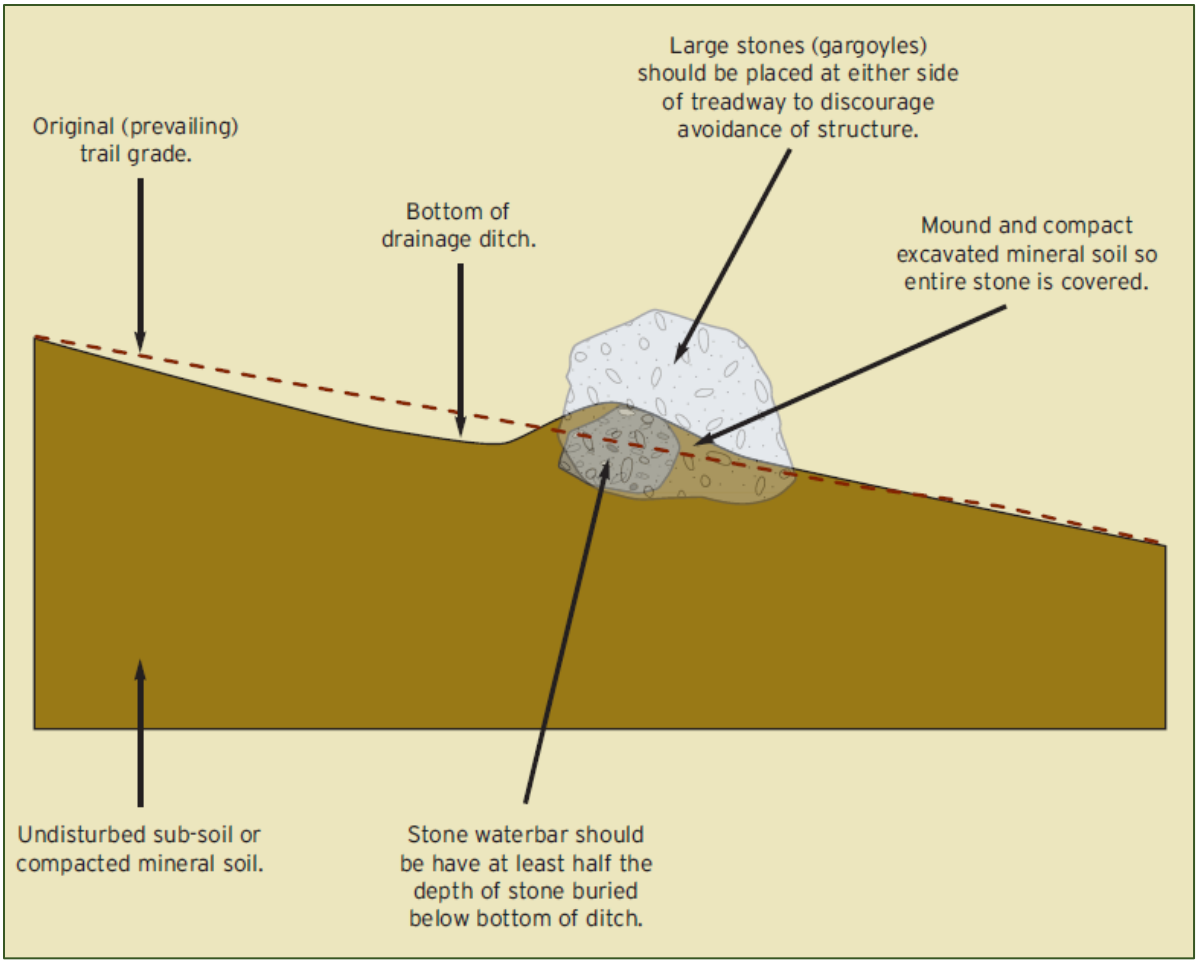
Photographs - Waterbar 1.3

A classic stone waterbar. In this example, water would flow from the viewer toward the structure and then be directed off to the right of the trail.

The reddish mound in the center of the photo is a covered water bar. The stones underneath lend strength and durability to the structure, while the mounded soil allows wheels to pass over. While this example is intended for mountain bikes, particularly firm and stable mounds may be able to meet FSTAG standards. Photo Credit: Bibbulmun Track (bibbulmuntrack.org.au).

Diagrams - Waterbar 1.3




Large stones (gargoyles) should be placed at either side of treadway to discourage avoidance of structure.
Original (prevailing) trail grade.
Bottom of drainage ditch.
Mound and compact excavated mineral soil so entire stone is covered.
Undisturbed sub-soil or compacted mineral soil.
Stone waterbar should be have at least half the depth of stone buried below bottom of ditch.

1.4 - Armored Swale 1.4

A swale is a shallow depression in the ground that can be used to collect and move water across a trail surface, similar to the structures described earlier in this section. In areas where the ground is frequently saturated and muddy, such as at the location of a subterranean seep, armoring can be very helpful. This consists of setting stones into the ground like tiles, providing a hard surface that can withstand both water flow and visitor traffic without being eroded.

While most of this trail's surface is firm and durable, one seasonally wet section was armored to remain firm and durable in all seasonal conditions.

Intent: To help shed water across the trail in a way that maintains natural drainage patterns in areas with higher waterflow and soil saturation
How it Works: Stones are set within the drainage crossing with flat faces presented, acting as armor across which water can flow.
Impact: By hardening the trail tread within the natural drainage crossing, significant soil loss and saturation is prevented, allowing users to enjoy a dry, stable crossing without contributing to erosion.

Accessibility Implications: Can meet all FSTAG standards as long as relevant technical provisions such as surface, slope, grade, width, and obstacle requirements are observed (7.4), with special exceptions for drainage dips (Grade and Cross Slope for Trails). In particular, no openings between stones should exceed 1/2" – due to water flow, stone dust and mineral soil cannot be used to fill gaps (7.4.7). Note that long-term maintenance to FSTAG standards can be challenging as the structure settles, so a more accessible alternative should be prioritized if possible.
Accessible Alternatives: Drainage lens, closed culvert, elevated tread surface.
New York Permits Required: *TBD*
New Jersey Permits Required: *TBD*

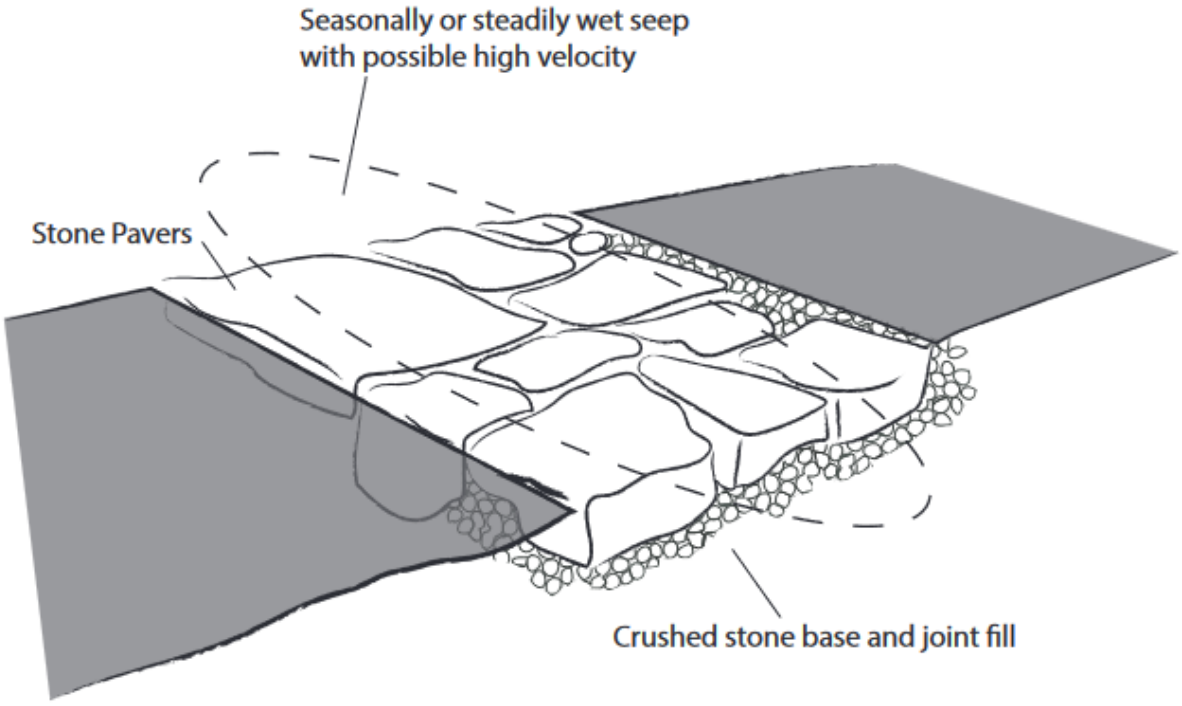
Photographs - Armored Swale 1.4

Armored swale with significant outslope.

Armored swale in slight dip.

A small armored swale with gravel on the right side to slow water flow and reduce erosion. Note that this example, and the others on this page, feature loosely-space stones which yield gaps that would not comply with FSTAG standards.

Diagrams - Armored Swale 1.4



In practice, building an armored swale is essentially the same as building a length of stone paving. The difference is in location and function: stone paving is usually longer and flatter to allow travel for a person along a wet section of trail, while an armored swale is typically shorter, cupped, and outsloped to allow the flow of water across a trail.

1.5 – Stone Culvert 1.5

While an armored swale is well-suited for areas of sodden ground and gentle intermittent flow, areas with more regular or higher-volume flow (like seasonal streams) may need a different structure. While an armored swale is built to be roughly level with the tread surface, a stone culvert provides a much more defined channel across a trail which allows water to flow. A stone culvert can be open, with nothing on top, or closed. When closed, a large flat stone is typically set on top to provide a level surface – especially important where an open culvert would provide a barrier to users.

The image is taken looking straight down at an open stone culvert which crosses a trail, showing how a steady stream of water is allowed to cross without eroding the trail surface. The resulting gap does not comply with FSTAG standards.

Intent: To provide a firm, erosion-resistant channel across very short areas which see intermittent water flow or a strong, well-defined seep.
How it Works: Stones are used to "pave" the surface over which water flows, and larger side stones hold adjacent tread in place firmly. The culvert can be capped with stones ("closed") to form a base for an uninterrupted tread surface.
Impact: By concentrating water flow into a durable and narrow channel, users can cross the area without directly impacting the waterway.

Accessibility Implications: Open stone culverts do not comply with trail surface opening requirements (7.4.7), but closed culverts do comply as long as other requirements such as width (7.4.2) and tread obstacles (7.4.6) are met.
Accessible Alternatives: Improved closed culvert cover, drain lens, buried tube culverts (usually metal or PVC), armored drain.
New York Permits Required: *TBD*
New Jersey Permits Required: *TBD*

Photographs - Culvert 1.5

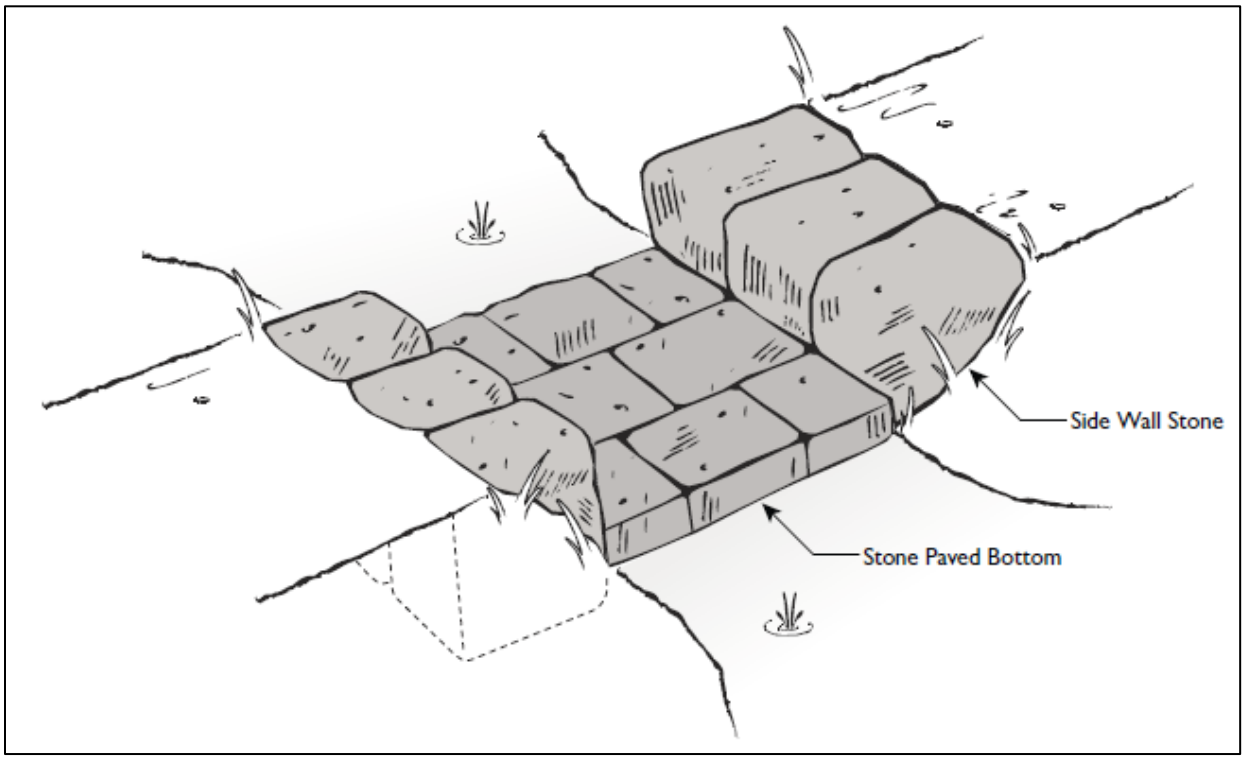
Open culvert using imported stone slabs. Always fails to meet FSTAG standards.

Closed culvert with single stone on top.

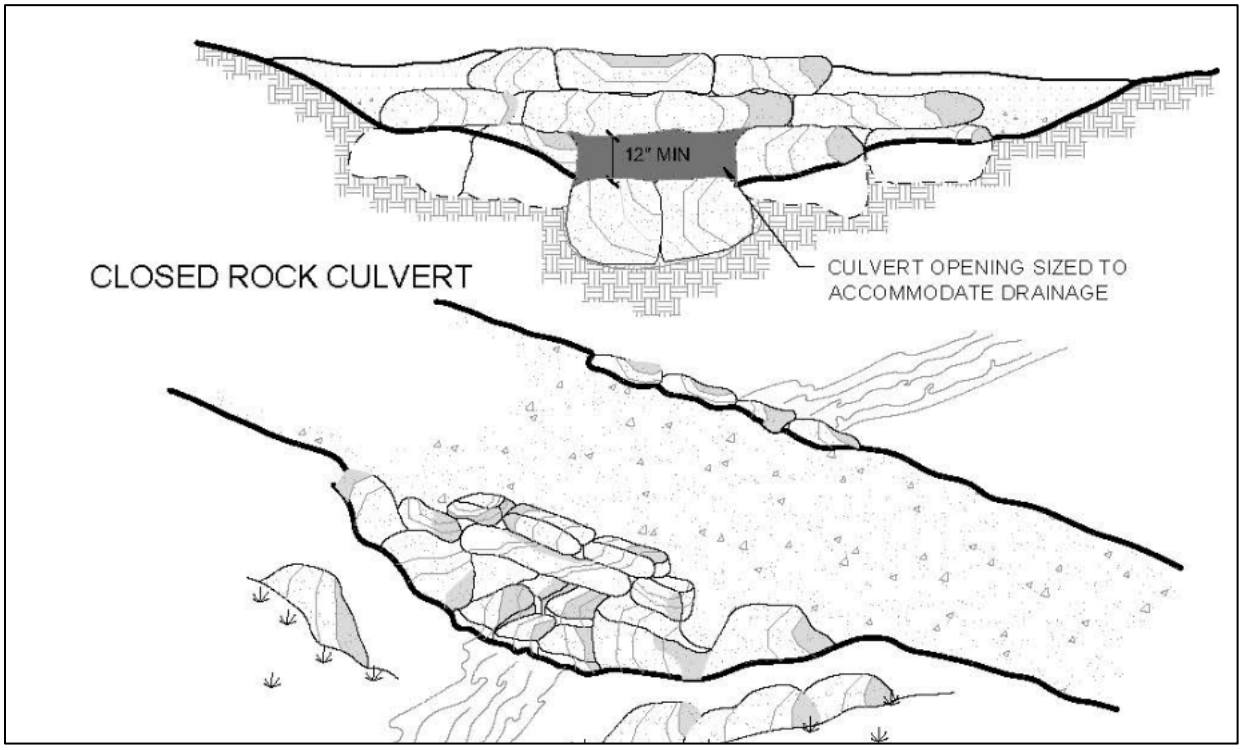
Closed and surfaced culvert.

These closed culverts, whether bare stone or surfaced with mineral soil, can meet FSTAG standards if designed and built to all other applicable tread surface standards.

Diagrams - Culvert 1.5



Open stone culvert.



Closed stone culvert. Credit: California State Trails Handbook.

1.6 - Drain Lens 1.6

A drain lens allows water to flow *though* loosely-arranged stones, rather than *over* the tightly-arranged stones seen in structures like armored swales. While an armored swale is installed flush with the wet trail surface, a lens builds up and over it to form an elevated mound that keeps users high and dry. Using geotextile and capping the lens will help reduce sediment and material settling into the structure, which can reduce its efficacy over time.

Capped drain lens, with arrows depicting where water flows downhill and passes through loose stones to travel under the trail.

Intent: To address low-volume ephemeral springs or seeps by carrying water under the trail tread, while also maintaining a firm and level walking surface.
How it Works: A stable foundation of large "drain lens" rocks has gaps large enough for water to flow through. Additional layers of progressively smaller rocks are added on top, and capped with a layer of native soil and/or gravel to form a high and dry tread surface.
Impact: Water is allowed to seep beneath the tread without saturating the base soil, preventing the creation a muddy, unstable trail bed, while maintaining both the linear grade of the trail and the flow of water beneath it.

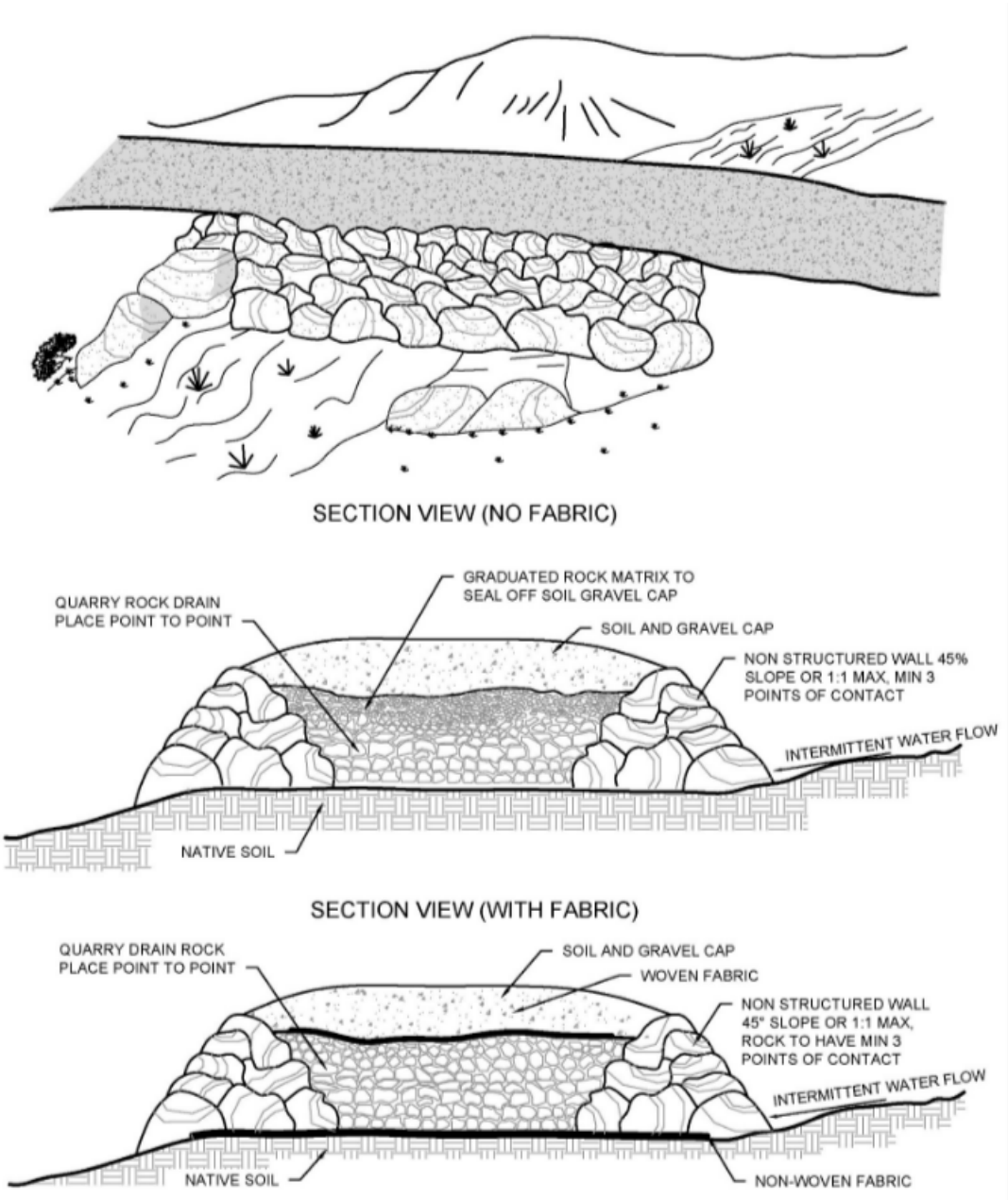
Accessibility Implications: Generally an excellent drainage structure for compliance when properly capped – facilitates drainage under trail and provides firm, stable, uninterrupted tread surface (7.4.1).
Accessible Alternatives: N/A
New York Permits Required: *TBD*
New Jersey Permits Required: *TBD*

Photographs - Drain Lens 1.6

The only evidence of a drain lens in this location are the exposed rocks on either side of the trail tread. These reveal that the trail is sitting atop a mound of large stones, loosely arranged, which allow water to filter through and elevate the trail above seasonal muddy conditions. Geotextile fabric supports the soil making up the tread surface, preventing it from settling or being washed into the stone's crevices.

Note that a drain lens which meets FSTAG standards would need to be wider and would likely feature a less pronounced convex surface.

Diagrams - Drain Lens 1.6



Credit: California State Trails Handbook.

2.0 Tread Construction

2.1 - Sidehill 2.1

When trails are too flat, they can collect water and become wet. When they are too steep, water tends to flow down them and lead to gullied erosion. Ideally, trails will be built into a sloped surface and designed so that water flowing downhill moves *across* them, without pooling in flat areas or diverting to follow the trail in steep areas. The type of construction that makes this possible is called "sidehill."

Note how the terrain is sloped, but the trail surface has been cut into the side of the hill ("sidehilled") so that it provides a nearly level walking surface.

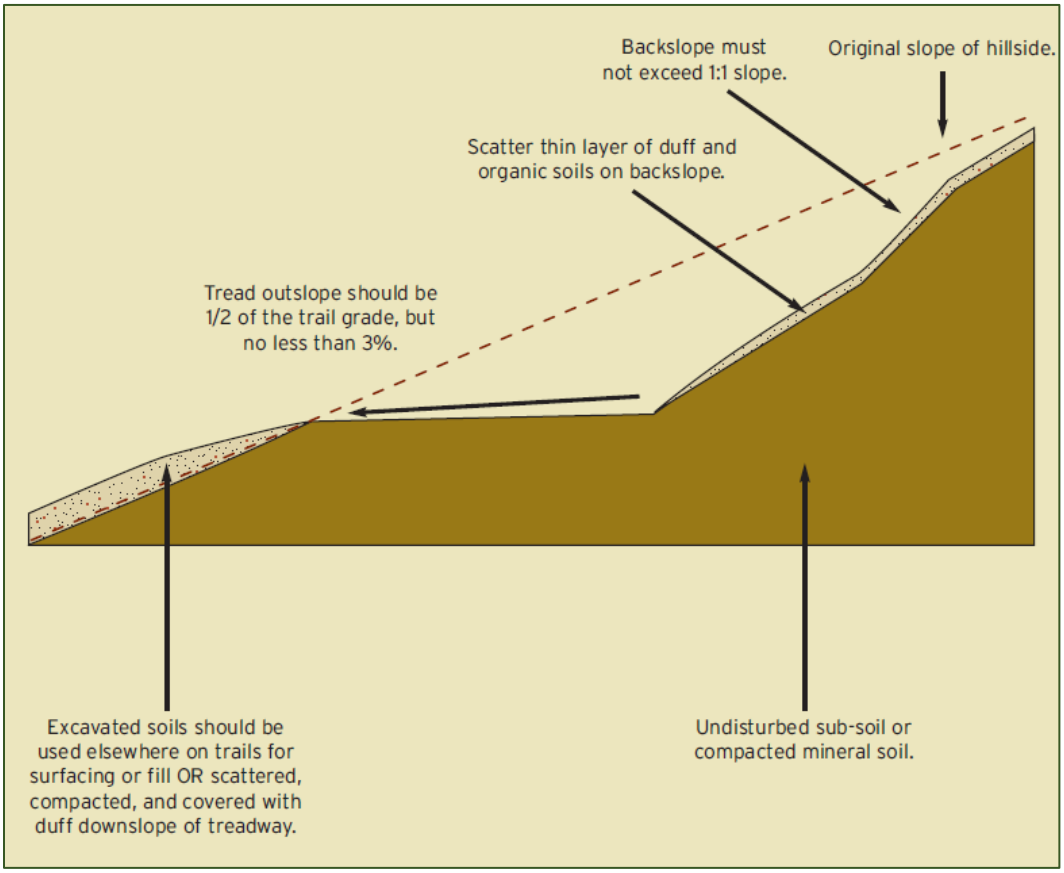
Intent: Create a gently outsloped walking surface which comfortably supports users while allowing water to naturally flow and drain downslope.
How it Works: Substrate is excavated with hand tools (picks, mattocks, shovels, etc.) and placed immediately downslope before being covered with leaves, sticks, and forest litter. The walking surface is intentionally graded to slope outward and down at no less than 3 percent grade (as seen in cross-section).
Impact: By cutting into steeply-sloped substrate, sidehill construction allows a relatively level walking surface even on steep slopes. The gentle outslope left on the trail surface allows water to naturally flow over and past the trail on its way downhill, instead of gathering in the trail and causing erosion as it moves down the trail.

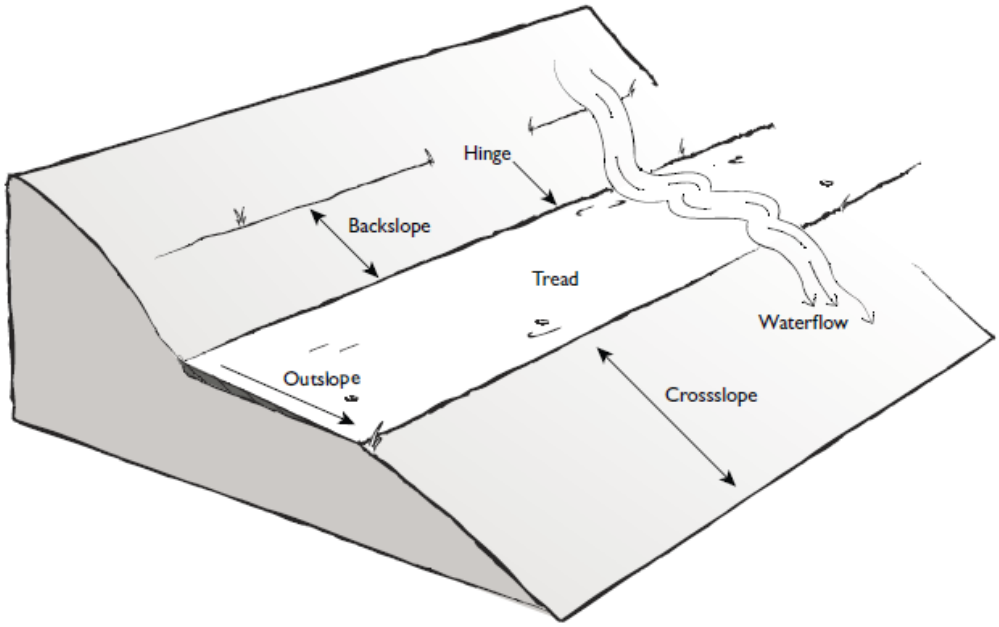
Accessibility Implications: Firm mineral soil can meet all FSTAG standards as long as relevant technical provisions such as surface, slope, grade, width, and obstacle requirements are observed (7.4). Note that natural surface trails require frequent inspection and maintenance to ensure these conditions do not degrade.
Accessible Alternatives: Use of imported stone/gravel/aggregate crush surfacing if local is inadequate, or other hardened surface (causeway, boardwalk, asphalt, etc).
New York Permits Required: *TBD*
New Jersey Permits Required: *TBD*

Photographs - Sidehill 2.1

Where the prevailing substrate is rich in firm mineral soil, as in this photograph, sidehill is an effective way to establish a durable surface. Note that this narrow treadway would need to be further widened and defined to meet FSTAG standards.

Diagrams - Sidehill 2.1





2.2 - Climbing Turn 2.2

Trail layout and design often requires gaining elevation within a narrow defined corridor, either because of property boundaries or natural features. To gain elevation while maintaining sustainable grades, climbing turns are used to "zig-zag" up a slope with the required run to offset a steep rise. A variation on the climbing turn, usually even steeper and with sharper turns, is called the switchback.

While the trail looks relatively flat, notice the significant gain in elevation to the left of the picture.

Intent: To reverse the direction of travel and gain elevation on sloped terrain. A climbing turn generally has a U-shape – it has a wide turn radius and is typically used on gentle or moderate slopes, allowing people to ascend or descend in a zig-zag pattern without the need for steep trail.
How it Works: Slope is a calculated function of "rise over run," and by introducing a longer "run" this technique allows a trail to achieve the same "rise" with less of a slope.
Impact: While climbing turns require more construction disturbance than steep fall-line trails, since they require more linear feet to gain the same height, they are far more accessible/sustainable and result in less erosion in the long run.

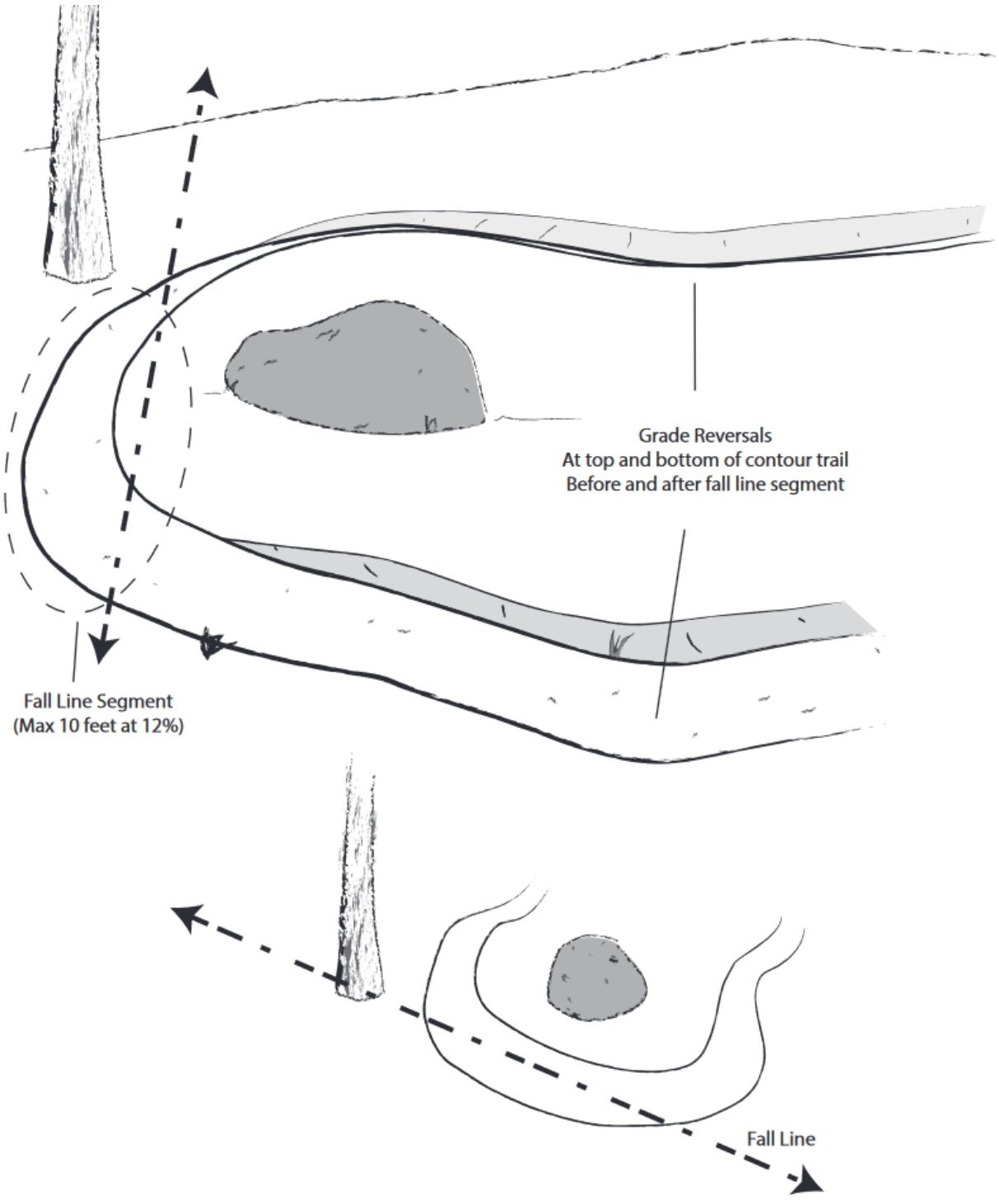
Accessibility Implications: Climbing turns are the most accessible way to traverse slopes, and can meet all FSTAG standards as long as relevant technical provisions such as surface, slope, grade, width, and obstacle requirements are observed (7.4). Note that turns must be located where terrain slope does not exceed 12% (7.4.3.1).
Accessible Alternatives: N/A
New York Permits Required: *TBD*
New Jersey Permits Required: *TBD*

Photographs - Climbing Turn 2.2

View from the top of a climbing turn. Note that this turn is designed for use by mountain bikers as well as hikers, so it features a banked berm that allows bicyclists to safely turn with it while maintaining momentum.

View from the bottom of the same climbing turn. Because of the banked berm, this turn will trap and channel water down the trail. For this reason, a grade reversal exists right behind the photographer's position to shed water as soon as possible.

Diagrams - Climbing Turn 2.2



2.3 – Timber-Cribbed Turnpike 2.3

A simple structure which is common in seasonally wet areas, turnpike consists of a "box frame" embedded in the ground and filled with durable material, usually surfaced with mineral soil or stone crush. It provides a stable walking surface even when surrounding conditions are wet or muddy. On slopes or any other area where any cross-flow is anticipated, gaps should be left between stretches of turnpike to let water flow through and avoid flooding.

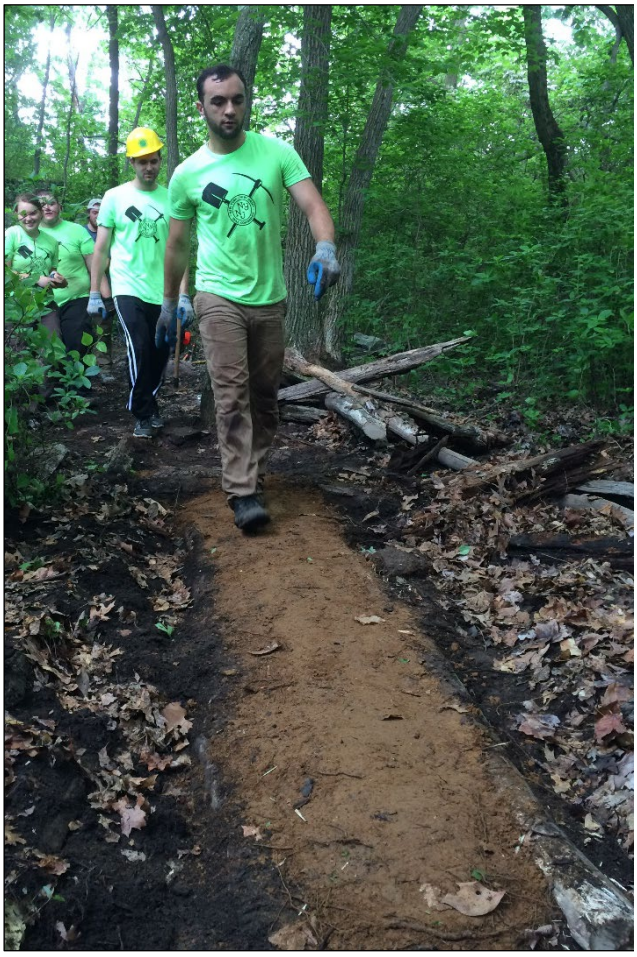
Hikers cross a weathered section of wood turnpike.

Intent: To slightly elevate short portions of tread across wet areas, allowing a firm and dry walking surface so that trail users do not attempt to circumvent the spot (thus widening the wet area and exacerbating the problem).
How it Works: Timber (often local small fallen trees) is set in two rows, comprising the "retaining walls" of the structure. The area between these rows is filled with smaller rocks or crush, then covered with geotextile and surfaced with firm mineral soil or stone crush.
Impact: Having a dry and pleasant walking surface keeps users on the established trail, minimizing unintended damage to the local environment.

Accessibility Implications: Can meet all FSTAG standards as long as relevant technical provisions such as surface, slope, grade, width, and obstacle requirements are observed (7.4). In particular, any openings to allow water flow should be covered (7.4.7).
Accessible Alternatives: Stone turnpike, boardwalk, drain lens.
New York Permits Required: *TBD*
New Jersey Permits Required: *TBD*

Photographs - Timber-Cribbed Turnpike 2.3

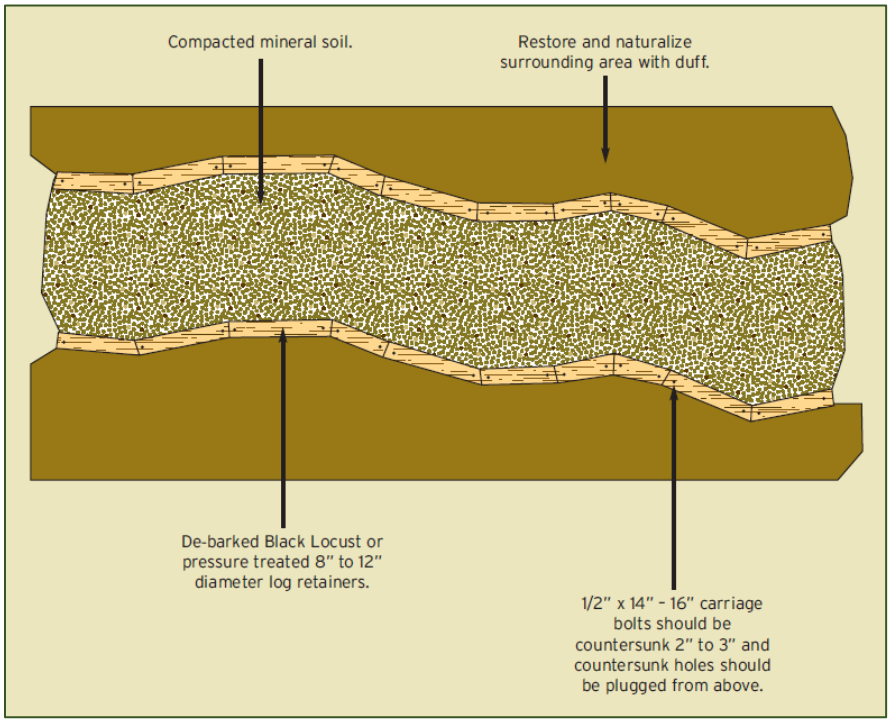
Timber turnpike with a base of stone crush fill.

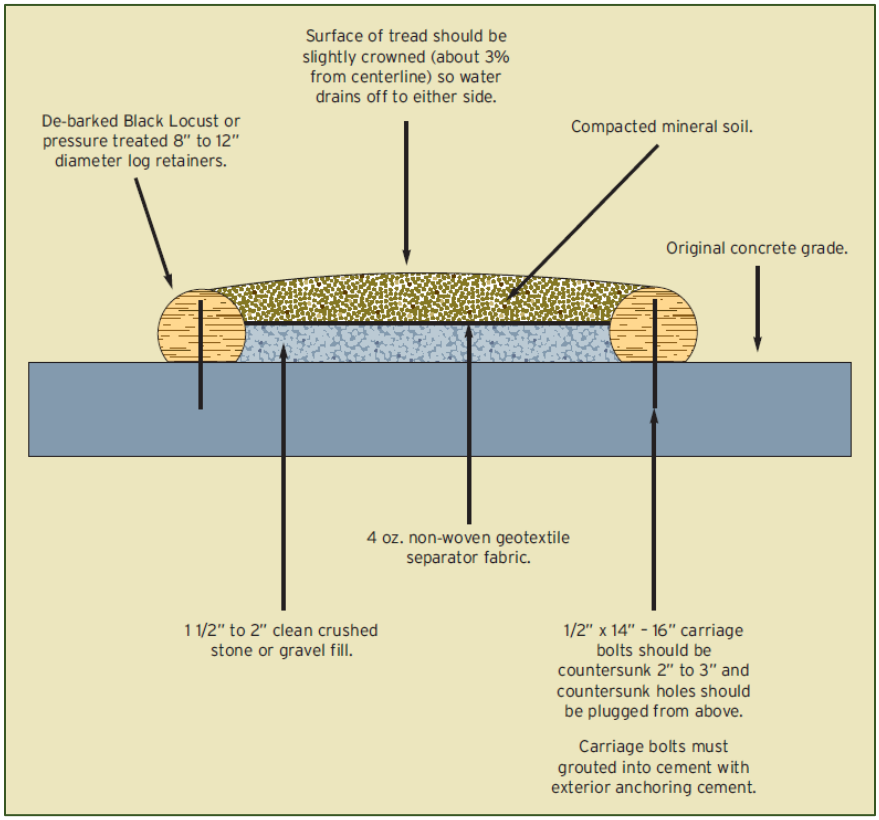


The same turnpike after mineral soil surfacing.

Even when the timber grows old and weathered, turnpikes usually continue to function as intended with little maintenance.

Photographs - Timber-Cribbed Turnpike 2.3





2.4 – Stone-Cribbed Turnpike 2.4

This structure is identical in function to the timber-cribbed turnpike, but uses stone to build the retaining structure. This makes it an alternative for projects far from trailhead access where timber may not be readily available, or where a more durable alternative to wood is desired. The use of stone also lends a more natural appearance to the finished structure than processed lumber, which is often desirable for natural surface trails.

This stretch of stone-cribbed turnpike is in the process of having mineral soil surfacing applied. The finished product will appear very natural, with the average trail user not recognizing the intentionality of the stone walls built on either side of the trail.

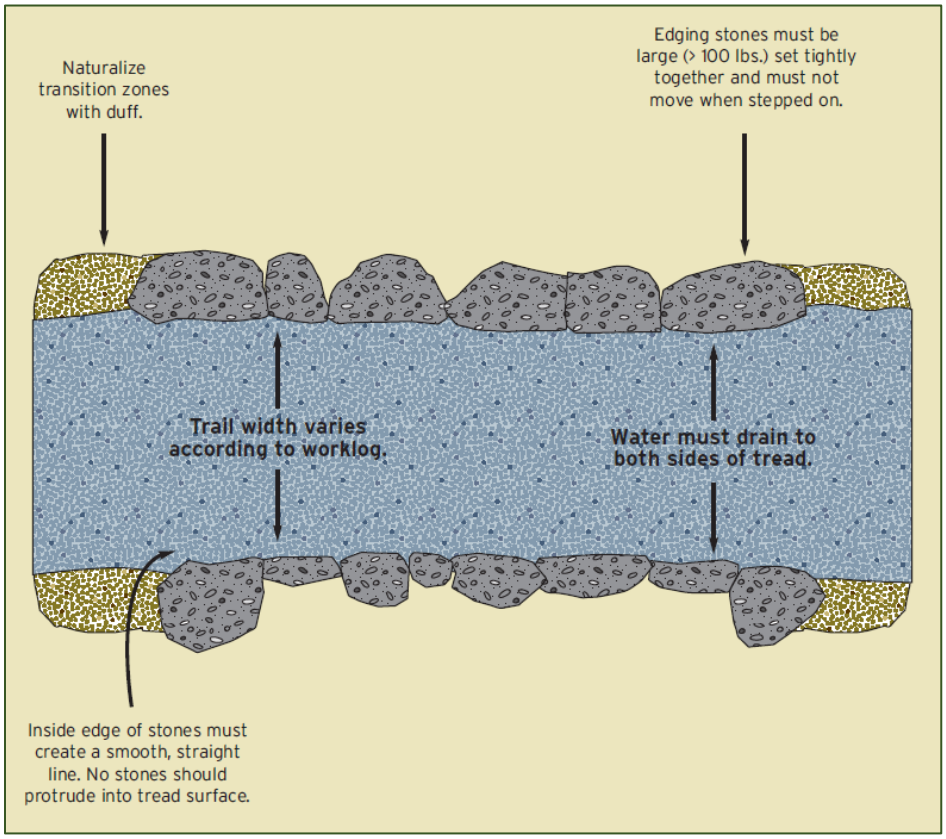
Intent: To slightly elevate short portions of tread across wet areas, allowing a firm and dry walking surface so that trail users do not attempt to circumvent the spot (thus widening the wet area and exacerbating the problem).
How it Works: Local stones are set in two rows, comprising the "retaining walls" of the structure. The area between these rows is filled with smaller rocks or crush, then covered with geotextile and surfaced with firm mineral soil or stone crush.
Impact: Having a dry and pleasant walking surface keeps users on the established trail, minimizing unintended damage to the local environment.

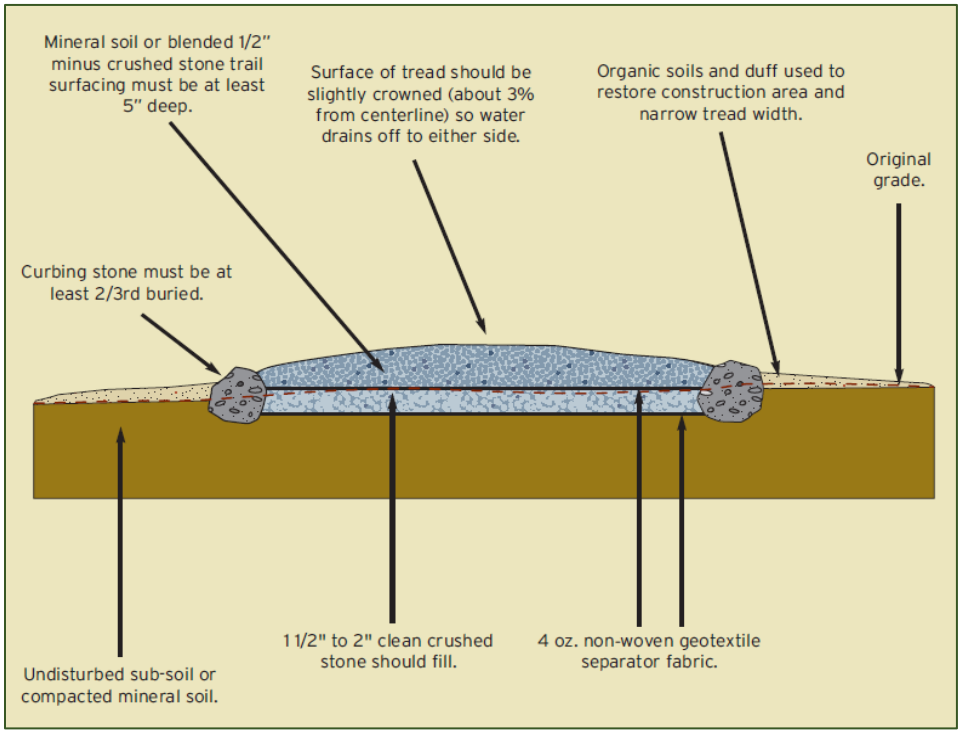
Accessibility Implications: Can meet all FSTAG standards as long as relevant technical provisions such as surface, slope, grade, width, and obstacle requirements are observed (7.4). In particular, any openings to allow water flow should be covered (7.4.7).
Accessible Alternatives: Timber-cribbed turnpike, boardwalk, drain lens.
New York Permits Required: *TBD*
New Jersey Permits Required: *TBD*

Photographs - Stone-Cribbed Turnpike 2.4

While significant work was put into arranging stones in rows and filling them with crushed rock, the surfaced final product looks and feels like it has always been there.

Diagrams - Stone-Cribbed Turnpike 2.4





2.5 - Stone Edging 2.5

Stone edging serves various purposes, and the reason for building it can depend on the location. It can help raise tread over difficult roots or rocks, allow for a wider surface on a steep cross-slope, provide a durable outslope on loose substrate, or simply serve as a visual deterrent to keep people from walking near the outer edge of the trail.

Notice how stone edging can appear similar to stone turnpike, where the trail backslope on the opposite side of the edging replaces a second row of stones.

Intent: To retain soil as a solid walking surface, while visually delineating the trail's outer edge.
How it Works: Local stones are placed along the edge of the trail, helping minimize erosion and keep the walking surface relatively level. As always on slopes, the tread surface should slope outward so that water flows across the trail and downhill.
Impact: Trails last longer, are subject to less erosion, and provide a more comfortable, level and stable walking surface.

Accessibility Implications: Can meet all FSTAG standards as long as relevant technical provisions such as surface, slope, grade, width, and obstacle requirements are observed (7.4).
Accessible Alternatives: Retaining wall, if more height is needed.
New York Permits Required: *TBD*
New Jersey Permits Required: *TBD*

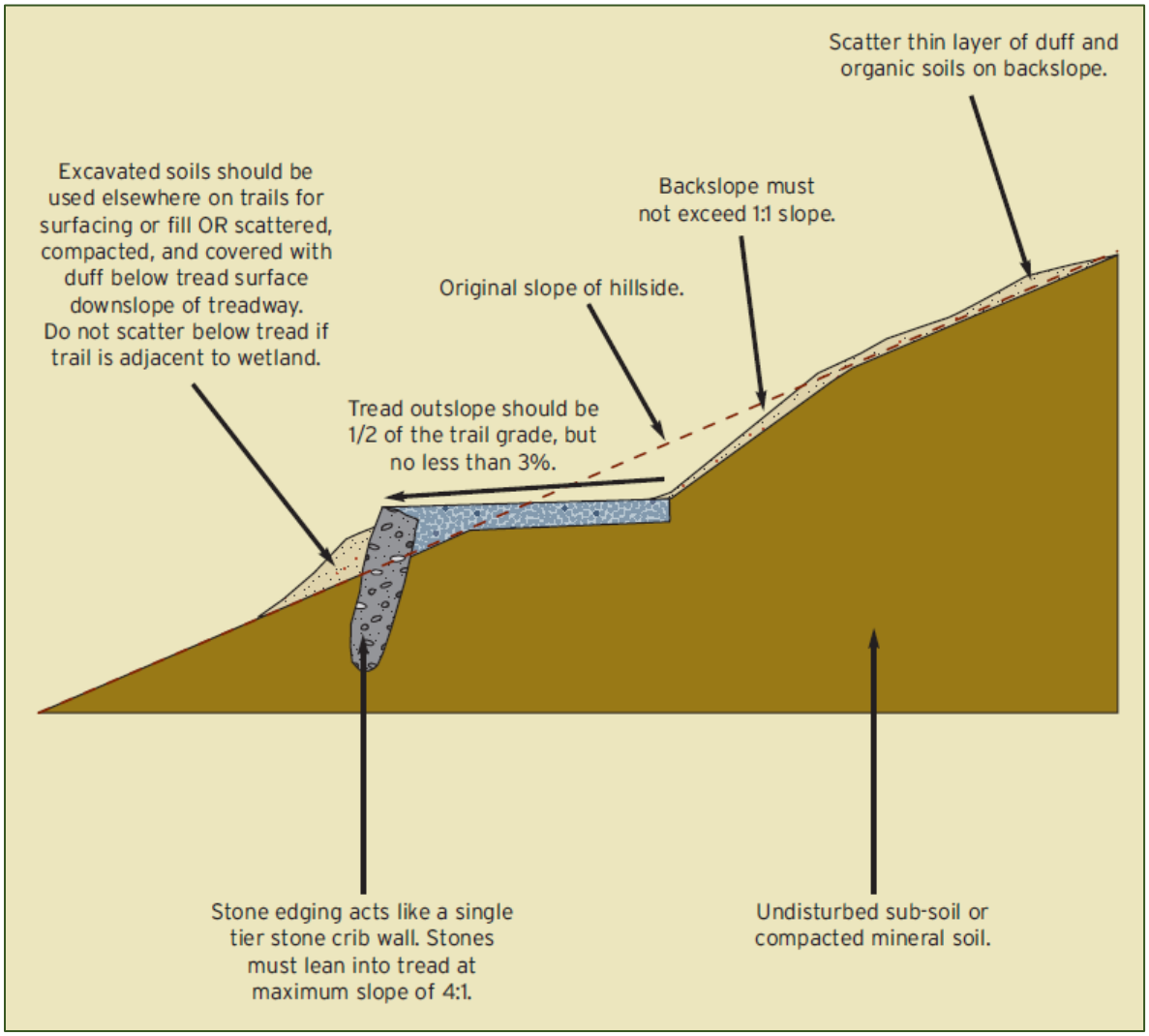
Photographs - Stone Edging 2.5

Neat "set stone" edging establishes a level tread surface, contains the stone surfacing material, and presents a tidy look for a trail next to a lawn.

In contrast, the loose rubble "junk wall" edging on this backcountry trail is intended to look completely natural after a season of rain and leaf fall.

Regardless of aesthetic, both forms of stone edging serve the same functional purpose – to define the outer edge of the trail and prevent the downhill slide of tread.

Diagrams - Stone Edging 2.5



2.6 - Retaining Wall 2.6

Retaining walls are built to hold back material on steep slopes. When the retaining wall is built below the trail, and designed to hold up the tread surface, it is called a "crib" wall. In principle, stone crib wall is a more technical multi-tiered form of stone edging.

After building a crib wall, fill with crushed stone is usually required to create an elevated, level, firm, and well-draining trail surface (photo is not yet surfaced).

Intent: To allow tread construction where building over an obstacle – such as exposed bedrock – is required. Can also help level trails on steep cross-slopes, stabilize backslopes, or support other trail structures (e.g. bridges, steps, ramps, switchbacks).
How it Works: An initial stone or timber layer is set within a foundation, and additional layers are placed in successive tiers (courses) with the necessary batter (inslope) to provide support and stabilization for the fill, slope, and/or structure.
Impact: Retaining walls allow trails to follow routes they otherwise would be unable to pursue.

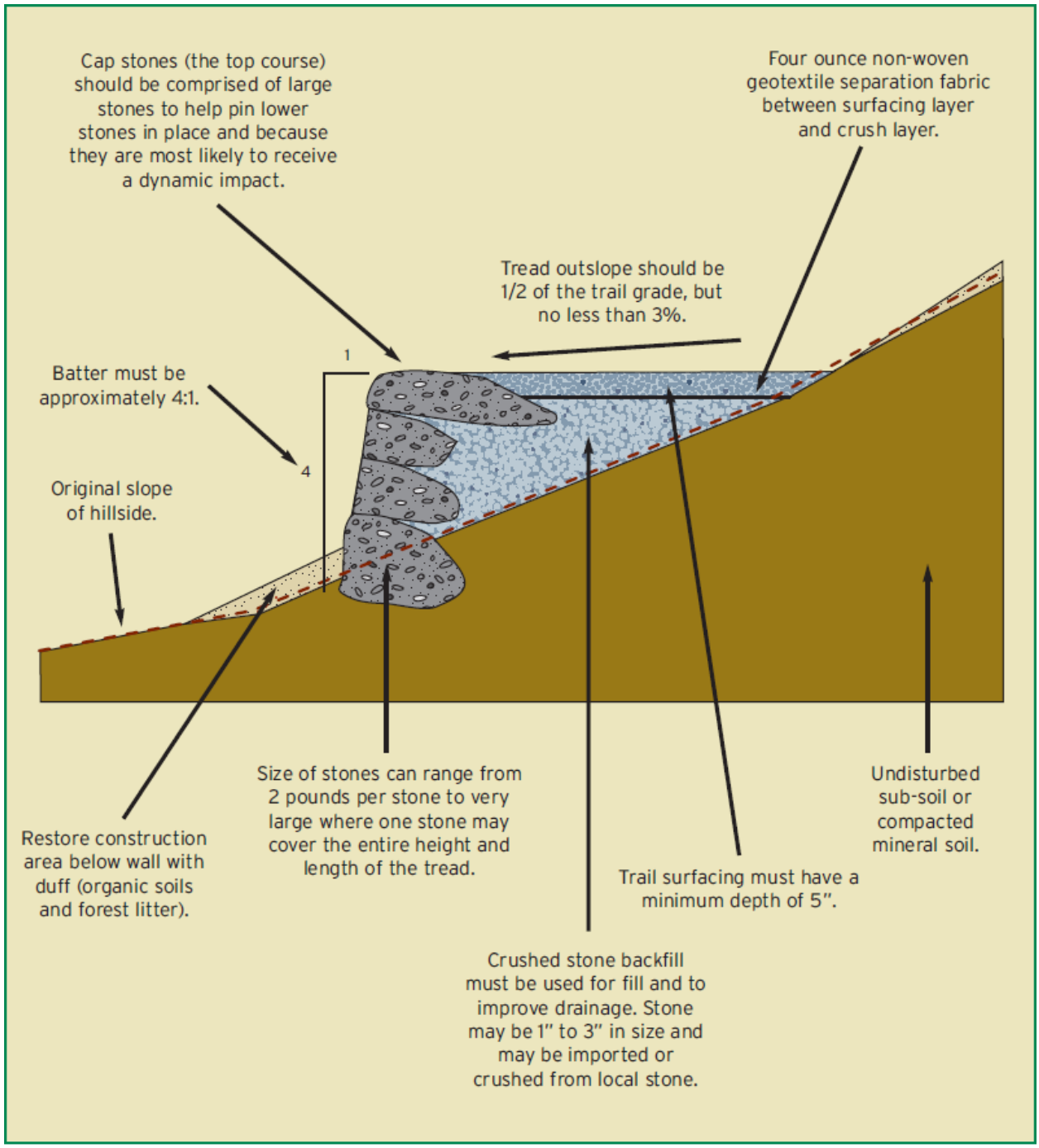
Accessibility Implications: Can meet all FSTAG standards as long as relevant technical provisions such as surface, slope, grade, width, and obstacle requirements are observed (7.4). Consider a defined edge (potentially with coping stones for taller walls) to mitigate falling risk (pg. 42, Edge Protection for Trails).
Accessible Alternatives: N/A
New York Permits Required: *TBD*
New Jersey Permits Required: *TBD*

Photographs - Retaining Wall 2.6

This retaining wall is built above the trail, to keep soil from sliding down onto it.

This crib wall is built below the trail, to allow a level and stable tread surface.

Diagrams - Retaining Wall 2.6



3.0 Tread Hardening

3.1 - Stone Stairs 3.1

Stone stairs (or "steps") are typically made of local rocks moved and set firmly in place to provide a stable and level walking surface. In very steep areas with rocky terrain, they can be the only way to build a sustainable trail that quickly gains elevation. Even in areas with moderate slopes, steps allow a trail to travel up the fall line without erosion.

When built well, stone steps blend into the environment and are a minimally disruptive way for people to pass through otherwise steep or uneven terrain.

Intent: To rearrange local stones to provide safe, comfortable hiking ascents up steep, eroded, gullied, or otherwise unsafe trail sections.
How it Works: Local stones are rearranged so that flat faces are exposed on top. Successive stone steps typically "lock in" behind the step below so that the series of steps remains stable, durable, and resistant to sliding or under-cutting erosion.
Impact: Stone stairs serve to check erosion in deeply gullied ascents where no other solution is possible. If built correctly they are low-impact, look like part of the natural environment, and last indefinitely with little needed maintenance.

Accessibility Implications: Stone stairs inherently create tread obstacles in excess of 2", preventing their ability to meet FSTAG standards (7.4.6). That said, they do provide firm, level, and stable surfaces on otherwise steep and uneven slopes – which can be very helpful for people with many different disabilities.
Accessible Alternatives: Trail realignment/reroute to meet grade requirements, usually with use of climbing turns.
New York Permits Required: *TBD*
New Jersey Permits Required: *TBD*

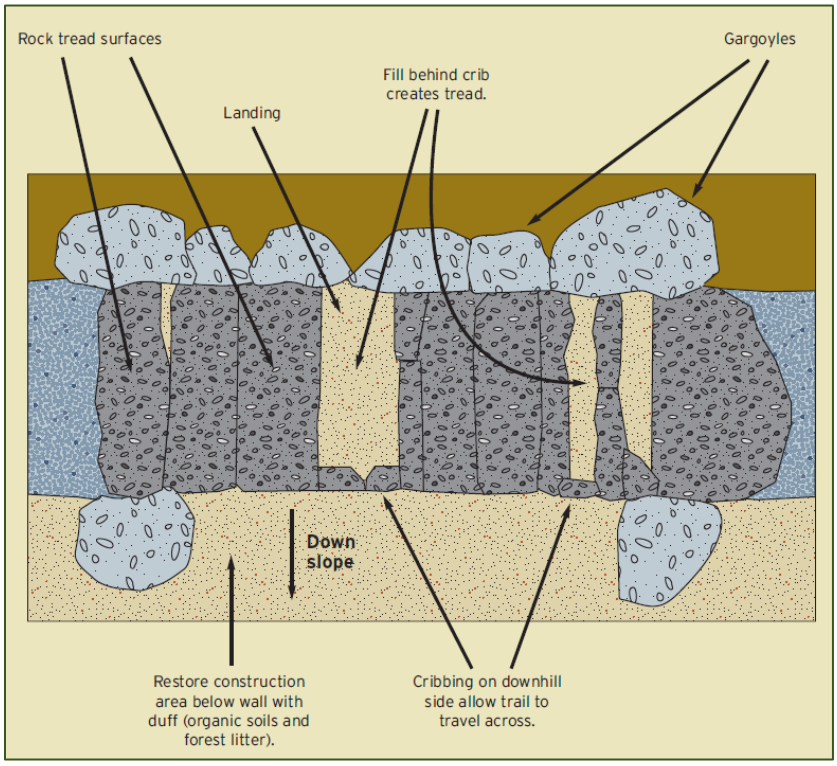
Photographs - Stone Stairs 3.1

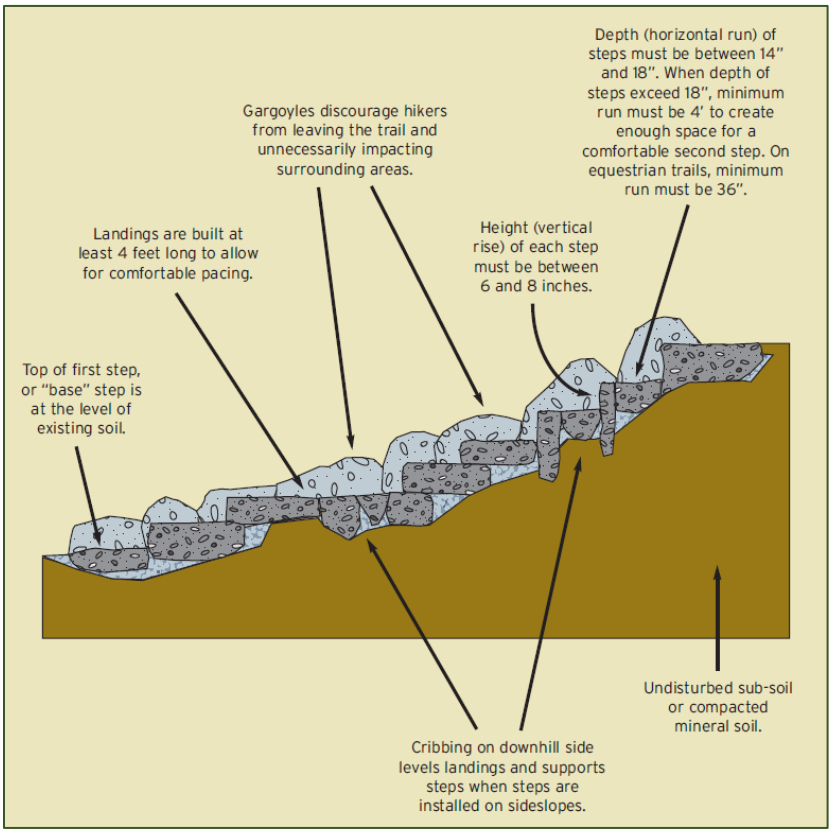
Before and after shots of a previously unsafe trail stretch converted to level, stable, and (relatively) evenly-spaced steps along a stone staircase. Photo Credit: Jolly Rovers Trail Crew (jollyrovers.org).

Short flights of stone stairs are a sustainable way to gain elevation on steep slopes, and when built correctly can last for many years with minimal maintenance.

Experienced trail builders can build curved staircases to follow the terrain organically.

Diagrams - Stone Stairs 3.1





3.2 - Timber Stairs 3.2

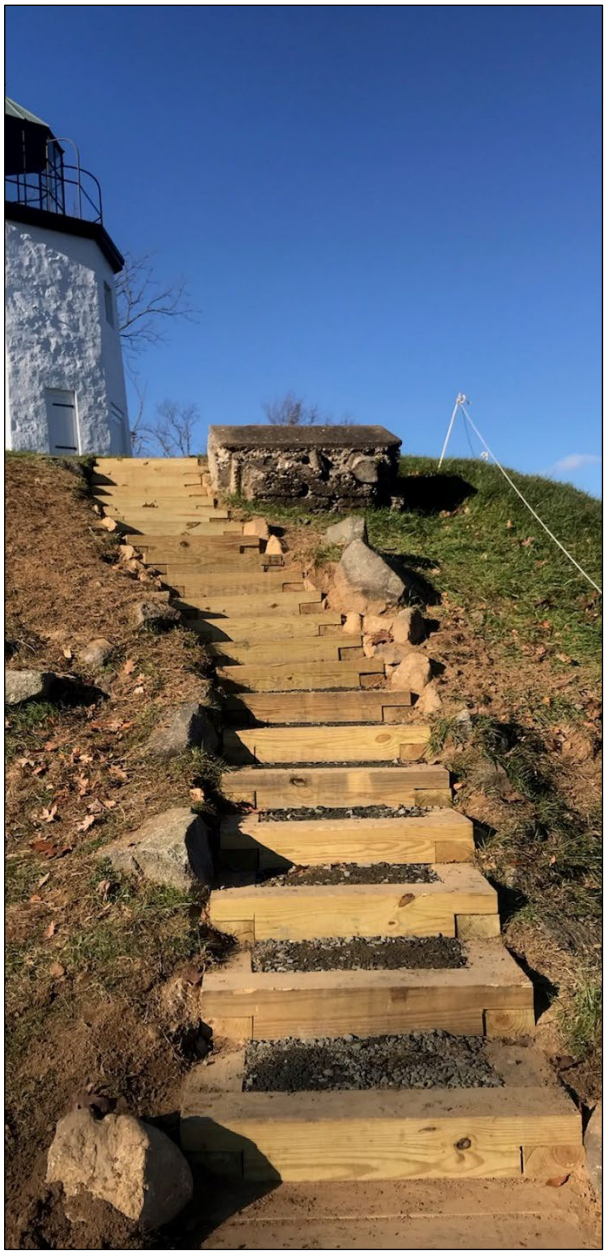
Timber stairs are built for the same reasons as stone stairs, to quickly and sustainably gain elevation. Wooden dimensional lumber can make these quick and easy to build compared to stone steps, but they look less natural and have a shorter lifespan.

Timber stairs can be easy to build and are an effective way to bring people up steep or loose terrain which would otherwise be vulnerable to erosion.

Intent: To use local or (more commonly) imported timber to provide safe, comfortable hiking ascents up steep, eroded, gullied, or otherwise unsafe trail sections.
How it Works: Timber segments are locked together, typically with pins or bolts, to form the frames of steps. Landings are filled with local stone crush and mineral soil to provide a stable walking surface.
Impact: Timber stairs serve to check erosion and provide access up steep ascents where no other solution is possible. If built correctly they are low-impact, provide a comfortable ascent/descent, and last indefinitely with little needed maintenance.

Accessibility Implications: Timber stairs inherently create tread obstacles in excess of 2", preventing their ability to meet FSTAG standards (7.4.6). That said, they do provide firm, level, and stable surfaces on otherwise steep slopes – which can be very helpful for people with many different disabilities.
Accessible Alternatives: Trail realignment/reroute to meet grade requirements, usually with use of climbing turns.
New York Permits Required: *TBD*
New Jersey Permits Required: *TBD*

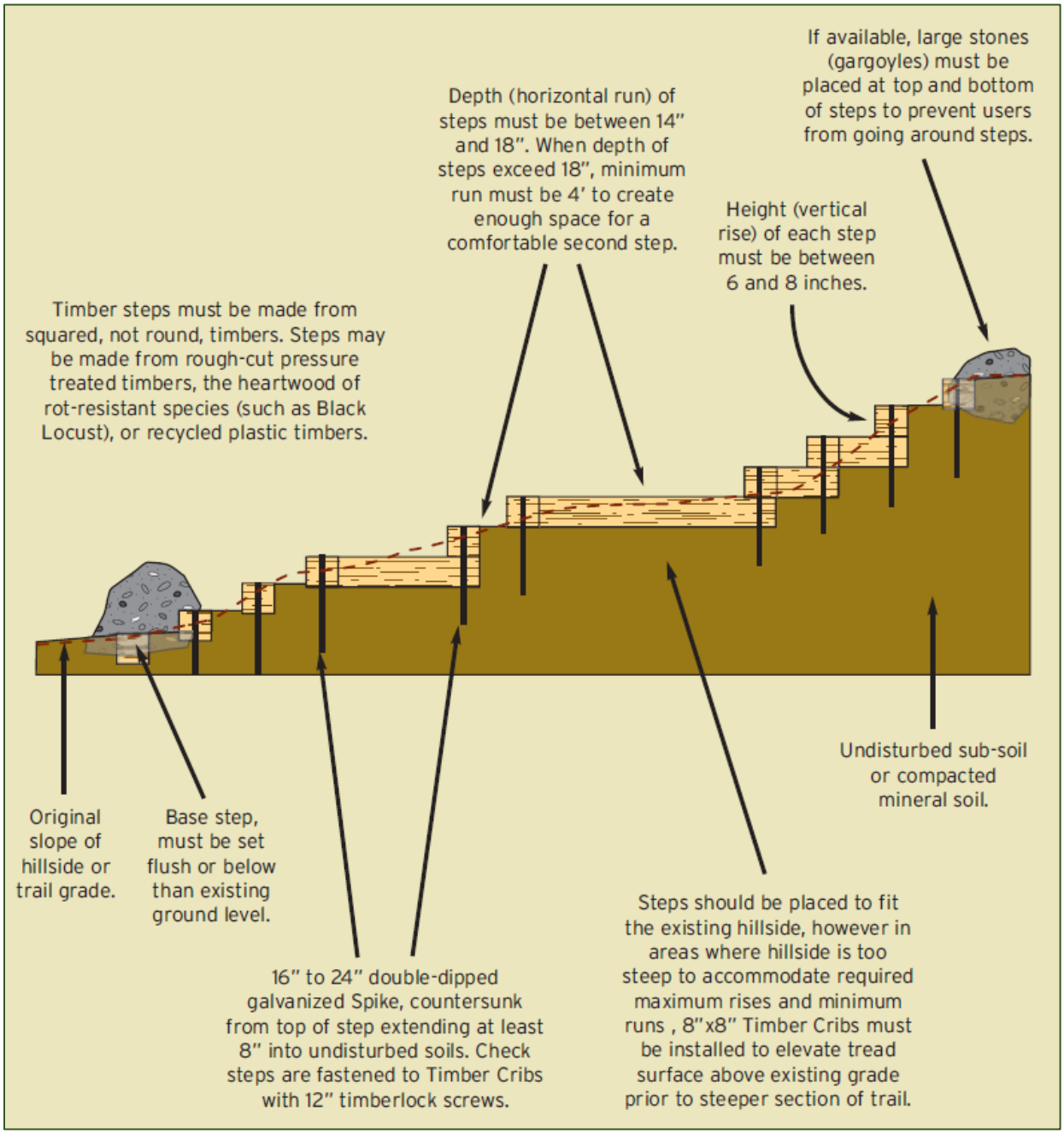
Photographs - Timber Stairs 3.2



Timber stairs leading directly up a steep hillside.

Timber stairs can be used in conjunction with other more typical staircases.

Diagrams - Timber Stairs 3.2



3.3 - Stepping Stone Tread 3.3

For ground that is seasonally wet or muddy, setting large stones in the ground as firm and stable stepping stones is often the lowest-impact way to allow dry crossing. These stones must have enough bulk and volume to be set deep in the ground so that they do not sink or settle any further, as opposed to flat stones which can quickly be swallowed up by soft ground. They are also defined by their spacing, which allows water to flow past if needed.

A series of stepping stones leads across a muddy area to a dry and firm landing.

Intent: Provide a low-impact way to traverse seasonally wet or muddy areas.
How it Works: Local stones are set so that their flat faces are set facing up as a stable walking surface. Adequate space is left between stones for water and light debris to flow through.
Impact: Stepping stones are most frequently used to cross muddy areas, rather than deep flowing water, and are typically set so that the majority of the stone mass is buried with only a few inches exposed on top. Water can easily flow over or between stones. Allowing this dry and stable walking surface prevents hikers from disturbing muddy ground or, by attempting to avoid wet spots, enlarging the wet area.

Accessibility Implications: Stepping stone tread inherently creates gaps and openings in excess of 1/2", preventing the ability to meet FSTAG standards (7.4.7).
Accessible Alternatives: Trail realignment/reroute to avoid problem, boardwalk, timber or stone turnpike (with any gaps covered). Note that very large and stable stepping stones may be suitable footings for small sections of boardwalk.
New York Permits Required: *TBD*
New Jersey Permits Required: *TBD*

Photographs - Stepping Stone Tread 3.3

Two examples of stepping stones used to cross muddy ground.

Stepping stones can be large, bulky, and pronounced or small, flat, and subtle depending on the severity and frequency of wet conditions along the trail.

3.4 - Stone Paving 3.4

Stone paving (also called "pitching") is essentially the same technique as armoring a swale, but applied to a linear stretch of surface intended for a person to move along rather than a very short stretch for water to move across. It can also be likened to the embedding of stepping stones in the ground like a mosaic, in as close contact as possible, to eliminate the space between them.

While not a traditional natural surface trail, the entrance to the Trail Conference office features shaped paving stones over a stone crush base, without mortar – similar to what might be seen on a trail. Photo Credit: Google Maps (google,com/maps).

Intent: To provide a hard, durable tread surface that is highly resistant to mechanical wear when the linear grade is low and the soil is weak/unstable.
How it Works: Stone paving entails setting large rocks that have a relatively flat surface. Rocks are partially embedded so that they are securely set, and their flat tops are at the desired tread elevation. Rocks are tightly fit against each other, minimizing voids and ensuring a relatively smooth, uniform surface. Any remaining gaps can be addressed with chinking or by filling with aggregate.
Impact: Stone paving, when installed properly, can transform an unstable surface into tread that will withstand highly erosive trail uses and visitation numbers. The process improves the stability and durability of the tread to the point where only bedrock or paving would be better.

Accessibility Implications: Can meet all FSTAG standards as long as relevant technical provisions such as surface, slope, grade, width, and obstacle requirements are observed (7.4). In particular, no openings between stones should exceed 1/2" – if needed, stone dust and mineral soil can be used to fill gaps (7.4.7). Note that long-term maintenance to FSTAG standards can be challenging as the structure settles.
Accessible Alternatives: Timber or stone-cribbed turnpike, asphalt paving.
New York Permits Required: *TBD*
New Jersey Permits Required: *TBD*

Photographs - Stone Paving 3.4

Building a strech of stone paving can be labor intensive, but the uniformity of the surface makes it easier to traverse for people who may have problems with mobility, vision, or other disabilities that would make stepping stones difficult. Photo Credit: California Trails Handbook (parks.ca.gov).

While stone paving looks simple, it is deceptively difficult to build in a way that meets all FSTAG standards. Over time, settling and erosion can also cause gaps to open or stones to tilt and present obstacles. ***If meeting FSTAG accessibility standards is important, and construction is limited to native materials, it is usually wiser to pursue a more accessible alternative.***

3.5 - Bog Bridging 3.5

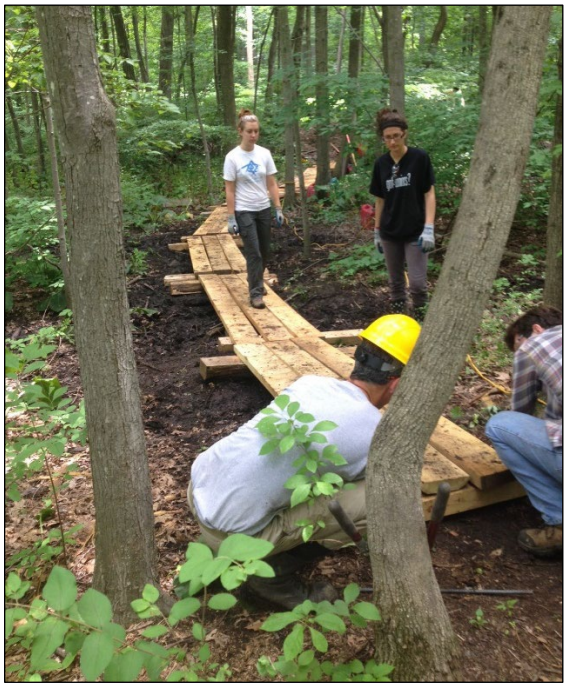
Bog bridging, sometimes called puncheon, is a simple structure that allows for quick and easy crossing of wet areas with minimal disturbance. In addition to being cheap and easy to build, it is elevated to allow water and animals to pass beneath it.

While this area is normally dry, bog bridges allow the trail to be enjoyed even during seasonal flooding without disturbing any local aquatic life.

Intent: Provide a low-impact way to traverse seasonally wet or muddy areas.
How it Works: Timber sills are spaced out and placed on the ground, often pinned in place. Planks are set atop the sills, without touching the ground, allowing water to seep or flow underneath.
Impact: The structure casts shade on the surface beneath it but, aside from where the sills make contact, the underlying surface is undisturbed and unobstructed. This elevated walking surface prevents hikers from disturbing the environment or, by attempting to avoid wet spots, enlarging the wet area.

Accessibility Implications: Does not meet FSTAG standards due to openings in the form of gaps both perpendicular to direction of travel, and between sections of bog bridge (7.4.7). Also typically has width of less than 36" (7.4.2).
Accessible Alternatives: Boardwalk.
New York Permits Required: *TBD*
New Jersey Permits Required: *TBD*

Photographs - Bog Bridging 3.5



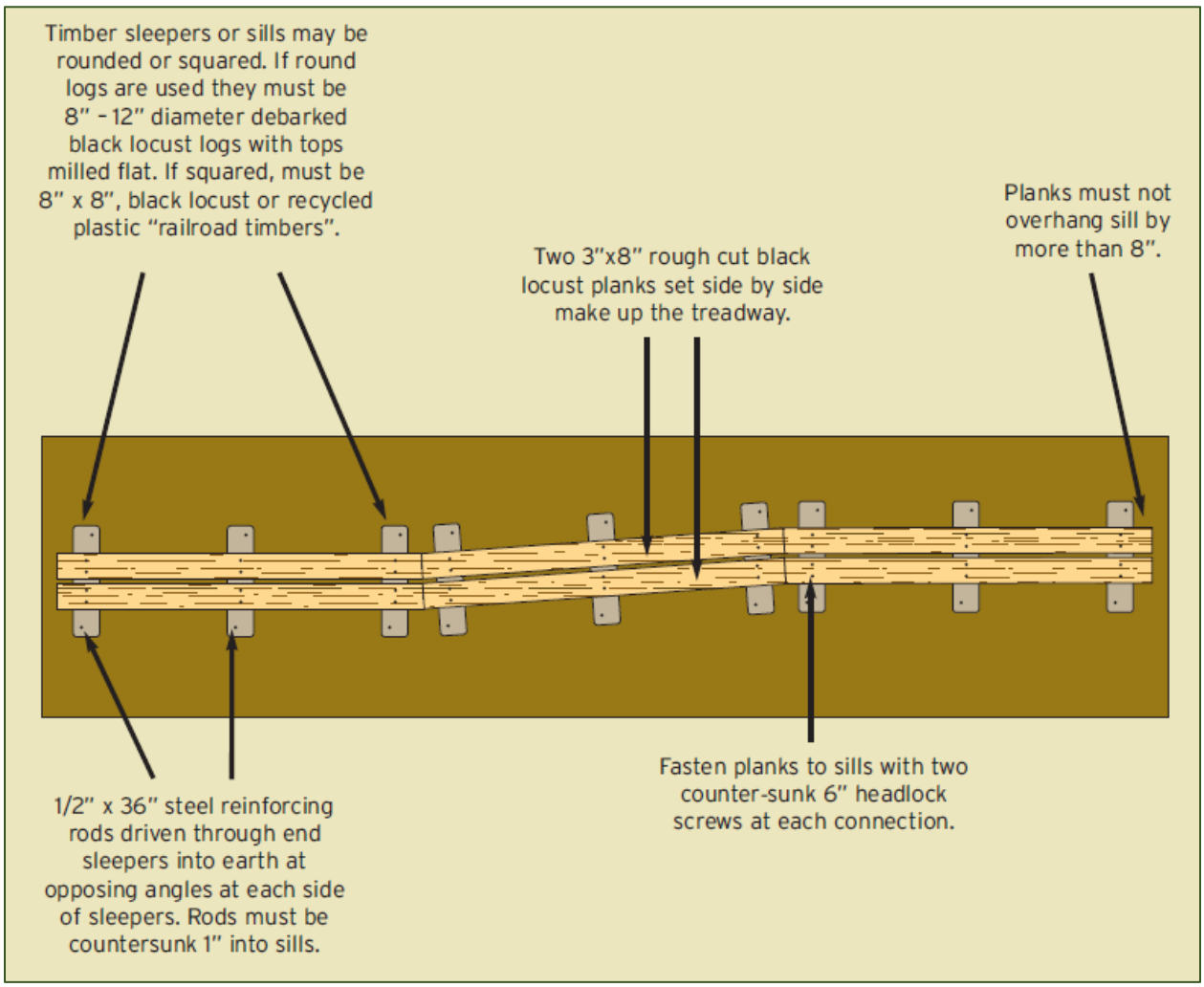
Because of its simple construction, bog bridge is a popular project for Scouts or youth crews.

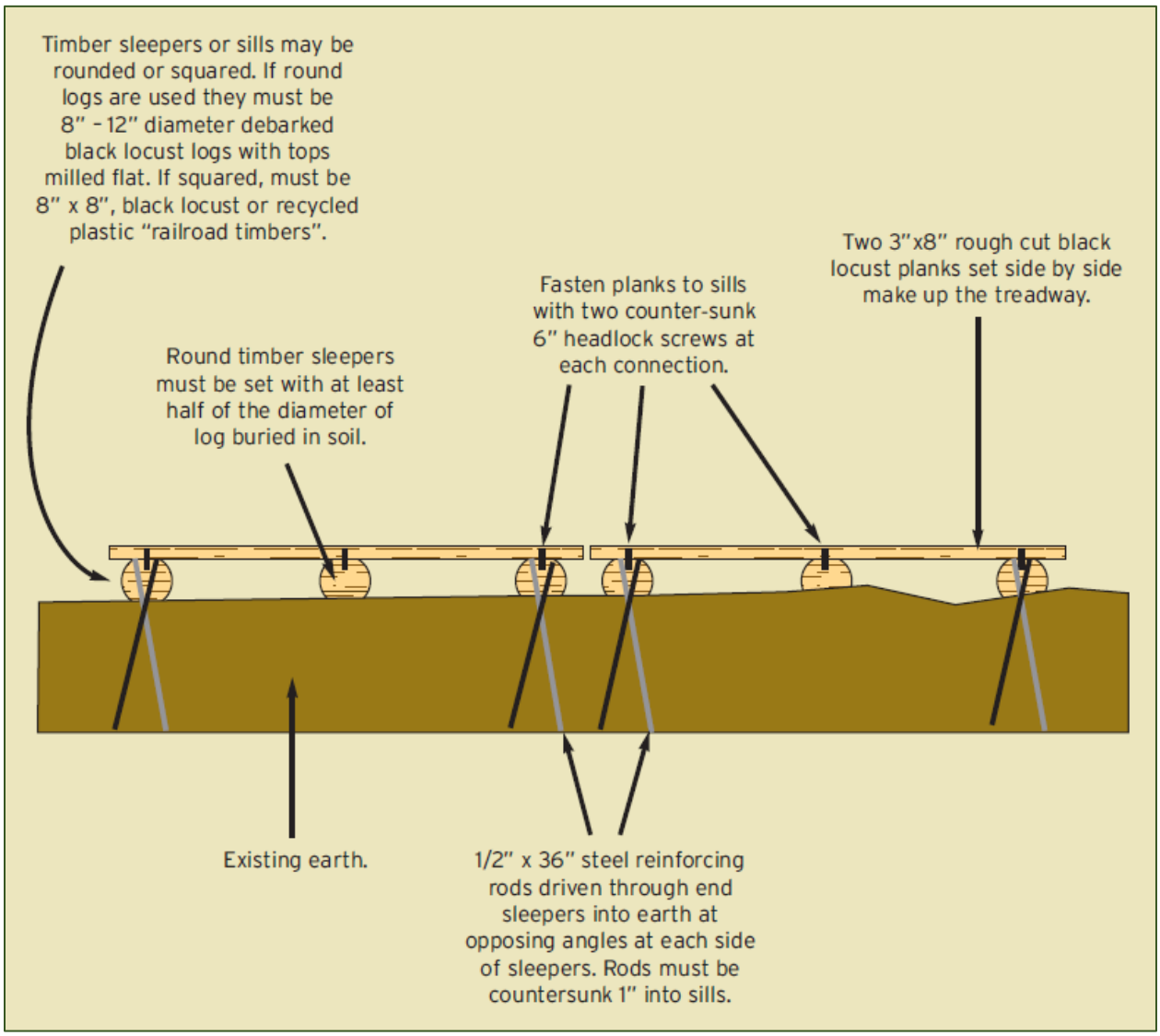
Bog bridges allow people to pass through sensitive wetlands with minimal disruption.

If a minimalist approach is wanted, bog bridge can be built with two planks rather than three.

The addition of chicken wire or roofing shingles can add friction if slippery wood is a concern.

Diagrams - Bog Bridging 3.5




Timber sleepers or sills may be rounded or squared. If round logs are used they must be 8" - 12" diameter debarked black locust logs with tops milled flat. If squared, must be 8" x 8", black locust or recycled plastic "railroad timbers".
Two 3"x8" rough cut black locust planks set side by side make up the treadway.
Fasten planks to sills with two counter-sunk 6" headlock screws at each connection.
Round timber sleepers must be set with at least half of the diameter of log buried in soil.
Existing earth.
1/2" x 36" steel reinforcing rods driven through end sleepers into earth at opposing angles at each side of sleepers. Rods must be countersunk 1" into sills.

3.6 - Boardwalk 3.6

Simple boardwalk is usually distinguished from bog bridging by the presence of stringer boards which run parallel to the direction of travel and have wooden slats or boards mounted on top, perpendicular to the stringers. Boardwalk also typically lacks any gaps between sections, which is common in bog bridging. This makes boardwalk construction more complicated and expensive, but also more durable and accessible.

Simple boardwalk construction in moderately wet areas does not require expensive equipment like helical piers. Stable, well-set sills are enough.

Intent: To span low, poorly drained areas with saturated soil, shallow standing water, sensitive areas, and other locations with weak parent soil unfit to support the intended user traffic.
How it Works: Wooden decking is installed upon a timber sill foundation to create an elevated walkway with a smooth, uniform surface. Some form of simple railing is often included for both aesthetic and functional reasons.
Impact: Boardwalks are primarily used on pedestrian and accessible trails, although they are appropriate on mountain bike trails as well. They are an excellent design solution for providing a firm, stable trail surface and bridging over obstacles where site conditions prevent the use of simple trail hardening, turnpikes/causeways, or other similar features.

Accessibility Implications: Can meet all FSTAG standards as long as relevant technical provisions such as width, obstacle, and opening requirements are observed (7.4). Consider edge protection (pg. 42, Edge Protection for Trails), and provide passing spaces as needed (7.4.5). Make sure that the transitions at either end of the boardwalk are designed to prevent obstacles developing over time. Consider anti-slip treatments or non-slip decking, especially in shaded areas.
Accessible Alternatives: N/A
New York Permits Required: *TBD*
New Jersey Permits Required: *TBD*

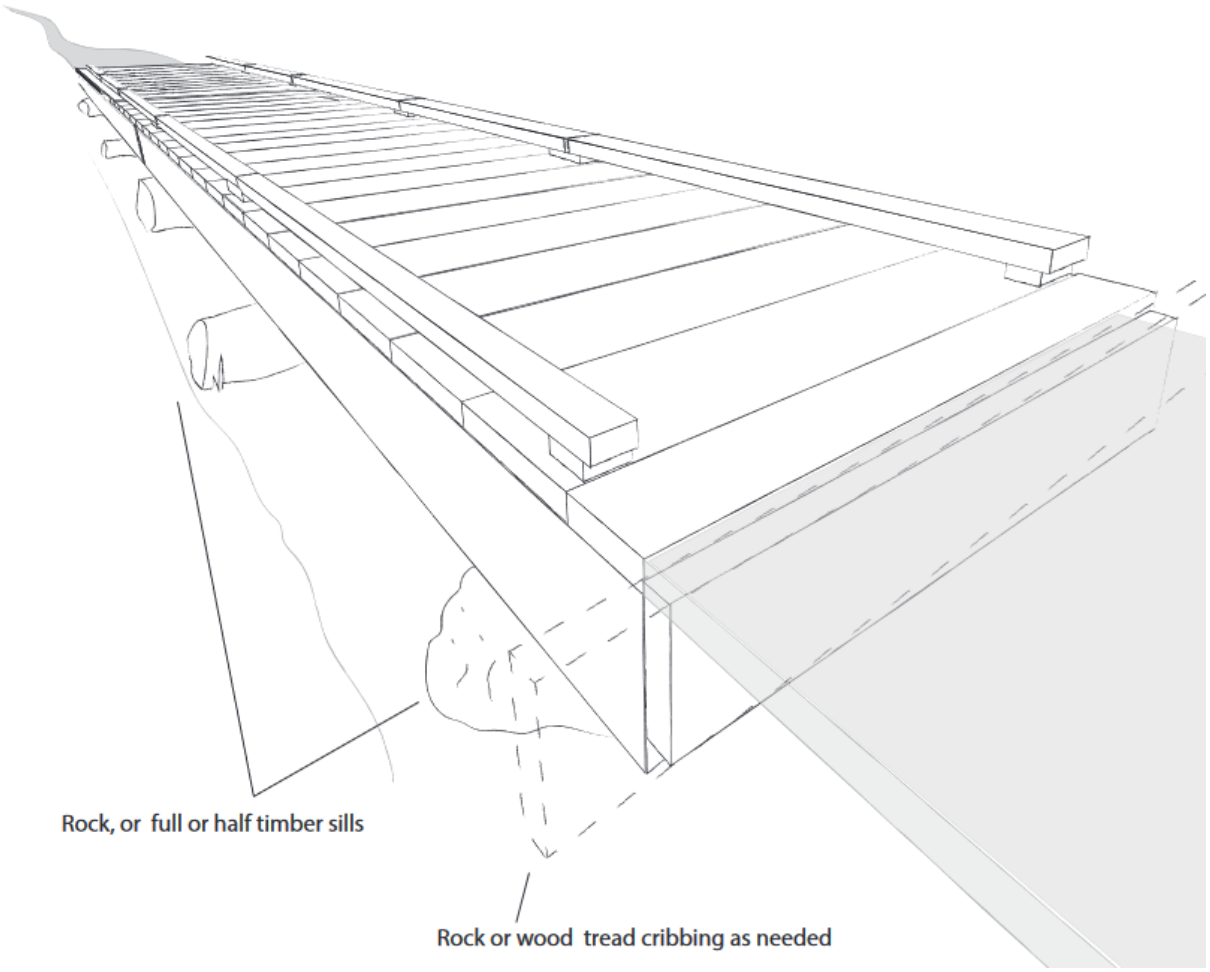
Photographs - Boardwalk 3.6

Simple, backcountry boardwalk showing how turns can be accomplished with planks cut at angles.

Boardwalks can meet FSTAG standards with increased width, smaller gaps between planks, and kick rails.

Boardwalks can use native stone as sills with the right pinning and mounting hardware, as seen in this creative mountain bike trail structure.

Diagrams - Boardwalk 3.6



3.7 – Stone Crush Surfacing 3.7

Trails that have very gradual grades and slopes are usually accessible to a wider audience, but water tends to pool in flat areas. For that reason, it is important for flat and wide trails to establish a firm, elevated, and crowned surface that sheds water off to the sides rather than collecting in the middle. With the correct use of stone crush surfacing, a trail can remain durable and dry even when the surrounding soil is wet and soft.

Even through a marshy wetland, this stone crush surface remains high and dry thanks to a stable base and a crowned surface that sheds water effectively.

Intent: To provide a firm, stable, and highly accessible surface across areas where soil is otherwise uneven, wet, or soft.
How it Works: A geotextile base prevents material from sinking or dispersing, a coarse stone layer provides a strong foundation and facilitates drainage, and a fine stone layer on top provides a stable and compactable surface.
Impact: Areas that were previous impossible to access for some people, especially those using wheelchairs, become accessible.

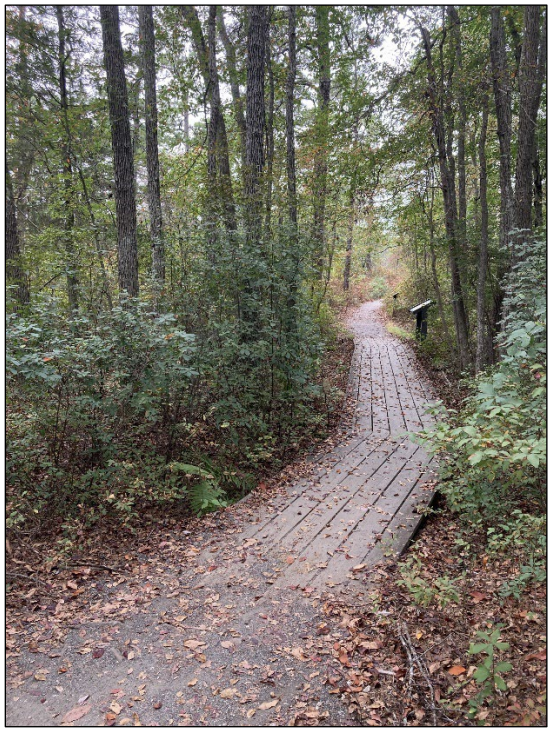
Accessibility Implications: Can meet all FSTAG standards as long as relevant technical provisions such as width are observed (7.4). Note in particular the need for resting intervals even, at low grades – these also help shed water and prevent erosion along sustained grades (7.4.4).
Accessible Alternatives: None needed, as this is considered the best option.
New York Permits Required: *TBD*
New Jersey Permits Required: *TBD*

Photographs - Stone Crush Surfacing 3.7

A meandering trail surfaced with stone crush.

A straight canal causeway converted into an accessible trail.

Crush-surfaced trails can appear very natural with the right layout and design.



To cross wet areas, crush-surfaced trails often transition into boardwalks.

Use of natural landmarks as "anchor points" can add interest to the trail, and provide tactile sensory opportunities for people without leaving the stone crush surface.

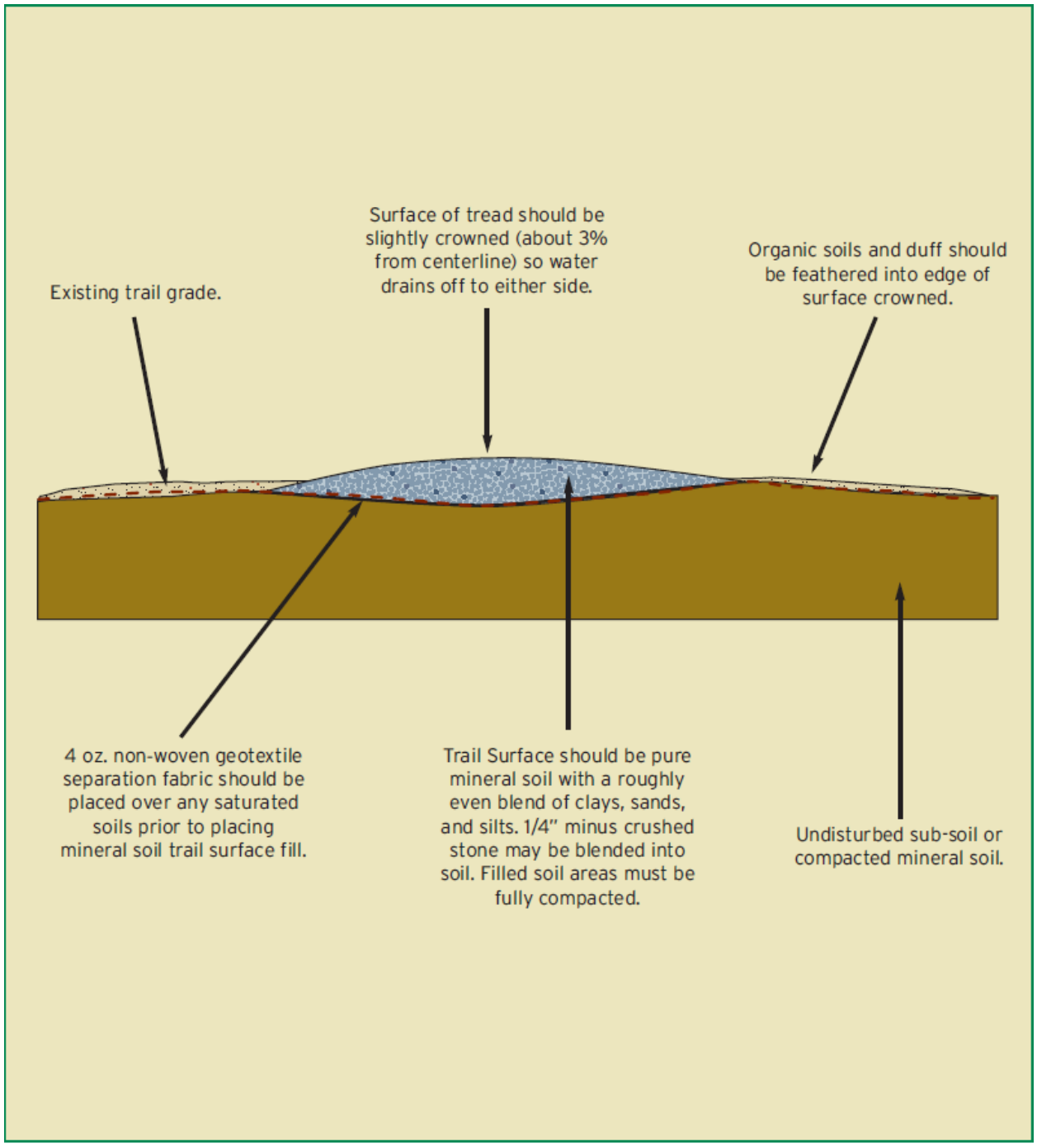
Bridges are an essential part of many accessible trails, and are often incorporated into stone crush trails. If bridges cannot be built for compliance reasons, accessibility can become extremely limited.

The more accessible the trail, the more people of different ages and abilities can spend time together.

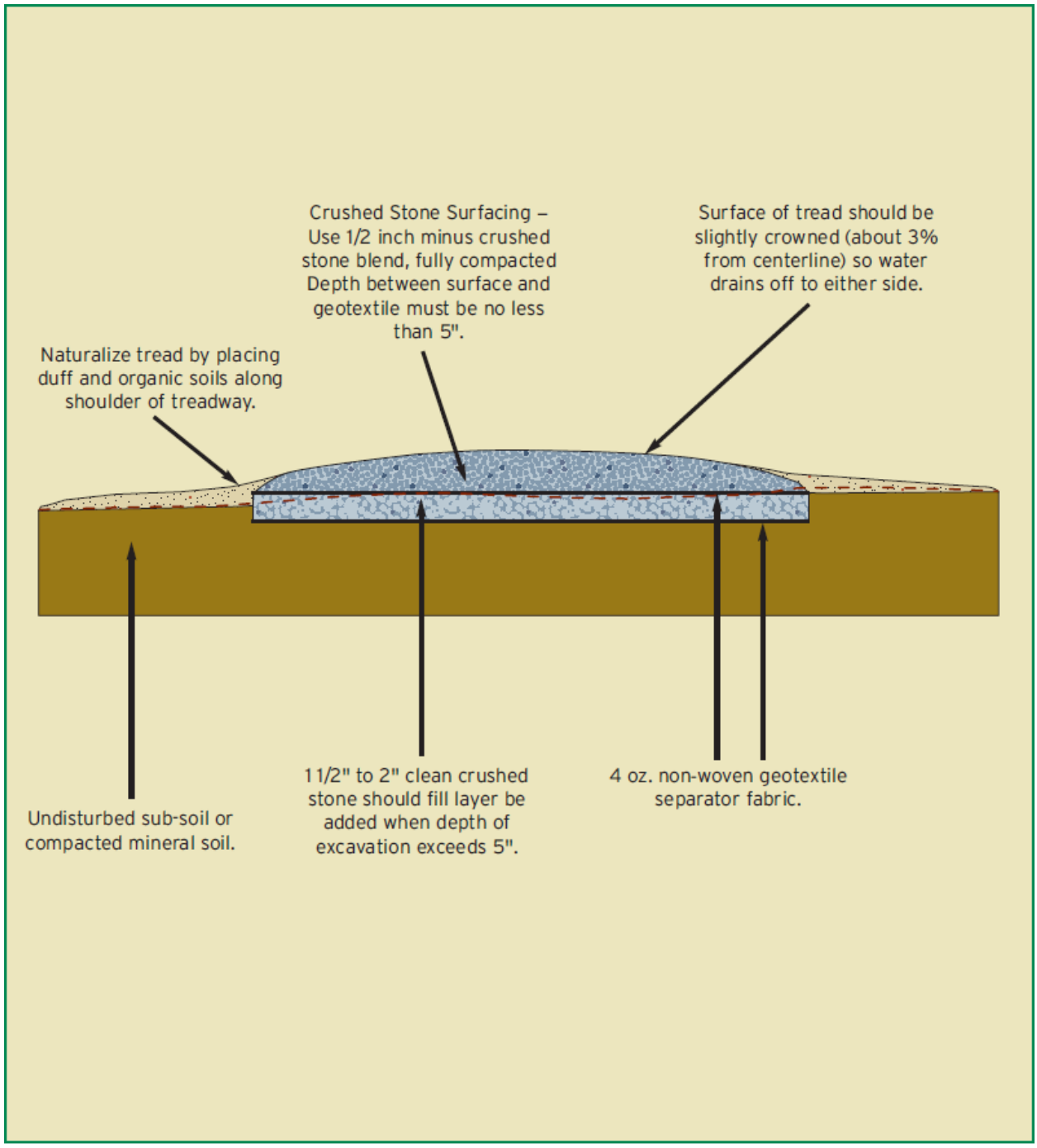
Disabilities that affect mobility affect many people, and not all of them use wheelchairs.

Everybody has a right to enjoy the outdoors, and land managers should help navigate compliance challenges that serve as barriers to accessible construction .

Diagrams - Stone Crush Surfacing 3.7



When the existing substrate is firm, stone crush surfacing can be applied directly over geotextile as shown above. In the long term, this lack of a durable base layer may negatively impact the trail's ability to adhere to all FSTAG standards.



When the existing substrate is soft, or full and long-term compliance with FSTAG standards is required, stone crush surfacing should be applied over a base layer of coarser crushed stone. This base of crushed stone will provide a more durable surface over time.

4.0 Water Crossing

4.1 – Wooden Trail Footbridge 4.1

Bridges are essential infrastructure to keep visitors safe, ensure access along established routes, and prevent the ecosystem damage that comes from clambering down banks and across streams. It is **critical that land managers work collaboratively with trail builders** to ensure that complex engineering requirements intended for vehicular bridges, or major river crossings, are not inappropriately applied to tiny stream crossings in remote settings.

As many land management agencies enact stricter permitting requirements, small bridges in the middle of the woods - previously made by Boy Scouts and other volunteers - can now require thousands of dollars in engineering review and result in grossly over-designed structures. These bridges are often not only incongruous with the environment, but are logistically impossible to build. Where construction of these over-engineered bridges is possible, it can cause more damage than it prevents.

Often, wooden trail footbridges are far too small to be reasonably subjected to engineering and permit requirements. Land managers should have latitude to apply common-sense requirements for bridges on their properties.

Intent: Provide safe passage over short spans of water.
How it Works: Abutments are embedded in each bank, far enough from the bank edges and deep enough to prevent erosion and undercutting. Stringers connect the abutments, and deck boards provide a walking surface across the stringers.
Impact: The structure casts shade on the water beneath it but, aside from where the abutments are set, the underlying stream channel is undisturbed. Allowing this dry and stable walking surface prevents hikers from disturbing sensitive waterways and streambanks.

Accessibility Implications: Many small trail footbridges are more akin to stand-alone sections of boardwalk rather than engineered bridges. The same accessibility implications for boardwalks can be applied to footbridges.
Accessible Alternatives: N/A
New York Permits Required: *TBD*
New Jersey Permits Required: *TBD*

Bridges vary widely in size and scope, and different land managers have vastly differing policies on what types of bridges need formal engineering and state-issued permits, versus a simple "go ahead" from the local park manager.

Many trail footbridges, of the style built by Scouts and other volunteers, fall within the following parameters. It is our hope that land managers will make reasonable exceptions to permit and engineering requirements for small bridges of this style:

- **Users:** Pedestrians and, where appropriate, bicycles
  - *No vehicular crossing, including small ORVs like ATVs or dirtbikes*

- **Width:** Not to exceed 4' tread/deck
  - *Not including width added by handrails or braces mounted outside the tread surface*

- **Thickness:** Not to exceed 12" from top of deck to bottom of stringer
  - *This assumes up to 2" x 10" boards for the stringers, with deck board on top*

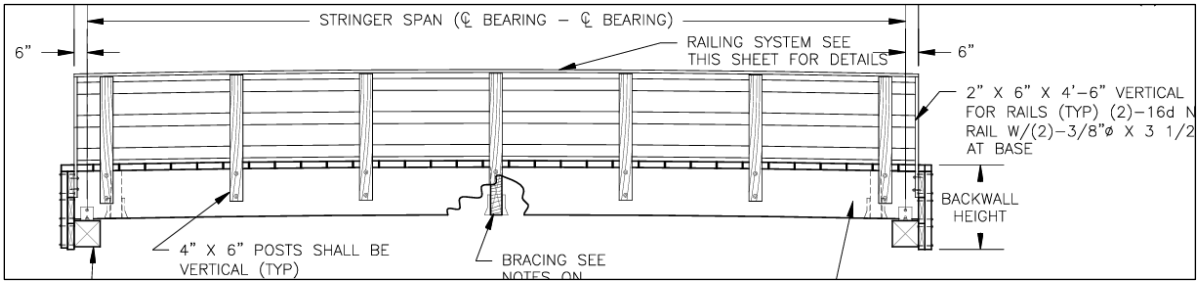
- **Span:** Not to exceed 20'
  - *Including necessary overlap with the tops of both banks*

- **Materials:** Stringers made from wood or timber
  - *Deck boards may be made from other materials, like synthetic plastic lumber, where appropriate*

Note that these parameters do not address abutments or foundations, which by necessity have to be considered on a location-by-location basis. Solid abutments are a critical part of long-lasting bridges, and in some locations may be subject to more consideration and scrutiny than the bridge span itself.

United States Forest Service (USFS) Bridge Plans

If land managers want to use engineered bridge plans for all projects on their property, but want to keep project approvals realistic and affordable, the USFS offers free plans for a variety of wooden trail footbridges. Requiring that bridges be built according to these plans is a great way to ensure quality structures without introducing exorbitant design fees into a project, even if a local engineer needs to review and sign off prior to construction.



Photographs - Wooden Trail Footbridge 4.1

Many wooden trail footbridges are exceedingly small, designed to cross small trickling streams. To require complex permitting and engineering for this style of structure is counterproductive to building safe trails that protect water resources.

In some instances, small bridges can be located to take advantage of existing rocks in the waterway. This style of construction, utilizing metal pins to attach wood to rock, allows for construction with no disturbance to the existing channel.

A classic wooden trail footbridge built in the simple "box bridge" style by an Eagle Scout. This location is inaccessible to vehicles and mechanized equipment, so all materials had to be carried to the location piece by piece.

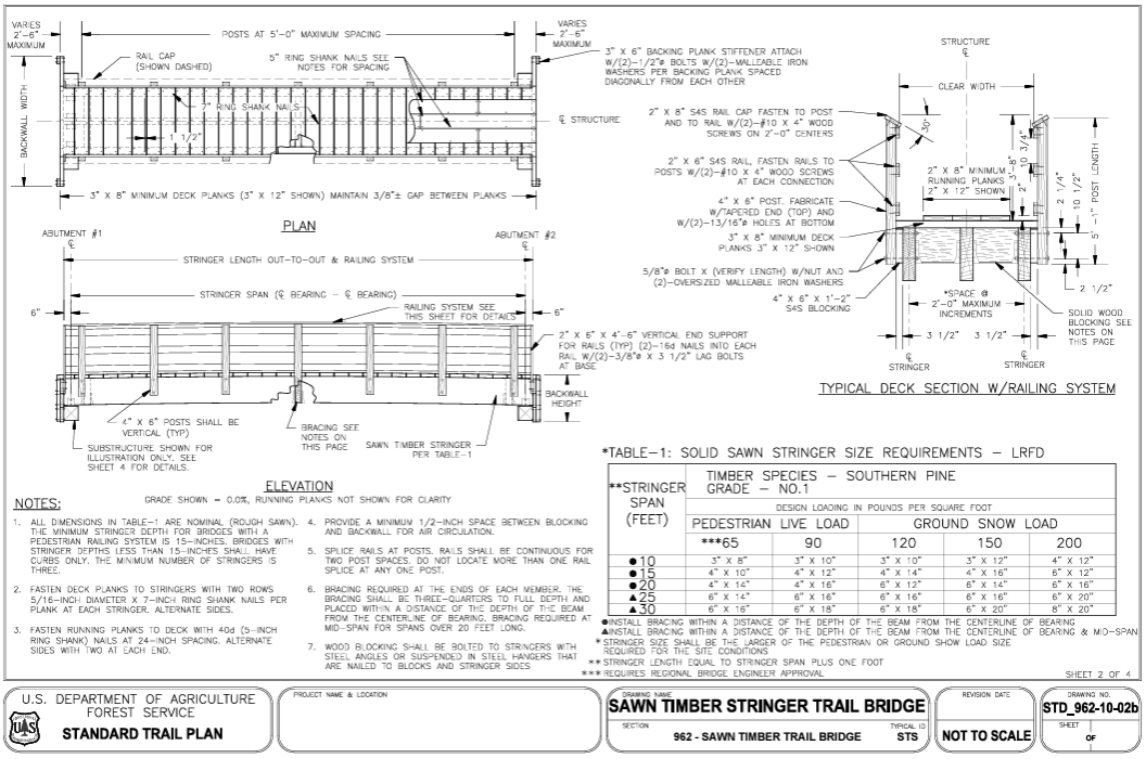
The same bridge, seen from the opposite bank. This style is considered the standard for bridges in the 15'-25' range.

The bridge shown below is an example of a simple "break-away" bridge, intentionally designed to easily float aside during times of high water flow. This prevents any significant obstruction to hydrology, and the steel cable tether keeps the structure from floating far. This entire bridge is less than 7' in length – small enough that after water flow has subsided, it can easily be lifted back into position by two volunteers.

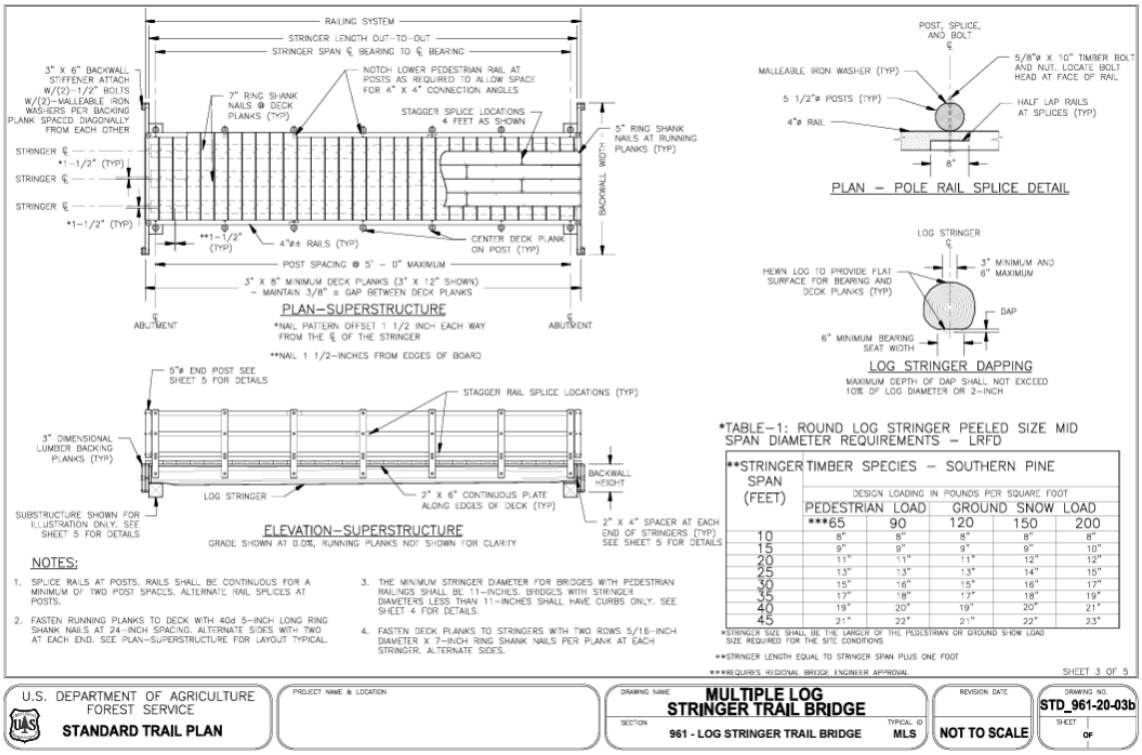
Some land managers waive permit and engineering requirements for these small and simple structures, understanding that they cause no environmental harm and are perfectly adequate for trail users in a backcountry "primitive footpath trail" setting.

While the example shown above does not meet FSTAG standards for several reasons – width under 36", gaps greater than 1/2", obstacle greater than 2" in the transition from trail tread to bridge deck – it should be possible to design short break-away bridges that meet all FSTAG standards.

Diagrams - Wooden Trail Footbridge 4.1



Examples of [free USFS bridge plans](), using either dimensional lumber or logs.



4.2 - Stepping Stone Stream Crossing 4.2

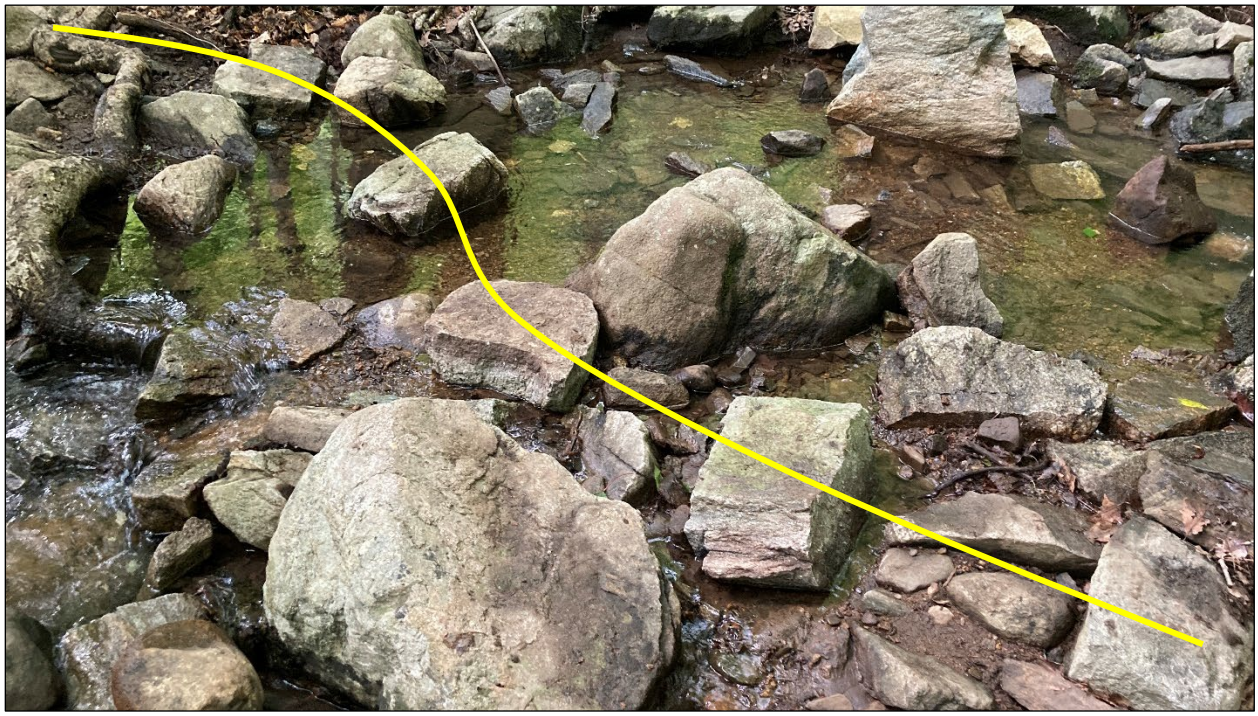
For small streams, where accessibility is not a concern, stepping stones are often considered the easiest way to establish a dry crossing. Stepping stones should be large and bulky, placed to protrude out of the water even during the times of highest regular seasonal flow, as opposed to treadway stepping stones which are sunk low into the ground to present a surface almost flush with the surrounding surface.

Though the stream bed is currently dry, these stepping stones are elevated to allow visitors to pass even when water is at its seasonal height.

Intent: To offer dry passage across relatively low-volume and low-velocity streams.
How it Works: Stepping stones are set in a spaced line at an advantageous crossing point dictated by the relative waterflow, channel shape and size, and streambank and streambed conditions. Visitors step across the stones.
Impact: A well-constructed stepping stone crossing provides a comfortable and dry crossing for users while minimizing impacts on the stream and associated watershed. It mitigates the tendency of visitors to either avoid water crossings altogether or disperse in all directions trying to find the driest possible ford, and generally makes the trail more defined and appealing.

Accessibility Implications: Stepping stone stream crossings inherently create gaps and openings in excess of 1/2", preventing the ability to meet FSTAG standards (7.4.7).
Accessible Alternatives: Bridge.
New York Permits Required: *TBD*
New Jersey Permits Required: *TBD*

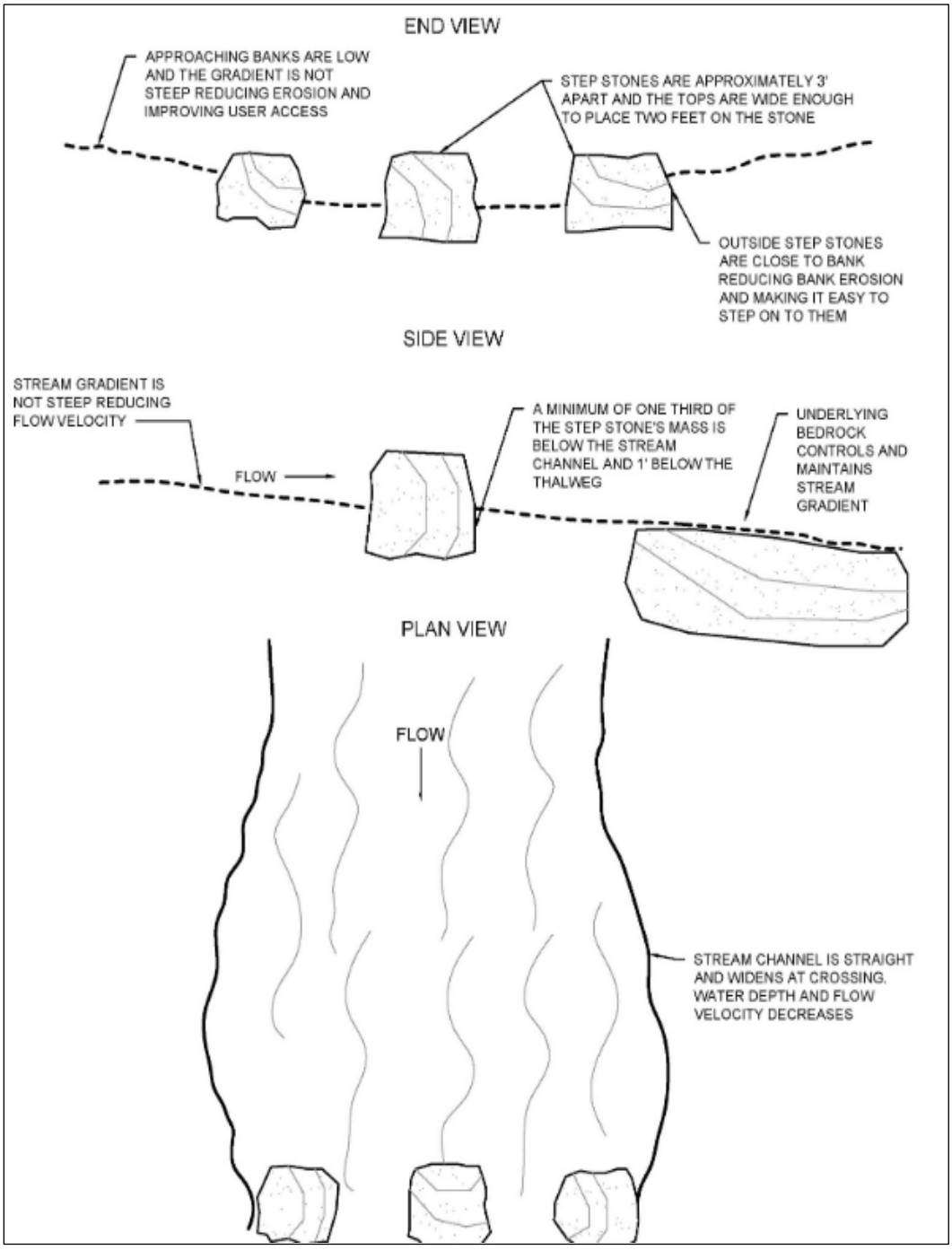
Photographs - Stepping Stone Stream Crossing 4.2



Stepping stones can be intentionally subtle, with careful re-arranging of existing rocks within the waterway to provide stable footing. In this instance, most visitors would find dry footing during high water and not realize it was arranged intentionally.

To make a broader audience feel safe and comfortable while crossing, larger rocks and a "handrail" rope can be used.

Diagrams - Stepping Stone Stream Crossing 4.2



Additional Resources

This document is intended as a broad and highly visual introduction to trailbuilding structures, techniques, and terminology. It is intended to help explain proposed work to partners and compliance officers who are not familiar with the nature of natural surface trail building.

With that in mind, this document does not provide the technical guidance necessary to build many of those structures. Many of the resources below are written with that purpose in mind, and can guide you towards more detailed plans and instructions.

Trail Resources

- USFS - Standard Trail Plans and Specifications
  - https://www.fs.usda.gov/managing-land/trails/trail-management-tools/trailplans
- Trail Conference - Trail Design & Construction Resources
  - https://secure.nynjtc.org/content/trail-design-construction-resources
- Trail Conference - Blazing & Maintenance Resources
  - https://secure.nynjtc.org/document/trail-maintenance-manual

Accessible Trail Standards

- 2015 – USFS - Forest Service Trail Accessibility Guidelines (FSTAG) - Pocket Version
  - https://www.fs.usda.gov/sites/default/files/FSTAG-Pocket-Guide.pdf
- 2014 – U.S. Access Board – Outdoor Developed Areas
  - https://www.access-board.gov/files/aba/guides/outdoor-guide.pdf
- 2013 – USFS - Forest Service Trail Accessibility Guidelines (FSTAG)
  - https://www.fs.usda.gov/sites/default/files/FSTAG-2013-Update.pdf
- 2012 – USFS - Accessibility Guidebook for Outdoor Recreation and Trails
  - https://www.fs.usda.gov/sites/default/files/Accessibility-Guide-Book.pdf
- 2006 – USFS - Accessibility Guidebook for Outdoor Recreation and Trails (Web Version)
  - https://www.fs.usda.gov/t-d/pubs/htmlpubs/htm06232801/toc.htm

Other Accessibility Resources

- ADA.gov - The Americans with Disabilities Act Standards for Accessible Design
  - https://www.ada.gov/law-and-regs/design-standards/
- U.S. Access Board - Architectural Barriers Act Accessibility Standards (ABAAS)
  - https://www.access-board.gov/aba/
- National Center on Accessibility
  - https://ncaonline.org/
- Northeast ADA Center: About Recreation Accessibility
  - https://www.northeastada.org/resource/about-recreation-accessibility
- American Trails – Trail Accessibility Hub
  - https://www.americantrails.org/resources/accessibility-hub
- Guidance on Developing and Designing an Accessible Trail
  - https://acrobat.adobe.com/id/urn:aaid:sc:US:a363e440-f32d-4111-a8bd-94845aa83bd3
- Nature: Accessible For All – Trails Map (Pinelands Preservation Alliance)
  - https://storymaps.arcgis.com/stories/5d5e1b29f76a42299b708dc0457e7086
- Site Assessment Form for Accessibility (Pinelands Preservation Alliance)
  - https://survey123.arcgis.com/share/59110e7d5c7143d19d0f8735c70abf76

Acknowledgements

This document was originally written for Trail Conference internal use in 2018. In 2024, the work of the Access Nature Forum identified regulatory and compliance challenges as one of the major barriers to building new accessible trails. Members of the Access Nature Forum Regulatory Reform Working Group determined that a visual guide, written for people unfamiliar with common trail structures and emphasizing accessibility elements, would be helpful in navigating compliance conversations.

A generous stipend award from the Pinelands Preservation Alliance, which hosts the Access Nature Forum, allowed the Trail Conference to invest the staff time needed to update this document. The following contributors in particular made the update possible:

- **Sean Kane Holland, Access Nature Disability Advocate, Pinelands Preservation Alliance:** For assisting with identifying the need for this document, coordinating the necessary funding, and providing valuable input and revisions.

- **Carleton Montgomery, Director of Strategic Initiatives, Pinelands Preservation Alliance:** For project support, review, and suggestions to ensure that the final document was clear and met the needs of its intended audience.

- **Andrew Rosenthal Baxter, Trail Builder, Trail Conference:** For collection and curation of trail structure photographs and diagrams, as well as supplementary written information.

- **Peter Dolan, Trail Program Manager, Trail Conference:** For providing the initial document, organizing the update project, and overseeing final content and formatting.

ACCESS Nature

The Access Nature Forum was created to bring together a diverse selection of like-minded individuals to have conversations about improving access to natural places. It aims to engage those with disabilities, their families, caregivers, veterans' groups, assisted living organizations, advocacy groups, nonprofit organizations, state, and local officials, and agencies in a public discourse that identifies public interest, concerns, and ideas, and joins their voices for improving access to natural places.