SECTION

3 Principles of Ecological Sustainability

Overview

This section considers ecological sustainability as related to trails in Minnesota. The section covers:

- A vision of ecologically sustainable trails
- Guiding principles for sustainable trails
- Common methods for defining natural areas and sensitive ecological systems

A Vision of Ecologically Sustainable Trails

Trails at the local, county, regional, and state level all across Minnesota provide recreational opportunities for residents and visitors throughout the seasons. An ever-growing network of trails links urban and suburban places to the rural countryside, natural open spaces, and parks of many shapes and sizes. Individually and collectively, recreational trails enable visitors to experience Minnesota's natural and cultural landscapes.

Trails must be responsibly developed to avoid diminishing the natural environment or the experience of being in a natural setting. The objective of this manual is not to limit or preclude trail opportunities, but to embrace and promote them in a sustainable manner, striking a reasonable balance between resource protection and human access and enjoyment.

The blufflands of Minnesota are among the many natural features that add to the quality of life in the state. Providing access to these areas via trails in a sustainable manner is a major emphasis of this manual.

Minnesota is uniquely blessed with three major ecological regions, or biomes, which provide a diversity of recreational experiences. Trails provide the conduits for observing and experiencing many of these wonderful landscapes.

Guiding Principles for Sustainable Trails

Guiding principles for ecologically sustainable trails provide the underlining rationale for actions related to protecting, restoring, and managing natural environments associated with trail development. There are seven core principles, as the following graphic illustrates.

Regulatory Reminder!

Refer to Section 1 - Framework for Planning Sustainable Trails for typical regulatory requirements whenever planning a new trail.

Adherence to These Principles Will Ensure Ecological Sustainability

Minnesotan's have long appreciated the simple pleasure of accessing a natural setting via trail. The challenge is to maintain this access in the context of increasing use pressures and increasingly sophisticated means of getting around – enjoying the experience without diminishing it in the process.

Application of these principles will minimize the impact of trails on natural resources and sensitive ecological systems. *Importantly, the strict application of these guiding principles has to be balanced against the need to locate trails where they will be of high recreational value to the targeted users,* who often want to be close to nature, enjoy beautiful scenes, and observe wildlife. This is an important consideration and underscores the need for resource managers and trail designers to work together to determine which values are most important for any given situation.

For example, under the guiding principles, it is reasonable and desirable to buffer a given trail from sensitive ecological systems, such as a rare fen. However, once a trail alignment is agreed upon, the design of the trail should be consistent with the parameters set for that type of trail to avoid compromising its safety or value to targeted trail users. In other words, the width or clearance zone for a trail should not be modified to reduce its ecological impact if doing so would appreciably diminish its value and defeat the purpose of providing the trail in the first place.

The following considers each of the guiding principles for sustainable trails in greater detail.

Guiding Principle #1 – Avoid Sensitive Ecological Areas and Critical Habitats

Even when the most stringent safeguards are put into place, all development, including trail development, has an impact on natural systems. This includes direct (i.e., the trail itself) and indirect (e.g., changes to surrounding hydrological patterns, erosion, invasive plant migration, habitat fragmentation) impacts.

Although trail development is often justifiable, avoiding sensitive ecological systems is always the best protection strategy and should be the first considered when planning a trail. Ecologically sensitive systems include:

- Native plant communities and critical habitat for endangered, threatened, and special concern species as identified by the Natural Heritage Program, County Biological Survey, National Wetland Inventory, and by other means
- Significant geologic features, such as eskers
- Wetlands, lakes, rivers, and streams
- Steep slopes and soils that are easily eroded or rutted
- Habitat for animals that are sensitive to habitat fragmentation
- Larger remaining open spaces exhibiting high-quality natural systems, and smaller patches of isolated remnant landscapes that are vulnerable to development

The benefit of extensively mapping ecological systems is that sensitive areas are more clearly defined and more readily protected as trail alignments are considered and established.

Additional perspective on avoiding sensitive ecological systems!

The publications entitled *Tomorrow's Habitat for the Wild and Rare: An Action Plan for Minnesota Wildlife* and *Natural Areas: Protecting a Vital Community Asset* are important resources in support of this principle and underscore the importance of avoiding sensitive areas. The most poignant point is the fact that relatively little natural habitat remains in Minnesota, and once disturbed, natural systems are both difficult and expensive to restore. These publications can be found at www.dnr.state.mn.us/cwcs/index.html.

Public Perception of Naturalness

The general public's perception of "naturalness" is often less discriminating than that of a trained professional ecologist or naturalist. This enables many trail users to have an enjoyable and satisfying experience even though a trail is routed through areas that are not very ecological sensitive and pristine.

However, allowing controlled access to sensitive ecological areas is an integral part of educating the public about the value of protecting them. Most often, this takes the form of routing a corridor trail on the periphery of a sensitive area (with adequate buffers) and allowing more direct access to specific settings only in very select locations for closer observation. This approach provides reasonable access while limiting the potential for environmental impact.

This sensitive wetland ecosystem is best viewed from a single or a series of strategic vantage points, rather than traversed directly with a trail. Insightful planning and design can make the visitor experience very compelling without unduly impacting the ecological system that is being observed.

A view such as this across a small lake in the northern forest can be a compelling trail terminus point that is accessed with a spur trail from a main trail that is a sustainable distance away from the ecologically sensitive shoreline zone. Although the temptation is to provide a trail around the lake, that is not always the most compelling or ecologically sustainable approach.

This simple nature trail alongside a prairie pothole is ecologically sustainable due to light levels of use, a reasonable natural buffer between it and the pond, and restored and managed natural vegetation surrounding it to prevent erosion. Close monitoring, maintenance, and general stewardship by park staff and trail users will be necessary to maintain this balance.

Guiding Principle #2 – Develop Trails in Areas Already Influenced by Human Activity

Consistent with the first principle, new trail development should occur primarily in environments already influenced by human activity. Depending on the circumstances, this can take a variety of forms, as the following considers.

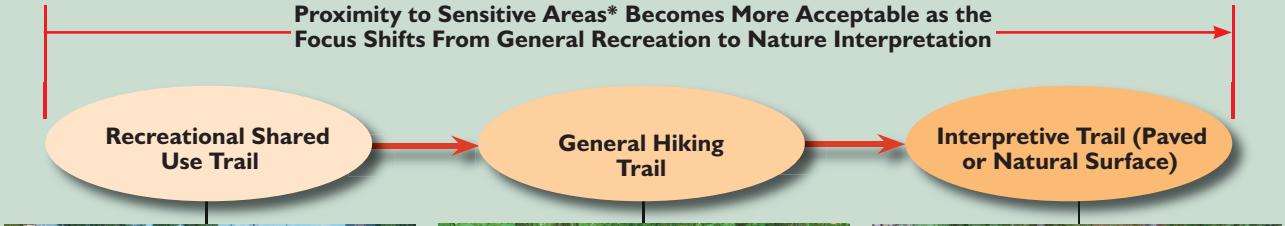
Park Settings

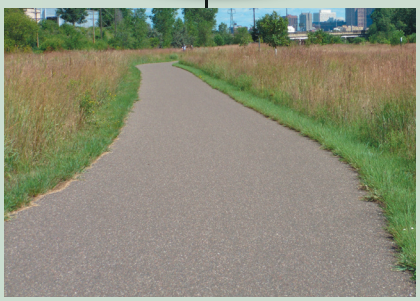
In park settings, ecological and cultural inventories and analysis are typically used to define the most sensitive areas and, subsequently, areas most suited for various forms of recreation-based development. In most cases, development of trails is best suited in previously disturbed or degraded natural areas. Trail alignments should also be consistent with ecological stewardship plans related to restoring disturbed sites to higher quality natural areas.

The type of trail also affects its alignment relative to sensitive ecological systems. The more a trail focuses on interpretation, the more appropriate it is for it to approach sensitive ecological areas, as the following graphic illustrates.

Trail Alignments Relative to Sensitive Ecological Systems in a Park Setting

There is a direct relationship between the trail type and its proximity to sensitive ecological areas, as the following illustrates.





This paved trail traverses a greenway that was once a rail yard. In this case, the alignment of the trail was based more on recreational value than needing to respond to existing sensitive ecological systems. (Notably, the restored native landscape adds value to the trail, but it did not greatly influence its actual alignment.)

This natural hiking trail places value on the natural experience and so proximity to sensitive ecological areas is important. But the trail does not need to traverse any sensitive systems as long as the trail user is able to obtain a similar experience.

When natural interpretation is a desired value of a trail, direct encroachment can be acceptable as long as it is done sustainably with manageable ecological impacts. This boardwalk is more sustainable than building a footpath or paved trails through the sensitive wetland system.

* Sensitive ecological areas refers to natural values, not scenery. With respect to the latter, all trails should take advantage of scenic opportunities and follow the principles of good design as defined in Section 2 to ensure that a trail is of high recreational value.

An important consideration!

Creating a high-quality recreational experience must be taken seriously during route selection if the trail is to be of value to the targeted users. At times, this will require creating a new trail through an area that does not conveniently follow existing routes. Under these circumstances, environmental impacts must be balanced against the benefit of the trail to intended users. This will require close coordination between trail designers and resource managers to ensure that an acceptable balance is reached.

Forests and Other Public Lands

Nonpark public lands most often consist of county, state, and federal forests throughout the state. These lands are often managed for multiple uses such as timber harvesting, hunting, maintaining biodiversity, and recreation.

In many of these settings, an extensive network of forest access routes and roads already exists for resource management and timber harvesting, and subsequently for hunting and general public access to forests. Whenever designated trails are established, these existing routes should be used when feasible to avoid creating a larger ecological footprint and further encroachment into ecologically sensitive areas.

The one limiting factor in using existing roads and trails is that they are often too straight or not challenging enough for some uses, especially OHV riders and mountain bikers. As defined in Section 4 – Trail Classifications and General Characteristics, a mix of dedicated trails, trail conversions, and on-road trails is typically used for designated OHV trails to provide an interesting trail experience, as the following photos illustrate.

On-road trail *takes advantage of the existing road infrastructure and provides its own diversity of experience. (Typically, these are lower-level roadways within a forest setting.)*

Trail conversion *takes advantage of an old road by letting it "grow in" to create a narrower, more intimate trail experience within the same developed footprint.*

Dedicated trail *is shaped specifically for OHV use and designed to add challenge and excitement. Careful assessment of ecological impacts is a key aspect of selecting new trail routes.*

An important consideration!

In instances where new dedicated trails are developed to augment existing ones, decommissioning an equal number of forest roads and trails (that are not needed for other resource management purposes) should be considered. In doing so, the quality of the trail experience is enhanced without expanding the overall road and trail footprint associated with a given parcel of land.

Guiding Principle #3 – Provide Buffers to Avoid/Protect Sensitive Ecological and Hydrologic Systems

Maintaining buffers between trails and adjacent sensitive natural areas is essential to ensuring their long-term ecological quality, diversity, and habitat value. Irrespective of how well they are aligned and designed, trails have an impact on the resource, including habitat fragmentation, soil compaction, increased runoff and erosion, and introduction of nonnative plant species. For these reasons, the use of buffers is an essential part of trail planning and design.

Limitations of Buffer Guidelines

All sensitive ecological systems exhibit intrinsic natural values that require individual attention and various site-specific protection strategies. Scientifically, the optimal width of a buffer is variable due to the uniqueness and complexity of living environments that often require different types of protection. In addition, different types of trail development have more or less impact on ecological systems, which in turn affects the desirable width of an ecological buffer. Understandably, a specific buffer "standard" is inherently elusive to define.

At the same time, natural resource managers and trail planners need some clarity about buffer requirements in order for trail planning to occur. For this reason, general guidelines are provided in this manual to provide a basis for determining the optimal buffer width under a variety of situations. Notably, these guidelines should not be construed as being a substitute for site-specific evaluation of ecological systems to determine the protection strategy best suited for any given circumstance.

Buffer Definitions

"Buffer" refers to the area between a sensitive ecological system and the edge of a trail or construction related to the trail. It is an area in which no development is meant to occur, with the exception of restoration, management, and stewardship of natural resources. Stormwater may be managed in this zone through the use of natural infiltration techniques if it is done in harmony with the natural systems on the site.

The term "sensitive ecological system" refers to lands where ecological systems exhibit qualities that would be degraded (e.g., health, function, diversity) due to development if a buffer were not provided. It includes all ecological systems that hold the promise of being stable, functioning, and productive systems if managed and cared for through a routine stewardship program.

Wetlands, riparian areas, and water bodies are always considered sensitive ecological systems irrespective of their location and condition – whether that is in a northern Minnesota forest, a suburban regional park, or along an urban creek corridor. This also holds true for steep slopes and other landscape or geological features that if disturbed would significantly impact other ecological systems. In each case, adequate buffering is essential to protecting these systems.

Regulatory Reminder!

Minnesota has specific regulatory and permitting requirements associated with buffers that may have application to trails. These include, but are not necessarily limited to:

- MPCA's NPDES Stormwater Construction Permit www.pca.state.mn.us/publications/wq-strm2-51.doc
- MPCA Water Quality Standards in Minn. Rule 7050 www.revisor.leg.state.mn.us/bin/getpub.php?pubtype=RULE_CHAP&year=current&chapter=7050
- Minnesota Environmental Review Rules (Minnesota Rules Chapter 4410) at the EQB's website www.mnplan.state.mn.us/eqb
- Section 404 of the federal Clean Water Act
- MPCA Clean Water Act Section 401 Certification is required prior to the issuance if any Corps of Engineers Section 404 authorization.
- DNR Protected Waters Program
- Wetlands Conservation Act

These requirements should be reviewed to determine their application to any specific trail project.

Buffer Width Guidelines

Buffer widths vary in response to a number of conditions, including:

- Sensitivity of the ecological systems being impacted
- Extent of the natural open space or greenway corridor being traversed
- Type of trail being proposed and its potential for creating ecological impacts
- Desired trail experience

The type of trail and desired trail experience are important considerations when establishing buffer requirements for a trail. For example, a natural trail is more likely to cause erosion and migration of soils downstream than is a paved trail, while a paved trail can produce concentrated runoff that has to be infiltrated. Depending on the circumstances, each of these situations will affect the optimal width of a buffer.

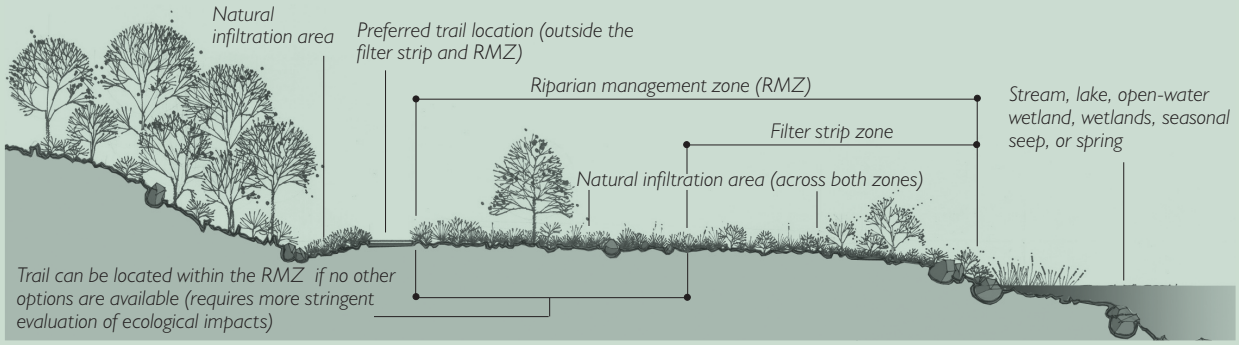
Certain trail experiences can conflict with buffer guidelines – for example, a nature trail may purposefully be routed through a highly sensitive area for its interpretive value. Guidelines should be tempered with site-specific evaluations when making a final determination on the type of buffer needed. The following defines general guidelines for buffers under various circumstances.

General Buffer Guidelines for Riparian Areas

Sustaining Minnesota Forest Resources (Minnesota Forest Resources Council, 1999) provides guidelines for buffers ("filter strips") for managing nonpoint pollution near surface water and wetlands associated with timber harvesting, prescribed burning, and road construction. These guidelines also have application to trail development adjacent to perennial and intermittent streams, lakes, open water wetlands, wetland inclusions, seasonal seeps, and springs.

The guidelines distinguish between filter strips and riparian management zones (RMZs). Filter strips help minimize the runoff of sediment, debris, nutrients, and pesticides into water bodies and wetlands. RMZs encompass the area of land and water forming the transition from aquatic to terrestrial ecosystems along streams, lakes, and open-water wetlands. Within this zone, a higher level of protection is recommended, including greater scrutiny of trail alignments. The following graphic defines the width guidelines for filter strips and RMZs.

Buffer Width Guidelines Associated With Filter Strips and Riparian Management Zones



Filter Strip Zone Width Guidelines

Slope of Land	*Recommended Width*
0%–10%	*50'*
11%–20%	*51'–70'*
21%–40%	*71'–110'*
41%–70%	*111'–150'*

Non-Trout Stream RMZ Width Guidelines

Water Body Type	*Recommended Widths*
Stream > 10' wide	*100' minimum/200' preferred*
Stream 3'–10' wide	*50' minimum/100' preferred*
Perennial Stream < 3' wide	*50' minimum and preferred*
Open water > 10 acres	*100' minimum/200' preferred*
Open water < 10 acres	*50' minimum/100' preferred*

Trout Stream RMZ Width Guidelines

200' preferred (150' minimum) for all designated trout streams, lakes, and tributaries

Regulatory Reminder!

Pay special attention to MPCA's NPDES Stormwater Construction Permit for special waters and calcareous fen requirements

www.pca.state.mn.us/publications/wq-strm2-51.doc

Buffers Within Greenways and Trail Corridors

In settings where parcel size does not limit buffer width, the filter strip and RMZ widths previously defined are recommended for trail development adjacent to any ecologically sensitive area. In most situations, these widths will be adequate to manage stormwater using natural infiltration, ensure ecological diversity and provide a corridor for wildlife travel.

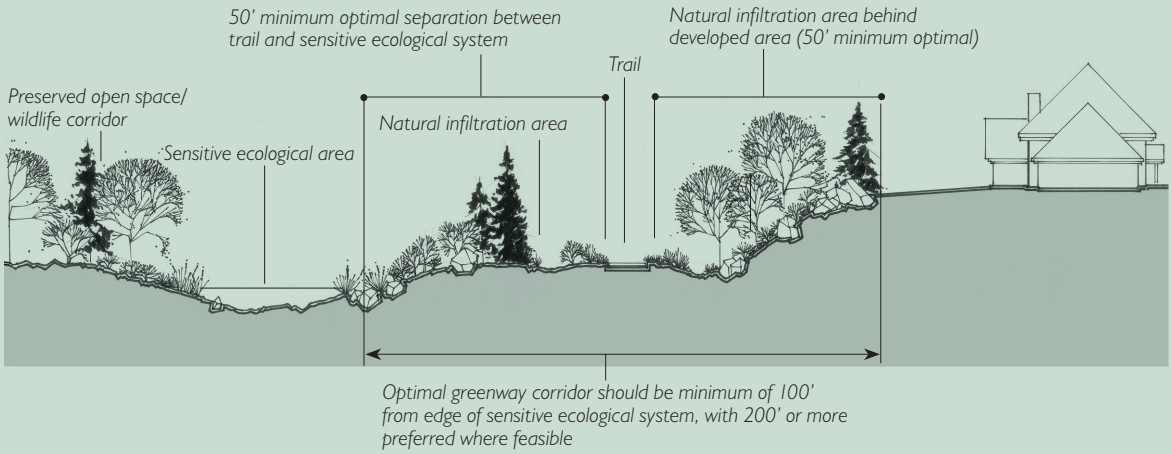
In highly sensitive settings, such as near rare fens and "special water", the buffer zone may need to be wider. It is not uncommon for these to be 200 feet or more. Also, the buffer width for trails should not be confused with buffers set up for wildlife migration, which vary depending on the setting and type of wildlife being accommodated.

Buffers Within More Constricted Greenways and Trail Corridors

In many urban and suburban settings, where greenways and trail corridors are often constricted, the recommended filter strip from the edge of a sensitive ecological system to the edge of a trail should still be maintained. In most cases, 50 feet is adequate for natural systems to infiltrate stormwater runoff and provide some space for wildlife.

Although not all of the values associated with RMZs can be met with a narrower buffer, providing adequate natural infiltration in areas that adjoin sensitive ecological systems remains important to maintain water quality and natural hydrologic flows, each of which has dramatic effects on native plant communities and the overall health of ecological systems. In some cases 50 feet will be adequate to ensure this protection, while in others a wider buffer would be more appropriate. The following graphic illustrates this situation.

BUFFERS IN CONSTRICTED GREENWAY OR TRAIL CORRIDOR

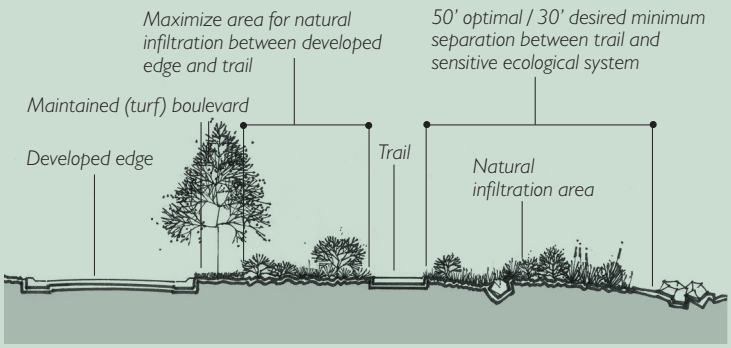


Buffers Within Highly Constricted Areas

In highly constricted areas or where a trail is being retrofitted into a developed area with a narrow corridor, there may be no alternative but to limit the width of the buffer. In these cases, the buffer can be reduced to a recommended minimum of 30 feet, assuming that any ecological impacts from trail development can be mitigated.

If the buffer is less than 50 feet, additional attention needs to be given to ongoing stewardship of the impacted ecological systems to avoid increased potential for further degradation. The following graphic illustrates this situation.

Buffers in Highly Constricted Areas



Additional Guidelines for Determining Buffers

The following considers a number of additional guidelines for ecological buffers.

Trails Around Lakes

In natural settings, avoid closely paralleling or encircling lakes with trails, especially where wildlife is abundant. Instead, provide access for observation at select points to minimize impacts to surrounding ecological systems and wildlife corridors.

In urban and suburban settings where much of the area surrounding a lake is maintained parkland, trails are often among the most important recreational features. In these cases, buffers should be maintained between the lake and trail primarily for infiltrating stormwater and using natural processes to remove contaminants before they enter the lake system. Typically, a 50-foot buffer is optimal, with 30 feet being the minimum typically needed to be effective. Anything less requires careful site-specific evaluation.

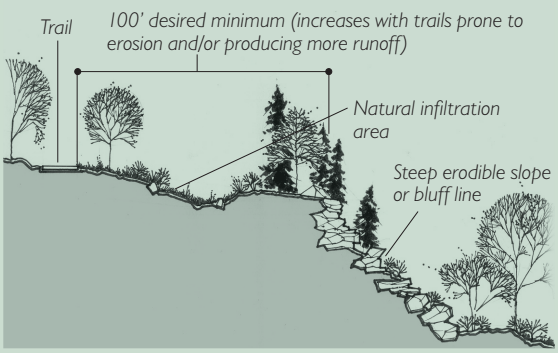
Trails Adjacent to Streams

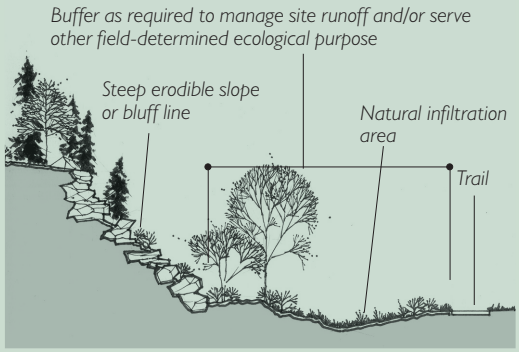
In a natural setting, trails should not parallel a stream for an extended distance. Rather, the trail should move toward and away from it at select intervals to provide a buffer for wildlife, protect natural systems in ecotonal zones, and make the trail more interesting. The buffer width should follow the guidelines previously described. Stream crossings should also be kept to a minimum to avoid unnecessary disruption to the riparian area.

Trails Adjacent to Steep Slopes (in Nonriparian Areas)

Steep slopes are inherently more susceptible than level ground to erosion, which can quickly undermine native plant species and send sediment downstream. A 100-foot minimum buffer is desirable above a steep slope. If stormwater can effectively be routed away from the slope line and the area is otherwise stable and not prone to erosion, 50 feet could be adequate. Anything less requires careful site-specific evaluation. The following graphic illustrates this situation.

Buffers Along Slopes and Bluff Lines





Sometimes a trail must traverses a steep slope. In such cases, it is important to align the trail where site impacts related to stormwater management and erosion can be managed. (Section 6 – Sustainable Natural Trails extensively covers this issue.)

Buffers Associated With Ecotonal Areas

Ecotonal areas are the transition zones between ecological systems where native plant diversity is often greatest. These areas are also notable corridors for wildlife where animals travel from one type of habitat to another. Poorly placed trails can significantly impede travel for some species, even creating "sinks" that trap animals in an isolated area.

Understandably, ecotonal areas also appeal to humans, and it is very tempting to run trails continuously right along or through the edges of these diverse landscapes. As defined in Section 2 – Principles of Designing Quality Recreational Trails, the "edge effect" is a key element of design and plays a major role in making a trail interesting and exciting.

Finding a balance between providing the experience of traveling along an ecotonal edge and protecting the ecotone is a major consideration. A robust understanding of these systems is critical to aligning the trail in the least disruptive manner. Even locating a trail a few feet one direction or another can substantially improve the protection of ecotonal areas without diminishing the visitor experience.

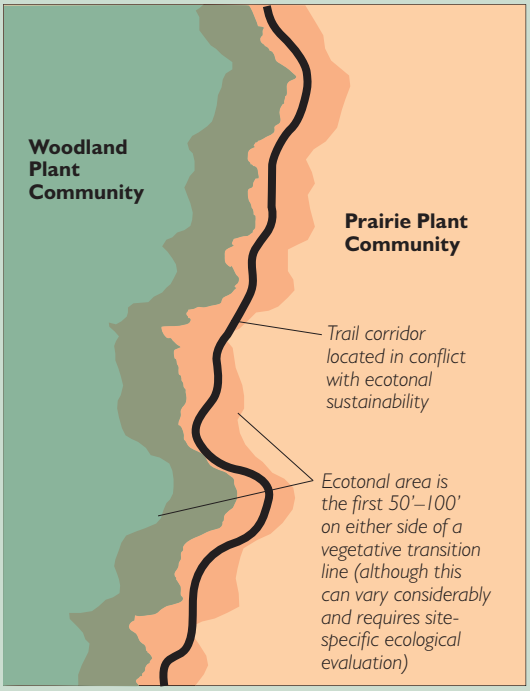
The ecotonal edge typically is the first 50 to 100 feet on either side of a vegetation transition line, although this can vary considerably. Generally, locating a trail right along the ecotonal edge should be the exception, not the rule. If trails are located within this zone, careful consideration should be given to minimizing the impact on diverse natural systems. This typically requires technical evaluation by a trained ecologicist or naturalist.

When trails must cross vegetation transition lines, it should be at select locations where impacts can be minimized. The following graphic provides examples of trails on the edge of ecotonal areas.

Buffers Associated With Ecotonal Areas

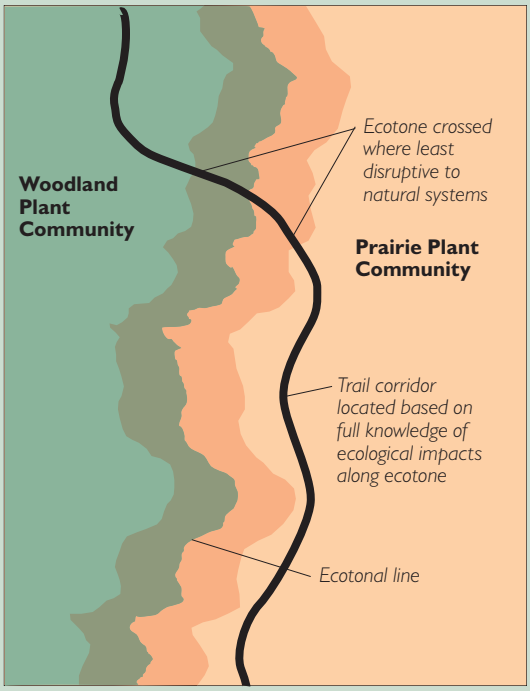
Trail in Conflict With an Ecotone

A trail located right along the edge of the ecotone impacts the most diverse area of native plants and disrupts the primary wildlife corridor. It also makes it more challenging to manage the ecotone with prescribed burning, since the trail creates an unnatural fire break.



Trail in Harmony With an Ecotone

A carefully located trail on the periphery of an ecotone but still close enough to enjoy the "edge effect" makes for a pleasant trail that is sustainable. Although all trails impact the site, through thoughtful design they can be much more sensitive to native plant communities and wildlife.



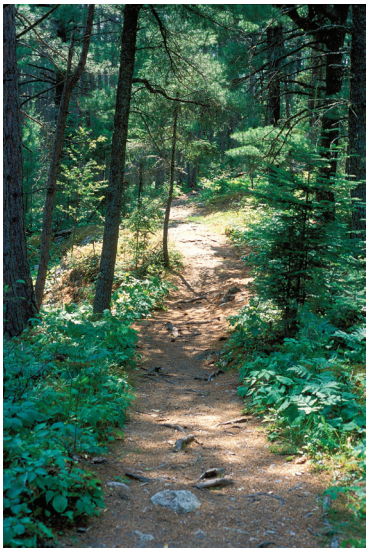
Using Buffers to Reduce Habitat Fragmentation

Mapping ecological systems, setting aside land for greenways, and providing buffers adjacent to development collectively reduce habitat fragmentation. In spite of these efforts, fragmentation can still occur if wildlife needs are not specifically considered as trail alignments are planned.

Reducing Habitat Fragmentation

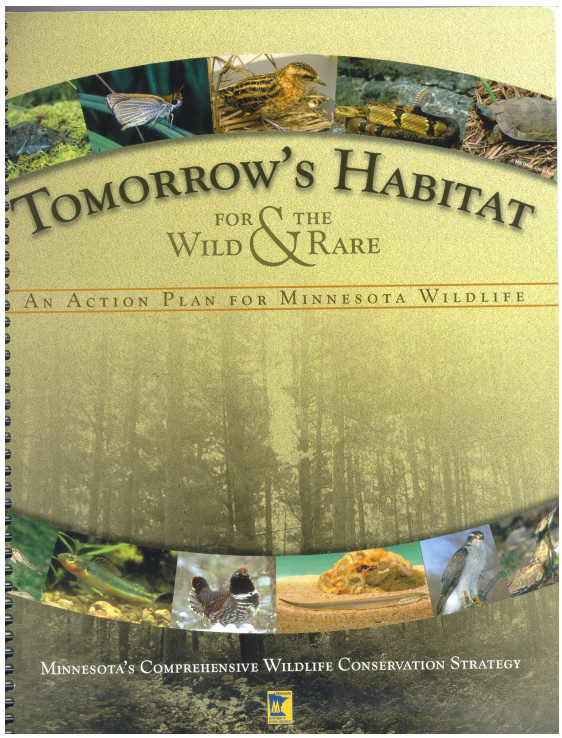
Wildlife concentrate along ecological edges. This is especially true of riparian areas, the edge between forests and meadows, and areas adjacent to cliffs and major rock outcrops. The less a trail encroaches into these areas, the less fragmentation will occur.

To reduce habitat fragmentation, the physical design and management of a trail should incorporate the needs of wildlife and protect the ecological values that are most important to species of greatest conservation need. *Tomorrow's Habitat for the Wild and Rare: An Action Plan for Minnesota Wildlife* is an important resource in this regard and should be referenced whenever a trail traverses a natural area, especially one that is known to harbor wildlife species that may be threatened.



This narrow ATV trail poses fewer impacts to wildlife than wider, unmanaged trails. The large trees on either side of the trail help keep it that way – as does responsible use by visitors. In some cases, a narrow trail will actually be used by wildlife.

The buffer between this ATV trail and a small pond and wetland is inadequate to prevent soil sediments from migrating into this sensitive ecological system, much less provide for the needs of wildlife. The trail needs to be realigned and the vegetation restored to make this more acceptable.



This publication can be found at www.dnr.state.mn.us/cwcs/index.html.

Design considerations include the use of vegetative screening, trail alignment away from key wildlife corridors, topographic screening, and seasonal closures. The photos illustrate a variety of these situations.

The topography along this trail was used to provide vertical separation between the trail user and a major wildlife corridor several hundred feet above the trail.

The enclosed character of this trail is less intimidating to wildlife than if there were no sense of protection. One limitation, however, is that wildlife will not be able to recognize an approaching user as quickly, especially if the user is not making much noise.

The impact of this walking trail on wildlife movement is limited. In many cases, natural visual screening of a trail in a wooded area frequently makes most wildlife tolerate human disturbance more than they would in open terrain.

The edge effect caused by trails can alter wildlife migration patterns. The wider the trail corridor, the more accentuated the break in natural systems. In forests, fragmentation can be caused when the canopy is excessively broken, which increases sunlight reaching the forest floor. Removing as few large trees as possible and weaving the trail through the forest using trees as anchors can markedly reduce fragmentation.

With natural trails, fragmentation can also be reduced by using native soil for the trail tread. Imported trail tread material, such as aggregates and soil stabilizers, increase the potential for fragmentation and introducing nonnative plants.

To limit disturbance to fish habitat, the most critical consideration is managing stormwater to avoid sedimentation of water bodies. Stream crossings need to consider fish migration needs and what effects winter ice dams could have on fish movements.

Guiding Principle # 4 – Use Natural Infiltration and Best Practices For Stormwater Management

Whether a trail is paved or natural, managing stormwater runoff is one of the most important trail development considerations. Passive, overland routing of runoff offers distinct advantages over conventional stormwater systems (i.e., storm sewers, engineered ponds, and other built structures), including:

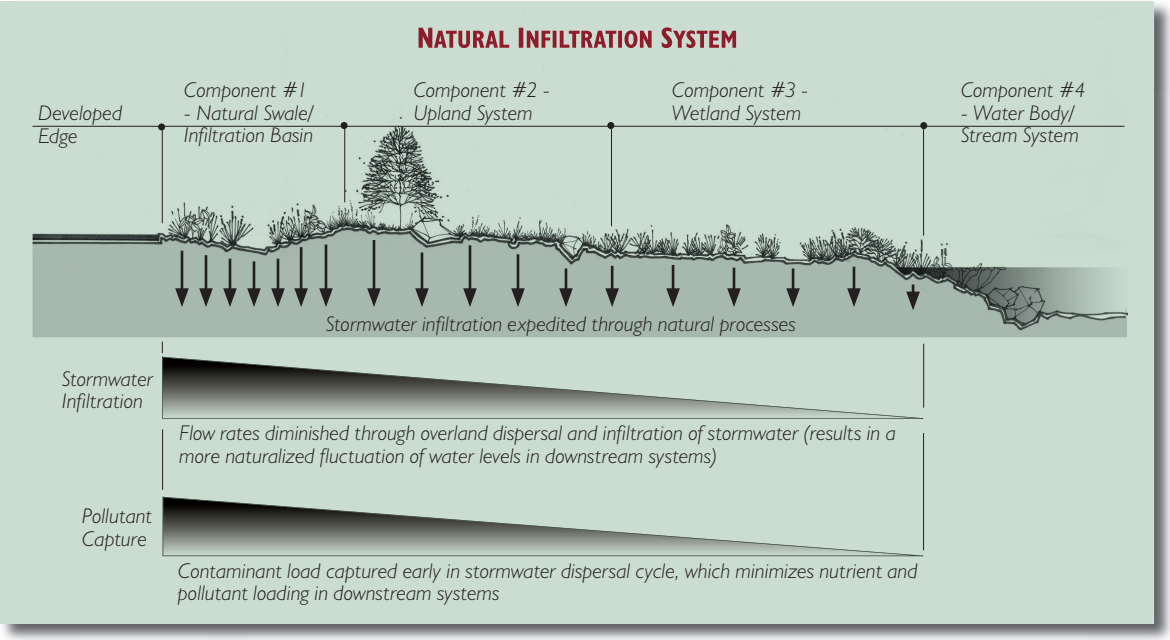
- Contaminants picked up by runoff are removed at the initial stages of water flowage, rather than being transported to downstream locations and accumulating in wetland, lake, and river systems. This greatly reduces degradation of water quality and vegetative health in downstream systems.
- Stormwater flow rates and volumes more closely emulate natural conditions. This greatly reduces unnatural fluctuations in water levels in downstream systems (wetlands and lakes) and therefore reduces impacts to the natural condition of water systems and vegetation.

It is essential that large and small hydrologic features be treated with the utmost sensitivity to avoid disruption to natural processes while still providing a unique trail experience.

For these reasons, the use of natural infiltration for managing stormwater is fundamental to creating sustainable trails where impacts to adjacent ecological systems are to be kept to a minimum.

Components of Natural Infiltration Systems

Natural infiltration systems typically consist of four primary components, as illustrated in the following graphic.



Each component of the system functions in sequence to treat the water before it enters wetlands, lakes, and rivers.

Shallow Natural Infiltration Swales and Basins Systems

Initially, stormwater runoff from the trail is routed into natural or artificial shallow swales or into natural infiltration basins (raingardens) planted with native plants with deep roots. These swales and basins provide initial infiltration and removal of pollutants, convey runoff from developed areas, and disperse runoff across upland and prairie systems.

(Left) The "ribbon infiltration area" between these trails is a depression (about 5 feet deep) to promote natural infiltration of runoff. With native grasses, absorption rates are increased and standing water only occurs after long or heavy periods of rain.

(Right) This natural infiltration approach is ecologically sound and also visually appealing to trail users.

Upland Systems

Upland systems (e.g., prairies, oak savannas, upland forests) are the second component, functioning to convey stormwater as diffused overland flow to the wetland systems that often link directly or indirectly to bordering lakes and rivers. These systems infiltrate a substantial portion of the annual surface runoff due to their very deep root system. They also provide additional solids settling capacity and biological treatment.

(Left) Deep-rooted prairies are well suited for natural infiltration. They slow down the flow of stormwater from hard surfaces, including trails.

(Right) Diverse forested systems also capture stormwater runoff in a natural way. Systems that are degraded (due to buckthorn infestations, lack of management, etc.) are much more susceptible to erosion than more diverse systems. This needs to be taken into account when planning a trail.

Wetland, Lake, and River Systems

Wetlands, the third component of the natural infiltration system, provide stormwater retention and biological treatment. The fourth component is the lake or river, which provides additional stormwater retention, solids settling, and biological treatment.

(Left) By the time water gets to a wetland, most of the impurities should be taken out by the previous parts of the infiltration system. Still, wetlands serve an important cleansing function and are critical to ensuring surface- and ground-water quality.

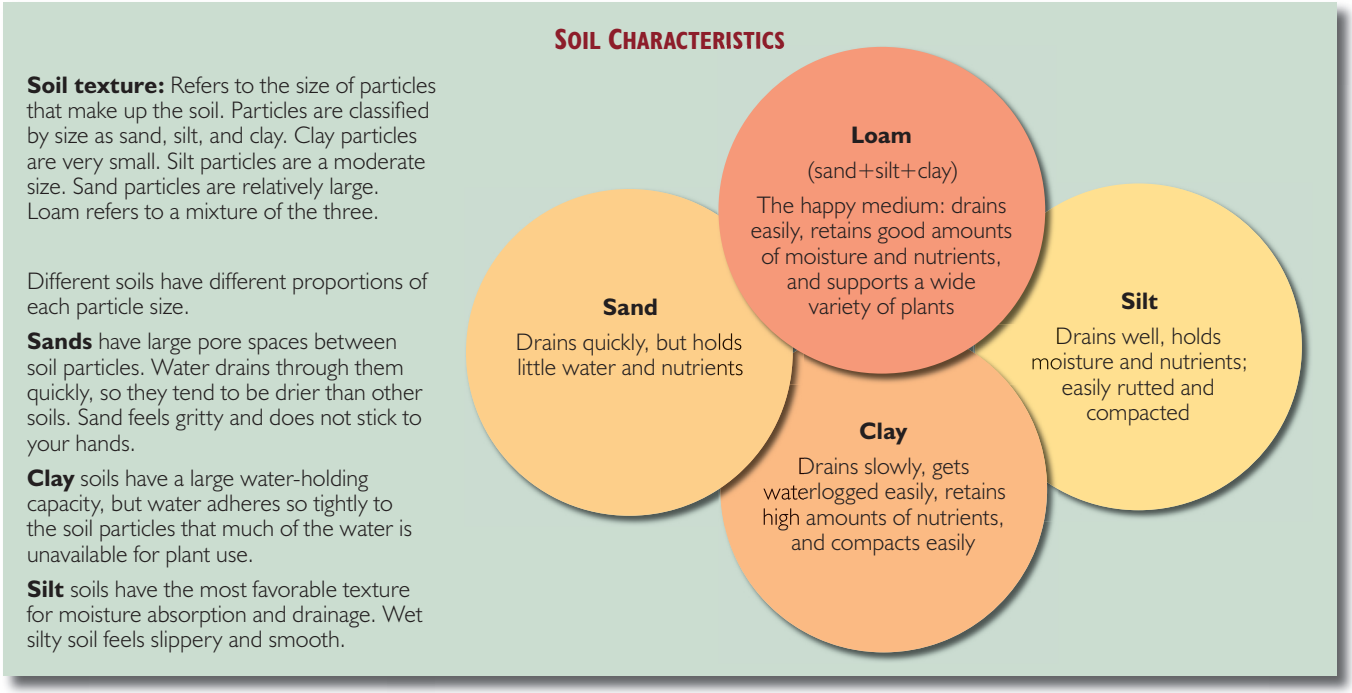
(Right) Natural infiltration systems help keep water fluctuations in lakes and rivers natural and stable. Limiting unnatural water fluctuations helps native plants compete with nonnative species that thrive when natural systems are compromised.

Other Factors Associated With Natural Infiltration Systems

The following considers a number of other factors associated with natural infiltration systems.

Soil Characteristics

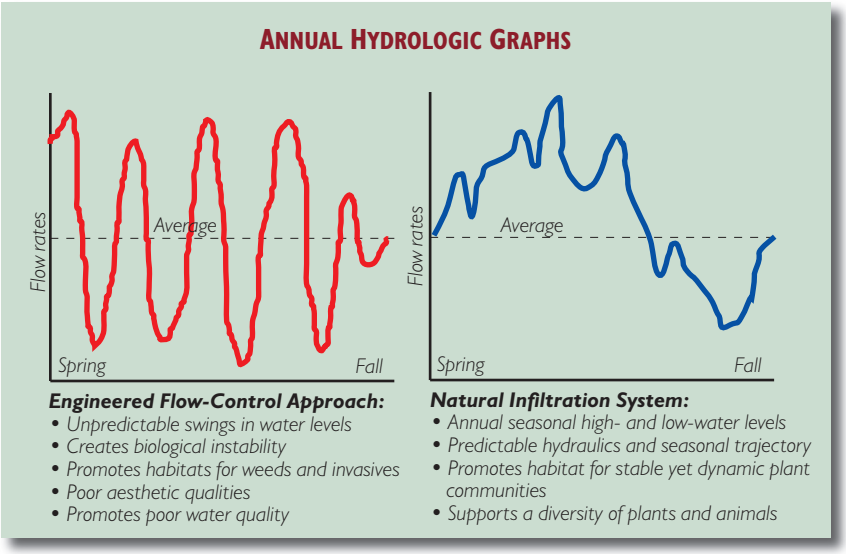
The character and texture of soils significantly influences infiltration. In general, the tighter the soil, the slower the percolation rates (i.e., rates of absorption) and the more area needed to infiltrate stormwater. The following graphic illustrates the general characteristics of major soil types.



The character of the soil affects the size of the buffer zone needed adjacent to a sensitive ecological system to accommodate natural infiltration. The size and scale of the first two components of the natural infiltration system described on the previous page are most affected by soil types because that is where much of the infiltration is to occur.

Hydrograph Associated With Natural and Flow Rate Control Approaches

A natural infiltration system also produces a much more natural hydrograph than does a typical engineered flow rate control approach, with lower peak flows and higher base flows as illustrated in the following graphic.



Natural infiltration has numerous advantages over a flow rate control approach to stormwater management, and should be used whenever possible.

Regulatory Reminder!

Minnesota has specific regulatory and permitting requirements associated with stormwater management and applicable to trails. These are considered in more detail in Section 1 – Framework for Planning Sustainable Trails.

Best Practices for Stormwater Management

The use of natural infiltration for managing stormwater should also be supported by the use of other best management practices (BMPs) that address common development circumstances likely to be encountered as trails are developed. There are a variety of BMPs related to managing stormwater, preventing erosion, and limiting nonpoint water pollution that have application to trail development and complement the guidelines provided in this manual. The following table highlights three publications that are recommended resources covering many relevant best practices.

MPCA

The MPCA has developed a manual entitled *Protecting Water Quality in Urban Areas* to help local government officials, urban planners, developers, contractors, and citizens prevent stormwater-related pollution. The manual contains detailed information about BMPs that can be used to protect lakes, streams, and groundwater from stormwater-related pollution. The manual is available at www.pca.state.mn.us/water/pubs/sw-bmpmanual.html and covers the following topic areas:

- Water quantity and quality
- BMP selection
- Comprehensive stormwater policies and plans
- BMPs for stormwater systems
- Stormwater-detention ponds
- Erosion prevention and sediment control
- Pollution prevention
- Models and modeling

Metropolitan Council

Available through the Metropolitan Council, *The Urban Small Sites Best Management Practices (BMPs) Manual* provides information on tools and techniques to help municipalities and watershed management organizations (WMOs) guide development and redevelopment. The manual includes detailed information on 40 BMPs aimed at managing stormwater pollution for small urban sites in a cold-climate setting. The manual is available at www.metrocouncil.org/environment/watershed/bmp/manual.htm. Key sections that have application to trail development include the following:

- Runoff pollution prevention
- Impervious surface reduction
- Pavement management
- BMP maintenance
- Landscape design and maintenance
- Grading practices
- Soil erosion control
- Mulches, blankets, and mats
- Vegetative methods
- Sediment control
- Silt fences
- Inlet protection
- Temporary sedimentation basins/traps
- Check dams
- Stormwater treatment BMPs
- Infiltration systems
- Infiltration basins
- Infiltration trenches
- Filtration systems
- Bioretention systems
- Filter strips
- Wet swales
- Retention systems
- Wet ponds
- Detention systems
- Dry ponds
- Dry swales

Minnesota Stormwater Manual

Available through the MPCA, the Minnesota Stormwater Manual is a valuable tool for those involved in stormwater management and conserving, enhancing, and restoring high-quality water in Minnesota's lakes, rivers, streams, wetlands, and ground water. The manual is revised every two years, and posted at www.pca.state.mn.us/water/stormwater/stormwater-manual.html#manual.

Individuals involved in the planning, design, development, and maintenance of trail corridors should become familiar with and apply pertinent BMPs whenever a new trail is being developed. Existing trails should also be periodically assessed in terms of compliance with these BMPs to minimize their ecological impacts.

Guiding Principle #5 – Provide Ongoing Stewardship of the Trail and Adjoining Natural Systems

Stewardship refers to the initial restoration, ongoing management, maintenance, and monitoring of natural systems that adjoin a trail. Maintenance of the trail itself is also an aspect of stewardship since the lack of it can result in ecological impacts to adjoining natural systems.

Stewardship of the Trail Tread

Stewardship of the trail tread starts with a sustainable design followed by routine monitoring and maintenance. This is typically the responsibility of an agency or LGU, although trail user groups often play a role in maintenance. Preparation of a stewardship plan for the trail tread is recommended when the trail is first developed to ensure routine monitoring and maintenance requirements are understood, consistent with the trail's classification, and adopted as part of the initial plan for the trail. This should include anticipated maintenance schedules and cost projections.

Typically, maintenance of the trail encompasses the tread and the adjoining clearance zone. Notably, a well-implemented stewardship plan for the trail tread helps reduce the need for stewardship of adjoining natural systems. By limiting the concentration of stormwater and preventing erosion in the first place, the impact of a trail on adjoining natural systems can be limited. (Other sections of this manual should be referred to for detailed recommendations on trail design and maintenance.)

Stewardship of Adjoining Natural Systems

In this context, stewardship refers to 1) preserving and protecting ecosystems outside the actual development footprint, and 2) restoring and maintaining ecosystems directly impacted by construction. An ecosystem is defined as an interacting group of natural physical elements (soils, water, plants, animals, etc.) found within or inhabiting a particular place. All of these elements and their interactions need to be considered in developing goals and plans for stewardship of these systems.

Development of a trail carries with it an expectation that impacts to adjoining ecological systems will be kept to a minimum and some level of stewardship will be provided. Specific stewardship goals to this end should include:

- Preserving or enhancing the health of adjoining ecosystems
- Enhancing the biological diversity of native habitats that are encountered
- Providing an appropriate balance between resource preservation and recreational use

Stewardship programs should focus on achieving a sustainable ecological quality, which is defined as the point at which the ecosystem along the trail functions in a manner consistent with adjoining natural systems. If, for example, a trail traverses a very sensitive and pristine natural area, a very high level of stewardship would be appropriate. In less sensitive areas, such as an urban park, a less intensive stewardship program may be appropriate. In all cases, stewardship programs should be scientifically sound and economically sustainable.

By preparing a well-conceived and -defined stewardship program as part of the planning process, a certain level of confidence can be gained that natural systems adjoining a trail can be ecologically sustained and the natural qualities of the area preserved.

Note, however, that even well-conceived stewardship programs need to be flexible due to the changing nature of any living system. Rather than being seen as conclusive or absolute, stewardship plans should be considered starting points in an ongoing process that relies on monitoring and research to provide feedback on program effectiveness.

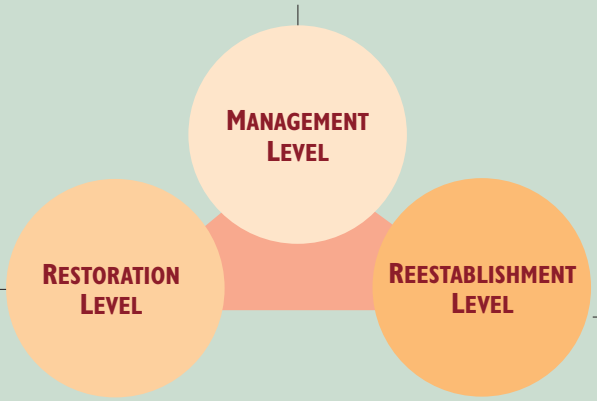
Stewardship Based on Site-Specific Needs

Depending on site-specific circumstances, ecological stewardship typically falls under one of three levels of intensity, as the following graphic illustrates.

Intensity Levels Associated With Ecological Stewardship

Least intensive approach *– refers to taking care of existing systems and encouraging the growth of natural communities already in place on a site. Also relies more on natural processes to restore disturbed areas associated with trail construction or to take over once a trail has been closed or realigned – although some remedial work (e.g., grading rutted areas, stabilizing erosion) is often needed to establish the conditions for natural processes.*

More intensive approach *– refers to undertaking a process of restoring a degraded natural community that is consistent with its original structure and species composition. Areas to be restored usually offer the "basic ingredients" necessary for a natural system to thrive, but the quality of the overall community is less than what it should be. Restoration efforts focus on enhancing what is already present and improving the overall quality and long-term viability of a given natural community.*



Most intensive approach *– refers to attempting to reestablish natural plant communities on a disturbed site with few, if any, native plant remnants remaining. Of all the approaches, this is the most challenging because it entails reestablishing something that no longer exists in its historic form. A reestablishment approach to stewardship is usually undertaken within the context of an ecological stewardship program for a site that goes beyond that of a trail corridor alone.*

The "management level" is the base line for all stewardship programs and the minimum required to ensure that a trail corridor will remain sustainable and that natural systems will be preserved or enhanced. All trail development programs should include at least this level of stewardship.

The "restoration" and "reestablishment" levels are used when a higher level of intervention is needed to ensure that the trail corridor will be sustainable, as determined in the field by a trained natural resource specialist. These levels of stewardship tend to be applied on sites that are already degraded and when the likelihood of natural processes alone being successful in restoring healthy natural systems along the trail is uncertain. The determination of stewardship needs should be made by a trained natural resource specialist familiar with the site and associated restoration and management techniques.

Recommended reference material!

Guidelines for Managing and Restoring Natural Plant Communities Along Trails and Waterways (DNR – Division of Trails and Waterways) covers this subject matter in more depth and is a recommended reference for stewardship of natural systems along trails. The publication covers:

- Guiding principles for sustainable resource management
- Managing, restoring, and reestablishing prairie, savanna, woodlands, and forest plant communities and riparian environments
- Controlling exotic species
- Planting and pruning of woody plants

Another worthwhile publication is the Minnesota Forest Resources Council's *Voluntary Site-Level Forest Management Guidelines,* which covers virtually all aspects of forest management by homeowners, loggers, and resource managers.

Watch for more on this subject!

Since treatments continually change, the following websites are a good sources of current information:

- DNR, Invasive Species (www.dnr.state.mn.us/nr/index.html)
- The Nature Conservancy Element Stewardship Abstracts, Invasive Species Initiative (tncweeds.ucdavis.edu/esadocs.html)

Preventing the Spread of Invasive Plants

DNR natural resource specialists continually work to educate the public about controlling the spread of invasive plants into the natural landscape and including prevention as part of stewardship programs. The following excerpt from a draft publication entitled *Best Management Practices: To Prevent the Spread Terrestrial Non-Native Invasive Plants on Trails and Waterway Lands* is presented here to underscore its importance.

Invasive terrestrial plants have caused unwanted impacts to thousands of acres of grasslands, forests and nonforested native plant communities. Impacts include loss of native plant communities, degradation of wildlife habitat and loss of recreational use. Recognizing which activities facilitate the movement of invasive plants into natural settings and what can be done to limit this is vital to preventing their spread. The following table defines the type of activities that can contribute to the spread of invasive plant species and actions that can be taken to limit the potential spread.

Preventing the Spread of Invasive Plants (Part 1 of 2)

The following provides an overview of techniques for preventing the spread of invasive plants (as excerpted from a draft DNR publication, *Preventing the Spread of Terrestrial Invasive Plants on DNR Managed Lands).*

Type	Discussion and Solutions
Trail Maintenance	Trails provide corridors along which invasive species move. Seeds and plant parts are common hitchhikers on equipment such as mowers and graders. **Solutions:** • Segregate work activity in infested areas from work in "clean" areas. Always clean mower prior to mowing natural area trails. • Clean maintenance equipment of seed and plant parts between uses, especially when moving between infested areas and areas free of invasive plants. • Consider less frequent maintenance activity in areas where concern over invasive plant spread is high – roads and trails that abut infestations but lead into areas clear of the invasive plant. Minimize mowing and grading in areas infested by invasive species when such activity is likely to spread the infestation. Postpone activities until the infestation can be reduced, or time them to occur when seed is not present on the invasive plant species. • Minimize the amount of area mowed to encourage existing native species. Where mowing is necessary, raise the mower height during the growing season. The more above-ground plant mass, the better the native plants resist competition from non-native weedy species. Above-ground mass also allows less sunlight to penetrate to the ground surface, which inhibits invasive species seed germination. • When re-vegetating disturbed areas, native plants usually provide a reasonable alternative to both hybrid cultivars and non-native species. In general, natives require less maintenance in terms of watering, mowing and tending, are often drought resistant and cold hardy, and often provide better wildlife habitat. • Woodchip piles can create a growing medium for exotics when they suppress the native plant cover. Such piles should be removed immediately to preserve native vegetation.
Construction Projects	Development activity that disturbs the soil surface exposes a dormant, weed-containing seed bank and creates a growth medium that favors invasive plants. Landscaping after new construction often also introduces undesirable invasive plants. **Solutions:** • Minimize/eliminate trail cuts that create new openings into either high quality natural areas or areas adjacent to endangered species. Invasive species nearly always move along trails. Avoid designing or constructing new trails that will link areas of existing infestations to high quality natural areas and/or endangered species. • Keep trail improvement activity to one side of the corridor when possible to limit disruption to native plants and reduce the extent of open soil, which helps minimize the flush of weed growth. An established native plant community is usually more resistant to invasion by aggressive non-native species. • Preserve existing native vegetation. Peel topsoil that contains natives away from the work zone, stockpile and then replace it at the end of construction. This quickly reestablishes natives back into the construction zone. Avoid impacting high quality natural areas if possible. • Keep construction activity confined. Use temporary fences to reduce the harm caused by equipment, such as root compaction and plant crown damage. Signs at the perimeter of native areas also helps construction workers recognize the boundary of their work or parking zones. • Examine purchased fill material. Insist that it is free of invasive plants or seed. • Landscaping post construction: a. Purchase weed-free fill material if stockpiled topsoil is inadequate. b. Mulch is source of invasive plant seed, so purchase only certified weed-free mulch, and also use caution. c. Planting native vegetation can reduce the need for purchased black dirt and mulch since native plants are already adapted to local growing conditions. Drought tolerant native grasses often accept mowing to normal lawn height. d. Soils that come with purchased container plant material can be a source of unwanted invasive plant species. Minimize such purchases and monitor such planting areas for unwanted plant growth. • Manage storage areas to prevent weed growth, especially stockpiled fill and top-dressing material. Covering stockpiles with tarps or black plastic (to force seed to germinate and eliminate open soil exposure to airborne seed) or periodically applying glyphosate (Round-UpTM.) to growing unwanted plants is recommended. • Prevent trail equipment from carrying seed or plant parts into non-infested areas. • Herbicide treatments that eliminate the native, nonwoody ground cover, are an invitation for an invasion by unwanted plants and should not be used. Use selective herbicides rather than broad spectrum ones for reforestation work and apply as band or spot treatment, rather than broadcasting.

Preventing the Spread of Invasive Plants (Part 2 of 2)

Type	Discussion and Solutions
Planning and Site Preparation	Design access routes, assign trail classes, and close trails as needed to minimize spread by trail users. It is especially difficult to control the spread of invasive species by motorized forms of transportation. Access routes should be located away from high quality natural areas. Creating public awareness of the threat to such areas from invasive species is also very important.
Recreation Activities	Recreational users can contribute to the spread of invasive species. **Solutions:** • Educate recreational users about invasive plants and what they can do to avoid spreading seed or plant parts (i.e., boots causing the spread of garlic mustard seed). Signs promoting "stay on designated trails" to help minimize spread is one example. • Keep horses on trails and horse feed in designated areas. Handle horse manure with caution as it often contains large amounts of viable plant seed. Stockpiling and covering with plastic can help force seed to germinate. • Target infestations in high recreational use areas for aggressive control. High use areas with invasive plant infestations (i.e., parking lots, trail heads, trails, campgrounds) should be a high priority for control efforts. • Use areas or trails with rampant invasive plant infestations should also be considered high priority for control efforts until such infestations pose less of a spread threat by recreational users. If labor is not available to control the infestation, consider closing or limiting access to the area. • Trails leading from infested areas to high quality natural areas should be high priority for control. If control measures cannot be implemented, consider closing or limiting access to the trail. Rerouting may be needed if the problem persists. When designing trails, isolate high quality natural areas from all forms of motorized transport, mountain bikes, or other related activities when possible to prevent spread into these sensitive areas.
Off-Road Use for Work Purposes	ATVs and vehicles are an effective, convenient way to access remote areas for research or resource management activities. However, invasive plant seed/parts can be easily spread long distances by these means. **Solutions:** • Minimize spread into natural areas by keeping vehicles, ATV's, etc. on designated roads and trails. • Remove plants and seeds from vehicles, tires and undercarriages, before entering uninfested areas.

Limited trail corridor. *The corridor for this hiking trail with compacted soil and vegetated tread is only a few feet outside the trail clearance zone since there is very limited likelihood of erosion or major concentrations of stormwater.*

Wider trail corridor. *On this ATV trail, the corridor includes the buffer area between the trail and ponding area because maintaining healthy natural systems in this area is critical to ensuring the quality of the adjoining wetland and pond system.*

Defining the Stewardship Zone

In the context of site-specific trail development, stewardship programs can be limited to the trail corridor or incorporated as part of a larger program associated with a greenway, natural park, or other open space setting. Whatever the scale, stewardship of surrounding ecological systems at some level is fundamental to creating sustainable trails.

Trail Corridor

The trail corridor refers to the trail tread itself and the ecological buffers on either side of the trail. This zone encompasses areas needed for managing stormwater, preventing sediment transfer due to erosion, and managing invasives that migrate to the site through trail construction and use. The photos at left illustrate the direct impact zone for a couple of trail situations. As illustrated, the impact zone can vary from one type of a trail to another, so site- and use-specific evaluation is needed to determine the impact zone.

Greenways, Parks, or Open Space Settings

The stewardship program for a trail should be consistent with any program already established for a larger greenway, park, or open space area where it is located. When a stewardship program does not exist, stewardship along the trail corridor should still occur within a defined trail corridor, at a minimum.

Stewardship Relative to Trail Classifications and Economic Resources

Part of what defines a particular trail classification (or system of trails) is the level of stewardship or maintenance required to keep it sustainable, which carries with it significant practical and economic implications. This pertains to both the trail tread itself and the adjoining ecological systems. The implications of this can be significant when planning a system of trails and should not be taken lightly. *As a general rule, the length of a given trail or the extent of system of trails should never exceed the implementing agency's capacity to provide stewardship.* This underscores the importance of considering this issue at the point a trail or system of trails is first planned to ensure that the implementing agency does not overextend its capacity (human and economic resources) to provide ongoing stewardship.

Importance of Educating User Groups About Stewardship Issues

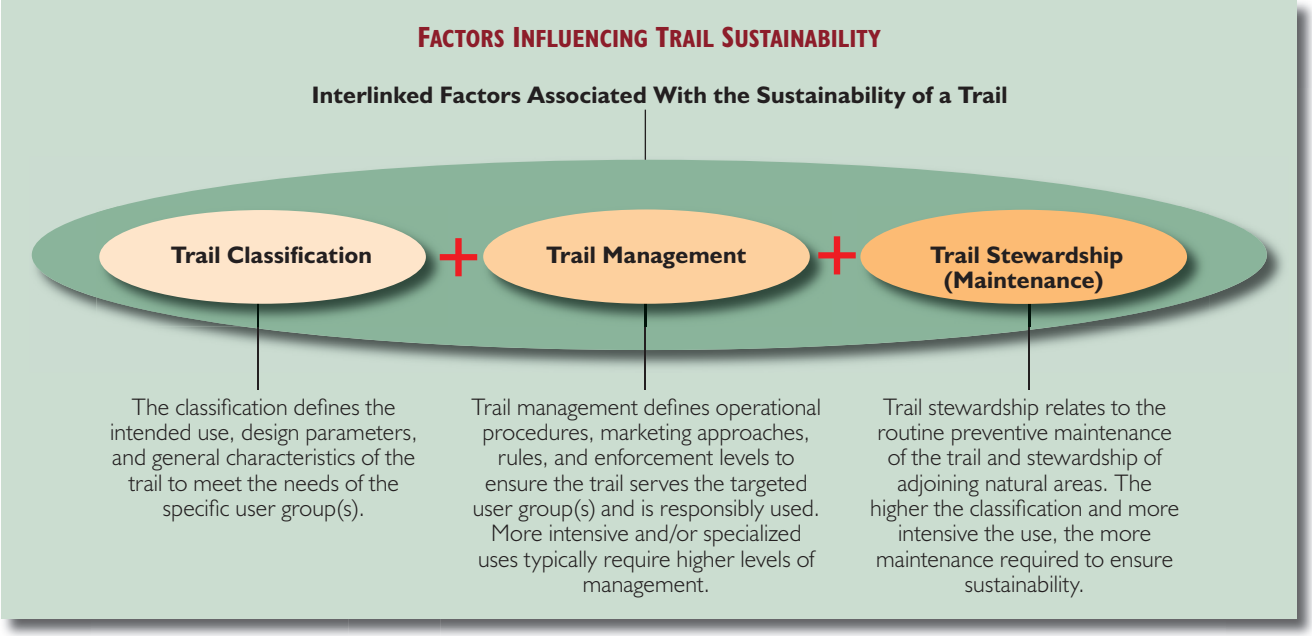
Trail users must also be made aware of the limitations an implementing agency has on providing stewardship for a system of trails, and the ramifications if an unsustainable condition is found. This should be clearly defined when a trail or system of trails is first developed to ensure all stakeholders have a clear understanding of individual and collective stewardship responsibilities. (Guiding Principle #6 – Ensure That Trails Remain Sustainable considers this issue in more depth.)

A pertinent example of the limitations of stewardship relates to forest access routes (as defined in Section 4 – Trail Classifications and General Characteristics), which are essentially the *informal* use of existing corridors in the forest for recreation and other uses. These networks can be very extensive and it is unlikely that forest resource managers would be able to provide much, if any, maintenance associated with recreational uses. As long as use is relatively low, users are responsible, and uses are consistent with an overall forest management plan, these routes can be sustainable. However, should use levels or improper use of a forest access route cause unsustainable ecological or other impacts, use of the area would likely have to be restricted or the corridor decommissioned.

Redefining a forest access route as a designated trail (e.g., reclassifying it as a designated OHV trail) creates considerably higher design, management, and stewardship requirements (and substantially higher costs) that must be borne if the route is to remain open in a sustainable condition. Since decommissioning or even changing a classification is never easy, it is imperative that trail planners and implementing agencies give extensive consideration to the long-term costs and commitment to stewardship and clearly define as part of the development plans what will happen if a trail turns out to be unsustainable. User groups should be part of this discussion so that they too understand the importance of stewardship and personal responsibility for keeping trails (or forest access routes) sustainable and open for public use.

Guiding Principle #6 – Ensure That Trails Remain Sustainable

Trail classification, management, and stewardship (maintenance) all factor into a trail's long-term sustainability, as the following graphic illustrates.



Each of these factors need to be in alignment to ensure that a trail remains sustainable. In most applications, trail management and stewardship are linked to a specific classification to ensure consistency across a system of trails. For example, a designated OHV recreation area entails a fairly intensive level of development and a higher level of day-to-day management and maintenance than would be the case for a designated OHV trail or a forest access route. Making this distinction when trails are first planned and designated is critical to making sure user groups understand what types and levels of use will allow the trail to remain sustainable and therefore open. If established thresholds are passed and the trail becomes unsustainable, the possibility of closure must be clearly articulated to user groups.

Sustainability of Natural Versus Paved Trails

The sustainability of natural surface trails is much less assured than that of paved trails for several reasons:

- Hard surfacing is specifically designed and engineered to sustain extensive use and withstand climatic conditions
- Landscape architecture and engineering practices that are typically applied to paved trail design limit the potential for impacts to adjacent areas
- Paved trail users are more inclined to stay on the trail given their mode of use, such as bicycles, in-line skaters, and pedestrians wanting a hard, consistent surface

The most likely unsustainable condition associated with paved trails is erosion occurring adjacent to the trail due to increased hard surfacing and concentrated stormwater runoff. The best solution is to follow the guidelines provided in this and other sections and other applicable best practices to prevent the problem in the first place.

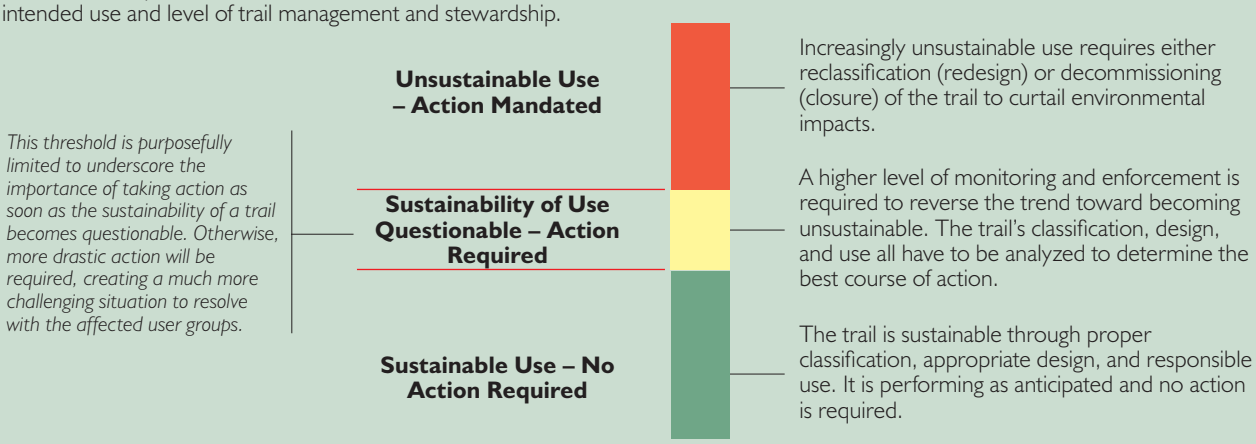
Lacking a hard surface, natural surface trails are inherently more subject to sustainability issues and require an attention to detail design and stewardship on an ongoing basis. With natural trails, once a minor problem occurs, it tends to grow quickly into an unsustainable condition. For these reasons, the sustainability of natural surface trails is given the majority of the attention in this section.

Sustainability/Impact Thresholds

Thresholds provide trail managers and user groups with a common basis for determining if a trail is sustainable. Each threshold triggers a certain type of action to ensure the trail either remains sustainable or is decommissioned due to an unacceptable level of environmental impact. The following graphic provides guidelines for sustainability thresholds.

Sustainability/Impact Thresholds

Sustainability or impact thresholds provide trail managers and the public with a rational and consistent basis for determining the type of action necessary to ensure that a trail remains sustainable. Each trail classification will have its own set of thresholds consistent with its intended use and level of trail management and stewardship.



For more on trail classifications!

Refer to Section 4 – Trail Classifications and General Characteristics for more information on the listed classifications.

Sustainability or impact thresholds should be defined as part of the trail planning process to ensure that trail managers and user groups have a common understanding and expectation about actions will be taken if a trail proves unsustainable.

If a trail's condition does become unsustainable, the action taken depends on the trail classification, management approach, and stewardship program. Natural surface trails and forest access routes tend to fall into three categories, as defined in following graphic.

Categories for Natural Surface Trail and Forest Access Routes as Related to Sustainability

The action taken if a trail or forest access route becomes unsustainable is related to its classification and the level of management and stewardship (maintenance) that is intended to be provided. In trail planning, it is important to educate trail users about this so that they form appropriate expectations.

Potential Actions if Trail is Unsustainable:
- Redesign to be sustainable
- Reclassify to lower impact use
- Decommission trail

Designated Natural Trails

- Designated trails designed for a specific use
  - Hiking Trails
  - OHV Trails
  - Equestrian Trails
  - Multiuse Natural Trails
- High level of use promoted
- Routine management provided
- Routine stewardship (maintenance) provided

Potential Actions if Forest Access Route is Unsustainable:
- Redefine as a designated trail* for a specific use and provide additional design, management, and stewardship to ensure sustainability
- Restrict use, such as limiting use to nonmotorized activities (hunter/walker trail designation, for example)
- Decommission restore corridor to natural vegetation

Forest Access Routes

- Open for informal *motorized* and *nonmotorized* use (if sustainable and consistent with overall forest management plan)
- Lower level of use promoted
- Very limited management provided
- Very limited stewardship (maintenance) provided

Potential Actions if Trail is Unsustainable:
- Reclassify to a higher classification* (requires more design, management, and stewardship)
- Decommission trail and restore corridor to natural vegetation

Hunter/Walker Trails

- Open for informal *nonmotorized* use (if sustainable and consistent with overall forest management plan)
- Low level of use envisioned and promoted
- Very limited management provided
- Very limited stewardship (maintenance) provided

* Since forest access routes and hunter/walker trails are typically only made available if they are used in a sustainable manner, they are not routinely or extensively redefined or reclassified to a higher level. More typically, uses become more restricted or the route or trail is decommissioned if use makes it unsustainable.

Defining Sustainability Thresholds

A sustainable trail is one that can be indefinitely maintained for its intended purposes, assuming routine management and stewardship is provided consistent with its classification. If a trail is well designed and appropriately used, site impacts will stay within acceptable parameters.

A trail becomes unsustainable when its physical condition passes a defined threshold where site impacts are no longer within acceptable parameters. Under these circumstances, action is required to avoid continued degradation of the trail and adjoining ecological systems.

For general application, sustainability can be reasonably described using written criteria and photographs. The following complements the guidelines found in Section 6 – Sustainable Natural Surface Trails by providing a physical description of sustainable and unsustainable conditions common to various natural surfaced trails. These are general guidelines that can be used as a means to alert trail managers and users if the sustainability of a trail is in question. Note that these criteria may have to be refined based on site-specific conditions, including soils, vegetation types, hydrology, and other factors.

Sustainability Relative to Trail Classifications

In practice, all natural trail types tend to exhibit similar physical signs of being either sustainable or unsustainable, as reflected by rutting, erosion, by-passing, and impacts to adjoining ecological systems and hydrology. The main difference between classifications is the extent to which a particular problem is likely to occur and the type of action taken should an unsustainable condition be found.

For example, if rutting occurs on a designated OHV trail due poor design or unforeseen conditions, realignment would be appropriate to solve the problem to keep the trail operational. This contingency would be part of the management plan for this class of trail. On the other hand, if that same level of rutting was found on a forest access routes (where the commitment to management and maintenance is much less), closure of the area might be in order since OHV use was only allowed if the route remained sustainable.

Sustainable Trail Characteristics – No Action Required

With all natural trail types, a certain level of compaction and displacement is expected and acceptable. It is also acceptable to cross natural drainageways and create a corridor wide enough to accommodate the trail as long as it is done in a sustainable manner and site impacts are kept to a minimum.

In general, trails are considered sustainable if the following conditions are found:

- Trail tread is stable and compacted, with a constant outsloped grade preferred (the depression on a well-worn trail should average less than 3 inches in most soil types)
- Displacement of soils from the trail tread is minimal relative to the use and soil type (only limited berming on the outside of curves)
- Tread drains well with minimal to no signs of ongoing erosion, especially into water bodies of any kind
- Tread does not restrict site hydrology and impact surface- or ground-water quality
- Impacts to surrounding ecological systems is limited to the trail tread and directly adjacent clearance zone, with no bypassing and cross-country travel occurring

The following photographs illustrate sustainable conditions associated with a variety of natural trails.

***Forest access routes must be well suited for the use to remain sustainable**, especially since these are minimal maintenance areas. Corridor closure is the typical result if these routes prove unsustainable.*

***Rolling grade design and alignment** ensures that this ATV trail will remain sustainable. If runoff is managed through dips and crests, erosion can be largely prevented with normal use.*

***A superelevated curve plus embedded rocks help ensure that this mountain bike trail will remain sustainable.** Simple considerations like this are vital to creating trails that can handle years of heavy use.*

***This sustainably designed trail naturally follows site contours,** which also make the trail more appealing. Notice the trail drainage dip that drains water off the trail (to the left).*

***Sustainable forest access route.** The grasses on this lightly used trail will help keep it sustainable, perhaps over decades.*

*Although this OHM trail is in sandy, noncohesive soil, systematic displacement on the curve has formed a superelevated curve that limits further displacement. **Since the tread remains porous and the site has only gentle slopes, erosion is not a problem and trail is sustainable.***

Superelevated corners can be very sustainable if they stay within the established treadway. *However, if trail "creep" begins to occur, the trail starts to slide into an unsustainable condition.*

This rolling grade trail is both fun and sustainable*, in spite of its heavy use. Notice how the dips and crests help manage stormwater and prevent erosion.*

Soil variability factors into sustainability. *Compactible soils, such as well-graded gravel (left), are best suited for natural trails due to their inherent stability. On these soils, displacement and rutting should be minimal. On sandy soils (right), more displacement can be expected and cause somewhat deeper ruts than would be expected in other types of soils. As long as erosion, migration of soil into water bodies, excessive rutting, and bypassing are kept in check, this trail can remain sustainable even though the tread itself shifts a bit over time. Trails on sandy soils generally require more monitoring and prompt action if a problem occurs.*

Questionable Sustainable Trail Characteristics – Action Required

A trail that is improperly designed for its intended use or is irresponsibly used is susceptible to becoming unsustainable. In general, the sustainability of a trail is considered questionable if one or more of the conditions are found:

- Tread is showing signs of becoming unstable, with the surface not capable of supporting the intended use (most often exhibited by ruts 3 to 6 inches deep)
- Displacement of soils from the trail tread is more than desired for superelevated corners, causing concerns that trail users will start to bypass the area
- Trail is showing signs of poor drainage, with water ponding, standing water, and mud holes
- Erosion is becoming an issue, with soil starting to move into adjacent water bodies
- Trail tread is starting to restrict site hydrology and alter surface and subsurface water flows
- A growing potential for impacts to ecological systems (especially wetlands and rare and endangered species) is becoming evident, often due to the factors listed above

Where these signs begin to manifest themselves, *action is required to forestall a worsening of the situation*, which would require even more drastic action, possibly even trail closure. The following photographs illustrate questionable conditions associated with a variety of natural trails that suggest the need for action.

Problem: Trail creep. *This low spot on a mountain bike trail is routinely wet, forcing trail users to go around it. Either a reroute or hardening with rocks or a boardwalk is necessary to avoid continued expansion of the trail.*

Problem: Soil limitations. *With sandy soils, trail creep can become a sustainability issue. If this is limited to an occasional stretch, no major action is required. But if this problem persists over a significant distance, rerouting or closure may be necessary.*

Problem: Lack of underlying soil stability. *Organic soils are inherently prone to rutting. Although still within rutting limits, this trail is close to becoming unsustainable, especially if soils begin to migrate to adjacent systems and water bodies. If foot traffic is low, periodic reseeding and filling may be the best approach. If the problem continues, rerouting may be necessary.*

Problem: Bypassing trail protrusions. *Even a few rocks and roots in a hiking trail can entice trail users to find another route. Left unchecked, this type of activity can slowly detract from the trail experience and the natural setting. Stronger anchors (and "stay on trail" signs) are needed to keep this from getting worse.*

Problem: Erosion due to fall-line alignment. *In both of these cases, the trail follows the fall line (i.e., is aligned straight up the slope), creating an opportunity for erosion. In the left photo, erosion is becoming a problem and soil is migrating to the base of the slope. If periodically maintained, this trail could remain reasonably stable, although a better solution is to realign it. In the right photo, erosion of a forest access route is clearly becoming an issue with increasing use and exposure to the elements. Realignment or closure of this segment will ultimately be necessary to keep this trail sustainable.*