Great Trails:

Providing Quality OHV Trails and Experiences

A resource guide for the design, planning, construction, maintenance, and management of quality off-highway vehicle trail systems which are sustainable and fun to ride.

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Riders enjoy spending time with their friends and family while riding

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Dedication

This book is dedicated to those people who strive to provide, promote, and protect off-highway vehicle recreation opportunities. Thank you for what you do for the OHV community.

Great trails don't just happen. They are created, managed, and maintained through vision, passion, and sound engineering.

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Disclaimer

The photographs used in this book are just that; photographs. They are used as an example to clarify text. Unless otherwise noted, the photos do not represent a particular site nor are they intended to reflect on the management, operation, or maintenance of any site. The photos are taken out of context and merely show conditions that can be and are anywhere.

Any brand names used or depicted do not represent an endorsement of the manufacturer.

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Introduction

In our fast-paced hectic society, it has never been more important to recreate; to immerse ourselves in an activity other than work with our family and friends and plunge ourselves into a different realm. Indeed, recreation is really re-creation: the act of rejuvenating our minds and bodies. Most people who recreate in the great outdoors utilize trails to enhance their experience, and they especially enjoy a great trail. A great off-highway vehicle (OHV) trail offers an outstanding recreation experience, but it can trigger something deeper than that; an emotion, an inspiration; the WOW, that invigorating, re-creating feeling. What made that trail so great and what created that feeling? A multitude of physical, subliminal, and emotional elements triggered that WOW feeling. How can it be re-created?

This book offers guidance on the planning, design, and construction process, using proven principles and techniques, to create a great OHV trail on the ground. But it goes beyond that. Creating a great OHV trail is one thing, but keeping it great for the long term is another. How can the trail be managed and maintained to preserve that special quality? What can be done with an existing trail to make it the best that it can be?

While it is difficult to teach creativity, managers can learn about the elements, tools, and techniques they can incorporate into a project to help ensure its quality and success. With the right mix of those elements and with the right frame of mind, the outcome just may be creative.

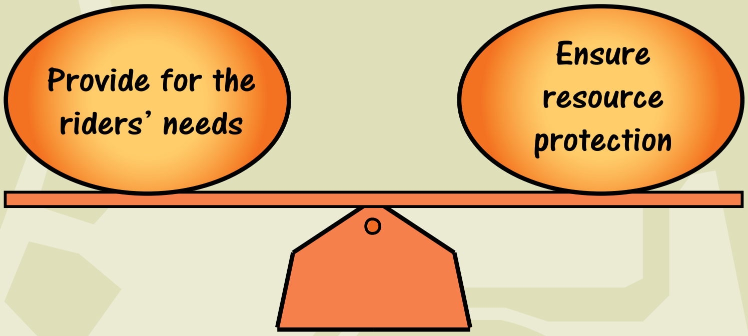
Traditionally, trail planning, design, construction, maintenance, and management are separate processes. Most agencies fund these steps separately and often different departments within the agency handle each one. However, to have a truly great tail system, it is important to realize that all of these steps are really components of one process: the process of creating a great OHV trail. Each component must be implemented effectively or the whole project could fail. There have been trails planned and designed well, but poorly constructed; and there have been trails planned, designed, and constructed well, but poorly maintained or managed. The result may not be failure in all cases, but it isn't total success either. The trail may not meet the riders' needs, may not be sustainable, and may be costly to maintain. The outcome is dependent on the sum of its parts. This book integrates those components into one process and one thought pattern.

THE GREAT TRAIL CONTINUUM

Many books are available about trails, but from an OHV perspective, the information out there is: a) not relative to OHVs; b) out of date since technology or best management practices have changed; or c) not current since off-highway vehicle types and the vehicles themselves have changed. What was state-of-the-art technology 20 years ago may or may not be valid today. Certainly, the vehicle types have changed. Thirty years ago, motorcycles dominated the market and all-terrain vehicles (ATV) were an emerging market. Over time, motorcycle sales have flattened, ATV sales have soared and flattened, and recreational off-highway vehicles (ROV) are the booming emerging market. Trail planning, design, construction, maintenance, and management techniques all need to change to adjust to the changing market and ensure that what is on the ground provides quality, sustainable recreation opportunities. Change will always occur, but the principles presented in this book will provide resiliency to that change.

Creative vision: Is this just a tree to be cut out of the way of the flagline, or is it an opportunity to create a technical challenge feature for an ROV trail?

In starting to write this book, the question was: Is an OHV-specific design guide needed? The answer was a resounding "Yes." Off-highway vehicle modality is vastly different than any other recreation trail modality. Motorized vehicles have motors and this is a critical difference. With the motor comes the desire to use it. With power assistance, OHV riders can climb, tackle technical terrain, and travel farther in a single day than any other user group. Most also desire to challenge their vehicles as well as themselves. All of this creates trail system planning and design considerations unique to OHVs. More physical, displacing forces are being delivered to the ground making trail design and durability a critical factor. Most OHV trails are wider than non-motorized trails and they collect and channel more water, which needs to be mitigated through proper location, design, and engineering. All of this necessitates more emphasis on effective OHV management, maintenance, and thorough trail system planning. The wide variety of motorized vehicle types and activity types generates the need for multiple sets of design parameters to address trail width, clearing, grade, obstacles, drainage, hardening, etc. While many design principles and techniques may be similar to those for non-motorized trails, the scope and complexity of those applications is much broader with OHVs.



Across the country, each trail has a unique combination of soil, topography, vegetation, and climate, so there cannot only be one tool in the tool box to solve a problem. Also, the tools used in one place may not be the same tools used on another trail in a similar situation. The need for a variety of tools and options is also driven by the huge regional diversity in OHV use types, numbers and concentration of riders, private and public land ownership mix, state and provincial laws, and agency policies. Rather than offer charts and tables filled with values that may be meaningless to a manager's situation, this book offers a thought process to help the technician or manager understand the use, the riders' needs, the natural environment, and the physical forces being applied to any given trail. With this understanding, the technician or manager can predict effects and make informed decisions. There are principles and guidelines, but few absolute rights and wrongs. Rather, there are choices: If I do this, what will be the effect? Because we all live in the real world, the best solution might not be possible.

What makes a great trail great? Understanding, knowledge, engineering, passion, vision, creativity and conscientiousness.

There is a main theme running through this book: provide for the riders' needs while ensuring resource protection. Applying this theme from planning to maintenance will help OHV managers achieve success, provide a high-quality recreation experience for the riders, and ensure resource protection.

The WOW factor is an important aspect of trails. WOW is relative depending on the age, skill level, and the desired recreation experience of the rider. When managers create a high-quality trail, thousands of people will ride that trail and have smiles on their faces at the end of it. That is a WOW for them and for the OHV manager. WOW generates energy, project support, compliance, volunteerism, and increased funding opportunities; all key elements in a successful project and successful OHV program.

Please note that for the purposes of this book, the term "OHV" refers to off-highway motorcycles (OHM), all-terrain vehicles (ATV) or quads, recreational off-highway vehicles (ROV), also known as utility vehicles or side-by-sides, and four-wheel drive vehicles (4WD). The term does not include snowmobiles or other over-snow vehicles.

Each chapter contains at least one of several insets:

A Look Back – a summary of key talking points

A Second Look – a photo or subject that has been brought up before, but is discussed again with a different option or viewpoint

A Closer Look – a subject that is brought up in the chapter, but is highlighted in more detail

A Case in Point – an actual example of a talking point discussed in the chapter

Tips, Tricks, or Traps – key points for success or failure

Need More? Learn More Here – key references that are applicable to the chapter material

Now, let's start down that trail to success...

Plan trails the right way or your riders may take a bad turn

PART ONE

The Building Blocks of Great Trails

Riding off-highway vehicles is a great way that families explore the great outdoors together.

Chapter One

Principles of Successful OHV Management

The 4Es: Engineering, Education, Enforcement, Evaluation

The process of creating great OHV trails starts with an understanding of the fundamental principles of OHV management. These principles need to be carried through planning, design, implementation, maintenance, and program management and they apply to existing trails and new trails.

The Need for Management

The first underlying principle is that OHV recreation needs to be managed. The use is not going to go away and it cannot be ignored. The days of having a block of land where they go and ignoring what is really going on there are no longer possible. The ostrich approach to management is prone to failure. Unmanaged OHV recreation can lead to user-created trails, unacceptable resource impacts, poor recreation experiences, conflict with other stakeholders or other recreationists, antagonistic community and media relations, and litigation. The target of most of this negativity is usually the group of riders who really just want their share of the recreational resource, a place to ride responsibly, and to be left alone. Too often, the eventual result is closure and a reduction of riding opportunities.

When OHV use is managed, trails are designed to provide high-quality recreation experiences, resources are protected, past impacts are rehabilitated, there is a positive working relationship with stakeholders and other recreationists, there is community and media acceptance, if not support, and the riders are seen as partners rather than the enemy. Ultimately this leads to continued or increased riding opportunities.

A motivation for and a benefit from recreation is an escape and a release. Endorphins and adrenalin are released. All of this is beneficial, but needs to occur in a managed setting, not an unmanaged setting. Certainly, two questions that arise are: "Can an unmanaged setting be transformed into a managed one?" and "How do I accomplish that?" The simplistic answer to the first question is: "In most cases, yes." This book gives the answer to the second question.

Management includes parking, signing, kiosk, maps, barriers to control and direct use, and a clean toilet for customer service

A Case in Point...

In 2007, the Bear Creek OHV area in Kelowna, British Columbia, was on the verge of closure. Unmanaged OHV use had been occurring there for 35 years; there was a maze of user-created trails, hillclimbs, significant resource impacts, angry stakeholders, and upset residents. The community and media were up in arms. The local club, the Okanagan Trail Riders Association, saw the writing on the wall and started taking action by seeking advice from experts. Not long after, Recreation Sites & Trails BC declared the area a Recreation Site and began active management. At 35,000 hectares (110,000 acres), it is the largest recreation site in the province. There was a lot at stake.

By 2012, the accomplishments included: 224 km (139 miles) of sustainable, well-designed trails; a trail ranger program; a camp host program; a massive closure and rehabilitation effort was completed; riders were compliant with sound and spark arrester requirements; a new trail pass was being overwhelmingly accepted; a sensitive grassland ecosystem had been protected; and the stakeholders, media, and residents were appeased.

Bear Creek is the first designated, managed OHV trail system in BC and it is now being used as an OHV model for the province.

Bear Creek Before Management...

Bear Creek Today...

The Three Key Elements for Success

The creation of any successful trail, trail system, or OHV park involves the successful application of three key elements: provide for the riders' needs; design for sustainability; and develop an effective operations and maintenance (O&M) program. These three elements form the basis for the Great Trail Continuum.

1. Provide for the Riders' Needs. What does this mean? If the riders want hillclimbs or other potentially high-impact activities, does a manager give it to them? Not necessarily. It means that the manager evaluates the site to determine what experiences can be reasonably and sustainably provided. Then the manager can ensure that whatever experiences can be provided are delivered as high-quality, high-fun factor opportunities. A key point here that cannot be overemphasized is that if riders get the experience they want ON the trail, they will not look for it OFF the trail. From an OHV management standpoint, this is huge. There are those who are skeptical, including some riders, but this theory has been validated in project after project.

> **Tip, Trick or Trap?**
>
> **Tip:** Three Key Elements for Success
> - Provide for the riders' needs
> - Design for sustainability
> - Develop an effective O&M program

High Quality Opportunities + Varied Opportunities = Success

When riders have a high-quality recreation experience, they are smiling at the end of the day. What does that mean to the OHV manager? The riders recognize they have something good. This means they become proud of it and want to protect it. Compliance with the rules and regulations increases. Peer pressure to make others compliant goes up. Volunteerism increases. Vandalism goes down. The need for enforcement goes down. There is an increased willingness to accept trail fees. And management spends less time and money dealing with problems on the "have to" list and more time working on the "want to" list.

> **Tip, Trick or Trap?**
>
> **Tip:** When riders find what they want ON the trail, they will not look for it OFF the trail

Happy Riders = Happy Managers

How do managers provide for the riders' needs? First of all, they need to know who the riders are and understand the various vehicle types and the experiences those riders are looking for. This book covers a wide range of vehicles and a wide range of riders, but fortunately, they all have similar recreation needs and desires.

Riders' needs and desires:
- Fun, fun, and more fun. People recreate to have fun.
- Connect with nature. Find our roots and a simpler existence.
- Escape from society
- Relieve stress
- Physical exertion and exercise
- Challenge for their vehicles and themselves
- A variety of experiences and difficulty levels
- Build camaraderie with friends and family engaged in the same activity
- A sense of belonging to a group
- A legal place to ride and feel welcome
- Enjoy quality facilities: kiosks, toilets, camping, etc.
- Enjoy quality trails, signing, and mapping
- Access to water features, scenic viewpoints, and unique features
- The opportunity to view wildlife

A skilled OHV specialist understands these desired experiences. Many planning teams however, do not have an OHV specialist or an OHV representative, and the planning team members are not expected to become OHV enthusiasts. If at all possible, put at least one OHV club, area, or state association representative on the planning and design team. Also, attend some club meetings and take the team out on a club ride. It is a great way to learn about the activity, what draws people to that activity, and the very social nature of that activity. Most important of all is go out to the project area on the weekends when the riders are there and talk to them. It will be easy to discover that they are real people and they like to talk about their activity. It is also a very effective relationship builder.

> **Tip, Trick or Trap?**
>
> **Tip: Size Does Matter**
> When the demand for trails exceeds the supply, managers have lost control of the use

A word of caution when soliciting input on what riders would like to see in the project area - many times riders will say "I like it the way it is." Their answer will reflect what they've experienced. If all they know is poor quality, then there is no bar to measure it against. It is a place to ride and it's their place to ride, so it's good. It is important to recognize this so that the trail system planning and design is not swayed in the wrong direction by inaccurate input. Many riders have never ridden a designated, well-designed, or managed trail system.

There is another potential trap. If there is an unmanaged project area today, chances are that the customers are locals who have ridden there forever. It can be a mistake to base planning on that rider group and their current riding activities. Once a designated, managed trail system has been implemented, the rider base and demographics will change. As soon as a map is produced, or a website is developed (recommended), or someone puts videos on YouTube, suddenly the whole world knows about this trail system and riders will come from all over the area, state, or region to experience it. What was maybe once an all-male group of locals with a single focus, can now be a mix of singles, families, and extended families with multiple vehicle types. Where perhaps there were fifteen riders on a weekend day, there may now be 150 or more. These are changes that managers need to recognize and assimilate into the planning process.

> **Tip, Trick or Trap?**
>
> **Trap:** User-created trails meet the users' needs

Another common mistake managers make is to stop treating riders as people. Don't exclude a facility or interpretation because the area is an OHV riding area. And don't exclude trails or activities because the riders might already have enough. People will want and enjoy whatever the developers can reasonably provide: parking, camping, concession area, a wide variety of trails and difficulty, motocross (MX) tracks, youth training area, safety training area, mudding area, sand pit, 4WD trails, rock crawl, endurocross, hillclimbs, open riding areas, etc. The only limitations to amenities provided should be the size of the site, physical characteristics of the site, dollars for construction, dollars and infrastructure for O&M; and social, political, resource, and legal constraints.

OHV recreation is a family activity, so plan to provide opportunities for a variety of vehicle types, ages and skill levels

2. Design for Sustainability. Sustainability is one of those terms that many use and few really understand. In reality, there are four key aspects to sustainability: resource, experience, political, and managerial. Most people just think of resource sustainability so let's delve into that first.

There are many definitions of resource sustainability. It is one of those terms that makes a trail or project feel warm, fuzzy, and good; and the hope is that it will make the antagonists feel good also. Managers and developers say to the trail consultants: “I don’t know what it is, but that’s what I want.”

A sustainable trail:
- Flows and harmonizes with the landscape
- Lays lightly on the ground and maintains natural drainage patterns to minimize impact and reduce erosion
- Provides resource protection over the long term when properly managed and maintained
- Provides a high-quality recreation experience now and in the long term
- Can be managed and maintained efficiently and cost-effectively
- Minimizes conflicts between stakeholders and other recreationists
- Minimizes political and media controversy by having the right activity in the right place

A sustainable trail does not mean that:
- It is the cheapest trail to construct or the least costly means to upgrade an existing trail to achieve durability
- The trail will not require maintenance since every trail requires some degree of maintenance every year
- The trail will not require adaptive management
- The trail will continue to be sustainable if use patterns or use types change

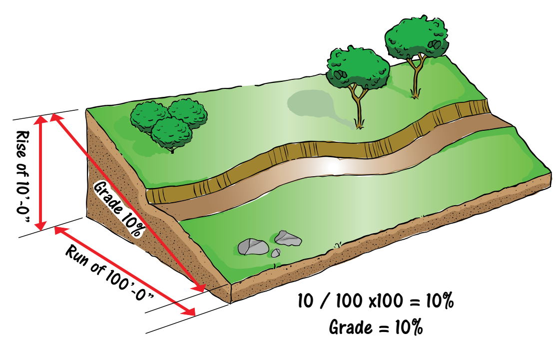
A sustainable trail has constant flow and roll. Tangents are minimized and grade reversals force water off the trail at regular intervals. Flow is the rhythm of the trail, which is usually created by a very curvilinear horizontal alignment. Roll is the vertical rise and fall of the trail grade. Roll also contributes to the rhythm of the trail, but its key role is providing natural drainage points through grade reversals, which significantly reduce the potential for soil movement. Trail hardening is used where needed and a multitude of trail design and engineering structures are incorporated where applicable. The tread is durable and the trail offers a high quality recreation experience within the intended difficulty level without the difficulty changing over time due to unintended degradation.

Horizontal Flow + Vertical Roll = Increased Sustainability

Let’s take one more step in this discussion. Listed under *Providing for the Riders’ Needs* are hillclimbs, mudding areas, and open areas. How sustainable are these? They may not be, but every trail section or challenge area does not have to be sustainable. The value of the recreation experience may outweigh any potential impacts or the value of the resource may not warrant any special mitigations. The key is that management understands that a trail or area may not be sustainable and makes a conscious decision to manage it that way. There are some steep, gnarly, rutted trails that are going to run water when it rains. Often these are the trails that provide the WOW and are highly valued by the riders. If that runoff does not have direct connectivity to a stream or if that connectivity can be mitigated with something like a sediment basin, management can decide to accept the tread impacts and more frequent maintenance costs, and keep the trail for its recreation value.


This ATV trail rolls and flows with the landscape.

Calculating grade or sideslope



Grade is the vertical rise and fall of the trail. Rolling the grade means frequent transitions from positive (up) grades to negative (down) grades. We also talk about the steepness of the ground referred to as slope or sideslope. Both grade and sideslope are calculated the same way.

3. Develop an Effective Operations and Maintenance (O&M) Program. As stated previously, OHV recreation needs to be managed and this means ongoing management. The trail or trail system needs to be maintained and evaluated on a regular basis, and adaptive management applied in a timely manner to keep indicators from becoming problems (i.e., effective application of the 4Es described later in this chapter). This takes personnel, materials, the proper equipment, and funding. Too often, project planners and developers focus on the design and construction and overlook the critical elements of management and maintenance.

Having shop and storage space, the proper equipment, and skilled personnel are key to an effective O&M program.

For someone new to OHV O&M, it is hard to envision that ATVs, ROVs, or motorcycles will be needed just to access the trails and haul tools and materials where needed. All of these usually require trailers and tow-vehicles to move them around.

The team will also need much of the same equipment and materials needed for non-motorized trails. They will need hand tools and power tools plus signing, fencing, culvert, and barrier materials. They may need a small backhoe, mini-excavator, trail dozer, tracked dumpers, and other equipment. They will need stockpiles of dirt and various gradations of rock, silt fence, filter cloth, and a place to store all of this. Vehicles and equipment always have something broken, so a place for repairs with hoists and tools is also needed. Then, of course, there is the need for personnel trained and qualified to perform the work and operate the equipment. Much of this can be acquired over time while renting, contracting, or using volunteer resources until the O&M program is fully implemented.

Elements of a successful O&M program:
- Multi-year maintenance plan
- Comprehensive management plan
- Dedicated and knowledgeable personnel
- Management commitment at all levels
- Dependable funding
- Positive attitudes
- Pro-active management
- Strong volunteer program
- Adaptive management techniques

These well engineered signs provide clear, simple and effective education messages

Effective Application of the 4Es

The 4Es are the most basic and most essential principles in the successful implementation of an OHV project, or any project for that matter. They are inter-related, co-dependent, and all must be considered and applied to ensure success. They are:
- Engineering
- Education
- Enforcement
- Evaluation

Success will be achieved by utilizing the 4Es in conjunction with commitment, persistence, firm resolution, and hands-on management. It isn't enough to put up a sign and walk away. Signs make good targets or garage wall decorations. It is important to stay in the ring for all 10 rounds. Persistence leads to success. The message will get through.

Engineering happens on the ground. It is applied during trail and facility location, design, and construction. It is using structures for resource protection or mitigation. Engineering is using effective signing, fencing and barriers to control and direct use. It is having proper tools and equipment for operation and maintenance.

Education happens in the mind. It is used to welcome the public, set expectations, inform visitors of the rules and regulations, inform riders of open trails and areas and the allowable vehicle types, and inform the rationale for closed or restricted trails. These messages are conveyed through effective signing, quality mapping, websites, kiosks, conducting complimentary tech checks, and face-to-face communications with the riders. It can be done by managing agency personnel, volunteer trail patrollers, or campsite hosts.

Signing and mapping are the primary media by which management communicates with their customers. Both must be clear, concise, effective, and agree with each other. Properly engineered signs significantly increase rider compliance and reduce the need for the third E: Enforcement. The overwhelming majority of riders want to ride legally. When they get lost or confused due to poor signing or mapping, management has lost control of the use and must live with the consequences.

Effective education results in:
• Improved compliance
• Improved quality of the rider experience
• Reduced conflicts
• Reduced resource impacts

Enforcement happens in the wallet. But it is not just about writing tickets and assessing fines. Effective enforcement uses a variety of tools such as face-to-face communication, warnings, and just being seen. Of course there are those people who only respond to citations and fines. But the majority of the riders feel more secure in areas with visible enforcement and may feel the agency cares about the area. Riders have seen too many riding areas closed due to a few irresponsible people and understand the agency is working to keep these trails open.

Effective enforcement results in:
• Increased compliance
• Increased agency and management visibility
• Less vandalism
• Increased visitor security
• Support for field personnel or volunteers

The area with the least resources is always enforcement. However, by doing a thorough job of engineering and education, the need for enforcement can be vastly diminished, although it can never go away.

A Case in Point…

At the Bear Creek Recreation Site in Kelowna, British Columbia, a major effort was launched to change rider behavior and ethics from go anywhere/do anything to designated routes only and to convert from no rules to spark arresters and 96dbA sound limit required. A trail ranger group was formed by the club and they diligently educated and patrolled every weekend for two years. After that period, the riders who would conform did and the riders who refused to conform knew that the trail rangers had no enforcement teeth. Those riders showed up weekend after weekend and flaunted the rules in the trail rangers' faces. The trail rangers needed enforcement to back them up, but the enforcement was in a different Ministry and protocols had not been established for OHV enforcement. The trail rangers became discouraged and participation waned. The education program was at a critical point and without all of the 4Es, failure loomed on the horizon. Too much had been invested and too much had been gained to risk failure. Riders had sustainable trails, resources were protected, past impacts had been stabilized and rehabilitated, and stakeholders were gaining acceptance. All of this hard work and positive results were about to be negated by the lack of the ability to implement all of the 4Es.

Evaluation tells us what is happening. It tells us how well the managers have achieved the other Es. Monitoring is the component that ties all of the Es together. How is the manager doing? What is working and what isn't? Are the closure and rehab efforts successful? Is the signing effective, fading, shot up, or still in place? Are riders compliant with the rules and regulations? Is there a high level of customer satisfaction? What feedback is coming back from the riders, law enforcement, stakeholders, or general public? Are the erosion control measures in place and effective? Are the trail structures in place, sound, and effective? Is the trail starting to degrade from poor design, lack of maintenance, or increased use?

Tip, Trick or Trap?

Trap: To think an issue, such as enforcement, is one department's issue. If it's a management problem, it's everyone's problem. All 4Es and all personnel must work together.

For the best results, have everyone perform the evaluation. Yes, everyone. Anyone involved in the project site should be involved in the monitoring of the site. This includes the riders, all field personnel, law enforcement, trail patrollers, management, etc.

How often does evaluation occur? At some level, it occurs daily. It is a team effort and everyone should have their eyes and ears open whenever they are on site.

The 4Es are a process of adaptive management. Implement, observe, and then make any necessary corrections in a timely manner. With experience in OHV management and behavior, the observers will be able to predict what will or could occur before a problem or issue even starts. Management then has the unique opportunity to make pro-active adjustments. It's also a process of recognizing reality and understanding human nature. Managers will always be more effective if they can work with human nature rather than against it.

Design and Management Strategies for the 4Es

Here are a few strategies for using all of the 4Es.

- Conduct education prior to any rule changes, closures, or restrictions.
- If there is a trail through an area to be restricted, never close it before an alternative route around the area is open.
- Never just put a fence across a trail to close it.
- Never just put a sign on a trail or off to the side of the trail to close it.
- Don't invest in expensive rehab and native seeding until rider behavior has changed.
- If a sign gets stolen, replace it. If it gets stolen again, replace it again. Persistence and resolution will eventually prevail.

- When tracks appear where they shouldn't be, go back to the 4Es and ask why. Is it errant rider behavior, or is there a problem with trail alignment, signing, or mapping; is the trail not meeting the riders' needs?
- If a closure gets breached, fix it. If it gets breached again, fix it and install more barriers or signs.

Effective Application of the 4Es = Successful Project Implementation = Successful OHV Management

The 3Ds: Dispersal, Dispersal, Dispersal

Dispersing the riders is a key to successful OHV management because it spreads the riders out over a larger area. Why is this a benefit? By providing dispersal, there are fewer riders on any given section of trail. While this can reduce trail maintenance costs and potential wildlife disturbances, it primarily reduces the number of encounters with other riders and enhances the quality of the recreation experience. Like any other trail recreationist, OHV riders value stopping and enjoying the natural environment. OHV recreation is a very social activity, but just because the riders enjoy being with their group doesn't mean that the riders enjoy being with all of the other groups on the trail system.

Having a large acreage to work with and a high-mileage trail system is certainly an advantage in providing the opportunity for dispersal, but dispersal is actually achieved by providing multiple loops or trail junctions. Each trail junction serves as a decision point, a rider can go left or right. The more decision points there are the more effective the dispersal. From a trail planning and design standpoint, the more decision points that can be provided in the proximity of the trailhead or staging area, the more quickly the riders can be dispersed. Even on small trail systems or OHV parks, though the trails may be more concentrated and the available mileage reduced, some level of dispersal can still be achieved by providing more trail junctions. As a general rule, as the opportunity for dispersal goes down, the need for site hardening goes up to increase durability.

Tip, Trick or Trap?

Tip: Having several junctions in the vicinity of the trailhead will disperse riders more quickly

Trail Junctions = Decision Points = Dispersal

Seat Time and Recreation Activity Time

Recreation time is highly valued and often very limited. It is important to understand that OHV recreationists have come to a managed OHV park or trail system to ride. The sooner they can get onto their OHVs and the longer they can stay on their OHVs, the happier they will be (remember: Happy Riders = Happy Managers). Seat time, or riding time, is the primary component of the recreation activity time in which a rider participates or experiences in a given day.

The more seat time, the better the recreation experience. Why is seat time important to the OHV manager? If someone comes to an OHV park to spend 6 hours and they've done everything in 2 hours, what are they going to do for the rest of the time? The same applies to a trail system. Suppose there is a destination trail system with a campground. It will not be uncommon for an ATV group to come and camp for 2 to 5 days over a long weekend. If an ATV rider can ride 50 miles in a day on the trails and there are only 50 miles of trail, there is one day of riding provided. What will the rider do for the other days of their stay?

"Design it like a rifle and they will ride it like a bullet"
– Jim Schmid

More Recreation Activity Time = Higher Quality Recreation Experience

Remember the discussion on providing for the riders' needs. If riders find what they want ON the trail, they won't look for it OFF the trail. Having adequate mileage while still protecting resources is essential, but the other part of the equation in determining seat time is speed. If there are 20 miles of trail and it can be ridden at 20 miles per hour, one hour of seat time has been provided. If the designer is creative and makes the trails tighter, more serpentine, and reduces tread width so that the trails can now only be ridden at 10 miles per hour, the seat time has doubled. The advantages to the OHV manager are obvious. The challenge for the system planner and trail designer then is to maximize the mileage and reduce the speed.

Tip, Trick or Trap?

Tip: Speed causes issues

Reducing speed:
- Increases safety
- Increases seat time
- Reduces tread impacts and maintenance needs and costs
- Generally increases the fun factor and the recreation experience

Reducing the maximum possible speed does not eliminate the challenge or experience for the riders. They can still ride a trail at their fastest possible speed regardless of whether that speed is 2mph or 20mph.

Recreation Activity Time Includes...

- Seat time
- Spectating time
- Learning time (skills building, interpretaton, etc.)
- Viewing time (scenery, wildlife, etc.)
- Socializing time (trail rests, campfire gatherings, etc.)
- Eating time (including picnics)
- Other activities (fishing, group activities such as volleyball, swimming, etc.)

What if the size of the project area or OHV park does not allow for enough trail miles for one or more days? While seat time is important, spending quality time with friends and family in the outdoors also is an important aspect of recreation activity time.

Being able to ride to a desirable destination can extend and enhance the time on the ride. Viewpoints, interpretive sites, cultural or historical sites, ponds, streams, waterfalls, wildlife viewing opportunities, lunch at a lodge, photo opportunities, etc., can all extend and enhance the length of time the riders have with their group. The objective for the OHV manager is to provide sufficient recreation activities for the time the average visitor will spend at the site. OHV parks can do this nicely because they can offer many diverse activities, including trails, a variety of tracks, mudding areas, training and kiddie areas, rock crawl, endurocross and other technical features, play areas or open riding areas, concessions, fishing, and camping.

One-Way Trails

Tip, Trick or Trap?

Trap: One-way trails increase safety

This is a topic that always generates a lively discussion. Riders will often request trails be made one-way. Their argument is safety by reducing the risk of a head-on collision. In theory this may sound reasonable, but the fact is that as soon as riders are on a one-way trail, their speed will go up and their position in the trail will change because they don't have to worry about encountering any oncoming riders. Because riders will change their riding behavior if there is a possibility of another vehicle coming from the opposite direction, a two-way trail can be safer than a one-way trail.

In addition, trails ride differently in different directions. The view is different, the flow is different, and the challenges are different. In essence, having two-way trails doubles the riding opportunity. This is especially important in OHV parks or other areas with low-mileage trail systems. One-way trails should be the exception and not the rule.

That being said, there are places where it is appropriate to have one-way trails. There are two elements necessary to make them work: one is that there be a limited number of controlled access points to the one-way trail, preferably no more than two; the second is the need for increased signing to adequately warn and educate the riders as to the proper direction of travel. With the signing comes an increase in monitoring to ensure that the signs stay in place. Many learner loops and kiddie tracks are one-way. Some most difficult technical trails are one-way since the ground is so technical that encountering a rider coming up an obstacle as another rider is coming down the obstacle could leave no way to stop or pass.

A one-way trail does not guarantee safety or ensure that there isn't a rider going the wrong direction, even with adequate signing. Consider as an example, if a rider starts down a one-way trail and has some type of mechanical or personal issue, human nature will dictate that the rider will take the quickest way back even if that means going the wrong way on a trail. There is always a risk of collisions on OHV trails. However, there are much better and more effective engineering methods to decrease potential impacts with two-way trails than are possible with one-way trails. These other methods have the advantage of keeping seat time greater.

Using Existing Infrastructure: Roads and Trails

There is a tendency among managers to use existing elements in their project area, usually roads and user-created trails. The rationale is that using existing infrastructure reduces ground disturbance by using what is already there; roads and user-created trails were intended for motorized use and therefore they should serve well as designated motorized trails; reduces construction costs; possibly simplifies the environmental analysis and process; and potentially placates project critics. While all of these may be true, there can be adverse effects from a recreation and OHV management standpoint. Most roads were intended to provide a transportation experience, not a recreation experience. Many user-created trails follow the path of least resistance or maximum vehicle stability to get from Point A to Point B, which usually means that they follow the draws or ridges. These are called fall line trails and they are not desirable because they channel water, which leads to scouring, soil movement (erosion), and sedimentation. Many user-created trails just happened, they weren't designed. Many were created by competitive events, so they may satisfy that experience but they do not satisfy the needs of recreational riders. A trap that planners can fall into is to assume that since users made the user-created trails they must provide a quality experience for the users. Some do, but most do not.

Tip, Trick or Trap?

Tip: Create a recreation experience, not a transportation experience

Trails and roads that are not properly designed can have unwanted characteristics, giving unwanted results.

This user-created fall line runs right up the bottom of a swale, so water drains in from both sides and has no place to go except down the trail. As the water gains velocity, it starts to scour the tread surface and carry sediment to the bottom. This is evident by the trench eroded down the middle of the trail.

Many existing roads and trails are likely to be non-sustainable and offer a low or poor recreation experience. This is directly counter to two of the three elements for success: provide for the riders' needs and design for sustainability.

Is the solution not to use existing roads and trails? Absolutely not. Let's be realistic. Most trail systems use existing infrastructure to some degree because it's there and no one can afford to start from scratch. The challenge for the planners is to creatively explore what they have, but not automatically be married to it. The key is separating out the roads, trails, or segments that are sustainable, provide variety, and contribute to a quality experience, and can be incorporated without incurring increased maintenance. Utilizing existing infrastructure can be a useful trick or an expensive trap.

This straight trail following a seismic line does not provide a quality experience

This existing trail segment is not sustainable. Being confined to this existing corridor is creating resource impacts.

This trail segment has both quality and sustainability

This road provides a recreation experience

This road provides a transportation experience

Existing roads can:	Existing trails can:
Be too straight (poor flow)	Be too straight (poor flow)
Be too fast (Reduced seat time)	Be too fast (Reduced seat time)
Be too boring (poor experience)	Utilize the fall line (ruts and erosion)
Have long, sustained grades (no roll)	Have long, sustained grades (no roll)
Have poor drainage (not sustainable)	Have poor drainage (not sustainable)
	Provide inconsistent difficulty (poor experience)

Variety

Variety and its benefits have been mentioned several times in this chapter because it is an important management tool. Riding on the trails is the primary reason OHV riders visit a riding area. Expanding the variety, and thus, the experience adds to the quality of the riders' experience. Planners can expand the variety by adding loops, narrow trails, trails on roads, changes in difficulty, changes in topography and vegetation, youth training areas and learner loops, mudbogs, play areas, or technical challenge courses.

Providing variety is an effective OHV planning and design tool that will help ensure management success.

This rest was during a 'group' ride. It was a beautiful day and a beautiful setting. The different machine types took different routes. They used trails, roads, road to trail conversations; encountered flat terrain and steep terrain; experiences smooth and rough trails; and went through areas of high vegetation and no vegetation. There was great variety and lots of smiles; a WOW experience.

Quality

The final tool is quality. Quality doesn't mean expensive, it means simple, effective, well-maintained, and well-managed trails and facilities that meet the riders' needs. Quality is created when there are trails with adequate mileage, a high fun factor, and creative variety; a simple well-organized kiosk that has maps in the map box; the information on the map matches the signing on the ground; a toilet that looks and smells clean and is stocked with paper and sanitizer; and the trails and the signing look professional and are well-maintained. Quality is the effective application of all of the components of the Great Trail Continuum: planning, design, implementation, maintenance, management.

Breaking News! Always use quality materials (for OHV trail systems)

Need more? Learn more here…

Designing Sustainable Off-Highway Vehicle Trails, Kevin G. Meyer, USDA Forest Service, Technology & Development Program, 1123-2804P-MTDC, 2013

Management Guidelines for OHV Recreation, Tom M. Crimmins, National Off-Highway Vehicle Conservation Council, 2006

A Look Back

Here are some of the OHV management elements discussed in this chapter:
- The need for managed recreation

The three key elements for success:
- Provide for the Riders' Needs
- Design for Sustainability
- Develop an Effective O&M Program

Understanding the riders' needs and desires:
- Fun, fun, and more fun. People recreate to have fun.
- Connect with nature. Find our roots and a simpler existence.
- Escape from society
- Relieve stress
- Physical exertion and exercise
- Challenge for their vehicles and themselves
- A variety of experiences and difficulty levels
- Build camaraderie with friends and family engaged in the same activity
- A sense of belonging to a group
- A legal place to ride and feel welcome
- Enjoy quality facilities: kiosks, toilets, camping, etc.
- Enjoy quality trails, signing, and mapping
- Access to water features, scenic viewpoints, and unique features
- The opportunity to view wildlife

The 4Es: Engineering, Education, Enforcement, Evaluation =
successful project implementation = successful OHV management

Sustainability defined: sustainable trails flow & roll with the landscape
The 3 Ds: Dispersal, Dispersal, Dispersal
Understanding seat time and recreation activity time
The trap of one-way trails
- Using existing infrastructure: roads and trails
- Creating a recreation experience, not a transportation experience
- Variety = high-quality recreation experience = successful OHV management
- Quality = control = effective OHV management

Chapter Two
Planning: The Foundation of a Successful Project

Respect the Land, the Water, the Wildlife and the Rights of Others

Creating a sustainable trail or trail system is very similar to building a house: it takes a vision, a good plan, a solid foundation, sound construction practices, and then proper maintenance to protect the structure's integrity. If the proper time and effort is not spent in each one of these steps, the entire project could be jeopardized.

THE GREAT TRAIL CONTINUUM

This is the basis for the concept of the Great Trail Continuum. Each component is equally important and each component must be effectively performed and implemented in order to create a great trail. Some planners look at planning as a white elephant; a paper exercise that wastes time, wastes money, and is not productive. But it is an essential component of the continuum. Why is it called a continuum? Because the process never stops. The team plans, designs, implements, maintains, and manages. Then using the 4Es, the team monitors the results and if something isn't working, members plan, design, and implement corrective action. This is called adaptive management. It is important because a trail is imposed on a dynamic landscape, therefore the trail and its management must be dynamic. There will always be a need for change.

Tip, Trick or Trap?

Tip: A trail is placed on a dynamic landscape, therefore the trail and its management must be dynamic

Chapter 1 discussed the three elements for success: provide for the riders' needs, design for sustainability, and develop an effective O&M program. Neither of the first two elements can be achieved without first planning for them. The essential steps in the planning process are:

- Develop a vision
- Conduct a site assessment
- Refine the vision
- Build a resource map
- Develop a trail concept plan
- Develop trail management objectives (TMO)
- Perform any required environmental analysis
- Build broad-based support
- Assemble the remaining foundation building blocks

This is a swamp buggy trail in Florida. Though quite different, the principle of Providing for the Riders' Needs applies here just as in any other OHV trail.

Develop a Vision

Developing a vision means that planners must ask the following questions: What needs to be done? What can be done given the constraints of the site, resource concerns, politics, or management? What vehicle types will be accommodated? What experiences will be provided? What opportunities are there for difficulty levels and challenges? What facilities will be provided? What opportunities are currently being provided in the area or region? What levels of visitation can be expected? Where will this system fit into the big picture; what is the niche?

The vision is important because it provides a target or goal. If planners don't know where they're going, they don't know when they get there or, more importantly, they don't know how to get there. The vision should be written down, and the entire project team and stakeholders should be in agreement so everyone is working together toward a common goal. The vision can change as more information is collected about the project area. It also needs to be realistic, attainable, and affordable. It is one thing to obtain funding for construction, but it's another to obtain funding for operation and maintenance in the long term.

Vision without Action is a Daydream.
Action without Vision is a Nightmare.

The team also needs to understand the uses that are currently occurring at the site. Planners should go out and look at the trails; look at the impacts, if any; and talk to the riders to find out what they like, don't like, and want. Planners can then refer back to the first key element for success: provide for the riders' needs.

Planners must understand the use before they can develop a vision.

Without proper planning a great vision can become a trail nightmare.

A key consideration in planning for riders' needs is to understand that OHV riders travel in groups and that generally those groups have a mixture of vehicle types. It is not unusual for a group to have OHMs and ATVs or ATVs and ROVs. If at all possible, provide a variety of trail widths that interconnect at intervals to accommodate those different vehicle types. By doing this, a group can ride their respective trails and still have the opportunity to meet up with the rest of their group. It is a definite benefit to have an OHV specialist on the planning team. If one is not available, consider adding a club member, state or provincial association member, or an OHV expert.

Resorts and campgrounds connected to a trail system offer variety for the riders and a positive economic impact for the surrounding communities.

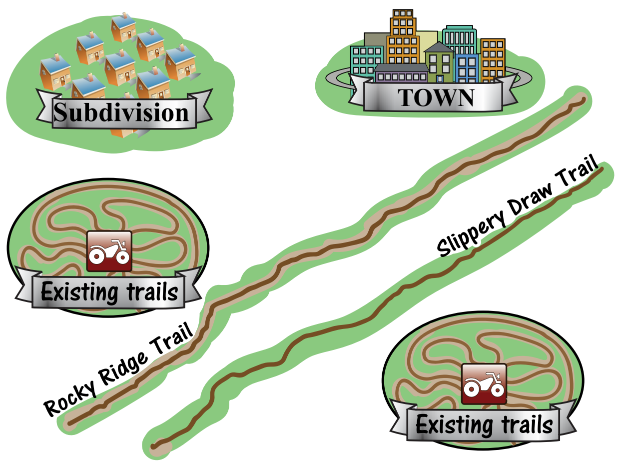
Planners should next consider their niche by asking about other opportunities that are currently being provided in the area or region. Will the trail provide something different or unique? Where will customers come from? If most of the customers are within a couple of hours driving distance, most of the use will be day use. If a motorcycle rider can ride 50 miles in a day, then there should be at least 50 miles of trail. However, if customers will be coming from outside of the area, then they will likely be coming for a weekend or long weekend. If that motorcycle rider is here for 2.5 days, there should now be 125 miles of trail or there should be other facilities and activities to occupy the recreational time that customers are on site.

The Vision
With no challenging terrain available, this rock garden was created. This group had a blast and spent more than an hour in this 200' section.

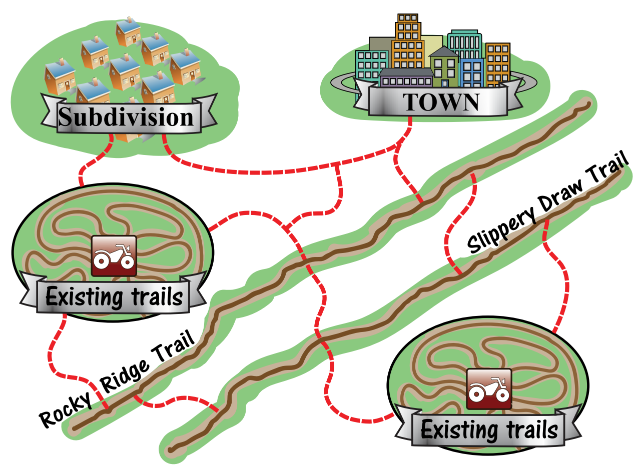
Having a grasp on the demographics has a definite influence on the project planning beyond just the miles of trail being provided. If customers are coming for a weekend, where will they stay? Perhaps there should be a campground, or maybe there are local motels or RV parks that could use an economic boost from the trail system or OHV park. An important consideration, though, is do these existing facilities have adequate parking and turnaround space for big rigs? What about an event area for closed course races, drag races, tractor pulls, or other competitions? Some parks provide non-OHV activities such as zip lines, activity areas for volleyball or badminton, and playgrounds. Other areas provide equipment rentals or food concessions.

Are there ponds or lakes that could provide swimming or fishing opportunities? Could the trail or trail system connect with other trail systems or towns to provide multi-day ATV, ROV, or dual-sport touring? If so, there is the potential to create some outstanding and unique recreation experiences. The Hatfield-McCoy trail system in West Virginia and the Paiute trail system in Utah not only provide fabulous riding but also are huge economic boosts to the local economies because they connect the trails to the communities.

All of these potential activities could contribute to the essential element of variety. Few people ride their OHV for 10 hours straight every day. Planners should provide a creative mix of activities and experiences.



Taking isolated trails



and adding connections to make a trail system

Will there be events on the trails? Depending on the soils, vegetation, and topography, trails that will have competitive events may need to be designed differently in order to be sustainable. Many soil types cannot endure a high volume of use in a short duration of time. This also applies to OHV parks where there may not be events on the trails, but there is a high volume of use on generally a low-mileage trail system.

When developing a vision, it is easy to become micro-focused on just the area of concern, but the planning team should step back and look at the big picture. Instead of looking at one trail, planners should look at developing a system of trails. Instead of looking at a group of individual trails, they should look at developing a managed trail system. On a broader scale, planners should consider if there is an opportunity to link several trails or groups of trails to several communities. All of these can add to the quality of the recreation experience and to the effectiveness of the management of the use.

Trail system features	Meet riders' needs
Loops	Connectivity
Mileage	Seat time
Dispersal	Seat time
Scenic diversity	Variety
Terrain diversity	Variety

Conduct a Site Assessment

To continue the vision, the planners need to conduct a site assessment to determine the feasibility of the vision. Will the site support the vision? If not, what can it support? The assessment needs to look at the topography, soil types, vegetation, climate, known resource concerns (wildlife habitat, riparian areas, cultural resources, etc.), known management constraints (conservation areas, restrictive management areas, etc.), known stakeholder issues, existing uses and their impacts, safety issues with the current uses, and the feasibility of adding other recreational activities. All issues need to be assessed and documented. If no one on the team has the expertise to conduct this assessment, consider having a consultant do it. Consultants may see things that the team has not considered and their eyes are unbiased, objective, and professional.

This area was assessed to determine its suitability for OHV trails and its recreational value. The result? Outstanding!

Refine the Vision

So far, the team has acquired: a) an understanding of the physical characteristics of the site; b) a site assessment; c) comprehension of the vehicle types and the OHV recreationists; d) a grasp on the types of experiences to be provided; and e) knowledge of other OHV opportunities in the area or region (niche). With this broader knowledge, it's time to refine the vision statement. Below is a sample vision statement from the Gypsum City OHV Park in Fort Dodge, Iowa.

Gypsum City OHV Park is a community partnership developed and dedicated to enhance recreational opportunities and promote tourism and economic diversity. With its many diversified activities and year-round usage, the goal is to provide a place where families can enjoy the Iowa outdoors in a beautiful well-managed setting. High-quality sustainable trails will provide a range of experiences while well-designed facilities will cater to the needs and comfort of our visitors. The Park will provide a legal designated place for OHV recreationists, and the vision is for the Gypsum City OHV Park to be the premiere destination for not only Iowa, but the entire Midwest.

Build a Resource Map

The next step is to build a spatial database with all known information about the site. Often this is called a resource, inventory, opportunity, or constraint map. This data is best recorded as layers in a program such as a geographic information system (GIS). Each type of information is recorded in its own layer, and the layers can be easily turned on or off depending on the type of information needing to be displayed on the screen or map. Commercial-grade global positioning system (GPS) units have the ability to store a wide range of information about each trail or trail segment. These are called data dictionaries and they can be downloaded to form the GIS layers. Data can be collected as to the road and trail widths, use type, grade, trail condition (degradation), surface type, indicators of erosion, condition of road and trail structures, etc.

Many GPS units on the market have the capability of taking photographs and linking them by position to the trail being inventoried. This can be extremely helpful, especially if the planner is not the person collecting the data. The photos can be great tools to show general trail width and condition; indicate trail problems; portray difficulty; portray soil and vegetative type and cover; show existing signing; or highlight unique features, opportunities, or habitats.

The following information should be collected for the resource and planning analysis utilizing existing databases, GPS collected information, and field data.

- Roads divided into major, minor, and primitive roads and classified by federal, state, county, and city ownership
- Existing trails, designated and user-created
- Water features including lakes, ponds, creeks, springs, wells, irrigation lines or canals, known wet areas, known riparian zones, and livestock water troughs

- Utility lines and corridors, both above and below ground
- Fencelines including gates, cattle guards, and corrals
- Grazing allotment boundaries
- Existing facilities including trailheads, parking areas, camping areas, toilets, shelters, motocross tracks, and training facilities
- Property boundaries, road rights-of-way, or other easements
- Known wildlife corridors, raptor nest sites, animal dens (bear, rattlesnake, etc.), beaver dams, etc.
- Known threatened, endangered, and sensitive (TES) species and their habitats
- Known cultural sites
- Noxious or non-native plant populations
- Management area boundaries including old growth, deer winter range, general forest, watershed boundaries, and tree farm license boundaries
- Soil type, and terrain stability
- Vegetative type and cover
- Active commercial operations such as mines or logging
- Existing rock pits, quarries, borrow sites
- Points of interest including lookouts, historical sites, viewpoints, cabins, and wildlife viewing areas
- Any unique features including rock outcrops, cliffs or rimrock, rock slides or scree, interesting formations, unique vegetation, scab flats, and meadows

Tip, Trick or Trap?

Tip: For inventory of the trail centerline, the smoothest GPS tracks will be obtained by riding the trail, but assessing the condition of that trail is best done on foot

The inventory data will be displayed as points, lines and polygons.

Point data are used for controls, points, unique features, nest sites, etc.

Line data are used for fencelines, utility corridors, roads, trails, etc.

Polygon data are used for management boundaries, cultural sites, non-native plant populations, water features, etc.

Although this is a lot of data, planners should remember that the goal is to design a sustainable trail or trail system that protects resource values and provides high-quality recreation experiences. These objectives can only be accomplished by having thorough knowledge of the site.

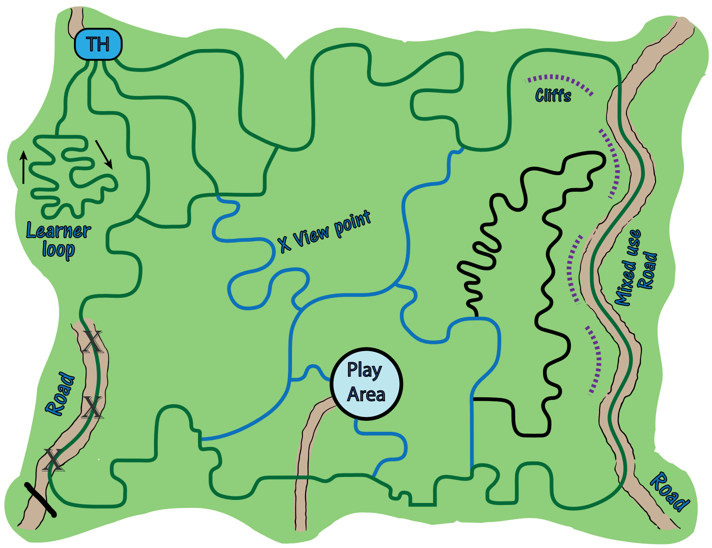
The next step in the process is to develop a trail concept map. For planners to produce a good product, they need multi-resource, accurate, and complete data. It can be expensive to collect this comprehensive data; however, planning is the building block or foundation of the trail system. It will be cheaper and more efficient to gather the information now than to have a critical resource issue surface after the construction crews and equipment are on site. In addition, the person doing the trail layout and design must be intimately familiar with almost every square foot of the site. When that person stumbles across a trail or other feature that was not on the inventory, everything must stop until that feature is explored, GPS inventoried, and incorporated into the trail concept plan as either a designated or closed route. Paying for good data upfront can save project dollars and time later on in the process.

Features like these should be included in the inventory and utilized whenever possible.

Who should be collecting the field inventory data? Ideally, from a consistency and continuity standpoint, it should be the trail planners and designers. That way, the same set of eyes and evaluation criteria are used to gather the data and translate it into a plan on paper. Often that is not possible. Sometimes club volunteers gather the data, but they may not have the skills to recognize sustainability issues or understand resource values. Sometimes, agency personnel collect the data, but they may not have a good grasp of desired rider experiences, difficulty, the elements of a sustainable trail, or recognize potential opportunities. Planners could consider hiring contractors with OHV expertise who can gather quality data quickly and efficiently.

The resource map is a working document; therefore, it reflects the information currently available and can change as additional or modified data is obtained.

Develop a Trail Concept Plan



Given the knowledge of the project area, the vision, the understanding of the vehicles to be accommodated, the desired recreation experiences to be provided, and the inventory map, planners can now sit down and start mapping out a conceptual trail system. In designing a trail system, the planners must understand:

- The statutory and administrative requirements
- The resource values and constraints
- The users and their desired experiences
- The landscape
- The issues
- The politics
- The climate
- The existing condition
- The vision

Creating the concept plan is a complex and cerebral process. Depending on the size of the project area, it can be a huge task. If there isn't someone on the planning team who is qualified to perform this task, it might be beneficial to consult with a professional trail planner. This is also a good time to talk about the importance of developing open, honest working relationships with the resource specialists. These relationships must be based on unbiased professionalism and trust. Without that, the cohesiveness and the effectiveness of the planning team could be diminished.

A Case in Point...

The planning for the Shoshone OHV Trail System in north central Nevada began in 2003. The members of the local club, the Northern Nevada ATV Association, were excited and anxious to get a new riding opportunity. They spent years attending meetings with stakeholders, the county, and the Bureau of Land Management. The environmental analysis process took years to complete and then was further delayed by an appeal. During that time, there was a change in the county commissioners and support at that level was no longer assured. It took eight years before construction could finally begin and by then the energy of the club had waned, membership had dropped, some members had developed health problems, and others had quit out of frustration. However, the club as a whole prevailed. Without the dedication and persistence of the club, the project may not have come to fruition.

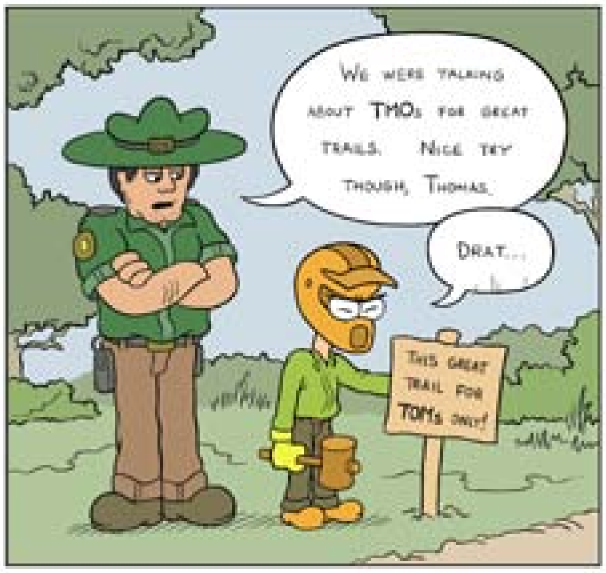
Not only is the development of the trail concept plan a huge step in the process, it is the first step that produces a tangible visualization of what the project will look like. Up until now, there is usually only a map with a project area boundary on it. Having a visual aid can stimulate and encourage the planning team and invigorate the clubs and potential volunteers. Getting from project inception to trail concept plan can take years. It is very difficult for any group, especially one made up of volunteers, to maintain energy and enthusiasm for that long of a period. The trail concept plan is a good tool to take to the stakeholders so they can see how the proposed trails may affect their interests. Lastly, having the trail concept plan in hand is a huge advantage when seeking grants or other funding opportunities.

The development of the trail concept plan is the true foundation of the trail system, and it is such an important step it is discussed more thoroughly in the next chapter. Once the trail concept plan has been reviewed and any necessary revisions made, the next step is to develop alternatives if necessary.

Develop TMOs

The trail management objectives (TMO) document describes the use and management of a trail and outlines the following:

- The primary uses and vehicle types
- Other allowable uses
- The desired recreation experience: transportation road, recreation road, trail, loop trail, destination trail
- The intended difficulty level (this may change once the trail is finally located on the ground)
- Design guidelines including clearing width, tread width, and grades
- How the trail will be constructed: machine or hand-built
- Maintenance frequency and methods
- Trail management such as open all year, seasonally closed for wildlife, closed during wet season
- Frequency of trail inspection and assessment
- Any specific resource concerns or issues associated with the trail including grazing allotment, wildlife, cultural sites, sensitive plant sites, water quality, and nearby residents



By documenting this data, TMOs provide continuity as well as operation and maintenance consistency. Personnel will change, but the trail will still be on the ground and the new personnel will need to know the vision and intent. Over time, the TMOs should be reviewed and revised as use, use type, climate, and landscape changes occur.

The TMOs are the thread that weaves the continuum together. The designer must know the intended user, the intended difficulty level, and how the trail will be constructed. Construction personnel must know the user and the difficulty so that technical features like rocks, logs, and roots can be left or removed. Maintenance personnel must understand the use, the desired experience, and difficulty in order to properly maintain the trail (so they know to cut out a log or keep a technical feature). Whoever is inspecting the trail needs to understand the resource values and determine if they are becoming impacted. Those people also need to determine if the trail is still providing the desired experience or difficulty level and ascertain if maintenance, reconstruction, or relocation is warranted.

Perform Any Required Environmental Analysis

A lot of good solid data and work has gone into the formation of the trail concept plan, so it can often be used as the proposed action in the environmental analysis process. Each agency, state, or province has different legal requirements and processes for environmental review. It is absolutely critical that their requirements be identified and followed. Environmental review can add months or years to the project planning but that time period can be reduced by having a solid trail concept plan based on sustainability and resource protection.

On federal land in the United States, the National Environmental Policy Act (NEPA) legislates the environmental review process. Under that umbrella, each federal agency then adopts additional regulations and policies for their jurisdictions. There are three levels to NEPA and each level increases in process and complexity.

First is Categorical Exclusion (CE or Cat Ex), which is a category or list of actions that, barring extraordinary circumstances, do not individually or cumulatively have a significant effect on the quality of the environment. These categories vary widely between agencies; however, designation or construction of new roads and motorized trails are not generally included. Depending on the agency, a CE may be used for minor reconstruction or relocation of an existing trail.

Tip, Trick or Trap?

Tip: Planning Virtues:
- Patience
- Persistence
- Long-Term Commitment

Second is Environmental Assessment (EA), which is the most common and used when the expected effects of the proposed action are well understood to have no significant impacts. The process usually, but not always, explores alternative ways to achieve the purpose and need, analyzes the effects of those alternatives, and affirms that the selected alternative with appropriate mitigations has no significant environmental impacts. If the EA concludes with a Finding of No Significant Impact (FONSI), the environmental review process is complete. If it doesn't, then the EIS process must be followed.

Third is the Environmental Impact Statement (EIS). This process is used for projects that may have a significant environmental impact. An EIS will almost always explore more than one alternative that meets the purpose and need. The alternatives display options and trade-offs between significant issues. The EIS discloses the effects of those trade-offs and how they will be mitigated and concludes with a Record of Decision (ROD).

Often, the processes for an EA and EIS are similar in that both have:
- Purpose and need statement: What is it and why is it needed?
- Proposed action: A course of action that could be taken.
- Scoping: Asking for public input for issues, concerns, opportunities, or other courses of action. Sometimes this is done through public meetings.
- Alternatives: Usually one of these will be no action or no change, one will be the proposed action, and then one or more alternatives to the proposed action.
- Analysis: Review of effects of the proposed action versus the alternatives.
- Public review and comment.
- Final agency decision: A final document with a ROD or FONSI and required findings is issued, often with administrative appeal opportunities. The final could be altered from the draft due to the public comments.

Scoping and Stakeholder Involvement. Scoping is an essential component in the NEPA process. While not every project goes through the NEPA process, in every project area, there are individuals or groups who have an interest in the area or who could be directly affected by the project. Scoping needs to be done to determine the interests and stakeholders. A contact list should be developed and those stakeholders notified of the project and its progress. This is important because any or all of the interests may have issues or concerns with

Trail enthusiasts need to be good partners to help agencies develop their trails.

the proposed trails in the project area. It is far better to flush those issues out early, rather than to have irate opponents surface later. When all of the issues are on the table, planners can address them either by changing the trail concept plan, developing another alternative, or changing the scope or level of mitigations. Time allows the planners to better understand the issues and also allows the opportunity to build a working relationship with the interested public.

There are two types of interested public: special interest groups and stakeholders. Special interest groups have an indirect interest, advocacy, or philosophical position. These groups lobby for a position and they could be OHV groups, conservation groups, or timber groups. Stakeholders are individuals, groups, or entities that have a direct and active interest in the project site. Stakeholders could include riding club(s), private inholders, range permittees, timber interests, mining interests, other tenure holders, neighboring residents, utility companies with corridors through the project site, irrigation districts, tribes and First Nations, hunters, and other trail user groups.

A Case in Point...

The NEPA process was followed for the Lost Ox OHV Trail System in Ely, Nevada. An EA was prepared, a FONSI was signed, and there were no appeals. Grants were secured and a contract was let to perform trail layout and design. Several months later, four hunters realized that the project could affect “their interests”. They went to the county commissioners and got their support in opposition to the project. That group had been in favor of the project until a recent election changed the commisioners. Then the hunters went to the media and started beating the war drums of emotionalism. A town hall meeting was held followed by more meetings with the Bureau of Land Management. The result? The Decision was vacated, the contract cancelled, the project forever dropped, and a loss of more than $1 million in grant funds. The NEPA process was followed, but could the outcome have been different with more scoping and public involvement early on?

Sometimes the stakeholders are brought together as a group with regular meeting dates. These can be called an advisory committee, oversight committee, or steering committee. These committees can be a good forum for an open discussion of the issues. They can also be a forum for heated debate, collusion of interests, and shifting focus to positions (to interests that impede rather than expedite the process). If a group is formed, an experienced and impartial moderator should facilitate the group to keep it focused and moving in a positive direction.

It can be more effective to meet with the stakeholders individually rather than in a group, and it is very productive to conduct that meeting in the field if possible. In the field, it is easier to deal with the real issues, the conversations tend to be less polarized and dramatic, and the perspective of the issues and scope of the landscape is much better than gazing at a map. Like the resource specialists, it is important that planners develop a positive, professional working relationship with the stakeholders. This relationship does not stop when the planning is finished, it continues through the implementation and beyond.


A meeting with stakeholders in the field.

No discussion about stakeholders, planning, and environmental review processes would be complete without talking about the 3Ps: politics, politics, politics. There are politics in everything, including in a family, club, state and provincial organization, and work environment. Certainly, in dealing with relationships with stakeholders, interest groups, the land managers, and their staff planners must put on their political hat and diplomatic face. This is not a realm where the “damn the torpedoes, full speed ahead” approach is appreciated or effective.

Building one-on-one relationships with stakeholders. At left, the Okanagan Trail Riders Association (OTRA) uses its operator and equipment to help the range permittee dig up and repair plugged up pipes to a water trough. Below, the OTRA worked with the representative of the tree farm license holder to install barriers and signs to deter hill-climbing at a private gravel pit.

Involvement means building trustful working relationships, even with people who may have very different philosophies. Successfully working with multiple interest groups can be like walking a tightrope. Smiles and sincerity can open doors; negative body language and careless remarks or actions can close them. A wise man once said that there is a time to talk and a time to listen. The wise approach when walking into a new group is to listen first and talk second or not talk at all. By listening, planners can better understand issues, agendas, underlying motivations, and under the table alliances. Listening builds trust and allows planners time to mold their thoughts into effective comments.

Change happens often in planning, including with use levels; use types; climate; sensitive plants and animals appear and disappear; sometimes trail locations, grades, and structures are tried, but they didn't work as expected; and sometimes there are errors in the initial planning or implementation that need to be corrected. Since a trail lays on a dynamic landscape, the trail and its management must be dynamic. In the NEPA process, two ways to facilitate change are 1) survey and assess the effects of a trail corridor, not just a trail, and 2) include adaptive management verbiage in the NEPA document.

Establishing a corridor of 50, or better yet a 100, feet on each side of the trail centerline gives the designer room to make final alignment or grade adjustments prior to construction. It also provides flexibility during construction to move the trail slightly if solid rock or other unsuitable material is encountered. And finally, as the planning team moves along the continuum into long-term maintenance and management, a corridor allows room for minor relocation of the trail as the condition of the trail, its use, or its environment changes.

A Closer Look…

Adaptive Management

Advantages:

- Flexibility to change
- Increased sustainability
- Proactive management
- Increased rider satisfaction
- Decreased resource impacts

Adaptive management verbiage means including a few sentences in the NEPA document that say: "If this happens, the team will consider or do that." For example, "If use increases to the point where the trail is no longer sustainable in its current location, the team will consider moving it". Or "If there is a catastrophic fire or weather event that affects the sustainability of the trail, the team will consider moving it". Some simple wording in the body of the document and consideration in the effects section can expedite the need for changes later on because the change is still meeting the intent of the document.

Build Broad-based Support

Some people vehemently dislike OHVs. This sentiment can complicate the planning process as managers and planners need to sort out the physical issues from the emotional issues. Physical issues can usually be addressed and mitigated; emotional issues are more difficult to resolve. The issue of sound can be mitigated, but "I don't like OHV noise" cannot. Because of this, it is critical that the OHV club provides support to the planners and land managers and that they speak with a unified voice.

A Case in Point...

Let's go back to the Lost Ox OHV Trail System in Ely, Nevada. The project was initiated by the BLM in an effort to be pro-active in providing for and managing the rise in OHV use. There was no local ATV club, so there was no local support base. Even though there are a lot of ATVs used for ranching and hunting, most of those users did not see the benefit in developing a trail system since they could already ride almost anywhere they wanted. So when the support of the county commissioners was lost and the media turned negative and there was a public outcry to stop the project, the BLM was left standing alone and they couldn't support the project.

The more people or groups that work together, the stronger the planner's position will be to promote and defend the project. It's never fun to stand alone in a sea of adversity, so having partners and supporters is a definite advantage. Some of the best partners can be stakeholders who can see a direct benefit to themselves. Talk to them individually, find out their needs or concerns, and determine how the project can address them. City officials, county commissioners, and regional districts can also provide a good support base. Planners should talk to them and show them how the project benefits the community and the economy. Local support is far more effective than non-local support, so while it is a benefit to have a letter of support from state or provincial officials or user associations, that support is not the same as support from those who are directly affected.

Tip, Trick or Trap?

Trap: Don't fall into the trap of arguing or defending your project or position in the media

This is another arena where effective use of the 3Ps is essential. The media tends to feed on contention because that's what sells their product; however, sometimes planners can find reporters who are interested in the project and fairly report what they see. This is an asset, so planners should capitalize on it. Opponents will focus the media on negative aspects of the project. Planners need to turn that around and find, focus on, and highlight the project's positive aspects.

Tip, Trick or Trap?

Trap: All non-motorized recreation groups are opposed to motorized recreation. This is a trap because opening new motorized trails which allow non-motorized recreation can create additional opportunities for all trail users.

Assemble the Remaining Foundation Building Blocks

Several other components or building blocks are necessary to complete the planning foundation. Just as having broad-based support builds solidity, planning documents also add to the solidity of the project. They can answer questions before they are asked, can address concerns early on, and put the planners and managers in a proactive, knowledgeable position. These documents include the management plan, sign plan, map, architectural theme, barrier design, monitoring plan, interpretive plan, and rehabilitation and erosion control plan.

Management Plan. A management plan provides programmatic direction and guidance, and includes these key components:

- Documents the vision
- Fully describes the trail and facility opportunities to be provided
- Establishes the vehicle and rider rules and regulations
- Establishes hours of operation, seasons, and weather restrictions
- Establishes who will administer the site and who will perform operation and maintenance

- Discusses whether there will be events
- Documents the decisions of the steering and advisory committees
- Discusses OHV use of roads
- Outlines the mitigation of issues
- Describes who will perform enforcement
- Outlines the role of volunteers
- Discusses who will do education
- Lists design guidelines for trails and facilities

Sign Plan. Signing and mapping are the two primary means that management has to communicate with its customers while they are on site. Simple, consistent, effective signing is critical to the success of any project. The sign plan establishes direction regarding the types of signs, shapes, colors, messages, materials, and placement.

Map. While it's too early in the process to produce a user map, planners can still include an example of what the map could look like. It is more important to have a map be functional than to have it look pretty and be expensive. The map must be rider friendly and effectively provide riders with the information they are looking for.

If the signs and the maps do not clearly work together and tell the riders where they should go, the management for the area has failed. This will cause impacts. Since these areas are critical, they will be discussed in more detail later in this book.

Architectural Theme. Many projects have an architectural theme to give the project an identity and a brand. Sometimes the theme conforms to the recreation opportunity spectrum (ROS), which provides guidance for the look and recommended materials in a setting that ranges from primitive to urban.

Barrier Design. Barriers control and direct use. Planners should have a barrier design that is used consistently throughout the project. Just like signing, riders learn to recognize a barrier and what it means. Barriers do not need to be tall, obtrusive, physical barriers. A low barrier that blends with the setting can be more effective and visually appealing. The riders' eyes are constantly scanning to pick a line to ride. It doesn't take much of a barrier for the roving eye to see that a potential pathway is not the best line.

A hydrologist monitors the stability of a beaver dam above this trail.

Monitoring Plan. There are two types of monitoring plans: formal and informal. Formal plans are specific and scientific. They involve establishing photo points, plots, and data collection points to measure and record changes in the trail or surrounding environment. They can include water quality monitoring or radio collaring game species to assess changes in behavior and physiological effects. Formal monitoring often requires specialized equipment and specially trained personnel which make it expensive and labor intensive, two attributes that are generally in short supply. When budgets get cut, monitoring is often on the top of the list. This can result in incomplete data that doesn't result in a conclusion. It can also put the managing agency in the awkward position of not doing what it said it was going to do.

Formal monitoring plans need to be:

- Relevant: What information does the team really need to know?
- Feasible: Can the data be obtained with the available personnel and equipment?
- Affordable: Given budget limitations, what data gives us the most useful information for the dollar?

Talking with the riders regarding their experiences at your trail system is important. Be sure to talk about all aspects including the trails, the facilities, the signing, the mapping, etc.

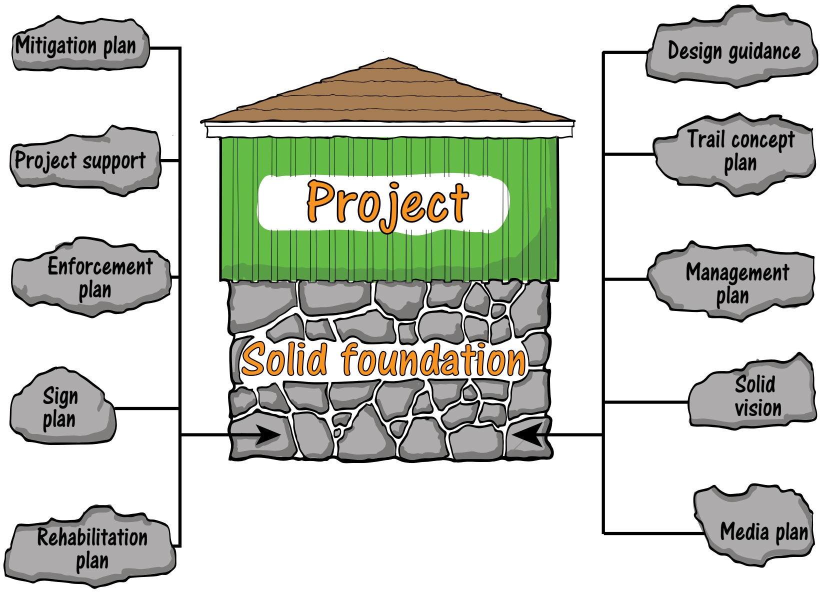
Informal monitoring is the fourth E in the 4Es: Evaluation. What is really happening? These are simple questions with readily attainable answers through observation, photos, trail counters, user surveys, and rider encounters. Are the trail management objectives being met? Are resource protection measures effective? Is there a high level of customer satisfaction? Is there compliance with the rules and regulations?

Informal monitoring has three elements: observe, record, report. Most field-going personnel including volunteers become the observers. Data can be collected with digital cameras, and information can be recorded on a simple monitoring form. The forms and photographs then need to be turned in to the person responsible for storing and compiling the data.

This interpretive sign adds to the rider experience along an ATV trail.

Interpretive Plan. Motorized recreationists are no different than any other recreationists; they like to understand their natural environment and learn about the history and geography of the area. Interpretation can benefit management by giving riders an understanding and appreciation of various resources or resource management activities and objectives. Interpretive sites can serve as destination points for the riders, they add seat time, and they increase the overall recreation experience of the riders. The sites are a win-win. Interpretation can be elaborate with expensive kiosks, or simple self-guided handout information with numbered posts along the way. Interpretation can engage resource specialists in the project area, it can bring a myriad of potential partners to the table, and it can provide new sources of grant funding.

Rehabilitation and Erosion Control Plan. This plan describes the methods that will be commonly used to close and rehabilitate prior impacts or undesignated trails or areas. It also explains the tools that will be used to control erosion and protect water quality during and after construction. If specific problem areas are known, the plan should address specific remedies for each site.



The more solid the foundation, the more likely the project will succeed.

Most of these plans can be simple documents that don't take a lot of time or money to prepare and some of these plans can often be incorporated into the management plan. Of all, the sign plan can be the most intricate and complex, but it doesn't have to be. Sometimes, a few representative pictures of typical signing could suffice. The important point is that all of these plans serve as blocks that build a solid foundation for the project. The broader the foundation, the more stable the structure, and the more likely it will succeed through project implementation.

A rock check dam being constructed to control erosion and stabilize a gully created by an old hillclimb.

If the project is an area with existing unmanaged OHV use, there could be a maze of user-created trails, resource impacts, social conflicts, negative media, and public outcry. All of these can complicate the planning process because it becomes difficult to separate the past from the present and future. There is another element: fear. Fear over what has happened in the past and fear over what could happen in the future.

Some tips to help deal with those issues and build positive relationships:

- Be patient, but persistent.
- Work to build trust at all levels.
- Do what was agreed upon and document it.
- Seek professional advice.
- Utilize the 4Es and all of the tools in this book.
- Maintain the high road.
- Address issues because they don't go away.
- Recognize that conditions will change; the past is not the future.
- Record everything new or changed on the project site.
- Use photos and brief verbiage in project newsletters or implementation updates.
- Be willing to conduct multiple field trips with stakeholders.
- Focus on the big picture, not on minor setbacks.
- Feed positive, pertinent, and truthful information to the media and stakeholders.

Some great trail planning strategies:

- Minimize the use of roads. Due to their large tread watersheds, roads are generally not sustainable and will increase maintenance costs. Roads increase speed, decrease seat time, and can decrease the recreation experience.
- Minimize the use of existing trails. Most existing trails were not designed and purpose-built for the use and most are not sustainable and will lead to resource impacts and increased maintenance costs.
- Seize opportunities for new construction. Most purpose-built trails are sustainable and provide a higher level of resource protection and rider experience.
- Maximize the use of existing structures to reduce construction and maintenance costs and reduce resource impacts.
- Plan for change in the landscape, climate, use type, or use level.
- Include adaptive management verbiage in NEPA documents and provide a corridor for the trail.

Here, water quality and sedimentation were an issue. Woody debris was placed in a herringbone pattern between rock check dams in a heavily eroded trail leading to a creek that feeds the community water intake.

Major structures like bridges, culverts, and fords are expensive to build and maintain. It is becoming increasingly more difficult to install these structures due to water quality or aquatic species regulations. Utilizing existing structures on roads, trails, or railroad grades can reduce cost, reduce process, and reduce potential resource impacts.

A Look Back...

Here are some of the planning elements discussed in this chapter:

- Develop a clear vision to guide the planning process
- Conduct a site assessment. The assessment will give the planner in the office a clear picture of what is on the ground.
- Refine the vision
- Conduct a thorough inventory and build a resource map
- Develop a trail concept plan
- Consider creating trail systems, not just trails
- Develop TMOs
- Conduct any required environmental analysis
- NEPA basics: CE, EA, EIS
- Include adaptive management verbiage and/or corridors
- Understand the importance of stakeholder involvement, including rider involvement
- The 3Ps: Politics, Politics, Politics
- Build broad-based support for your project
- Assemble the remaining building blocks of the project foundation:

  Management plan
  Sign plan
  Map
  Architectural theme
  Barrier design
  Monitoring plan
  Interpretive plan
  Rehabilitation and erosion control plan

Chapter Three
Developing the Trail Concept Plan

Know before You Go. Find Out before You Ride Out.

Up to this point, the only visual concept of the project may have been a project area boundary displayed on a map or perhaps a boundary with a bubble-diagram of potential facilities or opportunities. The trail concept plan will be the first tangible document that displays what the vision could look like on the ground. It's an exciting step.

The trail concept requires a broad vision. What will be provided and what could it look like? But vision doesn't end there. For a quality project, vision will be required in every step of the planning, design, and implementation process. In developing the concept plan, planners should shift their vision from the regional scale down to the landscape scale. Creative vision will be required to search for opportunities that may not be so obvious and to link those opportunities into a trail system of logical loops that will provide quality recreation experiences and resource protection.

Developing a concept plan is like working on a giant jigsaw puzzle. The vision, inventory, resource data, opportunities, and constraints are the pieces. How do they all fit together? Can they fit together in more than one way?

The first step is to have a thorough knowledge of the project area. In developing a concept plan, the planners must understand:

- **The riders and their desired experiences.** Planners cannot provide for the riders' needs until they understand those needs. Who are the riders? What are the vehicle types and sizes? What are their motivations and desired experiences?
- **The landscape.** What are the soil types? Are there any soils with naturally occurring asbestos, arsenic, or other harmful elements? Are there any contaminated soils on site? If there is rock, what kind is it? What are the vegetative types? What is the topography? Are there springs, perched water tables, or permafrost?
- **The issues.** The issues can include everything from noise, dust, wildlife disturbance, and water quality to potential conflicts with non-motorized recreationists. If there are clubs, is their support unified? Are there conflicts with stakeholders?
- **The politics.** What is the level of agency commitment? Are there multiple agencies or ministries involved? Are they all supportive? Is there community support and club support? Is there anyone against the project and, if so, why?
- **The climate.** What is the range of temperatures? Are there one, two, three, or four seasons? What is the average annual rainfall and snowfall? Does the rain come as gentle daily showers or intense thunderstorms? What are the humidity levels? What are the wind patterns? Will the use be seasonal?
- **The resource values.** Are there high cultural values, wildlife values, water values? Are there threatened, endangered, or sensitive (TES) plant or animal species? What are the land management allocations?
- **The statutory requirements.** What are the state or provincial licensing requirements, registration requirements, and definitions of OHVs? What legislation may be applicable (federal, state and or local laws regarding clean water, wildlife and fisheries protection, forest management, operator use restrictions, legal and designated routes, environmental protection, etc.)?
- **The existing condition.** What uses are currently occurring in the project site? What levels of use? Seasons of use? What impacts, if any, are occurring? In looking at the existing trails, roads, skid trails, game trails, and stock trails, how durable are the soils? What grades and length of grades appear to be resilient and sustainable?

- **Management constraints.** Are there budget or time constraints? Can only certain types of work be done due to the source of funding or deliverables in a grant? Does new construction have to be minimized? Does management desire the incorporation of all existing roads and trails, or only those portions that can be made sustainable? Are there road or trail density constraints?
- **Vision.** What is the intent and goal of the project? What facilities are to be provided? Will the project be an open riding area or will there be trails or a trail system, or a mixture of trails and open riding areas? Will the trails be used in the winter by a different user group?

The answers to these questions will affect how the various pieces of the puzzle are fit together. Time to get started.

Section 1: Compile and Refine the Data

Just like the jigsaw puzzle analogy, the best place to start is by assembling the obvious pieces like the border. For the trail concept plan, this equates to examining the constraints and eliminating the "no-go" zones, marking out the "partial-go" zones, and identifying the "don't-want-to-go" zones. A query of the GIS resource layers should quickly identify polygons for these three zones.

Control Points

Control points are features that have a direct influence on where a trail goes. There are two types of controls: a place where riders have to be (positive control point), and a place where riders can't be (negative control point). The planners' first trips to the project area should focus on identifying control points. The more of these that are found early on, the more solid the trail concept plan will be. When an impassable ravine or other feature not previously identified is found, the process can come to a halt. The feature needs to be added to the concept plan and the trail corridors adjusted accordingly. Sometimes these adjustments can significantly alter the concept plan, and that consumes time and project dollars.

Some common **positive control points** are trail termini, road and creek crossings, points of interest, etc.

Termini of the Trail. Certainly, the first thing planners need to know is where a trail starts and ends. Does it start at the trailhead, staging area, campground, or someplace else? With existing facilities, sometimes the termini are obvious, but if the project area is a clean slate, the first order of business is to determine where the trailheads, campgrounds, or other facilities will be located. Depending on the site, this task can be a challenge.

Road Crossings. First of all, is it legal to cross the road? If it is legal, where are the crossing locations that have flat approach grades and adequate sight distance given the speed of the traffic on the road. Some road crossings may require a permit from the road authority. If so, these should be obtained early in the planning process.

Points of Interest. Planners should identify unique features, interpretive points, and naturally occuring features which add interest and seat time to the riders' experience.

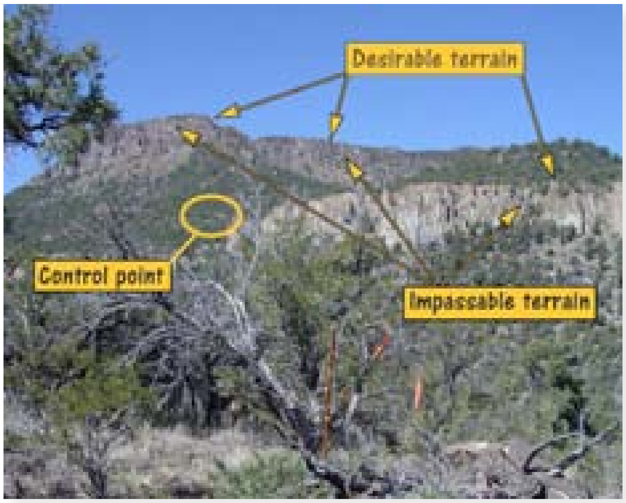
Creek Crossings. Every agency and area has different criteria for stream crossings, especially if it is a fish-bearing stream or a tributary to a community water source. The first thing planners need to do is determine the classification for the stream and any associated agency, state, federal, or provincial laws or regulations. As with roads, some streams may require a permit with seasonal constraints to work in the stream.

The best practice for crossing perennial streams is to avoid tire contact with the water. This offers the most protection for the stream and the environment by minimizing the risk of sedimentation. This involves the installation of a bridge, culvert, or in low flow streams, well-placed cobble rock to keep the tires out of the water.

If it is legal and appropriate to cross the stream on-grade with a ford, a qualified person must determine where the crossing points are that have good approach grades, a narrow riparian corridor, and the lowest stream flow. These ford crossing points become control points.

Where bridges are required, proper bridge sites also become control points. These are sites where there are stable banks for the bridge abutments to set; where the stream is down in a channel so there is a good elevation drop from the top of the bank down to the stream level; where the stream flow is straight to minimize scouring of the banks; and where the bridge span will be the shortest possible. Planners can find these sites, but usually an engineer will be required to assess the site and perform any necessary engineering surveys.

Saddles. These are a break or the lowest points in a ridge line. Some regions refer to them as gaps or notches. If a trail needs to cross a ridge, a saddle will require the least elevation gain and loss. In very rugged, technical terrain, the saddle may be the only place to cross the ridge line.



This picture shows cliffs which are impassable terrain for traversing up or down the slope. However, being on top of the cliffs is desirable terrain with a WOW opportunity for a trail. The only way to access the rim is through a gap in the rock which also becomes a control point.

Existing Road Infrastructure. When it comes to major stream crossings with bridges, major culverts, or pipe arches, it can be a good strategy to try to utilize existing road infrastructure for these crossings. Not only does it save project dollars, it can reduce potential environmental impacts. Contact the road authority and obtain any necessary permits. There will need to be additional signing for mixed use and that should be addressed in the sign plan.

Some common **negative control points** are impassable, unstable, or undesirable terrain and prohibited or restricted areas.

Impassable Terrain. These controls could be cliffs; deep, heavily eroded ravines or gullies; lakes and ponds; or fault lines.

Unstable Terrain. These could be landslides, slumps, avalanche chutes, or any area with steep ground and unstable soils. On slopes of more than 30 percent, avoid areas that have a shallow lens of soil on top of slab rock. A terrain stability map can help identify these areas, though often they need to be ground-truthed for accuracy.


After searching ¼-mile upstream & downstream, this was the only bridge site that would work to cross this very sensitive stream. It was not perfect (few are), but there was topographic relief on both sides, a straight channel, and minimal scour of the banks. This site became a positive control point. The next challenge was to get the trail down to it.


Steep scree slopes like this are high maintenance for trails. Many occur in snow country where snow creep will constantly drag rocks into your trail tread.

Undesirable Terrain. Wet areas fall into this category as well as those areas that will be wet like flood plains. While rock rubble fields like scree can create a beautiful and technically challenging trail, they can be high maintenance because rock is constantly sloughing off into the trail. The wider the tread, the bigger the issue. If the trail is to be wide and of low difficulty, scree becomes a negative control point.

Examine the Constraints

Prohibited Areas. What are the areas where a trail can't be put? These areas are usually dictated by resource management rather than by the physical characteristics of the site. As no-go zones, they become negative control points. Examples of these areas are rare or sensitive vegetation areas, bald eagle management areas (BEMAs), areas of critical environmental concern (ACECs), and community water intakes or water reservoirs.

Cultural resource sites usually fall into the no-go category; however, if they are subsurface, sometimes they can be crossed if they are mitigated by trail hardening or by additional monitoring of the tread depth. Seek and follow the recommendations of the archaeologist.

Private property boundaries and agency boundaries are generally no-go areas unless agreements are in place to cross into areas of other ownership. The lease or tenure boundaries for active mineral extraction are generally no-go areas depending on how firm the project area boundary is.

Restricted Areas. Bird nest sites, especially those of TES species or indicator species, are often restricted. A trail can't go under the nest, but it can go a specified distance away from the nest. Planners should find out the restricted area for that particular species and draw a circle around each known nest site. These partial-go zones also become negative control points. Rattlesnake dens or other dens may have similar protection. Some cave entrances, particularly those with sensitive bats, may be restricted. Water features like wells, springs, and water troughs often have a restricted area around them.

A den of rattlesnakes in a culvert

Some areas like deer or elk winter range may have seasonal restrictions such as winter closures. The requirements, if any, change by agency, state, or province. Planners should take the time upfront to identify these areas. It will make the plan more solid and environmentally defensible.

Riparian areas are often restricted. Trails can often cross them at 90 degrees to minimize impact, but they usually can't meander through them. The number of crossings may also be restricted. In some cases, trails through riparian areas need to be elevated or hardened. Some jurisdictions may require a permit to cross riparian areas.

Big game connectivity corridors are often restricted. Like riparian areas, a trail can usually cross them at 90 degrees, but not meander through them. Often there is a buffer zone around private property. Some reservoirs, especially those associated with community water intakes, also may have a buffer zone.

Undesirable Ground. Each project has areas where there could be trails, but it's not desirable to have trails. The first is flat ground. Flat ground? Isn't it cheaper to build a trail on flat ground? Actually, no. A trail on flat ground can become a trench over time making it difficult to drain water off the trail. Flat ground can hold water that saturates the soil and creates mudholes. It is also more difficult to maintain the designed tread width on flat ground since riders will push out the edges to pass or to get around standing water that can't drain. This results in trail braiding and widened trails.

Closely associated with flat ground are wet areas: riparian areas, bogs, wetlands, springs, or any area where the water table is at or close to the ground surface. These areas have saturated soils and are rich in flora and fauna diversity. It is best to avoid them. Wet areas are certainly red flag areas and usually become negative control points.

Flat ground, wet ground, lack of woody vegetation to deter use can lead to impacts.

Large, open grassy, or sparsely vegetated areas go on this list also. Unless there is some topography or rocks, it is difficult to maintain the integrity of a serpentine alignment in these areas since riders can see the next curve and cut cross-country to intercept it. The alignment eventually becomes braided and straight. Unless natural or manmade barriers are used to protect the alignment, the designers are forced to flag in a very lazy S that is close to straight. This increases speed, increases impacts, and decreases seat time.

Tip, Trick or Trap?

Trap: Building, maintaining, and managing use is MORE difficult on flat ground than on sloped ground. Slopes of 15% to 45% are ideal.

Depending on the type of riding, open areas can also be an issue. Any area that may have speed events should not have a large amount of trail in an area where sights are visible for long distances. The riders will cut the trails in order to gain position. This will result in trail braiding and straighter trails.

Although flat ground is thought to be erosion-proof since water doesn't run off of it, flat ground is more susceptible to erosion due to lack of drainage. Water collects on the surface and it is difficult and expensive to remove.

The more difficult the machine is to turn, the less likely a serpentine trail in an open area will stay intact. However, an OHV trail with a tight set of curves creates a technical challenge.

Trails through meadows fall into this category, but trails through recently harvested cut blocks or through recent burns do not. The natural environment is dynamic, not static, so change is a given. The planners and designers must visualize how a denuded area will look in 2 years, 5 years, and 15 years. Depending on the growing environment, the pace of recovery can be amazingly dramatic.

Though very scenic, this trail would be better located on higher ground and in the trees to provide varied views of the meadow without being in the meadow. Note the lazy S alignment. In the wet season, this trail probably intercepts and carries water from the yellow arrow to the blue arrow.

This fall line trail cannot drain, is not fun to ride, and is not in harmony with the natural landscape. Trails need to lay lightly on the land, not conflict with it.

Three of the areas of concern just discussed are shown on this map.

This motorcycle trail follows the spine and fall line of the ridge. It is becoming rocky because the soil fines are being washed away by the lack of drainage control.

Once again, avoid fall line trails. They generally have sustained (long, unbroken) grades and poor drainage so water is typically channeled down the trail. It usually requires manmade structures to provide drainage, and these are costly and difficult to construct correctly, expensive to maintain, decrease the rider experience, and can fail in a significant weather event. Sometimes in technical terrain with tightly spaced controls on each side, the only option is to use the fall line. In these cases, mitigations like more drainage structures, trail hardening, or increased maintenance frequency are required.

Tip, Trick or Trap?

Trap: Do not fall for fall line trails; they will fail

Ridgetop trails can also be undesirable. If the slope of the ridgeline is uniform with a long and sustained grade, these trails become fall line trails. The sight line is often long on these trails and this tends to increase rider speed and decrease rider experience. The better alternative is to design a trail that serpentines up and crosses from one side of the ridge to the other. This breaks up the sight line and increases the trail aesthetics, creates positive drainage, and increases the rider experience by constantly changing the viewshed of the rider.

Examine the Opportunities

This next phase is the fun part. It's time for the planners and designers to look at desirable terrain.

The ideal ground has a 15 to 45 percent sideslope with deep, stable soil and vegetative cover. Trees are preferred over brush, brush over grass, grass over a barren slope. Patches of thick trees or brush allow the designers to lay in a tight, technical serpentine alignment that slows down the riders, adds seat time, adds difficulty, and adds trail distance. Dense vegetation helps control tread width and protects the integrity of the alignment by deterring short-cutting of the curves.

A challenge for the planners and designers is to provide technical difficulty for the riders and still have a durable trail. For ultimate durability, look for rocks: boulder fields, rock gardens, solid slab rock that is on a slope, rimrock, slickrock, rock ledges or stepups, and hummocky broken ground. Rock provides opportunities for challenging trails while still maintaining durability.

This is approaching the upper limit in slope, but still good ground. Trees anchor the trail, hold the soil, inhibit splash erosion, control trail widening, and deter off-trail use.

Slab rock like this is a designer's dream. It provides challenge, fun, and durability. After being in the trees, popping out on an outcrop like this provides vegetative and topographic change plus a scenic opportunity. The moss and lichens on the rocks can be very beautiful.

Broken, uneven sideslopes with benches provide terrain diversity that gives the designers opportunities to reduce grade to provide drainage and flatter areas to change direction with a climbing turn. Terrain diversity also adds to the rider experience.

Desirable features include dramatic, unusual, or subtle features like rock formations; topographic edges like cliffs and rimrock; vegetative edges like the edges of meadows, cutblocks, and burns; old-growth forest; unique vegetation (twisted character trees, fields of wildflowers, tiny patches of moss or lichens, etc.); and vegetative changes such as moving from open to dense vegetation.

Rimrocks may be impassable terrain, but being on top of them is WOW terrain; a feature that will create a memorable experience.

Understand the Human Element

Where do riders (or any recreationists) want to go?

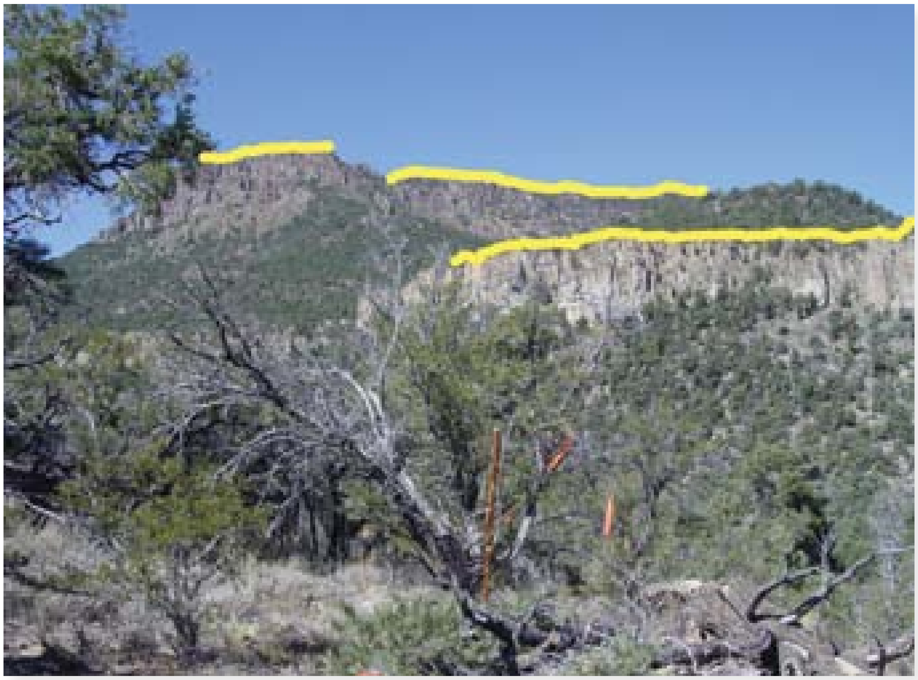
- **The Highest Point.** It is human nature to get to the highest point of land, not only for the view but also for the sense of achievement.
- **Water.** Lakes, ponds, creeks, springs, waterfalls are a natural attaction.
- **Viewpoints.** Whether it's the highest point of land or just a break in the trees, people love scenic views of the landscape.
- **Historic and Interpretive Sites.** Riders enjoy seeing old mines, cabins, ghost towns, abandoned equipment, mills, etc. Those along with any interpretation of the natural environment enhances the riders' experience.
- **Wildlife Viewing.** Riders of all ages enjoy seeing wildlife, including deer, elk, turkeys,

This is a great example of a poorly located trail on good broken ground with benches. This trail could have been more fun, longer, and durable if it had utilized the terrain and vegetation. The trail goes right up the spine or fall line of the ridge. This proved to be unsustainable, so pavers were installed to harden the trail. This is also a great example of investing a large amount of time and money into a bandage fix on an existing trail that doesn't solve the real issue of poor location.

bears, beavers, raptors, wild horses, and even snakes.

- **Food.** There is something about getting a burger on the trail that is very appealing to most riders. Food is a natural human attraction.

What do all of these six items have in common? They all provide a destination, a goal for the ride; they all provide photo opportunities; they all extend the time the riders are on the trail; they all provide an opportunity for riders to socialize with their group, which is an important element in OHV recreation; and they all add to the quality of the recreation experience. Around the campfire at the end of the day, these will be the highlights that everyone will talk about. These are the places that riders want to go. If at all possible, the planners should get them there.



It was difficult to get through the control and onto the top of the cliffs, but once there, this trail was destined to become the signature trail of this trail system.

Tip, Trick or Trap?

Tip: Invest in a good pair of hiking boots. OHV reconnaissance is best done on foot

Why? From a quality recreation and an effective OHV management standpoint, planners should always try to work with human nature rather than against it. The trail should take people where they want to go. It's the WOW factor; that is what riders should say at the end of the trail. Planners should strive to find the WOW points and put them on the inventory and into the trail concept plan.

Designers with vision controls the viewshed of the riders. They can be creative like artists, framing the picture for the rider. WOW!

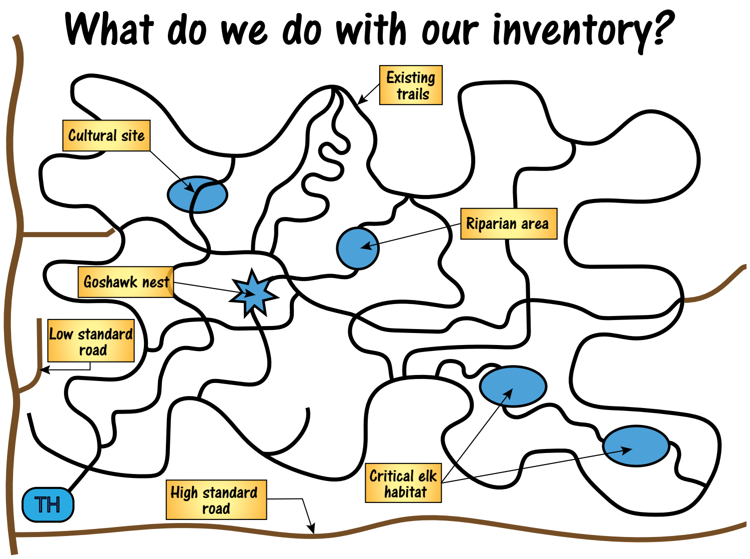
Tip, Trick or Trap?

Tip: For effective OHV management, it is always to your advantage to work with human nature, rather than against it

WOW features: durable, scenic, fun, challenging.

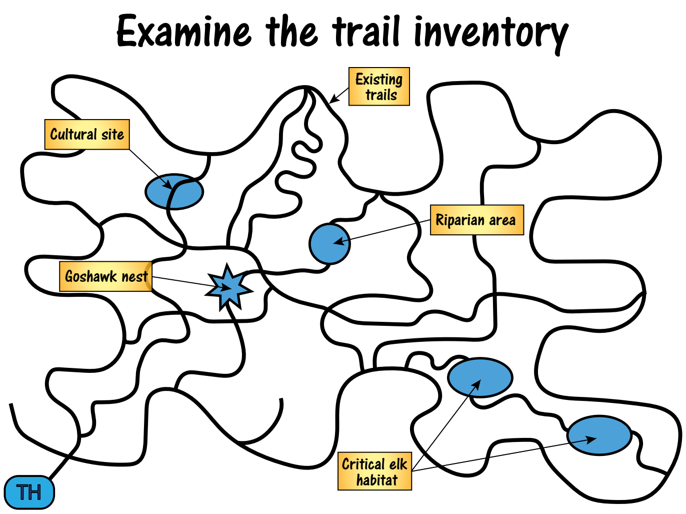
Section 2: Assemble the Data into a Trail Concept Plan

Now that the data has been gathered, it's time to organize and manipulate that data so it can start making sense. The inventory data will be displayed as a maze of points, lines, and polygons. To make sense of them, planners and designers should assign colors or other attributes to the data and then organize it into groups. Groups could be roads, trails, resource data, water features, opportunities, and constraints. This is what a typical inventory could look like with trails and roads as lines and resource concerns as shapes.



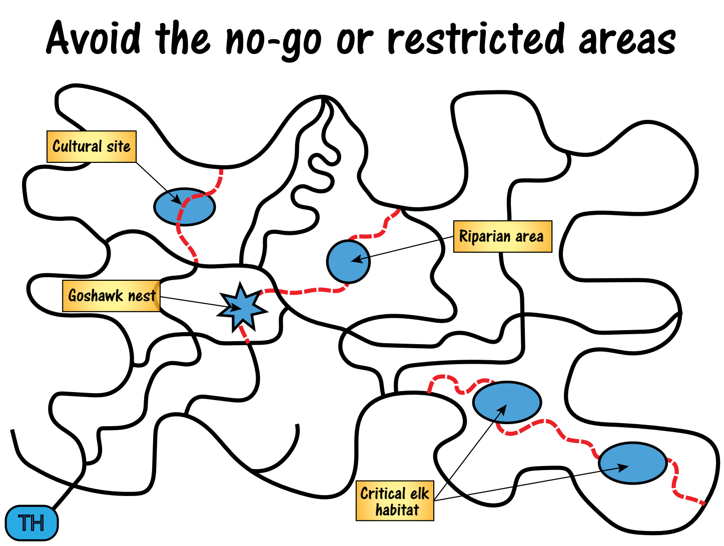
Examine the Trail Inventory

Planners should first look at the trail data and eliminate the obvious. Look at the trails that lead into the no-go or restricted zones. If the assumption is made that all of the resource areas of concern require avoidance, then the trails leading into those areas would be slated for closure in the trail concept plan.

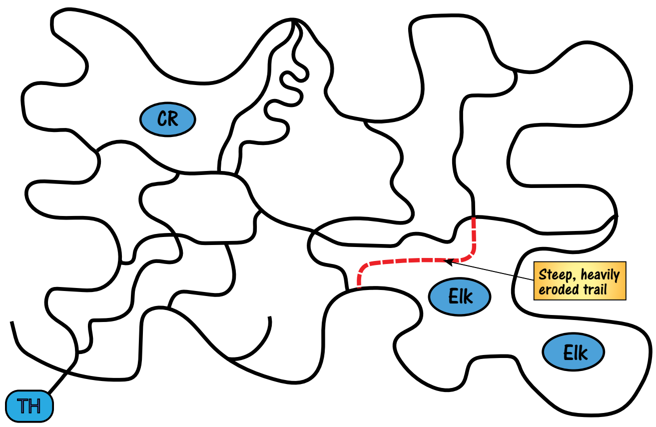


Next, planners should look at the trail inventory and data dictionary information and identify: a) which trails or sections of trail are sustainable and provide a quality recreation experience; b) which trails or sections of trail need some relocation or reconstruction to become sustainable and provide a quality experience; and c) which trails or sections of trail are non-sustainable, cannot be made sustainable, or do not provide a quality experience. Those trails in "a" and "b" will remain on the trail concept plan for the time being. Those trails in "c" will be slated for closure. Sometimes, there isn't enough information in the inventory to make these determinations at this time, but often the planners can make subjective assumptions by looking at the alignment and grades of the existing trails. If the alignment is straight and gains 100 feet of elevation in only 200 feet (50 percent trail grade), it is probably a hillclimb or fall line trail and is probably not sustainable.

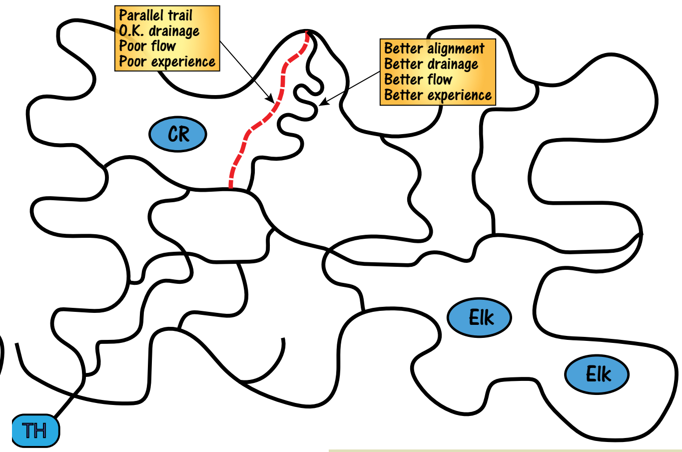
If there are two trails that parallel each other and both go from Point A to Point B, examine the inventory data to determine which one has the most sustainable characteristics and provides the best recreation experience. Keep the most sustainable one and consider the other for closure. If both trails can be made sustainable and one provides a higher degree of challenge, consider keeping both trails if they fall within trail density or other constraints.



Eliminate non-sustainable trails



Eliminate un-needed trails



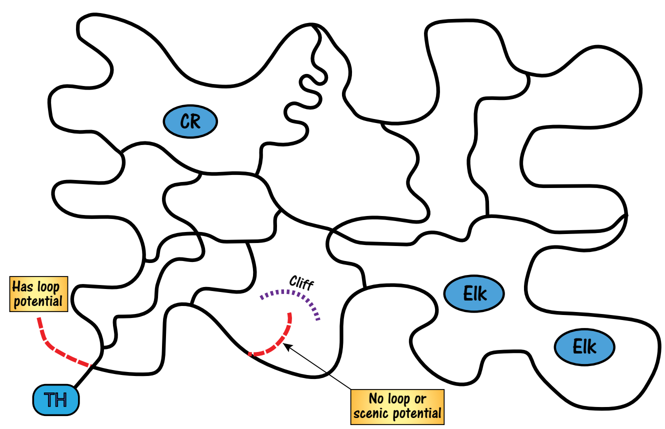
Often, the existing trails do not flow in the proper direction. They go up the slope, but sustainable trails go across the slope. If the existing trails do not provide access toward a desirable area or feature, they will become possible candidates for closure. The point here is to start eliminating the obvious. These trails can always go back on the trail concept plan if needed once the process progresses.

Tip, Trick or Trap?

Tip: Destination trails are only good if there's a destination at the end of them

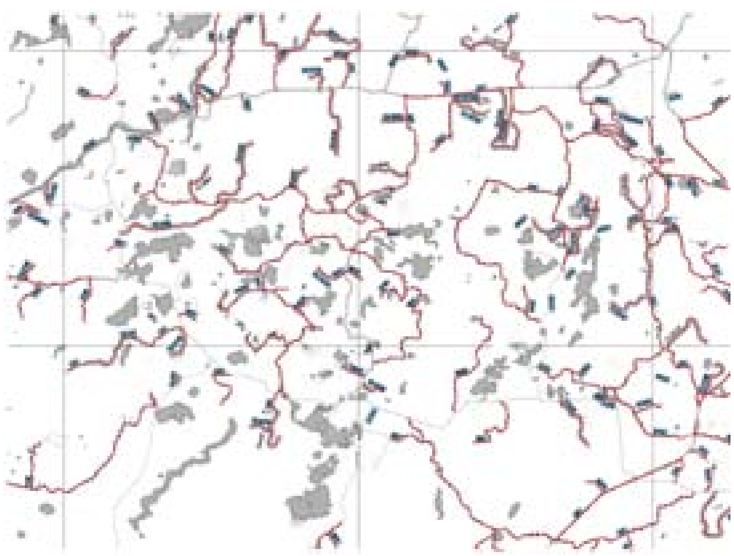
Next, planners should look for dead-end trails. There are two types of dead-end trails: those that end at a destination and those routes that just end. The former are opportunities, the latter can be traps. If a trail ends at a viewpoint, unique feature, or structure (i.e., a destination), then the trail will work as a dead-end trail. If the trail just ends, planners should look for a way to loop it back into another trail. From an OHV management perspective, no one likes to ride out to the end of a trail and turn around and come back the same way. This significantly detracts from the quality of the recreation experience. Instead, riders will tend to look for various ways to connect into another road or trail and this can lead to a proliferation of user-created trails and potential resource impacts, and management has lost control of the use. If for some reason it is impossible to make a loop out of a dead-end trail, consider slating it for closure.

Eliminate dead-end trails



Examine the Road Inventory

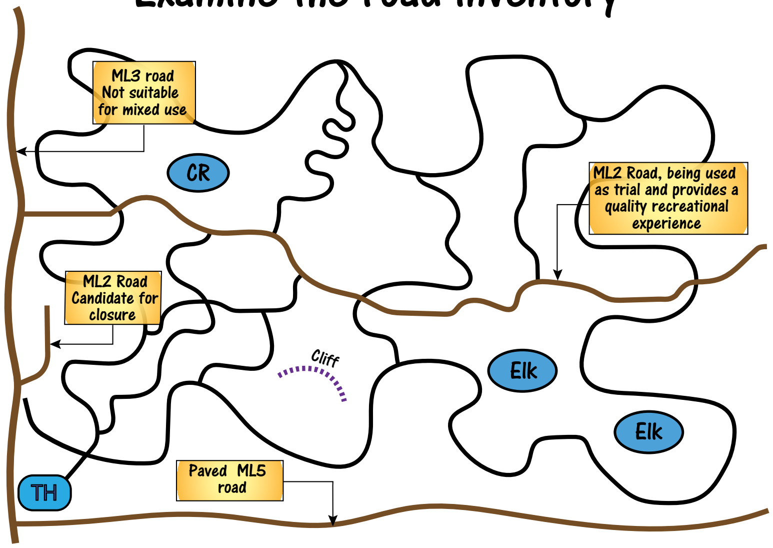
There is a wide range of road classifications and standards from interstate highways to primitive logging roads. For simplicity, it works quite well to have just two standards or two colors for roads: one for primitive low-standard roads that are suitable for high-clearance vehicles; and one for higher standard roads that are maintained for passenger cars. These would correspond with the USDA For-



To the astute planner, these dead-end routes should signal a red flag from an OHV management and recreation experience standpoint. Work with human nature, not against it.

est Service road classifications of Maintenance Level 2 roads (ML2) and Maintenance Level 3-5 roads. Just like the trails, planners should look for the obvious. Which roads can have mixed use? Which roads can be closed and converted to trails? Which roads will require the least maintenance? Which roads provide a transportation experience and which provide a recreation experience? Answering these questions will help the planners determine the roads or sections of roads that could or should be incorporated into the trail concept plan.

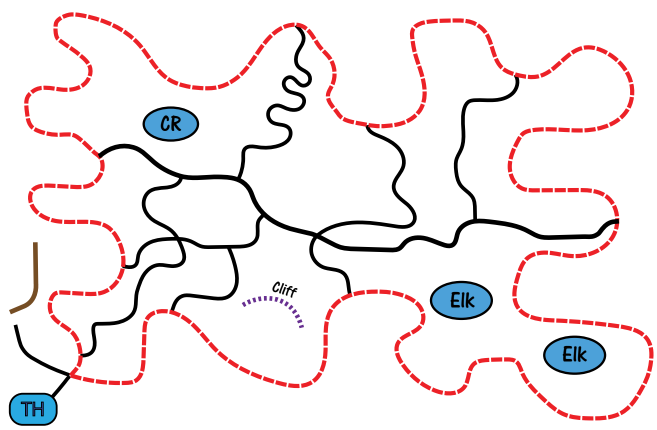
Examine the road inventory



Establish a Perimeter Trail

It isn't always possible or desirable to have a perimeter trail, but there are advantages to having one. Potentially, it will be the longest trail in the trail system and that is always desirable from a mileage and seat time standpoint. The perimeter trail can also serve as the boundary trail and can help riders recognize the outer limits of the project area. The perimeter trail is a loop in itself, but it also provides loop opportunities for all of the connector trails that tie into it. In this example, the perimeter trail has nine trail connection points that create a wide variety of potential loop opportunities.

A perimeter trail has advantages



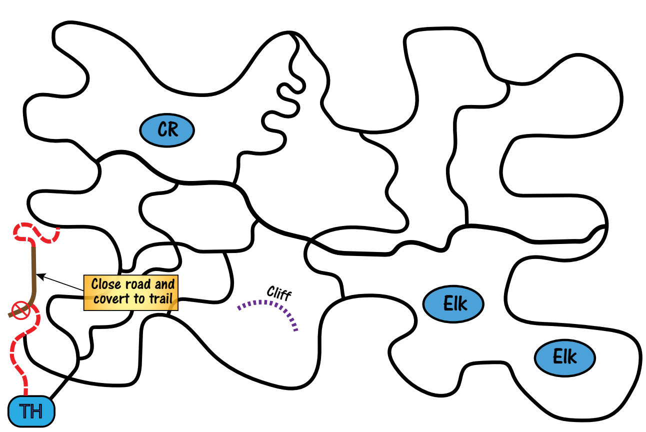
Note: The entire perimeter trail does not have to have the same identifier (trail number or name) although it can be desirable. Also, all segments of the perimeter trail do not have to have the same difficulty level although again, it is desirable to have consistent difficulty. If the difficulty does change from trail segment to segment, make sure the riders have the option to maintain the original difficulty level by taking another loop.

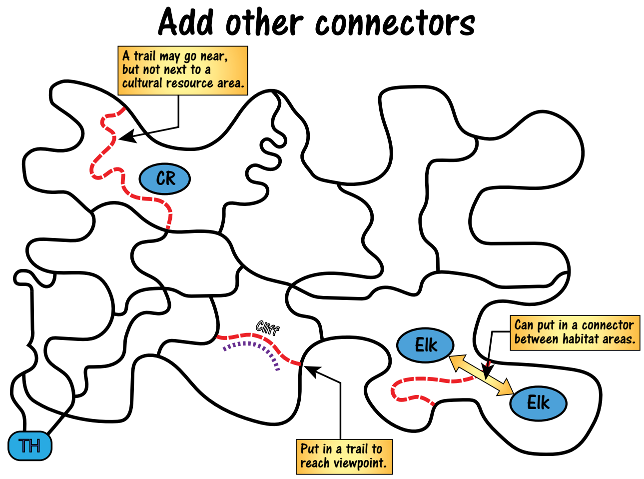
Connect the Remaining Pieces

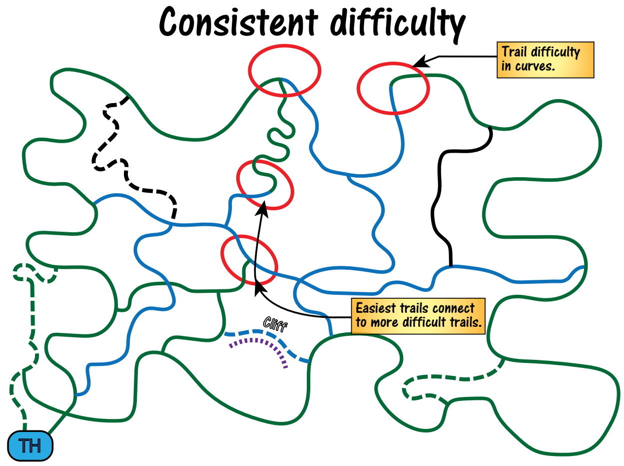
So far, planners have eliminated trails or portions of trails, but now they need to connect the remaining pieces into a trail system with logical loops separated by difficulty level or by the recreation experience offered. Connecting the suitable roads, the suitable trails, positive control points, and opportunities into a system of trails and loops while avoiding the negative control points, prohibited areas, restricted areas, and undesirable areas can be a challenge.

To quickly disperse riders and reduce encounters and tread impacts, it's desirable to have more than one trail out of the trailhead. Having several small loops in the proximity of the trailhead provides warm-up loops for riders and short practice loops for kids and families.

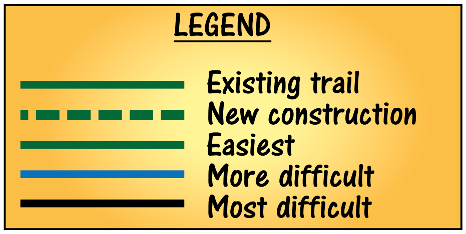
Add a connector out of the trailhead

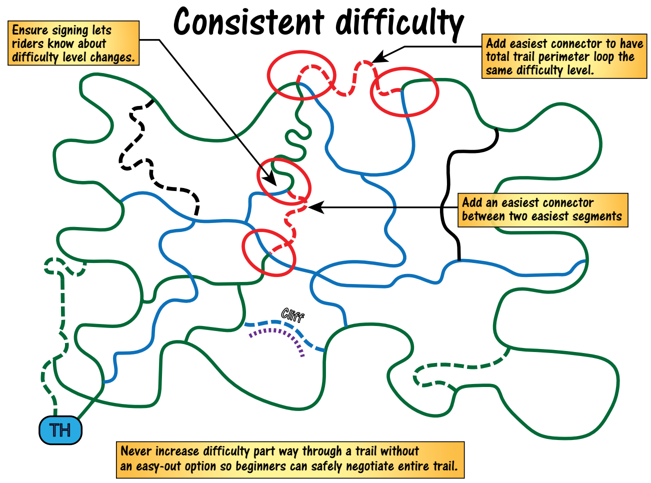






The example shows a dead-end trail and a road suitable for closure that can be used to provide two more loops. This example also shows that the planner had to eliminate the trail through two critical elk habitats. After talking with a wildlife biologist, it was agreed to cross the big game connectivity corridor between the two habitat areas as long as the length of trail within the corridor was minimized. The planner also found an opportunity to capitalize on some technical terrain in the northwest corner of the project area that avoided the cultural resource site. The dead-end trail that went to the base of the cliff was eliminated. There is a great scenic view from the top of the cliff and a trail across the rim was added to enhance the experience.





Establish Difficulty Levels

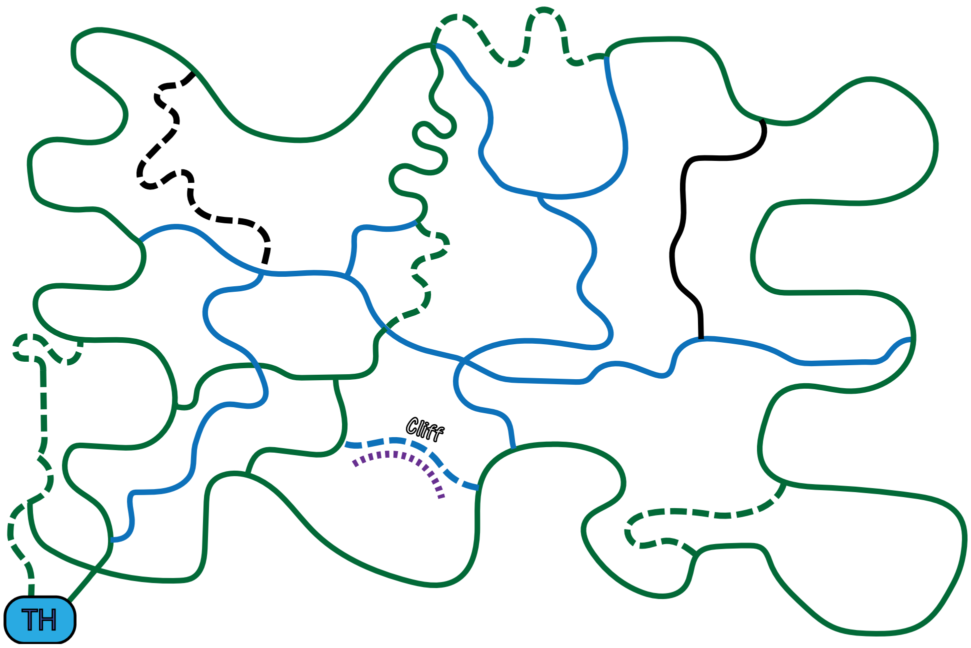
This step-up is a great technical feature to keep, however the trail on both sides of it was much easier and less experienced riders became trapped here. Rather than increase the difficulty level for the whole trail, an easier route around this feature was built.

Often there isn't enough detailed information to establish difficulty levels at this time, but if some of the difficulty is known, planners can start plugging that information into the trail concept plan. Planners and designers often hear: "I want more of the tough, technical stuff." The reality is that the percentage of riders desiring that experience is the lowest, so often the most difficult trails are the ones that are under-utilized. Planners still need technical trails to provide that opportunity, but the bulk of the recreational riders are seeking the easiest and more difficult trails.

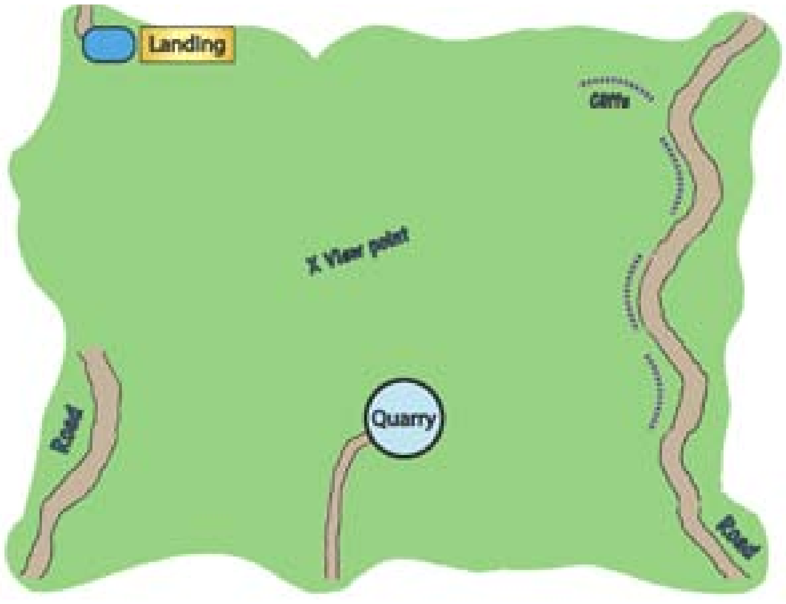
Planners can assign the standard colors for difficulty with green being easiest, blue being more difficult, and black being most difficult. In general as the difficulty increases, clearing and tread widths decrease, grades can increase, and obstacle size and number increase.

To help manage risk and avoid trapping riders by forcing them to ride over their skill level, there are two guidelines: a) difficulty levels must only change at trail junctions, not between; and b) never terminate an easier trail on a more difficult trail. If there is one or more short sections of more difficult terrain on a trail, instead of increasing the difficulty level of the entire trail, planners should consider making an easier trail around that section in line with the difficulty level of the rest of the trail. These easier sections around an obstacle are called easy-outs.

The completed concept plan



For this example, the planner saw there were four areas with issues. In the center, two easiest trails terminated on a more difficult trail. The solution was to correct the inconsistent difficulty by connecting the two easiest trails together with an easy route and leaving the more difficult trail as a loop (but signing it as more difficult).

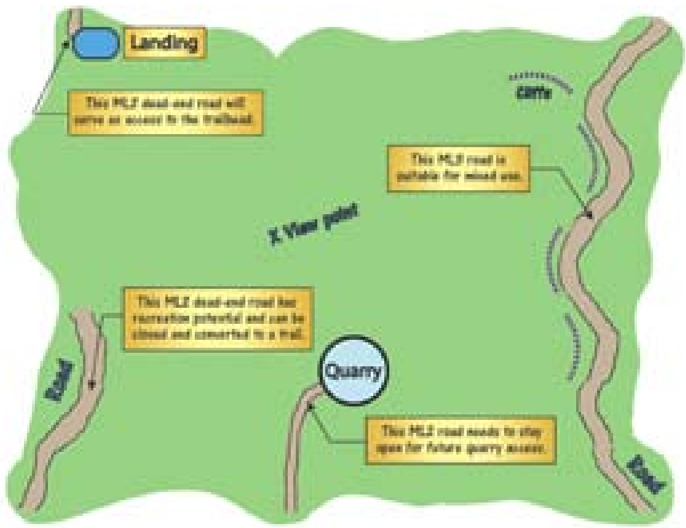


At the top on the perimeter trail was a section of trail that was more difficult with the easiest trail on each end. There was no way to loop around that section and still be on an easy trail. Using the planner's knowledge of the ground and examining the contour map, it was decided to build an easiest connector trail to avoid the more difficult section. This added another loop to the trail system and made the difficulty of the perimeter trail consistent.

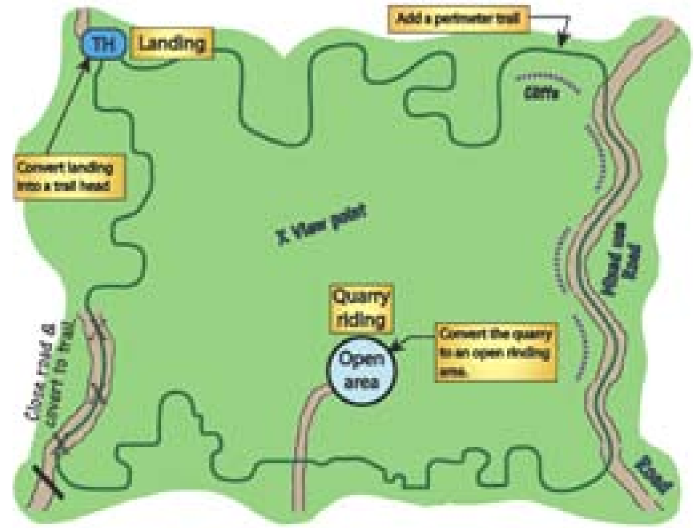
And the trail concept plan (above) is now complete.

In another example (starting at left), the inventory shows that there were no existing trails, but there were some interesting features like the viewpoint, cliffs, a landing, and a rock quarry.

The landing was large enough to be converted into the trailhead. The rock quarry, though still in occasional use, was suitable to serve as a good open riding area. There was a great potential viewpoint in the center, and the rocky ground above the cliffs could provide some good technical riding opportunities.

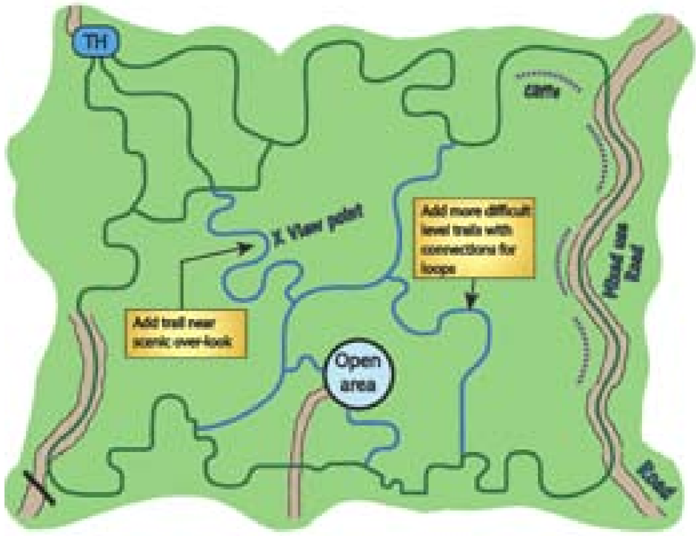


Planners started the trail concept plan by examining the road inventory.

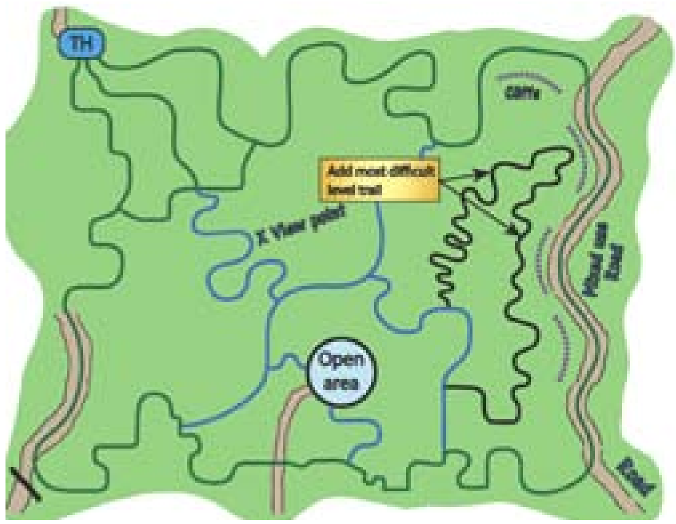


They continued by establishing a perimeter trail that incorporated the road options discussed above.

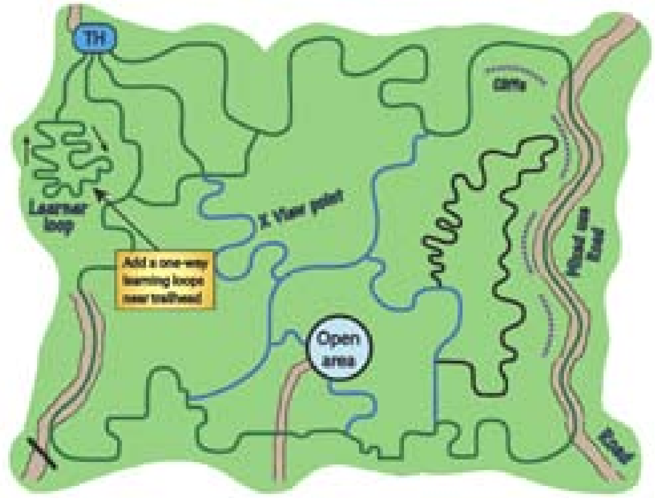
Next, they added some loops out of the trail-head. These serve as warm-up loops and as a means to disperse riders quickly out of the trail-head area.



Then they added some more difficult loops and connected the open area into the system. In doing so, planners also connected in the out-standing viewpoint. Note: Since the viewpoint is a signature feature of the trail system, it is desirable to have the access trail be an easi-est trail so that everyone can access it. In this scenario, however, that was not possible due to the grades and technical rocky ground sur-rounding the viewpoint.



Planners then drew on some most difficult trail to take advantage of that rocky ground by the cliffs.



And finally, they added a learner loop adjacent to the trailhead. This is a directional one-way trail. All other trails in the trail system are two-way. The trail concept plan is now complete.

Tip, Trick or Trap?

Trap: Many design guides specify the number of turns per ¼ mile

The trail alignment should be constantly turning. This creates flow, enhances the rider experience, increases seat time by decreasing speed, inhibits water flow and presents more opportunities for effective drainage, and decreases tread maintenance.

Take a Break

Planning a trail concept is a tough mental process and should not be done hastily. At this point, planners should put down the trail concept plan for a couple of days. Then they can go back and review the plan again. Planners should review if they have maximized the opportunities and minimized the constraints. Can they add more loops or miles? Do they see something differently? If they do, then they can fine-tune the plan. If they don't and still agree with all of the previous decisions, it's time to move on.

Develop Trail Data

Once planners are satisfied with the quality of the product, they can start building a database or spreadsheet with the following trail information:

- How many total miles of trail will be provided?
- How many miles of trail for each use type?
- How many miles of trail construction for each use type?
- How many miles of trail reconstruction for each use type?
- How many miles of roads will be closed?
- How many miles of existing trails will be closed?

Send It Out for Review

Planners should now present the completed trail concept plan on an appropriate base map that at least displays topography, administrative and project boundaries, and key resource areas to the planning team and the project management. When the draft is reviewed and approved by the specialists, the planners should present the proposed concept plan to OHV clubs or other interested stakeholders. If substantive comments are received, planners should incorporate them into the trail concept plan, or if the comments call for a different approach, they should incorporate it into an alternative.

Develop Alternatives

If it is necessary to develop alternatives, now is the time to do that. In developing the concept plan, planners have analyzed a lot of data and made myriad decisions. At this stage, planners should keep most of what they have, but take the options that they didn't use and incorporate them into alternatives. Then they can develop a trail database for each alternative.

A Case in Point...

Planning for the Riders' Needs

The Maryland Department of Natural Resources (DNR) managed large areas of land that contained no designated OHV routes, however unauthorized OHV use was taking place leading to resource degradation. The Department realized that closure alone would not solve the issue of unmanaged OHV recreation; they also needed to provide designated areas for OHV use. The DNR began working with local riders to develop a plan. Initially, they considered creating a test area that would prove the concept that providing OHV recreation was a part of managing OHV use. To this end, they developed a concept plan containing 15 miles of trail with a difficulty level of easiest. To validate this idea they shared the concept with OHV consultants. After a review, the consultants agreed that providing OHV designated routes was a great move, however, the test area needed to be an OHV destination with miles of quality trails and varying difficulty levels. Having only one small designated OHV area with only easiest difficulty level trails can lead to further resource damage. Riders want to do the right thing and stay on designated trails. Too few trails can lead to resource damage from over-use. Not meeting the riders' needs for skill levels can lead to user-created trails.

The Maryland DNR is now working to develop an alternative concept plan which will better meet the needs of the riders. Had the DNR not sent their concept plan out for review, it may have built a trail system that would have failed to meet the riders' needs.

Develop Generic Design Guidelines

Generic design guidelines can be written for each type of trail and will give broad design parameters for an OHM trail, ATV trail, ROV trail, or 4WD trail. Sometimes, the guidelines are called design parameters, but the term "guidelines" is preferred because it infers flexibility (the word "parameters" can infer a set of limits). The design guidelines can be used in environmental documents to help establish acres of impact. They also give the stakeholders, and eventually the trail designers, a description of the intended vision for each type of trail.

It should be noted that a guideline is just that: a guide that gives potential ranges. Those ranges can and will change from the north side to the south side of the area and as soil type and vegetative cover changes. Some design guidelines have been developed for national application but that just won't work because there are too many regional and local variables. It is best to take a sample guideline and modify it for local conditions based on local knowledge and field experience. Some guidelines are also becoming so detailed that, if interpreted literally, the designers can be or feel restricted from seizing onsite opportunities. The have also been applied as the "rule" but this doesn't work either. There are principles, but few rules. This book is about making informed decisions based on actual site conditions. Planners can't do that if their decision space is administratively removed.

Develop Generic TMOs

It is too early in the process to develop trail management objectives (TMO) for each trail, but a generic TMO document can be written for each type of trail separated by difficulty level. This will provide important information and continuity to the person doing the location and design. Once the trails are located on the ground and all adjustments have been made to the concept plan, trail numbers, names, and agency identifiers will be added and the trail concept plan will then become the design plan or final project plan. At that time, TMOs can be written for each trail. If there is a need for the management of the trail to change, the TMOs should be updated.

The process of developing the concept plan is now complete; however, the plan is a working document so it will change as better resource data, additional inventory data, or better field knowledge of the project site is obtained. It is important to point out that a concept plan is just that, a concept. Its accuracy and completeness are directly dependent on the amount of time invested in the field and office to develop it. Some plans are compiled in a couple of days, and others are developed over a period of weeks or months.

The plan will now be handed over to the person doing the trail location and design (L&D). Certainly, for a seamless, consistent, and cost-efficient process, it is highly desirable for the planner and the designer to be one in the same. The designer will take to the field and perform a thorough reconnaissance of the entire project area; that person will validate or complete the road and trail inventory data; confirm the control points and look for others; and start to ground-truth the feasibility of the concept plan. Obviously, the more time spent in developing the concept plan, the less time will be needed to validate it and refine it. To do a good job of trail layout, the designer will need to become familiar with nearly every square foot of the project area, which can involve a considerable investment of time and money. That is why it is cost-effective for the planner and designer to be one in the same. The designer can build on the previous knowledge rather than starting from zero.

	Sample ATV Trail Design & Difficulty Guidelines			
	(These guidelines are to assist in design, construction, and maintenance. Any guideline should be adjusted to reflect local experience and actual site conditions.)			
		Easiest	**More Difficult**	**Most Difficult**
Grade:	Typical grade	< 20%	< 25%	< 30%
Grade should roll and not be sustained	Max. Pitch	Maximum grades are the exception, not the rule		
	Grade	15% - 20%	20% - 30%	> 30%
	Length	Variable 50’ - 100’ dependant on soils,use type and use intensity, and climate. As grade increases, length on grade should decrease.		
Clearing:	Width	60” to 72”	50” to 60”	50” (maximum)
	Height	7’	6’	6’
	Helmet and leg slappers	Few	Many	Common
Tread:	Width (minimum)			
	Sideslope <25%	60”	50”	50”
	Sideslope 25% - 70%	60” to 72”	55” to 60”	50”
Surface:		Some roots or rocks, obstacles rarely exceed 6-8” and are imbedded solidly in tread; obstacles generally on tangents; tread plane relatively flat with 15% max. outslope for short sections; sweeping curves and some circular climbing turns, more open alignment with circular longer radius curves; sand acceptable and some sections of slippery clay or loose material.	Many roots or rocks, obstacles rarely exceed 8-10” and are loose; obstacles on tangents and some on curves; tread plane flat to irregular with 25% max. outslope for short sections and long sections with less outslope; climbing turns and some circular switchbacks; sections of tight alignment with circular short and long radius curves; sand acceptable and long sections of slippery clay or loose material.	Very many roots or rocks; many obtacles exceed 10”; obstacles on tangents and curves; tread plane very rough and irregular with long sections exceeding 25% outslope; non-circular climbing turns and switchbacks; long sections of very tight alignment with non-circular curves; entire trail may be soft sand, slippery clay, loose material or mud.
Exposure:		None	some, potential injury	Could be common, potential serious injury.
Maintenance:		Trais receive appropriate maintenance to remain within their TMO, maintain effective signing, and to protect resource values.		

Need more? Learn more here…

Designing Sustainable Off-Highway Vehicle Trails, Kevin G. Meyer, USDA Forest Service, Technology & Development Program, 1123-2804P-MTDC, 2013

Management Guidelines for OHV Recreation, Tom M. Crimmins, National Off-Highway Vehicle Conservation Council, 2006, System and Route Planning

A Look Back…

Here are some of the key trail concept plan development elements discussed in this chapter:
- Provide for the riders needs through good planning

The project planner must understand:
- The riders and their desired experiences
- The landscape
- The issues
- The politics
- The climate
- The resource values
- The statutory requirements
- The existing conditions
- Management constraints
- The vision

As planners compile and refine their data, they must:
- Examine the constraints
- Identify control points
- Examine the opportunities
- Understand the human element

In assembling the data into a trail concept plan, planners should:
- Examine the trail and road inventory
- Establish a perimeter trail into logical loops and connect the pieces
- Avoid or minimize dead-end trails
- Establish difficult levels
- Take a break from the project
- Send it out for review
- Develop alternatives, generic design guidelines, and generic TMOs

Chapter Four
Engineering and the Natural Environment

Plan Your Ride, Ride Your Plan

Providing for the riders' needs is one of the key elements for success discussed in Chapter 1. Those needs were examined in Chapter 2 and incorporated into the trail concept plan in Chapter 3. The link between getting those needs on the ground and designing for sustainability is covered in this chapter on engineering.

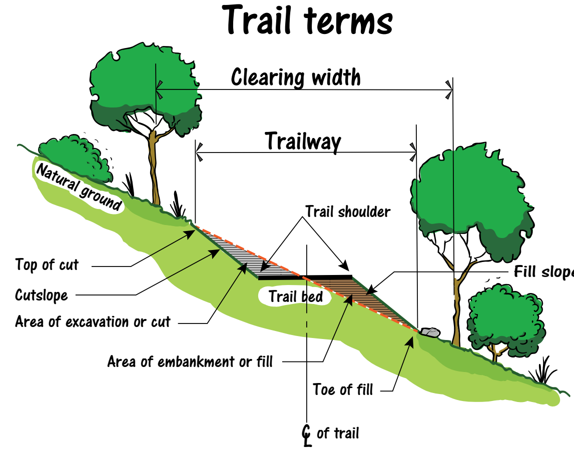
Engineering isn't just circles and squares or tangents and curves; it's understanding the natural environment and applying scientific knowledge to address or solve practical problems in that environment. Engineering is used to solve or mitigate trail issues or concerns. For example, what will happen to a particular soil when the forces of an OHV tire are applied to it? If the soil displaces, how will it be mitigated? The more engineering knowledge and experience that the designers have, the more tools they have to design a fun and sustainable trail under a variety of circumstances and conditions. Having creative vision is one thing, but being able to put that vision on the ground is another. In otrder to put a trail on the ground and keep it there, designers need to understand the physical properties of that piece of ground and the physical forces that will be applied to it.

Vision without Action is a Daydream
Action without Vision is a Nightmare
but Vision and Action without Engineering Ensures Disaster

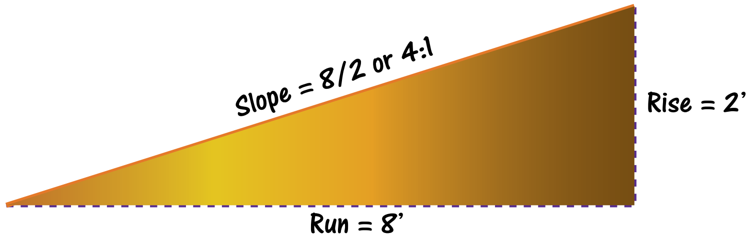
Section 1: Trail and Engineering Terms

Understanding Trail Terms

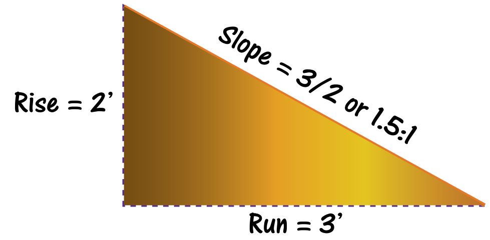
The three trail types are terra firma or land, water, and over-snow. For the purposes of this book, terra firma trails are discussed. The winter use of summer trails and the summer use of winter trails (snowmobile trails used for OHV trails) are discussed later in this book.



Horizontal run is the distance a slope runs along the ground. The vertical rise is the distance the elevation of the slope is increased. The angle of the cut slope and fill slope is normally expressed as a ratio of the horizontal run over the vertical rise. If a run is 1 foot and the rise is 1 foot, the slope is 1/1 or 1:1. If a run is 2 feet and the rise is 1 foot, the slope is 2/1 or 2:1. If a run is 1 foot and the rise is 2 feet, the slope is 1/2 or .5:1.

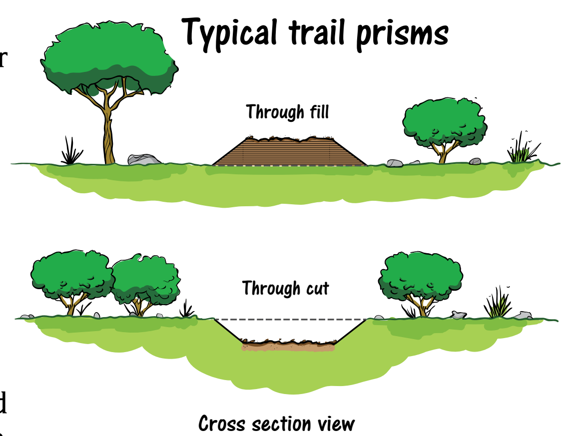


For this example there is 4' of run for every 1' of rise.



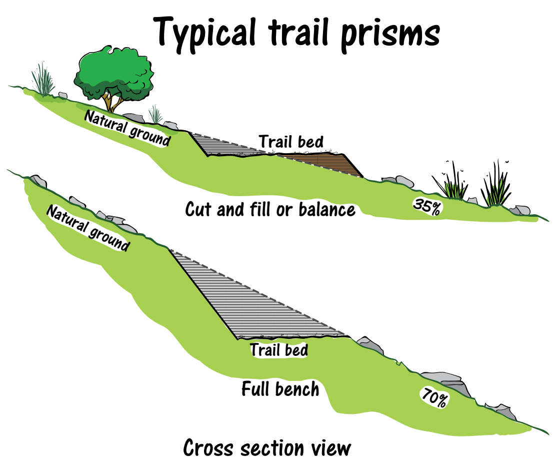
Here, there is 1.5' of run for every 1' of rise.

Backslopes are commonly 1:1 or steeper (.5:1) and fill slopes are commonly 1.5:1 or flatter (3:1). The soil type dictates the slopes that will be most stable for that particular type of soil. (More on that later.)



The trailway is the area from the top of the cut to the toe of the fill. By tracing a line down from the top of the cut to the inside trail shoulder, across the trailbed to the outside shoulder, and down the fill slope to the toe of the fill, a trail prism is created.

On flat ground with a sideslope of 0 to 10%, the entire trail prism is either going to be above the natural ground, called a through fill; or below the natural ground, called a through cut.

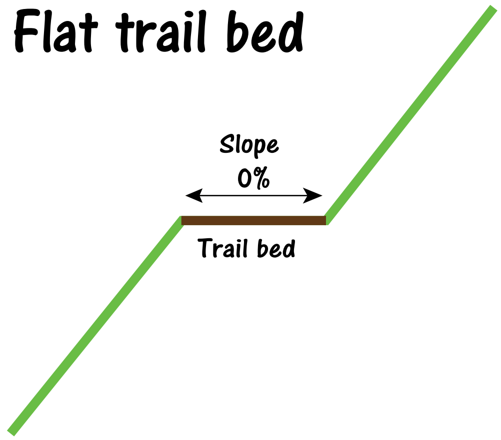


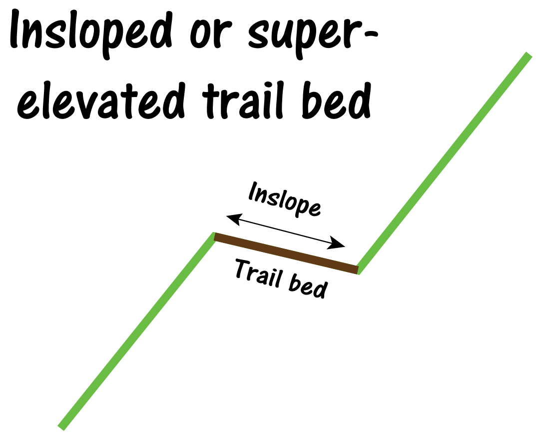
As the slope of the natural ground steepens to around 35%, the trail prism lies on the ground as a cut and fill or balanced section, which means that the amount of material excavated or cut will compact into the amount of embankment or fill needed.

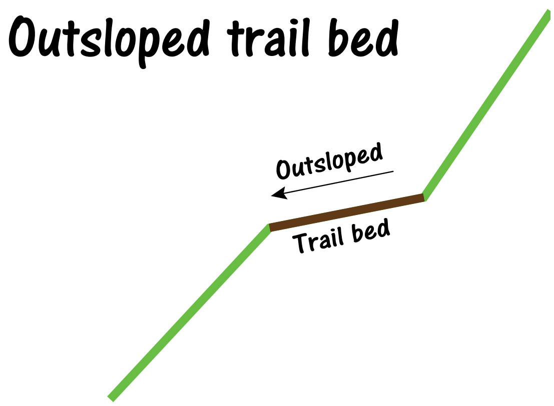
On sideslopes of 70% or steeper, the ground is too steep for a stable fill to be constructed so the entire trail prism is excavated. This is called a full bench section. The material excavated is usually wasted over the side, but with the proper equipment and sufficient funding, it can be hauled back to be utilized for fills elsewhere on the project. This is called end haul and it may be required in sensitive areas that do not allow the wasting of material.

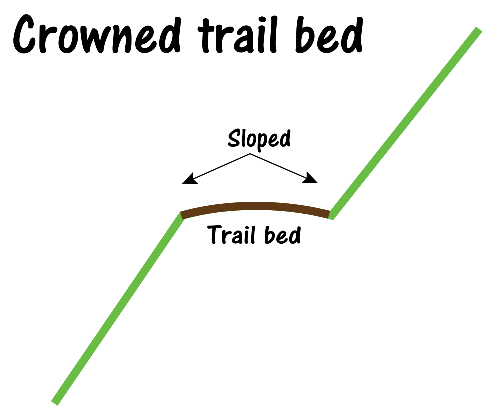
Why is the trail prism important? The prism can be dictated by the slope of the topography, but that isn't always the case. Trail design is all about options and making informed decisions after weighing the advantages and disadvantages of each option. If the trail is in a wet area or in an area subject to heavy rainfall, a through fill prism raises the trailbed above the natural ground so it will stay drier. In the through cut scenario, water will become channeled and collect on the trailbed making it more difficult to drain the water off the trailbed. When fills become saturated with water, they can fail. Whereas trails constructed as full bench prisms will have the least risk of failure. Given the soil, climate, and storm patterns, designers may choose to build an entire trail as a full bench or a through fill prism, or they may choose to use all four prisms and apply rock hardening in areas of through cut or cut and fill. Is one wrong and one right? No. What is important is recognizing the thought process and evaluating options.

The trailbed is normally configured into one of four shapes: flat, insloped, outsloped, and crowned. While flat is the most common for OHV trails, insloped, outsloped, and crowned trailbeds can be used to control and direct the flow of water.









An insloped trailbed sheets the water to the inside so the inside shoulder essentially becomes a ditch unless a ditch is actually constructed as part of the trail prism.

When inslope is constructed on curves, it is generally used to superelevate the curve. This holds riders into the curve and allows riders to carry more speed through the curve, which increases flow and can decrease tread impacts.

An outsloped trail is intended to sheet water evenly off the outside shoulder of the trail.

Continuously outsloped trails are awkward, if not difficult, to ride on an OHV. This is especially true in wet slippery soils and on curves where the outslope acts as a reverse superelevated turn that tends to slide riders off the curve, rather than hold them on it.

A short section of outslope is usually used in grade reversals, grade breaks, or rolling dips to help force the water off the trail.

The crowned trailbed is intended to sheet the water in both directions. Most roads are constructed with a crown, but it is far more difficult to build a crown and maintain it on a narrow, natural surface trail. Crown can work well on wider trails that are hardened to hold their shape.

For any prism other than flat, the key to have it effectively sheet water is regular maintenance. If the team doesn't have the budget, personnel, skillset, or equipment to routinely perform this maintenance, do not rely on a shaped trail prism for water control.

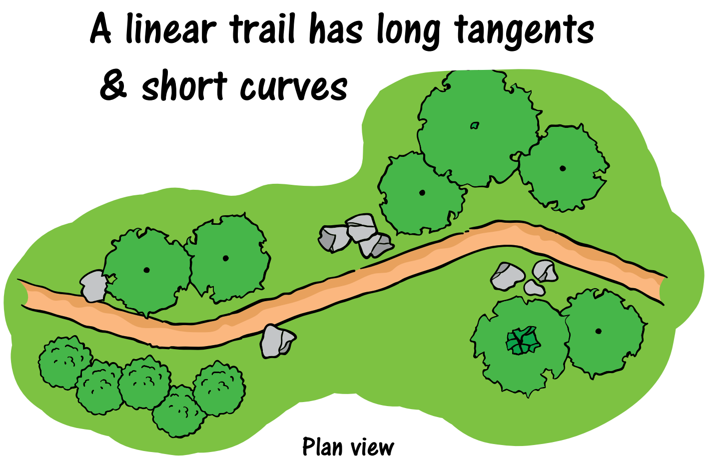
Design and Management Implications of the Trail Prism

The configuration of the trail prism can affect the stability of the trail.

- A full bench prism will always be more stable than a cut and fill prism.
- Mechanical compaction during construction will improve the stability of the trail and the durability of the trail tread.
- The shape of the trailbed can affect water flow, trail flow, trail difficulty, rider experience, and rider safety.
- An outsloped trailbed should not be used in fine-grained soils that become slippery when wet.
- Any trail prism other than flat will require increased maintenance to keep the shape functional. Relying on maintenance and the shape of the trail prism to control the flow of water can be a trap.

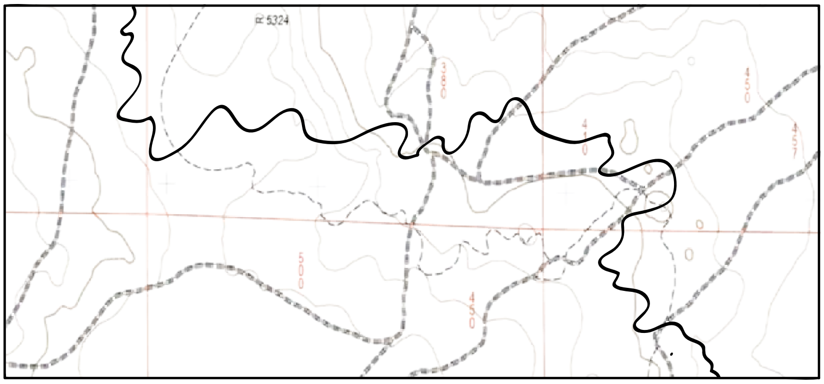
Understanding Engineering Terms

Engineers see the world in a three-dimensional view that allows them to take any point along a trail and view it on paper or on the computer in 3-D. The three views are the plan view, the profile view, and the cross-section view. The plan view is from the top looking down on the horizontal alignment of the trail. The horizontal alignment is comprised of a series of tangents (straight lines) and curves (arcs). The shorter the tangents, the more serpentine or curvilinear the trail becomes. A curvilinear trail provides more flow, and a linear or straight trail provides less horizontal flow. While the linear trail appears to be fast and boring, it does have its place in the realm of OHV trail design.



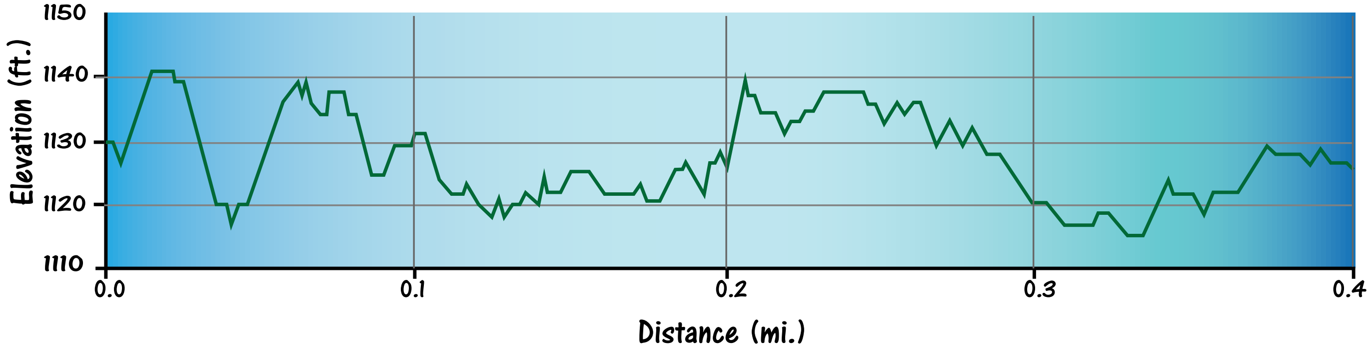
The plan view shows the trail route. What it does not show is the smoothness of the trail surface: smooth equals fast, rough equals slow. The plan view also does not show the character of the vertical alignment. For that, the profile view is needed.

The profile view is from the side. It shows the vertical alignment of the trail. The vertical alignment is also a series of tangents and curves that represent the elevation or grade changes from one point to another along the trail. Horizontally, a trail should constantly move from side to side, and vertically, the trail should constantly move up and down. Both of these are essential for sustainability and quality rider experiences.



This is the plan view or aerial view of a trail segment

Trail grade is one of the most critical elements and often the most abused element in OHV trail design. As grade increases, so can rider experience, but water velocity also increases, which potentially decreases trail tread stability and sustainability. This is a major dilemma in design: how to create a fun trail without excessive grades. (More on this later.)



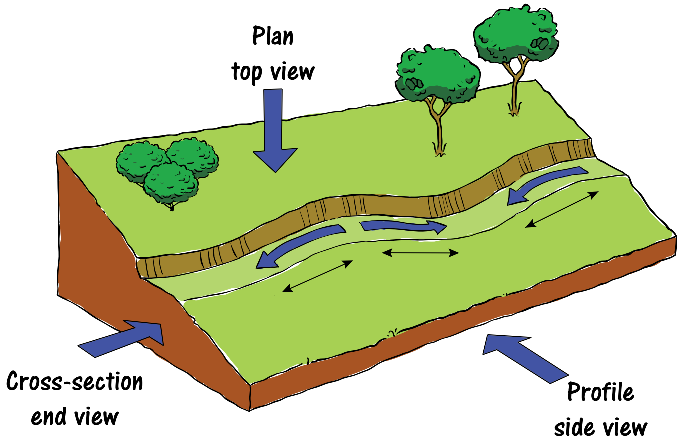
Above is the profile view of the same trail segment shown in the plan view. A rolling grade has recurring grade reversals, which means that the grade goes up and then it goes down. Grade reversals are 100% effective at stopping water flow down the trail. The shorter the interval between grade reversals, the less water volume, velocity, and potential erosion and sedimentation.

The third engineering view is the cross-section view, which is a cutaway view of the trail's transect, slicing into the ground and then viewing it from the end.

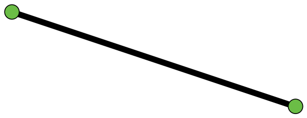
The schematic below summarizes the three views. Note the frequent grade reversals.

Tangents and curves comprise the horizontal alignment of the trail. Any two points make a line or tangent and any three points can make an arc or curve.

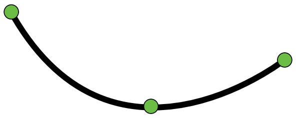
3D view of ground



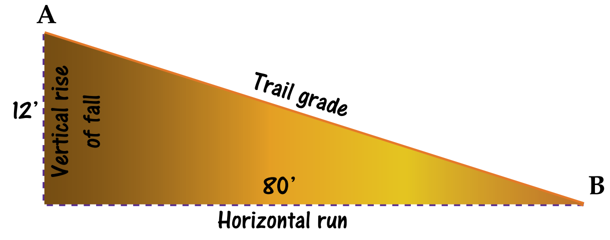
Any two points
make a line or tangent



Any three points
make an arc or curve



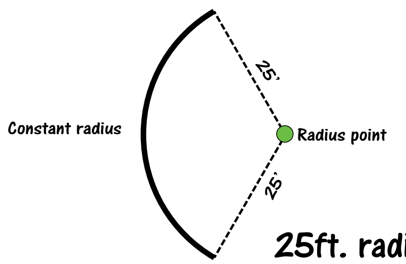
How to calculate trail grade
between any two points



Rise / Run x 100 = Grade

12/80= 0.15 x 100 = 15%

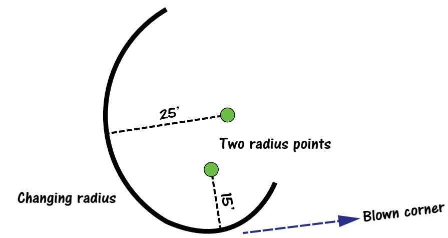
Circular curves are measured in degrees or in radius. This is a simple curve



25ft. radius curve

There are two types of curves: circular and non-circular. Circular curves have a constant radius as in a circle, and non-circular curves have no radius as in a spiral or parabolic shape. Circular curves have three main configurations: simple, compound, and broken back. Simple curves have a constant radius and are easy to ride in either direction. The smaller the radius, the sharper the curve.

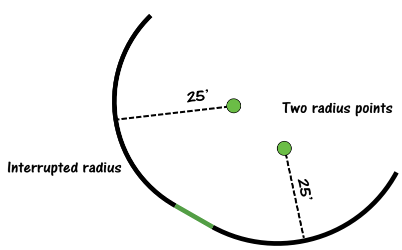
Compound curves are two simple curves of different radii connected together



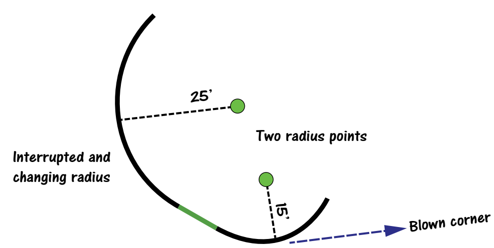
Compound curves start with one radius and end with another. In this example to the right, the curve is rideable in a clockwise direction, but not easily rideable in a counterclockwise direction. Why? Riders will adjust their speed accordingly to negotiate the larger radius curve, but as the curve tightens, they will be carrying too much speed, which often results in blown corners. Riders cannot easily stay on the trail unless they brake suddenly to lose speed. This results in skidding and excessive tread displacement. From an experience standpoint, compound curves increase difficulty when riding in the direction of decreasing radius.

Broken back curves are two simple curves connected in the middle by a short tangent. If both curves have the same radius, they can be rideable from either direction.

Broken back curves are two simple curves connected together by a short tangent

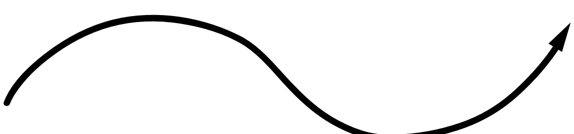


Broken back curve with curves of different radii



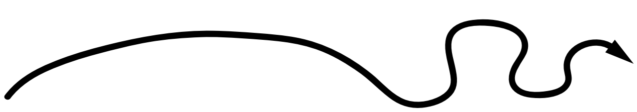
If the two curves have a different radius, then they are similar to the compound curve. In this example, it will be rideable in a clockwise direction, and not easily rideable in a counterclockwise direction, which again can result in tread impacts and blown corners. Like a compound curve, a broken back curve with tightening radius increases difficulty in that direction.

It is human nature to accelerate as the sight line increases. As the length of a tangent increases, the speed increases accordingly. Having a chance to increase speed improves the rider experience by adding variety, but it also decreases seat time. Designers and managers need to recognize that most riders will ride a trail as fast as they can within their skill level. This is part of the desired challenge of providing for the riders' needs. Most riders challenge themselves. This means that speed and any resulting impacts are always factors on any trail.



Open and flowing

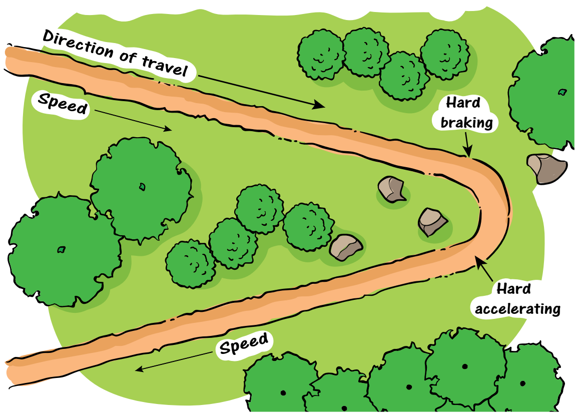
Tight and technical



Poor flow - abrupt transitions from one type of flow to another

Whether a trail is linear or curvilinear, the tangent lengths, curve radii, and the sequencing of those tangents and curves can affect the trail flow, difficulty level, rider experience, and potential tread impacts.

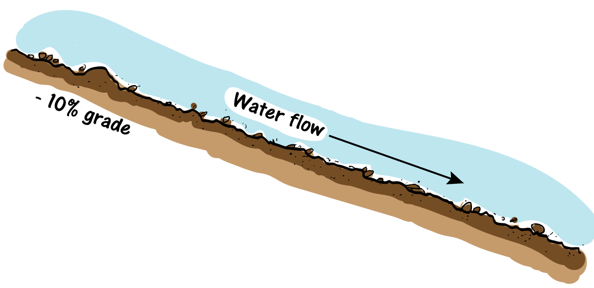
Impacts created by design



Speed increases with the length of the tangent, but what happens when the tangent ends in a curve? If there is a long tangent and then a short-radius curve (poor flow), riders will have to brake hard to negotiate the curve. Coming out of the curve, the riders eye the next tangent and start rolling on the throttle. These two actions result in increased forces being applied to the trail tread creating potentially severe tread impacts called brake chop and acceleration dishing. These two impacts can be reduced by: a) shortening the tangents, b) increasing the radius of the connecting curve so it can be negotiated at a greater speed, c) superelevating the curve so riders can carry more speed through the turn, or d) a combination of the above.

Tangents and curves play a similar role in the vertical alignment of the trail. A long tangent in this case means a long grade up or down, which again can result in an increase in rider speed. It also means that any water on the trail is going to increase in volume and velocity, which will increase erosion. Both of these actions can create significant tread impacts. Short or no tangents between curves increases the rider flow in the horizontal alignment. It also increases rider flow in the vertical alignment and decreases water flow.

Constant unbroken grade

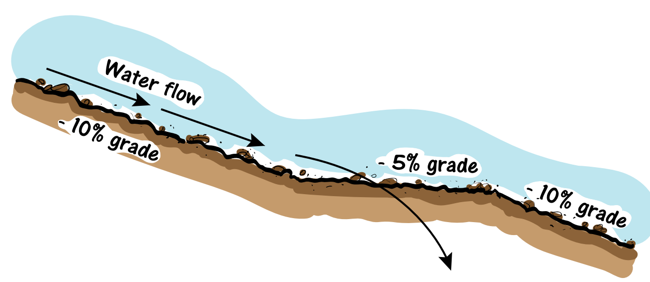


No opportunity to drain

Water collects on the trail and then starts flowing down grade. The longer it flows or runs, the more velocity it gains and the harder it becomes to turn the water so it will drain off the trail. On a constant or unbroken grade, it is very difficult to effectively get water to drain off the trail. Four main profile shapes are utilized to get water off the trail: grade break, grade reversal, rolling dip, and waterbar.

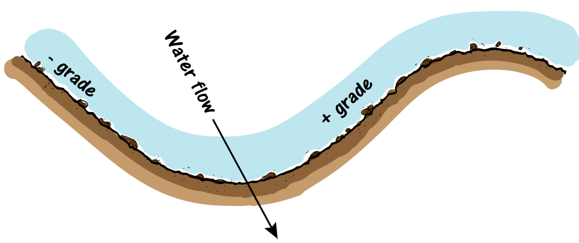
A grade break is a place where the prevailing grade flattens off for a while without changing from negative to positive. As soon as water hits the flatter section of grade, its velocity reduces significantly and it will start to drop its load of sediment. If the trailbed is outsloped here, there is a good opportunity to turn the water and drain it off the trail. The flatter and longer the grade break, the more effectively it will drain.

Outsloped grade break



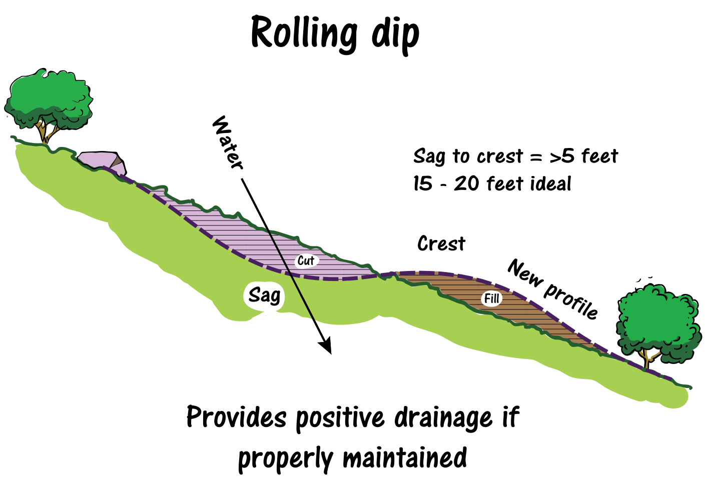
Opportunity to drain

Grade reversal



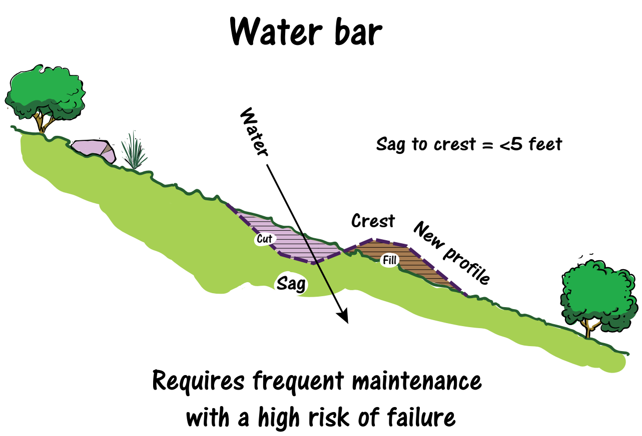
Guaranteed to drain if properly designed

As discussed with the profile view, rolling the grade by changing from negative to positive is 100% effective in stopping water flow down the trail. This is called a grade reversal and it is flagged into the trail location on new trails or the relocation of existing trails; therefore, it is a natural feature and not a manmade structure. The longer the grade reversal and the greater the elevation difference from the bottom to the crest where the grade rolls down again, the more rideable and effective it will be. Ideally, the grade is reversed for 50 feet or more, but the minimum is three times the design vehicle length unless terrain features are incorporated. There should always be a minimum of two feet of elevation difference or gain, otherwise the forces of tires, rutting, and erosion may cause them to fail. If properly designed, a grade reversal will not fail to function due to weather, amount of use, or lack of maintenance (though ponding may occur). Because of this, a grade reversal is always the preferred method to provide drainage.



A rolling dip is usually installed on a long section of constant grade to provide drainage where there was previously none. Many refer to these as grade reversals and technically they are, but they are a manmade structure, not a natural terrain structure like the grade reversal. Rolling dips are often installed as a maintenance or reconstruction action on roads, road to trail conversions, and user-created trails. They do work, but they require regular maintenance to stay effective. The longer the distance from the sag to the crest of the dip, the more rideable and more effective the dip will be. About 15 to 20 feet is ideal. The shorter the distance, the more the dip functions like a waterbar. On steeper grades, a rolling dip acts like a ski jump. In doing so, forces are applied to the crest, which will increase the need and frequency for maintenance. Also on steeper existing grades, the over-steepened slopes going into the sag and out of the crest may exceed the maximum grade for durability for a given soil type.

Waterbars, the last category, are also used on existing trails but are not effective on OHV trails. They are short rolling dips with only 2 to 5 feet from the sag to the crest. These create an abrupt hump in the trail and the force of the tires against this hump will cause rapid deterioration and failure of the structure. On ATVs, ROVs, and 4WDs, waterbars are uncomfortable to negotiate and typically there is hard braking going into them and acceleration coming out of them, which results in lack of flow and further tread impacts. Waterbars require the most maintenance and are the least effective method to drain water off the trail. Rolling dips roll and flow, waterbars don't.



Design Implications of Horizontal and Vertical Alignments

- The configuration of horizontal and vertical alignments affect rider experience, rider speed, and rider flow, and have some effect on the velocity and volume of water.
- Trail flow is a constant series of serpentine horizontal and vertical curves. Flow does not necessarily equal speed.
- Less flow potentially has more tread impacts. High flow equals a high fun factor.
- Water creates issues and it only flows downhill. A grade reversal blocks that downhill flow and if provided regularly, reduces the velocity and volume of water.

Guidelines and Rules

It is human nature to want hard numbers: what is right and what is wrong? Many people will ask, "How steep is too steep?" As is often the case, the answer is, "It depends." The next question people ask is, "Then what is a range or a guideline?" This is a trap not only because of site variables but also because guidelines tend to become rules.

One such rule is that all trails should be outsloped at 5%. In principle, there is nothing wrong with outslope. Every opportunity to get water off the trail is a benefit. The tread shape, however, will change over time from the shape it had right after construction through the forces of compaction, displacement, and erosion. Unless the tread is regularly maintained or is hardened to maintain its shape, the outslope will likely fail, especially with OHV trails. It's a trap for designers to assume that outslope will work. On curves, outsloped trails can be awkward to ride in a motorized vehicle. On tangents, riders will tend to hug the upslope edge and potentially widen out the trail. In areas with slippery soils and steeper terrain, an outsloped trail can increase the difficulty level by increasing the exposure or risk of the vehicles and riders sliding off the trail.

Another rule is called the half rule. It states that a trail grade should not exceed 50% of the grade of the sideslope, so on a sideslope of 30%, the trail grade shouldn't exceed 15%. The theory is that if the tread is outsloped, overland water will sheet across the trail if the grade is less than 50% of the sideslope, but will be intercepted by and run down the tread if the grade is more than 50% of the sideslope. This is a trap. On motorized trails, the outslope will likely fail; the tread will become a trench; and water will be intercepted by and run down the trail. While flatter grades are a definite benefit, designers of a motorized trail should always assume that any water intercepted by the trail will run down the trail. The key point for the designers is to recognize that the steeper the grade, the more velocity the water will have, so the length of the grade needs to be shorter to reduce the potential for scouring and sedimentation.

One final rule is called the 10% average grade rule. While increasing grade increases the risk of erosion, designers also need to recognize that increasing grade enhances rider experience. The problem with this rule is that most people don't understand what it means or how to apply it. This so-called 10% Rule often gets misinterpreted to mean that the maximum grade for a trail should not exceed 10%. This is not correct. It means that the average grade on a given section of trail should not exceed 10%. In the example above, there are plus and minus grades with some up to 29%, but the average grade from Point A to Point B is 8.2% over a distance of 1.5 miles. (6875 – 6225 = 650' rise, 1.5 X 5280 = 7920' run).

What if the grade was a straight line from one end to the other? The grade would still be 8.2%, but would it be sustainable? No. So the length of the trail segment has a significant bearing on the outcome of the average grade. What length should be chosen? There are too many variables for this rule to be useful. Instead of rules, field personnel need to understand the physical forces that will be applied to the trail and make informed choices.

Section 2: Physical Forces Affecting the Trail

Things that make OHV trails unique from a design and sustainability standpoint are the vehicles themselves which have a motor, weigh more than most other trail modalities, and have torque of a wheel under power. These all create forces that are applied to the ground. Designing for sustainability requires understanding how the forces of compaction, displacement, and erosion impact the trail.

Compaction, Displacement, Erosion

Compaction is the downward force of the vehicle onto the ground. The amount of this force is influenced by the weight of the vehicle, occupants and gear, the number of tires, and the size and inflation pressure of the tires. Compaction is measured as pounds per square inch (PSI). As the contact area of the ground increases, the PSI of contact decreases. A 500-pound vehicle with four tires has more contact area, thus less PSI, than the same vehicle with two tires. In snow, sand, and mud, riders typically decrease the air pressure in their tires. This gives them more grip because their tires have more contact area.

Displacement is the physical movement of the trailbed surface particles as a result of the ground contact and torque of the vehicle. The softer and less cohesive the trailbed surface is, the higher the potential for displacement. Displacement is a force caused from human and animal interaction with nature, such as from tires, horse or other animals, a person walking, etc. A tire with high air pressure will generally cause more displacement than the same tire with lower pressure.

Erosion is the movement of the tread surface particcles due to natural causes like water and wind. Again, the softer and less cohesive the trailbed surface is, the higher the potential for erosion. If displacement has also occurred, the potential for erosion increases since soil particles have already been loosened and ruts have been created to channel the water and thus increase its velocity and potential for scour.

A basic theorem of physics 101 is that for every action, there is an equal and opposite reaction. If the OHV applies 100 PSI of downward force to the tread surface, the tread surface will react with 100 PSI of upward force. The amount of upward force will always equal the amount of downward force. If the trailbed surface is inflexible, as in solid rock or pavement, the physical forces are depicted by the diagram below. The downward and upward forces represented by the size of the arrows are equal and directly opposite.

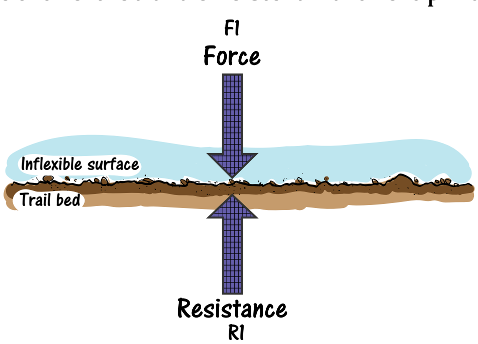
A Provoking Thought...

For every action, there is a reaction

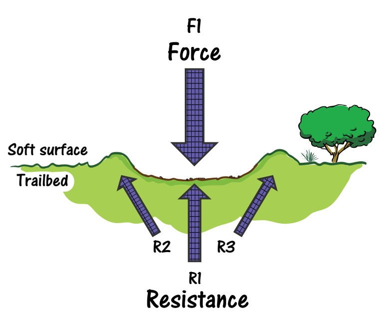
You cannot touch something without it touching you

You cannot touch someone without being touched

As the hardness of the trailbed decreases, the tread surface cannot support the downward force so the tread deflects and the upward forces are sent in different directions. Here, the downward and upward forces represented by the sizes of the arrows are equal but indirectly opposite. This is how ruts and berms are created in the trailbed. The softer the tread surface, the deeper the rut and the higher the berm. This action is mitigated in one of four ways: a) harden the tread surface so the forces become more equal and directly opposite; b) decrease the amount of force applied by having more tires or more ground contact area, which equates to less PSI; c) decrease tire pressure; or d) a combination of any or all of the above.



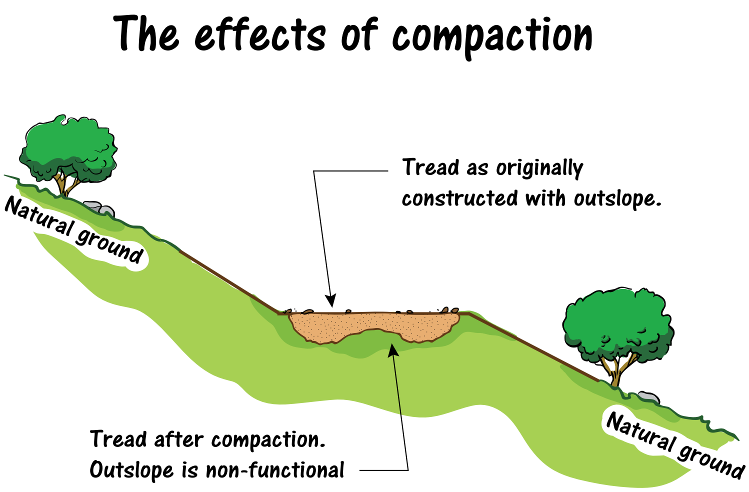
Resistance = Force (R1=F1)



Resistance = Force (R1+R2+R3=F1)

The Interaction of Compaction and Displacement

When OHV tires are put on a newly constructed trail, compaction will start almost immediately and will cause the trail tread to compress. Naturally, the compaction will occur the most wherever the tires have had the most passes over any one place on the surface. For a single-track OHM trail, the compaction will be mostly in the center of the trail, but on an ATV, ROV, and 4WD trail, the compaction will create two ruts on either side of the center. Over time, the entire compacted tread will be lower than the untrafficked tread and potentially lower than the surrounding ground.



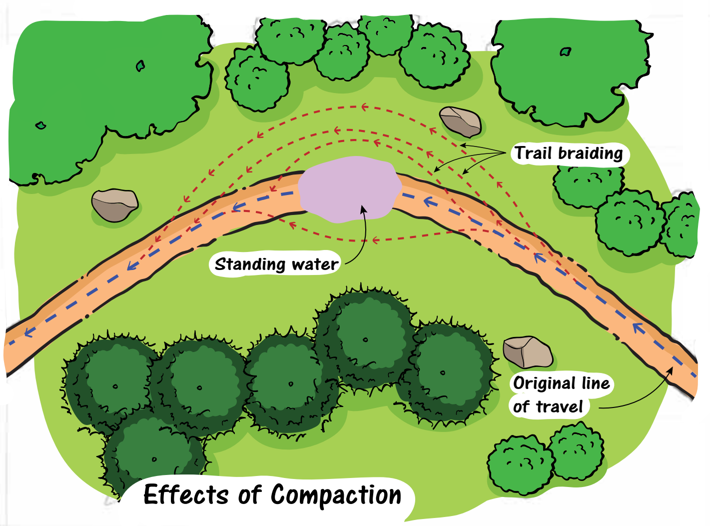
Why is this important to know? If the tread was constructed with outslope, water will no longer come down the slope and sheet across the trail as originally designed. The water will now be trapped in the ruts of the trail and will either collect on the trail or run down the trail.

As compaction occurs, the soil particles in the tread become packed together tighter as voids become filled with finer material. This makes the tread surface less porous, so now water is less likely to be absorbed into the tread. Instead, water will either pond on the surface or accumulate and run down the trail. There will be more water since it is not soaking in. As the grade increases, the velocity of the water will increase, which will increase the likelihood of scour or erosion.

The designers must recognize that these actions will occur and plan to force the water off at regular intervals through knicks, rolling dips, or best of all, grade reversals.

On flat ground, the compaction will cause water to pond up in low areas. If the trail is not confined by vegetation or topography, riders will tend to go around these ponds thus widening out the trail tread or make alternative routes that results in trail braiding.

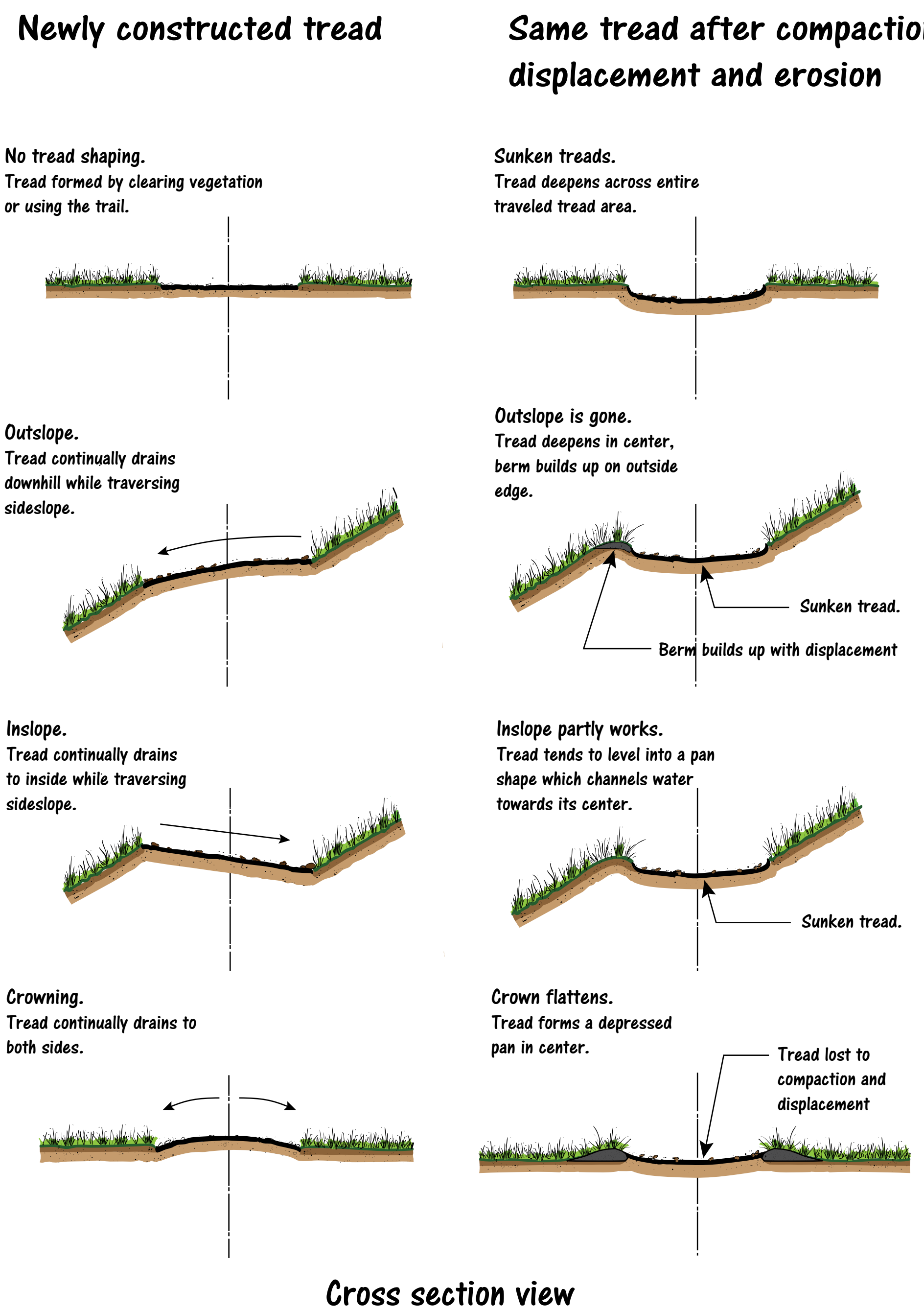
Once all of the voids are filled and the tread is consolidated, compaction will cease unless the vehicle types change. This may happen naturally, as when a new type of allowed vehicle begins to ride the trail. This can also be caused when the land managers open existing trails to new types of vehicles. If the managers allow ROVs on trails that previously only allowed ATVs, the forces on the trail will change because of the difference in vehicle weight and size. It is important that the managers recognize and plan for the potential impacts prior to changing vehicle trail designations.



Effects of Compaction

The trailbed is constructed using one of four shapes: flat, crowned, insloped, or outsloped. The important point to remember here is that unless conditions are ideal, which rarely happens, all of these shapes will change over time with vehicle use and become rutted, entrenched, or concave. After compaction has occurred, the trail could be restored to its original shape through maintenance if the funding and equipment with skilled operators are available to do so. If this is not done correctly, the tread material can easily become unconsolidated and the compaction, displacement, and erosion process will start all over again.

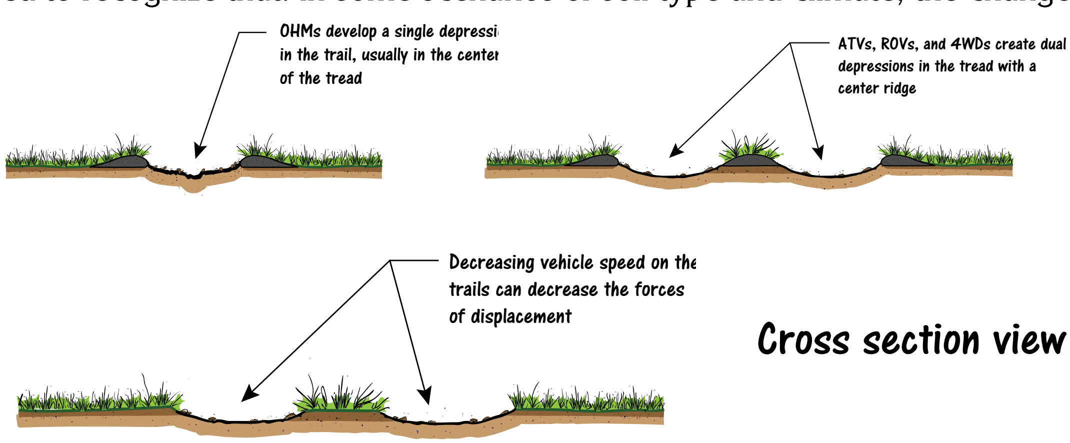
The forces of vehicle compaction can be reduced and the integrity of the trailbed shape can be significantly improved if the trailbed is compacted during construction with a roller or other equipment. This can be labor-intensive and expensive. For the roller to have full ground contact, often rocks and roots are removed. The down side of this is that the trail no longer looks and feels natural and some riders object to that. The character has changed and so has the trail experience, but the tread is far more durable.



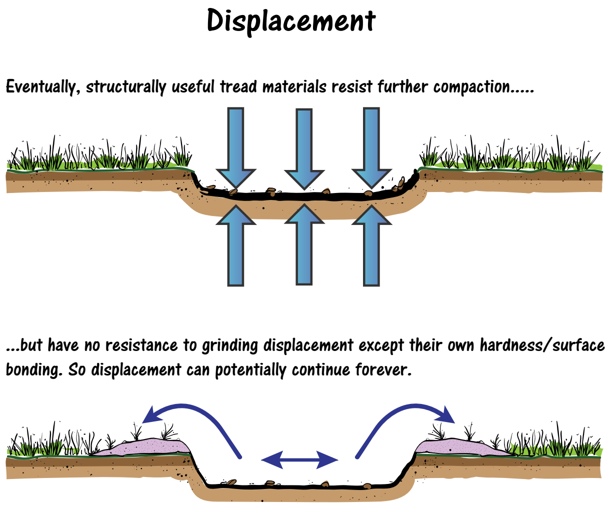
The crowned trailbed is more difficult and expensive to construct, but given good, non-saturated soils, once the forces of compaction, displacement, and erosion are applied, it is the only shape that is still close to the original ground line, rather than a trench below the ground line. This can be a benefit since it will make it easier to drain water off the trail and help keep the trail tread from becoming saturated.

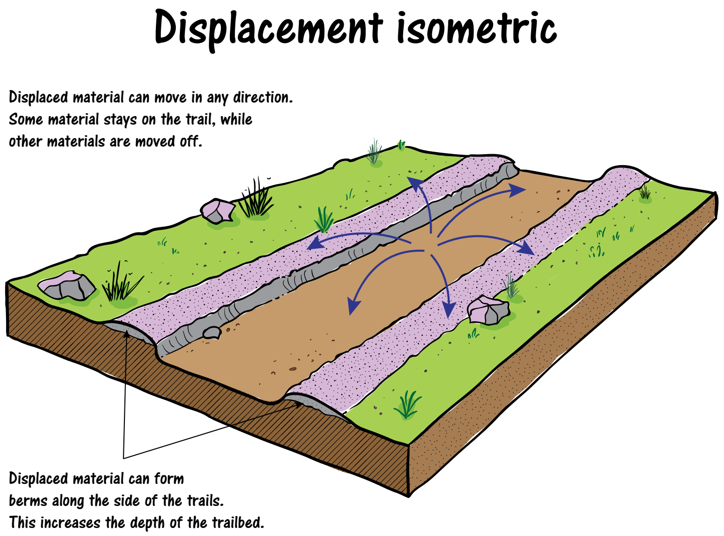
While compaction slows down and can even cease, displacement does not. The force and torque of tires creates constant displacement of the tread surface. In addition, the forces of braking and accelerating and the centrifugal forces try to slide the vehicle to the outside of curves. All of these create progressive grinding of surface particles and displacement of the tread surface. Embedded rocks can get dislodged and solid rock can get ground away over time. Faster speeds and steeper grades will exponentially increase these forces and their effects.

Since compaction consolidates the tread particles, compaction makes the tread less susceptible to displacement and erosion, but it never stops these other forces. Trails will change over time and designers need to recognize that. In some scenarios of soil type and climate, the change has no effect on the functionality of the trail or can sometimes improve it, but in other scenarios, that change can lead to drainage issues and the loss of the trail's integrity.



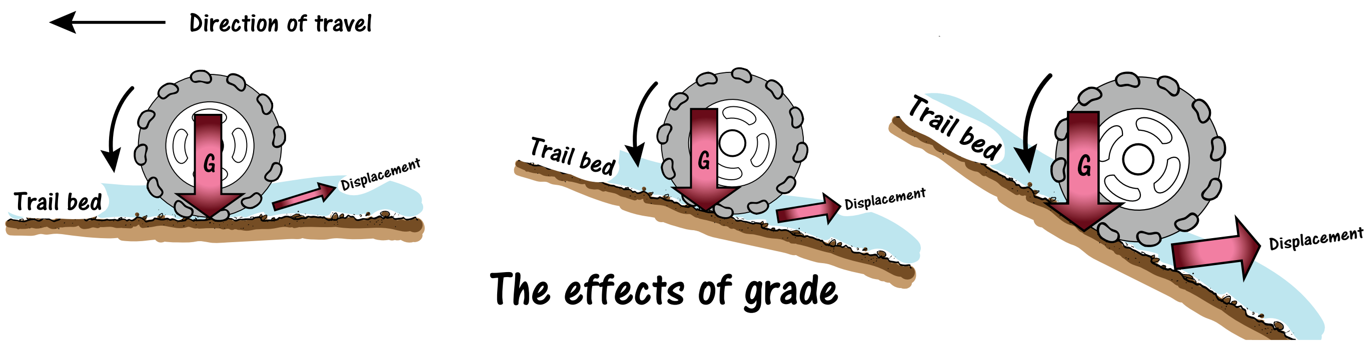
Hardening is a tool that can be utilized where needed in that latter scenario, but as with mechanical compaction, hardening changes the character and feel of a natural surface trail. Instead of riding on dirt and natural terrain features, the riders are now on gravel or some other unnatural surface, which is like riding on a miniature road. While it provides variety, it is not the experience that most trail riders are seeking. What is the effect of displacement on a grade? The gravitational force (G) is always a vertical force. When the trail is flat, the gravitational force is close to perpendicular to the trailbed. The torque of the tire still creates some displacement.





As the grade increases, the gravitational force is no longer perpendicular, but is being applied at an angle to the trailbed. This angle, combined with the torque of the rotating tire, disrupts trail tread. More particles and rocks are dislodged and displacement increases.

As the grade increases more, the angle between the G force and the trailbed decreases, which makes the G force a more effective tool to dislodge tread particles. This increases displacement even more.



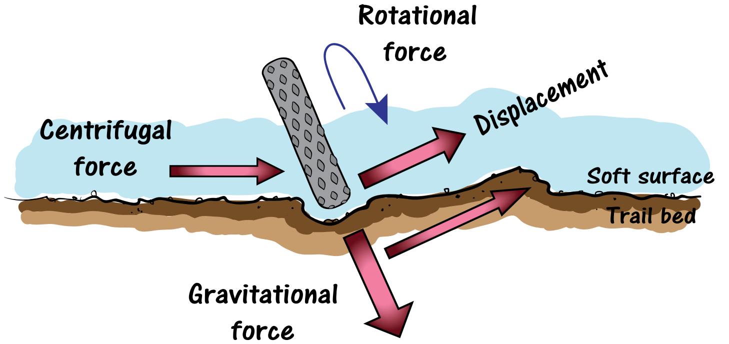
What is the effect of displacement on a curve? Just like on a grade, the angle of the force being exerted combined with the sideways centrifugal force dislodges tread particles. These particles are always thrown to the outside of the curve where they accumulate and eventually form a superelevated curve. The faster the vehicle speed and the softer the trail tread, the more rapidly the superelevation forms. If not confined by vegetation, the trail will continue to widen out until the superelevation is fully formed. Depending on the soil type, speed, and amount of use, this could take a few months or a few years to occur.

Some riders do not like superelevated corners because they don't appear natural and riders feel like they're on a motocross track instead of in the woods. Even in dry climates, superelevated turns can entrap water causing ponding and even soil saturation after heavy rain events. However, one advantage of superelevation is that riders can carry their speed through the turn without braking going into it and accelerating coming out of it. This creates flow and a very high fun factor.

What else does it do? By having a superelevated turn, designers can eliminate or certainly reduce two of the three forces that accelerate displacement: braking and accelerating. Since the angle of the superelevated turn is now closer to perpendicular with the tire, the amount of centrifugal force is also greatly reduced as is the amount of displacement. This reduces tread impacts and reduces maintenance needs and costs.

If the trail was originally constructed with superelevated corners, there is less widening of the trail over time and compactive forces can start much earlier. A superelevated corner increases tread stability and reduces the loss of tread material because the banked tread contains the displaced soil particles and they roll back down into the tread.

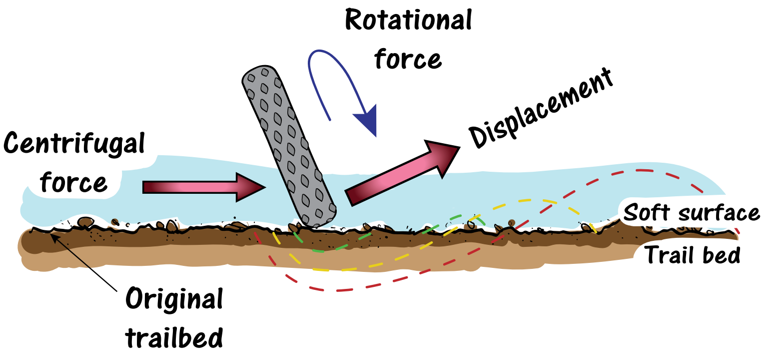
Forces exerted by a motorcycle on a flat curve



Tip, Trick or Trap?

Tip: Superelevated curves equal superelevated rider experience

The development of superelevation

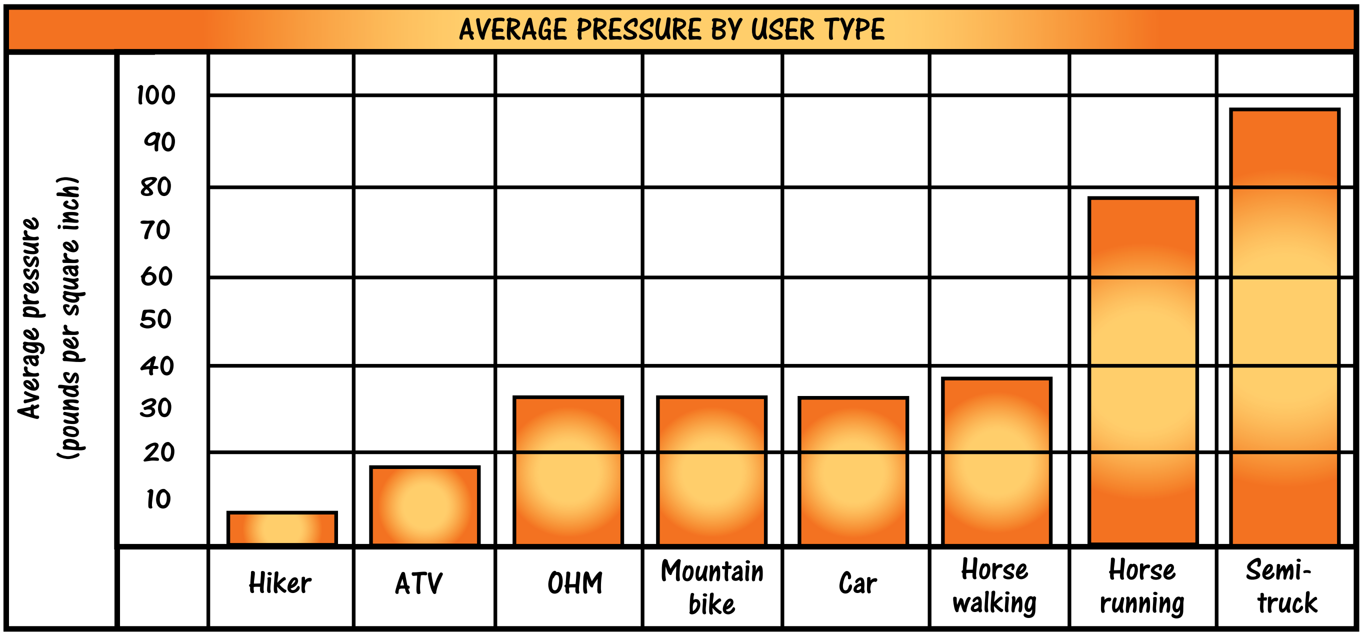


Superelevated curves can reduce the effects of displacement. On a curve like this, any soil particles that are displaced will roll back down into the tread.

A series of back-to-back superelevated curves is like riding a roller coaster with a super high fun factor that produces smiles and adrenaline.

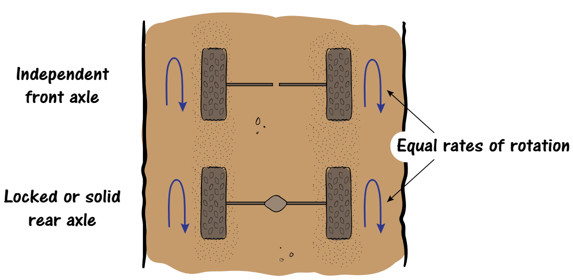
Special Considerations for Four-Wheeled Vehicles

There are some special considerations when the OHV has four instead of two wheels. One obvious difference is that now there can be at least two drive tires next to each other (two-wheel drive OHMs have a single drive tire forward and rear) delivering rotational forces and potential displacement forces to the ground. Depending on tire size, inflation pressures, actual vehicle size, and weight and loading, those forces may or may not exceed those exerted by a motorcycle. The real difference, though, comes into play on curves.

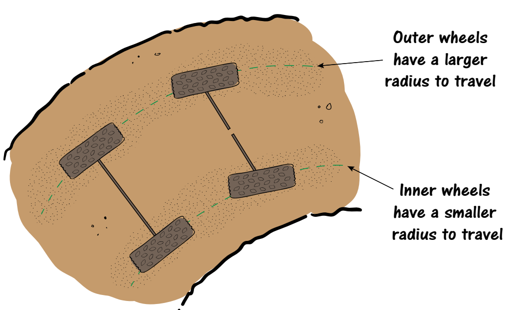


When a four-wheeled vehicle is on a curve, the outside tires are on a larger radius than the inside tires. That means that the outside tires have to travel farther and faster to stay in line with the inside tires. If the tires roll independently like those on the front axle of a rear-wheel drive vehicle, the outside tire will roll more and the inside tire will roll less to get around a curve. The drive tires behave differently. If the drive axle is solid or if the differential is locked, the two tires turn at the same speed and cannot roll independently. This means that as the outside tire is traveling farther to get around the curve, the inside tire is going at the same rate, but has a shorter distance to travel, which causes wheel hop and tire spin on that inside tire. Depending on the trail surface, these forces can cause severe displacement. Non-cohesive soils, loose rocks, or pavers and other materials used for trail hardening can be churned up, broken, or moved. These forces must be considered while designing the trail.

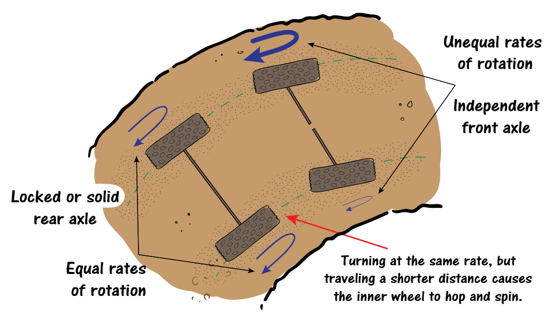
Four-wheeled vehicle on a tangent



Four-wheeled vehicle on a curve



Four-wheeled vehicle on a curve



Increasing the vehicle width increases the effect because of the larger difference in radius between the inner and outer wheels. Increasing the grade increases the effect because of the additional torque being applied to the tires. Increasing the curve radius decreases the effect because the outside tire has to turn less to keep up with the inside tire. Other than rotational forces, there is no churning effect on tangents because both tires travel the same distance at the same speed. The effects will be most noticeable on a climbing turn since it involves grade and a turn.

Erosion

The third force is erosion, which is the movement or removal of the tread surface particles due to natural causes like wind and water. Poor trail design and lack of effective drainage can accelerate erosion. Soil particles displaced by vehicle tires are more susceptible to erosion. Vehicle operation during periods when the soils are most susceptible to displacement, such as very dry or very wet (saturated), can create ruts that channel water and increases its velocity and scouring action.

Erosion is generally viewed as being bad, but it is a natural, ongoing, and eternal process. The Grand Canyon is viewed as spectacularly beautiful, but it is a product of eons of erosion.

Tip, Trick or Trap?

Tip: It is better to understand nature and work with it, rather than against it. We cannot control nature.

Here are some key points on erosion:

- Erosion is a natural process that is caused by weather patterns or weather events, whether they are major or minor events.
- Major rain events and catastrophic storms like tornadoes and hurricanes will happen and they will result in erosion.
- Given the right conditions, even normal weather patterns can and do cause erosion.
- Steep ground is not needed in order for erosion to occur. The potential for erosion is everywhere and it is non-selective.
- Erosion is cumulative. Even minor soil movement from a single storm can add up to significant soil loss over several years of storms.
- While erosion cannot be stopped, designers and managers can take measures to minimize it through good design and trail management.
- The trailbed is a precious resource. Once the tread particles are displaced and eroded, they are generally gone forever. It is more efficient to be proactive and invest time and money up front in design to protect that resource rather than be reactive and try to fix the trail after the damage has occurred.
- Even if everything is done right and a sustainable trail has been built, erosion will occur to some degree. The fact that there is erosion does not necessarily mean that the planners and designers have failed or that the trail will fail.

An early fall event on these dry sandy soils resulted in severe displacement. A high wind or thunderstorm could result in major impacts and soil loss.

Chapter 3 included a tip that said planners and designers are always better off trying to work with human nature rather than against it. That same concept applies here.

Dirt in the air and grit in the teeth: it's part of the experience, but it's erosion.

They cannot fight a natural process and must learn to live with it. They can, however, do some things through design to reduce the impacts of that process on our trails.

The Interaction of Compaction, Displacement, and Erosion

With any natural surface trail, the vegetation at the surface gets removed and roots that hold soil either get cut through construction or broken through use. These actions weaken the soil and expose it to the forces of compaction, displacement, and erosion. Compaction can help minimize displacement. If displacement is minimized so is erosion potential; therefore, compaction helps reduce erosion also.

Many soil types appear to be stable at a given time of year, level of use, and moisture content. Change any of those three variables and the soil stability will change, which means that the potential for displacement will change. Clay soils turn to gumbo when wet. Sandy soils turn to flour when dry. Soils with low stability cannot endure a high volume of use in a short duration of time, as in an OHV event or race, unless they are frozen or have the optimum moisture content, which rarely happens.

A rill of water forming after a rain shower

When the surface of clay or silty soils is dry, the smaller particles become easily dislodged by the displacing action of tires and become airborne, hence dust is created. Most people, especially the riders, see this dust as a nuisance and pray for a breeze to blow it out of their way. However, what is occurring here is erosion. Those soil particles that are blown away are now gone forever, resulting in tread material being lost every year due to dust and wind.

After even a minor rain event, small rills or channels may form in the trail and at the downhill end of each rill will be a small deposit of sediment. These can seem innocuous, but over time they build up and can fill the bottoms of rolling dips and block the entrances to lead-off ditches. These rills can start forming within just a few feet of a drain and they can form on any grade, not just the steep ones.

Notice the rills of water draining down the slope and into this trail. Notice also how quickly the rill down the edge of the trail deepens as more water feeds into it and the water velocity increases.

Sedimentation from erosion can fill up drainage structures and cause them to fail, but ruts caused by displacement can do the same thing. Water collects in those ruts, becomes channeled, increases velocity, and can blow right by lead-off ditches and under-sized rolling dips. This is another reason why properly designed grade reversals are preferred over man-made structures; they cannot fail.

A Closer Look...

Evaluation or monitoring is the fourth E in the 4Es discussed in Chapter 1. Whoever is monitoring a trail needs to have an eye trained to spot those little rills and sediment deposits and watch for the gradual filling of drainage structures so that maintenance can be scheduled in a timely manner. If this is not done and the deposits are allowed to accumulate, the next major rain event could wipe out the drainage structures and create severe trail damage, extensive sedimentation, and unneeded resource impacts. Just as important as scheduling maintenance is to have that monitoring person take the next step and ask: "Where is this water coming from? Can we reduce or eliminate it?" This is what the 4Es are all about: asking why and implementing adaptive management. Too often, the issue is overlooked and these questions are not asked as the person climbs on his OHV and rides on up the trail. In doing so, the trail manager is taken from a potential proactive position and placed in a potential reactive position after the real damage occurs. Chapter 2 stressed that assessments need to be done on foot. On a machine, managers are traveling faster and are focused on other things besides the little insidious forces at work on the trail tread. Managers can see more, understand more, and be more effective on foot.

As the rills join together farther down the slope, the volume and velocity of the water increases even more resulting in scouring and erosion. If the source of the water feeding into this slope cannot be diverted, there will be long-term issues. A mitigation here could be to install an armored ditch to collect and channel the water down the slope. The ditch would need to be lined with cobble size or larger rocks to prevent further erosion and to dissipate the energy of the water.

Water will always take the path of the least resistance. This lead-off ditch gradually filled up with sediment due to lack of maintenance and the next major rain event blew right by the ditch and over the rolling dip.

This trail appears to be stable, but it is actually the product of years of sedimentation as evidenced by the log buried in the fill. Unless the source of the water carrying this sediment is found and corrected, this trail will not be sustainable.

The alluvial fans in the desert appear timeless and unchanging, but they are the product of erosion and sedimentation that started when the mountains were created. The sediment in these fans can be several thousand feet thick. The erosion process has not stopped and will continue forever.

This is a good example of displacement and erosion at work. This grade is too steep and too long without adequate drainage. Over time, water has carried away all of the fine material that bound this tread together leaving only a loose "rock garden." The trail above and below this section would be rated as EASIEST, but this section is no longer suitable for novice motorcycle riders. This lack of drainage has not only removed a lot of soil, it has created inconsistent difficulty which could put a novice rider at risk.

A Second Look…

It was discussed previously how erosion has washed away the fines and left a rock garden on this section of trail. What if that water has no direct connectivity to a stream? What if this trail had a higher difficulty level? What if our options to relocate this long grade are limited? Is it okay to accept this? Under certain conditions, the answer can be yes. For example, as long as signing and mapping reflect the appropriate difficulty level, the trail could be managed as More Difficult. On the easier trail sections on both ends of this, some simple entrance management techniques could be implemented to indicate to the riders that there will be more difficult sections to negotiate.

Section 3: Understanding Tread Materials

Natural surface trails generally use the native soil as the tread surface. Some soils are more stable and durable than others. Indeed, soil type is one of the key elements, if not the key element, in trail design. Unless the soil is modified or hardened, it will dictate the steepness of grade, tightness of alignment, frequency of drainage, smoothness of the trailbed surface, and the level of difficulty. Tread materials are generally composed of a mixture of soil and rock.

Soils

Soils are composed of different mixtures of sand, silt, and clay (called the soil separates) with the additives of organic matter (humus) and larger mineral fragments such as gravel-sized material. The mixtures of the soil separates define the texture of the soil and the texture influences the behavior of the soil. Will it drain? Will it displace? Will it be slippery? It is very common for the soil type or soil mix to change several times on any given trail, so the designers must be constantly watching for these changes and adjust the design accordingly.

Clay soils have the smallest particle size and the particles are shaped like flat platelets. The platelet shape makes clay very durable when there is sufficient moisture to bind the particles together. They can hold a lot of water, which makes them poor draining, and when wet, those platelets slide over each other, which is what makes a clay soil so slippery. Clay has high cohesion and that means it holds onto and binds particles together. That's why it feels sticky when moist. A quick field test is to take a handful of the soil, apply enough water so the sample is moist (wet, but not saturated), and then make a fist to form it into a ball. A clay soil will form a ball. Then rub hands together to try to roll the material into a pencil shape. A clay soil will roll into a pencil; the thinner the pencil, the higher the clay content.

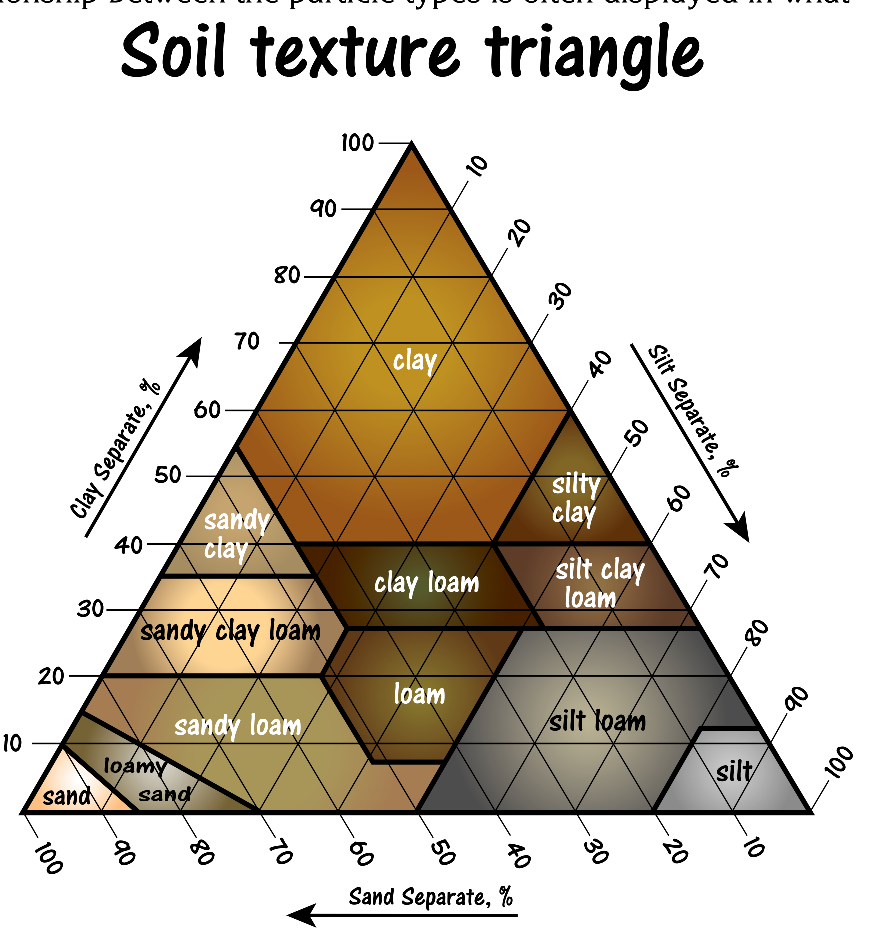
Silt soils are the next larger particle size though the particles are still small and not visible. Silt feels smooth like flour. Due to their particle size, there are numerous voids between them, so they can hold a lot of water but not as much as clay, so they drain better than clay. Silt has medium cohesion, so it will also bind particles together to make a firm trail tread. In the field test, a silty soil will form a ball and feel smooth, will not be as sticky as clay, and will not roll into a pencil.

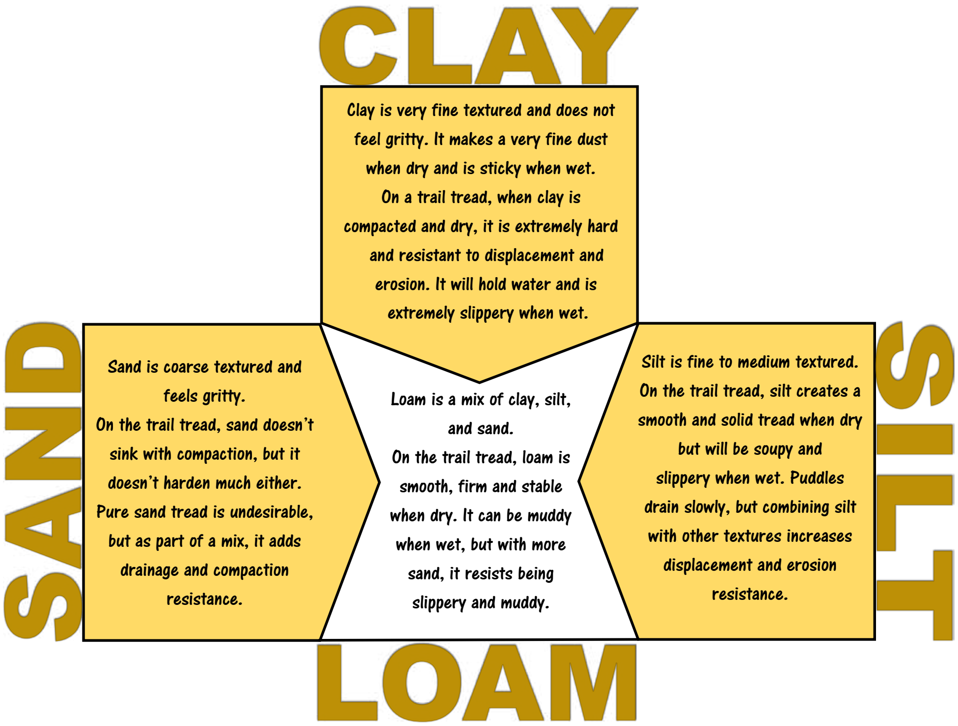
Sand has the largest particle size and is visible and gritty. The pores between the particles are large, so water drains through them very easily. Pure sand has no cohesion and does not bind with other particles, so sand does not compact and is therefore easily displaced. In the field test, pure sand will not form a ball and will disintegrate easily when pressed lightly.

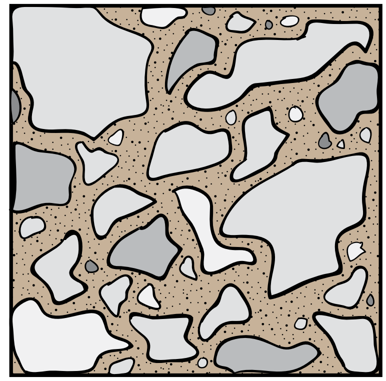
Rarely is a soil one pure particle type. Instead, it is a mixture of the three soil separates, which is a good thing since pure soils are not desirable for a trail tread. When mixed together though, the soil, which is called **loam**, tends to have more of the advantages of each of its components and less of the disadvantages. The relationship between the particle types is often displayed in what is called the soil triangle with clay, silt, and sand in each of the three corners and the combinations of loam near the center.

The table displays the properties and behaviors of each soil type.

Humus is a dark brown to black layer of decomposed organic material often referred to as the A horizon. When mixed with the soil separates, humus significantly increases the bulk density and moisture retention characteristics of the soil. Being organic, it also adds nutrients that stimulate plant growth which in turn can help stabilize the soil. Like the soil separates, in the right mix humus is good, but the higher the percentage of humus, the more muddy the soil will become making it very susceptible to displacement and erosion.





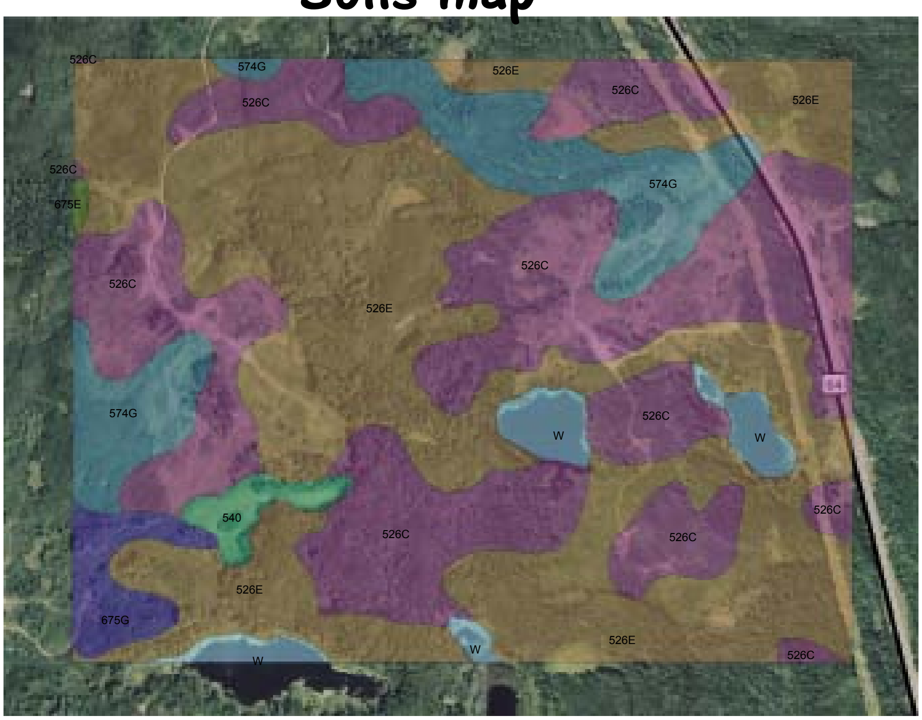


A wide range of particle sizes from clay and silt and larger makes the best soil for trail tread. The smallest particles are binders, larger particles better resist displacement and erosion while providing strength in wet conditions, and medium particles of all sizes add structure that helps stabilize the tread. Compaction greatly strengthens such treads by eliminating spaces and improving binding.

The ideal tread material is a loamy mix with humus and a significant gravel content. Such a mix will provide stability, durability, and drainage. The mixture will be able to withstand the forces of compaction, displacement, and erosion. Unfortunately, that ideal mixture is generally not very prevalent, hence the need to either modify the trail design parameters or modify the tread material.

There is comprehensive soil mapping and information available for every state and county in the United States through the USDA National Resources Conservation Service (NRCS). NRCS provides tables that interpret soil map units for different uses. Those interrelations vary depending upon the age of the surveys, but often there are interpretations for light roads, or foundations that may be useful to the trail planners. Their website has just about everything planners and designers would need to know about soils. Soil mapping for Canada is available through the Agriculture and Agri-Food Canada, National Soil DataBase (NSDB). Many federal, state, and provincial agencies also have their own soil mapping database. As with any area mapping product, the level of detail may not be sufficient for the desired application, so some level of ground verification is usually needed to ensure the accuracy of the data.

Soils map



An example of soil inventory mapping from the NRCS. Depending on the detail of the mapping effort, the mapping polygons may include small areas of other soils called "inclusions," or may describe soil complexes or associations. The mapping unit description and interpretive tables that accompany the maps will help you extract valuable information from the soil survey.

Rocks

Most tread materials also contain unconsolidated bedrock or loose rocks. In the right mix of size, shape, and content, rocks can add to the durability of the soil. And like soils, these materials are also categorized by size. There are four classes:

- Gravel: 2 to 75 millimeters (mm) (sand size to 3")
- Cobbles: 75 to 250 mm (3" to 10")
- Stones: 250 to 600 mm (10" to 24")
- Boulders: larger than 600 mm (larger than 24")

These materials are a benefit to any trail tread because they provide weight bearing and durability by resisting the forces of compaction, displacement, and erosion. They also add to the natural character of the trail, so they increase the rider experience. A challenge for OHV trail designers is how to provide challenge and still have sustainability. Rocks can help provide that opportunity. Soils with a high angular rock content may allow the designers to increase the grade. Exposed bedrock, firmly embedded rocks, slab rock, slick rock, and boulders can provide outstanding technical challenge while maintaining tread durability.

This rock outcropping was used as a pivot point for a curve in the trail. The rocks help stabilize the soil and increase the variety in the trail.

Unfortunately, a rock is not always as hard as a rock; some are durable and others are not. The three types of rock are igneous, sedimentary, and metamorphic. Igneous rocks have solidified from a molten state. They are tough, hard, and have little texture or layering. Examples are granite, dense basalt, and obsidian. Sedimentary rocks have been formed by the accumulation of particles that have been compressed under heat and pressure to create rock layers of hardened sediment. These are not as hard or durable as igneous rocks. Because the rocks are compacted in layers, each layer may have a different density and bonding strength, hence the layers can separate under the forces of turning tires. Examples are sandstone, limestone, shale, and gypsum. Metamorphic rocks are older rocks that have been altered by extreme pressure, temperature, or chemical actions. These are tough, hard rocks. Examples include quartzite, schist, marble, and gneiss.

The high rock content on this grade has made it durable. The grade is steep (25%) but short (50'). In spite of a dramatic increase in use, this slope has changed little in 15 years of monitoring.

Depending on their compositon and hardness, some rocks on or near the surface tend to weather more than others. The forces of expansion and contraction created by hot and cold cycles cause micro-fractures and the freeze-thaw action of water expands those fractures and weakens the rock. Therefore, rocks near the surface may become rippable even though they appear solid. Depending on the type of rock, this weathering could make the rock rippable for a few inches or a few feet. As designers lay out a trail, they should be looking at and assessing the protruding rock. Is it rippable or is it tied to the center of the earth? Should it be taken out, circumvented, or left as a challenge feature? A couple of quick pokes with a pick or other implement will give designers a hint as to the solidity of the rock. The designers should remember that the material will be harder below the surface.

With the softer rocks moguls can actually develop in the rock; grooves can be cut into it by tires. Softer rocks used as technical features can literally disintegrate over time. Rocks that have cracks or fracture lines are likely to break along those lines under the forces of vehicles. Does that mean that the designers should avoid utilizing the softer rocks? No, any rock is better than no rock, but the designers need to realize that changes will occur. Ten years of durability is better than none, and ten years of providing a high-quality rider experience is better than none.

Another type of common tread material is decomposed granite or DG. It is granite rock that has weathered and broken down into various sizes from gravel to sand-sized particles. Depending on the area and the mix of sizes, it can be a good tread material or a very poor one. It tends to have round particles, but if there is a good mix of sizes, or if they have been mixed with other soil types, especially clay, they can produce a durable tread. If the particles are homogeneous regardless of their size, they do not bond together and displace very easily.

Volcanic rock, being molten from the ground, is igneous rock that includes basalt, rhyolite, and andesite. Basalt is the most common and it has several forms depending on how quickly the lava cooled and how much gas was trapped in it forming vesicles. A gray lava flow is basalt. It can be very hard and durable with a low vesicle content, but it gets weaker as the size and number of vesicles increases. The reddish lava rock are cinders. They are highly vesicular. The tan to white pumice has so many vesicles and trapped air that it floats. Cinders and pumice make poor tread materials because they are granular, weak, and non-cohesive. They will compact over time, but they are dusty as they break down and with no cohesion, they displace very easily. Loose pumice on the surface of the trail tread can float away in a heavy rain, which is undesirable in a tread material.

Design Implications of Rocks

- Bedrock or well-embedded rocks provide superior resistance to compaction, displacement, and erosion.
- Angular rock binds well with other tread materials as long as the voids between the rocks are filled with a variety of other rock and soil particle sizes. The more rock, the more durable the tread becomes. This could allow for steeper grades.
- Round rock like river rock does not bind well with other tread materials and can be easily displaced.
- If all of the rock particles are homogeneous in size, both angular and round rock can be displaced. Consider mixing in clay and other soil and rock particles as a binder.
- Rocky treads tend to drain well so they do not become muddy when wet, but they can get slippery.
- Gravel, cobbles, and stones can be used to harden wet areas.
- Hard rock doesn't erode, but the soil particles around it does. Frequent drainage is still important to control water volume and velocity.
- Soft rock can break down and erode.
- Rocks with horizontally oriented sharp edges can be tire busters and rim benders. Either break off the edges or pad the approaches to them to reduce the angle and force of impact.
- While surface rocks provide variety and challenge, less experienced riders will often try to ride around them if possible, which creates widening of the trail. Strategically place boulders, logs, or other barriers to deter this widening. Better yet, if possible, provide an easy-out around the rocky area.

As the soil at the base of this rock slab gets displaced, it will be increasingly difficult to negotiate this black diamond designated trail. This rock slab provides challenge and a WOW experience.

Solid rock outcroppings make great opportunities for challenge.

The natural process of erosion has provided a durable and exciting technical challenge along this stretch of trail.

Firmly embedded angular rocks on trail providing technical challenge

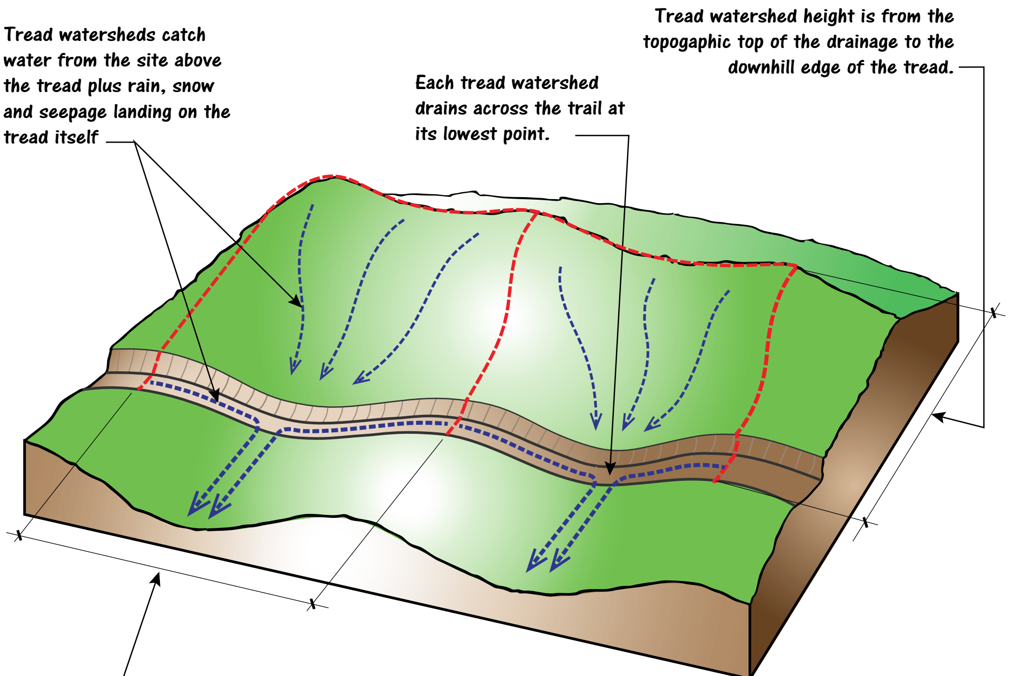
This trail uses a short, but steep climb, to add challenge. The steep grade is stable because the tread is made up of large rocks firmly embedded in the soil.

This shale rock is durable, technical, and has an outstanding WOW factor.

These rocks are too small and not embedded well enough to withstand the forces of this 4WD trail. They will displace causing diminishing challenge of this run and potentially unacceptable site impacts.

Section 4: Understanding the Dynamics of Water

In trail design, speed and water create issues, but both can be managed through proper design. Designers can roll the grade to force water off the trail at regular intervals. Many factors influence how water is forced off the trail, including soil type, topography type, frequency and intensity of use, control points, trail grade, tread width, vegetation (ground cover and tree canopy), climate (arid or wet), and seasonal weather patterns (potential for high-intensity thunderstorms). All of these can affect the amount of water collecting on the trail tread and the behavior of that water. To manage that water, designers need to focus on not only the water on the trail but also the sources of that water. Certainly, as it rains water is falling directly onto the trail tread, but it is also falling on the land above the trail. Some of this water is absorbed into the ground, some of it runs as an overland flow onto the trail, and some of it drains as a subsurface flow and spurts like a spring in the trail. How much water is this and how does it influence the design? Determining how much water may enter the trail profile involves looking at the bigger picture of the landscape and dividing it into tread watersheds.



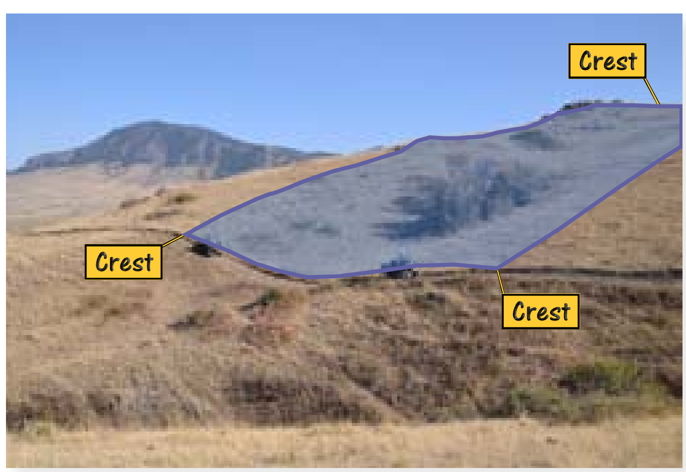
Tread Watersheds

The tread watershed is the area from one grade crest to the next grade crest and all of the land that drains into it from the top of the ridge or a topographic crest.

The topography of the site controls the height of the tread watershed, but designers can control the length of the watershed. Through the actions of compaction, displacement, and erosion, the tread sinks over time and the integrity of whatever shape it had at the time of construction is usually lost. When the tread sinks, it traps the water and the tread becomes a conduit or channel for the water to run. The water will run from the top of the grade crest to the bottom of the grade sag. The longer water runs on a grade, the more velocity it gains, and the more potential it has for scour or sediment delivery. This is called runoff erosion. To increase sustainability, these runs must be as short as possible.

Tools to Manage Water

The designers control water by rolling the grade, which not only helps make the trail sustainable, it enhances the rider experience and fun factor. This is one advantage of designing for OHVs: with a motor, riders don't mind going up, back down, and up again. It's not a chore, it's fun.



Tip, Trick or Trap?

Tip: Topography is your friend because it can be drained. Avoid flat ground.

In order to roll the grades and provide point drainage, designers must have the trail on a sideslope. Flat ground with flat grades does not allow the designers to control the size of the tread watershed and it becomes difficult to drain the water away from the trail.

This is one of many reasons why roads do not make good sustainable trails: the grades do not roll enough and their watersheds are too large. Roads are generally much wider than a purpose-built trail; therefore, the road surface is collecting more water volume than a trail, which can result in accelerated erosion, washouts of the road shoulders, or slope failures below the road drainage points.


This severe erosion occurred below a road drainage point after a high-intensity thunderstorm. The sediment carried all the way to a sensitive creek below.

When rolling dips are constructed on roads with long sustained grades to provide additional drainage, what is really occurring is that those grades are being broken up into smaller tread watersheds. This works but rolling dips require regular maintenance or they are prone to failure under normal or extreme weather events. The better alternative, if available, is to take the trail off those road segments so it can be built with rolling grades that provide shorter tread watersheds and will not fail.

Water Volume + Water Velocity = Increased Runoff Erosion Potential

Here is one example to put things into perspective. A mile of 12-foot roadway has a surface area of about 1.5 acres. A rain event of only 1" will produce about 40,000 gallons of water on this roadway. That same 1" rainfall on a mile of trail with a 50" tread will yield about 14,000 gallons of water. If that trail has a grade break every 300', then the amount of water flowing to each drainage point will be reduced to about 315 gallons. This is the water just landing on the trail. It does not include the water flowing onto the trail from the rest of the tread watershed. As the velocity of the water increases, the number of soil particles and the size of the soil particles being carried away increases. There are variables, but the velocity of the water can double when the grade quadruples. The velocity of the water flow on an 8% grade is twice that of a 2% grade. When the velocity is doubled (2X), the volume of sediment that can be moved quadruples (4X), and the size of particles that can be transported octuples (8X). Clearly, the key to creating a durable trail is to effectively control and manage the water.


This trail has a long, steep grade, and poor soil type; all ingredients of non-sustainability. Like the rolling dips in roads, these belted waterbars reduce the distance that water runs thereby reducing the size of the tread watersheds. Unfortunately, these won't work. As you can see, riders are already starting to ride around the waterbars and as soon as this happens, ruts will form to channel the water and bypass the waterbars. The result is failure. A bandage fix like this is all too common and it doesn't address the root of the problem: poor trail location.

Designers can reduce the water volume by keeping the tread width as narrow as possible and by reducing the size of the tread watershed. They can reduce the water velocity by reducing the grade and reducing the size of the tread watershed.

There are four factors which affect the runoff volume and speed:

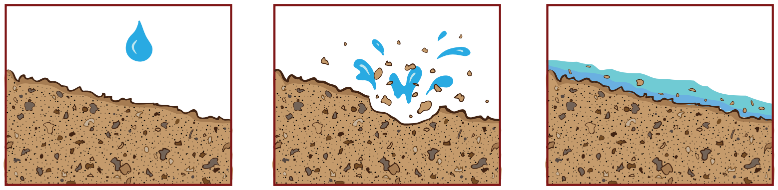
- The height of the tread watershed affects the volume of water.
- The steepness or slope of the topography affects the speed of the water.

- The soil type affects the absorption of the water. If the soil type is hard like clay, has a high rock content, or is slab rock, very little water will seep into the ground and the runoff potential increases.
- The amount of vegetative cover affects the speed of the water. Thick forests or grasslands slow the runoff rate and act like energy dissipaters to stop or divert the direction of the runoff. The less the vegetation, the higher the runoff potential. With vegetation comes vegetative debris called litter such as sticks, branches, needles, and leaves on the ground. This accumulation of litter helps reduce runoff potential. This is why there can be devastating erosion after a wildfire; the vegetative cover has been removed.

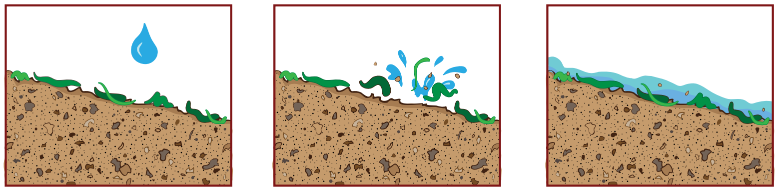
The height of the watershed above this trail is relatively low, but the topography is steep with low vegetative cover and exposed soils. The runoff potential here is high.

Runoff erosion is created by water volume and speed, but there is another type of erosion: splash erosion. The force of the water, even a raindrop, hitting the surface dislodges soil particles and can actually make little craters in the soil. This displaced soil then becomes subject to being carried away by surface water. A tree canopy can act like an umbrella by intercepting the initial force of the raindrops and allowing them to fall gently to the ground below. By locating a trail in the trees, the potential for splash erosion can be reduced. Ground cover and the accumulation of vegetative litter also protect the soil from splash erosion.

The ideal time to design or assess a trail is during the wet season when the amount and effects of the water are clearly visible. Unfortunately, that isn't always possible, so it's important to visualize how the site looks when wet. Sometimes looking at existing road and trail cuts can give clues as to the water dynamics. As a trail is being located, all potential water sources to the trail must be examined. Direct rainfall or snowfall, perennial streams and creeks, and seasonally wet drainages are obvious, but other water sources may not be that obvious. There may be a subsurface flow of water and the trail, once cut into the sideslope, may intercept that water. Groundcover can often



With no protective cover, raindrops can splash soil particles up to 3' away. Soil particles and aggregates that have been detatched are then transported down the slope by runoff water.



Tree canopies and vegetative cover cushions the fall of raindrops and reduces or eliminates splash erosion.

This heavy tree canopy helps protect this trail from splash erosion. The high rock content in the tread will add to the durability of this trail.

A high-intensity rain storm shortly after this fire resulted in a massive overland flow that washed across this trail, filling it with mud.

Tip, Trick or Trap?

Tip: Significant weather events such as 100-year floods can't be predicted, but designers must assume they will occur and protect the trails accordingly

Though not steep, the grade on this fenceline trail is too long making the tread watershed very large. This area is subject to high-intensity thunderstorms, so the erosion risk here is high.

This is a view of the bottom of a large tread watershed. The soils on this site are very poor. When the spring storms started, so did the erosion. Though grassed in, look at the rills on the slope that are feeding water to this drainage point.

Though dry, the rills at the base of these rocks indicate springs during the wet season. Even in the winter, the moss is an indicator of a different micro-climate.

cover up tiny rills that will feed water into the trail. Springs can dry up and be hidden. Designers should look at the base of rock outcrops for evidence of seeps. A change in vegetation to a type more indigenous to moisture can be a good clue along with moss, lichens, and small dry rills.

A Closer Look…

Designers should keep trail grades as low as possible. What does that mean? Increasing grade increases the risk of erosion, but increasing grade also enhances the rider experience. If the rolling grades on the trail never exceed 10%, it would probably be quite sustainable, but how fun would it be to ride? Provide for the riders' needs has been a fundamental guiding principle throughout this book. The designers must be constantly assessing the risk factors in each segment of a trail and weighing reduced grade vs. increased rider satisfaction. The designers should ask if they can push the grade at this point or not. If not, what other options can be employed to enhance the experience? Trail layout and design involves a very complex mental process of asking questions and answering them. The intent of this book is to teach designers and planners which questions to ask.

Some of the erosion risk factors are listed below:

Risk Factor	Lower Risk	Moderate Risk	Higher Risk
For the Tread			
Tread Grade	<12%	12%-20%	>20%
Length of Tread Watershed	Short	Medium	Long
Tread Width	Narrow	Medium	Wide
Stability of Tread Material	High	Medium	Low
Tree Canopy Over Tread	Thick, continuous	Intermittent	None
For the Watershed Above Tread			
Surface Area	Small	Medium	Large
Slope	<20%	20%-40%	>40%
Soil Type	Well-drained, sandy	Loamy, moderately drained	High rock content, clay, impervious
Vegetative Cover	Thick forest, thick litter cover	Medium vegetation, grassy, shrubby, no litter	Light vegetation, bare soil

The higher the number of risk factors, the shorter the tread watershed should be unless other mitigations are implemented like hardening or ditching.

Design Implications of Water Dynamics

- During trail layout or trail assessment, carefully examine all potential water sources and analyze their effects.
- Trail grades should be kept as low as possible, yet still provide the desired experience.
- Tread watersheds should be as short as possible by rolling the grade.
- Trail tread should be as narrow as possible. If converting a road to a trail, any excess width should be removed.
- Seek out vegetative cover whenever possible.
- Avoid steep, open slopes whenever possible.
- Consider other design or management mitigations such as reducing the grade, hardening the tread, increasing the maintenance frequency, or temporary closures to minimize potential effects.

Management Implications of Water Dynamics

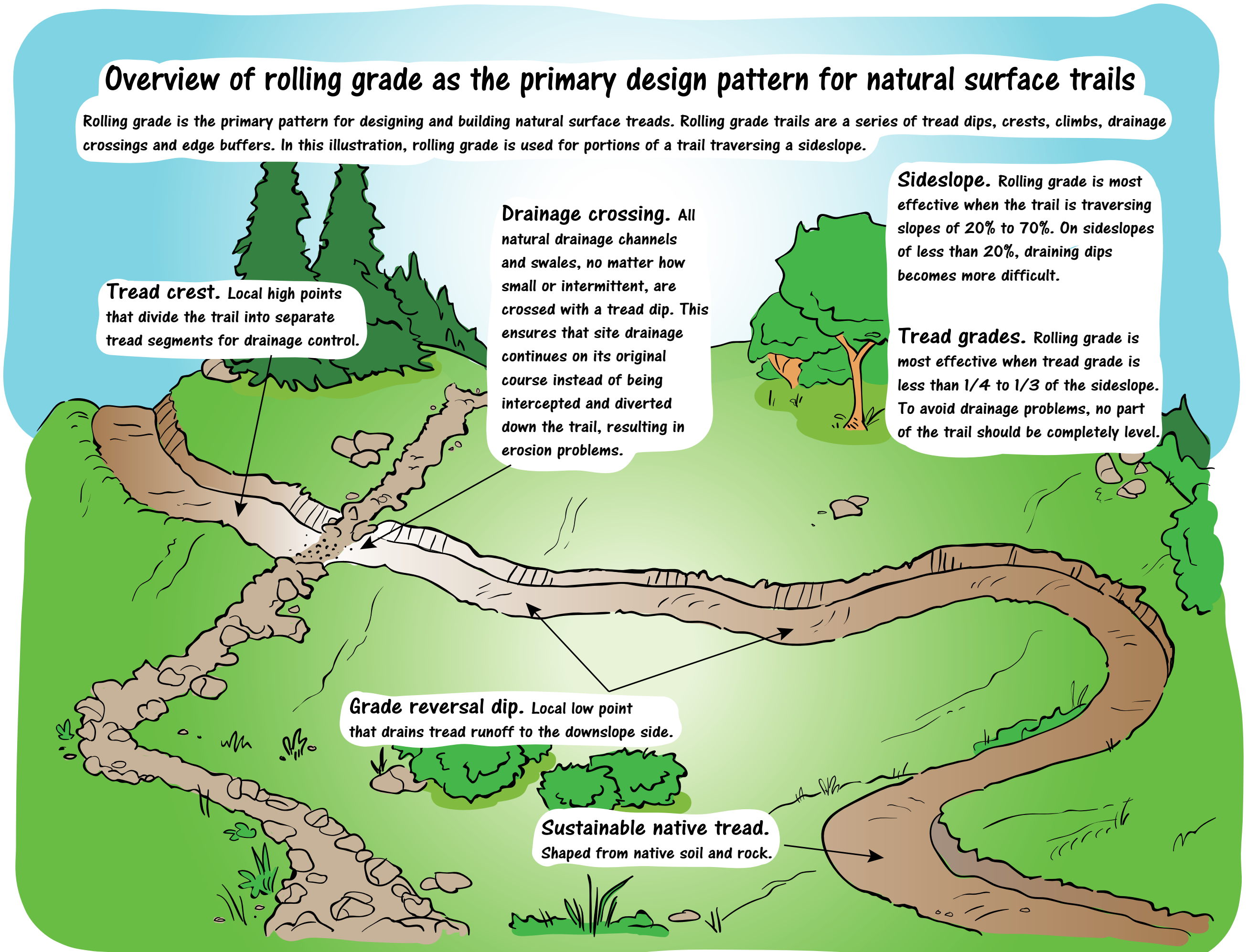
If designed properly, trails will be most susceptible to compaction, displacement, and erosion within the first year after construction. After the first year, compaction helps reduce displacement and erosion risk to some degree. Delaying the opening of a trail can assist natural weather events to help compact trail tread. If a trail is constructed in the fall, consider closing it to use until the following spring. If a trail is constructed in the spring, consider closing it until there have been several weather events.

- If possible, do not schedule an event on a trail within the first year after construction.
- Schedule events during the times when soil stability is likely to be the highest.
- Train trail personnel to look for indicators of problems before they become major issues.
- Schedule and perform routine maintenance.
- Consider closing the trail to use during periods of tread instability.
- Use websites and other media to educate riders to avoid riding during periods of tread instability.

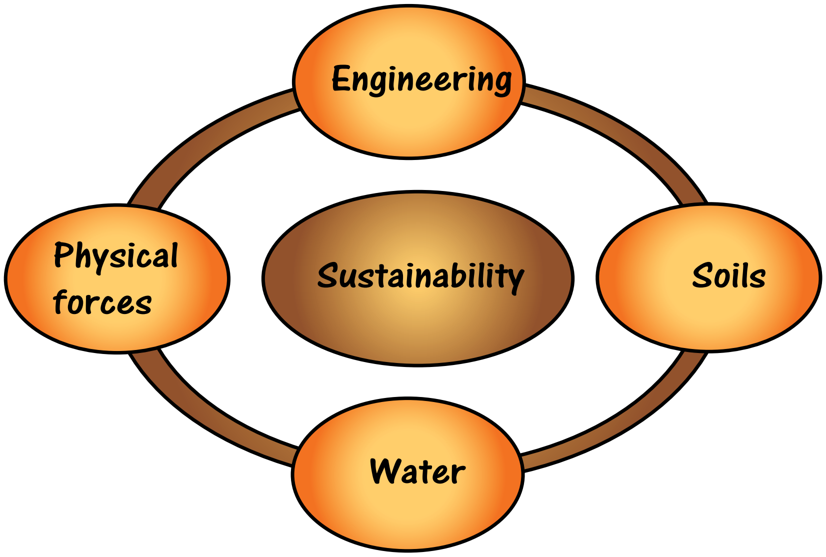
The Elements of Sustainability

It is important to understand the elements of resource sustainability: engineering, the physical forces, soils, and water. This gives a better understanding of the natural environment and how to create a great and sustainable trail.

Who needs this understanding? ALL field personnel. The trail planners and designers, but also the people conducting assessments or condition surveys, maintenance personnel, key volunteers and partners, construction supervisors, and the managers all need to have the ability to look at a piece of ground and understand what is or could be going on there. With that knowledge, they can be pro-active and implement adaptive management in a timely fashion. It isn't by accident that all of these personnel fit into the Great Trail Continuum. A great trail is only created by effectively and equally applying all five elements of the continuum together.



Elements of sustainability



Tip, Trick or Trap?

Trap: The "it's been there forever" trail: It is not uncommon during planning for riders to show planners one of their secret trails. It is often an old race trail that runs up the slope at 40+%. It is stable, grown in, shows little signs of erosion, and can be a really fun trail. The riders want this trail incorporated into the designated trail system and their argument is that "it's a great trail and it's been there forever."

Often, the only reason that trail is stable is because just a handful of riders know about it. If incorporated into the trail system, instead of having six riders per year, the trail could have six riders per day. The trail will not be sustainable and will fail because the use level was changed significantly. Designers should not fall into this trap.

Need more? Learn more here...

NRCS website: http://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home/

NSDB website: http://sis.agr.gc.ca/cansis/nsdb/index.html

Designing Sustainable Off-Highway Vehicle Trails, Kevin G. Meyer, USDA Forest Service, Technology & Development Program, November 2013

Natural Surface Trails by Design, Troy Scott Parker, Natureshape, LLC, 2004

Trail Planning, Design, and Development Guidelines, Minnesota Department of Natural Resources, 2006

Trail Solutions, IMBA's Guide to Building Sweet Singletrack, International Mountain Bicycling Association, 2004

Water Harvesting from Low-Standard Rural Roads, Bill Zeedyk, Zeedyk Ecological Consulting, LLC, 2006

A Look Back…

Here are some of the elements discussed in this chapter:

- Engineering is the link between providing for the riders' needs and designing for sustainability
- Vision without action is a daydream, action without vision is a nightmare, but vision and action without engineering ensures disaster
- How to calculate grade: Rise/Run x 100 = Grade
- Sustainability Basics: Designers should keep the horizontal alignments moving by using curves and short or no tangents, keep the vertical alignments moving by rolling the grades, minimize the grades, minimize tread width, minimize the size of the tread watersheds, avoid the fall line
- Curvilinear trails increase sustainability
- Both circular and non-circular curves can affect flow and trail difficulty
- Grade reversals provide the most effective drainage
- The physical forces of compaction, displacement, and erosion must be managed through design
- The key to good design is to understand the natural forces and predict their effects
- The trail tread is composed of a mixture of soil and rock. The designer must understand the mixture and the properties of the soil and rock at the trail location
- Designers should keep tread watersheds as small as possible
- Speed and water are issues. Vegetation and topography are friends.
- The key to a durable, quality trail is to effectively manage water
- A quality trail depends on the effective and equal application of all five elements of the process: planning, design, construction, maintenance, and management

Chapter Five
Preparing for the Field

Riding Takes All of Your Wits, Don't Impair Them

The most important and gratifying part of creating great trails occurs in the field. The saying that even a bad day in the field is better than a good day in the office is very true. The field is where the creative juices can flow; where there are options, challenges, and opportunities; and where all of the pieces of the puzzle come together. The planning and design team members can apply their understanding of the landscape, environment, recreation use, and physical forces to make informed decisions that will most benefit the riders while ensuring the protection of the resources. To make effective use of the time in the field, team members need to arm themselves with tools and techniques and have as much knowledge of the area as possible.

Section 1: Gearing Up for the Field

Safety and Risk Management

The field is a wonderful place, but it is full of personal risk. Before heading to the field, the team needs to take some time to examine the risk factors and mitigate them. The primary objective every day is to come back safely and the team does that by stacking the odds in their favor; being prepared and alert. What is the weather forecast? Dress accordingly. Are the soils slippery when wet? Wear appropriate footwear. What insects are in the area: bees, mosquitos, ticks, chiggers, scorpions? Wear appropriate clothing; take insect sprays; and look before walking, sitting, or reaching. If someone is allergic to any bites or stings, take an Epi kit. What animals are present: bear, deer, elk, moose, or domestic livestock? Don't be too proud to wear a bear bell or pack bear spray. What poisonous reptiles are present? Again, look before walking, stepping, and reaching. Snake gaiters are hot, bulky, and certainly not fashionable, but the peace of mind they offer is worth it. What poisonous plants are in the area? Know what they look like and where they grow and dress accordingly. Vehicles are needed to get the team in and out of the field every day. What condition are the trucks, ATVs, OHMs, etc. in? If there should be a mechanical malfunction, how will the team get out? Is there party or drug activity in the area? Are there people who want to live off the grid? Be aware and avoid walking into a situation that may put the team at risk. Finally, know the team members' physical limitations. If team members don't think they can safely traverse the terrain on a given day, don't go. Stay in and catch up on paperwork.

The proper gear helps you have a safe and enjoyable day in the field. Minimizing your risk will help ensure that you can enjoy another day tomorrow.

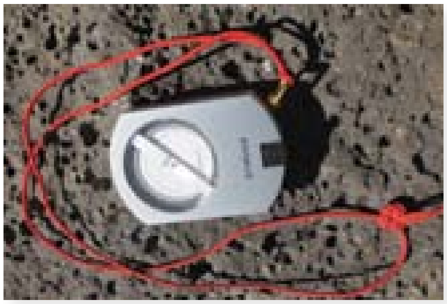
Certainly, one of the best things to do to keep the odds in a team's favor is to carry and use personal protective equipment (PPE). This may include riding gear, chainsaw gear, climbing gear, hardhats, high visibility vests, etc. There is no valid excuse to not wear it. Manage risk and keep everyone safe. No one can do trail work if they're hurt.

Being prepared can turn a cold, wet lunch from something to endure to an enjoyable event. When you take a bite of your sandwich and you get more bugs than sandwich, it's time for the bug nets.

The goal of all of this is not only to keep team members safe, but to maximize the efficiency of the time spent in the field. Many agencies formalize the project analysis and self-protection process on a Job Hazard Analysis (JHA) form.

Basic Field Instruments

Whether doing reconnaissance of a project site, assessing an existing trail, performing trail layout and design, or establishing construction controls, the team needs to have an array of tools available to help perform whatever task is needed. Once in the field, the office, supply room, and shop are in team members' day packs.



Consider taking a variety of key instruments and tools. A short list is described below. Additional information can be found on the Great Trails website at www.greatohvtrails.com.

A **clinometer** is an invaluable little device used to measure the percent of slope or degree of slope between any two points. It requires binocular vision and takes a little practice to use, but it is the number one companion of any trail designer. The clinometer is not highly accurate and if it gets knocked around in the field it can lose calibration. There is no calibration adjustment, but a good test is to shoot the grade to the uphill point and then once there, shoot the grade back to the downhill point. If they are off by 3 or more percent, it's time for a new one.

A **GPS receiver** uses global positioning satellites to pinpoint position, track progress, approximate elevation, and establish waypoints. Many have a built-in camera, radio, barometer, compass, or other handy features. Even recreation grade units are highly accurate. Team members should learn how to navigate and use the TRACKBACK or GOTO features on the GPS before they need them.

Taking handwritten notes or typing in waypoint data on a GPS receiver can be laborious. Instead, it's faster and easier to record the data on a **voice recorder**. This data can be digitally downloaded and saved to a computer. A voice recorder app on a smartphone can also be used.

Though a lot of other devices have built-in cameras, a quality pocket-sized **digital camera** still takes better pictures and offers more functions. Because there can never be enough photos taken in the field, it's a good idea to have one at all times. Don't forget a fully charged spare battery. A flexible mini-tripod is also handy to capture the perfect shot.

Roll-up **100-foot cloth tapes** are very handy for measuring or designing structures or facilities.

Small multi-blade, **multi-function tools** are invaluable in the field.

Spare batteries should be packed for whatever device uses batteries. Field time is valuable. Don't have it cut short because of dead batteries.

Team members should have **radio communication** so they can coordinate and work together more effectively and safely. The little consumer-grade GMRS or FRS radios have a good range and good call quality.

Flagging and Pin Flags

The flagging that comes in a roll is called ribbon flagging and it is offered in a variety of colors and patterns. Flagging is used to mark the trail alignment as well as various work items. Most projects have a list of flagging protocols that spell out the color and pattern to be used for each work item. It is very important that the flagging used for a trail does not conflict with what is used by other agencies or industry for timber sale boundaries, road surveys, proposed utility corridors, mining claims, seismic lines, transect surveys, etc.

Ready for the field with the day pack, pin flags and carrier, and pre-tied paper clips on an embroidery hoop.

A key point to remember about flagging is that it is not very durable. Deer, cows, rodents and insects eat it; the UV rays from the sun can fade the color in just a few months; and the wind, hail, and cold tear it to shreds. Hanging long streams of flagging is great for visibility, but it is more susceptible to the critters and the elements and thus has limited longevity. Shorter flags last longer. Since a large percentage of the flags will disappear, tie them close together. A 15-foot interval works well. It can be several years from the time a trail is designed to the time the trail gets constructed.

What is the best method to tie the flags? A simple overhand knot works well for temporary flags. A key thing about knots is that they should be simple to tie and untie when there are changes. A double overhand knot is not simple to undo. A bow knot is simple. One pull on the loose end and it comes off. Unfortunately, if that pull is coming from an animal, the flag will be lost. A loop knot works well. Fold the piece of flagging into a loop, place the loop over the limb, and pull the tails through. This simple knot is easy to tie and untie. Repeat the process for a double loop.

A simple loop knot is easy to tie and untie and it's durable. (loosely tied to illustrate the knot)

It takes more time, but tying a double or triple knot will last significantly longer and after a couple of years, only the knot will be left. The downside of using multiple knots is that it is very difficult and time-consuming to remove the flags to change the line. Tie the multi-knots on the last pass through a flagline, not the first.

A trick is to pre-tie flags onto smooth jumbo paperclips. These are easy to clip on and off, are durable, and are more visible when only the knot is left. There are four main advantages to the paperclip trick: it eliminates the fumbling and pain of trying to tie a knot in a briar patch; knots are tight and consistent since they are tied in a warm controlled environment; it is fast, clip it on and move on; and rather than focusing on reaching in and tying a difficult knot, the designers can stay focused on what the trail grade, alignment, or drainage is doing.

The loop knot tied onto a jumbo paper clip is a slick trick: fast, efficient, durable.

The paper clips come in boxes of 100. Tie a box at a time and hook them onto a string. When ready to use, transfer them from the string to a slightly modified steel spring-tensioned embroidery hoop from a fabric store and head to the field.

A pin flag is a wire whip with a colored flag on top. The length of the wire and the size of the flag vary. Pin flags are handy in open areas or meadows where there are few trees or brush to hang flagging. The longevity of pin flags can be shorter than that of ribbon flagging. The flag tends to break off in the wind and cold leaving only a rusted wire as a marker. The wire will usually stay in place and at least the critters won't eat it, but it can be very hard to find once it is no longer shiny or if it's in tall grass. It is best to install the flags at short intervals. Pin flag carriers or quivers are available in a variety of lengths. Pin flags provide a great visual because they highlight the flow of the trail. They can be especially helpful when creating circular curves in the field.

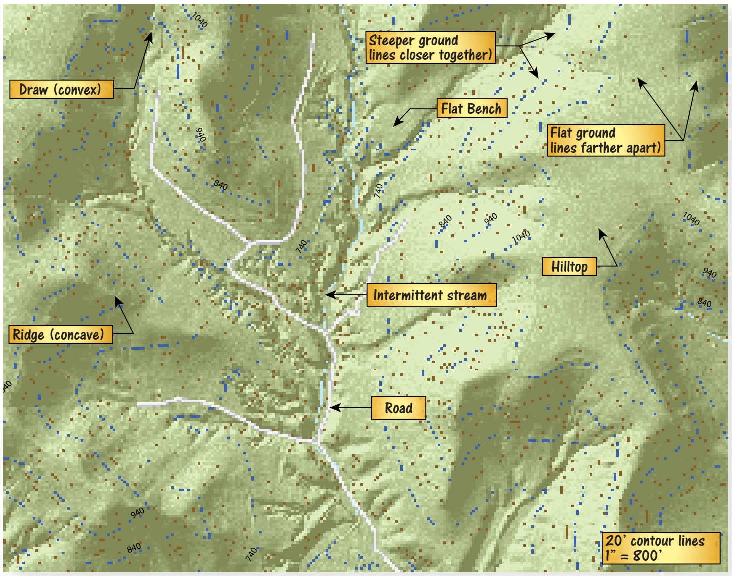
Re-flagging is necessary on most projects that won't be implemented within one year. Making an accurate survey of the flagline with a good GPS is essential in order to re-establish the line.

Section 2: Finding the Way in the Field

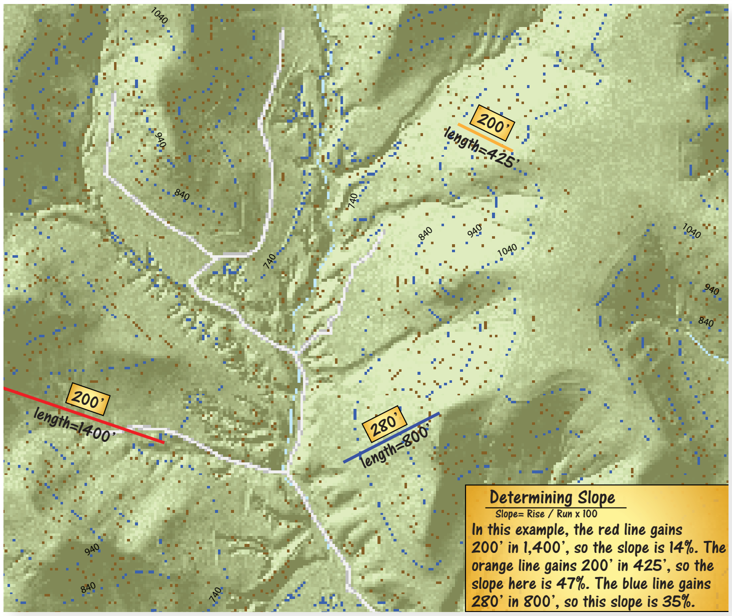
Before going to the field, planning and design teams should arm themselves with as much knowledge of the site as possible. They should study maps and imagery for valuable information on the site, where to go, and how to get there. Resource data in GIS layers can show opportunites as well as constraints. Knowing how to use a GPS receiver in conjunction with maps can help the team efficiently navigate to where they want to go and can tell them where they are in relation to the opportunities and constraints. Mapping technology is constantly evolving with more recreation-grade products, higher quality, more features, and lower cost.

Using Topographic Maps in the Field

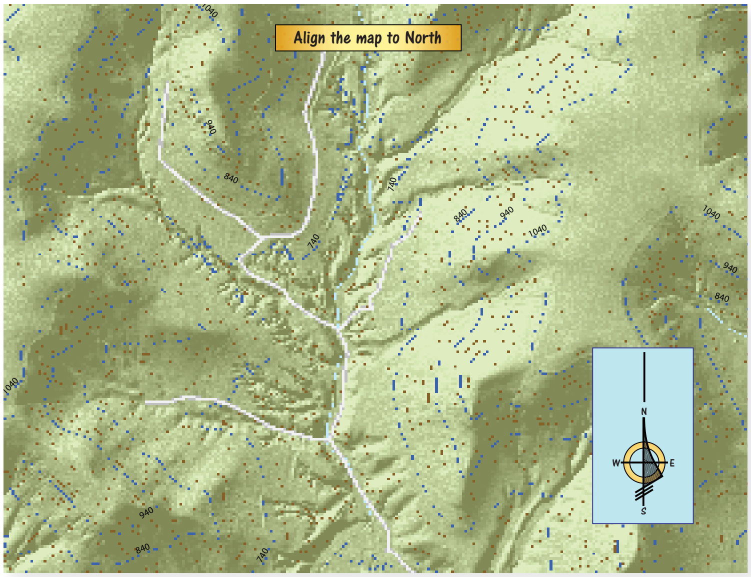
Topographic (topo) maps illustrate features such as contour lines, mountains, roads, trails, streams, lakes, towns, buildings, power lines, forested areas, open areas, and other features. These features are mapped using aerial photographic interpretation called photogrammetry. In the United States, most of this mapping was done by the U.S. Geological Survey. The entire country is divided into named rectangles and the maps are referred to as USGS quadrangles, or quad maps.

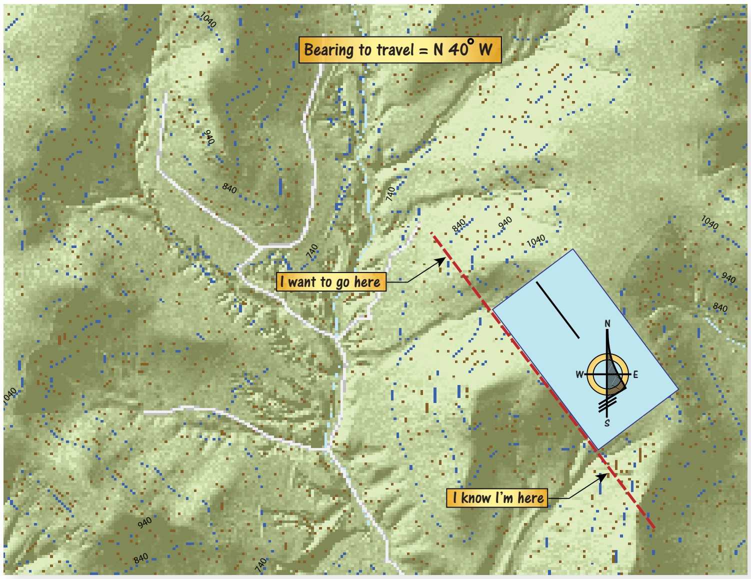


Contour lines are informative features on topo maps and represent points of equal elevation (height) joined together to form a line. Contour lines typically represent elevation intervals of 10, 20, or 40 feet. The exact contour height above sea level is less important than how the lines represent the shape and slope of topography. The closer the contour lines are together the steeper the topography is. Contour lines also illustrate ridges, valleys, and depressions. Convex lines pointing uphill represent valleys or drainages. Concave lines pointing downhill represent ridges or hills. Contour lines that are concentric circles indicate a hilltop. Saddles are flat areas on a ridgeline often between two hilltops. Saddles are indicated where the same contour line on each side of a ridge comes close together without touching. Lines that have small segments at right angles to the contour line represent depressions or sinks and are typically wetlands, lakes, or holes. A contour line ending at the edge of another one depicts a cliff that has height but no width.



Topo maps are useful not only because they show vertical relief as contour lines, but also because they are plotted in a horizontal scale, usually 1:24,000 or 1:50,000. This means that 1 inch equals 24,000 inches (or 50,000 inches). Because topo maps are two-dimensional, the distance is horizontal distance, not slope distance. The slope of the ground or the grade of a trail can be calculated from the elevation difference and the horizontal distance between any two points. As planners and designers become more familiar with contour lines, they will be able to understand slope simply by studying the contour lines. An experienced trail designer can create a conceptual trail alignment by drawing it on a topo map and then refining it in the field.





While topo maps can be used to plot a trail, there are often features such as large rocks and sometimes ledges that do not appear on contour maps. Aerial imagery used in conjunction with the topo map can help identify these features, but often they need to be located in the field, marked on the map, and recorded with a GPS unit.

Using Aerial Imagery in the Field

While topo maps and other maps are very useful, they still don't allow a clear visual of the landscape before venturing into the field. Aerial photographs merged into a seamless map are available from several software sources. Some are free, but the ones with highest quality imagery and the best drawing and editing tools are not. With aerial mapping, planners and designers can see the ridges, draws, creeks, ponds, rock knobs, cliffs, vegetation type and density, timber management units, wildfires or fire management units, and other important features.

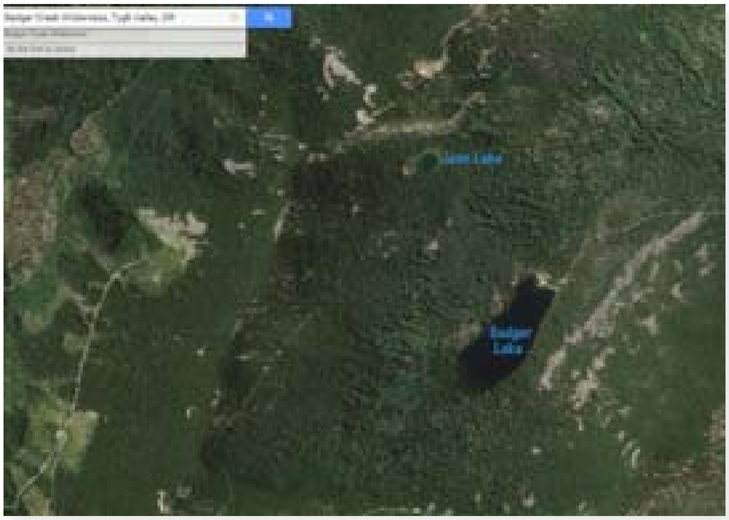
The most common free aerial mapping is Google Earth and the software for most GPS units can view the tracks and waypoints in Google Earth. While it is primarily used to view data, it can also be used as software to create very basic data by drawing points, lines, or polygons. GIS data can be exported from other software as KMZ or KML files and easily overlaid in Google Earth. Layers exported to these formats can easily be added by clicking on them as an email attachment or as a link on a webpage, or opened from within the program. The end user must have Google Earth software loaded on a computer and have an internet connection for this software to work. Aerial photography and terrain data are automatically loaded into Google Earth if an Internet connection exists. The quality of the aerial photography depends on the area of interest, but it tends to get very pixelated as the user zooms in.

Two views of the same landscape: above, a 2-D topo map with shaded relief showing Badger Lake using DeLorme Topo North America software; right, a projected 3-D view of the topo map with shaded relief.

Another useful tool is the ability to record a flyover path, which can also be shared with others. For example, a recorded path can illustrate the alignment of a proposed trail as a 3-D flyover.

Many of the better GPS units have aerial maps available at a cost from the manufacturer that can be downloaded and used as a base map in the GPS. Assuming that the mapping is current, this feature allows planners and designers to view the landscape not only where they are, but also where they may want to go. They can view a desirable feature on the GPS screen and the unit will give them a bearing and distance to get there. This can be a real timesaver when exploring new ground.

An aerial view of Badger Lake using ExpertGPS software.



The same view using Google Earth software.

Using GPS Technology

The global positioning system (GPS) is a satellite-based navigation system made up of a network of 24 satellites placed into orbit around the world by the U.S. Department of Defense. GPS works in any weather conditions, anywhere in the world, 24 hours a day. There are no subscription fees or setup charges to use the GPS signal. A GPS receiver or unit is used to receive the information from satellite signals and uses triangulation to calculate the person's exact location. Essentially, the GPS unit compares the time a signal was transmitted by a satellite with the time it was received. The time difference tells the GPS receiver how far away the satellite is. Adding measurements from a few more satellites enables the receiver to determine the person's electronic map or as a coordinate such as longitude-latitude. A GPS unit must be locked on to the signal of at least three satellites to calculate a 2-D position (latitude and longitude) and track movement. With four or more satellites in view, the receiver can determine the person's 3-D position (latitude, longitude, and altitude). Once the person's position has been determined, the GPS unit can calculate other information, such as speed, bearing, track, trip distance, distance to destination, altitude, sunrise and sunset time, and more.

Atmospheric and topographic conditions can affect the quality and strength of GPS signals and cause distortions in the data. The location of satellites at given times of the day provide for better or worse signal strength, which affects the accuracy of triangulation. This is typically only important when trying to locate a feature within a foot or two of where it is actually located. Cloudy, rainy, or snowy conditions can have an effect on signal strength and of course lead to moisture build-up in the electronics. GPS signals can be distorted by bouncing off buildings and rock cliffs. When working in areas with tall hard surfaces or in a deep canyon, it may be necessary to use higher quality GPS units that can filter distorted data or switch to the use of a map and compass in these areas. Another technique is to capture a good GPS position from a nearby high point and then measure a bearing and distance from that GPS position. Dense forest canopy can also have a significant effect on GPS signal strength. This can be overcome by using higher quality GPS units or using a combination of GPS, map, compass, and laser range finder. GPS units are usually more accurate after they have acquired GPS data for at least 15 minutes. A good accuracy test for a GPS unit is to see how accurately it is locating a known point such as a road intersection in an open area.

GPS units come in many sizes, colors, and most important price ranges. There is a general correlation between price, accuracy, and functionality. The most commonly used and lower cost GPS units are incorporated into smartphones and tablets. Smartphones formerly only used cellular signals to triangulate location; most now have GPS receivers so their navigation apps can work in remote locations. While these devices are more suited for general navigation purposes, they can be used as GPS units if they are thoroughly tested to make sure they provide adequate accuracy and a reliable signal. GPS accuracy is usually measured in both horizontal and vertical precision.

A Closer Look...

How are you going to use your photos? While it may be convenient for your GPS or other device to take pictures, the quality of those pictures may not be as good as with a digital camera. They may be fine for trail file or condition assessments, but they may not have the desirable quality for presentations and formal documents.

For general navigation and trail design work, planners and designers should find a GPS with an average horizontal accuracy of 3 meters or less. This means the GPS unit will consistently provide an average position within 3 meters or less of the actual location. Accuracy for vertical measurement, or elevation above sea level, is less precise and will usually be within 30 to 100 feet of the actual elevation. A couple of the most important features when shopping for a GPS include the ability to easily download GPS data from the unit and to display topo maps or other imagery on the unit. One of the biggest downsides of recreation-grade units and software is that they don't allow for large format printing. Only what is shown on the screen can be printed, so making a map involves the laborious process of printing several pages and cutting and pasting them together.

When selecting a GPS unit, make sure it has the ability to connect to a desktop computer or send files electronically.

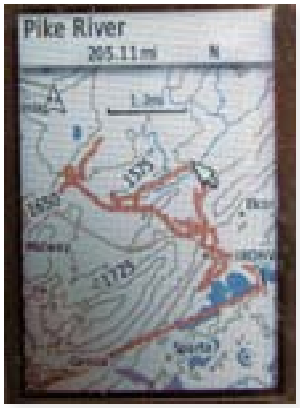
GPS units are very useful tools for a wide range of uses. Some of the most useful functions for trail-related work are provided below.

- Provide an accurate geographic location
- Provide the straight-line distance and direction to a destination
- Record the day's travel as a track, creating an accurate bread crumb trail to reverse and follow home, or use as backup data
- Provide the altitude within 30 to 100 feet
- Record or refer to destinations as waypoints
- Record or refer to trail alignments as tracks
- Load custom base maps on the GPS, including data such as topo map, slope map, recreation sites, trails, campsites, trailheads, sensitive areas, private property, etc.

A conceptual trail design alignment can be completed on a desktop computer and then loaded on the GPS unit. The loaded alignment can be used as a reference line while refining the trail design in the field.

A geotagged photo documenting a water issue

On the right, the GPS cursor shows a location right on a contour line. With the same map datum, it is easy to find the same location on the topo map. Note how the elevation displayed on the GPS matches the contour line elevation.



Smartphones and some GPS units geotag digital photos, which can be used to document the location of trail alignments, features, and scenic views.

Video and voice recordings can also be geotagged to provide more detailed documentation of trail designs and conditions for construction and maintenance purposes. If a video is geotagged to an entire trail GPS line, a split view of a map and video can be used to illustrate a trail design or existing trail. This provides a virtual tour of a trail before it's constructed.

Geotagging records a GPS coordinate within the header data of a jpeg photo. Software such as GeoJot can be used to create GIS points from this geotag information, which can then be illustrated on the GPS for future field work or on maps. GeoJot software can also be used to geotag photos from standard digital cameras using a GPS track or track log. There are digital cameras such as the Ricoh GPS camera that can assign location attributes to photos. This type of camera greatly improves efficiency and quality of digital photography.

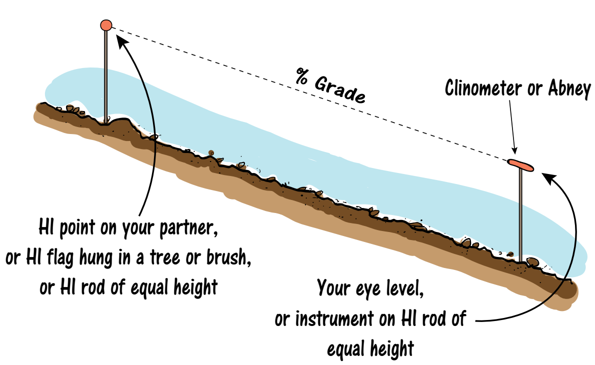
> **Tip, Trick or Trap?**
>
> **Tip:** Practice, Practice, Practice
>
> Spend plenty of time to get familiar with using your maps, compass, and GPS unit. Don't wait until you are in an emergency situation to learn how to use and trust all of the features of your GPS.

Transferring files from a GPS to a computer used to be difficult. While there are many kinds of files used by GPS units, there now are free tools such as the Minnesota DNR Garmin GPS tool and the GPS Bable tool available to convert between these types of files. ESRI ArcGIS software also imports and exports to the most common types of GPS files, including GPX files.

Section 3: Applying Engineering in the Field

Before going to the field, planners and designers need to be able to measure grades and apply basic engineering principles to measure or calculate lines, areas, and volumes.

How to measure grade

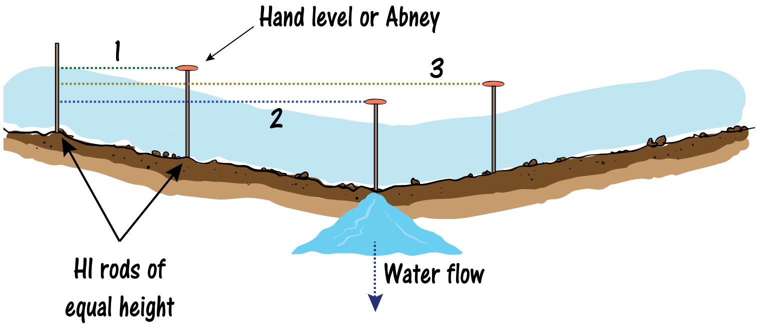


How to Measure Grade

There are three primary methods of measuring grade in the field. The first is the two-person method. On flat ground, two people stand toe-to-toe in front of each other. Using a clinometer or Abney, one person puts the bubble on zero percent and notes the spot where that hits his or her companion (chin, tip of nose, hairline, etc.). That spot becomes the height of instrument (HI) point or zero point on the partner.

Sighting on that same spot as the partner moves up and down the slope will give the percent of grade difference between the two people.

Determining the low point using the HI rod method



The second method is the HI rod method. Take two rods, sticks, or lath of equal length. If there are two people, have one person hold one rod stationary and vertically level while the other person moves up or down slope. If there is only one person, pound one rod into the ground just far enough so it will stand by itself. Put the other rod next to the first and mark the spot where the second rod is level with the top of the first or stationary rod. The first person moves up or down slope with the second rod. That person uses a clinometer or Abney to shoot between the mark on the top or the level marking of the first rod and the second. The result will be the grade difference between the two rods. On flat ground, up or down slope can be visually deceptive. Don't guess. This method is foolproof.

The third method is the one-person method. At a starting point, tie a short flag at eye height on a tree limb or brush (this becomes the HI flag), move ahead and up or down the slope as needed, sight back at the HI flag with the clinometer or Abney and the result will be the difference in grade or slope between the person and his or her starting point. This method does not work well in open areas where there is no vegetation at eye height or in places with very dense vegetation where the HI flag can quickly become obscured.

Tip, Trick or Trap?

Trap: Never rely on your "eye" to determine grades, especially on flat ground or when determining the low drainage point in a trail

How to Find the Lowest Point in a Grade Sag

On very flat ground or when trying to determine the low point of a drain, the HI rod method works very well. It is usually best to mark off elevation lines on the stationary HI rod and create a makeshift leveling rod. Take a tape measure and make a short dash at 1-inch intervals with a magic marker. It is best to use a hand level or Abney level set on zero because these are more accurate than a clinometer and they usually have magnification in the optics for easier reading. In the example above, sight #1 is below the top of the stationary rod, so elevation has been dropped. Sight #2 is below sight #1, so elevation is still dropping. Sight #3 is above sight #2, so elevation is now rising. Go back to the area of sight #2 and take a couple more shots at the stationary rod. The lowest reading or sight point on that rod will be at the low point of the trail.

How to Lay Out a Circular Curve without Instruments

A lot of work field technicians do is conducted without assistance, so to make effective use of time, they need to be able to perform basic engineering applications by themselves. As discussed in Chapter 4, circular curves provide improved flow, increased rideability, and reduced

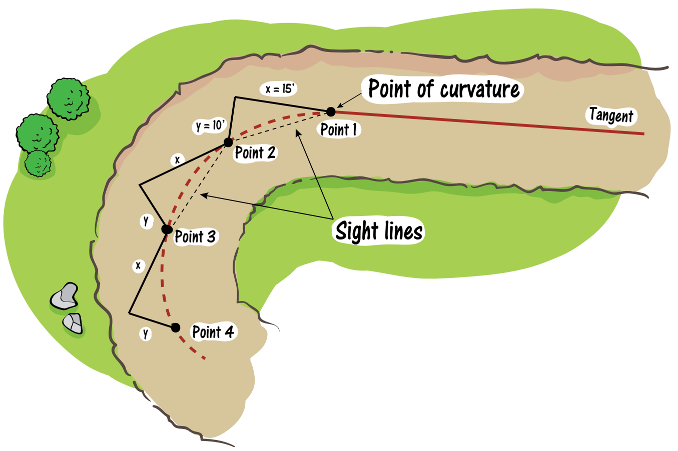
To be effective, climbing turns must have a smooth radius curve.

tread impacts. There are times when it is essential that the curve be circular such as when designing a climbing turn. These types of turns are the most effective way to gain elevation on a motorized trail, but they must be smooth, flowing, and circular; or significant tread impacts can develop.

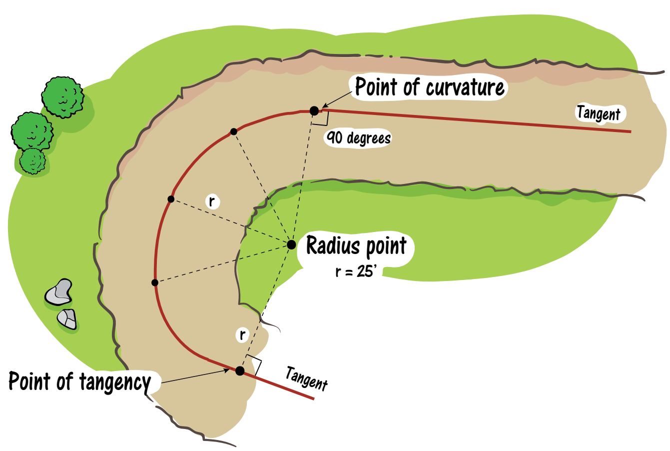
Any two points make a line and any three points can make a curve; that same progression can be applied in the offset method to make a curve. It is best to practice this technique in an open field with good visibility. At the starting point of the curve (called the PC or Point of Curvature), insert a pin flag or lath into the ground. This is point one.

Walk ahead 15 feet (x) staying on line between point one and the tangent behind it. From that point, measure 5 feet (y) in the direction the curve will go and insert another pin flag or lath at that offset point. This is point two. Walk ahead another 15 feet staying in line with points one and two. From there, measure 5 feet in the direction of the curve and insert another pin flag or lath. This is point three. A degree of curvature for the curve has now been established.

Offset method



Radius method



Planners and designers can now visualize how the curve is taking shape. They can continue this process until the curve is completed (called the PT or point of tangency). They can add intermediate flags as needed between points and adjust any that look out of place.

To make a tighter curve, increase (y) or increase (y) and decrease (x). Once planners and designers have practiced this technique, they can use steps or paces instead of measuring the distances. When they have mastered the technique, they will be able to lay out any curve using just flagging and their eyes.

Another method for laying out curves is the radius method. For this method, the radius (r) of the curve is known. If it isn't known, estimate the radius that will fit the site and then adjust it up or down as necessary. For example, assume a 25-foot radius is needed. From the starting point or PC, turn 90 degrees to the back tangent and measure 25 feet in the direction of the curve and insert a pin flag or lath. This is the radius point of the curve. From this point, measure out 25 feet and insert pin flags along the arc of the curve. If trees or brush are in the way, make several arc measurements. Add intermediate flags as needed between points and adjust any that look out of place.

In case you don't remember your basic geometry or trigonometry, we created a special crash course for you in Chapter 5 on our website. Find it at www.greatohvtrails.com.

This is a well-designed and well-constructed climbing turn. The person building the trail must have the same vision and understanding of OHV recreation as the person designing the trail or a great design will not become a great trail.

A Look Back...

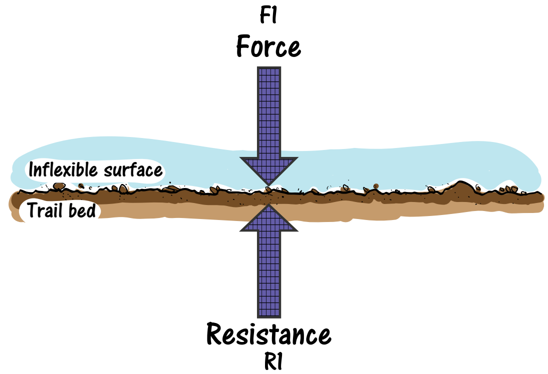
Here are some of the elements discussed in this chapter:

- When preparing for the field, recognize hazards and manage risk. Take the proper clothing and survival gear and always wear the appropriate personal protective equipment (PPE).
- Take instruments to measure and record data easily and effectively in the field.
- There are pros and cons of flagging and pin flags. The paper clip trick and fingerless gloves will make the process of hanging flagging faster and less painful. Pin flags or stake flags generally have a shorter lifespan than flagging.
- Though only 2-dimensional, learning to read contour maps can give the field technician a good 3-dimensional view of the ground.
- A contour map, aerial imagery, GPS, and a compass are basic tools for efficiently navigating in the field.
- Points, lines, and polygons are the primary geometric shapes used in identifying and mapping important features and data.
- Three common methods to measure grade: 2-person method, HI rod method, 1-person method. Remember: Rise/Run x 100 = Grade. Never eyeball grade or drainage low points.
- On flat grades, use the HI rod method to find the low point for drainage.
- Two methods to stake a circular curve in the field without instruments: offset method and radius method

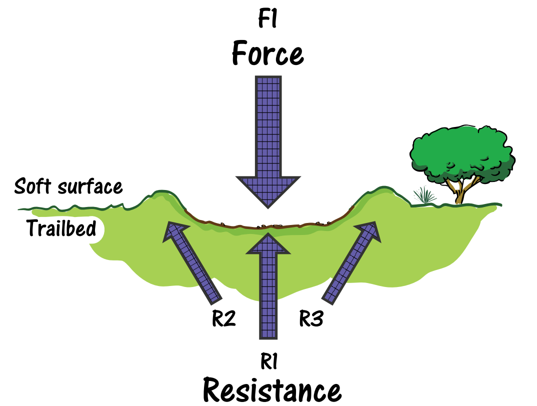
Chapter Six

Tools in the Toolbox: Soil Stabilization and Trail Hardening

There are times when trails must go through wet areas or soft soils, and there are times it is desirable to have them there to enhance the scenic quality, variety, and rider experience. There are times when no matter how good the soil is, it can't withstand the vehicle volume of use or weight. There are also places, as in road and structure crossings, where the approaches need to be enhanced to ensure smooth transitions. All of these scenarios require some type of tread reinforcement.



Resistance = Force (R1=F1)



Resistance = Force (R1+R2+R3=F1)

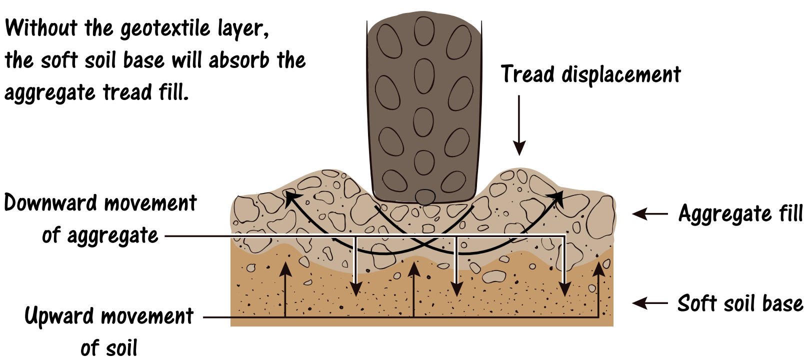
Chapter 4 discussed the physical forces and the fact that for every force down, there is an equal and opposite force up. On a hard surface, the upward force is equal to and directly opposite the downward force. As the surface softens, the vertical upward force decreases and lateral upward forces increase resulting in soil displacement and berms. A goal for a durable trail is to minimize displacement, and one way to accomplish that is to increase the strength of the tread surface.

There are two ways to increase the strength of the tread: stabilization, where another material is mixed into the soil, and trail hardening, where another material is added on top of the soil. Before discussing these two methods, Section 1 explains geosynthetics, which are often used in both soil stabilization and trail hardening.

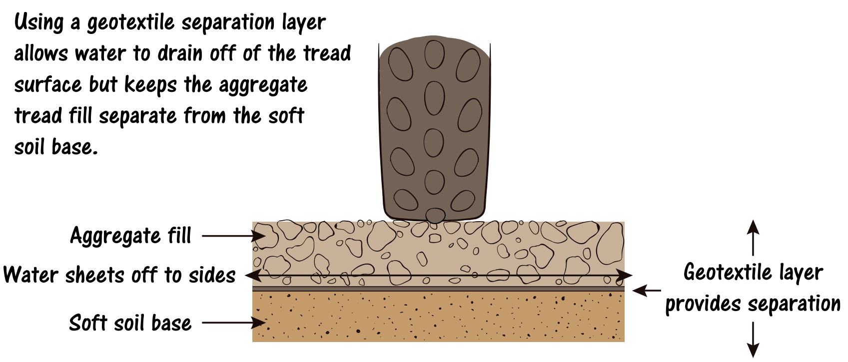
Section 1: Geosynthetics 101

Geosynthetics Defined

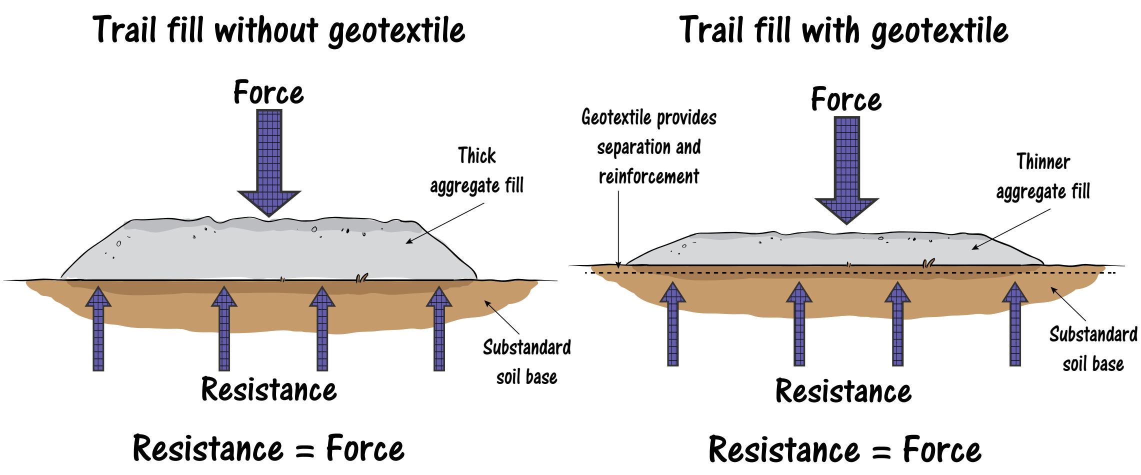
Geosynthetics are synthetic polymers that are woven or formed into a variety of shapes. These materials perform six major functions: reinforcement, separation, drainage, filtration, containment, and erosion control. The first four functions are most commonly used for trails and are explained below.



The tough polymer fibers give the geosynthetics lateral and longitudinal tensile strength, which provides reinforcement and helps prevent deformation under a load. This tensile strength distributes the load over a wider area reducing the PSI of the load and improves the weight-bearing capacity of the material above it. Since the geosynthetic supports much of the load with little deformation, less force is directed down into the layer of soft soil resulting in less displacement and less subsoil pumping. The geosynthetic acts as a structural bond between the good upper layer and the poor lower layer, which increases the weight-bearing capacity of both layers. Using a geosynthetic or a geosynthetic layer can reduce the amount of fill needed on a tread surface, saving costs and maintenance in the long-term.



A layer of geosynthetics is used for separation and prevents good material, like crushed rock, from intermixing with poor material, like soft or saturated soil. For example, many times rock is placed in a mud hole but in a couple of years it has disappeared. When moisture conditions are right, the rock gets pushed into and absorbed by the soft soil. Geosynthetics provide important separation of and reinforcement between the layers of rock and soil.



Some geosynthetics are used for drainage and designed to allow water to drain laterally across them so water is diverted off to the sides rather than down, which reduces the saturation of the subsoil and increases its strength.

Some geosynthetics are used for filtration and designed to allow water, but not soil, to pass through their pores. It is this filtration property that makes silt fence and French drains so effective.

Common Geosynthetics Shapes

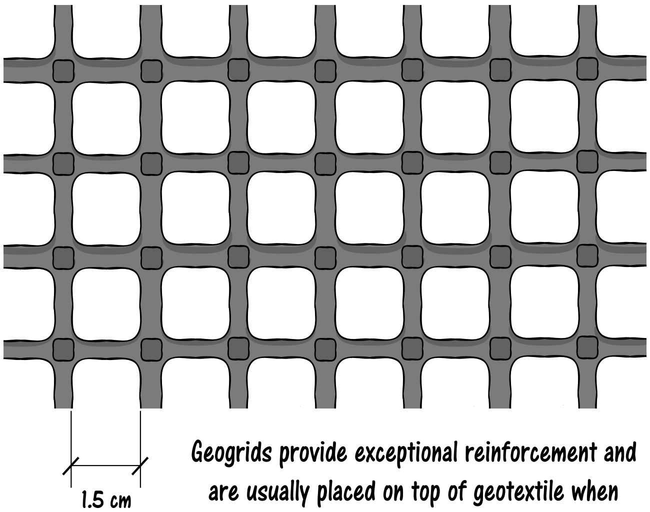
The most common geosynthetics shapes are: geotextiles, geogrids, geonets, geocells, grass pavers, and geocomposites.

Geotextiles are synthetic fabrics that are most commonly used for separation, reinforcement, and filtration. These are great for OHV trails because they allow water but not soil to seep through and their tensile strength can support heavier loads.

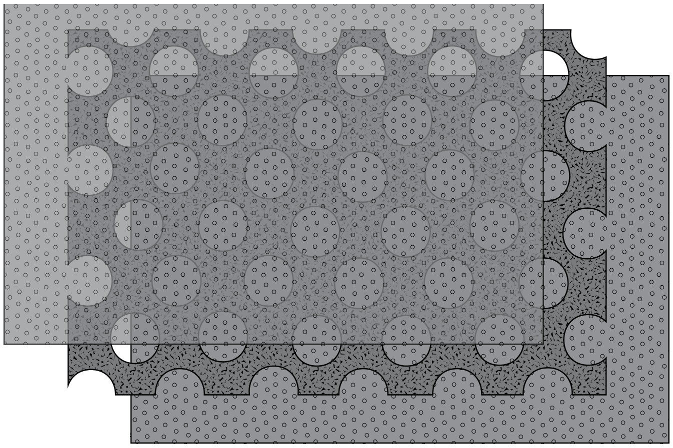
Felt like products are easier to use than slick products because they are easier to cut and place on curved trail sections.

Geogrids are polyethylene strands that are bonded into a grid pattern like a fish net. They are heavier and less flexible than geotextiles and therefore provide a higher level of reinforcement. They are often used in retaining walls and buttresses for added strength and shear resistance. For OHV trails in wet areas, geogrid is often put down over a layer of geotextile fabric and topped with a layer of coarse rock. This combination provides a superior level of separation and reinforcement.

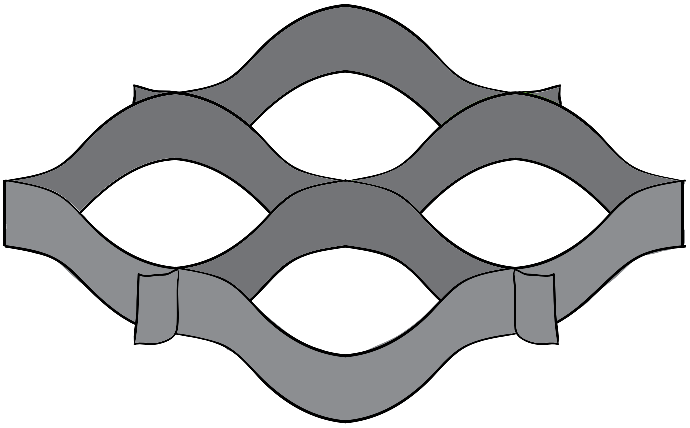
Geonets are a composite consisting of a thick geogrid sandwiched between two layers of geotextile. Because there are two layers of fabric, they provide excellent separation and reinforcement, but they are primarily designed to allow water to flow through the center grid and off to the side of the trail.



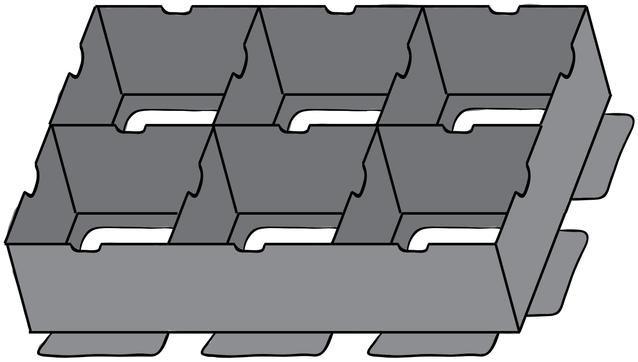
Geogrids provide exceptional reinforcement and are usually placed on top of geotextile when separation is also needed.



Geonets are considered a geocomposite because they incorporate more than one type of geosynthetic.



Geocells open up like an accordian and provide great lateral containment. The fill material needs to drain well so it doesn't squish out of the cells.



Grass paver is tough and rigid which provides excellent reinforcement while allowing for direct tire contact.

Geocells are polyethylene strips that are bonded into a honeycomb shape. They come in a variety of thicknesses, and are shipped flat for easy transport and then expanded on site. Once expanded, the honeycomb is filled with good soil, rock, or a mixture, which is then compacted. The cells contain the material so it can't displace out to the sides and each cell provides increased load-bearing and rigidity. The primary function of geocell is to provide reinforcement, not separation, so when it is used in a wet area with saturated soils, a layer of geotextile is put down first to provide the necessary separation.

Grass paver is a category of very stiff panels that can provide cellular containment like geocell but has a partial bottom that gives it excellent reinforcement properties. The panels interlock, which helps to distribute the load, reduce PSI, and stabilize the structure. Lightweight and easy to use, this is the one category of geosynthetic that is designed for direct tire contact.

Geocomposites such as sheet drains have a large cross section that allows drainage. If geotextiles are placed under the trail tread, the sheet drain should be oriented with the geotextile on the bottom and the plastic core on top. This orientation reduces the amount of fill needed.

Tip, Trick or Trap?

Trap: Installing only geotextile under a non-cohesive soil is not a quick fix

Why? Because the tires will quickly displace the soil cover and expose the geotextile. Once that occurs, the integrity of the structure will be compromised and it will rapidly deteriorate.

This is an excellent example of boxing in the trail hardening to provide lateral and longitudinal support. Unfortunately, the cover over this geocell has been lost and the structure is rapidly degrading. The large cobble rock in the center section is actually holding up better.

Here are some key points on geosynthetics:

- The need for any structure requiring a geosynthetic is a potential red flag indicator of poor trail location. Explore other options first, if available.
- Some geosynthetics are not UV stabilized so they deteriorate when exposed to the sun. Check specifications before purchasing and store them in their original wrappers out of sunlight.
- Ensure that the fill material covers the entire top and sides of these UV sensitive geosynthetics and is maintained at this level. Geosynthetics are tough, but most are not designed or intended to be used as the tread surface. Forces from the tires will quickly break down the material, tear it, and displace it.
- When used for trail hardening, the geosynthetic installation must be wider than the designed trail width. The more the load is centered, the more effective the weight-bearing will be. This keeps the tires off the shoulders of the installation, which protects them from displacement.
- Because of its reinforcing property, less fill is needed with a geosynthetic to attain the same weight-bearing capacity as a fill without it. This reduces the amount of material that needs to be hauled in and reduces the cost of the installation.

Tires and geotextile do not mix.

Section 2: Soil Stabilization Techniques

Just as gardeners treat the soil to add nutrients and organic matter, trail designers can fortify some soils to add structural strength. The intent is to give the soil the ideal clay content for binding and the ideal rock content for loadbearing strength. Benefits include increased strength to withstand heavy traffic pressure (reduced displacement), reduced sedimentation (soil loss), and increased intervals between heavy maintenance operations. Another advantage of stabilization is that in most cases, the trail retains its natural appearance and character, which enhances the rider experience. Designers should consult with an engineer, geologist, or soil scientist to determine the best treatment for a particular soil. The amendment process is simple: excavate the top layer of the tread, mix in the amendments usually with a rototiller or similar machine, spread the mixture back out onto the tread, add water if available, and compact it with a roller. Adding a layer of geosynthetics between the original soil and the treated soil will further increase the durability of the trail.

Tip, Trick or Trap?

Tip: The fist test: a simple field test for assessing water content and soil strength

Put a sample of soil about the size of a golf ball in the palm of the hand and make a tight fist. If the mass easily flakes apart, it is dry and below the Optimum Moisture Content. If the mass is firm and resists breaking apart, it is at or near the OMC. If water squeezes out of the soil, it is wet and above the OMC.

Soil Stabilization Materials

There are five common types of soil stabilization materials: clay, lime, aggregate, mix, and chemical.

A non-cohesive soil is one that has a low clay content. One way to remedy that is to add clay as a binder. This will not work for fine-grained soils like sand because the clay adds binder, but not load-bearing capacity. However, if the soil is course-grained with a high rock content, just adding clay can work quite well. There can be a fine line between not enough and too much clay, so getting the right mix is important but hard to control in the field.

Above, a rototiller on a 3-point tractor hitch makes an effective mixing implement. Below, an adjustable spreader box towed behind an ATV was used to measure out bentonite clay. The clay was too fine and the spreader box did not work well.

Lime has long been used to stabilize wet soils, especially wet clay soils. It dries the soil, bonds it together, and increases its load-bearing capacity. It has been successfully used under roads, runways, and building foundations, but there is little documentation on its use on motorized trails.

Some soils have a high clay content, but not a high rock content. Adding aggregate, which binds with the clay, increases the structural strength of the soil. Crushed rock works the best because it is highly angular and the rock points tend to lock the rock in place, but other rock can work also.

For non-cohesive fine-grained soils like sand or pumice, the soil lacks clay and rock content, so amending the soil with a mixture of clay and aggregate can work quite well.

Bentonite clay being rototilled into non-cohesive pumice soil.

A variety of chemical products are available which provide dust abatement by stabilizing the tread surface. Some are salts like magnesium chloride and calcium chloride and some are polymers like Road Oyl®, Soiltac®, Envirotac®, and Soil-Sement®. To be effective on trails, these products cannot be applied topically and must be disked or rototilled in for deep penetration. While there have been some studies of chemical stabilization for accessible trails, there has been limited testing of its use for OHV trails.


As an experiment, a section of this heavily used trail was stabilized with crusher reject (often called dirty rock, it has a lot of fines and angular material which can bind up like concrete). The rock was rototilled into the non-cohesive soil in an attempt to reduce displacement and mogulling. It worked. Ten years later, the stabilized section is firm and has retained its original prism while both ends have heavily displaced and moguled.

Tip, Trick or Trap?

Tip: The ribbon test: a simple field test for assessing the clay content of the soil

Add water to a sample of soil until it is at its optimum moisture content. Then take a small sample of soil about the size of a golf ball and squeeze it into a ribbon between thumb and forefinger. If the ribbon breaks apart in <1” sections, the soil is sandy. If the ribbon breaks in <2” sections, the soil is a clay loam. If the ribbon is >2” sections, the soil has a high clay content.


For some soil types, a variety of chemical dust abatement treatments can help stabilize the soil as well as prevent dust.

Here are some points regarding soil stabilization:

- Even with a mix design from a specialist, field application and mixing methods are crude at best and consistency is difficult to attain.
- The application and mixing is labor and equipment intensive and thus expensive.
- Because of the cost, a common mistake is making the stabilized soil layer too thin. Tire action can quickly break through it creating potholes and maintenance equipment can quickly wear it away. Minimizing the design to save money is a false economy.
- Unlike a road, runway base, or building foundation, trails have roots and rocks. In order to obtain a uniform depth and consistent mix, those need to be taken out, which adds to the cost and detracts from the naturalness of the trail.
- If chemicals are being considered, check for regulations that prohibit or restrict their use. A permit may also be required.
- When considering a project, check with local road or trail authorities to see what their experience has been. There may be a local mix or a local material that has exceptional qualities.
- Don’t be afraid to experiment.

When the spreader box plugged up, the eyeball measuring and hand distribution methods were used.

Section 3: Trail Hardening Techniques

Gravel and Stoning Reinforcement

This trail has been hardened with open graded crushed limestone from a nearby source. The trail drops into a sensitive watershed and hardening was required as a mitigation to reduce potential sedimentation. Though the rock was inexpensive due to its proximity, the poor gradation does not provide sufficient binding to prevent moguls on this grade, so maintenance costs are high.

Often the easiest and cheapest way to harden a wet spot or a soft spot is to simply add rock to it. A well-graded crushed rock works the best since the fine components fill in the voids between rocks and the crushed angles lock the whole mass together. Because crushed rock binds together so well, it is more impervious to water, which helps prevent the further saturation of the underlying soil layer. Most times people use whatever material is readily available to save cost. That's okay, try it and see how it works. Typically, the rock should be 3 - 4" or less. Anything larger than that can be too rough to comfortably ride with a motorcycle, but may be okay for ATVs, ROVs, and 4WDs.

With a nice serpentine alignment, this hardened trail harmonizes with the landscape. Notice the tightly compacted densely-graded aggregate.

Stoning works well in soft non-cohesive soils and in seasonal wet areas. It does not work in perpetually saturated soils. Stoning provides a host of benefits: a) it provides both bearing and binding for increased weight capacity and decreased rutting and displacement; b) it reduces or eliminates trail widening or braiding by creating a firm trail tread; c) it protects the underlying soil layer from erosion thus reducing sedimentation; d) it has a rough surface and doesn't form rills so it reduces the velocity of the surface water, which makes it easier to drain water off the trail; and e) being more durable, it increases the interval between required tread maintenance.

On the negative side, stoning: a) reduces the naturalness of the trail and detracts from the rider experience; b) can conflict with the aesthetics of the setting, especially if the rock color does not harmonize with the landscape; c) can cover up roots and rocks that are challenge features; d) can increase speed and therefore decrease seat time; and e) in wet or clay soils, can gradually sink in and need replacement.

This straighter alignment and light color aggregate makes the installation more visually intrusive.

This rock is almost uniform-graded. While it will reduce the velocity of water running down this trail, it has no binder to hold it together. Given the steep grade, this rock will quickly displace and form wheel ruts as the tires seek firm ground to gain traction.

A Closer Look...

Rock mixtures like crushed aggregate are categorized by the size of the largest rock size and the mix of progressively smaller particle sizes. There are three main categories:

- Uniform-Graded. This is rock where all the particle sizes are about the same. A 4” UG would have all rocks about 4” in diameter. There are no fines to fill the voids, so the rock does not compact or bind together well, but it does allow water to drain through it.
- Open or Poorly-Graded. This has a mix of particle sizes, but they may not be progressively smaller. PG will bind together better that UG, but will not stay compacted and will not drain water as well.
- Dense or Well-Graded. This rock has progressively smaller particle sizes so that all voids between the particles are filled. WG compacts tightly, stays bonded together, and has the best weight-bearing capacity. Water will run off the surface rather than drain down through it.

Due to a lack of load bearing, tire ruts have developed as this fine rock has been pushed into the mud.

Other Trail Hardening Materials

There are seven other commonly used materials for trail hardening: cobble reinforcement, geotextile fabric, grass pavers, geocell, pavers, slab rock armoring, and tire mats. There are also inventive materials or “others”.

Cobble reinforcement is similar to stoning except it uses rock that is 6 to 10” or less in size. Cobbles work well because they have a large surface area for increased load-bearing and that surface area also reduces the tendency of wet soils to suck the rock down into oblivion. Because cobble rock is usually uniform-graded, the voids between the rocks allow water to run through them, thus providing load-bearing as well as drainage. This is why cobble rock is used in drains.

In wet, mucky areas, cobble rock is often put down first, worked into the ground, and then covered with a layer of smaller-sized gravel. This allows water to drain through the rock subsurface, but the tread surface is smoother. The combination has less displacement since a mix of particle sizes holds the tread surface together.

When soils are wet more frequently than seasonally or if they are saturated, any applied gravel or cobble will eventually get sucked down into the soil and disappear. In this case, a layer of geotextile fabric will provide separation of the wet and dry layers and provide reinforcement by distributing the load over a wider surface area. This technique is simple, effective, and probably the most widely used trail hardening method.

This mixture of cobble and smaller rock is being spread over a layer of geotextile to provide load bearing for this ROV trail.

The trail through this draw used to be a mudhole in the spring. A layer of 8-10” cobble rock was put down and then topped with a layer of finer 4-6” cobble rock. It has not displaced after four years of heavy use. Even in a wet year, the cobble provides bearing while allowing water to run through it and over it.

Geotextile Fabric. When soils are wet more frequently than seasonally or if they are saturated, applying gravel or cobble won't be a long-term fix. Eventually, the stones will sink into the soil and disappear. In these cases, a layer of geotextile fabric will provide separation of the wet and dry layers. It will also provide reinforcement by distributing the load over a wider surface area. This technique is simple, effective, and possibly the most widely used trail hardening method.

Note the flared inlets on the culverts. These not only funnel the water into the culvert, but also retain fill material to keep it from sloughing off into the culvert.

Geotextile is being put down to provide separation and reinforcement on this Alaska trail.

Grass pavers can be placed directly on the surface with sandy or wet soils or placed on a layer of geotextile in saturated soils. The geotextile provides separation and additional reinforcement. Some varieties of grass pavers are the only geosynthetic that can take direct tire contact. It can be used as is or covered with a layer of fill for additional support and a more natural appearance. When placed directly on the surface with no geotextile or fill layer, the holes in the bottom of the panel allow vegetation to grow up through the panel. This results in less site disturbance, increased soil stability since the root zone is not disturbed, and increased visual appeal. The panels can be easily cut in the field to create curves or irregular shapes. Geoblock® is a grass paver often utilized for OHV trail hardening.

This is a good installation that is confined on the sides and segmented into blocks with treated timbers. However, water has not been managed and the cover of fill is being eroded away. Over time, this will weaken the structure and make it more slippery to ride. Tire impact forces on the timber may cause it to dislodge resulting in potential movement of the grass paver panels.

If only dual-track vehicles use this trail, why armor the entire width? The geotrack installation uses two rows of grass pavers attached to plastic timbers. Note how the grass pavers have been cut to form an angle. The entire installation was then covered with soil and rock.

Though able to withstand tire contact, grass pavers will break down under repeated tire impact. This end panel should have been angled down into the soil to provide a shallower impact angle. It could also be protected with a log or treated timber pinned into place. The left side has been dug down and is confined and protected, but the right side is vulnerable to damage by tires and should have been framed in or protected by fill. It appears that riders are avoiding the approach impact and are riding off to the right.

Grass pavers makes an excellent hardened approach to this bridge installation.

They did a nice job of making a circular curve on this installation, but a poor job of confining it. Unfortunately, riders are short-cutting it either to avoid the structure or to take a quicker path and the edges of the GeoBlock will start to break down. Strategically placed debris or a barrier would remedy this.

Notice how the installation was excavated down below natural ground elevation. This provides containment and support for the structure. The cells were filled with uniform graded rock and then everything was covered with fill layer of soil and rock. Maintaining an adequate cover layer is critical to ensure the integrity and longevity of the structure.

Geocell is commonly used for retaining walls and other support structures like bridge abutments. It is available with perforated or non-perforated cell walls. It has been used for trail hardening, but many of those installations have failed due to the lack of maintaining an adequate layer of fill. Geocell will disintegrate if exposed to direct tire contact.

One advantage of geocell is that it is easy to make curves. In this installation, geotextile has been placed under the geocell to provide separation and additional support.

The fill for this bridge approach and bridge abutments has been constructed in layers of geocell filled with a good soil and rock mix. Note the grass paver panels to insure a smooth transition onto the bridge deck.

The fill layer over this installation was not maintained. Direct tire impact displaced the material in the cells and destroyed the integrity of the structure.

This geocell bridge approach is in the process of disintegrating. Bridges and other structures can be very slippery. Having an approach on a curve is not desirable since the vehicles are still on the curve once they hit the bridge deck which increases the risk of losing control and sliding into the railing. The curve also creates more lateral tire forces which act to increase displacement on the geocell and deck approach. Note the lip on the bridge abutment (arrow). This will bounce a motorcycle tire off the ground and increase the risk of sliding on the bridge deck.

Tip, Trick or Trap?

Trap: Never assume that the pavers will stay in place because they are heavy concrete with edges that will bite in

Anchor or confine the pavers. OHVs exert tremendous rotational and lateral forces that must be counteracted by strong anchors.

This is an excellent example of a trail hardening installation that will likely fail. On the plus side, the material is framed into sections which help prevent movement. The gap between these two sections (yellow arrow) serves as a log culvert. On the minus side, this cobble surface is rough to ride on and the rotation action of the tires will displace the rocks out of the Geocell (red arrow) and the exposed cells will start to break down. The life and functionality of this structure could have been extended if it had been covered with a layer of well-graded aggregate.

Both of these pavers are designed to interlock. These are easier to install and they allow for flex, but they resist lateral movement. The ones on the right are pre-formed with holes so they can be tied together which further inhibits movement.

Pavers include concrete blocks and cinder blocks. When installed properly, these are tough, durable, and can withstand direct tire contact. The concrete edges provide traction, so pavers can be used on very steep grades. They are heavy, so transport into the site can be a challenge, and their installation is labor intensive, but pavers are one of the most commonly used trail hardening methods.

There are as many examples of poor installations using pavers as there are of good installations, but here are three points to ensure success with pavers:

1. The pavers must lay on a smooth, even surface. The bedding could be compacted native soil if it is a cohesive soil that won't displace. Compacted gravel will provide a firm bedding and bearing for the pavers. If the soil is always wet, a layer of geotextile can be put down under the bedding material to provide separation and reinforcement. Roots, rocks, or any surface protrusions can cause a paver to break or move.

2. When pavers are allowed to move, the installation will be doomed to failure. They must be thoroughly anchored or confined in place to prevent movement. It is easy to assume that since they are so heavy, they will never move.

3. In some soils, such as non-cohesive soils like sand, pumice, or wet muddy soils, the pavers are likely to move even if they are pinned. Also, factors like the grade and alignment can affect the forces being placed on the installation. A 100' stretch of pavers on a 35% grade exerts huge downward forces on the bottom pavers and enough force for the installation to eventually blow out at the bottom. The best, most durable, and longest lasting installations are divided into sections and are confined on all sides with logs or preferably 4x4 or 6x6 treated timber that is pinned in place. Each section performs independently and has no impact on the others. Downward and lateral forces are controlled and contained and the pavers cannot move. An additional benefit of framing is that the edges are supported and protected. This helps prevent breakage. As soon as breakage starts to occur, movement will soon follow.

A Closer Look…

A key consideration in the design of any trail hardening, but especially rigid structures like pavers and slab rock, is the forces being applied to them. Vehicle size and weight are factors, but more important is the vehicle width. Vehicles with solid axles or locked axles have different rates of rotation between the inside wheel and the outside wheel. The wider the axle, the bigger the rotational difference. This results in the exertion of twisting forces that cause either the tire to spin and hop, or the tread surface to twist and move, or both. Structures that are poorly bedded and confined can be displaced and destroyed by these forces. Acceleration will compound the forces, so where possible minimize grades or grade changes on hardening structures. Also, the larger the turning radius, the less rotational difference between the inner and outer tire, so larger radius turns will have less impact than small radius turns. This is especially important on climbing turns, which combine grade changes with the directional changes. Interlocking pavers or structures that are confined with frames will help resist these forces.

Depending on the availability of materials or access to the site, flat flagstone-type rocks or other materials can be used to harden short sections of trail. As with pavers, proper bedding and prevention of movement are essential.

The approach to this technical step-up is being armored to prevent the step from getting higher and eventually becoming unrideable.

These rock slabs are well-placed and keyed together, but they lack confinement. Rotational and centrifugal forces will gradually displace them.

Recycled tire mats have been available in some fashion for many years. Though using recycled material is good for the environment, the mats to date have not held up well to the forces of OHV use.

Right and above, once again, the key to success is keeping the material anchored. Once it is allowed to move, it will self-destruct.

Trail hardening can be expensive, but there may be local sources of materials available for free that might work quite well. Don't be afraid to experiment. Trying something and having it fail may be disappointing, but it's probably still better than doing nothing at all.

This hardening installation is composed of chunks of sidewalk that was headed for the landfill. Being heavy and angular, the pieces should key together very well. Notice that they have been embedded so that the edges are contained by the natural soil.

This hardening installation is another recycling project. A brick and concrete high school was being torn down and was headed for the landfill, but a heads-up project planner thought to grind it up and try it for trail hardening. The material was free, it worked, and it set up like concrete due to a good mix of particle sizes. This was a win-win for the project, the community, and the environment.

Here are some things to consider about trail hardening:

- Product manufacturers can assist in product selection, application, and design specifications.
- A key consideration before installing any trail hardening is how it will be maintained. A relatively thin layer of fill over a structure requires awareness and a light touch by maintenance workers, especially when using equipment.
- It is also critical that the layer of fill over a structure be maintained at the designed depth to prevent exposure and damage to the material underneath.
- In areas with limited trail access points, another consideration is how maintenance equipment will be able to get from one end of the installation to the other without damaging the structure. If the maintenance equipment is a trail dozer with steel tracks, what will that do to pavers or grass pavers without a layer of fill?
- Placing heavy angular material directly on top of geotextile can tear the fabric and affect the integrity of the structure.
- Don't be afraid to experiment with unusual or locally available materials or methods.
- Trail hardening projects can be labor and equipment intensive so they can provide great opportunities for volunteer work parties or for creatively seeking new partnerships for the task and project.
- Depending on the soils, reducing speed and increasing the flow of the trail by changing the alignment can reduce the need for hardening in some situations.
- Trail hardening is often seen as a "fix" for steep grades and excessive erosion, but the forces at work need to be understood. Tire action and displacement is one, but water volume and velocity is the other. Hardening does little to manage the water, so it is essential that as much water be removed from the trail as possible before the water gets to the installation.
- It may be better and less expensive in the long run to move a trail instead of hardening it.

The Good…

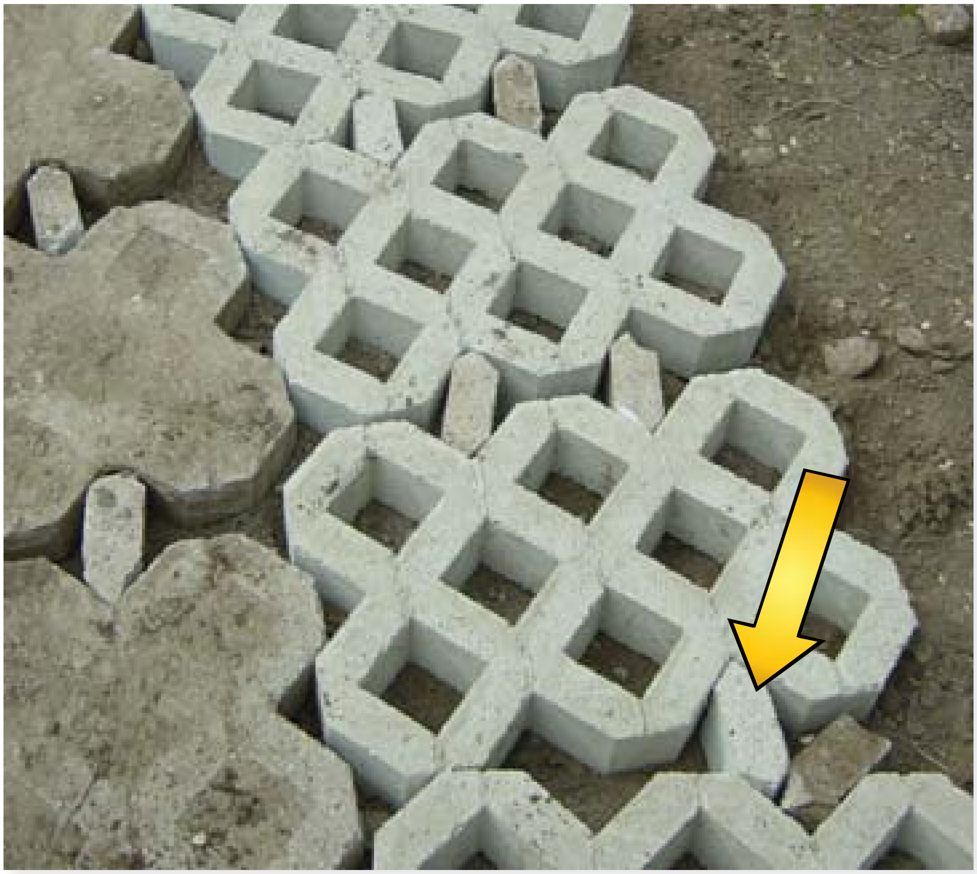
This installation has been framed in which not only resists movement, but provides lateral support and decreases the chance of breakage.

The eroded trench of this site provides natural containment for the blocks. The fill is a densly-graded aggregate that is holding together nicely.

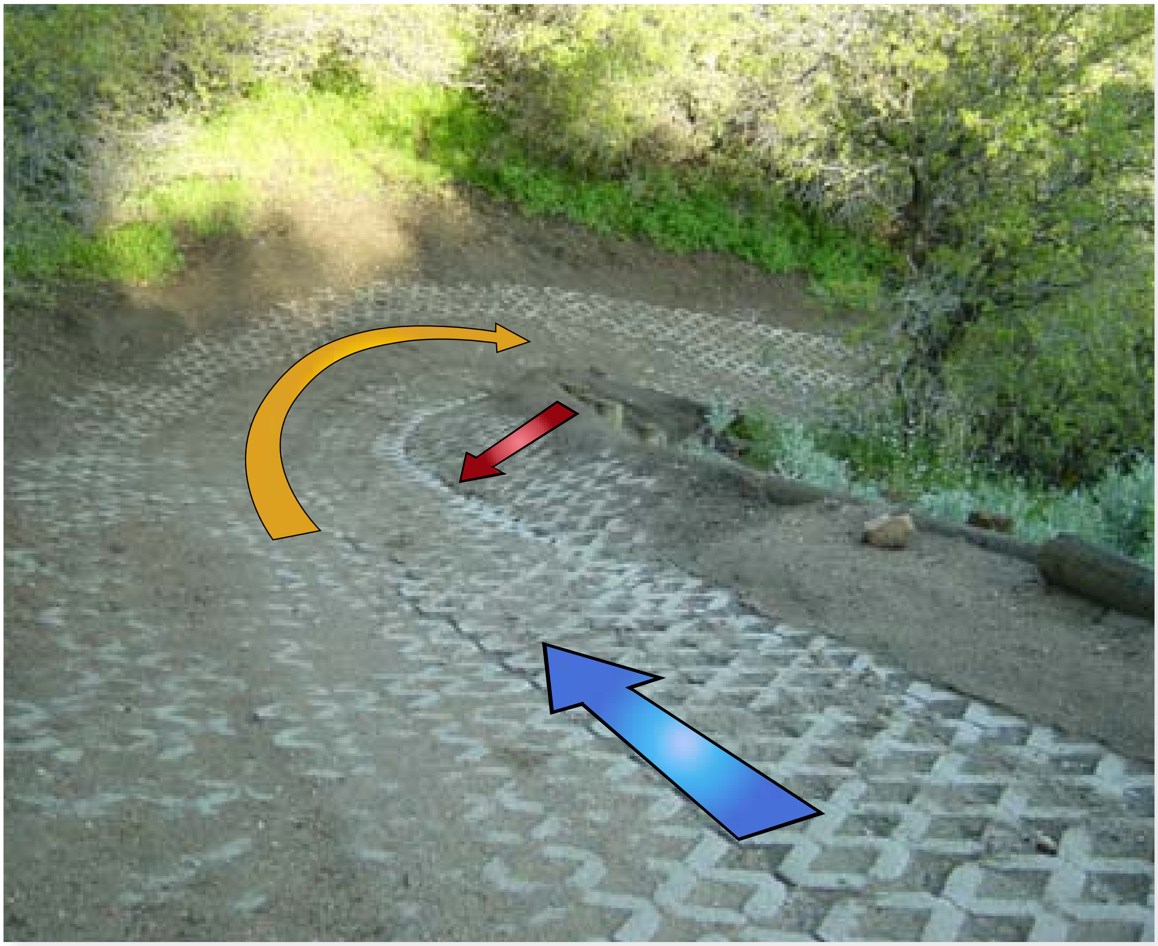
To help manage tire forces, it is important to have a smooth transition onto any structure. Here, the last four end blocks are angled down into the soil. This also helps anchor the structure and resist movement.

Not contained or framed, but this soil binds like concrete. The logs are pinned in a wishbone pattern to help drain water off to the sides and to force riders to stay on the structure. This is a nice touch.

Well contained, these blocks make a beautiful and functional approach to this bridge deck.



These blocks are being laid to form a curve. Notice how spacers have been placed to maintain the shape and resist movement.



This is a beautifully hardened climbing turn. The edges have been embedded and are well protected. The curve is super-elevated so speed is easily carried through the turn and lateral forces are reduced which helps to minimize the risk of block movement. Riders hug the inside edge, so the inside is armored which keeps riders on the structure and resists breakage of the edges. The V on the inside edge also keeps water on the structure and resists erosion.

This steep grade approaches 30%. The sides are contained by the shape of the site and the installation is framed to absorb the downward forces. Nicely done. It is essential that the water be effectively managed before it reaches the top of this slope.

These interlocking blocks are being tied together to build this ford. This design resists movement from the lateral forces of the water, but still allows a little flex in the structure. Any non-interlocking blocks would not stay in place and would soon fail in this situation.

The Bad...

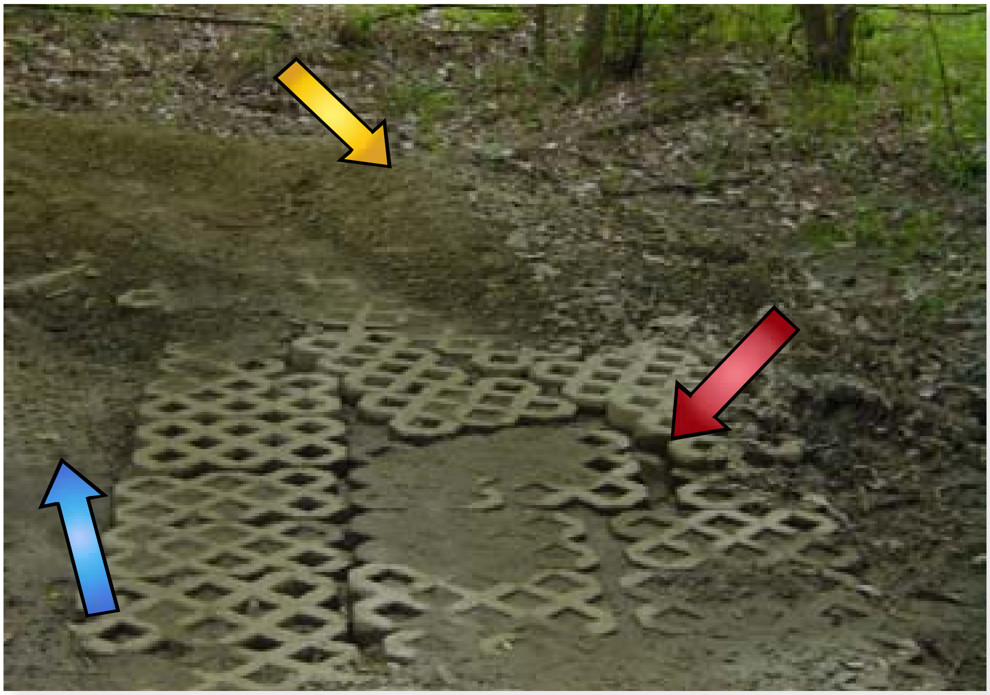
This armored drain dip is a great idea, but is subject to failure. Why?

1. The curve in front of the bike will exert lateral forces on the single row of blocks and they will be subject to movement.
2. The sharp angles of the blocks armoring the crest will receive increased impact forces from the tires which will result in movement.
3. The right edges of the blocks on the crest are poorly supported and these blocks will likely slough off to the right as the fill softens and erodes.
4. Riders will tend to use this as a jump which will increase the forces imposed on the structure.

The edges are not contained and will be subject to movement and breakage (yellow arrow). The blocks were poorly bedded (red arrow) creating an irregular surface which will result in movement and breakage. Water has been poorly managed (blue arrows). Soils saturated by the pond will allow the blocks to sink, deflect, and eventually break. A lead-off ditch should have been constructed on the left to drain the low area (maybe it was, but poorly maintained). The log on the right actually inhibits water flow into the grass behind it and deflects the water onto the trail which increases ponding.

For the most part, these pavers have been embedded to resist movement. The leading edge (blue arrow) should have been angled down for a smooth transition or otherwise protected with a treated timber. Without frontal support, the leading edges will be subject to breakage. All of the roots were not removed (yellow arrow) so there is irregular bedding which will result in movement and eventual breakage and failure. As the trees grow and roots expand, they will pop out the pavers.

It looks like this structure had a cover of fill at one time. The curve has caused displacement of the material and has formed a berm on the outside edge (yellow arrow). Water apparently drains across the middle which has washed away the fill material there. Due to the curve, the lateral forces are starting to move the blocks. Notice the increased gap (red arrow) between the outside blocks and the inside blocks. Riders are also being allowed to short-cut the structure (blue arrow) and ride off the inside edge. This will lead to block breakage and movement.



What's wrong here?

1. The steep uphill road approach does not allow riders a place to easily stop and start up again, so they probably won't stop at all.
2. The stop sign nailed to a tree is obscured by vegetation and does not allow adequate sight or reaction time. It should be on a post within 24" of the trail.
3. Concrete blocks have a taller profile than other blocks. This makes them more prone to movement and breakage, so it is more critical that they be confined.
4. Water draining off the road (arrows) is eroding the right edge of the blocks which will increase the risk of movement and failure.

Bedding and containment are important because concrete blocks are brittle. Note the broken blocks (yellow arrows) on this relatively new installation. The wide gap between these blocks (red arrow) will invite movement. The railroad tie provides a strong anchor for the bottom of the structure.

Tip, Trick or Trap?

Trap: Manage your risk

Poor construction + poor maintenance + poor management = Increased tort claim risk.

The Ugly...

Poor bedding + no containment + movement = failure. You can see (arrows) where riders are going up the right side to avoid this installation.

No containment, no protection for any of the edges, and uneven surfaces. Note the settling that has occurred (arrow) between the two rows of blocks. Given a choice, which there is, any rider would avoid this.

Pavers poorly bedded and placed on an uneven surface of rocks will move and fail.

The results of a poor installation: broken pavers, two eroded trenches instead of one, risk, resource impacts, and a mess.

Poor paver installation in this stream crossing resulted in resource impacts. Cobble stone would have been a better choice.

Need more? Learn more here...

Geosynthetics for Trails in Wet Areas: 2008 Edition, USDA Forest Service, Technology & Development Program, 0823-2813-MTDC, April 2008

Managing Degraded Off-Highway Vehicle Trails in Wet, Unstable, and Sensitive Environments, USDA Forest Service, Technology & Development Program, 0223-2821-MTDC, October 2002

Wetland Trail Design and Construction, USDA Forest Service, Technology and Development Program, 0123-2833-MTDC, September 2001

Having an army of volunteers certainly helps with a trail hardening project.

A Look Back...

Here are some of the elements discussed in this chapter:

- Soil stabilization and trail hardening are primarily needed in:
  - Soft soils
  - Wet soils
  - Any soil that cannot support the vehicle volume or weight
  - Structure approaches (including roads)
- Stabilization is mixed into the existing soil, trail hardening is placed on top of the existing soil
- The need for stabilization and hardening can be a red flag indicator of poor trail location, excessive grade, or poor soils. Look for alternatives where appropriate
- Geosynthetics provide reinforcement, separation, drainage, and filtration
- Except for grass pavers, tire contact with geosynthetics must be avoided
- When applying stabilization products, it is difficult to attain a consistent mix design in the field
- Stabilization and hardening methods are expensive and labor-intensive. Cutting corners in the design or installation will affect the longevity and integrity of the structure.
- Hardening products need to be properly bedded, confined, and anchored to resist movement.
- Don't be afraid to experiment such as using local material sources or seeking local expertise
- For installations that have been designed and built with a fill layer, it is critical that the depth of that fill is maintained over time. If that isn't likely to happen, consider another option.
- Engineers, geologists, soil scientists, etc. can have valuable insight. Consult them during the planning.
- While planning hardening and repairs, consider the largest and heaviest vehicles using the trails including reconstruction equipment; especially steel tracked equipment
- Hardening is a manmade structure that is added onto the trail. Manage your risk through proper design, installation, maintenance, and management.

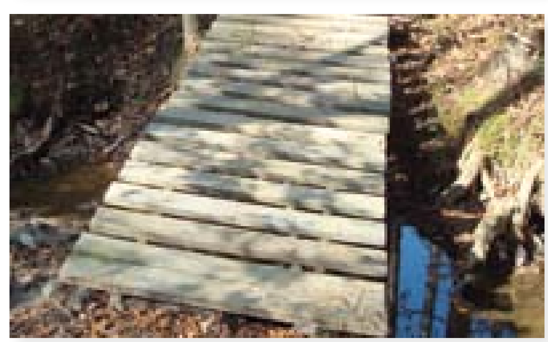
Chapter Seven
Tools in the Toolbox: Structures

A large part of the success in the engineering of a trail system is to know what to do in a particular situation. Certainly with a new trail location or the relocation of an existing trail, the first option is to avoid potential issues. However, there are a multitude of structures available that can help mitigate almost any circumstance.

Structures help meet two of the three elements for successful OHV trail systems: provide for the riders' needs and design for sustainability. Many structures enhance the OHV experience by providing variety either visually or in tread surface character. Structures provide a more stable, durable trail tread, which increases rider safety and the fun factor. Increasing stability and durability is what designing for sustainability is all about: protecting resources while providing a quality recreation experience. OHV management is facilitated when riders want to and are able to stay on the trail.

Here are some key points to remember when selecting and designing structures:

- The vehicle specifications (width, weight, etc.) critical to the trail design may not be those of the OHV using the trail; they may be the trail dozer used to construct or maintain the trail, or the snow groomer in the winter.
- Some agencies use structures as a management tool to limit the width of the vehicle that can use the trail, for example, making a bridge 24" wide to preclude use by ATVs. Structures can be expensive and this tactic can be short-sighted when larger vehicle access is needed for maintenance or reconstruction; vehicle sizes or types change; or management direction changes. Proper entrance management is a better option.
- Many structures require professional engineering calculations on material strengths, vehicle loads, snow loads, and watershed analysis to determine bridge, culvert, or arch sizes. This is not a place to cut corners since under-designed structures can lead to catastrophic failures and public safety issues. Manage risk and liability by having your structures properly engineered.
- The need for multiple structures can be a red flag indicator of poor trail location. Explore other options if they are available.



Neither of these bridges has been designed to accommodate the vehicles that need to use them. Hardhats may need to be substituted for helmets in certain cases.

• Structures require regular inspection and maintenance. The cost and personnel to perform these tasks must be built into the operation and maintenance (O&M) program.
• The longevity of most structures depends on use type, use level, soil type, climate, proper design, proper installation, and proper maintenance.

Section 1: Water Control Structures

An essential key for a durable trail is managing water. Structures help drain water off the trail, allow water to flow under the trail, help raise the trailbed above the ground water level, drain water across the trail, and drain it away from the trail; all of which help manage water.

Draining Water Off the Trail

There are several ways to help get water off the trail: rolling dips, outsloped sections or kinks, and waterbars.

Rolling dips are man-made grade reversals constructed on existing trails with long sustained grades or steep grades to reduce the size of the tread watershed. They are also used in new construction where there is no other opportunity to reverse grade to provide drainage. The key to good rolling dips is just that, keep them rolling.

This is a nicely constructed rolling dip. Notice the distance from the sag to the crest and notice how the grade smoothly rolls into and out of the dip.

Here are some general points about rolling dips:
• Any manmade structure requires maintenance. A rolling dip will never be as effective and as maintenance free as a grade reversal.
• Rolling dips must roll. The shorter the distance from the sag to the crest, the more abrupt and less functional the rolling dip will be. If it feels like a rider will fall into a hole when riding, the dip is too short.
• The structure will fail more rapidly in non-cohesive soils like sand or cobble rock or a sand and rock mix.
• Armoring a rolling dip with mechanically compacted crushed aggregate will increase the effectiveness and longevity of the rolling dip by: a) reducing the velocity of the water so it can be more easily diverted off the trail; b) hardening the trail tread to reduce rutting; and c) protecting the crest from displacement.


The best way to start building a rolling dip is to borrow as much material for the crest as possible by using lead-off ditch or drainage sump excavation. Excavating the sag to build up the crest increases the grade going into the dip, reduces the flow of the dip, and can make it more difficult to drain water out of the dip.

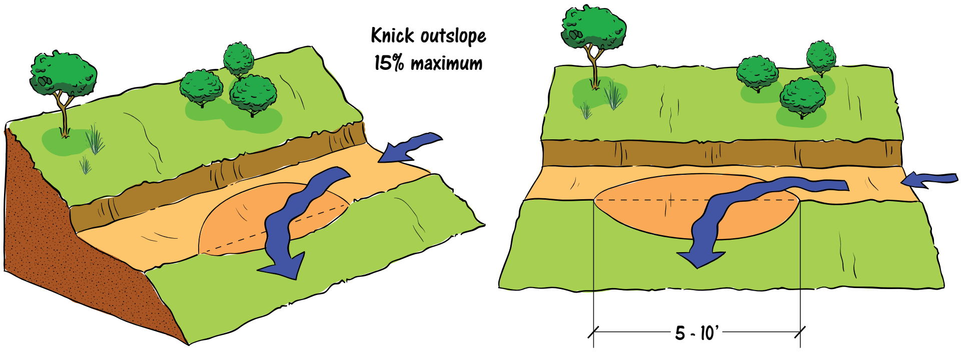
When controlling water with rolling dips:
• Use the trail alignment to help turn the water. Place the structure either on a tangent, or better yet, on a curve that turns in the direction the water should go. Trying to turn the water in the opposite direction of the curve will usually result in failure.
• Locate the rolling dip where there is a break or flattening in the grade. This will help slow the water down so it can turn and flow off the trail.
• Drain the water off the trail before the grade and after the grade, not mid-grade.

Rolling dips and grade considerations:
• Avoid installing rolling dips mid-slope on grades over 15 percent. The approaches become too steep and riders lose most of

their momentum. Riders must roll on the throttle to get going again, which results in tread impacts and increased maintenance.
- On steeper grades, rolling dips can invite riders to make jumps out of them.
- Generally, as grade increases, tread watershed size increases, or soil quality decreases; the spacing between dips needs to decrease.
- As the grade increases, the transitions into and out of the rolling dip must proportionally increase.
- The steeper the grade, the more difficult it is to make the dip reverse grade. Often, the best that can be achieved is a grade break, which can easily be breached by rutting when the soils are saturated and most vulnerable.

Use the trail alignment to help you turn the water. This dip is trying to move the water in the opposite direction of the curve. The gradual formation of superelevation on the outside of the curve will work to defeat the flow of water in that direction. This installation will work briefly. Then the formation of a berm will block the lead-off ditch and water will pond up in the sag of the dip. This pond will build in depth until it saturates the crest. Tire ruts forming in the soft crest will lead to breach and failure of the structure.

An outsloped section or knick is a short piece of trail that has been steeply outsloped at 8 to 10 percent or more to provide drainage. These are best used in grade sags or flat low areas that tend to puddle water. The difference between a knick and a rolling dip is that there is no sag and crest in a knick. Instead, a section of the trail is cut away in a "C" shape and the excavated material is removed from the site. A dip forces water off the trail while a knick allows the water to run off the trail. Knicks can be effective on flatter grades up to about 5 percent, but on anything steeper, too much



The flatter the trail grade, the more functional and durable the dip will be. This one is perfect: long, flowing, and deep.

Though this dip rides nicely, it wasn't constructed with enough elevation difference from the sag to the crest. Due to the soft, non-cohesive soils, displacement from a few motorcycles has already created a rut deep enough for the rolling dip to fail.

outslope is needed to turn the water. In these situations, riders will tend to hug the uphill side of the trail, and water carried by tire ruts will soon deform and breach the structure. Rolling dips are a far better alternative.

Avoid flat ground. Even with outslope, the water won't drain off the trail if it has no place to go. This lead-off ditch has plugged up or was under-sized and needs maintenance. A drainage sump may be a better alternative.

This trail has been outsloped to provide drainage. The rocks at the outlet serve as energy dissipaters and are a nice touch.

When constructed, this trail was outsloped so the small drainage entering from the left would drain across the trail. Through compaction, displacement, and lack of maintenance, the trail bed is now lower than the ground on the downhill side, so the water runs down the trail. Now, a rolling dip should be installed here. In reality, there was an error in the initial location and the alignment should have pitched up on the arrow line to create a grade reversal and positive drainage.

When constructed, this low spot was outsloped to drain water. Through compaction, displacement, and lack of maintenance, the trail bed is now lower than the ground on the downhill side. So the water ponds up in the trail which is causing trail braiding. The trail now requires reconstruction and armoring with rock to help maintain the shape and provide additional bearing when it is wet.

One of the biggest issues with waterbars is that, given a choice, riders will go around them. Here a log was brought in to force riders over the waterbar, but riders are going around it also. Due to lack of use, note how green the original trail tread is between the waterbars.

Earthen water berms can be a quick fix for OHV trails, however they don't last long and need to be replaced often.

Waterbars are shallow structures that are used to drain water off the surface of a trail or road. They can be made out of a combination of rubber belts, logs, rocks, treated timber, or dirt. They are usually installed at about a 30 degree angle so that water will hit the structure and be directed off the trail. As a drainage structure on a motorized trail, none of these are effective because they are too abrupt and they fail due to the tires rolling over the structure. Logs are slippery at an angle and dislodge, rocks become dislodged, and dirt gets displaced. Though widely used historically, they are now being replaced with rolling dips, which are far more effective.

This log reinforced waterbar is currently working. A couple of reasons for that are that riders are forced to go over the waterbar because vegetation prevents going around it, and because the trail is wide enough for riders to square up and avoid hitting the potentially slippery log at an angle. Note the sediment being deposited (arrow) as the water slows before it flows off the trail.

A belted waterbar has a piece of conveyor belt sandwiched between two 2"x 6" treated boards. The belt sticks up out of the boards a minimum of 6" and the structure is buried in the trailbed so that only about 3" of the belt protrudes above the surface. The belted waterbar has long been thought to be an effective drainage structure option for wheeled trails, but that has not proven to be the case. The main reason for their failure has been misuse of the structure.

There are six main reasons why waterbars fail:
1. Most belted waterbars are not constructed properly and have too much exposed belting, which becomes ripped or flattens over and becomes slippery.

2. Most installations are not long enough and invite riders to ride around them.

3. Most are not installed in the proper location where the trail alignment or grade will help them work.

4. Many have been installed on a fall line trail in an effort to make a non-sustainable trail more resistant

This log waterbar is doing nothing but putting an obstacle in the trail. With the amount of water coming down from above, the need for this waterbar is a red-flag indicator of a much bigger problem.

to degradation. Waterbars can be an aid in some situations, but not a cure-all. Other options like relocation should be considered first.

5. Many have been installed on excessive grades (hillclimbs) and the tires damage them or water rushes over them.

6. Lack of maintenance. Any manmade structure requires maintenance and eventual replacement. Waterbars require frequent maintenance.

The fact is that the need for any waterbar is a red flag indicator of a bigger problem. Water is running down the trail due to excessively steep grades, excessively long grades, excessively large tread watersheds, or failure to recognize and seize other drainage opportunities. Rolling dips are a better option, but in most situations, the best long-term solution is trail relocation.

This treated timber waterbar provides a formidable obstacle from below (blue arrow) and being full of sediment, it provides ineffective drainage (yellow arrow). The issue: the tread watershed is too large. Poor soils cannot sustain this grade that is too steep for too long. The solution: relocation.

Draining Water Under the Trail

Several structures are available to help direct water under a trail, including bridges, arches, culverts, headwalls, catch basins, and trash racks.

Bridges are used to span streams or other terrain that cannot be traversed on the ground like a deep, rocky ravine; and they can add to the aesthetic beauty of a trail and the quality of the recreation experience. There is a wide array of materials available for bridge building, including steel, treated timber, log stringer, fiberglass, and other composites. Many are prefabricated, which aids in transport and assembly. Choice of materials can depend on local availability, local preference, or conformance with a local or agency architectural theme. Fiberglass, though not as aesthetically pleasing as other materials, is lightweight and easier to transport and assemble at the bridge site. Its initial cost can be higher than other materials, but transport and assembly costs are much lower.

This prefabricated steel bridge is durable and has a natural appearance in this open setting.

Things to think about for bridges:

- There are specific criteria for bridge site locations and they are critical to the longevity and integrity of the structure. Seek help from a bridge specialist, engineer, or hydrologist.
- Most bridges will require a permit of some kind. Find out what is needed and what the requirements are for erosion control, etc. Get permitting started as early in the process as possible. It can take some time.
- Many streams have conditions or restrictions for operating equipment in or near the stream. Gather the information before mobilizing materials, equipment, and personnel.
- Time and unusual weather events can negatively affect a bridge's integrity. Public safety trumps

With transport and assembly advantages, a fiberglass pony truss bridge can work well in a variety of settings.

This log stringer and treated timber bridge spans an extremely sensitive creek that was a hotbed of controversy. Though there were less expensive design options, its beauty and functionality was worth the cost as it allowed this project to move forward.

If there is no railing, rub rails provide a margin of safety on OHV bridges. This is a nice, low-profile treated timber bridge.

cost, so manage risk. Regular bridge inspections by a qualified engineer must be conducted and documented.

- Make the bridge large and durable enough for the largest vehicle using the bridge. In most cases this is construction or maintenance equipment, including snow groomers.
- In wet conditions, tires, especially OHV tires, can slide across the boards of a bridge. Ensure a rail or a rub rail is on the bridge to catch the tires before they go off the side.

Arches are used to allow water to flow under the trail. They are slightly elliptical and come in either an open or closed bottom configuration. Open bottom arches are most common in trail work. They have a flange on the bottom edge that allows them to be pinned in place with rebar. Arches are available in a variety of sizes and come in corrugated galvanized metal or corrugated high-density polyethylene (HDPE) plastic. Plastic is usually preferred due to its lighter weight and ease of transport and installation. Arches have a wide and low profile that gives them several advantages: a) the streambed or drainage bed is left in its natural condition; b) the flow of water is less restricted, yet the capacity to carry water is one-third more than a similar sized culvert; c) the wider mouth of the arch is less likely to plug up with debris; d) the width of the arch makes it easier to clean out; and e) the arch shape is stronger than a round shape.

Durable, lightweight, and easier to clean out, an arch is a good choice for trail projects.

Culverts are another structure that allows water to run under the trail. The most common culverts are corrugated metal pipe, often referred to as CMP, and corrugated plastic pipe, commonly referred to as CPP. The metal pipe is aluminum or galvanized steel. The plastic pipe is HDPE. Metal pipe comes in a variety of shapes: round, elliptical, box, pipe arch, and arch. Round corrugated aluminum is the most common metal culvert for trails since it is 70 percent lighter than steel and just as strong. Plastic pipe comes in round and arch shapes. The round pipe is available with a single wall, which is corrugated inside; or a dual wall, which has a smooth interior.

There are two types of corrugations: annular and spiral. Annular is easier to band together, but each corrugation can become a sediment trap. Spiral tends to clean itself out better since one corrugation leads to the next.

Plastic culverts are usually preferred for trails due to their light weight and ease of transport. They are also easier to cut in the field. Most culverts come in 20-foot lengths and have available bands to connect sections together as well as elbows, flared inlets, drop inlets, downspouts, and other attachments.

Here are some key points on culverts:

- Culverts need to be sized correctly to accommodate the maximum high flow events from the drainage area. Failure to do this can result in a catastrophic failure.
- Any pipe less than 18" in diameter is more prone to getting clogged with debris and harder to clean out. Ensure there is routine inspection and maintenance for these structures.
- Culverts can fail in a significant weather event causing the culvert and the trail to wash out. This may result in not only a severe trail impact, but also has the potential to impact sensitive habitats or fish-bearing streams below. For these reasons, fords or armored drains are usually a better alternative if management allows tire and water contact.
- Dual wall plastic pipe with the smooth interior tends to flush itself out during rain events or can be flushed out manually with a hose.

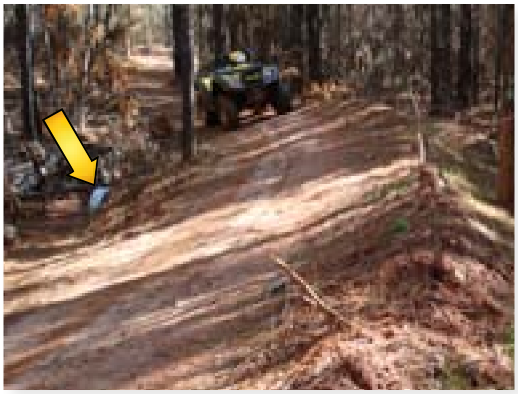

There are drawbacks, but culverts allow water to drain under the trail and keep the tread dry.


When culverts are undersized, the results can be disastrous and expensive. Spend the money up front to do it right the first time.


It is dry now, but this runs a lot of water in the winter. Two plastic pipes in this shallow drainage keep the trail fill low and provide a safety net to handle unusually heavy flows. Two pipes have to be carefully bedded to prevent water from running between them.


The first culvert (yellow arrow) was properly installed in the drainage. The second culvert was added later possibly to drain a spring but was not installed properly due to rocky ground. Manage your risk. The second culvert does nothing but create a safety hazard and an opportunity to ruin what was a good section of culvert. A side ditch draining into the first culvert may have been a better solution here.


A flared inlet and headwall are being added to this culvert to help funnel the water into the inlet. Though a small diameter culvert like this may be adequate to handle the flow of water, it is very hard to keep cleaned out.


This heavily superelevated curve is a blast to ride, but water runs to the inside, gets trapped, and ponds up. The solution? Add a culvert.

• Check the classification of the stream before installing a culvert. Some small streams, even ephemeral ones, are classified as fish-bearing and may require a bridge or other mitigations to allow fish passage.
• Cover depth will be lost through erosion, wheel displacement, and maintenance. To minimize the risk of having an exposed structure, culverts should have a minimum of 12" of fill over the top of them.
• Installing two smaller diameter culverts rather than one large one can increase the flow without increasing the height of the fill required to adequately cover the pipe.

A headwall is a structure that surrounds the inlet of a culvert or arch and has three functions: 1) to keep the trail fill from sloughing or eroding off and blocking the entrance of the culvert; 2) to help funnel the water into the culvert inlet; and 3) to dissipate the energy of the water and protect the toe of the trail fill from eroding. Headwalls are normally constructed of rock, but bags of pre-mix concrete are also used.

A catch basin is often constructed as part of a culvert or arch installation, especially where the water needs to turn in order to enter the culvert. It usually consists of a headwall and an "L" shaped berm or wingwall either made of or lined with cobble rock. The water enters the catch basin, hits the back of the berm where its energy is dissipated, and then is allowed to turn and enter the culvert. Catch basins will fill up with debris and sediment and require routine inspection and maintenance.

Culvert headwalls are always a nice touch. This rock headwall supports the trail fill.

When rock is not available or when extra support or protection is needed, bags of premix stacked dry will make a solid headwall. They will absorb moisture over time and solidify into a concrete block wall. Do not use sandbags since the bags will eventually rot and your structure will disintegrate.

Note how water is running past this culvert rather than flowing into it. This installation would be more effective if there was a rock catchbasin to help turn the water into the culvert.

As the wrappers fall off, a premix headwall can look a little shoddy, but that is temporary. To avoid that, the wrappers can be torched off after the concrete has set.

This trash rack is properly placed in advance of the inlet and the widely spaced bars will let water and smaller debris through.

This trash rack has been placed directly over the culvert inlet. The slots in the expanded metal are too small and will catch finer debris. Through a lack of maintenance, it is becoming overgrown with brush which will inhibit its effectiveness. With the next high water, the dead sticks and limbs could easily plug up this structure.

A trash rack is installed in advance of the inlet of some culverts or arches to collect sticks, logs, and debris to prevent them from blocking the inlet. They are usually widely spaced metal screens or vertical metal bars. Sometimes, they are placed directly over the inlet, but this defeats the purpose as debris can plug up the culvert inlet. By preceding the inlet, the debris gets collected, but water can still flow through or around the debris to get to the culvert inlet. As with many structures, the key to their effectiveness is regular inspection and maintenance.

Elevating the Tread Above the Water

Sometimes, it is desirable or necessary to cross broad wet areas. Boardwalks, corduroy, side ditches, puncheons, and turnpikes can all be used to elevate the tread above the water.

A boardwalk is essentially a trail on stilts that keeps the trail above the water level and out of sensitive riparian vegetation. Though expensive to construct, boardwalks allow access through sensitive environments, provide interpretive opportunities, are extremely aesthetic, and provide a unique riding opportunity that adds to the quality of the trail experience. Riders will remember the boardwalk and talk about it around the campfire.

This boardwalk is being built over a wet trail area. The boards are placed length-wise to help keep OHM tires from slipping across wet boards.

Though more expensive to design and construct, placing bends in the boardwalk improves the look and feel of the structure and enhances the rider experience.

Corduroy is an old technique of placing logs perpendicular to the wet area so that water runs through the voids of the logs and the vehicle tires run on top of the logs. This is generally not a long-term solution since the logs will eventually rot. There are two basic configurations for corduroy: logs placed on stringers and logs placed directly on the ground. Both can provide an uneven, slippery surface. When placed directly on the ground, some logs will sink or heave. In high water, they can float providing an unstable trailbed. Both methods can be rudimentary, but if properly installed and consistent with the management objective for the trail, they do work and will offer a unique riding experience and challenge that can add to the quality and excitement of the day's outing.

This poorly crafted installation was thrown together during an exceptionally wet spring. It is too short, too narrow, and some of the logs are floating. Some ditching should have been done to help drain the water better. This is a good example of the issues usually associated with corduroy: poor patch jobs that don't address the problem and usually degrade into a hazardous situation.

This is nicely constructed with poles of the same length and diameter. Unfortunately, it isn't long enough. This is a common and costly problem with many tread structures.

Corduroy anchored onto stringers will last longer and create a more stable tread. This is an example of a poor quality installation. The stringers already show signs of rot and the corduroy logs should have been cut into even lengths.

This is a well done installation that is fun to ride and adds to the rider experience.

In the backcountry, corduroy is sometimes used as a bridge. This is not a recommended practice and should be considered a temporary bandage due to its structural instability. Grade should be avoided with corduroy, especially in wet climates. The slippery, uneven logs on this installation make it a liability.

A puncheon is basically a bridge that lies on the ground. It has stringers, deck, and rub rails that are laid on mud sills. It looks like boardwalk, but a boardwalk is on stilts which elevate it off the ground. Puncheons are typically used to cross wet, boggy, or seasonally wet areas. They can be used to bridge small creeks and protect sensitive resource areas like threatened or endangered plants or cultural sites. Materials are generally logs, sawed timber, treated timber, or a combination of those materials. Depending on how soft the ground is, the mud sills are placed directly on the ground or in shallow trenches that are dug down to firm ground, filled with rock or gravel, or filled with gravel on top of geotextile for increased bearing. The most common fault of puncheon installations is that they are too short and mudholes develop on each end. Be sure to terminate them on firm or higher ground. The approaches to structures like this are still subject to compaction and displacement, which creates low spots. To avoid this, the approaches should be hardened with rock or a geosynthetic with a rock cap. Puncheons can be slippery when wet, so grades need to be kept to less than 5 percent and approaches need to be on a tangent, not a curve. As with many other structures, puncheons enhance the riding experience while protecting resources.

One of the oldest trail structures, puncheons can be beautiful, functional, and fun to ride. Note the muddy spots where the structures end too soon (arrows). These should be filled with rock or hardened with a geosynthetic and a rock cap.

It's harder to construct, but a curved line usually fits the landscape better than a straight line plus it enhances the rider experience.

Side ditches generally run parallel to the trail and help drain the trail tread by allowing ground water to seep into the ditch. The lower the groundwater level is, the drier the trail tread will be. When converting roads to trails, a good practice in wet areas is to use whatever excess width is available for a ditch. This helps drain the trail, enhance the trail experience by having a narrower trail width, and reduce the surface area of the trail. Like ditches along roads, side ditches need cross drains at regular intervals to reduce water volume and velocity and to help maintain the natural hydrology of the landscape.

A side ditch was cut along this trail to help drain the trail tread. However, it does not have adequate cross drains so the water is running too long and too fast which has resulted in erosion. Cross drains need to be added here or the ditch lined with rock to dissipate the water's energy and protect the ditch side walls.

Water will always take the path of least resistance. A mudhole developed by water from this spring saturating the soil below it. A ditch was cut towards the log (arrow) to drain the spring water away from the trail. There was a layer of solid rock that prevented the ditch from being cut lower than the trail tread, so even though some water flows down the ditch, gravity will still pull water down the impermeable rock layer and into the trail. An alternative is to blast the ditch lower or install a French drain in the trail.

This trail runs up a draw which has springs on both sides of the trail. In the wet season, this flat area at the outlet of the draw would become a saturated mudhole. Ditches were cut down both sides of the trail to intercept the spring water and drain the trail tread. The excavated material was used to raise the trail elevation of the tread and a culvert was installed to drain the ditch water under the trail (arrow).

Three years later, the trail tread is high and dry and lush vegetation is growing in the ditches. Use the 4Es. Evaluation is a valuable tool to show what is working (or what isn't). Pictures like these can give managers positive encouragement, can mollify critics, and build support with stakeholders.

Turnpikes have myriad variations, but the principle is always the same: use fill to raise the trail tread above the water table. The higher the tread is, the drier it will be. There are two configurations of turnpikes: ditched and ditchless. Ditched turnpike is most common and uses parallel side ditches to lower the water table. The excavation from those ditches is used as borrow to raise the elevation of the trail tread. However, there are times when sensitive resources prevent the excavation of a ditch or where the side ditches will interfere with the natural subsurface hydrologic flow of water by changing its direction. In these situations, a ditchless turnpike, called a causeway, can be used.

A combination of log and rock causeway. One advantage of rock is that it is easier to make curves. This installation flows very nicely and the structure is in harmony with the site.

An example of ditched turnpike. Ruts are forming in the trail tread because either the ditches are not deep enough, or the ditches do not drain under the trail at regular intervals. If water is allowed to pond in the ditches, it may saturate the trail tread.

Tip, Trick or Trap?

Trap: The process of creating a great OHV trail does not end with construction

It must be followed with long-term monitoring, maintenance, and management

Most turnpike installations start with a layer of geotextile to separate the fill material from the underlying mud or poor quality native material and to increase the load-bearing capacity of the structure. Some installations encapsulate the fill with the geotextile, often called the sausage or burrito technique. Most turnpikes have logs, rocks, or treated timber to confine the fill to keep it from sloughing off into the ditches. The best surface, if available, is gravel or crushed rock with a shallow cap of soil to provide a durable tread surface and to help maintain the shape of the trail tread.

Ditched turnpike may require cross drains, culverts, and lead-off ditches to drain the side ditches. Over time, the ditches will slough in and collect debris, so regular inspection and maintenance is needed to retain the shape, depth, and function of the ditches.

This ditchless turnpike has been in place 10 years and has crushed gravel on top of geotextile. Much of the gravel has worn away or has been displaced and it's time to maintain this structure with another load of gravel. Note the wet spots appearing next to and behind the ATV.

Causeways can work well in seasonally wet areas with soils that drain well. They may not work well in perpetually wet areas with saturated soils since

This is a drier site and the ditches are very shallow, but probably adequate. This may have been an old road corridor. If not and the trail was located here, it is way too straight and does not look natural. Create a trail experience, not a transportation experience.

the structure may slowly sink into the ground. The use of a wider geotextile base or other geosynthetic materials may remedy this.

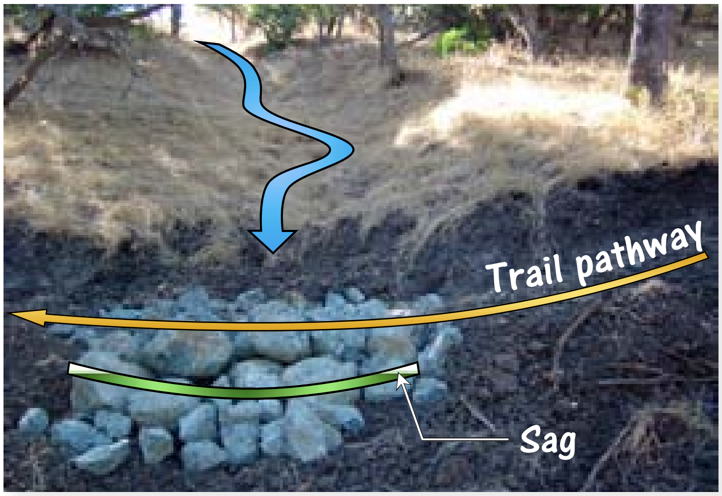
If a supply of mineral soil is available, a turnpike can be cheaper and easier to build than a puncheon, have less maintenance, and have a longer lifespan. Like many other structures, riding on a turnpike is different and adds to the rider experience.

As with many structures, there are short-term impacts upon implementation. Don't let those impacts deter your design decision. Above, a section of recently constructed turnpike on a road-to-trail conversion. Right, the same section one and a half years later. High, dry, and a great single-track experience.

Moving Water Across the Trail

Water from springs, seeps, or ephemeral streams can saturate the trail tread and create mudholes. There are two ways to move the water across a trail: drains and fords.

Drains are structures that carry water across the trail either on the surface or under the surface. Surface drains are a trench outsloped so the water runs across the trail and the trench is filled with cobble rock that provides weight bearing for the vehicles while allowing water to flow through the voids in the rock. These voids will eventually fill up with sediment and the water will then flow over the surface of the rocks. The most common subsurface drains are the French drain and curtain drain. The French drain is usually used to carry water under the trail from a point source of water like a seep or spring. It is a trench dug laterally across the trail, lined with geotextile, filled with clean drain rock, and then the geotextile is folded over the top. Usually, a perforated drain pipe is added as well to help carry the water. Unfortunately, the geotextile usually plugs up over time at

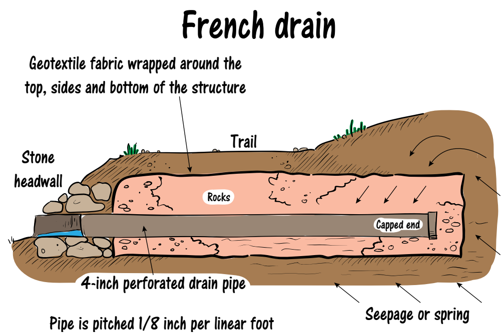


At some point, water will run down this drainage way, either from a thunderstorm or snowmelt. A hardened drain protects the tread and any fillslope from erosion. A properly designed trail would have a grade sag here so the tread drains from both directions at this point.

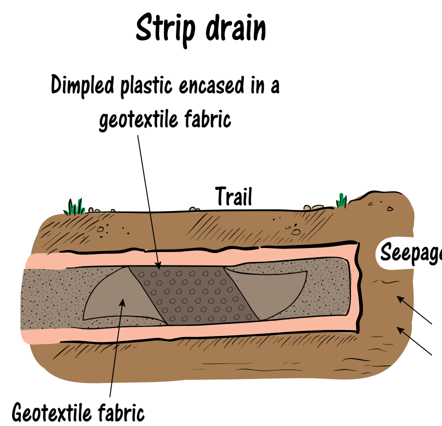
This seasonally wet crossing has been hardened with cobble-sized rock. This is simple and effective and there is no culvert to clean out or plug up. In arid country, runoff from a high-intensity thunderstorm can wash out a culvert, but a hardened drain will likely endure.

This area has pistol-butted trees above the retaining wall (red arrow). This is an indication that the ground is slowly moving or slumping. Trail locators should watch for these indicators and avoid the area if possible. For this area, relocation was not an option and a curtain drain has been installed within the retaining wall to collect and drain water seeping out of the bank. The pipe exits off to the side (yellow arrow).

the inlet causing the structure to fail. Also, if drains are not installed deep enough or if the cover material is not maintained, displacement will expose the geotextile and the integrity of the structure will begin to fail. For these reasons, a culvert or an armored surface drain may be a better alternative.



Curtain drains are installed longitudinally above the trail or along the inside shoulder of the trail. They intercept a sheet flow of subsurface water to prevent it from saturating trail tread or from pumping up through the trail tread with repeated traffic. Depending on the depth of the subsurface water layer, these trenches can be considerably deeper than those of a French drain. They're usually lined with geotextile on the sides and bottom and filled with clean gravel or drain rock. They may or may not have perforated pipe in the bottom. Since they typically intercept a linear water source rather than a point water source, they can be 100 feet or more in length. For lengths greater than 50 feet, the water that is collected needs to be drained across the trail at regular intervals. The cross-drains can be surface drains at a grade reversal or rolling dip, or subsurface drains like culverts, or French drains.



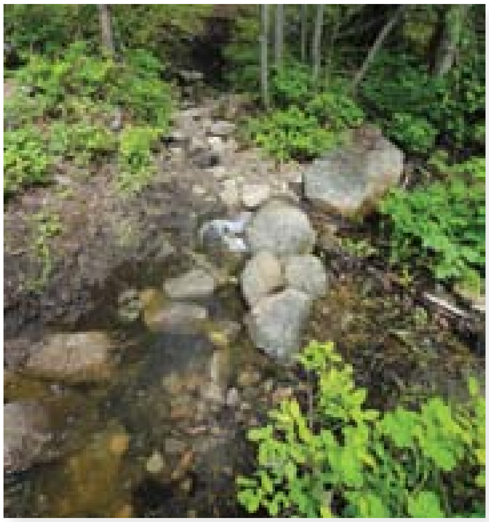
Prefabricated geocomposite sheets or strip drains are also available that function just like curtain and French drains only they're a whole lot easier to install, less expensive, and easier to replace if necessary. They are a piece of dimpled plastic encased in a geotextile fabric and they are available in rolls of various widths and lengths. The trench for these is much smaller and is backfilled with correspondingly smaller volume of sand rather than rock. Strip drains can be an alternative to the traditional trench drains that may be worth considering. Note: If too close to the surface, they can collapse under the weight of vehicles.

As with any structure, these drains need regular inspection and maintenance. French drains especially can clog with sediment and debris at their input point.

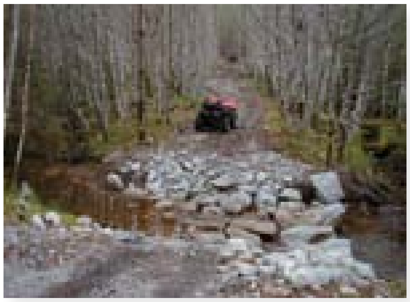
Fords are an on-grade, wet-tire crossing that can offer an alternative to the expense of a bridge or the risk of a culvert. They aren't appropriate in some settings and their use is not allowed everywhere. The biggest issue with fords is the potential for sediment delivery from vehicle tires directly into the stream. From a rider standpoint, fords can offer fun, challenge, and a unique riding experience. There are advantages of fords over culverts: fords don't have to be cleaned out, they can tolerate wide fluctuations in flow, and there is generally less risk of a major structure failure or washout.

This ford is hardened with concrete boat ramp planks. These are commonly used and they work quite well.

A flat stream gradient, gravel bottom, and gravel approaches make this a very suitable location for a ford. Low cost, natural appearance, and high rider experience are all benefits.



A few well-placed boulders on the downstream edge and this simple ford is complete. The cobble rocks in the bottom of the ford could have been removed and replaced with smaller rocks for a smoother crossing depending on difficulty level.



Boulders on the downstream side help reduce the gradient of this ford and the banks are well armored with large cobbles for stability and reduction of sediment delivery. However, if fish need to pass through this site, this design could be an issue and an option like a culvert may need to be considered.

Things to consider with fords:

- Fords work best on ephemeral or low-volume streams with low, stable water levels generally not exceeding 10" during the season of use.
- Check the classification of the stream before considering a ford. Fish-bearing streams or those with direct connectivity to community water intake will likely have restrictions or prohibitions on sources of sediment delivery. Some type of permit will likely be required.
- Check management plan direction, NEPA direction, agency policy, and state and local laws for restrictions and prohibitions before building a ford.
- As a general guideline, the farther upstream the crossing is, the more likely that a ford will be acceptable.
- For stability, the stream gradient must be very low or the ford will erode away.
- Trail approach grades should be low (4 to 10 percent) to minimize sediment delivery. Dropping off a steep bank into the creek creates a poor, non-sustainable approach.
- The stream bottom should be gravelly, not sandy or muddy. If it isn't, then some type of hardening will be required.
- A stream bottom with small-sized cobble rock can work well. A crossing with larger sized rocks would need to be consistent with the difficulty level of the trail.

Redirecting Water Away From the Trail

There are three ways to carry water away from the trail and redirect the flow of water to a more desirable location: lead-off ditches, sumps, and sediment basins.

Lead-off ditches are commonly used to drain grade reversals, rolling dips, and outsloped sections. If the material is suitable, push excavated material from the ditch onto the trail to be utilized as tread material, not away from the trail. As in all structures, regular inspection and maintenance is required to keep the structure functional.

On flat ground, it can be difficult to ditch the water away from the trail. One solu-

A new trail on the contour intersects this old fall line trail. This ditch carries water from the closed trail and redirects it into the natural drainage using the cobble rock as an energy dissipater. Note the log across the ditch entrance to catch the riders' eyes.

tion is to build a sump, which is essentially a hole in the ground that will collect any runoff water and allow sediment to drop. A sump will eventually fill up with sediment and will need to be cleaned out in order for the sump to remain functional. The trail tread material that a sump captures can be re-used on the trail. Sumps can also be used to keep runoff water from flowing into an area where it shouldn't go. When constructing a sump, it's important to make it big enough to accommodate the expected runoff volume from an average storm. As in leadoff ditches and rolling dips, when digging a sump never waste the excavated material. Instead, use it as tread material or as material to build up the crest of the rolling dip. Sumps make a good source for borrow material.

A nice lead-off ditch was constructed to drain a rolling dip, but as riders' eyes scan this area, it is difficult to determine a ditch or a trail going off to the right. A millisecond of uncertainty can draw a rider into the ditch. To avoid this, it is a good practice to place a small log across the ditch entrance so it spans the ditch without blocking the flow of water.

Similar to sumps, sediment basins collect runoff water from the trail and allow it to drop its load of sediment before flowing out over the spillway. The difference between a sediment basin and a sump is that a sump generally has no outlet. Sediment basins are usually used in the vicinity of streams to reduce sedimentation and hinder the direct connectivity of water from the trail to the stream. The basin should be of sufficient size and depth to handle normal runoff. In general, a sediment basin has some form of hardening. The entrance can be lined with cobble rock to dissipate the water energy. The back and side edges are usually an earthen berm lined with cobble rock. Sometimes the berm is reinforced with geotextile under the rock. The outlet or spillway is slightly lower than the rest of the berm and it is usually rock lined as well. The bottoms of the basins can be lined with rock, but this can hinder the maintenance task of periodically removing the deposited sediment. Sediment basins will fill up with debris and sediment and require routine inspection and maintenance.

Tip, Trick or Trap?

Tip: Tread material is a precious resource. Any suitable material excavated for a structure should be incorporated into the trail tread.

Before rehab efforts could begin on this heavily eroded trail, the source of the water had to be diverted away by ditching it into the natural drainage courses.

Due to the flat terrain, this rolling dip has little elevation difference between the sag and the crest. The lead-off ditch also has a flat gradient and it is almost full of sediment. Notice how the water is flowing past the entrance to the ditch and is almost breaching the rolling dip (arrow). If maintenance isn't performed shortly, this structure will likely fail.

Sediment basins allow a trail to drain water into the proximity of a stream and still protect the water quality of the stream. Notice the rock armoring in the outlet.

Without the sump, this water would just drain down to the trail below where it has the potential to gain more velocity and create more erosion. It would have been better if at least the back wall of this sump (arrow) was armored with rock. If it ever saturates and breaches, the flood of water could create unwanted and unnecessary impacts.

The excavation from this sump was used to construct the crest of this rolling dip. It appears that the sump could be bigger. Note the sediment (arrow) that has been deposited in the trail tread before entering the sump and how muddy the water is in the sump. This material can be reused.

Using Existing Structures to Control Water

Structures that are used to cross major streams can be very expensive to build and maintain. A strategy that can reduce those costs and reduce potential environmental impacts is to utilize infrastructure that is already in place, such as road or other trail crossings. This may not be desirable from a purist trail perspective, but it is desirable from a practicality and management perspective. The infrastructure could be a simple ford, a large multi-plate culvert, or a bridge. In many cases, the existing infrastructure is already in the best crossing location and other options may be limited or not as suitable. If it is a road structure, access would require mixed use of the road but this could be for just the minimum distance required to cross the stream and get to a point where there is good trail egress with flat grades and adequate sight distance.

Several things need to be in place before utilizing existing structures:

- The trail needs to be directed to the existing infrastructure and this is not always possible.
- When using the structures of an existing trail, determine if the trail uses are compatible with the existing structure and if the structure will safely accommodate the OHV width and weight.
- Existing stakeholders need to be consulted to flush out any concerns and to build and maintain stakeholder cooperation.
- Appropriate signing will be necessary to warn everyone that the structure will be multiple-use.
- When using existing road infrastructure determine if it is legal to have mixed use on the road.

The cost of a major culvert installation like this can be prohibitive, so routing the OHV use onto this road to share the structure only makes sense.

The strategy of using existing infrastructure has been implemented very successfully on many projects. Short-term benefits include reduced environmental analysis, reduced engineering costs, and reduced project implementation costs. But the long-term benefits can reap bigger rewards in reduced maintenance and replacement costs. It may also foster cooperative efforts between motorized and non-motorized stakeholders.

Erosion Control Structures

Erosion control structures are commonly used and often required on construction sites to prevent stormwater runoff from entering streams, riparian areas, or other sensitive areas. Their function is to reduce the velocity of the water and to trap sediment. They are also used to aid in closure; stabilization; rehabilitation of old trails; and any time the runoff is expected to be higher than normal and tax existing drainage facilities, such as after a wildfire, during or after a logging operation, or during an unusually wet rainy season. Erosion control structures are usually temporary structures since they do not have long-term effectiveness or durability.

This trench is a heavily eroded motorcycle trail in sandy soil. The sediment movement was halted by stabilizing the trenches. This was successfully accomplished with rock and log check dams, woody debris placed in the bottom, and ditches to drain water into its natural channel.

The most common types of erosion structures are check dams; energy dissipaters; silt fences; straw or coir wattles; and straw, hay, or other bales.

Check dams are used to close or rehabilitate heavily eroded trails or to stabilize the continuing erosion and growth of ravines. The word "dam" is a slight misnomer since most check dams allow water to percolate through them. The principle of the check dam is to reduce the velocity of the water so it will drop its load of sediment behind the dam. Eventually, the dam will fill up with sediment, which will help stabilize the floor and sides of the ravine or trench. The dams should be installed at regular intervals down the full length of the ravine or trench. Though check dams can be difficult to install, they are highly effective. Materials are usually cobble rock, logs, and treated timber, though steel guardrail has also been used. While curbing erosion from above, the dams also act as barriers to deter riding from below.

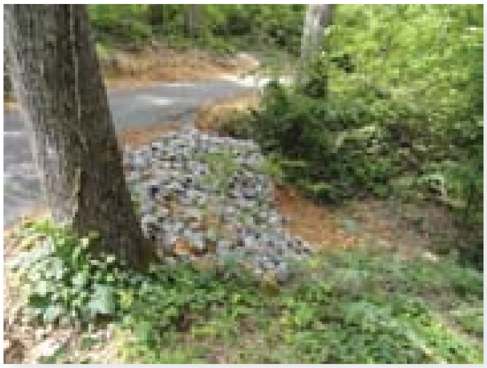
An energy dissipater is any structure that slows, redirects, or interferes with the flow of water. Water velocity is what erodes the soil, so the amount of sediment being carried by the water is directly proportional to the velocity of the water. The most common dissipater material is cobble-size rock or larger, but logs, steel, woody debris, or other materials can be used as well.

A dissipater should be considered at the outlet of any corrugated culvert installed on a grade exceeding 10 percent and on any smooth-walled culvert exceeding 5 percent. An energy dissipater should be considered at trail drainage

These log check dams were installed to stabilize and rehabilitate this old motorcycle hillclimb. After four years, use has been deterred and the impacts are starting to heal.

Above, material has started to fill in and revegetate behind this rock check dam. Rider access from the top and bottom was blocked and signed as closed.

Installing an energy dissipater at a culvert outlet points that have the potential to drain a high volume of water, especially if that drainage point is on a fill or a steep slope. Armoring the slope with rock reduces the velocity of the water and protects the slope from erosion.



A blanket of cobble rock at the drain point of this trail protects the fillslope from scour and erosion. This protection is especially important where there is the potential for high volume and high velocity water flows.

In order to get bridge materials and equipment up this old road, silt fence had to be installed any place there wasn't a vegetative barrier between the road and the stream.

Silt fence is a water-permeable geotextile fabric held upright and anchored to the ground by regularly spaced stakes. The fabric allows water to slowly seep through it, but filters out the sediment carried by the water. One advantage to using a silt fence is that it is readily available at most large home supply stores or farm and ranch stores. It can quickly become unsightly and should be removed after it is no longer needed.

Silt fence was installed at the base of this fireline to protect runoff and sediment from entering this sensitive stream. It often comes pre-attached to wooden stakes, but they will not last as long as metal T-posts.

Straw or coir wattles are commonly seen in the ditch lines along most road construction projects. They are net bags filled with straw or coconut fibers so they look like small logs. They come in a variety of diameters and lengths and are usually staked in a herringbone pattern at regular intervals in a drainage way. When used in trail or slope rehabilitation, they are placed on the contour at regular intervals down the slope. The steeper the slope, the shorter the interval. Wattles break the slope into smaller watersheds, which reduce water volume and velocity. The wattles trap sediment, but allow water to filter through slowly.

Wattles placed as part of the rehab of old hillclimbs. Between the wattle rows, the area is usually seeded and covered with mulch.

Above, rows of wattles staked closely together as part of the rehabilitation of this steep slope.

Bales have the advantages of availability, easy installation, and portability. Bales placed at regular intervals down a slope prevent water from gaining too much volume and velocity. This protects the seeding, mulching, and other erosion control efforts. In addition to straw bales, cedar shaving bales are also available. Cedar bales are heavier than straw, but they last longer and do not need to be certified as weed-free. Bales can also be used as a visual and physical barrier.

Bales are relatively easy to transport to the site and stake in place. They are effective erosion control devices and they provide more of a visual barrier than wattles.

Bales of cedar shavings work well, last longer than straw, and don't need to be certified weed-free.

Section 2: Terrestrial Control Structures

Retaining Structures

There are two types of retaining structures: gabions and retaining walls.

A gabion is a rectangular wire basket that is filled with rock. Once filled, a wire lid is secured in place. Gabions are support structures that are commonly used for bridge abutments, retaining walls, and stream bank protection. The top of the gabion should not be used for the trail tread since the wire mesh will eventually break and puncture tires.

Gabions are being used to support these two bridges. The baskets are a good alternative when there isn't a solid foundation.

Retaining walls hold material in place and include bin walls and crib walls. Bin walls are closed wall structures that are back filled to create a gravity fed retaining wall. Crib walls are created by stacking members (timber, steel, etc.) which creates a void that can be filled by rock or soil. Materials typically used for retaining walls include log, stone, treated timber, geocell, encapsulated geotextile (grass pavers which can be filled with dirt and stone to create a wall), interlocking concrete blocks, and steel guardrail sections. Often, the inside of the structure is lined with geotextile, which increases strength and helps contain fill material. Retaining wall kits are also available that provide durability, portability, and ease of assembly.

Common uses for retaining walls include the following:

- To support the trail fill when sideslopes are too steep, too unstable, or when full-bench construction is not desirable or feasible.

Log walls are classic and natural, but not as durable as other materials. This is a good example of a crib wall.

- To contain or stabilize the cut bank in steep ground, unstable soils, or loose rock like scree.
- To minimize the footprint (size of cut slope and fill slope) of the trail to enhance aesthetics or to protect resources.
- To contain trail fill material on bridge approaches and abutments so soil doesn't leach into streams, riparian areas, or other sensitive resources.

If available, rock is certainly the most aesthetic material, but it is best suited for small structures unless skilled crews are available to construct multi-tiered installations.

The Sutter retaining wall is a kit that uses treated lumber and pre-fabricated channel posts and caps. With ease of transport and installation, it can significantly reduce the cost of a retaining wall.

Interlocking concrete blocks (sometimes called no-pins) are a common material when there is good equipment access to the site. This wall was built to protect a trail from road fill slough. It is a new installation, so its success is not yet determined, but it appears to be too short to accomplish the objective.

This bridge approach bin wall has nice clean lines and makes a beautiful installation. Once vegetation is re-established, it will blend well with the landscape.

Structures for Controlling and Directing Access and Use

Managing entrances and using tank traps, barriers, fences, gates, and cattle guards all help control and direct the riders' direction.

A couple of well-placed boulders can effectively send the message that this trail is for single track only.

Entrance management is accomplished with a structure or a combination of structures and signing to inform the rider of the type of vehicle or vehicle width allowed on the trail. Bollards, barriers, or sections of fencing are often used to restrict vehicles exceeding a certain width from entering the trail. Entrance management is also a technique used to inform riders of the actual difficulty they will be encountering on the trail. Too often, a more difficult or most difficult trail does not appear challenging at the entrance to the trail, so riders start riding the easier part of the trail and then encounter a section with a technical challenge that may be beyond their riding capabilities. With entrance management, technical features (often called

Treated wood bollards are commonly used for entrance management. However, there is too much space on either side if the goal is to stop larger vehicles from entering.

filters or qualifiers) consistent with the difficulty level are placed across the entrance of more or most difficult trails so riders immediately know the level of skill needed or the requirements of the vehicle for the trail to be successfully negotiated. This protects the riders, but also protects the trail from undue impacts. For risk management and for rider safety and enjoyment, this technique should be used at the entrance of any trail that does not appear to be as difficult as it is signed.

Steel pipe is vandal-resistant and sends a stronger message when one is needed.

Effective entrance management controls use and sets expectations by answering questions for the rider:

- Which trail is it? This is indicated by a trail marker that shows at a minimum a direction arrow, and the trail number.
- What is the difficulty level? This is shown on the trail marker and indicated on the ground by a filter when necessary.
- Who can use it (use types)? This is shown on the travel management sign and sometimes shown on the trail marker. Width-limiting devices or barriers can be used to prevent some types of uses from accessing the trail.
- When is it open or closed? If necessary, this can be shown on the travel management sign or other regulatory sign and is often indicated on the ground by a gate or barrier across the trail entrance.

Other information that is often provided at a trail entrance is a “Two-Way Trail” warning sign or “One-Way” or “Exit Only” regulatory signs when appropriate.

Simple, innovative, and effective.

A

This is a good example of an entrance management installation: well-placed barriers backed up with good signing. The 4Es at work.

Anyone could move these treated barriers out of the way, but they didn’t. The barriers are not pinned so maintenance equipment can still get through.

A note on width limiters

Limiters are objects that have been installed within the trail prism. As such, they can increase risk of rider injury and management liability. Limiters MUST be clearly visible. Install them on a tangent, never on a curve. Control approach speed by tightening the trail alignment or other method. Insure that there is adequate time for the rider to see the object, comprehend the object, and react accordingly. Apply reflective object markers if necessary.


Tires were placed as a filter at the entrance to these trails to provide an immediate indication of the difficulty. Good entrance management sets expectations and increases rider safety and enjoyment. It would be preferable to have the filters fit aesthetically with the landscape, but that is not always possible.

Entrance management gone awry…. This was a creative attempt to close a road to full-size vehicles and limit use to ATVs and OHMs. While it's been effective and is still in place, it is aesthetically displeasing, there is no signing or reflective markers, and it's the type of structure that could provide an unwanted "challenge" to an irritated operator of a full-size vehicle.

Tip, Trick or Trap?

Tip: Before designing or installing any gate or limiter, be sure to check for compliance with accessibility requirements

From the front, this tank trap just looks like a mound of dirt that could invite challenge…

…but riders launching themselves over that mound would be looking at a face plant in a vertical wall. These structures have caused serious injuries to riders.

A tank trap is a structure commonly used as entrance management to close or restrict motorized access to roads or trails. It is constructed by digging a hole and using the excavated material to build up a berm in front of the hole. Often called "Kelly humps," the combination of the hole and berm can create a formidable structure that can be 12 to 15 feet deep. There has been much debate on the use of tank traps. On the one hand, they do provide a visual barrier to indicate that the road or trail is closed. On the other hand, for OHV riders looking for challenge, a tank trap can look inviting and attract unwanted use. Just a mound of dirt does not effectively communicate a closure. Unintentional use on poorly located or poorly signed tank traps can result in severe injuries or death. Tank traps can be especially hazardous if the road or trail is closed in the summer to motorized use, but open in the winter to over-snow use. In poor light or blinding snow, a snowmobiler can unknowingly ride into a tank trap.

Tip, Trick or Trap?

Trap: Poorly located, constructed, and signed tank traps are just that- TRAPS

They should not be used on or adjacent to an OHV trail or trail system

Barriers are another management tool used to control and direct where the riders can or can't go. Riders' eyes are constantly scanning for the open route and the best line through that route. It does not take much of a barrier to catch the riders' eyes and deter use. As such, a low, unobtrusive barrier can be just as effective as a large

Boulders make a great natural looking barrier when available. This installation is not complete since the trail that is being blocked has not been ripped and disguised with debris.

visually obtrusive barrier. A variety of materials can be used for barriers, including dirt, vegetation, logs, wooden rails or poles, rocks, steel, tires, hay bales, or treated timber. The choice of materials usually depends on local availability, price, architectural theme, or factors such as the risk of vandalism. The material selected can either send a strong visual message or a subtle one. Once a material is selected, it should be used throughout the project so that a consistent message is sent to the riders.

When used for closure or rehabilitation, the most effective installations include a sign behind the barrier saying “Area Closed” or “Trail Closed.”

Hay or straw bales can make good barriers to control and direct the use. Their portability makes them good for short term uses like trail closures. Bales may need to be certified as weed-free.

These large tires make an effective barrier. Though not aesthetically pleasing, there was a local source of supply and the price was right: free.

With no other materials readily available and in an area prone to vandalism, these pipe barriers are a good choice.

The spruce budworm provided an ample supply of logs for these beautiful and effective barriers.

A word about cable barriers…
On the pro side, cable barriers are easy to install, relatively inexpensive especially for large open areas like this, and are more vandal resistant than all wood structures. On the con side, they have the potential to create a safety hazard and increase your risk. Do not install these where grass or other vegetation can obscure the cable, in high dust areas, or where there is winter snowmobile use. It is not recommended that these be used in areas where there is a higher risk of operator error like around loading ramps, tot lots, or training areas.

Like barriers, fences are used to control and direct the trail use. Materials used to construct fences are often metal, chain link, barbed wire, plain wire, treated timber, rail, split-rail, and log. Material selection is often dictated by local supply, price, or architectural theme. Once a material is selected, it should be used throughout the project so that a consistent message is sent to the riders. As with barriers, fences can add to (or distract from) the aesthetics of an area. They can provide a subtle guide or a strong constraint. Fencelines should also be shown on the trail map to aid in orientation and rider awareness.

One issue that often occurs is a trail paralleling a barbed wire fence. Many factors need to be considered when siting a trail parallel to this type of fence, including speed, traffic volume, tread width, and smoothness of the tread surface. Consider also the consequences of a rider losing control. If the tread is narrower and the surface is loose rock, the risk goes up and that should be reflected in the difficulty level assigned to the trail.

Though not pretty, a requirement for this OHV park was that riders be contained and chain link was the best way to accomplish that.

For resource protection, it was essential to keep cows and riders out of a sensitive drainage and the barbed-wire range fence achieved that.

Gates can be a good management tool, but their primary use is to control access and facilitate travel management. Gates are commonly used for seasonal closures, such as deer winter range or snow melt; to protect resources in cases such as after a natural disaster or other storm events; or as part of entrance management.

This beautiful Russell fence actually enhances the rider experience while providing protection for a sensitive grassland environment.

This classic chilcotin fence harmonizes with the landscape. The mountain pine beetle created a surplus of poles, so why not use them to help manage the use?

There has been much discussion about the effectiveness of gates. They can foster ill will because those with a key can go in, but others are restricted, so they are prone to vandalism. Gate effectiveness uses three of the 4Es. A gate is an engineering structure, but it needs to be supported by education and maybe some enforcement. Most people will respect a closure if they understand the reason behind it. Put up a sign explaining the closure and back that up with information on the trailhead kiosk, the map, website, and other media. Time and effort spent on education will be rewarded with compliance, user satisfaction, and reduced risk of vandalism.

Chains and braided cables are sometimes used as an inexpensive alternative to a gate. DO NOT DO THIS. Gates are visible structures and most have signs or reflective markers on them to increase their visibility, but cables and chains hang low, are usually very thin, often poorly marked, and can be extremely hard to see in a storm or low light. They can be death traps, especially if the trail is also used in the winter by over-snow vehicles. Manage risk. Install the proper structures that will increase public safety and reduce liability.

Things to think about with gates:

- If possible, locate gates where vegetation or topography will inhibit bypassing.
- Use signing and education to inform riders as to why a gate is closed.
- Gates that are sometimes open or sometimes closed to manage access should have red and white retroreflective tape or object markers to increase their visibility. This is a simple step to help manage risk, and this protocol should be included in the project sign plan.
- Gates that are locked in the closed position should also be locked in the open position so that only management has control of the access.
- When gates are used for resource protection, ensure that they are opened in a timely manner when that protection is no longer needed. Similarly, when used for a seasonal closure, ensure they are opened on the date they should be opened.
- Gates should be fully closed or fully open and never in a partially open position. A partially open gate can be a serious safety hazard when there is limited visibility. Manage risk. Ensure that all gates have positive, functional latches or closure mechanisms.
- Work with human nature, not against it. If the complaint is that riders are leaving a range gate open, don't have a crude barbed wire gate closure that can shred expensive riding gloves and jerseys or is difficult to open and close. Use the 4Es. Improving engineering by installing a cam-lock gate closure device will increase compliance and facilitate OHV management.
- Never direct traffic around a locked gate without designating the side route as open, otherwise the public learns to ignore a locked gate.

A Closer Look...

On the gate below, the reflective red and white panel with diagonal stripes is called an object marker. They're available in several shapes, colors, and sizes; guidance for their use can be found in most sign handbooks and in the Manual on Uniform Traffic Control Devices (MUTCD).

Gates that are left in a closed position while the trail goes around them teach the public to ignore closed gates.

It is better to have a designated trail path when closing a gate to one use but opening it to another.

This trail is on an irrigation ditch access road. The innovative gate restricts trail access, but allows access for full-sized maintenance vehicles.

Here are two examples of using other structures as "gates" to control access.

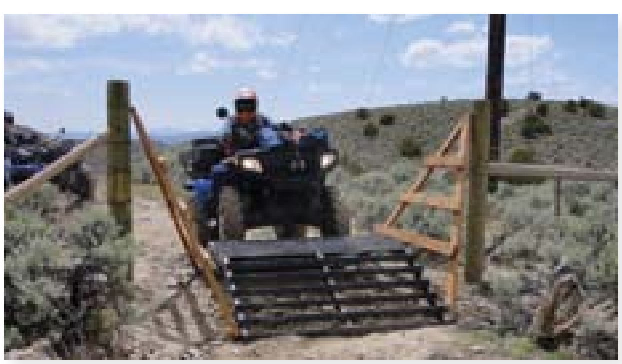
Cattle guards are often installed for livestock management. There are two basic configurations: arched and on-grade. Arches can be a good choice in rocky terrain or where resources preclude excavation. Having a dogleg in the trail alignment on each side of the cattle guard will control the speed of approach. The dogleg allows adequate sight distance but not enough distance to gain speed. On-grade structures can be easier to traverse, but they may require more frequent clean-out. A steel deck is far more durable than treated timber and a much better option.

All cattle guard installations should have a bypass gate to allow passage of equestrians, stock, pedestrians, or maintenance equipment. They can be very slippery when wet or icy. For rider safety and risk management, cattle guards should be installed on tangents, never on a curve, on the flattest grade possible, and level from side to side. Angled wings provide a margin of safety and allow room for transporting over-width materials or game.

Cattle guards are commercially available, but many agencies make their own. There is more science in design and rail spacing than one might think. Improper design such as too deep or too shallow trenches, sharp edges, slippery materials, too great an angle, etc., can pose a risk to both the cattle and the riders. Use caution when attempting to design a cattle guard.

This deck of this cattle guard has round steel tubing and a steel channel iron base. The strip of expanded metal down the center was intended to provide grip for motorcycles, but it is too narrow to be functional. The vertical wings are confining and provide no margin for error.

Above, this on-grade cattle guard has a 2"x 2" square tubing deck in an angle iron frame attached to a 2"x 12" treated timber base.



This arched cattle guard has an angle iron deck attached to a channel iron frame. Due to the forces exerted by tires on the deck ramp, it is essential that arched cattleguards are securely pinned to the ground.

Treated poles were used for this single-track cattleguard. The wood will provide a better grip than a steel deck, but note that this cattleguard in installed on a curve. Though slight, it is enough of a curve for a motorcycle with muddy tires to slide.

Need more? Learn more here...

Alaska Trails Training Modules: Mike Shields: *Slope Structures and Trail Stability,Trail Drainage: Structures and Hydrology, Trail Treadway Structures*

Best Maintenance Practices, Maine Motorized Trail Construction and Maintenance Manual, Bureau of Parks & Lands, Off-Road Division, May 2011

Locating Your Trail Bridge for Longevity, USDA Forest Service, Technology & Development Program, 1023-2808P-MTDC, June, 2010

Managing Degraded Off-Highway Vehicle Trails in Wet, Unstable, and Sensitive Environments, USDA Forest Service, Technology & Development Program, 0223-2821-MTDC, October 2002

Manual on Uniform Traffic Control Devices (MUTCD), http://mutcd.fhwa.dot.gov

Natural Surface Trails by Design, Troy Scott Parker, Natureshape, 2004

Standard Specifications for the Construction of Trail and Trail Bridges on Forest Service Projects, USFS National Technology and Development Program, October 2014

Trail Bridge Catalog, USDA Forest Service, http://www.fs.fed.us/eng/bridges/index.htm

Trail Construction and Maintenance Notebook, USDA Forest Service, Technology & Development Program, 0723-2806-MTDC, July 2007

Trail Planning, Design, and Development Guidelines, State of Minnesota, Department of Natural Resources, Trails and Waterways Division, 2007

Water Harvesting from Low-Standard Rural Roads, Bill Zeedyk, 2012

Wetland Trail Design and Construction, USDA Forest Service, Technology and Development Program, 0123-2833-MTDC, September 2001

A Look Back...

Here are some of the elements discussed in this chapter:

- Always start with the best location for the trail and be forced into utilizing a structure. Structures should be the last option, not the first, since good trail location will minimize the need for them. Structures are time consuming and expensive to build, maintain, and eventually replace.
- A principle element in achieving a durable trail is managing water. Structures help accomplish that by moving water off the trail, under the trail, across the trail, or away from the trail.
- When trying to drain water off a trail, use the grade and alignment to help you. Locate the structure where there is a break in the grade or in a curve where the natural superelevation will help turn and drain the water in the direction of the curve. Allow the water to run in its original direction as much as possible.
- The critical vehicle or design vehicle may not be the OHV using the trail, but the trail dozer or other equipment needed to maintain the trail
- Using entrance management to restrict or define difficulty level access may preclude future trail maintenance or management options
- Many structures require engineering calculations and design. Don't cut costs by short-cutting this step. Manage liability and risk by doing it right the first time.
- Any time that manmade structures are incorporated into a project, the potential risk to public safety goes up and the risk of liability goes up
- Structures require regular inspection and maintenance. The cost and personnel to perform these tasks must be built into the O&M program.
- The longevity of most structures depends on use type, use level, soil type, climate, proper design, proper installation, and proper maintenance. Failure to adequately assess and address any one of these elements may lead to structure failure.

Chapter Eight
Tools in the Toolbox: Equipment

Wear All Your Gear All the Time

To develop an effective O&M program, amassing materials, supplies, tools, vehicles, and equipment is a must. For the field technicians, this is where the fun starts, and they would probably term this chapter “Toys in the Toy Box” since equipment is what puts the trail on the ground and keeps it there. For the program managers, equipment poses a multitude of questions with not-so-easy answers, including what needs to be bought and when?; how will it be paid for?; where will it be stored and how will it be moved around?; and who will operate, maintain, and repair it?

Often two pieces of equipment are more efficient than just one.

Heavy Equipment
Here are some thoughts regarding heavy equipment:
- There isn’t one do-all machine; it usually takes a combination of equipment to accomplish all of the necessary tasks.
- Program managers should identify equipment needed for the short term (construction) and equipment needed for the long term (operation and maintenance).
- Managers should examine options to borrow, rent, or contract the equipment for the short term.
- Program managers should only buy the equipment they know they will need, not what they think they might need.
- In most cases, managers should not buy equipment that is wider than the intended trail widths.
- Equipment is just a tool that is useless and potentially detrimental without a skilled operator who has the finesse, vision, and experience to create a great trail and maintain it as a great trail.
- Trail construction takes a different skill set than road construction, so there can be challenges in trying to train a road builder to be a trail builder.

• Trails are a narrow path on steep, rocky, irregular, and often soft ground. Any machine can quickly go sideways and the operator must instantly know what to do. All operators must be trained. Don't trade expensive, but experienced operators for inexpensive, but inexperienced operators to try to save money. It could be a costly decision.
• As a minimum, managers should ensure that other personnel are on site in the vicinity of equipment operation. On technical terrain, spotters should be working with each piece of equipment.


A dozer can push through a rock pile like this and some of the rocks may roll down the hill. An excavator can create a bed for the rocks and carefully place each one. Rocks like this can be used to support the trail tread or used as anchors or chokes for the trail which will enhance the trail's aesthetics and the rider experience.

There are five main performance categories for heavy equipment: loaders, haulers, pushers, diggers, and other. Some equipment like dozers are purpose-built to perform as pushers, while others, like excavators and skid steers, have the ability to perform well as loaders, haulers, and diggers.

Dozers come in all shapes and sizes, but trail work usually requires only two sizes of dozers. Trail dozers have a track width of less than 50" and full-sized dozers are everything over 50" wide. Mechanized trail building is 10 times faster and cheaper than building by hand, and trail dozers are purpose-built for trail building. Though small in size, they are powerful and versatile with a six-way blade and draw bar with rippers. A variety of attachments are available, and they can grub a stump or move a large boulder. One advantage they have is that they can maneuver easily within the tighter confines of a trail corridor and minimize environmental impacts. The full sized dozers are great for anything which requires a larger foot print than can be accomplished by the trail dozer.


A 6-way blade makes short work of trails on steeper ground.

A Closer Look...

Building trails is not about plowing dirt. In fact, most times the objective is to minimize the amount of dirt movement and retain as many natural features as possible. More important than the size and type of equipment is the skill, motivation, and finesse of the operators. Trail planners and designers can have a great vision and a great design, but it's the operators who put it on the ground and keep it maintained. They can turn a great design into a great trail; a mediocre design into a great trail; or a great design into a poor trail.


With traction, power, durability, versatility, and maneuverability, a trail dozer is an excellent piece of equipment.

Mechanized equipment is faster and cheaper than building by hand.

There are a lot of jokes about the “baby” dozer, but it all comes down to selecting the right tool for the job.

Excavators are diggers and loaders. They are extremely versatile pieces of equipment because they can construct tread, dig holes, dig ditches, pluck rocks or stumps out of the ground, and drag debris in or scatter debris out of the trail corridor. Most have a two-way blade, but some even have six-way blades for efficient grading and shaping. Having a thumb on the bucket increases the machine’s versatility.

With a large selection of excavators in the rental market, it is easy to match the best sized machine to the job; two to look for are mini-excavators and full-sized excavators. It’s hard to beat the versatility and finesse of a mini-excavator, which is less than 50” in track width. Many have adjustable-width tracks, a zero clearance cab, and a bucket with a thumb for handy plucking and placing.

A bucket with a thumb is great for grabbing material and placing it strategically without a lot of ground disturbance. The versatility of a mini-excavator makes it a good choice for finesse or finish work.

The ability to work on steep slopes, scatter debris and reach down to remove woody debris from the embankment area is an advantage.

These are great for building narrow treads, digging ditches and drainage structures.

The operator is digging a hole to plant a boulder for a road-to-trail conversion.

Full-sized excavators are handy for constructing wider trails, closure and rehab, road-to-trail conversion, and facility construction. Often, the ideal equipment combination is a trail dozer and a mini-excavator working together.

A clamshell bucket is also very handy for plucking trees, stumps, or rocks. This one has a built-in grizzly that allows dirt and smaller rocks to fall through.

This excavator is rehabbing old hillclimb trails. It is scarifying the trail, installing waterbars in a herringbone pattern, and strategically placing logs that divert water and deter riders.

Need more reach? Not a problem as this excavator places a blanket of energy dissipaters in this drainage.

Equipped with a 6-way blade, this excavator is a versatile trail making machine.

Small size, fast walking speed, and a host of attachments give skid steers great versatility and make them ideal companions with other equipment to accomplish a wide range of tasks. They can be pushers, diggers, loaders, and haulers. One advantage they have is that they are readily available at most rental stores. Mini-skid steers are commonly called walk behinds because there is no operator cab or seat post. These small machines are maneuverable and have many of the same attachments as their big brothers. The common name is a misnomer since most have a platform for the operator to stand on. They don't have the force of a trail dozer, but they can work well for light excavation on flatter ground or finish work. Many have a six-way blade that helps them cut into shallow sidehills with soft soils. The auger attachment is handy for sign or barrier posts, but a slow walking speed does not make them efficient for widely scattered installations.

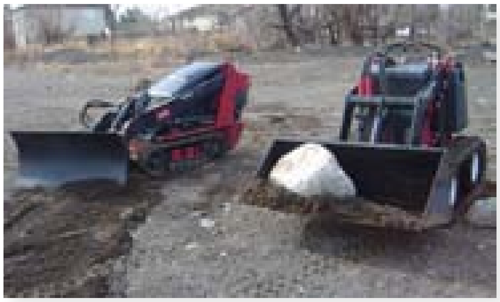
Whether used as loaders or haulers, skid steers are versatile trail-sized equipment. Because they are tracked with low center of gravity and good braking ability, they are far more stable and safer as a tow vehicle than an ATV or ROV.



The wide range of attachments for skid steers makes them useful for a variety of tasks. This bucket attachment with a fixed thumb works well for placing these barrier rocks.

This flail or mulching attachment makes quick work out of clearing brush and small trees as it pulverizes logs and woody debris on the ground.

If one thumb is good, two has to be better. A clamshell bucket can hold material with odd shapes and sizes.



Though most are equipped with either a blade or a bucket, mini skid-steers have a huge assortment of handy attachments and they are often available at local rental stores.

A tractor with a backhoe attachment can be very handy to load and haul material and to dig holes for barriers, fence posts, and sign posts. Thus they fall into the loader, hauler, and digger categories. Four wheel drive is recommended for most trail applications. Their fast walking speed gives them an advantage over mini-excavators or dozers with backhoe attachments when work is scattered over a wide area. Their three-point hitch and power take-off (PTO) allow for a wide range of power attachments from box blades to mowers.

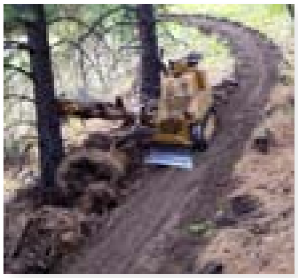


The clamshell bucket on this backhoe adds to the machine's versatility. It can scoop, load, back blade, pluck, place, and chop.

The backhoe attachment can increase the versitility of a tractor.

Trail dozers, mini-excavators and mini-skid steers are commonly used to build single-track trails. Motorcycle riders have always coveted sweet single tracks, but when it comes to a designed trail, the issues have always been how to build it and then maintain it. Riders will volunteer to build the trail and do. But it is a slow, laborious process and few volunteers can or will return day after day. Purists will say that the only good single track is hand-built single track because it is more natural. When done properly, it is pretty hard to tell a hand-built trail from a machine-built trail. It all comes down to the skill, vision, and conscientiousness of the operator. After some time, compaction and displacement will cause roots and rocks to show on the surface; the sides will

Whether on the machine or off, the control panel moves with the operator. This not only can increase operator safety, it allows the operator to always be in the perfect vantage point to control and finesse the machine.



Like its big brothers, the mini-dozer has brute force power, yet the agility to finesse. Note the big 6-way blade and pointed blade tips. These are great for digging out stumps and boulders if it's desired to have those features come out.

revegetate; trees will have fallen and been bucked out to a narrow width; and forest litter will make it look like it's been there forever. What is the big difference? With equipment, the production rate is much higher and the cost of construction is much lower. There are now machines that have been purpose-built for single-track trail construction and maintenance. Find more information about these machines at greatohvtrails.com.

Tip, Trick or Trap?

Tip: Equipment is useless if it doesn't work or breaks down when you need it

Keep all equipment clean and serviceable, do daily maintenance and inspection, and perform all scheduled preventive maintenance.

This single track trail was constructed with a mini-excavator and a good operator. It is narrow and has a beautiful flow, notice the roots appearing in the tread through compaction.

Tip, Trick or Trap?

Trick: Riders usually make the best operators

It can be easier to teach a rider how to be an operator than to teach a seasoned heavy equipment operator how to build a trail. Riders know the flow, can understand the vision, and can do a test ride to see and feel how well they did.

Rock crushers fit into the "other" category. There is usually a need for crushed rock on most trail projects. If a trail has sections of loose cobble rock, scree, lava, river rock, or glacial till and if those sections are not consistent with the intended difficulty level of the trail, crushing that rock in place can provide a more rideable and stable trail tread. Rock crusher attachments are available for skid steers, excavators, and some trail dozers. Grinders and pulverizers are available for loaders and other equipment. If there is a source of suitable rock, a portable crusher can be brought in and set up on site. The crushed rock is then loaded into dumpers and hauled to the work site.

This manual-feed crusher attachment reduces cobble size rock in place. The smaller, angular rock resists displacement and will provide a more solid, durable trail tread.

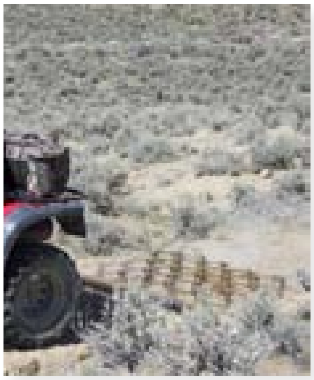
Rock, aggregate, and good quality soil are a great resource for check dams, bridge abutments, drains, headwalls, energy dissipaters, or trail hardening. The issue is getting the material from the source to the site. One solution is a motorized toter or dumper. They come in all shapes and sizes and some are even self-loading. Because they need to fit on the trail and traverse rough terrain, they can have a slow walking speed and relatively low carrying capacity. If there is a lot of material to be moved for any distance, several dumpers may be needed.

If there is a source of suitable rock, a portable crusher can be set up onsite. The crushed rock is then loaded into dumpers and hauled to the work site.

Tip, Trick or Trap?

Trick: Effective grooming: lighter is better

With any drag, making several light cutting passes is more effective than one heavy cutting pass. This produces a better product with less wear on the equipment.



A flexible pasture drag is great for smoothing a newly constructed trail and removing woody debris.

Drags are pull-behind grooming tools that are used in both construction and maintenance. The best drag or combinations of drags is often found by trial and error on a specific site. The choice of implement depends on many factors such as the task at hand, soil type, trail width and alignment, use type, and required maintenance frequency. There are five main types: flexible drags, rigid drags, rock rakes, box blades, and other.

This flexible drag has been modified with a heavier square tubing draw bar and rear channel iron. These work well in soft or disturbed soils, but not in compacted trails where displacement has occurred.

Flexible drags are pasture drags or tine harrows that are made from a draw bar and flexible steel web with steel tines on one side of the web. They can be flipped over when traversing rocky trail sections so the tines don't unearth more rocks. With the tines down, they smooth the trail tread, remove small rocks, and collect woody debris. As the debris collects under the drag, the operator must sporadically stop, flip the drag over, and clean it out. They are great for dressing up a newly constructed or reconstructed trail. Flexible drags are effective in loose soils, but not effective in compacted soils since they have limited weight and cutting ability. Being flexible, they are also not effective in smoothing out a heavily moguled trail since material is removed from both the humps and the dips.

Flexible drags can be modified in many ways, including replacing the round draw bar with a piece of channel iron or square tubing for more weight and cutting action. A piece of channel iron can also be added to the rear for more rigidity, weight, and cutting and smoothing action.

A downside of flexible drags is that they are always on the ground. They work well for construction since everything needs to be groomed, but not for maintenance where one section of trail may need grooming, but not the next section.

A rigid drag works well in non-cohesive soils that mogul out quickly. This crew uses a rigid drag followed by two rock rakes.

Rigid drags, the second type of drag, are long, rigid, and usually have cutting blades in a variety of configurations similar to a snowmobile trail groomer. Some rigid drags have cutting blades with adjustable angles and heights and most have rear wheels that can raise the whole implement off the ground for easy transport. Rigid drags will work in compacted soils to cut and fill moguls and to smooth out the trail tread. They are heavy and if they are allowed to cut too much, the weight can tax the transmission of the tow vehicle. Being long and low, they are

This rigid drag has non-adjustable angle iron cutting blades that are designed to cut the edges and fill the center of the trail.

not very maneuverable and they usually don't work well in super tight trails, but in open country they can be quite effective.

This sliding comb rake can reach out and retrieve material that is normally unrecovered and wasted in berms.

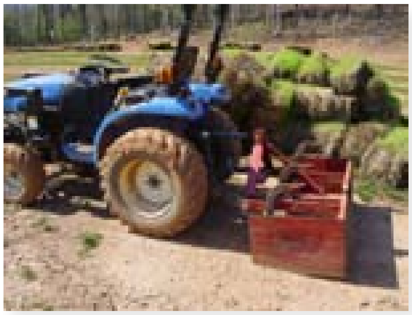
Rock rakes, the third type of drag, have a steel bar with spring steel curved tines bolted to them. Their name is misleading since the equipment is a rake, but not necessarily intended to only rake rocks off the trail. They have either electric motors or electric and hydraulic motors so that both the height and the angle of the comb are adjustable. Most have a u-joint coupler, a handlebar-mounted control box, and a safety breakaway wiring harness. The tines will wear out but they are replaceable. These are the most effective grooming tools on the market and will work in soft soils, compacted soils, and moguls. The small tines have a large psi so they have a powerful cutting action. The adjustable comb allows the operator to direct where the material goes.

The rock rake can cut material from the edges and drift it into the center. Combs are available in different widths. At full tilt, this fixed comb extends past the width of the ATV to retrieve berms.

This fixed-comb rock rake has hydraulic rams which have proven durability in dusty conditions. The steel tines are replaceable. Which ones wear out first? The outer ones since most trails are cupped by the forces of compaction and displacement.

With the comb off the ground, these are easy to back up, turn around, or avoid sections that don't need grooming like rock gardens.

Most vendors make two models of rock rakes. One has a fixed comb where the comb rotates on a fixed axis, and the other has a sliding comb that not only rotates, but extends out from one side to the other. The advantage of the sliding comb model is that it can retrieve berms that have built up along the sides of the trail. Their downsides are that they are heavier, have a higher center of gravity that may not work well on superelevated curves, and are considerably more expensive. A fixed comb model can also retrieve berms if there is enough clearing width to allow the tow vehicle and the groomer to straddle the berm. For most routine maintenance, the fixed comb groomer is both effective and a better value.



Box blades have ripper teeth inside the box, which shapes and compacts the material.

This disc and tire combination is being used on sandy trails. Due to its length, this unit would not work well with a tight curvilinear alignment.

Box blades, the fourth type of drag, attach to the three-point hitch of a tractor and are very common in track and arena grooming. Most have a set of ripper teeth mounted inside the box and the teeth can be down or up. The box shapes and compacts the ripped-up material. They are available in a variety of widths down to 4 feet and can work in a variety of soils. Unless the tractor is equipped with a float mechanism, a box blade will not work well on undulating or moguled trails. Other potential pitfalls are that they tend to cut a trench; the operator cannot drift material from one side of the trail to the other; and it is difficult to reach out and bring in berms.

The last type of drag is for everything else from bed springs to discs to tires. There are a lot of implements commercially available, or the trail team members can get creative and fabricate their own. They shouldn't be afraid to experiment until they find the implement or combination of implements that work the best for their situation.

Compaction equipment compresses soil or rock particles into a denser mass that increases durability and bearing strength. It is essential for the stability of large embankments. It's an important element in the installation of structures such as for the packing material behind retaining walls, bedding culverts, and foundations for bridge abutments. The desired density is best achieved when material is placed and compacted in shallow layers. A compacted trail surface, whether native surface or crushed rock, will retain its shape far longer than a non-compacted tread because it resists the forces of displacement.

A huge assortment of compaction equipment is available, including tampers, plates, and rollers that are either hand operated, self-propelled, or attached to other equipment. Vibratory rollers will compact better and deeper than non-vibratory rollers. Even without specialized equipment, some degree of compaction will occur just by running whatever equipment and vehicles are on site over the full width of the trail.

This sheepsfoot roller attachment behind a trail dozer doesn't vibrate, but it does a good job of compaction when there are favorable soil moisture conditions.

Tip, Trick or Trap?

Tip: You cannot roll out pie crust in a bowl

Do not use compaction equipment on a trail that has a concave or convex shape. The entire tread surface must be uniform from side to side and the soil density must be uniform or only the high points and dense points will receive compactive effort.

this tandem-drum walk behind vibratory roller is labor-intensive, but it produces a well-compacted product.

Moist soil will compact better than dry soil, so try to time compaction operations during periods of favorable moisture content.

These handy vibratory plates will not exert the same compactive effort as a smooth drum roller, but they do a good job smoothing and compacting the surface of the tread. One advantage of compaction attachments is that they can be raised by the equipment to avoid root or rock sections.

This trail size ride-on vibratory roller beats a walk-behind any day, however for safe operation, the tread surface must be relatively smooth and level from side to side. These will not work well with protruding roots or rocks.

A wide range of trailers are useful to haul equipment, materials, and supplies. There is not one do-all trailer and most O&M programs have a fleet of highway trailers and off-highway trailers. Highway trailers are usually full-sized flatbed trailers designed to haul equipment or utility trailers designed to haul materials. Off-highway trailers can help bring materials, equipment, and supplies to a trail work site. They can be pulled by ATVs, ROVs, or skid steers. The trail team members should heed towing capabilities of the tow vehicle before loading up a trailer. Uneven terrain and steep grades add to the challenge of towing off highway so exceeding the tolerances can be risky.

Without road access, it can be a challenge getting materials and supplies into a trail work-site. Trailers in a variety of configurations can be a big help.

Flatbed trailers with a built-in ramp like this are great for hauling OHVs, drags, materials, and supplies.

Tip, Trick or Trap?

Tip: Properly secure all equipment and materials

Never transport equipment that isn't tied down securely even for short distances

Tip, Trick or Trap?

Trap: Bigger equipment isn't always better

Although trails can be constructed with equipment that is wider than the intended trail width with care and some extra work, they cannot be maintained with equipment wider than the trail

Rubber tracks are flexible and have no grousers. With a low PSI and a careful operator, this machine can walk over hand placed trail armoring stones without breaking or displacing them.

A Closer Look…

How to Approach Equipment

It takes hand, foot, and eye coordination to be an operator and intense concentration to make the machine do what the operator wants it to do. The operator's focus is on safely and efficiently accomplishing those tasks, and not necessarily what is going on around him. It is dangerous to come within 20' of a machine being operated unless directed to do so by the operator. Workers should not assume an operator has seen them approach or they will put themselves at risk.

A good trick is the Stick Method. When approaching equipment, even from the front, pick up a good-sized stick (a lath or roll of flagging will also work). If you are unable to get the attention of the operator, throw the stick over the cab or beside the cab at the eye height of the operator. An astute operator will immediately stop to figure out where that came from. Once you have the attention of the operator, wait for a signal that it is okay to approach. A good operator will lower the blade or the bucket to the ground, throttle down, and take his hands off the control levers.

Equipment Drive Characteristics

Steel Track	**Rubber Track**	**Tires**
Durable	Durable on dirt, but a lot of sharp rocks will eat them up	Durable
Low PSI due to high ground contact area	Low PSI due to high ground contact area	Higher PSI due to lower ground contact area
Excellent traction in dirt and mud	Good traction in dirt and mud	Poor traction in dirt and mud
Poor traction on rocks	Better traction on rocks	Poor traction on rocks
Will not slip off in uneven terrain, but they can bind up when clogged with debris	Can slip off in uneven terrain	Potential to break the bead or puncture sidewalls in uneven terrain
Higher potential ground impact	Lower potential ground impact	Higher potential ground impact
Better on steeper grades	Good on steeper grades	Poor on steeper grades, better suited on flat grades
Smooth ride	Smoother ride	Bouncy ride
Highest potential to break or dislodge roots and rocks	Lower potential to break or dislodge roots and rocks	Lowest potential to break or dislodge roots and rocks
Steel grousers can damage bridge decks and other structures	Much less potential for structure damage	Much less potential for structure damage

	Dozers	Excavators
Functions	Push, sidecast, rip, back blade; good for construction and maintenance	Dig, pluck, place, load, scatter; limited push and back-blade; good for const., finish work, local maint.
Material Handling	Push, sidecast	Pluck and strategically place
Brushing	Unable to remove debris from embankment area on steeper ground	Able to remove debris from embankment on any slope
Cut slopes	Unable to shape steeper cutslopes	Able to shape any cutslope
Maneuverability	Needs flatter area to turn around. Locking tracks increase ground disturbance	Only needs enough clearance to swing cab to change direction
Stability	Low center of gravity helps stability but stability affected by rocky or slippery slopes	Higher center of gravity can hinder stability but ability to use boom to stabilize on rocky or slippery slopes
Compaction	Excellent embankment compaction by track-splitting or optional mechanical roller	Can use boom to compact embankments or use optional mechanical roller
Slash and Debris	Clears debris deposited in mound or ball	Able to scatter debris on any slope
Objects	Can roll objects but creates ground impacts outside trail prism	Can reach, grab, place objects while staying in trail prism
Digging	Good for trenches and large holes	Good for ditches, post, barriers

Hand and Mechanized Tools

No trail can be constructed by heavy equipment alone. Hand tools do the clearing, pruning, root cutting, structure assembly, and the final finesse work to make it all look pretty. Three common mistakes that are made when purchasing tools are: 1) not buying a good variety of tools like shovels, Pulaskis, and McLeods; 2) not buying enough of each tool; and 3) not buying or renting the right specialty tools (like drills, augers, and rock hammers) that make tough tasks easier. Each tool has a purpose and not having the right mix of tools can make a task much more difficult. Building a single-track trail with just shovels is a waste of time and energy. Tools have a tough life and often a short life as they get misplaced, broken, dulled, and misused.

It can be challenging just getting the tools and gear to the work site. From L to R, chainsaws, brush cutters, shovels, McLeods, pulaskis, and loppers.

Camaraderie is important with any crew, but this group is working too closely together for safety. There should be a minimum of 6' between workers. It is a good example of the use of hardhats and the number of tools that are needed for a work crew.

The following paragraphs describe some of the most common hand tools for trails.

Pulaskis are one of the most essential trail tools because they can cut, chop, dig, and pry.

McLeods are the second most essential trail tools. They combine a hoe and a rake and are great for chopping, moving dirt around, raking out rocks, and shaping the tread, rolling dips, or lead-off ditches.

Chainsaws, with a variety of chain and bar configurations, are essential for cutting trees, logs, brush, and trimming posts, barriers, and other wooden structures.

Loppers are great for pruning small limbs and cutting roots out of the cut bank or trail tread.

A good quality folding saw makes cleaner and closer cuts than a chainsaw and is very handy for final touch-up pruning. Adjustable pole pruners are great for trimming long droopy limbs and they're much safer and faster than using a ladder or standing on top of a vehicle.

Gas-powered brush cutters and hedge trimmers are great for removing or cutting back underbrush, both in construction and maintenance. Hedge trimmers come in either standard or pole units. They are good for keeping new growth from side vegetation from creeping into the trail in places where the tread is already established. Brush cutters come with a variety of implements from blades to nylon string. Choose the correct implement for the largest growth which needs to be cut.

In a deciduous forest, leaves can be a nuisance. Leaf blowers can remove leaves from the work site or blow leaves back onto cut or fill slopes to provide a natural appearance and to protect them from exposure to the elements. Blowers are also handy for removing dirt from bridge decks and other structures.

Spade shovels are indispensable for digging holes, moving dirt, prying out rocks, and cutting roots.

Bow rakes or smaller landscape rakes smooth out the surface and remove small rocks and woody debris. They are great for final shaping and finish work.

It is always amazing how many rocks there are in the exact place a hole needs to be made. Rock bars and tamping bars help to break up or dislodge rocks. A tamping bar is pointed on one end and has a small flat plate on the other, so it can be used for digging and compacting.

The pulaski is an essential trail tool.

McLeods are also essential trail tools.

Chainsaws are an essential trail tool for several functions besides tree removal.

Leaf blowers can move away nuisance leaves in a deciduous forest.

Depending on soil type and time of year, post hole diggers and power augers can be great for digging holes for sign posts and barriers.

Gas powered augers save time and hands for sign post or fence installation.

Portable air compressors are essential because there is always a need for compressed air. Tires go flat, filters need to be cleaned, dirt needs to be blown off parts or personnel, air tools can be more powerful than hand tools, and the list goes on. An industrial-grade air compressor is an essential component in the shop, shop truck, or field staging area. Some heavier equipment offers a compressor as an accessory and this is usually a worthwhile option to consider. Having the ability to use pneumatic drills, rock splitters, and compactors can save a lot of manual labor and is more efficient.

Portable generators are another essential tool because there is always a need to power lights, tools, battery charging stations, etc.

Sometimes, just the tip of a rock needs to be moved out of the way, not the whole rock. And sometimes it seems that rocks are anchored to the other side of the world. In those situations, having a pneumatic, gas, o electric rock hammer or drill is both safer and faster than ordinary hand tools.

Brush cutters are great for clearing underbrush from a single-track trail.

Pneumatic rock splitters clear away stubborn rocks in the tread.

Many of the wooden structures require the drilling of holes for bolts or drift pins. This can be a tough task that requires electric- or gasoline-powered drills and long drill bits.

Equipment and tools break. Being able to weld on site with a portable welder can save on downtime and expensive trips to a repair shop.

Equipment will also get stuck or find its way into a precarious position. Having a winch suddenly becomes an essential item in these situations. When ordering equipment, it is usually wise to purchase a winch if it's an available option. Chainsaw winches, come-alongs, and OHV winches can be invaluable in moving rocks or logs and in placing bridge stringers, puncheon, and other structures.

Equipment can find its way into precarious positions.

Drills and bits are invaluable for on-site structure assesmbly.

The list can go on forever, but some other tools worth mentioning include the following:

- pick mattock
- hazel hoe or adze
- mallet
- sledge hammer
- hand seeder
- fence stretcher
- fiberglass marker installer and removal tools
- T-post driver
- pop rivet tools
- complete mechanics tool sets (both standard and metric)
- cordless drill and drivers
- hand saws
- corded or cordless circular saws
- A tool bag is great for everything else:
  - a drill and driver with spare battery and bits
  - sockets and wrenches for whatever size hardware is being used on the project
  - an assortment of hardware
  - an assortment of decals
  - a fencing tool
  - torpedo level to make sure the signs and posts are straight
  - 25’ tape measure
  - notebook and pencil
  - hammer
  - scrench saw tool
  - ear plugs
  - 4-way screwdriver
  - pliers

Tip, Trick or Trap?

Trick: Want to be ready for just about anything?

When reviewing a project site, consider carrying:
tool bag
pulaski
McLeod
folding pruner
loppers
hand axe
lath or stakes
flagging

A Second Look...

Personal Protective Equipment (PPE): PPE includes gloves, hardhats, chaps, hearing protection, eye protection, boots (or steel toe boots), long-sleeved shirts, long pants, etc. For equipment, PPE includes the seat belt. Whatever personal protective gear is needed, HAVE IT and WEAR IT.

Did we mention the #1 function of hand tools?

A Look Back...

Here are some of the elements discussed in this chapter:

- There isn't one do-all piece of heavy equipment; it usually takes a combination of equipment to accomplish all of the tasks
- Identify equipment needs for the short term and long term
- Rent or contract short-term equipment
- In most cases, do not buy equipment that is wider than the intended trail widths, especially for maintenance
- Tracked equipment has better traction and less ground impact than wheeled equipment Steel tracks have more traction, but potentially more ground impact than rubber tracks
- Keep all equipment and tools clean, serviceable, and properly maintained
- Equipment is useless without a skilled operator who has the finesse, vision, and experience to create a great trail
- It can be easier to teach a rider how to be an equipment operator than to teach a seasoned heavy equipment operator how to build a trail
- Buy a full variety of hand tools and buy lots of them
- Whether operating equipment, working around equipment, or using hand tools, always have and wear appropriate PPE
- Ensure that all equipment and materials are properly secured during transport
- Never approach a piece of moving equipment unless directed to do so by the operator

Chapter Nine
Tools in the Toolbox: Communicating with the Public

If Not You, Who?

The foundation of this book is the effective application of the 4Es; and the basic premise of the second "E," Education, is that educated riders are responsible riders. Most agencies don't have the personnel or funding to have staff in the field when the riders are recreating, but it is essential that management communicate with the riders and that the riders understand that communication. If management team members don't effectively tell the public where they should be riding and how they should be acting, the team can't be disappointed when riders go where the team doesn't want them to go and do what the team doesn't want them to do.

Communication can occur through non-personal media, including signing, trail maps, websites, and social media. It can also occur through personal contact, including through agency staff, contracted site hosts, or volunteer trail ambassador programs.

Signing

Signing gives the rider key information about the site, rules, orientation, education, and safety. By clearly conveying these messages, management can better control and direct the use, maximize rider safety, and minimize agency risk. But signing does more than just convey a message, it conveys an image and an expectation: this site is professionally managed. Visitors will respond to that image with increased respect and compliance.

These signs are getting illegible; the lower ones look like an afterthought. What image are you sending to the public when using these signs? How is the public supposed to obey the signing?

Here are some key points on signing:

- Have a sign plan. This ensures consistency with sizes, shapes, colors, messages, placement, and decal application protocols.
- Signing must be clear, concise, and effective. Follow the Keep It Simple (KIS) principle.
- Trails are like miniature roads and should be signed in the same manner as roads.
- Ensure that signing on the ground agrees with the information on the map or other handouts and media (website, downloadable maps, downloadable GPS data, etc.).
- When first entering a trailhead, signing will give visitors their first impression of the site, its management, and its maintenance. Make it a good and lasting impression.
- Provide the information that is essential for the rider to know.
- During project development, the importance of signing is often overlooked and its cost is often underestimated. Signing costs can be significant and need to be factored into the project budget to ensure quality signs and signing.

Tip, Trick or Trap?

Tip: Entrance management components
- Trail marker
- Travel management sign
- Vehicle width limiter
- Difficulty filter (if necessary)
- Closure or restriction sign (if necessary)

A sign plan can be very detailed and provide site-specific data on sign location, sign type, and message. Or it can be a programmatic sign plan which identifies typical signing scenarios for a project area and provides guidance on what signs would be appropriate in each of those scenarios. This provides consistency by ensuring that similar scenarios have similar signing. In each scenario, the plan discusses the signs that are needed and their function. It provides guidance on the sign shapes, sizes, colors, messages, letter sizes, reflectivity, materials, decal placement protocols, and sign installation protocols.

Other benefits of a sign plan include:
- Identifies a sign theme that is consistent with the architectural theme and landscape setting for the project site.
- Helps ensure that the proper sign types are used in a given scenario.
- Minimizes sign clutter and maximizes sign efficiency.
- Provides all personnel with the same vision.
- Allows managers to budget for sign needs according to the vision.
- Allows volunteers to install and maintain the signs according to the vision.
- Over time, management and personnel will change, and a sign plan will maintain continuity and consistency through these changes.

Here, a low-volume spur road has been blocked where it continues on a single-track conversion. The motorcycle is parked in what is now a dead-end road with no cross traffic. There is nothing to Yield to, so why have a Yield sign?

There are eight key elements in effective signing (need, simplicity, clarity, quality, consistency, placement, monitoring, and maintenance) and having a plan helps address all of them.

1. Need
Determine the reason for a sign or if a sign is necessary.
- Are there other options instead of signs? Can the hazard be eliminated or mitigated? Can the trail be realigned or relocated to eliminate the hazard? It's easier to put up a sign than to physically correct the problem, but this may not be the best long-term solution.
- If a sign is needed, choose the appropriate sign from the sign plan.

These signs are simple and easy to read.

These signs have too much information and the important information like trail number and direction are not at the top where they should be. Agency and funding decals, if needed, should be at the bottom of the marker. Riders will not stop long enough to read or comprehend this data.

Having a plan helps avoid sign clutter like this. Though the information may be important, no rider is going to stop to read this barrage of signage. All of this could be put on one well-designed large sign.

Tip, Trick or Trap?

Tip: More signs do not equal more effectiveness

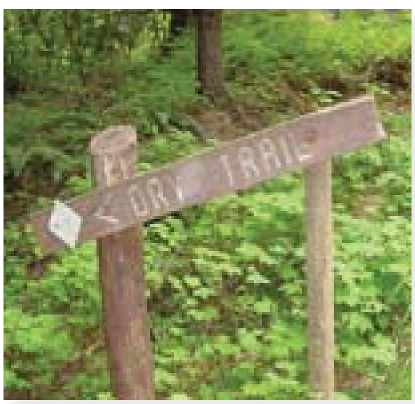

What do these signs mean? Riders cannot be compliant if they are confused by the message.

2. Simplicity
• Keep it simple and avoid clutter.
• The public spends very little time reading signs, so make them count.
• Use enough signs, but avoid over-signing.

The sign at left is too simple. Caution of what? The sign at right explains what the Caution is.

3. Clarity
• Use clear, concise messages.
• Will the rider understand the intent of the sign?
• Whenever possible, use symbols rather than words.

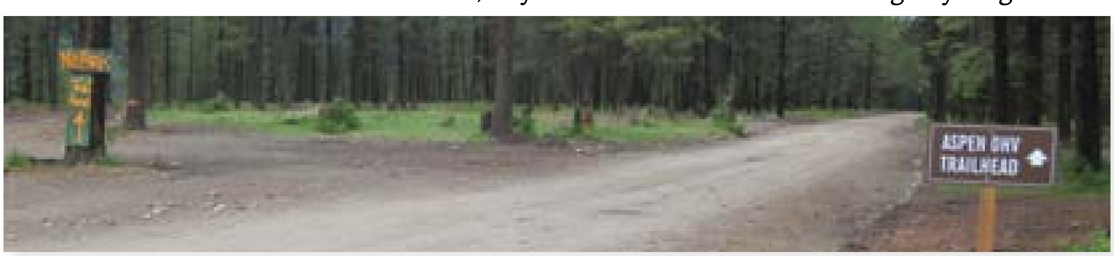
4. Quality
• Use durable materials that are vandal-resistant.
• Make sure the sign is taped to protect it from UV light or snow shear.
• Use professional letters and templates.
• Make the sign messages appropriate and professional.
• Check, re-check, then check again for correct spelling.
• The sign and the installation should be neat, legible, straight, and professional looking.
• The public respects quality, but quality does not necessarily equate to expensive.



While any sign may be better than no sign, what message is being given to the riders with this poor quality sign installation?

Why did management accept and pay for these poor quality signs? People respect quality. If management doesn't care, why should the riders care?

These signs may be inexpensive, but they do not meet size, shape, color, or mounting standards. The paper stop sign is illegible. All of this only increases tort claim risk and decreases agency image.



The better image? The home-made sign on the left was definitely inexpensive, but the sign on the right is far more professional and effective.

Both of these motorcycle crossing warning signs are on the same trail system. Neither meet size, shape, color, mounting, or reflectivity guidelines. This, plus the lack of consistency, increases risk.

5. Consistency

- Do all of the signs meet shape, color, reflectivity, and message standards?
- Are similar hazards and situations signed identically?
- Is the signing consistent with that of other OHV trail systems in your area, state, or province?

6. Placement

This is perhaps the most critical and abused element. Most OHV trail signs are viewed from a moving vehicle, so signs need to be sized and placed where they are readily visible.

This trail is approaching a paved county road, but the Yield sign was placed behind a rock fence support.

This reassurance arrow stuck up in a tree is not visible nor effective.

Install signs where the riders would expect to see them (generally on the right-hand shoulder of the trail, not up in a tree). This is where drivers and riders have been programmed to look for them. Occasionally, due to alignment or vegetation, a sign may be more visible if placed on the left side of the road or trail. Riders' eyes constantly scan the trail to pick the best line, but they aren't scanning trees and bushes looking for signs, so place the signs where the riders' scan will pick them up.

- Avoid placing signs in shadows or where vegetation may obscure them.
- Place the sign enough in advance of the hazard to allow sufficient time for the rider to see it, read it, comprehend it, and react to it. This is called the Perceive, Identify, Emotion, Volition (PIEV) time. The minimum sight distance for a warning sign should be 175 feet.
- The intent is to have professional looking signs, so all signs and posts should be as level or perpendicular as possible.
- When signing, assume that the rider is a beginner, unfamiliar with the trail, and there is poor light and visibility.

Even in poor light, this well-placed reassurance marker is clearly visible.

Effective signing is critical with one-way trails. This Wrong Way sign is poorly placed and is barely visible from the trail junction.

The sun has faded this Stop Ahead symbol to the point where it no longer meets color or retroreflectivity standards. In addition, the Stop sign is missing entirely.

Bullets beget bullets. Regular monitoring is essential to maintaining quality and effective signing.

On a mixed use road, it is essential that the public be warned of the mixed traffic. Someone has removed the OHV symbol and it needs to be replaced in a timely manner.

7. Monitoring
- Monitor the condition of the signs and supports on a regular basis.
- Check color, reflectivity, placement, and overall effectiveness of the sign.
- Review the signing under a variety of light and weather conditions.
- Use an outsider or someone unfamiliar with your trails and signs to objectively judge the effectiveness of the signing.
- Don't be afraid to take down signs. More signs are needed early in a new program to educate the public, but may not be needed in three to five years.
- An annual evaluation is suggested. Evaluate the following:
  - Are signs visible?
  - Are signs missing?
  - Are the existing signs in good condition?
  - Are the signs in compliance with the current standards?
  - Are any signs no longer necessary or appropriate?
  - Are messages appropriate or accurate?
  - Are new signs compatible with existing installations?
  - Based on accident reports or near misses, are engineering studies required to determine additional signage to alleviate a safety concern?
  - Have signs been evaluated at night to determine their overall effectiveness and retroreflectivity?

8. Maintenance
- Repair or replace signs as needed to maintain quality appearance and function.
- Keep vegetation pruned back so the signs are visible.
- Bullet holes invite more bullet holes.
- Warning and regulatory signs must be in-place and legible.

The reassurance marker lying on the ground is almost useless.

The forest is a dynamic environment. Inspection and maintenance personnel must be conscious of changes that can alter the effectiveness of the signing.

Types of Signs. When signing, it is important to use the right type of sign in the right situation.

Administrative

Recreation Site

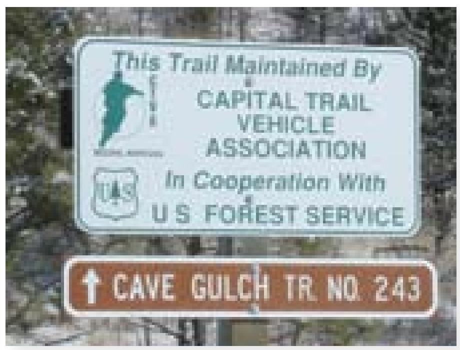
Visitor Information

Travel Management

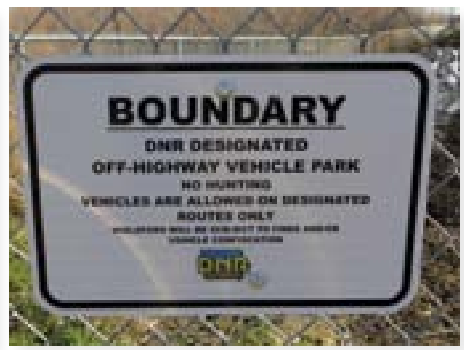
Trail


Warning

Regulatory



Cooperator



Program Area

Administrative signs generally identify who has jurisdiction of the site. Examples include Federal, State, Provincial, County, City, and Private property.

Recreation site signs identify the name of the site. Examples include trailhead, staging area, campground, and OHV park.

Visitor information signs relay rules, etiquette, information, education, and interpretation. Examples include: kiosks, map boards, and Required to Ride signs.

Travel management signs identify who can or can't use the route or area and any restrictions on use. Examples include: trail users allowed on routes, trail users restricted from routes, and seasons or dates trails are open and closed.

Trail signs include: trail junction markers, reassurance markers, destination (guide) signs, points of interest signs, and information signs (Use It, but Don't Abuse It; Stay on Trail or Stay Home; Please Stay on the Trail, the Future of This Trail Depends on You).

Warning signs warn of a potential hazard or unusual condition. They are diamond-shaped with reflective black on yellow or black on orange. Examples include: Intersection Ahead, Gate Ahead, Stop Ahead, and Yield Ahead.

Regulatory signs inform the users of traffic laws or regulations. Except for stop and yield signs, they are rectangular-shaped with reflective black on white. Examples include: Trail or Area Closed, Trail or Area Restricted, Stop, Yield, One Way, and Do Not Enter.

Cooperator signs recognize trail stewards, key volunteer groups, or other partners.

Program Area signs include open area boundary signs, OHV park boundary signs, and other boundary signs.

Sign Colors. As per the Manual on Uniform Traffic Control Devices (MUTCD) and EM7100-15, signs should conform to the following standard colors.

Red is used only as a background color for Stop signs, Do Not Enter, and Wrong Way signs. Red is used as a legend color for Yield signs, parking prohibition signs, and the circular outline and diagonal bar prohibitory symbol.

Black is used as the background color on horizontal arrow One Way signs. Black is used as a message color on white, yellow, and orange signs.

White is used as the background color for most regulatory signs, except Stop signs. White is used for the legend and border on brown, green, blue, black, and red signs.

Orange is used as a background color for construction and maintenance signs.

Yellow is used as a background color for most warning signs unless orange is specified.

Brown is used as a background color for guide, information, and recreation signs.

Green is used as a background color for state and federal highway guide signs, milepost markers, and as a legend color with white background for permissive parking regulation signs.

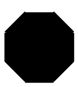
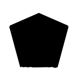
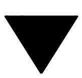
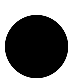
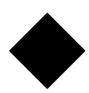
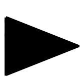
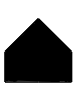
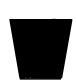
Blue is used as a background color for information signs and related motorist services on state and federal highways.

Sign Shapes. As per the MUTCD and EM7100-15, signs for motorized trails should conform to the following standard shapes.

Tip, Trick or Trap?

Trap: More signs do not equal less risk

Keep signing simple and minimal. Warning signs especially should be used very judiciously. Tort claims have been lost because one hazard was signed, but another hazard wasn't. There can be less risk by adding "ride at your own risk" verbiage to the map, kiosk, and web messages than by putting up warning signs.

Image	Shape	Sign	Image	Shape	Sign
	Octagon	Stop		Rounded pentagon	County route
	Equilateral triangle	Yield		Crossbuck	Highway-rail grade crossing
	Circle	Highway-rail grade crossing (advance warning)		Diamond	Warning series
	Isosceles triangle	No Passing		Rectangle (and square)	Regulatory series Guide series Warning series Recreation symbols
	Pentagon	School advance warning		Trapezoid	Recreational and cultural interest area series National forest route

Letter and Symbol Sizes. For motorized trails, the minimum letter size is 2 inches using an ASA (American Standards Association) Series C font and the minimum symbol size is 12 inches. Consider the intent of the sign, rider speed, and viewing distance when determining appropriate letter sizes. A 2-inch letter is difficult to read from a moving vehicle or from any distance, but a 3-inch letter is quite legible.

Sign Sizes. The minimum size for warning and regulatory signs is 12 x 12 inches. Smaller signs should not be used unless the rationale is documented in the project file.

This regulatory sign prohibits OHV operation in this area. The letter size is too small and the sign is placed too far away from the trail to be legible. We can't get compliance if we don't effectively deliver the message.

Letter sizes are important since it doesn't serve you or your customers to have a sign that cannot be read. This sign is intended to be read from a moving vehicle. The Required to Ride sign is legible, but the Attention sign is not legible even from a stopped vehicle. The letter sizes should be bigger or this sign should go on a kiosk for stationary, close-up viewing.

The USDA Forest Service Sign and Poster Guidelines EM7100-15 is a recommended resource for roads and OHV trails. It contains a plethora of additional information on sign messages, abbreviations, number of lines per message, the use of arrows, letter size in relation to speed, sign substrates, etc.

Tip, Trick or Trap?

Trap: Use the word "safe" as a descriptor of the trails, facilities, or experiences. Safe is a relative term, it can't be guaranteed, and lawyer will use it against you in court.

Recommended Sign Guidance. For safety, durability, and professional appearance, the following general sign guidelines are recommended:

- Use retroreflective backgrounds on signs so they appear to be the same shape and color by night as by day. Even if there is no night riding, search and rescue operations frequently occur at night.
- Put a border on the signs.
- Order signs with rounded corners and pre-drilled holes for attachment.
- Mount signs on posts or markers, not on trees.
- Only one warning or regulatory sign should be mounted per post.
- All signs with decals, letters, or numbers can be covered with clear plastic tape that wraps over the top of the sign. This helps prevent snow shear; protects the sign and decals from UV decay; and protects the sign from damage by weather, wildlife, or vandalism. This protective sheeting can triple the life of the sign or marker.

At the time of final design or construction, a Sign List should be developed that lists all the signs and markers needed on a particular segment of trail. Once the signs are installed, GPS coordinates can be added so the Sign List and can serve as a complete sign inventory as well as a maintenance tool. This list aids in the correct assembly and installation of the signs.

Signs up to 18 x 18 inches should be attached to posts with 5/16 x1¼ inches hex head lag bolts with washers. Larger signs should be attached with 3/8 x 1½ inches hex head lag bolts with washers. For all signs that are near roads, trailheads, staging areas, campgrounds, or other areas with public access, consider vandal-resistant hardware. To avoid damage to the sign face and decals, the holes for these screws need to be pre-drilled and care should be taken not to over-tighten the bolts or screws.

For quality aesthetics in most forest settings, it is preferred to have signs with brown backs since they blend with the landscape better and look more natural. This is an advantage of using brown polyplate as a sign substrate. In an urban or industrial setting like an OHV park or MX track, other background colors may be more appropriate.

Things That Harm Signs. When selecting sign materials, there are several environmental factors to consider.

Wildlife. Porcupines eat wood signs, so avoid using wood if these animals are prevalent. Deer and elk will use signposts to rub the velvet off their antlers. A 4 x 4 inch wood post can be rubbed to a toothpick in a few years. Fiberglass or metal may be a better alternative.

Livestock. Cows will scratch themselves by rubbing on signs and can easily break a sign or deface it. Consider using thicker materials and be sure to cover the signs with clear overlaminate tape to increase durability.

Ultraviolet light. The sun's UV rays will fade colors, damage adhesives so decals peel and multi-layer signs delaminate, and bleach the resins out of fiberglass so it fades and rots. When possible, order materials that are UV stabilized. Cover all signs and markers with clear overlaminate tape.

Weather. Rain will eventually saturate wooded laminate signs like plywood. Heavy hail can cause sign sheeting or decals to peel. Snow shear is a tremendous force that can also peel away the sheeting or decals. Extend the life of your signs by using clear overlaminate tape.

In areas that are prone to high winds or tornados, consider using thicker substrates and heavier bolts to attach signs to posts. Be sure that signposts and markers are thoroughly imbedded in the ground. This can be difficult in hardpan or rocky ground so drilling may be needed to obtain an adequate depth.

Human exposure. Graffiti, bullet holes, or breakage can be a common problem in some locations. Having a clear overlaminate sheeting will aid in the removal of graffiti. Regular inspection and maintenance are needed to address other issues.

Common Mistakes. There are several common mistakes that all management teams make when considering what signing to use on their trails. The photos below highlight the mistakes and give suggested solutions.

Mistake: Improper sign size and sign clutter.

At this trail and road junction, the important sign is the Yield sign, yet it is the smallest sign. The Intersection Warning sign should be placed in advanced of the junction. The Speed Limit sign should be put in a location removed from the intersection.

Mistake: Improper sign and placement, plus the top of sign is illegible.

A poster stapled on a tree is not an adequate warning sign and a sign like this increases agency risk. A proper warning sign should be installed on a post on the right side of the trail. The trail difficulty should be indicated at the beginning of the trail, not midway through it.

Mistake: Mixing sign types.

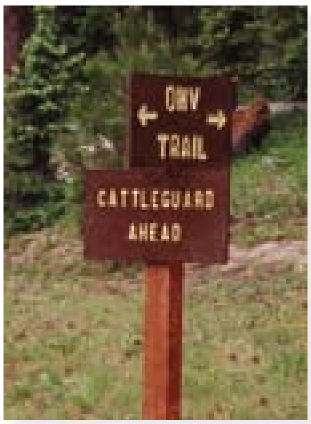
Yield is a regulatory sign, but 2-Way Traffic is a really a caution message that should be on a warning sign. The intent was good, but the sign is confusing. On a two-way trail, someone always has to yield to another rider. This Yield sign should be removed and replaced with a standard 2-Way Traffic sign.

Mistake: The agency logo at the top.

Don't be offended, but riders really don't care or need to know who owns the trail. If desired, agency decals should be placed at the bottom of the marker. Keep in mind that every decal adds to the sign installation and maintenance cost. Trail identifiers would be helpful.

Mistake: Improper sign, and the sign is illegible

In most cases, any sign is better than no sign, but can riders read this hand-stenciled sign as they go by? The letter color blends into the sign background. Having standard shapes, colors, and messages increases signing effectiveness and decreases agency risk.



Mistake: Improper size, shape, color, letter size, and reflectivity

The routed wood OHV Trail sign may be appropriate in some settings, but they are expensive and not as durable as other substrates. The Cattle Guard Ahead is being used as a warning sign but it does not meet proper sign guidelines for warning signs. A proper sign should be mounted on its own post on the right side of the trail.

Mistake: Improper size and placement of regulatory sign.

If a regulatory sign is really needed, then it is an important sign and it shouldn't be a 3"x 3" decal stuck at the bottom of a string of other decals. A standard Stop sign should be installed on its own post. Given that this is a primitive sand road, do riders really need to stop or would a Yield sign be more appropriate?

Mistake: Permanently mounted maintenance signs.

This is a good warning sign though it should be placed on the other side of the trail. The issue is that it is there all of the time. When riders see this sign, they will slow up and be cautious for a while, but if no activity is seen, they will roll the throttle back on and eventually ignore this sign altogether. A better sign would be a sandwich board that the maintenance crew temporarily places in the center of the trail segment being worked on. This is more work, but it's more effective.

Mistake: Conflicting messages.

Riders can't be compliant if we aren't clear in our communication.

Good ideas. There are also several good ideas for signing.

This sandwich board is easy to set up and it folds flat for easy transport. It is a good sign to use during reconstruction, maintenance, or if a trail needs to be temporarily closed for resource protection.

Signing trails and major road crossings can really help orient riders when they are staring at a map and wondering where they are. It can also help with search and rescue operations if they know a rider is near Trail X and Road 18.

Proactive management requires quick sign installations to inform riders and protect resources. A notice should also be posted on the trailhead kiosk and the trail website.

This sign alerting riders of hunting season is a great example of customer service. It could protect rider safety and it certainly gives riders a positive image of the managing agency.

People respect restrictions better when they understand the rationale behind them. People also like to understand the natural environment. This would be a good place to install a wild horse interpretive sign.

Trail Maps

As in signing, trail maps provide information, orientation, education, and safety messages. Riders may read the map information around the campfire or on the way home, but when first arriving on site, riders will make a beeline to the map so they can plan their route and start riding. The primary function of the map is orientation. As such, there are three critical factors: 1) the information on the map must match the signing on the ground; 2) the base map data must be recent enough to agree with the database used in most GPS units; and 3) maps must be available by handout or in a map box.

Tip, Trick or Trap?

Tip: Trail junctions can often be congested with riders looking at maps or waiting for others in their group. This intersection ahead decal alerts riders that a junction is approaching so they have time to slow up and watch for traffic. NOTE: if there was a known hazard at the trail junction due to poor design or unusually high traffic volume, a 12"x 12" warning sign would be required. Notice how the even decal spacing increases the legibility of this marker. The Single Track No ATV decal is a good travel management reminder on this reassurance marker but a larger sign should be located at the trail entrance.

If there isn't staff, a host, or a volunteer available to hand out maps and education material, a map box is the next best thing. Think of that box as a way to personally hand a map to the customer.

Though maps can easily be loaded onto mobile electronic devices, the paper map will never become obsolete because it can be wadded up and stuffed in a shirt or fanny pack; used when wet, muddy, or extremely dusty; and can survive a day of being bounced around on the trail.

When the map shows the trail going to the left and the sign indicates the trail goes to the right, you have lost control of the riders. This can lead to concerns with rider safety and resource impacts not to mention arguments.

A good, user-friendly trail map should have as many of the following elements as possible.

- The larger the scale, the better. 1 inch = 1 mile is good, but a larger scale allows more information to be displayed on the map and gives the rider a better sense of distance.
- Township, range, and section lines or UTMs (Universal Transverse Mercator) aid in navigation and orientation and are helpful for search and rescue operations. Most riders are GPS savvy and prefer maps with UTMs.
- US National Grid coordinates (previously US Military Grid) can be used in a GPS or as coordinates along the edges of a map, similar to

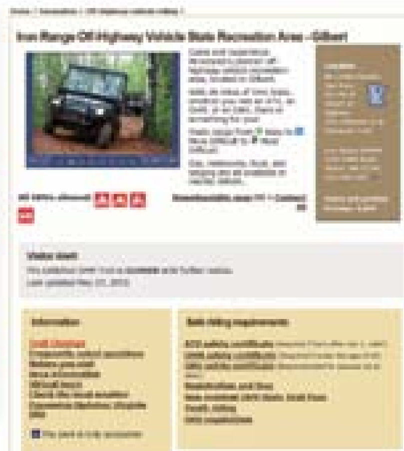
atlases so people with or without a GPS can find their location between the signs and the maps. Emergency response personnel can use the same coordinates in their system to easily find lost or injured recreationists.
- GPS coordinates for trailheads, campgrounds, shelters, or other key features also help riders orient and navigate.
- Topography contour lines or shaded relief. Riders tend to seek the trails with the most elevation change and will always go to the highest point on the trail system.
- The trails labeled by name or number with difficulty indicated by color or symbol and travel direction (one-way or two-way).
- Having the mileage between trail junctions is helpful in planning the day's ride and helps orient the riders as to the scale of the trail system.
- The allowable vehicle uses on each trail or all trails as well as allowed non-motorized uses. These can be shown with symbols on each trail, marked in the legend, or shown elsewhere on the map.
- All routes with indicators showing if they are open or closed to the designated uses. These aid in navigation and orientation. Access routes can be used when something goes wrong and riders need to find an alternate way back to the trailhead, or when there's a major breakdown and riders need to find the nearest vehicle access to retrieve a machine.


Where the heck are we? Why doesn't this agree with my GPS?


An empty map box is a lost opportunity for effective communication.

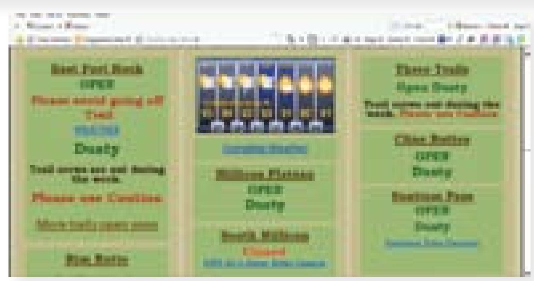
- Trailheads, campgrounds, shelters, viewpoints, play areas, interpretive sites, and other features or destinations identified.
- Key natural features labeled for orientation: mountains, lakes, major streams, etc.
- A good and complete legend.
- Access information from the nearest population center.
- A welcome section with brief information about the trail system.
- Emergency phone numbers, agency contact information, how to report a fire, websites, 24-hour hotlines, etc.
- Rules, restrictions, operator responsibilities, vehicle equipment requirements, seasonal closures, etc.
- Any fees to use the site.
- Hours of operation if day use only.
- Rider education, rider ethics, and safety information.
- Noxious weed information, important resource protection information for soils, plants, wildlife, fire, etc.
- Land ownership, wilderness areas, restricted areas, closed areas.
- A description of the key signs riders will encounter on the trail.
- A recreation opportunity guide (ROG). Some areas use ROGs to give the rider a brief description of what experience to expect on each trail, especially in relation to difficulty. What does a black diamond mean on this trail? The ROG will explain it.
- Camping and campfire information, group camping rules, firewood gathering rules, etc.

Websites and Social Media



The phrase “Know Before You Go” has never been easier to achieve. Most riders get maps, directions, weather, and other information from websites before they leave to go riding. Certainly, the cyber information era can be a blessing to management if management chooses to use it effectively. A website can have rules and regulations, downloadable maps, fee information, equipment and licensing information, current conditions, a volunteer page, links to weather and fire conditions, etc. The list of possibilities is almost endless.

A good website will be simple and easy to navigate. The general public should be able to locate the information easily on the site with a few simple clicks. Long pages where the public needs to scroll several times in order the find additional information usually causes important information to be missed. A higher number of shorter pages with a good menu or menu page is better.



Many maps are now geo-coded. This means a map can be downloaded to a smartphone or similar device. Map apps with the ability to read these maps use the internal GPS of the smartphone to track the rider’s location on the downloaded map as the trails. The website should have both the maps and a list or link to possible apps which will work with the geo-coding on the map.

Social media is the number one way to reach younger people. Facebook, Twitter, and Instagram can get important messages to younger riders and get them out to your trails.

Agency Staff

Any manager’s dream is to have the funding to have adequate staff who are conscientious, knowledgeable, professional, and customer service-oriented. However, as budgets tighten, that dream becomes less of a reality.

From the public’s perspective, having personable agency staff on site provides:

- A sense that the agency cares about them and their activity.
- Face-to-face communication personalizies the agency and can breach the sometimes daunting impersonal wall of bureaucracy.
- A sense of increased security.
- An understanding of agency challenges that can potentially lead to increased volunteerism.
- Visible evidence that the site is actively managed.

Contracted Site Hosts

When there is inadequate agency staff, non-agency site hosts can help fill the gap and provide a valuable service. Site hosts must have the social skills to effectively handle a variety of situations and they must have a friendly customer-service attitude. Hosts must be trained and have dependable communication with management and law enforcement. Since hosts are more likely to be on-site when the riders are present, they can be especially beneficial on projects that include a change in rider ethics, rules, fees, and riding opportunities.

A neat professional looking host site and the key: a host with a smile

Other advantages can include:
- Increased "agency" visibility
- Increased rider education
- An increased sense of visitor security
- Increased compliance
- Decreased vandalism
- An increase and more effective collection of fees
- Increased public image and awareness of active management
- People prefer personal contacts over machines. Friendly customer service helps to provide for the riders' needs.

Volunteer Trail Ambassadors and Rangers

Except for fee collection, a volunteer trail ambassador program can have all of the same benefits of a site host. Ambassadors need to be able to ride, but like a host, the most important prerequisite is possessing good social skills. To be effective, a personal encounter must have a positive outcome, and that is determined by the skill and attitude of the ambassador (or host). Ambassadors must be trained and should have a probationary period of supervised encounters to ensure quality and positive outcomes.

Volunteer Trail Ambassadors can perform many functions for the agency while out on the trail.

Here are some considerations for trail ambassador programs:
- Ambassadors must have a designation, ride in pairs, wear PPE, have a check in and check out procedure, and have dependable communication with law enforcement or management.
- Ambassadors must recognize the line between education and enforcement. The role of an ambassador is strictly education. They do not do enforcement and usually do not collect fees.
- Sometimes personal ownership and commitment can lead to a vigilante attitude, which is neither positive nor productive. Management must weed out those people.
- Since ambassadors can roam the trails, they provide a wider agency presence that is outside of the trailhead.
- By riding the trails, they are providing monitoring and can report trees down, signs missing, off-trail use, erosion, invasive species, or other trail issues. This can be a huge value to management.

Trail Ambassadors provide peer to peer education, not enforcement.

- Since they are dressed like riders, they can apply effective peer pressure because riders will associate with and listen to other riders.
- Ambassadors can be trained to perform complimentary tech check inspections.
- Ambassadors can develop pride by being part of an elite group that provides an important function. Their positive attitude can stimulate volunteerism.
- Ambassadors can also serve as effective agency representatives at fairs, trade shows, sportsmen shows, professional OHV events, and other venues.

Volunteers can help staff educational booths at shows or events. They can also perform and educate peers regarding tech inspections, including sound measurement.

An effective OHV program communicates well with the public at all levels and ages.

A Second Look...

The Three Tools for Success: Almost every chapter has linked back to the Three Tools for Success: Provide for the Riders' Needs, Design for Sustainability, and Develop an Effective O & M Program. This chapter is all about developing and implementing that third tool. Communication opens doors by fostering trust and understanding. It provides a crucial personal or non-personal link between management and the riders to transfer essential information and education. When a person's actual recreation experience doesn't match his expected experience, the result is frustration and emotion that gets termed and categorized as user conflict. Management can influence those expectations by effectively communicating with and educating the public, especially prior to their arrival at the trailhead.

Need more? Learn more here…

ATV Braking Study, Sign Recognition Analysis and Validation, Final Report, Michigan Tech, Keweenaw Research Center, March 2014

Manual on Uniform Traffic Control Devices, U.S. Department of Transportation, Federal Highway Administration, May 2012, http://mutcd.fhwa.dot.gov/

Sign and Poster Guidelines for the Forest Service, EM7100-15, USDA Forest Service, October 2013

Central Oregon Combined OHV Operations (COHVOPS), http://www.fs.usda.gov/activity/deschutes/recreation/ohv

Coalition of Recreational Trail Users/Minnesota Department of Natural Resources, http://www.findthetrails.com

A Look Back…

Here are some of the elements discussed in this chapter:

- Educated riders are responsible riders. Communication provides that education.
- Non-personal communication includes signing, trail maps, and websites and social media
- Personal communication occurs through agency staff, contracted site hosts, and volunteer trail ambassadors and rangers
- If the management team members don't effectively tell the public where they should be riding or how they should be acting, the team can't be disappointed when riders go where they don't want them to go or do what they don't want them to do
- A sign plan helps to ensure consistent and effective signing while increasing rider safety and decreasing agency risk
- Eight key elements of signing: Need, Simplicity, Clarity, Quality, Consistency, Placement, Monitoring, and Maintenance
- Signing and mapping provide information, education, orientation, and safety messages.
- Three critical map factors:
  - The information on the map must match the signing on the ground.
  - The base map data must be recent enough to agree with the database used in most GPS units
  - Maps must be available for handout or in a map box
- Management should seize the opportunity to have current, complete, and accurate website data and links
- Agency staff can effectively deliver communication messages by being knowledgeable, conscientious, professional, and customer service-oriented
- Site hosts and trail ambassadors can be very valuable tools to augment agency staffing. They can increase agency visibility, education, compliance, and sense of public security.
- Site hosts and ambassadors must be trained, understand their roles, and have effective social skills to produce positive encounters under a variety of situations
- An effective OHV program communicates well with the public at all levels and ages

Chapter Ten

Tools in the Toolbox: Management

Noise isn't Cool to Those Who Make the Rules

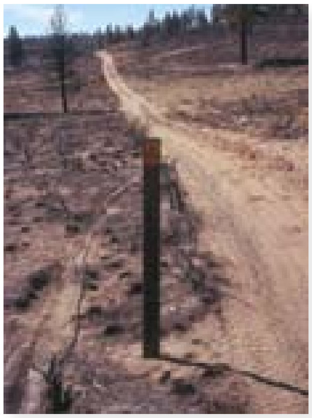
This chapter covers general strategies and tools available to managers. Like the Great Trail Continuum, management has its own sub-continuum: implement, evaluate, make changes, re-evaluate. It never stops. If it does stop, management could fail, the project could fail, and the riders could lose another place to ride.

Vegetation is your friend. Catastrophic events like this may necessitate changes in trail location or design.

Adaptive Management

The sub-continuum of implement, evaluate, make changes, and re-evaluate is called adaptive management. A trail is placed in a dynamic environment, and change of some type is inevitable. The need for trail changes should be anticipated in the planning process, and it is to the managers' advantage to include adaptive management verbiage in the initial environmental document.

There are several adaptive management tools available, including mitigations, restrictions, relocation, reconstruction, using existing infrastructure, entrance management and, when necessary, closure.



Catastrophic events can also create opportunities. This is a good time to step back and re-think this old road-to-trail conversion. A serpentine alignment would fit the landscape better and enhance the rider experience.

Closure Options

There are many closure options available to managers, each with a different focus and effect. Before any closure is implemented, ensure that there is sound justification, that there is an implementation and education plan utilizing the 4Es, and that the ramifications of the action are thoroughly examined. Riders will get displaced. Where will they go and what impacts will occur? Is there adequate personnel and funding for enforcement? Will the closure damage relationships with partners? For every action, there is an equal and opposite reaction. If a trail gets closed, there will be a reaction. Plan for it and be prepared to manage it.

Permanent Closure. To protect resource values or public safety, permanent closure is certainly a management tool. There are sensitive areas that need to be protected and there are non-sustainable trails that cannot be made sustainable. Closure is often seen as the easiest and cheapest management option. While it is the quickest option, it is often not the easiest or the cheapest in the long run. Displaced riders will need to go someplace. This could over-tax the few riding areas that are left, causing resource damage and conflicts.

A key point is, whenever possible, managers should not close something before opening something else of equal or greater mileage, quality, seat time, etc. When riders realize that they can still get from Point A to Point B or have a new higher-quality opportunity, compliance with the closure will significantly increase.

Sticking up a sign or a barrier to close a trail is not effective application of the 4Es. Engineering an effective closure should include a barrier, signing, and ripping and disguising of existing routes. Education regarding the rationale for the closure should be posted on the map, kiosk, websites, and other media as appropriate.

Emergency Closure. Management can implement an emergency closure any time there is extraordinary risk to public safety or resource protection. This could be due to an active forest fire, a severe weather event, or protection in the aftermath of those events.

Temporary Closure. A temporary closure is not recurring and can be used for maintenance, trail reconstruction, extreme fire danger, vegetation management activity, to protect the trails from damage when the trail treads are saturated, for range or livestock activities, for a special use permitted event, etc. When a change in trail use is not permanent and not recurring, it now becomes critical to successfully implement the 4Es. The word must quickly get out on the ground and in the media.

Temporal Restriction. A temporal restriction can be used to separate trail uses and users who are having difficulty being compatible with each other. An example could be that a trail is open for OHVs one week and open to hikers the next week. Here, the manager is placed in a position of conflict management and it will only be successful if: a) there is total agreement with all trail users that this is what they really want; b) if both or all trail groups are treated equally; c) if all share equally in the trail maintenance; d) if all groups commit to self-policing themselves; and e) if the 4Es are successfully implemented. This management option is an intermediate option between a trail being open to all groups and a trail being closed to one group. Most managers choose not to take this step because of the complexity of education and enforcement.

Tip, Trick or Trap?

Tip: With any closure or restriction, as the strength of the justification or rationale increases, compliance with the restriction increases.

This is a good example of closure tools; ripping, blocking, seeding, and signing. The Stay on Trail or Stay Home sign is a great sign, but it sends a confusing message here. Is the rider supposed to stay on the open trail or the closed trail?

This is a good example of a temporary closure. It would be better if the sign stated the reason for the closure to increase compliance.

Mitigations

Mitigation measures reduce the potential impact or the risk of impact. A seasonal closure is a mitigation measure to reduce the risk of impacts during a certain time period. Some resources like marshes, riparian areas, or subsurface cultural sites need to be avoided temporarily, but don't have to be avoided year-round. Mitigations can allow or restrict trail access while minimizing risk to a resource.

This seasonal closure is well signed with an explanation of the reason for the closure. However, if the trail is too wet for motorized use, is it really dry enough for equestrian and foot traffic?

Seasonal Closure. A seasonal closure is a recurring closure that regulates vehicle access. The three main uses are: 1) wildlife related, including big game winter range, fawning or calving season, and nesting season; 2) soil related, including closures during spring break-up or fall freeze-up; and 3) vehicle related, including closures to wheeled vehicles to allow access for over-snow vehicles. Any time there is a change in vehicle access, the effective use of the 4Es, especially education (signing, mapping, etc.), becomes more essential to ensure successful implementation.

A Forest Service resource specialist shows club members a sensitive plant population and explains why it has to be avoided.

Avoidance. When a sensitive resource is encountered, sometimes the easiest option is just to avoid going there. This usually simplifies the environmental analysis and minimizes risk to the resource. If the resource can't be avoided, use of design, structures, or other tools may provide adequate mitigation.

Monitoring. Sometimes monitoring can be used as a mitigation. A trail tread depth, for example, could just be monitored. When and if it gets down close to the depth of the resource, then trail hardening or structures could be implemented as additional mitigation.

Monitoring can be used to gain knowledge. Perhaps a sensitive or potentially sensitive bird decides to make a nest adjacent to an existing trail. Rather than implement avoidance, why did the bird choose to nest there and will the OHV trail negatively affect a bird which nested near its activity? These could be answered through monitoring if the manager and the resource specialist are comfortable with the risk.

A soil scientist measures changes in tread depth and width. This monitoring ceased after it was determined that recreation use had no effect.

One issue with monitoring is that there must be the budget, skilled personnel, and time for the personnel to perform the monitoring. When budgets get tight, monitoring is often the first thing to get put on hold. As personnel come and go, monitoring plans can sit on the shelf and fall through the cracks of implementation. In trail management and monitoring it is important that managers do what they say they are going to do in order to build trustful working relationships. That doesn't stop at planning, it follows through the whole Great Trail Continuum.

Interpretation. Sometimes, interpretation can be used as a mitigation measure. With interpretation comes potential risk to the site since people will be stopping and spending time there rather than riding through. But interpretation is education and that has value. The thought process is that some risk will be accepted here, and by educating the public, there will be reduced risk elsewhere. Sometimes people will give more respect to a high quality area that has interpretation than to an area where they don't understand the value of the surroundings. Interpretation can be expensive, but it is a valuable tool and one that is not used often enough on OHV trail systems. Interpretation enhances the rider experience, extends the length of that experience, and can help protect the resource.

This mining site with cabins and equipment has been beautifully restored and interpreted. The public appreciates and respects quality and that equates to education, compliance, and reduced risk of vandalism. Riders can spend an hour here and significantly enrich their experience and increase the length of their recreation time.

High-quality interpretation of this old mine site is one of the things that makes the Paiute trail system so appealing. Note the attention to detail with the mining theme on the steel post matched with a brand on the wood post. WOW.

The public has a strong desire to learn about history and the natural environment. Including interpretation is one of those extra steps that adds the WOW factor and turns a good trail into a great trail.

Interpretation can also open the door for some creative partnership and funding opportunities.

Structures. Though structures are a design element, many structures are mitigations for issues brought up during the planning process. Bridges are a mitigation to help protect water quality. Barriers and fencing can be mitigations to help protect sensitive areas. Cattle guards help mitigate the range issue of gates being left open. Implementing structures like boardwalks and puncheons can allow access through or over sensitive areas while still protecting the resource. Trail hardening can be used to help protect subsurface resources. The use of those structures not only helps protect the resource, they can greatly enhance the quality of the riding experience. Structures help provide a win-win scenario.

This narrow cattleguard is being used for both range management and entrance management.

This sign is posted next to the narrow cattleguard pictured above.

Restrictions

Using restrictions is a form of adaptive management to protect both the resources and the riding experience. There are two forms of restrictions. Vehicle restrictions are restrictions regarding the actual machine. Equipment restrictions are restrictions on accessories or other equipment on the machines.

Vehicle Restrictions. Vehicles are most commonly restricted by their width or type. OHV trails which are open to vehicles 50 inches or less in width could allow OHMs, ATVs, and smaller ROVs on the trail. Trails can also be open to one or more designated machine types. Single-track trails are often restricted to OHMs only. And a combination of type and width restrictions can be used. Some 4WD-only designated trails have width restrictions to preclude modified rigs with excessive width.

Vehicle widths are restricted to: a) maintain narrow clearing width to enhance the trail experience; b) increase rider safety by limiting the size of a vehicle that may be encountered; c) protect a trail prism that wasn't built wide enough or may not have the durability to safely accommodate wider and heavier vehicles; and d) increase rider experience by providing more difficulty levels in the trail system. Many existing NEPA documents do not allow vehicles or a vehicle type which wasn't expressly analyzed in the document. Changing those documents could re-open the door to appeals and litigation.

This sign is a good example of an equipment restriction. In addition to having the information posted at the area, the information should also be available to people while they are planning their trip.

It is important to note that even though state or provincial laws may allow certain vehicles, trail managers usually have the option to be more restrictive when necessary and justified to protect resources or public safety. These messages are conveyed through the 4Es using effective entrance management structures and communicated to the riders before they get to the trail.

Equipment Restrictions. Restrictions which include items like requiring spark arresters, limiting sound emissions, requiring safety flags, and requiring fire tools on vehicles of a certain size like ROVs and 4WDs are examples of equipment restrictions. As with vehicle restrictions, land managers usually have the prerogative to be more restrictive than state or provincial laws allow when it is justifiable. The risk of fire is almost always raised as an issue, and sound can be an issue, so spark arresters and silencers are easy mitigations for these concerns. Safety flags are often required in dune areas to increase the visibility of approaching vehicles.

The trail tread is a valuable resource and the force of displacement acts on that resource. There is often discussion on whether the tire type should be restricted. Many people believe that more aggressive tires create greater displacement. However, as the U.S. Forest Service tire study has shown, the depth of the tread is not a factor in the amount of displacement on a trail. Knobby tires are designed to grip, not to tear or slip. They can be likened to golf shoe spikes which help keep feet from slipping across the surface and creating divots.

> **Tip, Trick or Trap?**
>
> **Tip:** Knobby tires can be like golf shoes, which provide traction without disturbing the ground.

Impacts from tires are caused more by the mentality of the rider than by the aggressiveness of the tire, so management effort is better spent on the 4Es to improve rider ethics and promote peer pressure than on enforcing a restriction. Tread Lightly!'s, "Use It but Don't Abuse It," and "Ride It, Don't Slide It" can be good education messages.

Relocation and New Construction

Relocation is a tool that can be used to avoid a sensitive resource or move a section of non-sustainable trail to a more suitable location and alignment. Too often, managers pour money into multiple bandages for a trail that cannot be fixed when it would be less expensive in the long term to relocate the trail. Relocation is a tool that can protect resources, enhance the rider experience, and increase rider safety.

Relocation, of course, involves new construction, which may require additional environmental review and documentation. Because of this, some managers do not consider relocation as an option. However, if the trail still goes from Point A to Point B and the effects of the relocation fall within the scope of effects analyzed in the environmental document, the relocation could still be meeting the intent

> **Tip, Trick or Trap?**
>
> **Tip:** Utilize as Many Tools as Possible.
>
> Relocation is one of the most important, yet under-used tools to correct sustainability issues. Failure to use this tool can lead to over-use of another tool: closure.

of the original document and the process to implement the relocation could be relatively simple without opening the door to appeals and litigation. Adaptive management verbiage in the environmental document can facilitate the trail relocation process.

Reconstruction

Reconstruction can be used two ways: 1) to put a trail back into the condition it was in when it was first constructed (essentially performing backlog maintenance) and 2) to upgrade the original condition by re-grading; reshaping; and adding or improving structures, signing, facilities, and segments of trail.

This trail is in obvious need of reconstruction. The tread watershed is too big and too much water is draining at this point.

What is the lifespan of a trail? It depends on multiple factors like soil type, use level, type of use, climate, number and type of structures, etc. All trails require maintenance, but at some point, the trail may degrade to the point where routine maintenance will be inadequate to maintain the functionality of the trail. At that point, reconstruction, or heavy maintenance, is required.

Utilize Existing Infrastructure

There is usually a plethora of existing roads and trails but the goal should be not to maximize the use of existing infrastructure, but to examine what is available and creatively incorporate those sections that fit with the goals for the trail system. The key is variety in any form: scenic, tread surface, speed, tread width, destinations, vegetative, topographic, and interpretive opportunities, commercial access, etc. Providing an imaginative mix of experiences is what creates a quality trail or trail system. Trails are all about fun.

Structures. Utilizing or sharing existing structures is a great way to reduce project costs as well as reduce the number of structures on inventory. Sometimes, it requires creative solutions to use existing structures, but the benefits are worth the effort.

Natural Surface Roads. The use of roads can be seen as an expedient and low-cost way to provide trails. There can be many benefits, but there can also be many traps. Land managers have the option to use roads or not, and like existing structures, why not? The three main issues with roads are 1) the extent to which they are used, 2) the size of their tread watershed, and 3) the quality of the experiences they provide. If the road is being closed to mixed-use, consider using an existing road corridor and turning it into a trail rather than relying on the road as is.

It is important to remember that OHVs are not designed to be used on paved surfaces. When considering using roads as trails, only natural surface roads should be considered.

The opportunity to use this old railroad bridge as an OHV trail enhances the rider experience and saves project dollars. This could be a good place for some interpretation as well.

The outstanding visual quality of this site transforms the road experience from transportation to recreation. It's a road, but it's a WOW.

Use Natural Surface Roads as Trails. Roads are an existing infrastructure. Many state and provincial laws as well as agency regulations allow OHV use on roads, especially low standard or minimum maintenance roads. With roads, a key point to remember is that they can provide two types of experiences, transportation and recreation. The experience must match the riders' desired experience for the trail or it won't meet the riders' needs.

Convert Natural Surface Roads to Trails. Increasingly, roads are being closed to reduce road densities and reduce road maintenance costs. Often, this can present an opportunity to convert roads into trails. This is a good tool especially when options for creating new trails may be limited. There are many pitfalls of roads, including long sustained grades, infrequent drainage, and large watersheds; but when properly done, many roads can be converted into high-quality trails with high-quality experiences.

This road was closed and converted to a trail eight years ago. It was half-ripped and good entrance management was installed to restrict full-sized vehicles. Even in this dry environment, roads recover and revegetate very quickly once the use is off of them.

Convert Rails to Trails. Railroad grades can be too fast, too straight, and too boring, but this book is about WOW. What makes a great trail great? Traveling over a 150-year-old wooden trestle and looking 500 feet down through the ties to the river below or entering a dark tunnel. That is WOW. If there is an opportunity to incorporate that, seize it.

Trails. As in roads, there can be benefits and traps. Using existing trails can have the same issues as using roads: the extent to which they are used and the quality of the experiences they provide. Most existing trails were not designed, so primary concerns are their sustainability and whether they go where the planner needs them to go. Many user-created trails go up the hill whereas sustainable trails go across the hill, and the biggest trap that a manager can fall into is to assume that user-created trails meet the users' needs. Most do not.

Entrance Management

Entrance management is a tool that managers often overlook. Implementing effective entrance management:

- Provides rider education by indicating trail number, difficulty level, and allowed vehicles.
- Sets rider expectations through well-engineered barriers and filters.
- Reduces conflict by setting rider expectations.
- Sets the stage for enforcement by posting travel management signing and any pertinent restriction or closure signing.
- Increases rider safety by immediately indicating the skill level needed to negotiate the trail.
- Reduces impacts created by unskilled riders.
- Potentially reduces the number of riders on a trail, which can keep a marginal trail on the sustainable side of the fulcrum.

This user-created trail runs up the fall line, is non-sustainable, and is visually distasteful. Even if it could be made sustainable, it does not harmonize with the landscape and violates many principles of trail location by bisecting the meadow.

- Reduces or eliminates trail widening caused by over-width vehicle use.
- Increases the rider experience by maintaining the designed tread width, reducing the number of riders, and protecting challenge features.

These bollards and gate serve as width restrictons to keep larger vehicles from accessing the trail.

Tip, Trick or Trap?

Tip: Entrance management = Risk management

Every one of these items is an element of a great trail and of great trail management. Effective entrance management epitomizes the application of the 4Es; it helps ensure a quality recreation experience and reduces the managers' risk.

Administrative Tools

Below is a list of the management tools that can help build a successful program.

Partnerships. Having broad-based support for the project or program is imperative. Just like the Great Trail Continuum, the battle to have and keep OHV trails is never over. The stronger and broader the support base, the better it will survive attacks from critics over time. Time invested in strengthening and expanding partnerships is time well spent.

Donations. Having a broad base of partners can open the door for a wide variety of donated materials and supplies. Being in the position of asking for anything can be an awkward task, but vendors usually will not offer support without being asked. Managers who ask are usually surprised with the results. These donations not only help the program on the ground, but they serve as important sources for match contributions for grants.

Innovative Grants. Having partners helps secure grants, but having creative partnerships almost ensures grant success. Almost all resources benefit from having a well-managed, designated OHV trail system, so seek partners and grants from unlikely sources like the Nature Conservancy, Ducks Unlimited, the Rocky Mountain Elk Foundation, and Backcountry Horsemen, etc.

Volunteer Program. Having a lot of volunteer labor is another key to securing grants, especially if the labor comes from multiple volunteer sources. The organizing, training, and scheduling of volunteers takes a lot of time and energy, but again it is time well spent. Volunteers aren't free, but for building partners, grants, and a workforce, they are essential to any successful OHV program. Volunteer trail ambassadors can increase education, evaluation, peer pressure, and agency visibility. When it comes to maintenance, whatever work can be done by volunteers, should be done by volunteers. This will build support and ownership in the program. Volunteers are a key component in successfully implementing the 4Es. Like donations, volunteers usually don't step forward on their own, they need to be asked.

A local 4WD club conducts a trash clean-up day on public lands

External Relations and Politics. This would include anyone outside of the agency: dealers, local and regional clubs and associations, state or provincial OHV program and grant managers, community leaders, and stakeholders. Conducting a group or one-on-one field trip to the project presents a good forum to build and strengthen these relationships. Time spent here could lead to additional partners, grants, and volunteerism.

Kids listen intently to the instructor during a Family Fun Day Event.

Internal Relations and Politics. Dealing with internal politics can be far more challenging than external politics because of the day-to-day contact and interaction with co-workers. However, that effort is more than worth it when it comes down to gaining time commitments from essential personnel like resource specialists, obtaining labor from fire or smokejumper crews, or securing the fair share of a tight budget.

Permitted Activities. Permitted activities could include speed and non-speed events, jamborees or rallies, charity fundraisers, and special training or education events. There are many benefits to having permitted activities: clubs and the public enjoy them, so having them increases the external political connections and relations; clubs often rely on events as primary fundraisers; activities can stimulate interest, support, and volunteerism; they bring public and media exposure to the trail system that can help market the system and increase awareness of successful OHV management; they can provide an economic benefit to the community; and they can strengthen external relations and political connections.

Legislative Changes. Sometimes current laws are outdated or too restrictive to allow managers the flexibility they need to effectively manage the use. The only way to fix that is to work within the system to try to implement changes. Field trips with legislators, stakeholder group advocates, or state or provincial agency personnel can help show them the rationale for needed changes. Working with clubs and associations on these efforts can be well worth the time.

Tip, Trick or Trap?

Tip: Master the 3P's of Success:
Politics
Politics
Politics

Integrated Resource Management (IRM). IRM involves the coordination and cooperation between an OHV program and the activities of other resource entities within the agency: fire, other recreation, silviculture, range, law enforcement, engineering, wildlife, botany, cultural resources, etc. It takes effort to develop those internal relations and to get involved in the planning and execution of all of these other resource activities. But the trail is also a resource and the OHV program has or should have parity with any other program. Because trails are easy to traverse, they often get used as boundary lines for other activities, but those lines can affect the integrity of the trail and the quality of the trail experience. While a buffer strip usually isn't required, what is desirable is a mosaic that creates variety.

Due to good IRM, this trail is open and signed to protect public safety.

Here are some scenarios that could be avoided or minimized with IRM:
- The use of trails as skid trails or temporary roads.
- Having trails used as fire lines.

- Having trails used as timber unit or cut block boundaries.
- Having fencelines installed that cross the trail on steep grades or curves.
- Having sight lines and corridors opened up through vegetation management that can invite off-trail hillclimb use.
- Improper closure of temporary roads and skid trails that invite off-trail use.

A fenceline needed to be installed to keep livestock out of a stream to protect water quality, but there were limited places to cross this trail. This site was chosen after coordinating with range and the range permittee. Water, range, and recreation all benefitted by this cooperative effort.

And some benefits:
- Having advance notice of fire or timber harvest activities so trails can be signed and the public informed.
- Having pits and quarries shaped for use as play areas.
- Having a landing or other impacted site specifically located for future use as a trailhead or other site for OHV activity.
- Being able to relocate an undesirable trail or trail segment as a mitigation to avoid adverse impacts from the other activity.

Know the Customer. The demographics of the customer will change over time and managers can't provide for the riders' needs if they don't know who the riders are or where they are coming from. A short online survey or a registration box at the trailhead can give managers valuable information that can be used to better serve the customers and provide supportive data for grant requests and other reporting.

Tip, Trick or Trap?

Tip: Change is inevitable

As the demographics of your customers change, the configuration of your trails and facilities may need to change.

Volunteers are the heart of a successful OHV program.

Implement All of the 4Es

The 4Es: Engineering, Education, Enforcement, and Evaluation, have been mentioned several times in this chapter and throughout this book. Use them. Enough said.

Tip, Trick or Trap?

Tip: Utilize the 4E's:
- Engineering
- Education
- Enforcement
- Evaluation

For those with vertigo or fear of heights, this old railroad trestle may cause some trepidation. For the rest of us, this WOW experience is a great example of using existing infrastructure.

A Closer Look…

The fourth E of the 4Es, Evaluation, isn't just determining the success of a barrier or the effectiveness of erosion control measures. It includes zooming out and looking at the bigger picture: how is the program doing? In talking about building relationships with partners, stakeholders, and grantors, these people want value, efficiency, customer satisfaction, and resource protection. What do they see? Managers should put on their objective hat, go out to the project area on a weekend day, and look at their own program. Does it look professionally and successfully managed? Are the map boxes full, toilets clean, litter picked up, signs and posters neat and legible, smiles on the riders' faces, and tracks only where there should be tracks? No? Then the tasks of creating a successful OHV program and building internal and external relationships could be more difficult. Taking the time to zoom into the "on-the-ground" picture can help managers zoom out and better administer the big picture.

A Great Trail Requires Creating a Great OHV Program

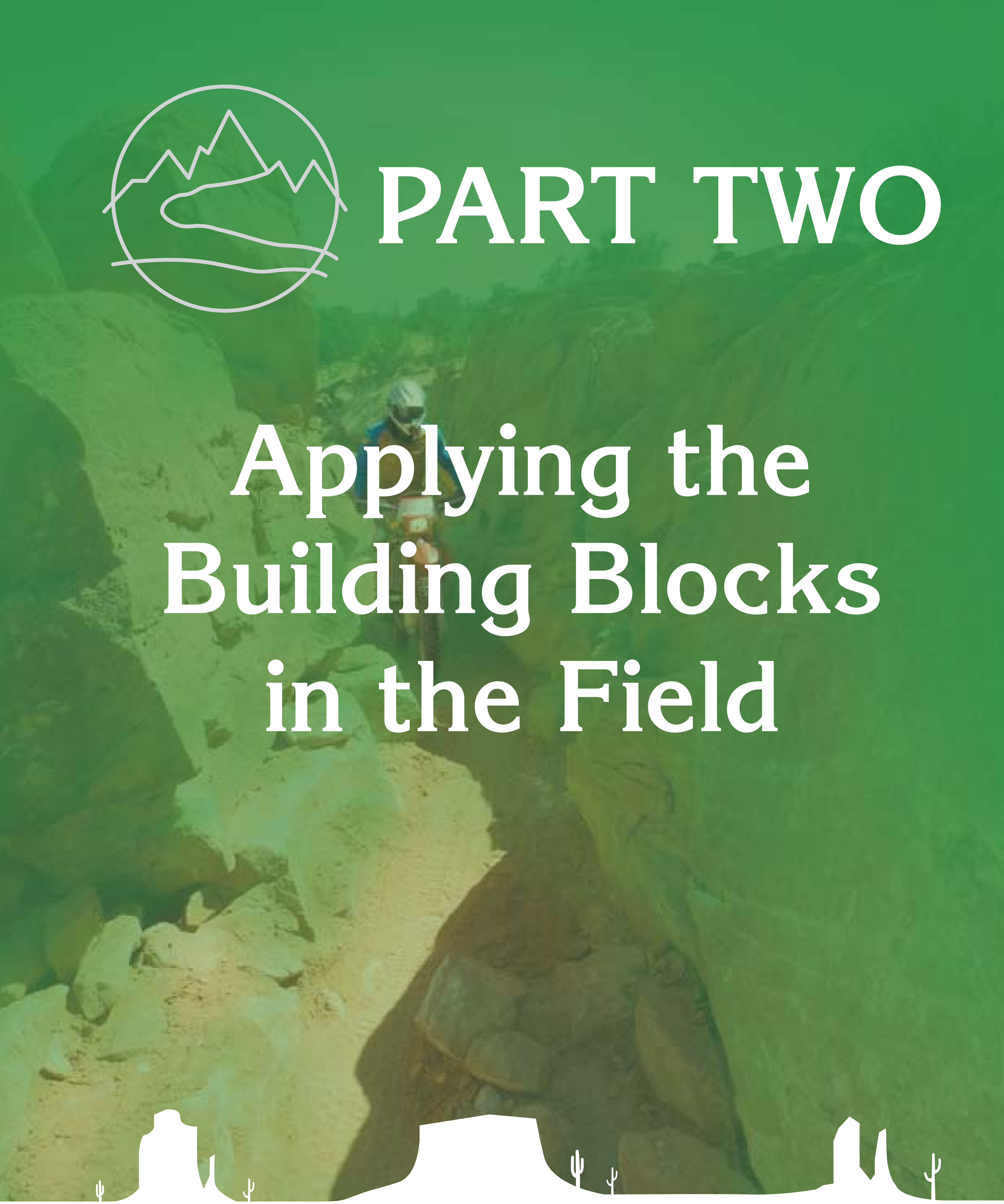
Need more? Learn more here…

ATV Effects Study and Existing Trail Conditions, U.S. Forest Service San Dimas Technology Development Center and the Rocky Mountain Research Station in Moscow, ID, http://www.fs.fed.us/t-d/atv_trails_site/pdf/ATVEffectsStudy.pdf

A Look Back...

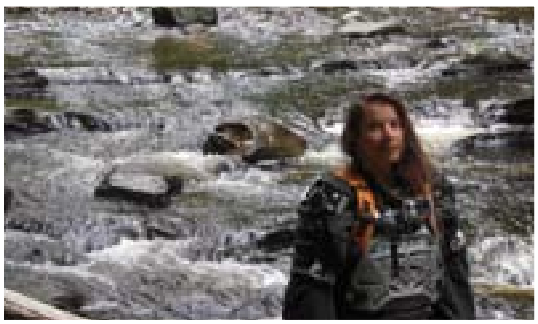
Here are some of the elements discussed in this chapter:

- A trail is imposed on a dynamic environment; therefore, the trail and its management must be dynamic, not static
- Like the Great Trail Continuum, management has its own sub-continuum that never stops: implement, evaluate, make changes, re-evaluate. This is called adaptive management.
- Having adaptive management verbiage in the initial environmental document can facilitate making necessary trail changes later
- Every trail requires maintenance, but at some point many will still degrade and require eventual reconstruction
- With any closure or restriction, as the strength of the justification or rationale increases, compliance increases
- Roads can provide two experiences: transportation and recreation. If the road is being used as a trail, the road experience must be equal to the desired trail experience.
- Relocation is one of the most important tools available to correct sustainability issues, yet it is the tool that is the most under-used
- Entrance management is an essential component of risk management
- Managers should not be afraid to step back and take an objective look at their program. Managers need to see what their customers are seeing.
- Few people have everything they need or know everything they need to know. Don't be afraid to ask for help.
- Politics is interwoven into everything, so master the 3Ps: Politics, Politics, Politics.
- As the demographics of the customers change, the configuration of the trails and facilities may need to change
- Great trails require having a great OHV program

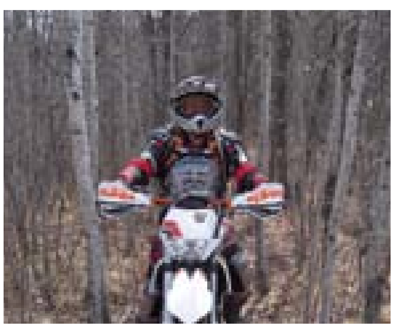


PART TWO

Applying the Building Blocks in the Field



More and more girls and women are enjoying OHV recreation.



Chapter Eleven
Conducting Assessments

Observe, Record, Report

The fourth E in the all-important 4Es is Evaluation, which is an assessment, appraisal, or review. If managers don't know the current conditions, they won't know how to plan, act, or react.

Assessments, which can be either routine or formal, are part of a continual process used in every component of the Great Trail Continuum:

THE GREAT TRAIL CONTINUUM

- **Planning:** What could or should be out there? This is used to develop the vision, trail concept plan, and draft trail management objectives (TMOs).
- **Design:** Does the location and design of the trails match the vision, the concept plan, and draft TMOs? Are the desired experiences and opportunities being provided?
- **Implementation:** Do the trails conform to the TMOs, design guidelines, and sign plan? Is the vision being realized on the ground?
- **Maintenance:** Are the trails being maintained in accordance with the TMOs? Is the frequency and level of maintenance adequate? Are there signs of non-sustainability?
- **Management:** Is there a high level of customer satisfaction? Are use types or use levels changing? Is the team successfully managing the use? Are resources being protected?

Routine Assessments

Routine assessments are daily or regularly scheduled inspections of the trail or trail system. The motto "Observe, Record, Report" forms the basis for these inspections. Every person in the field should be performing monitoring for obvious safety or maintenance issues. These should be recorded on an informal daily monitoring form and be accompanied by pictures, GPS coordinates, or other documentation as necessary. This report is then given to management so action can be scheduled. It is important to note that the project file should also have documentation of what is working and going well. This information can be used in preparing reports to upper management or in developing grant applications.

Blowdown is a common occurrence on most forested trails. Routine and timely inspections are essential to get these trees cut out before braiding and other impacts can occur.

Field personnel who perform routine inspections need to have a basic knowledge of engineering and the physical forces covered in Chapter 4, comprehension of trail durability versus trail degradation, an understanding of structure function and maintenance, and the ability to recognize routine problem indicators. Personnel need to detect the difference between what is there versus what should be there. The goal of routine inspections is to detect symptoms before they become problems. Field personnel don't necessarily have to know how to fix the issue, just observe it, record it, and report it.

Formal Assessments

Formal assessments are more comprehensive, detailed, and often look at the bigger picture that includes not just sites on the ground, but how those sites affect the overall effectiveness of the program. Rather than being proactive, a formal assessment is often requested as a reaction to an issue that is no longer a symptom, but a problem. A formal assessment answers the questions: What could be there? What is there? What should be there? How do I get to where I should be? The final report usually has three parts: observations, where the site is examined and evaluated to answer the first two questions (above); commendations, what is good or going well; and recommendations, actions to correct what isn't good and answer the last two questions (above). Often, these reports are precursors to a management action, used as a project basis (Purpose and Need), and incorporated into NEPA documents or management plans.

There are three main types of formal assessments: feasibility or site assessment, safety assessment, and condition survey or assessment.

Feasibility or Site Assessments. What activities could or should occur on a given site? What are the opportunities and what are the obvious constraints? A feasibility assessment is usually conducted at the project initiation phase, which could be at the beginning of a new project or the expansion of an existing project.

The assessor should understand:
- The vehicle types that use the trails
- Desired rider experiences
- Climate
- Vegetation
- Soil types
- Site hydrology
- Resource concerns, issues, and constraints
- Transportation planning
- Facility design
- Trail design
- Engineering and the physical forces
- GPS, data collection, and mapping software

Safety Assessments. A safety assessment examines agency risk and the risk to public safety. Perhaps there has been a tort claim, an increase in the number or severity of accidents, increased search and rescue incidents, customer complaints, or just an uneasy feeling or question by management. For objectivity, it is highly recommended that the assessor be unfamiliar with the site.

The assessor should understand:
- Transportation planning. Is there effective access and movement of people to and through the site?

- Facility design
- Trail design, including grade, alignment, consistent difficulty, conformance with TMOs, and a thorough understanding of challenge versus risk
- Use types and levels of use
- Rider demographics and ethics
- Seasonality and day use versus night use
- Soils
- Climate
- Effective signing, including guidelines for shapes, colors, sizes, symbols, reflectivity, messages, and placement
- Effective mapping
- Engineering, including guidelines for stopping distance, sight distance, junction design and spacing, road crossings, structure placement and approaches
- The physical forces
- Emergency communications and emergency plan
- Accident history
- Enforcement issues
- Actual liability versus perceived liability (it is helpful to have expert witness experience)
- The effective application of the 4Es

Condition Survey or Assessment. A condition assessment usually focuses on the physical condition of the trail and related facilities, but it can also look at the bigger picture and address safety and risk issues. It answers questions like: How often does this occur? Why does this occur? What else is occurring? Is the trail condition consistent with design and maintenance guidelines in the TMO? Does the trail provide the desired experience? Is the trail sustainable or is it degrading due to poor location and design or changes in use levels, use types, or maintenance? Are the structures sound and functional? Do the facilities provide good customer information and service? Are resources being protected? Is there compliance with the rules and regulations? Is off-trail use occurring? Is the trail providing a high-quality recreation experience and customer satisfaction? Does the site appear professionally managed and maintained?

Using the 4Es, the condition assessment examines trail issues (drainage, erosion, tread degradation) and recommends solutions (maintenance, reconstruction, structures, hardening, or relocation). Recommendations can also include staffing, training, or equipment needs. As with safety assessments, a condition survey is best done with someone who is knowledgeable, but not routinely familiar with the site.

The assessor should understand:
- Facility design and construction
- Trail design and construction, including grade, alignment, consistent difficulty, and conformance with TMOs
- Trail maintenance techniques and equipment
- Use types and levels of use
- Maintenance or reconstruction frequency
- Previous condition surveys
- Soils
- Climate
- Hydrology of the site
- Effective signing, including guidelines for shapes, colors, sizes, symbols, reflectivity, messages, and placement
- Engineering, including guidelines for stopping distance, sight distance, junction design and spacing, and intersections
- Structures, including placement and approaches and trail hardening techniques.
- Equipment needs and capabilities

Tip, Trick or Trap?

Tip: A qualified engineer must inspect structures that have been engineered such as bridges and retaining walls on a regular basis. Unless qualified, an assessor can only note the indicators of structure degradation and recommend further inspection by an engineer.

• The physical forces
• The effective application of the 4Es
• Costs for recommended actions
• GPS, data collection, and mapping software

How Do I Know If I Have a Problem?

Safety and condition assessments examine issues, but often managers may not recognize an issue or the indicators of an impending issue. Inexperienced personnel or familiarity with a site can blur the team members' vision, which is why a fresh set of eyes is best for conducting these assessments. Listed below are some of the issues or indicators that an assessment could highlight.

Issue: Ineffective drainage due to riders by-passing log and-belted waterbars

Concerns: Trail widening, erosion, resource impacts

Action(s): A) Replace log with belted waterbar and install barriers to force riders over waterbars; B) Replace waterbars with rolling dips; C) Relocate trail off old roadbed to create grade reversals

Issue: Deadfall tree hung up above trail

Concerns: Rider safety, agency risk, lack of inspection frequency

Action: Increase trail inspection and maintenance frequency

Issue: Creek draining into trail

Concerns: Erosion, lack of drainage. If the creek wants to be where the trail is, then the trail is in the wrong place

Action: A) Install culvert; excavate creek channel so it is lower than the trail elevation and runs through the culvert. B) Relocate the trail (preferred).

Issue: Fall line trail is now the drainage line

Concerns: Rider safety, erosion, sedimentation, poor trail location

Action: A) Relocate the trail (preferred). B) Drain the trail at the top of the hill (yellow arrow), line the ditch with cobble rock to dissipate the water energy and reduce sedimentation (blue arrow), ensure that water drains off the trail at red arrow, harden the trail if necessary.

Issue: Ineffective drainage

Concerns: Rider safety, saturated trail tread, resource impacts

Action: A) Increase size of sump, harden trail tread, or B) relocate the trail

Issues: Regulatory message does not meet sign shape, color, and placement guidelines. Poor quality workmanship

Concerns: Rider safety; ineffective signing; untrained, unskilled, or complacent personnel

Action: Increase personnel awareness and training, install proper regulatory signs

Tip, Trick or Trap?

Tip: Never close a trail by simply putting a fence across it. The result will be failure.

Issue: Trail marker not clearly visible. Marker does not meet placement or recognition guidelines

Concerns: Rider safety and orientation, lack of trained personnel, poor maintenance practices

Action: Increase personnel awareness and training, replace or reinstall marker with proper placement on right-hand side of trail

Issue: Trail washout due to under-sized culvert

Concerns: Rider safety, erosion, sedimentation

Actions: A) Conduct watershed analysis and install properly sized culverts; B) Install a ford or bridge if that option is allowed

Issue: Metal fence posts protruding into trail corridor

Concerns: Rider safety, agency risk, livestock retention, lack of maintenance personnel awareness

Action: Replace fencing, train maintenance personnel

Issue: Gate with no warning signs or object markers and it cannot be locked in the open position

Concerns: Rider safety, agency risk, compliance

Action: Install temporary markers for visibility. Educate management on proper signing and gate management techniques

Issue: Lack of toilet maintenance

Concerns: Poor customer service, public health, poor agency image

Action: Clean and stock toilet. Increase facility inspection and maintenance frequency. Determine how often this situation occurs and discuss with management if appropriate.

Issue: Good sign, but there is no gate

Concerns: Lack of pasture management and stock control. Potential range and recreation conflict

Action: Install temporary gate if stock is present. Notify range and recreation management to get permanent gate installed. Remove sign if no longer required.

Issue: Sign has been vandalized

Concerns: Leaving this sign can send the message these activities are acceptable.

Action: Install new sign, determine how often and where this activity is occurring

Issue: Ineffective cattle guard due to lack of maintenance

Concerns: Lack of pasture management and stock control, potential range vs. recreation vs. permittee conflict

Action: A) Increase inspection and maintenance frequency. Schedule clean out. Educate maintenance personnel on proper equipment and grooming operation at cattle guards. B) Replace with an arched cattle guard.

Issue: Confusing signing

Concerns: Rider education, rider control, management control

Action: Educate management on proper signing techniques, reconfigure this installation

Issue: Renegade trail developing (ahead)

Concerns: Rider control, resource impacts, lack of inspection or management action

Action: Install reassurance marker with left arrow at entrance to renegade trail, install barrier or debris at entrance behind marker, drag in debris to block trail, rake out tracks. Increase inspection frequency and awareness of off-trail use and impacts.

Issue: Inconsistent decal placement

Concerns: Lack of decal spacing decreases marker legibility, lack of personnel training, lack of decal placement protocols, personnel complacency, lost riders

Action: Train personnel in decal application and the need for consistency, establish decal placement protocols if none exist

Issue: Poorly maintained trailhead kiosk

Concerns: Lack of rider education, potential lack of rider control, sends the wrong message to the public, poor agency image, complacent personnel

Action: Clean and refinish kiosk, install new posters and education materials, cover with polycarbonate sheet if this is a recurring issue

Issue: Pavers are moving due to lack of proper bedding and containment

Concerns: Rider safety, failure of the installation

Action: Reconstruct the installation with proper bedding and containment

Issue: One broken concrete plank in ford structure. Two others have shifted position

Concerns: Rider safety, movement or failure of ford bedding, additional breakage, structure failure, lack of regular inspection or awareness of the issue

Action: Have structure inspected by qualified personnel, perform recommended reinforcement or reconstruction, ensure that regular inspection occurs, educate inspection personnel

Issue: Loss of cover material has resulted in direct tire contact and partial failure of geoweb structure

Concerns: Rider safety, continued structure failure, lack of maintenance, lack of regular inspection or awareness of the issue

Action: Reconstruct installation using grass pavers or other trail hardening technique, increase maintenance frequency, educate inspection and maintenance personnel

Issue: Tread inconsistent with TMO, tread degraded due to lack of drainage and loss of fine soils

Concerns: Rider safety, erosion, lack of effective or timely maintenance, failure of drainage structures (if there are any), poor trail location

Actions: Increase drainage awareness of inspection and maintenance personnel. A) Relocate trail if feasible. B) Reconstruct trail and install rolling dips if feasible. C) Change TMO and leave trail as is if resource impacts are acceptable.

Issue: Missing rub rail, uneven, loose or broken decking material, loss of structure integrity

Concerns: Rider safety, moss could indicate stringer rot, lack of bridge inspection, lack of structure maintenance

Action: Have bridge inspected by an engineer, sign as closed if structurally unsound, repair or replace structure, ensure that regular bridge inspections occur, increase awareness of inspection or maintenance personnel.

Issue: Inadequate hardening of bridge approaches, bridge elevation too low

Concerns: Resource impacts, trail widening, rider safety, lack of trail drainage, lack of inspection and maintenance

Action: Drain water off trail before the bridge, extend bridge approach hardening, educate trail personnel on proper inspection and maintenance techniques

Issue: Failure of trail hardening and drainage structure.

Concerns: Rider safety, agency risk, trail braiding, resource impacts, improper hardening technique, inadequate drainage structure design, poor trail location, lack of skilled trail personnel, lack of hazard warning signs.

Action: A) Install warning signs. B) Explore relocation options. C) Examine agency constraints for fish and water. D) Remove tires and culvert if possible. E) If relocation is not an option, raise grade of approaches and construct a ford. F) Conduct training for trail personnel.

Issue: Confusing sign message, poor visibility, lack of conformance with sign shape, color, and reflectivity guidelines

Concerns: Resource impacts, lack of sign plan, lack of knowledge of effective signing methods

Action: Determine existence of sign plan, if none, develop one; educate personnel on effective signing; revise message and install proper regulatory sign

Issue: Rill indicates water is running too long due to lack of drainage

Concerns: Erosion, resource impacts, tread degradation, lack of awareness of problem indicators, lack of inspection and maintenance

Action: Educate trail personnel on problem indicators and proper maintenance techniques, determine water source, install drainage, or relocate the trail

Issue: Inadequate and unsafe trail maintenance. Log on left protrudes into trailway. Log on right is on immediate trail shoulder and could be hit by an inattentive rider.

Concerns: Rider safety, agency risk, lack of risk awareness by inspection and maintenance personnel, inadequate training of maintenance personnel

Action: Cut logs back out of trailway, educate trail personnel on risk awareness and proper logout techniques

Issue: Due to compaction and displacement, trail tread is lower than surrounding ground resulting in flooding during the wet season

Concerns: Rider safety, water quality, saturated trail tread, poor recreation experience

Action: Construct lead-off ditches and sumps to drain water away from trail, use excavated material to help construct turnpike, apply gravel to harden tread

Issue: Log obstacles to slow down riders are becoming obscured by vegetation

Concerns: Rider safety, agency risk, lack of risk awareness by inspection or maintenance personnel, complacency of personnel

Action: Educate trail personnel on risk awareness and proper maintenance techniques, trim or remove vegetation in roadway, monitor trail to ensure vegetation does not cover obstacles

Issue: Damage to plastic culvert due to loss of cover material

Concerns: Collapse of the structure, maintaining water flow, lack of maintenance, lack of awareness of inspection and maintenance personnel

Action: Inspect the interior of the culvert for efficient water flow, inspect integrity of the pipe wall, if still usable, cover with a dirt and gravel mix that will bind together. If not useable, replace culvert and add adequate cover. Educate inspection and maintenance personnel.

Issue: Rocks are blocking culvert outlet

Concerns: Culvert blockage and washout of culvert and trail, poor risk awareness of inspection and maintenance personnel, poorly constructed culvert headwall

Action: Remove rocks, clean out culvert, rebuild headwall, educate inspection and maintenance personnel

Issue: Breached trail closure

Concerns: Ineffective closure techniques: sign placement, no ripping or disgusing of trail, no education. Management failure has resulted in lack of rider compliance.

Action: Repair fence, install temporary closure signs at nearest trail junction, install closure notice on map at trailhead, educate management on proper closure techniques

Issue: Decals degrading due to exposure to weather and UV rays. Fiberglass marker is fading and starting to "bloom", improper decal placement.

Concerns: Reduced legibility, short-term durability, rider compliance, lack of a sign plan or sign protocols. Markers placed on back of sign are in wrong location and may not be seen by riders.

Action: Ensure there are trail marker protocols that include covering decals with clear overlaminate tape. Educate trail personnel on effective signing techniques. Replace markers as needed

Issue: Improper trail maintenance

Concerns: Rider safety, agency risk, lack of maintenance personnel training and awareness

Action: Cut log back entirely out of trailway. Educate maintenance personnel on proper logout techniques and risk management

Tip, Trick or Trap?

Tip: Challenge is an expectation, risk is a surprise

Issue: Water running down trail, trenched trail tread

Concerns: Erosion, resource impacts, degraded trail tread, trail widening, lack of or poor maintenance of drainage structures

Action: A) Educate trail personnel on problem indicators and effective maintenance techniques. B) Determine source of water, add rolling dips or other drainage. C) Relocate the trail.

Issue: Bridge abutment footing is eroding

Concerns: Rider safety, inadequate structure inspection, lack of immediate action, impending structure failure

Action: Order an immediate bridge inspection to determine footing integrity, close trail and bridge if warranted, check inspection frequency and records, educate personnel on risk awareness, determine repair actions

Issue: Sediment deposit indicates excessive water volume and velocity

Concerns: Erosion, resource impacts, tread degradation, lack of awareness of problem indicators, lack of inspection and maintenance

Action: Educate trail personnel on problem indicators and proper maintenance techniques, determine water source, install drainage

Issue: OHV accident on the trail

Concerns: Rider safety, agency risk, cause of accident, lack of rider education and safety awareness

Action: Visit accident site and determine cause if possible (alignment, clearing width, obstacle, signing, rider error, etc). Take pictures, talk to witnesses, document incident, and inform management. Examine frequency and locations of other accidents to determine any commonality or trends.

Tip, Trick or Trap?

Tip: Every known accident should have some level of investigation to determine cause and agency risk

Problem indicators can be obvious or subtle, but they are all precursors of future management or maintenance issues. Many of these issues appear to be maintenance related, but they could also indicate issues with trail location, construction techniques, budget, priorities, available personnel, skilled personnel, complacent personnel, material availability, equipment availability, a lack of an assessment, or extended intervals between assessments.

Some problem indicators that often show up in assessments include the following:
- Increased frequency and cost of maintenance
- Large deposits of sediment after weather events
- The appearance of sediment deposits on bridges
- The development of ruts on grades or the creation of muddy sections on flatter areas
- Trail braiding or widening to get around pot holes, ruts, rocks, etc.
- The development of rock gardens because all of the soil fines have washed off the surface
- The intended difficulty level has increased, at least in portions of the trail
- User-created trails are developing to avoid or short-cut the nasty areas

Too often, trail managers choose to pour time, money, and materials into fixing a poorly located trail when the remedy of relocation would be less expensive and far more sustainable in the long run. Assessments can help managers identify the source of problems and make the right decisions to correct them.

Need more? Learn more here…

Designing Sustainable Off-Highway Vehicle Trails, Kevin G. Meyer, USDA Forest Service, Technology & Development Program, November 2013

Trail Planning, Design, and Development Guidelines, Minnesota Department of Natural Resources, 2006

A Look Back…

Here are some of the elements discussed in this chapter:
- Assessment, or evaluation, is a constant process that managers should use throughout the Great Trail Continuum
- The motto "Observe, Record, Report" is the backbone of assessments
- Field personnel should conduct daily routine assessments or inspections
- Field personnel need to be trained in what to observe and how to protect the trail infrastructure
- The goal of routine assessments is to detect symptoms before they become problems
- Formal assessments answer: What could be there? What is there? What should be there? How do I get to where I should be?
- There are three main types of formal assessments: Feasibility, Safety, and Condition
- Feasibility assessments examine site potential and the activities that could or should occur on that site
- Safety assessments examine risk potential to the public and the agency and recommend actions to reduce that risk
- Condition assessments focus on the physical condition of the trails and facilities to determine conformance to the TMO, level of customer service, quality of the recreation experience, level of sustainability, maintenance or reconstruction needs, and corrective actions
- Assessments should be timely and should be proactive rather than reactive
- Problem indicators can be obvious or quite subtle, but if ignored there could be dramatic resource impacts and management issues

Chapter Twelve
What Makes a Great Trail Great?

Protect Your Riding Area; Stay on Designated Routes

"Wow! That was fun!" What sets one trail apart from all the other trails and makes riders say this at the end of the day? Was it the setting and the landscape, the challenge, the recreation experience, or something else? Something about that trail evoked feelings and emotions. Managers must find the elements that made those riders say "WOW!"

Often, when riders are asked what makes a great trail great, the responses include:
- Fun
- Offers varying degrees of challenge
- Good signing and trail maps
- Variety
- Loops
- Enough length to meet the riders' needs
- Scenery, viewpoints, destinations
- Open areas
- Learner loops and places for kids to learn and ride
- Opportunities for camping
- Provides resource protection
- Good parking, kiosk, and restroom facilities
- Flowmentum

Did a wind storm create a mess or an opportunity? Is it an accident that this trail is sandwiched between the root wad and the tree? Does something like this even register as "cool" to a rider? Read on….

Note that all of these except for "fun" are physical features that are provided through good planning, location, and design. "Fun" is at the top of the list because it is often the first rider response, but what is "fun"? In reality, a fun experience is created by having all of the other bullets. Fun is actually a subjective assessment of the experience. It is an emotional response and the greater the trail experience, the higher the emotional response. Five factors come together to trigger that great trail emotion: capitalize on the physical elements, understand and design for the human elements, create trail flow, provide for the riders' needs, and create variety.

Tip, Trick or Trap?

Tip: Developing a WOW trail experience is similar to a painter creating a masterpiece

What makes a great trail great? Location, location, location. All five of the above factors center around trail location, which leads to emotions and experiences. The key to a great trail location is knowing what to look for and then finding it, so taking the time to do a thorough reconnaissance is essential.

Talk about picture perfect! This view has outstanding foreground, middleground, and background with a variety of colors, shapes and textures. WOW, what will be around the next turn in the trail?

Capitalize on the Physical Elements

The physical elements are the features of the landscape that the planners or designers have available to help mold the quality of the trail experience. These features can be grand or subtle.

If you ride by giant sequoias every day, this could be a ho-hum experience. For everyone else, it is a WOW. The contrasting black fire scar accents the shape of this feature and looks like an entrance to a cave and it sets this tree apart from the others.

First, planners and designers must find the WOW. Every region has its own WOW. Experiencing that variety of WOW is why groups of riders travel to different areas and regions. Whatever that feature is, good planners and designers will find it and showcase it.

Second, planners and designers must find the little wow, the subliminal absorption. The riders absorb the physical elements on two levels. The first level is the conscious level. The riders consciously see the big, showy elements above and think, “WOW, that is cool!” The second level is the subconscious level. The riders see the wow, but the riders don’t remember seeing the smaller wows because those wows aren’t registered at the same time as the larger wows. Instead, these smaller wows get recorded in the riders’ subconscious minds as small but cumulative images. At the end of the day, the riders’ minds add the subconscious images with the conscious images to create a subjective assessments: “WOW, that was really COOL!” But when asked what made the riders say that, the response is often a nebulous “stuff” because the riders don’t consciously know.

The astute trail locator with creative vision will seek out these subliminal images and locate the trail so the riders’ eyes see them, even though it is a subconscious recognition. This awareness of the little things can play a big part in making a great trail great.

This burn has a bunch of uprooted trees, but this is the only one with a peep-hole through it. Subtle, but uniquely different.

Great trail vision. The locator found this gap in the rocks and then figured out a way to get the trail there. Being nestled in the landscape produces the same feelings as panoramic views above the landscape.

When the trail locator finds a unique feature like this, it gets logged into the GPS as "must be here." Seeing and riding through an attraction like this is a WOW experience and a great photo opportunity.

Winding through the rock canyon is an incredible experience and a WOW moment. This will be talked about at the campfire for several years.

Creative location. How cool is this to ride through? Unique? Memorable? Yes. Depending on approach speeds, alignment, and sight distance, this may need a warning sign.

This could be an old log deck or old bridge stringers, but it is a feature that stands out in this sea of green. Why? It has more mass than everything else in the setting and it is a horizontal structure when everything else is vertical.

Suffer from vertigo? How can the ability to access a viewpoint like this not be a WOW experience? Will this moment be talked about at the end of the day?

Before the fire, these boulders may not have been visible or unique, but now they provide a stark contrast in color, form, and texture from the rest of the landscape. The trail locator needs to figure out the best view angle and direct the trail and the riders' eyes toward it.

Except for some outstanding vistas, this landscape had few WOWs. When the designer found this rock, the trail HAD to go under it. It offers a unique shape, the only shade, and the only water. The colorful lichen on the rock adds to the feature. Note the cobble rock to harden the spring crossing.

Obviously, this is a great view and the riders' eyes have been directed right at it, but equally striking are all of the contrasting shades of green. Other than the mountain top, all of the other shapes and textures are green.

This unique rock formation is pretty well hidden from view, but thorough reconnaissance discovered it. The rider will pass by it in one second but the shutter will have snapped and the image captured in the riders' minds.

Locals get used to seeing things that could be little wows to non-locals. This gnawed beaver tree is an interesting feature to non-locals. The size of the tree and the size of the gnawed chips set this tree apart from the other skinny ones. It would have been better if we could have located the trail between the log and the stump, but there wasn't room without disturbing the site.

This tree has had a tough life. These are called character trees because they are so different from all of the others. It is fire-scarred and has been hit by lightning at least twice.

Not grand in scale, but grand in shape. When all the other shapes are vertical, this heart stands out. Can you imagine having your family stop and pose for a shot through the heart? Neat.

This area is almost like traveling through a fairy-tale. Running the trail into the vegetative tunnel made the whole trail experience a WOW.

The colors, textures, and shapes in this overhanging rock make it a little wow.

The flowing shape of this trail harmonizes with the landscape. It fits, so the rider also feels like he fits into the landscape.

Every part of the country has a unique beauty. Find it and highlight it. When the desert is blooming, it is glorious, which transfers to the rider as a glorious day.

This charred stump is different and contrasts nicely with the fall grasses and shrubs.

Understand and Design for the Human Elements

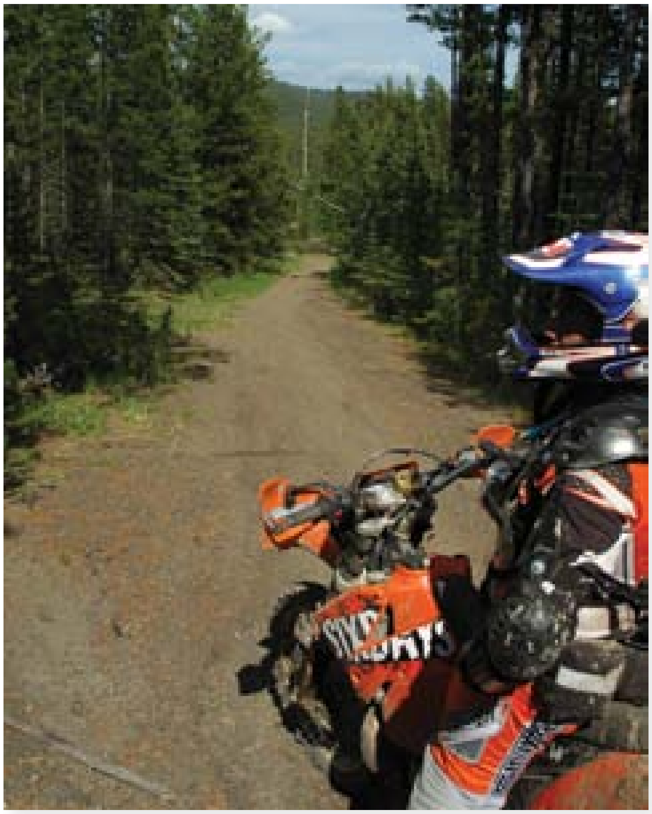
The arrangement of the physical features on a trail can trigger an emotional response within the rider. There are two components of this element: human perception and feelings.

Human Perception. What riders see, the order in which they see it, and how they interpret what they see forms a perception of the trail that molds the judgment of the experience. That perception is formed by the arrangement of natural features to form shapes, anchors, gateways, and edges. A trail that capitalizes on these features is one that will trigger an emotional response.

Some ways planners and designers can capitalize on human perception include the following:

Shapes. Does the shape of the feature fit into the perception of what is natural?

Anchors. Use anchors to bond the trail to the landscape.



The trail following this linear seismic line does not have a natural shape and fights with the landscape. There is no opportunity to change the viewshed or the experience of the rider.

Even though this trail has been hardened, it still has an inviting shape that appears natural.

This huge rock with cool ferns growing out of the top firmly anchors this trail. The fact that the trail wraps around it rather than just passing by it makes this feature a stronger anchor.

An excellent example of great trail location. Being anchored by both the huge tree and the rock, the trail fits and flows with the landscape.

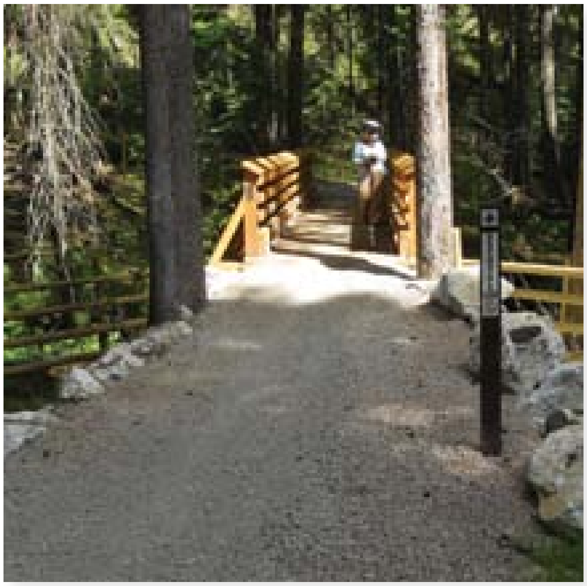
This landscape doesn't offer a lot of structure which is why the trail absolutely had to pass through and be anchored by these rocks.

Gateways. Use a gateway as a threshold that riders pass through. It confines the trail and frames it with the landscape. Two anchors side by side can become a gateway.

Talk about a dramatic gateway! This WOW will be etched in the riders' memories.

All of the glory doesn't have to go to the designers. Here, the maintenance crew had the vision to turn this blowdown snag into an interesting gateway.

A couple of smaller rocks had to be pushed out of the way, but the designer had the vision of what would remain, a great gateway.



The bridge itself is a gateway, but the trail has been carefully located and designed to fit between these two trees which enhances the gateway effect.

In a landscape pretty much devoid of gateway structure, this cattleguard becomes the gateway and it frames the riders' eyes of the great background view.

Edges. Use edges such as cliffs, streams, fencelines, vegetative changes (either natural lines or ones formed by wildfires or logging), ridge tops, rimrock, etc. Part of human nature is that riders tend to gravitate toward edges, so when a trail follows an edge, it is satisfying one of the human needs. Like anchors and gateways, edges confine riders and the trail.

This Russell fence provides a scenic edge for this trail. Though artificial, the edge fits the landscape and enhances the rider experience.

Good trail location. This trail follows the edge of the vegetative change and it curves with the natural curve of the tree line. Had the trail gone through the middle of the meadow, it would not fit our perception of "natural."

This lava flow provides a dramatic and beautiful edge for this ROV trail.

Part of our human nature is to gravitate towards water, so the stream provides an edge for this trail. The sight and sound of a babbling brook makes a great photo or lunch opportunity.

Human Feelings. Shapes, anchors, gateways, and edges are all a spatial arrangement of natural features. Because they trigger an emotional response from the rider, they are powerful design tools. Those tools form the perception of the trail, but the trail's location and design also stimulate feelings. By having positive feelings about the trail, the trail experience and thus the recreation experience is likely to be positive also. Great trail planners and designers create feelings of safety, efficiency, playfulness, and harmony.

Safety. Am I within my comfort zone? Am I going to be able to make it back to the trailhead? Everyone has a different comfort zone, therefore it is imperative that the condition of the trail be effectively communicated to the public. It must be designed according to its TMO, maintained according to the TMO, and be signed accordingly. Riders can get out of their comfort zone when signs are missing, the tread does not appear stable or of adequate width, trees haven't been cut out, or the trail is so overgrown it is hard to distinguish the tread from a game trail. All of these make the riders question what they're getting into.

Comfort zone does not mean the trail is free of challenge. Comfort zone is how a rider feels on the trail on a given day. Individual riders will have differing levels of comfort on the same trail. Trails are not one size fits all. Challenge is part of the experience the trail provides. Riders make a conscious decision to seek out challenges and many riders are in their comfort zone doing so. If challenge is imposed on the rider by surprise, it then becomes a risk, and risk can lead to liability.

If design, construction, or maintenance forces the rider outside of his comfort zone, the agency is at risk.

Above, the drivers on the rim chose safety for their comfort zone. The driver in the hot tub chose risk. As the recovery strap is attached, he risked his pride as well.

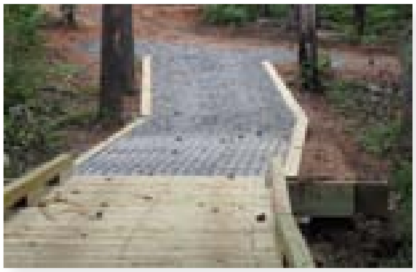
This trail is totally overgrown with vegetation. When riders wonder, "are there hidden logs or rocks?" they are probably outside of their comfort zone.

Hmmm, what am I getting into? Will I need those after the next section of trail?

Efficiency. This is the use of the landscape and structures to efficiently meet the riders' needs.

With efficient design, the rider would rather be on the trail than off it because it is the path of least resistance, it's the fastest, and it is fun. Why is this important? When efficiency is lost, trail widening, braiding, and resource impacts can occur. Efficiency is lost when:

- Riders bypass soft, wet, heavily eroded or excessively rough areas.
- Riders bypass structures like waterbars or trail hardening.
- Moguls develop due to speed and straight alignment.



Above and left, well-designed and constructed structures increase the efficiency of the trail which increases resource protection.

Right, these pavers have been lined with logs placed in a herringbone pattern. The logs not only encourage riders to stay on the structure but also deflect runoff water into vegetation before entering a stream.

Left, the original trail on the right became soft and rutted, so it was more efficient for riders to cut through the trees. Some riders will choose to ride the rutted route because that is the experience they want and the efficient route they want to take. But most riders will choose the shorter and drier route as the most efficient path, thus widening the trail and damaging vegetation.

Riders will usually ride as fast as their machines and their skills will allow them. That is part of the challenge and the experience. Because of that, speed limits do not work. Control speed through tight alignment and narrow clearing.

The end of this paver installation was improperly constructed resulting in a poor approach to the structure. It is no longer the efficient line and riders are choosing to go around it.

Playfulness. A trail that is playful moves with the landscape and uses the landscape to create flow and a fun factor. The creative use of anchors, gateways, and edges is playfulness. A continual change in horizontal and vertical alignment is playfulness. Continually changing the viewshed of the rider is playfulness. Constantly changing the experience of the rider is playfulness. Playfulness is one reason that roads do not make good trails. Roads tend to be straight and predictable. Trails are curvilinear with a sense of wonder around each curve. Roads cut through trees, trails go around them. Roads blast through rocks, trails go around them or over them.

Harmony. Harmony is a riders' feeling about how well the trail fits the landscape. A harmonious trail utilizes shapes, edges, anchors, and gateways and is designed to be playful and efficient while keeping the riders in their comfort zone. Harmony puts it all together. Harmony has rhythm and flow. A highly engineered trail with multiple structures and trail hardening is less harmonious than a primitive natural surface trail. A newly constructed trail isn't as harmonious as an established trail. A machine-built trail may not be as harmonious as a hand-built trail.

Use whatever topography is available to play with the landscape. The location of this trail fits the landscape, adds flowmentum and fun factor, and improves drainage.

This trail is both playful and efficient. The rider wants to stay on it and can't wait for the next corner.

This is a great example of playful location. Criss-crossing this dry draw creates a rollercoaster effect that is fun and sustainable.

Though an open landscape, this trail with two climbing turns blends into and harmonizes with the setting. The key to that is to minimize cuts and fills and to use whatever vegetation is available to screen the trail.

These trees twist and turn and so does the trail. Everything fits and flows together. Harmony is a perception that everything is right. As a perception, what is harmonious for one rider may not be harmonious for another.

The riders will tell you when the trail is not in harmony. Placing the trail in the flat portion of this area caused water to pool on the trail. Riders tried to keep out of the water and trail braiding occurred.

This ridgeline trail bisects the landscape and doesn't fit the natural shapes and contours. It doesn't vary the viewshed of the rider and it's boring because it is so predictable. Ridgetop trails are fall line trails and generally don't drain well. This trail definitely fits into the category of too long and too steep.

This is a much better example of how a trail that follows the ridgeline can harmonize with the landscape. The serpentine alignment switches from one side of the ridge to the other. This creates drainage and varies the rider viewshed. Very little of it is on the actual ridgetop except for the last rise. When the rider tops that crest, he is presented with a panoramic and totally WOW view of several mountain ranges.

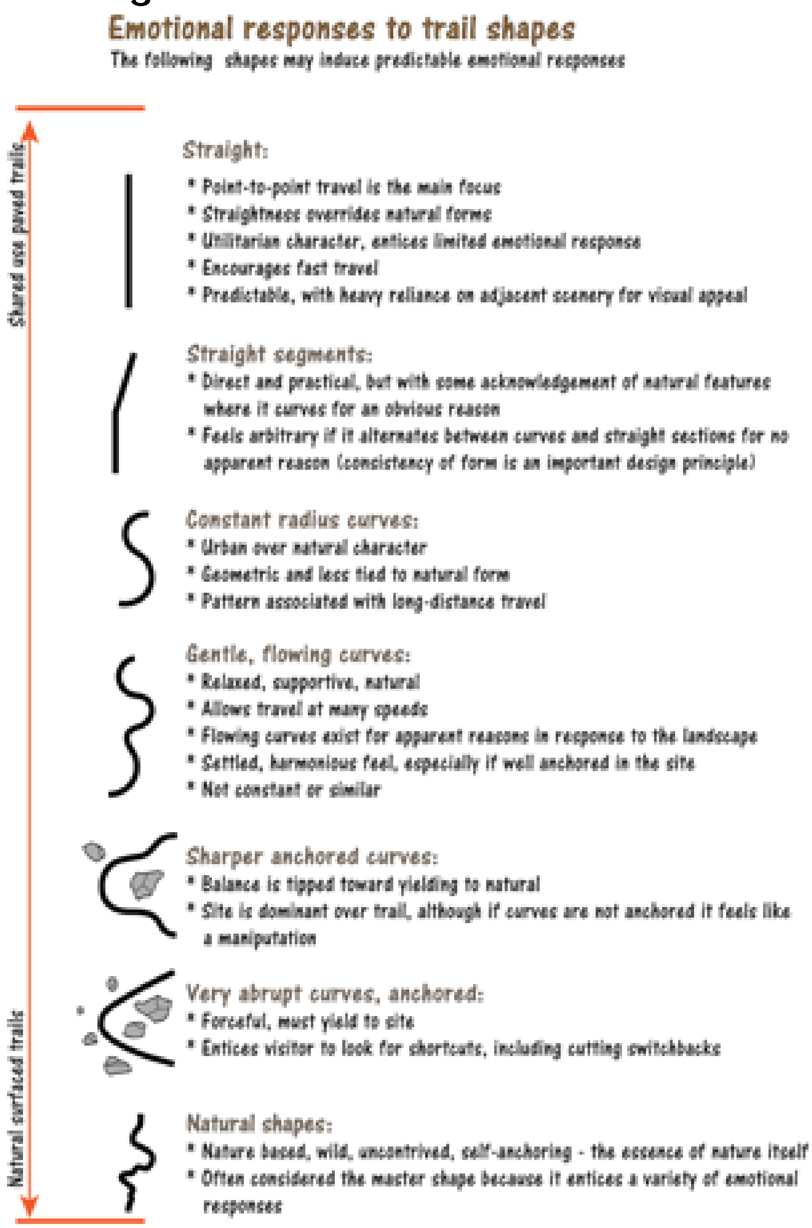
The trail will tell you when it is not in harmony with the landscape.

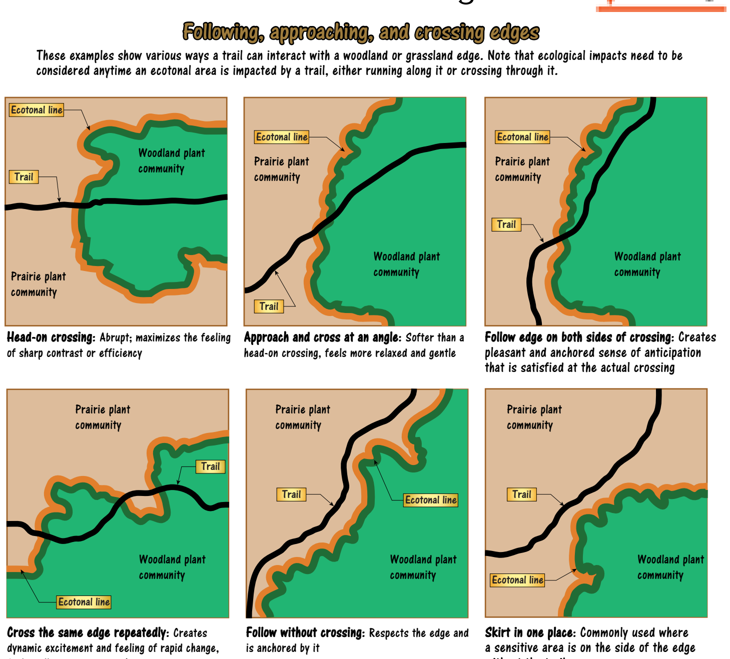
How the Human Elements Affect Design

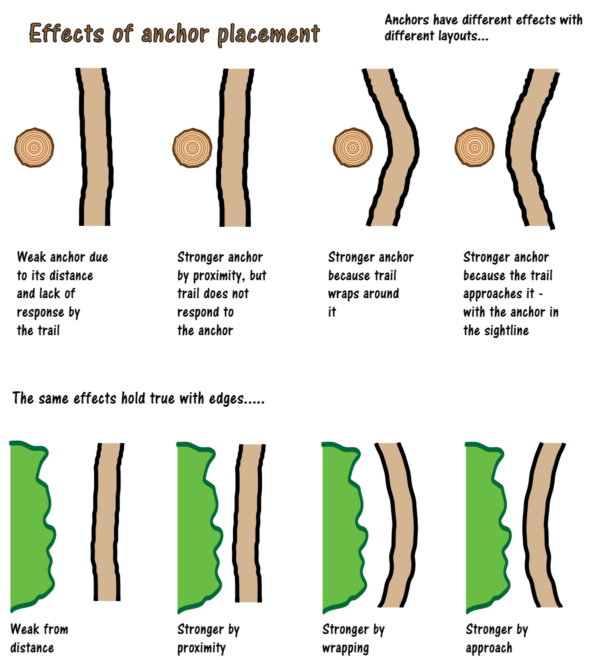
The riders' perception and reaction to the four factors of the human feeling is what makes a great trail great. The physical trail laying on the ground may be sustainable but it doesn't become a great trail until the combination of the human elements stimulate the riders' emotions and cause the rider to exclaim: "WOW, that was a great trail!"

It is important for the designer to understand this relationship between physical shapes and emotional responses and then to creatively seek and arrange those shapes, anchors, edges, gateways, the big WOW, and the little wow into a sequence that will create an image in the riders' minds and stimulate the riders' emotional responses. The trail is the connecting link between each one of those elements.

Triggering the positive emotional response also includes the riders' perception of the trail as part of the environment. The more that the trail fits the landscape, the more the trail will be perceived by the riders as being natural and the more likely that the trail will stimulate those emotional responses within the riders. The level of that response can be controlled by the physical relationship between the trail and the feature. Altering





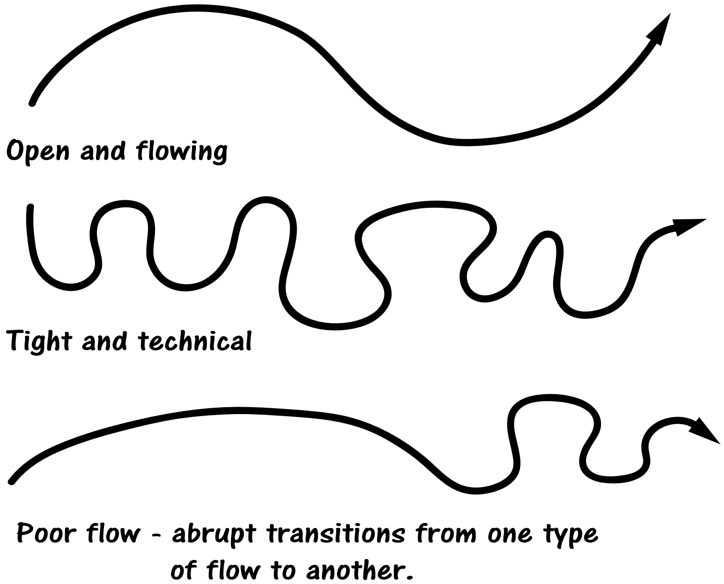


the approach, proximity, or length of time in the proximity of a feature can create a stronger or weaker response.

Create Trail Flow

Flow is the continual horizontal and vertical movement of the trail on the landscape without conflicting with the landscape. Flow is the rhythm of the trail and the riders feel that rhythm as the riders flow with the trail. That flow and rhythm stimulates emotional responses within the riders which is why it helps make a great trail great.

Designers purposefully create flow, rarely does it happen by accident. As designers flag in a trail, they should be riding the trail in their mind and tracking the experience they are creating. Sure, they must keep track of the grade, alignment, and drainage points, but they also must seek out anchors, gateways, edges, and viewpoints. Those experiences need to be mixed up so the riders are encountering variety and cannot wait to see what is around the next curve. Designers control the viewshed of the riders. On a trail with good flow that view should be constantly changing. Flow can be open and gentle or tight and technical. A trail that carefully transitions from one to another adds variety and increases the recreation experience.

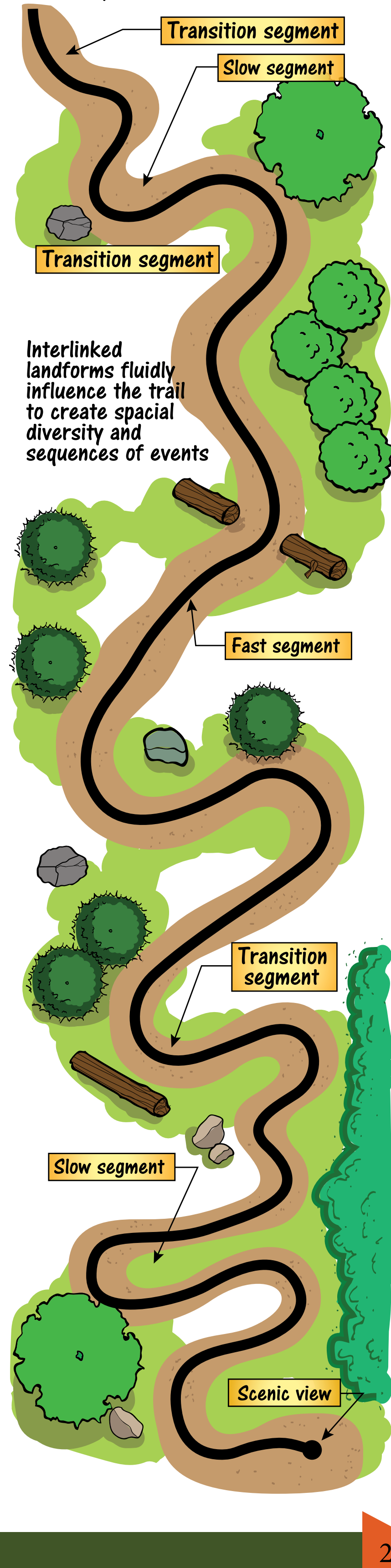


A trail with flow has the following:

- Rhythm, but this does not mean speed. Rhythm is the ability to throw a machine back and forth from corner to corner.
- High fun factor.
- Good control of the riders' view scape. The trail goes where the riders' eye thinks it's going to go. If it doesn't, that creates an awkward moment that can result in tread impacts and risk to rider safety.
- Feels "natural," not artificial or contrived.
- Natural transitions between trail conditions.
- Allows the riders to carry momentum which reduces the need for hard braking or acceleration and therefore reduces tread impacts and maintenance. This is often called "flowmentum."

Trail Flow

Trail flow is a function of thoughtful design and should not be left to chance. The most successful designs are those that respond to landforms and create a sequence of events using anchors, edges, gateways, terminus points, and destinations.



What do People Want From Their Experience?
- Connect to nature
- Escape from stress, re-create
- Fun
- Challenge, exercise
- Camaraderie, bonding
- Variety of experiences and difficulty
- Loops

Where Do People Want to Go?
- Highest point
- Water
- View
- Dramatic and unusual experience
- Historic interpretive site
- View wildlife
- Food

This snag is a character tree that is silhouetted by a dramatic panoramic view. The trail has been consciously located to frame the picture and direct the riders' eyes at the best possible angle.

Provide for the Riders' Needs

If at all possible, take the riders where they want to go and provide a variety of experiences while doing it.

Create Variety

Edges, shapes, gateways, and anchors need to be creatively mixed up and have short duration. The fenceline makes a cool edge, but not for mile after mile. A great trail will utilize the fenceline briefly, leave it to offer the rider some other features or experiences, and then maybe come back to the fenceline.

Tip, Trick or Trap?

Tip: The images in this chapter and their effects on the riders are powerful tools. The trail designer who incorporates these tools is one who will create a great trail.

A Closer Look...

Artists have their color palette, but the landscape is the palette for the trail designer. The artist has seven elements with which to create art: line, color, value (contrast), shape (2D), form (3D), texture, and space (scale or depth). Most of these terms have been used to describe the illustrations in this chapter because the trail designers use these same elements to create the images that will mold the riders' perception. Is creating a great trail art or science? It is both.


GET
READY...


WOW!

Need more? Learn more here…

Elements of Art, http://www.northernhighlands.org/cms/lib5/NJ01000179/Centricity/Domain/40/Elements-of-Art.pdf

Natural Surface Trails by Design, Troy Scott Parker, Natureshape LLC, 2004

Trail Planning, Design, and Development Guidelines, Minnesota Department of Natural Resources, 2007

A Look Back…

Here are some of the elements discussed in this chapter:

- A great trail is actually an emotional response to the trail. Five factors come together to trigger a great trail emotion: physical elements, human elements, flow, provide for the riders' needs, and create variety.
- Capitalize on the physical elements
- Find the WOW
- Find the little wow (subliminal absorption)
- Understand and design for the human elements: perception and feelings
- Human perception is formed by:
    - Shapes
    - Anchors
    - Gateways
    - Edges
- Human feelings are how riders feel about a trail's:
    - Safety
    - Efficiency
    - Playfulness
    - Harmony
- Designers and planners should creatively and frequently use shapes, anchors, edges, and gateways to form the riders' perception and feelings about the trail
- Manage and maintain the trail to perpetuate those qualities
- Create trail flow. Flow is the rhythm of the trail. Momentum + Rhythm = Flowmentum.
- Provide for the riders' needs by taking them where they want to go and provide the experiences they are looking for. The key is variety
- What makes a great trail great is the riders' perception of it. That perception is controlled by the designer
- The landscape is the designers' palette and like an artist they use the elements of line, color, value, texture, shape, form, and space to create the images that will mold the riders' perception of a great trail

Chapter Thirteen
Trail Location and Design

One Size Doesn't Fit All. Ride the Right Sized Machine.

Locating a great trail and protecting the natural resources can be a challenge, but it is worth the effort.

The key to a great trail is in the location of the trail and in the arrangement of certain physical features that can stimulate powerful perceptions and feelings. Indeed, the landscape is like a giant trail jigsaw puzzle. The pieces are out there, but where? And how do they get arranged? Is there more than one way to solve the puzzle and if so, which is the best way?

The challenge for the locators is to find the pieces and arrange them in the best possible way. In every scenario, there is always a way to solve the puzzle. It may take design tools or management tools or both, but there is a solution. It may not always be ideal, but that is okay. Creating a great trail is about making informed decisions and making the best of a given situation. It is not a perfect world and there is no such thing as a perfect trail.

Know the Complete Picture

When finding the best location for a trail, the locators provide for the riders' needs by managing the vehicle use and the riders' viewshed, speed, and experience all while protecting the natural resources. That is a heavy load to carry and it takes careful decisions to effectively place a trail on the landscape that meets all of those objectives.

The effort takes both physical and mental energy and can leave locators exhausted in both capacities. The locators need to be mentally sharp and physically prepared for a tough day of walking in the field. But the result of all this effort will be a well-designed, environmentally friendly trail that is fun to ride and a great success.

Good locators must know the complete picture. They must know and understand these eleven elements about the project site before going into the field:

- The issues
- The politics
- Resource values and constraints
- Management constraints
- Existing conditions
- The vision
- Trail management objectives (TMOs), including type of vehicles, difficulty level, experience type, and methods to build and maintain
- The soils
- The climate
- The vegetation
- The topography

Making Great Trails Requires:

- **Understanding**
- **Knowledge**
- **Engineering**
- **Passion**
- **Vision**
- **Creativity**
- **Conscientiousness**

Locators should take a close look at the scope and complexity of these eleven items. Each has equal weight and all except the vision and the TMO can change from one side of the ridge to the other. Great trails don't happen by accident, they are created by thoughtful and purposeful design. If someone on the project team doesn't have the range of skills and experience required, it is worth seeking professional assistance.

The Trail Location Process

1. **Know the Complete Trail Picture.** All of the eleven items are important to know, but the TMO has a direct bearing on almost every flag the locators hang. Generic TMOs were created during the development of the concept plan. Those TMOs could change if necessary during the location process once actual site conditions are thoroughly examined, but they are a place to start. The vehicle type will affect trail width, grade, and the physical forces applied to the trail. How the trail will be constructed will determine whether the team goes around a stump for hand-build or through the stump for-machine-build. The intended challenge level will affect whether the team goes around the rock for an easier trail or over the rock for a more technical trail.

This great rock feature is almost totally concealed by vegetation and would not be visible in an aerial photo or from another vantage point on the ground. It was found only through thorough reconnaissance.

2. **Use the Concept Plan.** Considerable work was invested in developing the concept plan, so it is a good place to start. Locators should use it as a guide, but recognize that it will likely change once more reconnaissance is performed and actual site conditions are identified.

3. **Identify Termini and Control Points.** In developing the concept plan, opportunities and constraints were identified as positive and negative control points. Knowing the termini and the control points can significantly shrink the size of the landscape and restrict where the trail can or can't go. Since they are so important, these points should be verified during the location and design processes. Also, depending on the amount of field time invested in developing the concept plan, the locators should look for additional opportunities or constraints.

4. **Break Up the Elephant into Chewable Chunks.** Figuring out how to access a large landscape can be overwhelming. The locators should use logical terrain features (like ridgeline to ridgeline) to break the landscape into smaller parcels. They should take careful notes, photos, and GPS data to help them join the parcels together.

5. **Conduct Total Reconnaissance.** Features can be hidden and soils can change dramatically. The locators should thoroughly explore each parcel to uncover its opportunities and constraints. GIS modeling can display a corridor with the optimum side slope, soils, and vegetation. While this can be a handy tool, it can also be a trap if the locators fail to look outside of this corridor. Some of the best terrain features can be found in areas that could be classified as unsuitable. The locators should find the features and then make their own determination as to whether or not the trail should or could be there.

Tip, Trick or Trap?

Tip: It is easier to make a great trail when the trail locator and designer are the same person or team

6. **Connect the Dots.** Once the controls are identified, what is left is to connect one control to another. While this sounds easy, the last thing locators want to do is just arbitrarily connect the dots. The space between controls is where the designers can play with the landscape, find those big and little WOWs, and provide variety and fun to enhance the riders' experience. This is the fun and creative part of trail location and design.

Here are some key points:

- Remember that OHVs have motors and riders like to use them. Keep the trail moving.
- Getting there isn't half of the fun, it's all of the fun.
- Miles equal seat time equals smiles.
- The best line usually isn't the first line, the easiest line, or the logical line.
- Mistakes will happen. The key is to learn from them.
- There is no such thing as a perfect line. Instead, there are options to make the best of a given situation.

The blue line is the logical line; base of the slope, natural opening, easy walking, could be a game trail. The yellow line is a better alternative with more flow, drainage, and it keeps the riders' eyes moving.

7. **Revise the Concept Plan.** Once all of the landscape parcels are connected together with actual flag lines, chances are that there have been a bunch of changes in loop configurations, junction locations, trail difficulty, and even trail use type. Locators should make sure that the plan is still compliant with the environmental documentation and update the concept plan. It will then become the design plan, which will be used through construction and maintenance.

8. **Develop Final TMOs.** The TMO has key information that triggers important design-build-maintenance parameters. Now is the time to update and finalize the TMOs so they can accompany the design plan through the remaining portions of the Great Trail Continuum.

9. **Prepare a Trail Log if Necessary.** The trail log is a list of work items that the designers prepare for the construction crew or contractor. Items would include: turnouts, rolling dips, chokes, special challenge features, easy-outs, drains, all structures and their size and length, trail hardening, and any special design items or notes. The trail log is where the locators and the designers have the opportunity to communicate their vision and intent with whomever is doing the construction. The trail log and the TMO are key documents used to develop a construction contract packet.

Work with the Landscape

Once the locators have done their job, it is time for the designers to step in. Since the landscape is the pieces of the giant trail system jigsaw puzzle, it is important that the designers recognize and understand the clues to each piece. This allows the designers to make informed decisions regarding the environment and rider experience, and thus assemble the pieces into a great trail.

Read the Landscape. The landscape gives the designers information about topography, climate, vegetative type, soil type, soil stability, moisture content, water sources, drainage, wildlife and stock use, features, and of course the potential opportunities for a quality trail experience. To the eyes of experienced designers, the landscape will indicate potential habitats for sensitive plant and animal species. Looking at existing impacts like roads, skid trails, game and stock trails, and existing recreation trails will give them clues as to soil stability, storm impacts, and the maximum grades that can still be sustainable. Some landscapes are breathtakingly heterogeneous and dramatic and others are incredibly homogeneous and bland. Both can be beautiful and both provide challenges for designers. Heterogeneous landscapes can offer exciting feature-rich trail experiences, but they can be difficult to preserve the viewshed, harmonize with the landscape, hide the trail from the riders and from other viewers, and effectively manage the OHV use. Homogeneous landscapes generally have fewer viewshed concerns, but can test the designers' ability to find and create an exciting trail with a lot of variety.

Below are some examples of what the landscape can tell designers.

The pistol-butted trees on the slope indicate that the soil is moving. The slabs of rock that are showing (arrows) probably means that there is a shallow lens of soil over the rock and that's why it's moving. It's been burned, but vegetation is sparse anyway which allows for overland flow of water. The tread watershed, combined with the wide trail and sleep slope causes water to flow down the trail. The result is erosion.

This is a bench where a steeper slope levels off for a short distance before getting steep again. Often, there can be springs or wet areas at the base of the steep slope and the taller green grass (arrow) may indicate that. The drier location for a trail is on the nose of the bench as it starts to steepen. There could also be viewpoint potential there.

The bushes are willows and they grow in wet environments. Though no water is visible, the dark strip of grass (arrow) indicates that water is not far below the surface. This is probably a very wet drainage in the spring. Notice how the shade of green intensifies from the top of the mound downslope to the fence. Water has drained from the highlands into the lowlands.

Aspen are generally an indicator of water, but look how brown the grass is below the aspen. Also note that the ground cover is grass and not leafy shrubs and forbs. The evergreens are Ponderosa Pines which grow in rocky or free-draining sandy soils, so the water table is not near the surface.

Here, the evergreens mixed with the aspen are fir trees which prefer wetter environments or soils that have more clay and hold their moisture. Notice how green the ground cover is here; leafy shrubs and forbs with less grass. The water table is closer to the surface here and a trail cut into the slope will probably intercept sub-surface water in the spring.

Though totally dry now, this patch of beaver-gnawed stumps is a red flag. Standing water was here once and it could be here again. The fact that the stumps are white probably indicates that they were in or under water when they were chewed. With further reconnaissance, the remnants of the beaver den were found.

This is WOW terrain and a trail locator's dream. The site is high and dry with a mixed pine-fir stand. Plenty of exposed rock means durable tread material and opportunities for natural challenge features. Scattered rock outcrops allow the trail to be in the trees and then pop out in the open for a spectacular view and a varied trail experience. Snags and juniper ground cover provide little wow subliminal features.

This is ideal ground for a trail. The trees are fir, their stems are bowed. The ground cover is green, but low-growing, so the site is relatively dry. The trees are nicely spaced so that a trail could easily sinuate around them. Downed trees help deter off-trail use and their stumps can provide subliminal features.

What appears to be a nice little meadow with an opportunity for a view is really a bog and another red flag. Bogs are a wetland and a place to avoid if possible. An interesting thing about bogs is that they can occur in the highlands as well as the lowlands, any place where water can become trapped, and they may or may not be associated with a stream or body of water.

A contiguous patch of green like this is a red flag for water. To cross this at the outlet (foreground), the designer would choose the narrowest low spot with higher ground on each side. Even then, trail hardening or a structure would probably be required. A better alternative would be to stay on the high ground in the back (arrow) and avoid the low ground entirely.

There is some excellent opportunity here for some technically challenging trail and outstanding viewpoints. Finding a way through steep, rocky terrain or deep, nasty canyons can be an arduous task for the designer. A good place to start is to find a game and stock trail and follow it. Chances are they have already found the best route through the area. If there isn't one, maybe there isn't a route and you could be in trouble.

Tip, Trick or Trap?

Trick: In rugged terrain, look for a stock and game trail. Chances are that they have already found the best route through.

There are many causes of slope failures: poor soil, saturated soil, soil on top of an impervious layer like rock, too much weight on the soil, erosion from a significant water event, etc. If it has happened once, it can happen again. As a designer, try to figure out why a slope failed, then avoid placing your trail within that same set of conditions. This failure is easy to spot, but older ones with trees are not so obvious. If you see a stand of trees on a slope or at the base of a slope and all of the trees are at different angles, it is probably an old slide.

Patches of standing water show how high the water table is. Though this ground seemed firm to walk on, it would not support the weight of vehicles and severe damage to this important ecosystem could occur. Crossing a bog can offer variety and an interpretive opportunity, but generally requires an expensive structure like boardwalk.

These are very old, highly-fractured rock formations that have been eroding and disintegrating for eons. The soils on a slope like this will have a high rock content and be quite durable. Note the rock showing in the trail tread.

Depending on the tree species, exposed roots can indicate a shallow soil layer with rock underneath. This can increase construction costs and cause you to change your location. If you don't see rock, dig a test hole to find out.

Scree slopes are areas of fractured rock or boulders that have been deposited over the centuries by the deterioration of a rock cliff or mountain top. They can offer technical challenge, views, and a varied riding experience. However, due to the forces of snow creep or avalanches, rocks can continually be deposited in the trail tread and maintenance can be high. To minimize this and to better harmonize with the landscape, a trail should cross at the top or bottom, not mid-slope.

A look at the landscape can also reveal changes in aspect, such as north-facing slopes versus south-facing slopes. The soils, vegetation, and micro climate can change, sometimes dramatically, from one side of the ridge to the other. North-facing slopes are generally cooler, wetter, and have more dense vegetation than south-facing slopes. Changing aspect is a good way to add variety and enhance the rider experience. It is also a good way to increase the durability of the trail tread. If the north aspect appears to be so wet that hardening or structures may be required, try putting more of the trail on the south side. Likewise, if the soils on the south slope are not durable because they are non-cohesive, try switching to the north slope for better conditions.

This photo shows the dramatic change possible from a south facing slope on the right to a north facing slope on the left. From a design and management standpoint, being in the trees offers more options to hide the trail and wind the trail.

In snow country, the aspect of the slope could be a consideration. North-facing slopes will hold snow longer than south-facing slopes. If two segments of the trail or trail system are on south slopes and the only connector between the two is high up on a north slope, the trail system will have no connectivity until all of the snow melts up high. When riders come to a snow field, they will look for a way around it and this could lead to management problems and resource impacts. If possible, designers should consider putting in another connector trail at a lower elevation. This will allow the trail system to be fully utilized earlier in the year and can provide another loop opportunity after all of the snow is gone.

The prevailing direction from which storms approach should also be considered by the designer. If there is topography, storms will generally dump more water on the windward side than on the leeward side.

The landscape changes in every region of the country and with that, the clues change. In order to locate a sustainable trail, designers must understand that landscape or consult with someone who does.

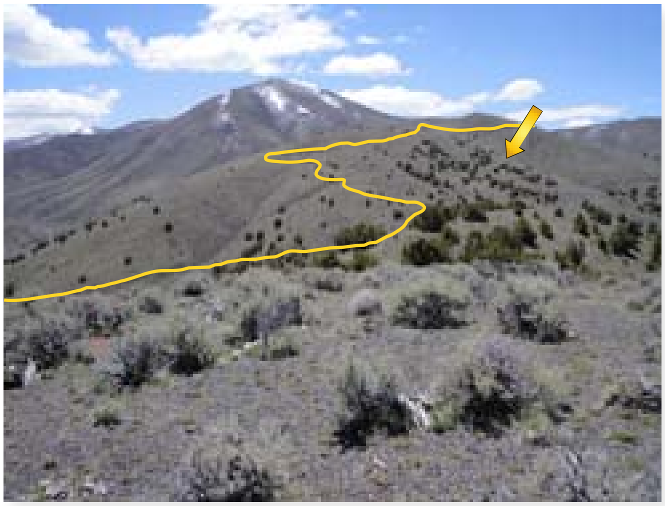
Make the Trail Flow with the Landscape. Making a trail flow starts with viewing a landscape, identifying the places the trail could go, and then visualizing the least intrusive route to get there.

While this may be a fun hillclimb and may even be sustainable given the soils, climate, and use levels, it does not flow with the landscape.

This location flows better, drains better, and uses the features of the landscape to enhance the riders' seat time and experience.

When putting trails into the landscape, consider:
- The trail should not interfere with the natural drainage patterns. It should dip into and climb out (drain) at all of the natural drainage points.
- Use the vegetation and topography to make the trail blend in with the landscape.
- Since a contour can be a straight line, follow the contour corridor without being on the contour. Keep the trail moving in a horizontal and vertical W pattern.
- Some edges conflict and others harmonize. The trail is an edge that can fall into either category.
- Laying lightly on the landscape means minimizing trail cuts and fills, which impact the landscape.
- Incorporate gateways and anchors that tie the trail (and the riders) to the landscape.

Even in an open landscape, this trail flows with the terrain, drains with the terrain, and has minimal impact on the terrain.



This trail would have had less visual intrusion on the landscape if it had been located in the trees (arrow), but the terrain was steeper on that slope and it lacked places for enough climbing turns to gain the elevation that this trail needed to gain to hit control points.

This trail is beautifully located. It is well anchored with the humongous rocks and it flows well from rock to rock. The riders' eyes almost ricocheted from one to the other.

Locating a fun, sustainable, and visually unobtrusive trail on an open landscape can be challenging. Note the undulating W shape of this location. If nothing else, this trail will drain well.

Dramamine anyone? A little too long and repetitive, but perhaps there was no option. It's not an ideal world. A sustainable trail beats no trail and sustainability trumps rider experience.

To drain and flow with the landscape, a trail across this slope could have a minimum of six grade reversals

This contour trail probably connects one saddle to another. It is definitely sustainable, but perhaps a bit too conservative. It's a line that bisects the landscape rather than flow with it and the riders' eyes are fixated on the same point for too long. Human nature is to go to the highest point, so perhaps the trail could have gone there. Down lower, there are trees and more roll to the topography, so a trail there could have more flow, roll, and fun factor.

Use the Landscape to Enhance the Rider Experience. Every landscape has topographic or vegetative features that can be creatively used to enhance the rider experience. There can be big WOWs or subliminal wows, but like gateways and anchors, the challenge for designers is to find them and piece them together.

In a thick deciduous forest the opposite effect may be desired by breaking the rider out into the open.

An example of using an enclosed canopy of vegetation to create a tunnel effect. Everyone enjoys going through a tunnel because it is so different. Being encapsulated by the vegetation creates the same response in riders. In a deciduous forest, doing this can mean increased maintenance to keep the vegetation trimmed back.

Here are some thoughts:

- Winding around or over boulders, stumps, or other features can provide a small grade reversal while enhancing the rider experience.
- Roots and rocks left in the trail bed add to the rider experience and can help drain the trail or at least slow the velocity of water.
- Rocks and thickets provide opportunities for technical trails. Seek them out.
- In dense forests, especially deciduous forests, opportunities for viewpoints can be limited. Consider doing some selective thinning to create or enhance a viewpoint and then manage that site for its view by keeping the vegetation cut back.
- Go through medium-height vegetation with an enclosed canopy to create a tunnel effect for the riders.
- Look for what is different in the landscape and take the trail there.

What is the different feature in this landscape?
It is the field of boulders and taking the trail there will vary the riders' experience.

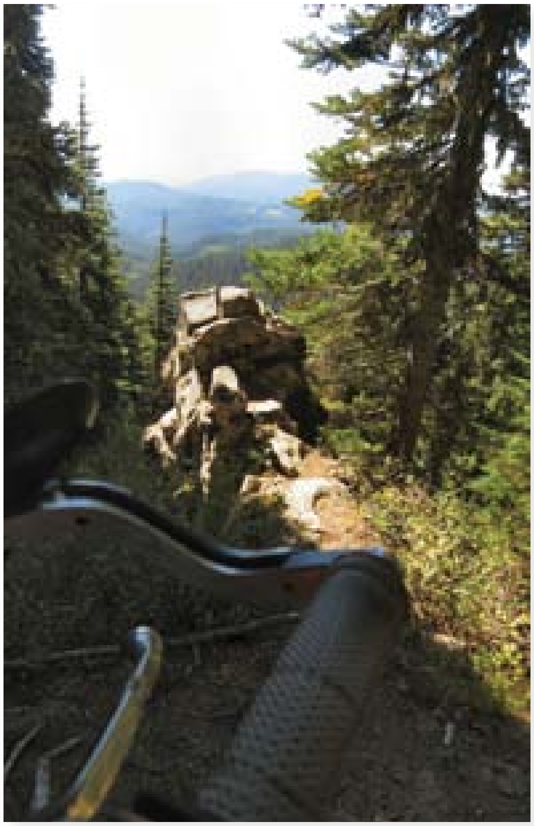
This isn't dramatic, but running the trail over this little rock knob creates a grade reversal and a varied experience for the rider. If this had been a more technical trail, the line may have crossed lower over the more jagged rocks if they were solid enough to withstand the use.

Running the trail between these two root wads is an outstanding example of creatively using what the landscape gives you. This not only creates a gateway, it provides a dip in the trail which can help drain water. Note: examining root wads and their holes is a good way to ascertain underlying soil conditions.

This rolling terrain in the Midwest has some great trail opportunities. With some selective thinning, a nice viewpoint of the valley below could be created.

We've talked about playing with the landscape and this trail does that very well. The original trail (blue line) was a fall line trail with a 38% grade. The new trail (yellow line) extends seat time, is more durable, and way more fun to ride. Yes, this roller coaster still has some steeper grades, but the rider can see them coming and flowmentum will carry the rider through the turns without undue tread impacts.

Rather than be on the ridgeline and have its inherent drainage issues, this trail is staying below the ridgeline to: A) screen the trail from others, or there could be another trail just on the other side of the ridge and screening the trail deters short-cutting; B) reduce sound impacts on the other side of the ridge; and C) tantalize the rider by denying the view, keeping the trail in the trees for interest, and then popping out on the ridgetop by the equipment for a WOW view.



Natural features like roots and rocks can act like waterbars to help drain the trail. Utilize these when options for grade reversals are limited. To preserve these, a light hand is necessary during construction and maintenance, so the designer must note these sections in the trail log or these subtle opportunities could be lost.

Utilize shapes, colors, textures, and lines to enhance the viewshed and interest of the rider. This picture is beautifully framed with rocks and trees in the foreground against a panoramic background. Was this an accident, or did an astute designer locate the trail to direct the riders' eyes at this feature?

What is different here is the three trees. The objectives for the designer were to maximize the experience of the rocks and emphasize the subliminal view of the three trees. Cows can produce decent single track trails. The two blue lines are cow trails that take good lines through the rocks and over to the ridgeline. The designer could have followed either one of those and they wouldn't have been "wrong" options. They just wouldn't have met the objectives as well.

The other feature that is different is the patch of low-growing juniper (arrow). The designer stayed low and close to the rocks to maximize that experience, popped out onto the ridge to treat the rider to a WOW view, and then turned to direct the riders' eyes at the trees before continuing on to the top of the rock feature. There is another trail just over the crest of the ridge, so the designer kept the trail below the ridgeline (yellow line) to hide this trail from the other while directing the riders' eyes up to the top of the next rock feature on the left.

Layout and Design Fundamentals

Here are eight tips to create a great trail.

Avoid monotonous scenarios like this. Once the riders have absorbed the initial view, they will roll on the throttle to get through this as fast as they can so they can maybe see or ride something different.

1. Speed is an issue. Reduce speeds to:
- Increase seat time.
- Decrease tread impacts, displacement, and maintenance costs.
- In many soils, tangents equal speed equals moguls. Moguls decrease the rider experience and increase the potential for braiding and widening. Reducing speed reduces moguls.
- Potentially increase rider safety and decrease agency risk.
- Enhance the fun factor.

How to achieve those benefits:
- Limit the riders' sightline. If riders can't see far, they will reduce their speed.
- Keep the horizontal alignment tight and curvilinear.
- Roll the vertical alignment.
- Tighten the clearing limits.
- Minimize the use of roads.
- Avoid one-way trails.
- Provide obstacles and challenge features to the extent the TMO will allow.

Tip, Trick or Trap?

Tip: If riders find what they want on a track they won't look for it off the trail.

2. **Topography is a friend.** Head for the hills and avoid flat ground. Use topography for:
- Increased opportunity to effectively drain water by rolling the grades, which reduces the size of the tread watersheds.
- Less potential for damage due to severe weather events.
- Reduced potential for trail braiding and widening.
- Reduced potential for off-trail use.
- Generally more opportunities to reduce speed.
- Generally more opportunities to provide challenge.
- Enhanced rider experience.

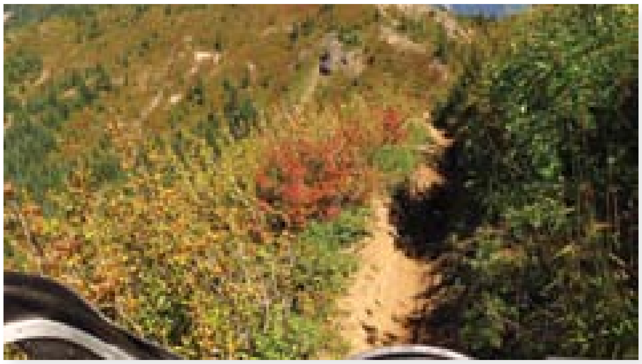
It is difficult to manage and drain water on flat ground. In spite of the flat trail grade, there is enough water volume and velocity to cause severe damage. This trail should have been located on either slope above the flat ground.

How to achieve those benefits:
- Seek whatever slope is available, preferably between 15 and 45 percent.
- Don't be afraid of steeper slopes. Steeper is almost always better than flatter.
- Most roads provide a flat surface and therefore have the disadvantages of flat ground. Minimize the use of roads.

3. **Vegetation is good.** Vegetation allows:
- More water absorption and lower overland flow, which results in less water entering the trail prism.
- Reduced splash erosion.

The benefits of dense, woody vegetation include:
- Decreased opportunity for tread widening or braiding.
- Increased opportunities for a tight curvilinear alignment, which decreases speed and increases seat time.
- Decreased opportunity to shortcut and straighten the alignment, thus a decreased opportunity for speed.
- Decreased opportunity for off-trail use, which results in better management.

- Generally, a decreased visual intrusion on the landscape due to more opportunities to hide the trail with vegetation.
- Increased rider experience.



If this isn't a great trail, it's certainly a great day. This vegetation is perfect to confine the riders, provide a great view, and leg-slappers make them feel like they are pioneering a trail. Vegetation can be trees, brush, or even tall grasses and sedges.

How to achieve those benefits:
- Taking the easiest path to walk or ride may not be the best location for the trail.
- Generally, locate the trail in the tallest and thickest vegetation available.
- Occasionally, pop out into more open vegetation to provide variety and viewpoint opportunities, then dash back in to the thicker vegetation.
- Keep the trail as narrow as possible and avoid the use of roads.

4. **Water is an issue.** Manage water to:
- Reduce volume and velocity of water, which reduces potential erosion and sedimentation.
- Reduce braiding and widening due to saturated trail treads or ponding.
- Reduce ruts and rills in the trail tread.
- Slow degradation of the trail tread, which results in less maintenance.
- Increase rider experience.
- Potentially increase rider safety.

In locating a trail, the designer must look for all contributing sources of water and design to mitigate them. Located in the bottom of a normally dry draw, snow melt is entering this trail prism and has nowhere else to go but down the trail. Water is also coming down the steeper trail grade on the right. This was an error in design. If the water ran longer or if the grade was steeper in the draw, this trail would not be sustainable.

How to achieve those benefits:
- Avoid flat ground.
- Avoid the fall line.
- Reduce the size of the tread watershed by rolling the grades and reducing tread width.
- Add drainage structures if grade reversals cannot be provided.
- Reduce the trail grade and make grade pitches shorter.
- Minimize the use of roads.
- Utilize soil stabilization and trail hardening techniques.

5. **Create a recreation experience, not a transportation experience.** Benefits of a quality recreation experience include:
- Provides for the riders' needs.
- Reduces speed and increases seat time and recreation activity time.
- Increases the fun factor.
- Increases compliance with rules and regulations.
- Increases ownership and stewardship of the trail by the riders. This will help protect and maintain the trail through volunteerism.
- Facilitates OHV management because riders want to stay on the trails.
- Potentially reduces resource impacts.

How to achieve those benefits:
- Unless providing a touring or destination experience, minimize the use of roads or creatively convert them to trails.
- Play with the landscape and the rider experience.
- Designers should ride the trail in their minds as they are laying it out. If they aren't enjoying it, the riders won't either.

- Provide variety and creatively utilize the landscape.

6. **Avoid Point A to Point B location.** Avoiding the straight line will:
- Keep the riders engaged. Constantly changes the riders' viewshed and creates variety and intrigue.
- Allow the trail to flow and blend with the landscape, which enhances the rider experience as well as the aesthetics of the trail.
- Decrease the size of the tread watershed and thus increase sustainability and decrease potential resource impacts.
- Decrease speed, which increases seat time and decreases tread impacts.

This road was 18' wide and a designated 4WD "trail." It was a transportation route that was converted for recreation use, but it had no recreational value. But then, a creative manager filled half the road with boulders of increasing size. The result? Outstanding! Now rigs can dive off into the rocks if they want to or stay in the now narrow trail and watch their buddies try not to break something. Seat time was dramatically increased as was the rider experience.

How to achieve those benefits:
- Unless it is absolutely necessary to hit control points, do not use the Point A to Point B approach in trail location. Avoid running grade lines.
- Exception: the trail to the restroom should be straight.
- Play with whatever the landscape has to offer.
- Do not be goal-oriented. The goal is to get there, but not necessarily quickly.
- Provide flowmentum. OHVs have motors and riders like to use them. Keep the trail flowing up and down and side to side.
- Avoid the fall line and generally avoid ridgetop trails.
- Minimize the use of roads.

Grade lines do not harmonize with the landscape.

7. **Head for the rocks.** Rocks can:
- Offer visual and riding diversity, which can enhance the rider experience and fun factor.
- Increase opportunities for challenge.
- Satisfy human nature to get to the high points since the high points are often rock outcrops.
- Provide an increased opportunity for dramatic viewpoints.
- Provide a durable and sustainable trail tread.
- Soils with high rock content can resist the forces of compaction and displacement.

How to achieve those benefits:
- Do a thorough reconnaissance of the area. While some rock outcrops are obvious on aerial photos or maps, others can be in unlikely places or hidden in the trees.
- Whenever possible, seek rocky soils rather than sandy or silty soils.

It was a surprise to find this neat rock feature hidden in the foliage. In dense vegetation like this, it can be difficult to find interest features and variety for the rider. Seeking people familiar with an area can help.

8. **Manage the riders' eyes.** Controlling the riders' eyes helps:
- Enhance rider experience by providing intrigue and visual diversity.
- Frame the landscape for the riders to focus on the big WOW and little wow.
- Potentially increase control of the riders and decrease resource impacts.

How to achieve those benefits:
- Keep the trail moving horizontally and vertically to avoid long views of the same scene.
- Designers should focus the riders' eyes on where they want the riders to go and what they want the riders to see, not where or what the designers don't want the riders to go or see.
- Creatively utilize the physical and human elements in the landscape.

If the intent is to keep riders out of this corridor, why focus the riders' eyes right at it? Why not put the sign in the middle of the corridor where the riders' eyes will readily see it? Why not fall some trees to help disguise the corridor?

Special Design Situations

Road Crossings. One place with potential risk is a road crossing. Roads can be low standard with low traffic volume and speed or high standard with high traffic volume and speed, but the trail crossing design is the same for both.

When designing road crossings:
- Verify if the road authority requires a permit or approval of the site and crossing plans.
- Locate the crossing on a tangent, not a curve.
- Make the tangent long enough to provide adequate sight distance for the speed of the traffic on the road.
- Place the crossing at or close to 90 degrees to the road.
- Keep the trail grade at the crossing as flat as possible so OHVs can stop and start easily without impacting the trail, road fill slope, or road shoulder. If there is a steep uphill, like riding up the road fill slope, riders will increase their speed to get up the hill. This will carry them into the road without the ability to see traffic or stop. If there is a steep downhill, riders could find themselves sliding into the roadway.
- Construct a level area if the grade is not flat. It must be excavated or filled to a sufficient size for the vehicle to come to a complete stop before entering the road shoulder.
- Install signing as per the guidelines for the road standard in the project's management plan or sign plan. If Stop or Yield signs are used, Stop Ahead or Yield Ahead signs must also be installed.
- Harden approaches to paved road crossings, providing a paved apron, to protect the road shoulder from damage.

Putting rock on this approach does nothing except make it easier to spin tires. The post (arrow) is for a Yield sign, but there is no flat area to stop a vehicle and get started again. The result will be damage to the road shoulder and an unhappy stakeholder.

This paved road approach is flat and has plenty of room for OHVs to stop and look before crossing. But even with a flat approach, the road shoulder has been damaged. A paved apron one vehicle length long would prevent this.

Creek Crossings. Many areas do not allow for tire and water contact or it may be allowed in only intermittent or non-fish-bearing streams. Check the classification of the stream and follow the crossing guidance in the management plan or other environmental document.

Here are some things to keep in mind for creek crossing:

- A permit may be required to approve the site or operate equipment near or in the creek; or there may be restrictions for the time of year that activity can occur.
- Crossings should be on creek tangents, not on curves. Tangents will have the flattest approaches and most level creek bed. Curves can have holes in the creek bed and scour on the outside bank.
- Crossings should be as close to 90 degrees as possible. This minimizes potential impacts to the creek and adjacent riparian zones.
- Trail approaches should be as flat as possible to minimize sediment delivery to the creek.
- Drain water off the trail before entering the creek.

This approach has been built up with fill (arrow) so there is a level platform to stop, look, and start. Note the Yield sign. This is a functional and professional looking road crossing. It costs more, but public safety is worth the cost.

Pavers must be properly bedded and anchored or they will fail. Note the creekbed littered with pavers. There should be one approach to the creek, not three. A ford constructed of concrete planks cabled together would have worked better.

This crossing has relatively flat approaches, but large boulders at the approach and in the creek could cause potential impacts.

Flat water and a gravelly creek make this a better crossing, but it's longer than it needs to be because it is not perpendicular to the creek.

Bridge Sites. Bridge sites need to be carefully selected and properly engineered. If at all possible, avoid having a bridge site down in a canyon where the only access is by having steep trail grades that lead directly down to the bridge, which can deliver sediment directly into the creek.

This is an excellent bridge approach. Raising the trail grade to the bridge forces water off the trail and helps prevent dirt and rock deposits on the bridge deck. Water drained off the trail has plenty of natural vegetation to flow through before entering the stream. This will slow the velocity and filter out sediment.

For bridge sites:

- Ensure that there is sustainable trail access to the bridge site.
- Trail approaches should be as flat as possible.
- Bridge approaches should be elevated (but not steep) so water can drain off before the bridge and debris can't be carried onto the bridge.
- If the approaches can't be raised, design the trail to drain water off before crossing the bridge and harden the approaches.

This bridge is in the bottom of a grade sag so water and sediment collect and drain in the middle of the bridge. When this creek is flowing, sediment will be delivered directly into the water. If this was a perennial, fish-bearing stream, this bridge site would not be acceptable.

This is a common, but poor bridge approach. This long grade has no drain. All of the water and sediment will be deposited directly into the creek. Vehicles trying to brake going down or accelerate going up will churn up more soil that will also end up in the creek. Old roads are often used for bridge access because they are existing and provide a means to get equipment and materials into the bridge site. This is okay, but using the road as a trail afterward isn't. A properly designed trail should be located and constructed and the old road closed.

The trail turns and dives down to the bridge at a steep non-sustainable grade. Look at the amount of sediment (arrow) that is getting ready to be flushed down to the bridge.

Ridges. It is human nature to want to get to the top, and a ridge trail is often at the top or leading riders to it. Ridges can offer dramatic views, wind-blown character trees, unusual rock formations, and almost always a change in topography and vegetation. All of these are good, desirable features; however, the goal for the trail designers is to arrange these in a series of big WOWs and little wows that treats and enhances the rider experience. Ridgetop trails can be undesirable because they often: follow the fall line, can be difficult to drain, do not provide enough riding diversity, do not vary the viewshed of the riders, do not frame the unique features for the riders, and divide rather than harmonize with the landscape.

Ridges provide a change in topography, vegetation, and viewshed. This trail may be heading toward the rock knob for a great view and some rocky terrain. Water coming down the fall line will drain off at the first rise (arrows). The trail will drop below the ridge to drain before going up to the ridge again.

This fall line trail becomes an edge which bisects the landscape. Considerable amounts of water will drain from both sides into the saddle. The lower grade is too long and a rolling dip should be constructed at the arrow. The upper grade, though fun is too steep. Notice how it is widening out, probably from riders avoiding ruts or exposed rocks.

Most ridgelines have game or livestock trails on them, so the easy path for the trail locators is to follow them. This is a trap. A better alternative is to wind a serpentine trail up the ridgeline, crossing from one side to the other. This creates positive drainage, varies the landscape for the riders, improves the aesthetics of the trail, and can create some dramatic views and scenic diversity.

Saddles are low points in ridgelines and as such they are natural targets for trail locators to cross over a ridgeline. However, they can drain water from both directions and any trail passing through the saddle can intercept this water. The designers must carefully assess the drainage patterns in a saddle and design the trail with drain points on each side of the saddle.

Meadows. Everyone enjoys looking at a meadow. Meadows offer vegetative diversity and beauty, often a chance to see wildlife, and usually a chance for a great panoramic view. As in a ridgetop trail, why put the trail through a meadow and divide, rather than harmonize with, the landscape? If possible, it is better to locate the trail in the trees, give the riders brief glimpses of the meadow to tantalize them into wondering what a full view would be like, pop them out to the edge while directing their eyes at the meadow and a WOW view, and then take them back into the trees again for variety before treating them once again to a view of the meadow. Designers should play with the riders' eyes and the rider experience to create a great trail.

This is a great trail. The trail comes close to the meadow without going through it. The riders are treated to beautiful views of the meadow framed by the aspen.

Here are some points about meadows:

- Meadows often provide photo opportunities; avoid placing the trail in the middle of the shot.
- Meadows can be sensitive ecosystems; minimize the fragmentation of that ecosystem.
- Meadows are often wetter environments, so trails located there could have water management and durability issues. The trees usually provide a drier environment.
- Crossing a meadow higher on the slope can be better than crossing lower where it is often wetter.
- Large meadows can be hard to avoid entirely, so the goal is to minimize intrusion into the meadow.
- It is better aesthetically and from a drainage standpoint to cross a meadow laterally on the contour rather than vertically down the slope.
- Indiscriminate off-trail use can severely impact a meadow. To help prevent this, it is essential that the riders' eyes be kept moving and that the fun factor be kept high. The trail needs to be more efficient (desirable to ride) than the meadow.

Climbing Turns. If the side slope is less than 25 percent and there is room for a curve radius of more than 8 feet, locating a climbing turn is almost always a better alternative than a switchback. Why? Climbing turns maintain flow-mentum, are easier to ride by most riders, and have less tread impacts and resulting maintenance.

This well-designed set of climbing turns harmonizes with the landscape and provides great flow and fun factor. Note the drain points (blue arrows). The cow trail (yellow arrow) probably went to the same point on the ridge, but the designer was smart not to follow it.

Considerations for climbing turns:

- By their nature, the middle of the arc on a climbing turn will be on the fall line and will pick up water. To mitigate this, it is essential that water be drained off the trail before the top of the turn and immediately after the bottom of the turn. Use grade reversals (preferred) or rolling dips.
- On steeper side slopes, sometimes a large rock outcrop, bench, or the uprooted stump of a large tree can provide a flatter area for a climbing turn.
- It is essential that climbing turns have a smooth and constant radius. Some inexperienced equipment operators will tend to square them off by making a sharp turn at the bottom, go straight up the hill, and make another sharp turn at the top. This defeats the purpose of a climbing turn.
- Vehicles with locked or solid axles can negatively impact tight climbing turns. Minimize this by making the radius as large as possible (35 feet minimum would be desirable).

Tip, Trick or Trap?

Tip: Many people do not know how to ride switchbacks and that's why they don't like them and why they are such high maintenance. If you have the topography at the trailhead, consider constructing a training switchback as part of the learner loop or youth training area.

Switchbacks. In terrain steeper than 35 percent or rocky, gnarly terrain that won't accommodate a climbing turn, a switchback becomes a necessity. Switchbacks have a radius of less than 8 feet and they can be very challenging to ride if they are not designed and constructed properly.

Some designers install switchbacks even when they could use a climbing turn, just to increase difficulty. A switchback is not a challenge feature and should not be used as such. It is a trail structure that is necessary to change direction and gain elevation. Switchbacks can be expensive to construct and even more expensive to maintain, especially if they are poorly designed. Most riders don't like them because they are difficult to ride and this can create severe tread impacts. Using them as a challenge feature only exacerbates the impacts and the maintenance costs.

Here are some thoughts on switchbacks:

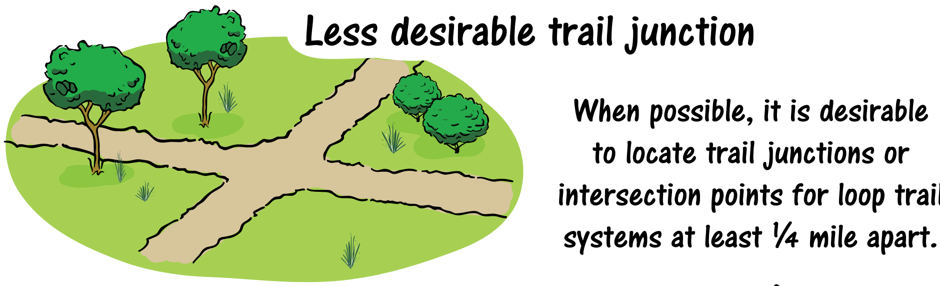
- A switchback consists of three parts: a lower approach, landing or turning platform, and upper approach.
- Like climbing turns, it is essential that switchbacks have a constant radius. Most do not and that is why they are difficult to ride.
- As in climbing turns, it is important that the trail is drained above and below the switchback.
- It is also essential that the radius be as large as possible.
- Many installations will require significant excavation and embankment in order to construct the proper radius and have a flat landing. Due to steep topography, retaining walls will often be required on the cut or fill side and this will increase the cost and complexity of the installation.
- The flatter the grade through the landing, the more rideable it will be, but it also increases the amount of excavation and embankment. Not flattening the grade through the landing will result in a highly displaced and eroded gully.
- During initial construction, the tendency is to minimize the excavation, embankment, and retaining structures. Don't do this. It can result in an unstable structure that is difficult to ride and requires high maintenance or repeated reconstruction.

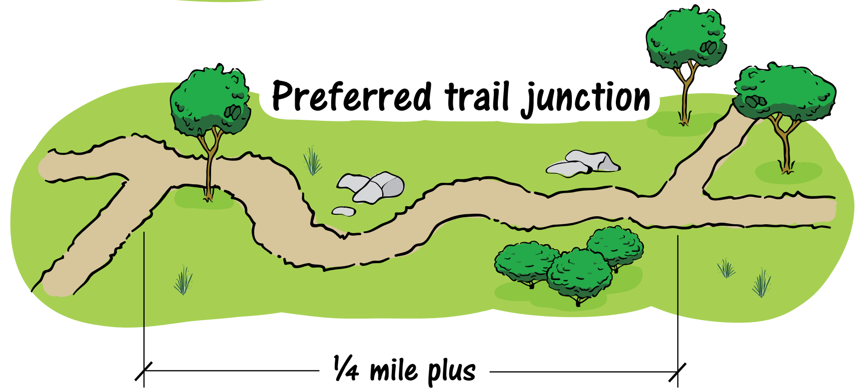
A nicely-designed switchback. Notice how the grade of the upper approach flattens off before the landing. This adds significantly to the rideability of the structure. The landing is long and wide to allow room for a smooth turn on a circular curve.

This switchback has almost no landing, no flattened approaches and is not easy to ride because it consists of two 90 degree turns rather than one circular curve. Obviously, the geography here limited options and that's the real world. This is also a most difficult trail, so the switchback is consistent with the TMO.

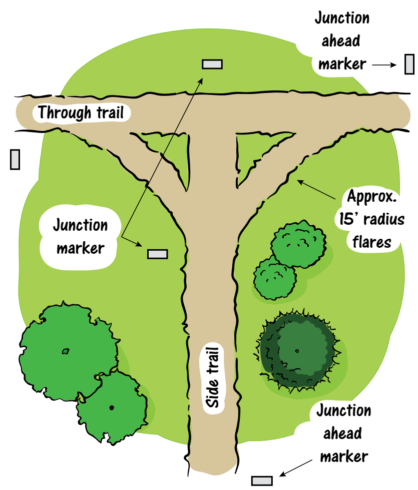
This structure has a nice circular curve, but no flattened approaches. Note the drain above and there's one below also which is good. It may have been better for drainage and rideability to use the top of the exposed rock as a flat area for the lower approach and part of the landing.

Trail Junctions. A well-planned trail system should have multiple loops, so well-designed trail junctions are required to access those loops. Trail junctions serve as decision points that help disperse the riders and enhance their experience by providing variety.

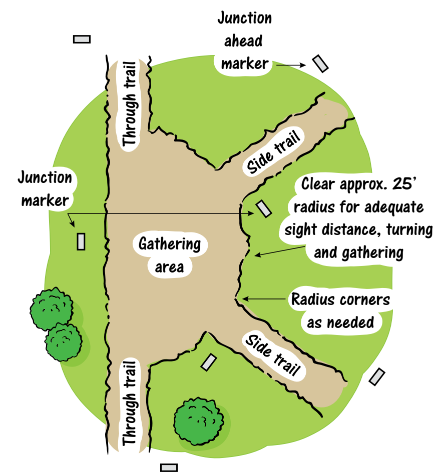




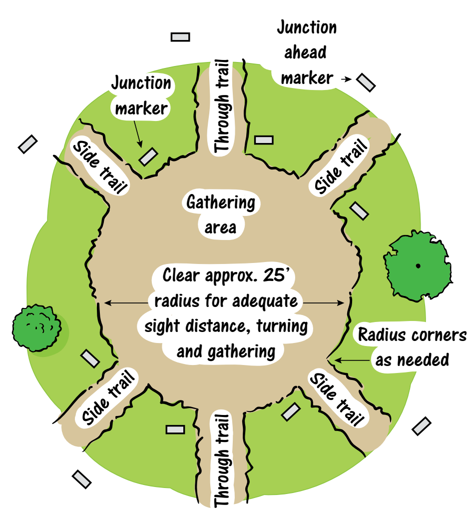
Typical T-junction



Typical half hub junction



Typical hub junction



Things to keep in mind for trail junctions:

- Since junctions disperse the riders, on high-use trail systems it is beneficial to have several junctions in the vicinity of the trailhead to provide quick dispersal.
- Junctions are places where there can be high tread impacts from stopping, starting, and turning; therefore, trail junctions should be located on flat areas where grades can be kept to a minimum.
- An adjoining trail can dump a considerable amount of water onto the trunk trail. Each trail leg should have a drain prior to the junction.
- Junctions can be sources of congestion as riders stop to look at the map or wait for their companions. Depending on the expected volume of traffic, the trail width should be increased to allow riders to park off to the side and still allow room for other riders to safely pass through.
- Mitigate congestion at intersections. Provide as much advance sight distance as possible, use a dog-leg or tighten the alignment to reduce speed, and install warning signs or decals as per the sign plan.
- Some riders may ride by a junction, decide that is where they wanted to turn, and then make a U-turn. Expect off-trail impacts in the vicinity of junctions, so avoid locating them in proximity to sensitive resources. Barriers may be required to control and direct use.
- For increased safety, T-junctions are preferred over 4-way junctions.
- To avoid constant starting and stopping, junctions should be spaced as far apart as possible; a quarter mile is desirable.
- In dense trail systems like OHV parks, consider grouping junctions together into hubs to reduce the number of junctions.

• Because they are flat, saddles make a tempting location for junctions; however, saddles are natural drain points for the fall line and since water can drain into them from both directions, they can collect a considerable amount of water. Design to drain off this water or locate the junction on the slope slightly above the saddle.

This is a T junction and the through trail (left and right) is in a draw bottom. Though the grade on the joining trail is not steep, look at the amount of water and sediment that has been deposited. Obviously, the water is running too long without a drain. Flatter ground and grades can trick a designer into thinking that water and erosion won't be an issue. Management direction was to use as many existing trails as possible and minimize new construction. That was a mistake. The through trail should have been relocated out of the draw bottom to join the other trail closer to the top of the break in the topography.

One half of a hub junction where five trails join a through trail. An OHM rider has seven choices. The trails on the left and right are OHM (note the width restrictors) and the trail in the middle is ATV.

There isn't much left of this trail which joins another trail on the ridgetop in the saddle. The fall lines on the ridge are steep, so the water has volume and velocity and thus erosion. Saddles can be a trap for unwary designers.

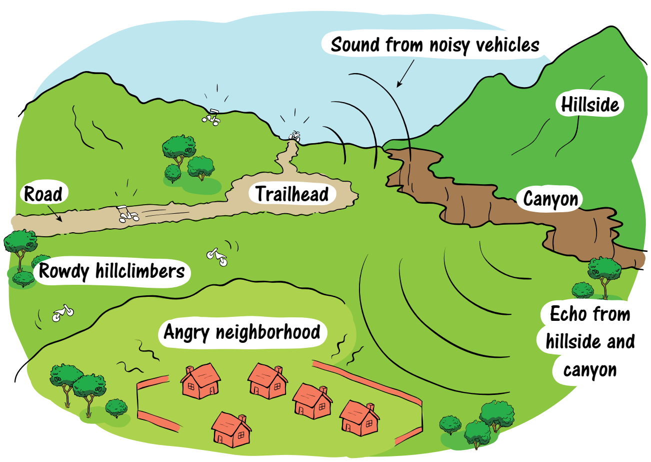
Sound Intrusion to Residents. Sound is produced by physical vibration that creates audible waves of pressure. Design can mitigate sound. Unwanted sound perceived as noise produces a negative psychological reaction. It cannot be mitigated outside of sound mitigations.

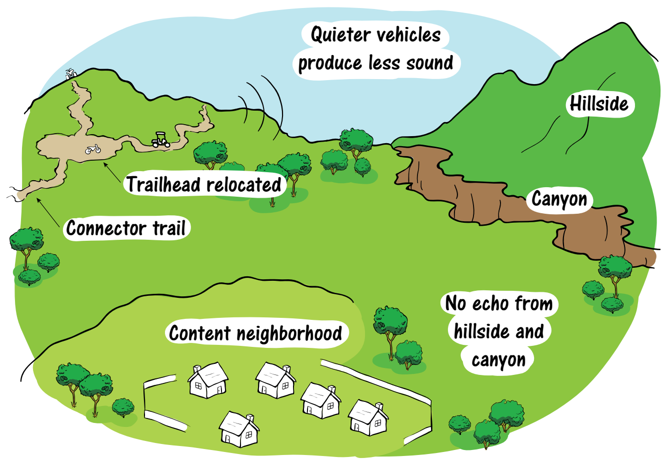
With residences ahead, sound has more chance to be buffered by vegetation and topography down on the flat than up on the side of the slope.

Mitigate sound by:

• Restricting vehicle sound emissions to a maximum of 96 dBA using test procedures established by the Society of Automotive Engineers under Standard J1287. Sound doubles for every three decibels; therefore, an OHM at 96 dBA is half as loud as one at 99 dBA.
• Designing for slow speeds in the vicinity of noise sensitive property (NSP) by using tight, curvilinear alignment and flat grades. Avoid trailheads, play areas, and hillclimbs around NSP.

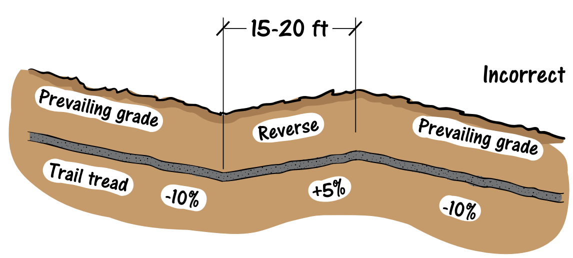
• Putting sound source a farther distance from NSPs. The amplitude (or intensity) of the sound wave decreases with distance.
• Placing berm of earth, a ridge, or dense standing vegetation between the sound source and the NSP can help block or reduce sound waves.
• Designing for the shape of the topography. Some areas can act like a megaphone to amplify the sound. Avoid placing high sound-producing activity in the bottom of a draw high up on the slope or near a body of water that has NSP.
• Placing running trails parallel to NSP to keep from directing or funneling sound into those areas.

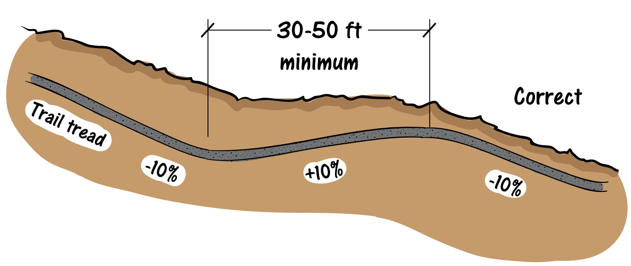




Grade Reversals. Grade reversals provide positive drainage, low maintenance, and are the most effective way to reduce tread watershed size. As such, they are the primary tool available for the designers to manage water. Many people refer to a rolling dip as a grade reversal. Technically it is, but a grade reversal is a drainage feature designed into a trail during location and a rolling dip is a constructed drainage structure that is added to a trail.

Here are some key points about grade reversals:
• To be effective, the grade must reverse, not just flatten.
• The height of the grade reversal must be sufficient to remain effective after the tread is cut in during construction and after the lowering effects of compaction and displacement. Making a grade reversal too small is a common mistake for trail designers.
• If at all possible on a new trail, design in grade reversals and avoid using rolling dips.
• Whenever possible, use the alignment to help turn the water in the desired direction. A curve to the right will help water turn to the right.





A grade reversal will not fail and does not have the maintenance of a rolling dip. Note: On a sideslope like this, water will puddle up on the inside of the curve (arrow). This can be an issue in wetter climates where the water will sit and saturate the soil. Depending on the topography, it can sometimes be avoided by having 25-50' of 0% grade before reversing the grade. When outsloped, this flat area provides an opportunity for the water to drain off the trail.

- Make the length of the reversal as long as possible. A good minimum is 30 to 50 feet.
- Use the terrain to create grade reversals. Roll into and out of natural draws and depressions.

To harmonize with the landscape, drain the trail at all natural drainage points. In arid regions, do not design a shallow fill across a draw like this or runoff from a weather event like a thunderstorm will wash it out. Likewise, avoid designing a deeper fill with a culvert unless the culvert is adequately sized for significant weather events and the inlet is heavily armored.

Turnouts. There are many benefits to two-way trails, but with steep topography or dense vegetation, opportunities to pass other riders can be limited. In addition, when riders try to squeeze by, weight on the outside of the trail can damage the trail shoulder making the trail narrower and potentially unstable. This can be remedied by designing in turnouts. As in roads, turnouts offer a place of refuge from an oncoming rider or a safe place out of the lane of traffic to rest, look at the map, or take photos. Turnouts are usually placed at the outside of horizontal curves, the crest of vertical curves, in thick vegetation with limited sight distance, or on very steep ground where riders don't want to back up. Spacing between turnouts depends on traffic speed, volume, and the physical conditions of the site.

Here are some considerations regarding turnouts:
- The width should be adequate to allow safe passage by two of the widest vehicles allowed on the trail.
- The length should be sufficient to accommodate one of the largest vehicles allowed on the trail to move in and out of the turnout.
- Turnout tapers should allow for safe and smooth ingress and egress from the turnout.
- Turnouts are a place of refuge, not risk. They should be cleared of all stumps and trees that could interfere with riders seeking quick refuge.
- Riders need to be able to clearly see the traffic on the trail to safely pull out of a turnout.
- On very steep ground and with unstable soils, a retaining wall may be required to support the turnout.
- To maintain flow and increase rider safety, turnouts should be designed as ride through, not ride in and back out.

Manage your risk. A rider accelerating to get up the hill on the right cannot see this stump that was left in the middle of the turnout. This is an accident waiting to happen. Turnouts are a place of refuge, not risk.

The vegetation indicates that this turnout is not used often, but the sideslope below this is steep with limited passing opportunities. Going downhill, a prudent rider would pull in here to let uphill riders pass without losing their momentum.

On steep ground like this, a retaining wall would be required to build a turnout. Fortunately, the vegetation is open enough to see other riders coming and you learn to look and listen before leap-frogging from one turnout to the next.

The problem with a pull-in, back-out turnout like this is that the riders' eyes are focused forward and the turnout corridor tricks the riders into thinking the trail goes straight, then at the last minute, they realize that the trail turns and they need to also. This situation can affect rider safety and lead to tread impacts.

Troublesome Spots

Sometimes there are management constraints that preclude the desiger from following the recommended guidelines. When this situation occurs, designers and planners should check the environmental document and talk to the manager. The intent of the plan document can often give designers more latitude than they may think. Depending on the political climate and the comfort level of the manager, a quick resource survey and letter for the file may be all that is needed to relocate a troublesome trail. The tips below will help mitigate the issues if the trail must go in a less than ideal situation.

The Fall Line. What if I have to be on the fall line?

- The important thing is to recognize that the trail will be picking up water and design to get rid of it as soon as possible.
- Drain the trail before hitting the fall line and immediately after leaving the fall line.
- Minimize the length and grade of the trail on the fall line.
- Avoid overbuilding a fall line trail. Leave rocks and roots that can help divert water off the trail or at least slow its velocity.
- Install rolling dips or belted waterbars if possible. Belted waterbars must have barriers installed to force the riders over the waterbar. The barrier should be big enough to deter use and be installed in a herringbone pattern to help drain water off to the side. If the grade is steep, a rolling dip or waterbar will interrupt flowmentum and may cause additional tread impacts.
- Install filters as part of entrance management to restrict use and impacts from unskilled riders.
- Accept the fact that impacts will occur and budget for increased frequency and cost of maintenance.

A technique similar to this can direct riders over belted waterbars. In open country, the barriers need to be long enough so it is more efficient to ride over the waterbar than around it.

This primitive road feels like a trail and provides a quality recreation experience as it meanders into the remote backcountry. The rolling topography provides some challenge, a mix of riding experiences, great views, and a lot of seat time.

Wider vehicles need wider trails and roads can at least partially fill that need. However, it's important to recognize that the operators of these vehicles are still looking for the same range of experiences as narrower vehicles, from touring to technical. Depending entirely on roads may not provide the desired range of experiences.

Using Natural Surface Roads for 50-Inch Trails. If natural surface (NS) roads can be converted to trails, take advantage of the opportunity. There are pitfalls of using NS roads, but the reality is that NS roads are going to be used as trails, so the key is to minimize the pitfalls (tread watershed) and maximize the experience. The experience that the NS road provides depends on two factors: the standard of the NS road and the setting that the NS road is in. The road standard is determined by factors like speed (high versus low), alignment (straight versus serpentine), and surface type (gravel or native).

This NS road provides more of a transportation experience. Being wide and straight, it is relatively boring.

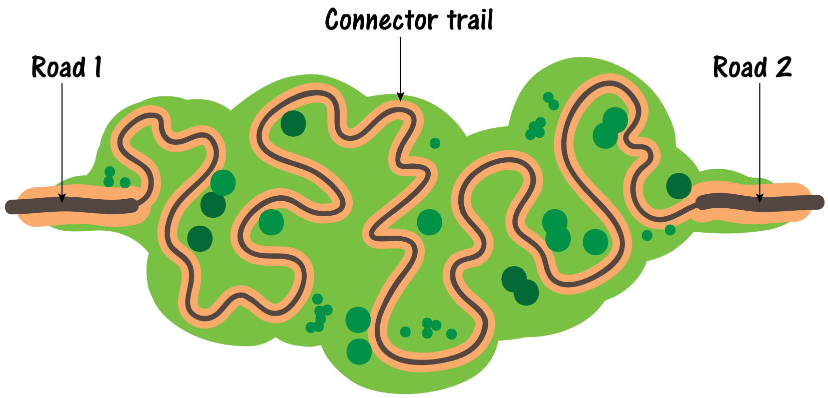
The setting is what is around the NS road. What is there for the riders to see and do the riders want to see it? Are their eyes confined to a corridor or are they open to a panorama? Is there scenic diversity? A high standard road tends to provide a transportation experience while a low standard road tends to provide a recreation or trail experience. However, a high standard road in a highly scenic setting can easily transform the experience from transportation to a quality recreation experience.

Right and above, both of these higher-standard roads provide scenic quality and diversity that creates a quality recreation experience. Rather than roll on the throttle, one is inclined to stop, say Wow, and snap photos.

Here are some thoughts regarding using natural surface roads for trails:

- If given a choice, select the natural surface roads that provide the best recreation experience. These are generally:
  - roads with lower traffic volume and speed;
  - a rougher, more primitive road;
  - a road with vertical roll (grade reversals) to reduce the size of the tread watershed;
  - a narrower road (this also reduces the size of the tread watershed);
  - a curvilinear road; and
  - roads that access viewpoints or destinations or offer a chance to see wildlife.
- Existing culverts and ditch lines need to be functional.
- Rolling dips may need to be added for drainage to reduce the tread watershed.
- Decreasing road width minimizes the size of the tread watershed.
- Utilize variety. Mixing up the road standards, scenic views, and riding experiences is a key to quality.

Connect One Natural Surface Road to Another. This is a common scenario. The connector will often be the only chance to provide a high-quality trail experience. Seize the opportunity to maximize that experience. If there is only a quarter mile between the two natural surface roads, try to squeeze in one-half to three-fourth mile of fun trail.



Using Flat Ground. Flat ground is not a sustainable trail location. However, sometimes it is required or desirable to use it.

When placing a trail on flat ground:

- Drain water off the trail before reaching the flat ground.
- Minimize the amount of trail on flat ground if possible.
- Design with sinuosity and avoid tangents. This will help decrease water velocity and increase chances to drain water off the trail.
- Incorporate structures like sumps, lead-off ditches, puncheon, and turnpike or use trail hardening techniques where necessary. Ensure that excavation from sumps and lead-off ditches is used to raise the grade of the trail bed.
- Perform regular assessments and address problem indicators before they become issues.
- Avoid falling into the trap of assuming there won't be erosion because the ground and grades are flat.

Recognize issues before they become problems. It is cheaper and more efficient to be proactive than reactive. By waiting to relocate the trail until a bypass trail develops, this fix now includes additional costs for closure, rehab, signing, and possibly barriers.

Inability to Relocate the Existing Trail. If a trail can't be relocated:

- Utilize structures and trail hardening techniques as necessary to stabilize and drain the trail. Rolling dips and belted waterbars may not be ideal, but they can work if they are installed and maintained properly.
- If trail is not in conformance with the TMO (especially in regard to difficulty), change the TMO, then ensure that the signing and mapping agree with the new TMO.

- Install a filter as part of the entrance management to ensure that only technically capable riders can access the trail.
- Accept the fact that impacts will occur and budget for increased frequency and cost of maintenance.
- If impacts to sensitive resources are occurring and there is no way to mitigate those impacts, an option is to close the trail. Use this as a last resort only.

Properly designed filters can reduce use levels and impacts caused by unskilled riders.

Some More Tips

Watch for the Red Flags. The need for multiple structures and trail hardening installations can be a red flag indicator of a poor location due to poor soils, wet ground, or unstable ground. Perhaps the trail shouldn't be there. Are there other options? If not, then plan for an increased maintenance budget.

In soils with a crust, water drains off in sheets or multiple rills until the crust is saturated. The best way to cross a slope like this is with a 0% grade so water can flow across the trail. With any other grade, the designer must recognize that the trail will intercept and carry this water and locate frequent grade reversals or drains.

Water, Water, and More Water. It can't be emphasized enough. Managing water is a primary key to a sustainable trail. The designers must look for all water sources entering the trail bed. The more water that comes onto the trail, the more often the designers must design ways to get it off the trail.

Too Steep, Too Long. The most common causes of trail rutting and erosion is from the grade being too steep, or the grade being too long without a drain or grade reversal. Or worse yet, the grade is both too steep and too long. The combination of the two is hard to mitigate. The steeper the trail grade is, the closer it becomes to a fall line trail with all of its inherent issues. How steep is too steep and how long is too long? There are many variables: soil type, climate, storm patterns, tread watershed size, use type, and use level, to name just a few.

Is It a Good Line? Since design is about making decisions, one of the best tests of a line is to walk it again after a couple of days. Designers should ask themselves the same critical questions: should I be here or there? If the answers are the same, they probably have the trail in the right location.

If possible during construction, designers should physically ride the trail. If something isn't right, they can fix it while the equipment is still there. If the designers can't ride the trail until after construction, they should acknowledge the fact that there is no such thing as a perfect trail. The important thing is that if a designer has made a mistake, the mistake should be corrected if possible and not made again elsewhere.

Is It a Fix or a Solution? Is adding a rolling dip or throwing pavers on a grade that is too long and too steep a fix or a solution? The problem is that the tread watershed is too large and the problem is still there even if mitigated with a dip or pavers. There is an installation cost, a regular maintenance cost, and a repair cost due to a significant weather event or poor installation. Too often, managers choose a bandage fix over the solution of relocating the trail. Putting the trail where it ought to be improves resource protection, enhances rider experience, and can cost the program less money in the long term.

Adding trail hardening to a long, straight, fall line trail. Is it a fix or a solution?

Take a Trip. Good designers learn from their experiences. They should visit or ride other trail systems so they can ride good trails and bad trails. They should assess what made the bad trails bad and avoid those scenarios in their design. Likewise, they should assess what made the good trails good and incorporate those scenarios. Better yet, they should embellish those good points to make a good trail great.

Design for the Riders' Eyes. Designing for the riders' eyes means putting the trail where the riders think it will be. If the trail does something unexpected, it can be difficult for the riders, which can lead to resource impacts and risk. That is why the designers must understand the vehicles and the rider experience. When locating a trail, designers should ride the trail in their mind as they are laying it out. Does it flow? Does it feel right? What is the TMO for the trail?

Some riders like the challenge of difficult situations. However, in some situations, such as in soft soils, challenge can increase maintenance costs. That may be okay if that is the best way to meet the riders' needs and if it is consistent with the TMO. Design is all about making decisions: what best fits the site parameters.

Above, coming around this curve, the riders' eyes go straight toward the people on the ridge. Instead the trail makes a 90 degree turn and pitches up the ridgetop. Several riders dabbed and others fell as a result of this surprising compound curve. A better location would be the dashed line which follows the riders' eyes plus adds a much needed drainage point. Right, the trail is widening on the left (arrow) as riders are trying to dump speed and correct for the tightening turn. What would happen if there was a tree there instead of dirt and grass?

Get Help. Trail location and design are parts of a very complex process that requires journeyman knowledge and experience in a multitude of disciplines. If team members don't possess that level of knowledge, get help; otherwise either the trail or the resources or both could suffer. The belief that trails are simple and anyone can design one is false, and it shows when the team has to go back and try to fix the mistakes.

A Second Look...

The evolution of trails: Due to the forces of compaction, displacement, and erosion, trails will change over time. With sustainable design, those forces can be slowed and managed, but not stopped. When first constructed, the tread often appears smooth and sanitized and riders often reject them as being unnatural. But in time, rocks and roots will appear, loose rocks will get rolled out of the way, and some of the features that were easy to negotiate become a little harder to negotiate. So the experience and challenge level can change. This is due to a trail settling into the landscape and the effects of thousands of vehicles and hundreds of weather events. Change is not necessarily bad and is often beneficial, but it should be anticipated by the designers and managers and reflected in the TMO, so that after the trail has settled in, the challenge level still falls within the parameters of the TMO. In maintenance, signs get replaced, blowdowns get removed, hazards get addressed, structures get inspected and addressed, and spot tread maintenance occurs, but rarely does the entire tread get maintained. If the condition of the trail after evolution will not be acceptable, then the designers must take steps now to keep the trail in its as-built condition.

A new trail.

The same trail after it has settled in. The tread is firmer and more well-defined, and embedded rocks are starting to get exposed.

A newly constructed rock waterbar with a smooth approach. (Note: these will work if the rocks are large and well-embedded to resist the tire impact forces.)

The same installation after it has settled in. No longer a smooth approach, the rock has become a challenge feature which is okay if that is consistent with the TMO.

Need more? Learn more here...

Alaska Trails Training Modules, Mike Shields, www.alaska-trails.org
Trail Design and Layout
Turns: Design and Layout

Best Maintenance Practices, Maine Motorized Trail Construction and Maintenance Manual, Bureau of Parks & Lands, Off-Road Division, May 2011

Designing Sustainable Off-Highway Vehicle Trails, Kevin G. Meyer, USDA Forest Service, Technology & Development Program, November 2013

Natural Surface Trails by Design, Troy Scott Parker, Natureshape, 2004

Off-Highway Motorcycle & ATV Trails: Guidelines for Design, Construction, Maintenance and User Satisfaction, 2nd Edition, Joe Wernex, American Motorcyclist Association, 1994

Trail Construction and Maintenance Notebook, USDA Forest Service, Technology & Development Program, 0723-2806-MTDC, July 2007

Trail Planning, Design, and Development Guidelines, State of Minnesota, Department of Natural Resources, Trails and Waterways Division, 2007

Trails Management Handbook, USDA Forest Service, FSH 2309.18

A Look Back...

Here are some of the elements discussed in this chapter:

- Trail location and design are about choices and informed decisions.
- The designers provide for the riders' needs, manage the OHV use, and protect the resources.
- The designers must know and understand the issues, politics, resource values and constraints, management constraints, existing conditions, vision, TMO, soils, climate, vegetation, and topography.
- The trail location process includes: know the complete trail picture, use the concept plan, identify termini and control points, break up the elephant into chewable chunks, conduct total reconnaissance, connect the dots, revise the concept plan, develop final TMOs, and prepare a trail log.
- Locators should learn to read the landscape and understand what it is telling them.
- Designers should design the trail to flow and harmonize with the landscape.
- Designers should use whatever the landscape offers to enhance the rider experience.
- Layout and design fundamentals include: speed is an issue, topography and vegetation are good, water is an issue, create a recreation experience rather than a transportation experience, avoid Point A to B location, head for the rocks, and manage the riders' eyes.
- Certain situations need special design techniques: road crossings, creek crossings, bridge sites, ridges, meadows, climbing turns, switchbacks, trail junctions, sound intrusion to residents, grade reversals, and turnouts.
- It's a real world, not an ideal world. There are mitigations available when designers can't do what should be done.
- The need for structures and hardening can be red flag indicators of poor soils and a poor location. Designers should look for options.
- Managing water is a primary key to sustainability.
- The biggest causes of trail problems are trails where the grade is too steep or too long or both. Designers should avoid that scenario.
- A bandage fix can be more costly than the solution of relocating the trail.
- Design for the riders' eyes by putting the trail where the rider expects it to go and avoiding awkward moments that result in tread impacts and increased maintenance.
- Experience is the best teacher. Designers should draw on their own experience and the experiences of others. This book touches on the intricacies of design, it does not make someone a designer. Designers should recognize when help is needed and get it.

Chapter Fourteen

Designing for Challenge

Ride Safe, Ride Smart, Always

Section 1: Challenge versus Sustainability

Like any other modality, an integral part of trail riding is challenge: riders constantly push themselves to determine how good they are and how good are their machines. Challenging trails or features can provide a boost of fun, excitement, extended seat time, camaraderie, and self-confidence if the rubber side stays down. By choice, they take riders out of their comfort zone. Adrenaline is pumped out as riders negotiate challenge and are left with a rush of endorphins as they complete the challenge. This creates a chemical high that contributes to the "WOW! That was a great trail!" feeling at the end of the day. These experiences and sensations are desirable and when trail planners provide them, they are definitely providing for the riders' needs.

Riders are constantly testing themselves and their machines

The issue, though, is how to provide for those needs and still have a sustainable trail. As one group of riders said: "We want sustainable trails, but don't take away our hillclimbs." In most cases, this is an oxymoron. In an era of rules like the 50 percent rule and the 10 percent average grade rule, it can be easy to design out excitement and challenge. That is why trail planners focus on making informed decisions on a given site rather than on conforming to rules. In many cases, planners and designers may have more latitude than they think.

Providing Sustainable Challenges

There are five ways to create and provide challenge: 1) utilize natural features; 2) utilize design features; 3) utilize manufactured topographic features; 4) utilize natural topographic features; and 5) utilize manufactured design features. A good designer will use all five, either independently or together, to create the desired experience.

1. **Utilize natural features.** These are features like rock outcrops, boulders, rock step-ups, scree, slab rock, slick rock, and cliffs. Notice that these are all rock features. Rock is generally more durable than soil and offers opportunities for a varied and challenging riding experience. Riding a smooth surface trail can be fun, but throwing in some rocks occasionally can increase that fun.

Soil type also fits into the natural feature category. Often, designers don't have a choice of the soil type that the trail goes through, but if they do, soil type can definitely affect challenge level. In dry climates, sandy soils are more challenging than silt or clay. In wet climates, silt turns to mud and clay turns into slick gumbo, but wet sand holds up quite nicely.

Very steep, but very durable. Bulldogging can be part of the challenge and definitely part of the experience. The crude board bridges a vertical step-up and the designer was being cursed, but what was talked about the most around the fire that night?

Although rocks are durable, the soil around them usually isn't as durable. Going from rock to rock can work well, but going from rock to soil to rock may result in considerable soil displacement. On some trails, ledges will continue to get higher as tires displace the soil at the base of the ledge. Eventually, even experienced riders may start looking for a bypass. Designers should anticipate this and harden the approaches to these features if possible.

Erosion has probably occurred to expose this bedrock, but now it is durable and provides a great challenge feature. Challenge varies by vehicle type. This feature could be moderate for an ROV or 4WD, difficult for an OHM, and very difficult for an ATV.

2. **Utilize design features.** While topographic features may be limited, there are a host of design features available, including grade, vertical alignment, horizontal alignment, obstacles, clearing, tread, and exposure.

Okay, we know that this is a fall line trail that doesn't harmonize with the landscape, BUT, it is a fun, challenging hillclimb. Given the durable soil type, climate, level of use, and type of use, this trail is sustainable though it could be managed better to reduce the number of approach lines. Design is about assessing the site and making informed decisions.

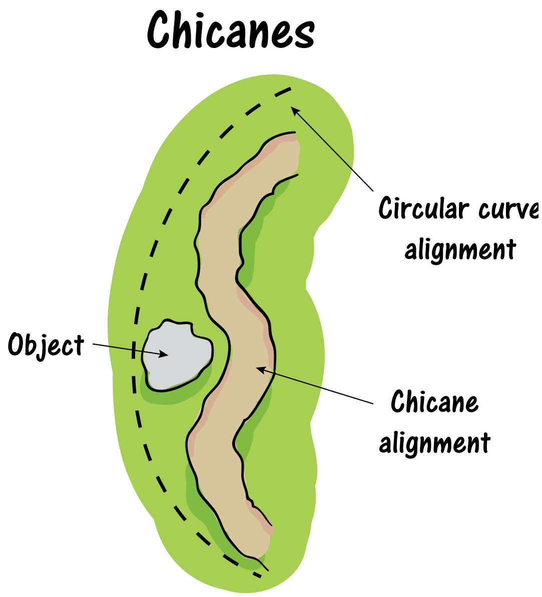
Grade is one of the challenge features that riders like the most, but it's also one that can cause the most impacts. The key is for designers to look at a given situation and make an assessment on how steep the grade can be. Grade pitches, even short ones, can increase the interest and variety of the trail.

Good horizontal and vertical movement

Even if there aren't steeper pitches, keeping the **vertical alignment** moving increases difficulty while increasing sustainability and fun factor, and reducing speed.

As with vertical alignment, it is important to keep the **horizontal alignment** moving. Take advantage of tree or brush thickets to tighten up the alignment. The tighter it is, the more technical it is. If ATVs and ROVs have to back up to negotiate a turn, up to a point it makes the trail more challenging. Compound curves, broken back curves, and non-circular curves can increase difficulty by decreasing flow, but they can also increase tread impacts.

Chicanes are another tool to slow down riders and increase challenge. A chicane is a feature that creates another set of turns, so a chicane hugs a rock or a tree where a circular curve goes around the rock or tree. Chicanes interrupt flow and are okay on tight and technical alignments, but shouldn't be used on open and flowing alignments without slowing the riders down first.



A good example of a chicane. An ATV riding at speed around the curve gets thrown at the tree with the flagging on it. Flow is reduced and challenge is increased, but is this appropriate on an Easiest trail? It could be depending on the alignment before and after this section.

This is a very abrupt chicane. The tree tends to stick out into the middle of the trail. It's been hit by the equipment and could easily grab an unwary rider, especially one riding toward you in this picture. Is this challenge or risk? One designer called it risk and another designer said challenge.

Obstacles are a great way of increasing challenge. The issue with using obstacles is that they can be removed over time through maintenance or by well-intentioned riders trying to help out. If obstacles are intended to be left for challenge features, they must be documented in the TMO, and the intent of the TMO must be communicated to the maintenance personnel. Riding over obstacles like roots, rocks, and stumps can increase the degree of challenge.

Six elements can affect the degree of challenge with obstiacles: size, frequency, stability, traction, location, and position.

1. Size. Certainly, larger objects are more challenging to ride over than smaller objects. There are guidelines for size, but really, there are too many variables to say that one size is more difficult than another size. Using a variety of obstacles can also affect the challenge of a trail.

2. Frequency. Getting over a single rock is one thing, but negotiating a rock garden is another as abrupt physical forces direct forward momentum sideways or backward.

3. Stability. Riding over an obstacle that is loose or rolls is more challenging than riding over one that is firmly embedded.

4. Traction. Challenge increases when traction decreases, so an object that is wet, smooth, or slimy with moss or mud is more difficult to negotiate than one that is dry and rough.

Roots can increase challenge, especially ones like this that are at an angle and on a curve.

These loose rocks of different sizes and shapes increase the challenge of this climb.

5. Location. Obstacles on curves are more challenging to negotiate than those on tangents because the riders are trying to turn the vehicles against forces that are directed forward and outward. Loosing tire contact or hitting an obstacle that throws the vehicle outward forces the rider to quickly react to keep the vehicle going in the direction of the turn. On a tangent, riders are more likely to see objects approaching and gauge speed and position appropriately, but that advantage is generally lost in a curve.

6. Position. Obstacles that are, or have surfaces that are, at an acute angle to the trail tread are more challenging to negotiate than those that are perpendicular to the trail tread. As the degree of angle decreases, the degree of challenge increases.

These angular log waterbars add to the challenge of this trail, however, the challenge features shouldn't be your drainage structures. Forces are exerted on these by vehicles going uphill and the log in the middle was probably displaced by those forces.

Putting all of these elements together, the most challenging scenario would be many large, loose, slippery, and smooth obstacles placed in a curve. What if the trail doesn't have any obstacles? Import them, or instead of wasting slash during trail clearing, bring some of it back in after construction and stake it in place to create obstacles.

This log adds challenge by being at an acute angle to the trail. It tends to throw the rider out of the curve rather than into the curve. No bark means less traction and when it's wet the challenge level increases.

Soil type can play an important part in deciding whether or not to incorporate obstacles. It takes traction to negotiate obstacles. While soft soils can increase technical challenge, that can also equate to unwanted tread impacts and maintenance costs as less skilled riders spin their tires to negotiate obstacles.

The properties of most soils change as the weather changes and with that the rideability and challenge changes, sometimes dramatically in just a few hours. This is a factor that designers need to consider when playing with alignment and features. As friction or traction changes, so does the level of challenge. Also, as the cohesiveness of the soil decreases, its resistance to displacement decreases, so what was a durable challenge feature one day, may not be so durable the next day.

Clearing width should be kept tight. The narrower it is, the slower the riders will go. They'll go even slower if there is a risk of losing a fender or breaking plastic. That risk equates to challenge. Having green leg slappers or brush scraping down the side of a vehicle not only slows and confines the use, it gives riders the illusion that they are pioneering a trail. It also affects their perception of safety.

The same idea in good soils will work just fine. Logs should be staked so they don't move. It also makes them less likely to be cut out by a well-intentioned rider.

Though short and not very steep, these soils displace easily when wet. This trench will continue to get deeper until the soil type changes or the tread is hardened. If it is hardened, the challenge level may decrease, but the grade and terrain feature will be perpetuated.

Vertical clearing or pruning height can also challenge riders and enhance their experience. Designers can create a tunnel effect; but brush is one thing, immovable objects like logs are another, especially if vehicles without roll bars are using the trails. Designers need to take extreme care to ensure that the speed is down and that riders have adequate time and visibility to see the overhanging log. This practice places the agency at risk. What if the log breaks and becomes a spear? What if vegetation grows in so riders can't see it coming? It's a poor practice and not worth the risk.

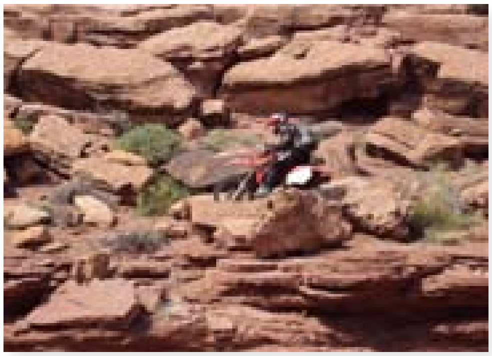
The stump and tree on the tread shoulder increase the challenge of negotiating this curve. Though easy for an OHM, it's very tight for an ATV.

There are guidelines for clearing height and width, but many of them appear to be founded on reducing agency risk rather than increasing rider experience. Designers should look at the TMO and then assess what features or opportunities they have on site to create the desired experience.

A rough, inconsistent **tread** is more challenging to ride than a smooth, consistent one. The design elements for tread are: width, irregular tread surface or rugosity, and irregular tread plane.

Width. A narrower tread has the same effect and benefits as narrower clearing. Note: Narrower equals challenge equals reduced speed; wider equals less challenge equals increased speed. Changing the tread width can add variety and challenge if it's consistent with the TMO. A good design tool is a choke, which is a narrowing of the trail tread accompanied by a restrictor like trees or rocks. These are similar to a gateway or anchor except that the tread width is less than the design standard. Chokes slow riders down by reducing their perception of safety: "Am I going to fit through that?" These are good in advance of junctions, technical sections, or anyplace else designers want the riders to slow down. Unless the speed is already slow or the trail is extremely technical, it is essential that riders have adequate sight distance to see the choke coming and prepare accordingly to negotiate it.

You can see this vertical obstacle coming, it's marked with an arrow, and it definitely slows the rider down. Challenge, yes; worth the risk, no. It is too low.



The high sides and rocks increase the difficulty of this trail and leave little room for a margin of error.

A narrow tread on an open slope like this reduces the margin for error, reduces the riders' perception of safety, and therefore increases the feeling of challenge.

A similar tool is the perceived choke. With these, the tread does not narrow up, but the clearance between trees or obstacles does. Usually, the trail corridor is cleared for a specified distance wider than the trail tread so that tree trunks are away from the trail shoulder, but tree limbs could still protrude into the trailway. Except for single track, OHV trail treads are wider than the machine. When there is zero clearance from the shoulder to the trees, there is adequate width for the ATV, ROV, or 4WD to pass through, but the riders' perception is that it is too narrow and they will brake hard.

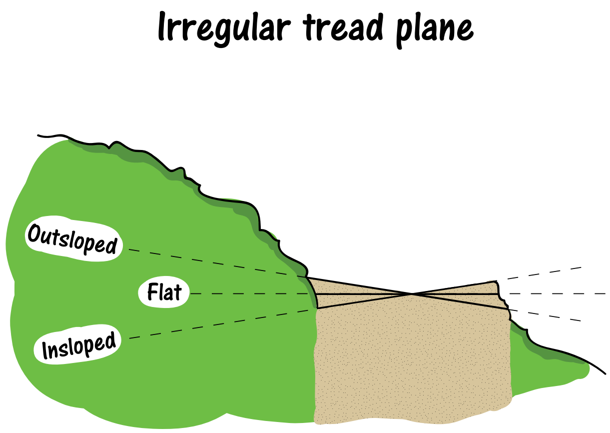
Here the tread is so narrow that riders must put a tire up on the rock on the left to get through. This can tip the vehicle toward the right which increases the risk of a bent rim, a broken bead, and scratched or broken plastic.

This is a good choke. Passing through this, the riders tend to stand as they wonder if the foot pegs are going to clear the rocks.

This is a great choke with a narrow tread and tight vertical confinement. The risk of losing plastic or damaging fingers is high as the bars have to be angled to fit through the gap. The rock obstacle in the middle of the tread (arrow) adds to the challenge.

Chokes serve as anchors and gateways. If the restrictors are less than wheel height, the riders will slow up much less than if they were above wheel height because they are less of a perceived threat. The higher the restrictors, the more intimidating they become.

Irregular tread surface or rugosity. This would include rutted or uneven trail treads. This increases challenge because riders often cannot choose their line and are forced to fall into a rut or try to stay out of one. Ruts are often associated with poor drainage and erosion or lack of maintenance, but they can be beneficial. If the issue is drainage, fix the drainage and leave the ruts for challenge if consistent with the TMO. Or, don't fix it if the erosion isn't damaging.



There are some obvious drainage issues going on here, but the irregular tread surface and the ruts that zig-zag from one track to the other make this hill quite challenging and fun. If the source of the water was dealt with before it reached the crest of the hill, this level of challenge could be perpetuated.

Irregular tread plane. The normal trail prism is flat, insloped, or outsloped, but what if the tread did all three randomly and unexpectedly? Pitching side to side changes the directional physical forces of the vehicle and requires corrective action by the riders. This increases the challenge level. In slippery soils, an outsloped curve on a steep slope can be dicey to negotiate.

In playing with natural features and design features, designers can increase the challenge by reducing flow. Rocks, obstacles, irregular tread widths and planes, clearing widths, and irregular alignment all affect how the trail flows and thus how easy or difficult it is for the riders to negotiate that flow.

When a rider is placed in a situation where a mistake could lead to equipment damage or loss, personal injury, or death; that is called **exposure**. Exposure equals challenge. Exposure is usually, but not necessarily, associated with cliffs or very steep, open sideslopes. When a rider is on a narrow trail and it is 1,000 feet almost straight down to the river; that is exposure. Add in an outsloped tread, obstacles, and slick soils and the degree of exposure has been compounded.

Exposure is the ultimate mind game. Here the driver of the ROV can't see the ground in front or the tire placement as the machine is negotiates down the rock.

From a challenge standpoint, the designer has several options: exclude exposure sections, include exposure sections if consistent with the TMO, change the length of exposure, and change the frequency of exposure.

To manage risk, it is important that exposure be reflected in the difficulty level of the trail, usually black diamond or double black diamond depending on the degree of exposure. Good entrance management and filters should also be employed to inform and limit unskilled riders. Since exposure can be an extreme challenge, it should be highlighted on the trail map and website and should include additional signing at the trail entrance.

Extreme? Yes. Edited photo? No. Who would do this? More than you think.

Tip, Trick or Trap?

Trap: Designers can fall into the trap of laying out trails which keep them comfortable or ones they like; not what keeps their customers comfortable or happy.

Like chokes, there is real and perceived exposure. Real is when riders are on the edge of the cliff and perceived is when they think they're on the edge of a cliff. When a vehicle is pitched up and off-camber and riders can't see what the ground is doing in front of them or where and how the tires are going to come down, that is perceived exposure. This is a really cool tool.

Certainly not as dramatic, but exposure nonetheless. The designer can control the degree of exposure.

3. **Utilize manufactured topographic features.** Manufactured topographic features include the remnants of extraction activities like rock pits, quarries, open-pit mines, and borrow pits; old landings; drill pads; processing and transfer sites; and runways (that is, any large area that has been used for another activity). What is good about these? They are already heavily impacted sites, so they are often a wash from a resource standpoint. As such, they offer an opportunity to be used as OHV facilities where high impact use could occur with little impact on the environment.

In this project area, designated open areas in cinder pits like this provide the only hillclimb opportunities. Cinders are like marbles so they enhance the challenge for the riders.

The sites in remnants of extraction activity areas could be used for OHV training areas, mudding, pit squid activity, hillclimb, and rock crawl by 4WDs, ROVs, and ATVs. These sites are often referred to as play areas or open areas that have little or no development.

The large areas that have been used for another activity could now also be used for OHV training areas, MX tracks, and technical challenge courses like terrain parks and endurocross. These activities require a higher level of development and often a higher level of maintenance for which management may not want to assume responsibility.

There are segments of people in the OHV community who have little interest in trails. These include rock crawlers, dune riders, mud riders, MX riders, pit squids, and often younger kids. Open areas provide places for these activities to occur. Some people think that open areas are just sacrifice areas. Not so. Like trails, they are designed and managed for a specific use or activity. In addition to providing a place for challenge and high-impact activities, open areas are excellent OHV management tools. When legal areas exist to do non-trail related activities, trail managers or rangers can direct the use away from non-legal areas to the legal areas. It is always better to work with human nature than against it.

An argument against open areas is that if designers provide for that use, they are telling the public that those activities are acceptable. Not at all, and in fact the opposite. What designers are saying is that those activities are not acceptable elsewhere, but they are acceptable here and only here.

Liability often comes up in discussions about open areas. The bottom line is that there is liability in everything. The issue is how the risk is managed. Play or open areas need to be signed that the area is to be used at the riders' own risk. The designers may add rocks for a rock crawl, a couple of simple dirt mounds for kids, or a mudding area, but as long as the designers aren't constructing technical features like doubles, triples, and table tops that require precise construction and maintenance, the risk is low. Unless a trail team member carelessly does something that changes the condition of the site without signing or warning of the change (like dumping storm-damaged culverts or a bridge, removing the back half of a mound, or creating a vertical face where it was once sloped), the risk is managed.

This small ½-acre open area is just an oval with four mounds of dirt for kids to ride. It has received heavy use and the mounds have worn down to a ¼ of their original size and need to be rebuilt.

As a test, 4WDs were invited to try out this OHM and ATV play area. They had a blast! Heavy equipment was brought in to enhance some runs and it is now a designated rock crawl facility as well.

Almost any size area can be used from a quarter acre to 40 acres or more. Depending on the expected use level, the bigger the better; but anything is usually better than nothing.

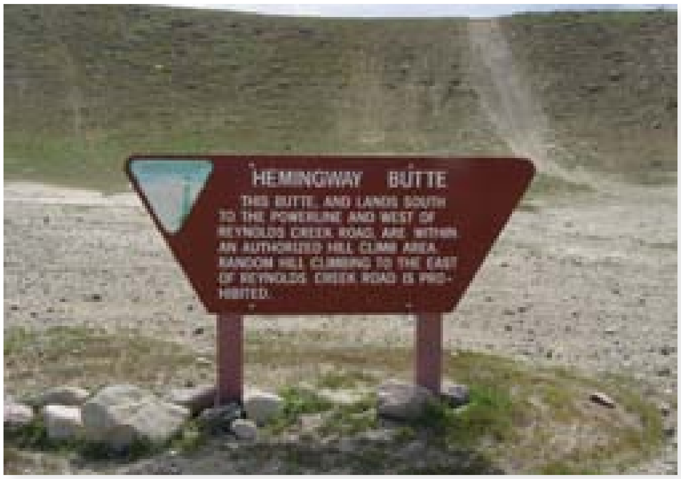
Since open areas are designated sites, there needs to be signing to identify the site, and the perimeter of the area should be clearly marked with boundary markers.

4. **Utilize natural topographic features.** Natural topographic features include any area where unrestricted cross-country riding is allowed. These are usually sand dunes, scab flats, rock knobs, or hills that have durable soils. These open areas are natural features, not commercially impacted features. Like the open areas discussed above, they are designed and managed to accommodate a specific use or activity and they need to be signed accordingly. They can offer high speed, high fun, and high challenge.

In the winter, open areas can offer a whole different experience and challenge level.

Some examples of effective open area signing. If the project includes open areas, their signing should be included in the sign plan.

Riding sand is an entirely different OHV experience. If it looks easy, it isn't and the challenge can be extreme.



High rock content make the soils in these hills suitable for open hillclimbing.

An area with boulders, rock slabs, and step-ups can be perfect for trials riders.

Natural terrain like this can provide some WOW challenge opportunities. The driver and this machine performed some awesome maneuvers. Large rock formations like this can also make great areas for a trials course.

One use for natural topographic features is as observed trials courses. What trials riders can do on a motorcycle is amazing. Like rock crawl, they need a variety of large obstacles and since it is a spectator sport, public access to the site is important. Very slow speeds and very low tire pressures make this a low-impact activity. Trials doesn't require a large area, only a few acres can be sufficient if the area has the right mix of terrain features. If designers have a suitable site, they could consider designating it for trials practice and events.

5. **Utilize manufactured design features.** In spite of all the tools available above, the reality is that there are many places that can't provide sustainable, quality technical challenge. Either they don't have the topography, features, or soils; or are too dry or too wet. Yet riders still want and need challenge, so how do designers provide that? It's time to think outside of the box and create it. By creating it, designers have the control to design what they want, where they want it. Management of the use, rider experience, and the resources can all benefit from that. The mountain bike community discovered this several years ago and has upped the challenge and fun factor with the development of coasters, ladder bridges, terrain parks, pump tracks, and freeride facilities. The OHV community could learn and benefit from these examples.

Other than site constraints and possibly funding, the ability to manufacture features is only limited by a person's level of vision and creativity. The opportunistic designer or manager keeps an eye out for free or low-cost material sources by staying in tune with other construction activities in the area that could have win-win potential: a road or building project that needs a waste site for dirt, stumps, logs, or rock; a building being demolished that could be a source for bricks or concrete chunks; a tire shop that needs to dispose of used or recalled tires; and the list goes on. Repurpos-

To provide more challenge opportunities in this project area, this designer imported material to create an ATV rock crawl. Cool!

Great innovative design. Take a flat trail on a ridgetop and dig alternating holes to create a "twister." It's fun, technical, and provides perceived exposure because your eye is pitched up and you cannot see where your tire is or how far down it will go.

It won't last forever, but the trees are more durable than the soil on this project and it made a great challenge feature that the riders enjoy.

A nearby highway project needed a waste area for rock and an OHV manager needed more 4WD challenge opportunities. A win-win deal was struck and a U-shaped rock garden was created. While only about 300 feet long, it can provide hours of seat time. Note the strategically placed winch tree(s) and signs for straps required.

Using old culverts and cement, this rock crawl adds difficulty by using the slope. A hillclimb without erosion. Neat.

The cement and rock structure has different levels of difficulty on each side to offer a 4WD rock crawl to various skill levels. It was simple to build and will last a long time.

ing materials destined for a landfill or other disposal facility helps the environment while helping designers provide for and manage the OHV use.

This entire trail was squeezed between trees so you had to stop or back up to get through. It was slow, you never got out of first gear, it had no flow, and the trail was no fun. The best part of the trail was the end of the trail.

Liability often comes up in this discussion also, but again the mountain bikers have set the example for risk management by incorporating tools to limit liability, including entrance management, filters, effective signing, easy-outs, access control, design standards, and inspection and maintenance protocols.

What makes a great trail great? Variety. Use the ways outlined in this chapter to create variety and mix them up, but even then, do riders want to bounce over rocks and roots, squeeze between trees, hang on the edge of a cliff, or have poor flow for 20 miles? That type of trail isn't fun. To the extent that it's consistent with the TMO, challenge features should be intermixed with all of the other design tools that truly make a great trail great.

There are plenty of creative options mentioned above to provide technically challenging experiences, but there are some things that shouldn't be done.

A well-intentioned, but misinformed maintenance worker deliberately cut out this tree to add more challenge to the trail.

Challenge? Not really. Agency risk? Yes.

This is a durable natural feature, but where is the line between challenge and risk? If an ATV is the design vehicle, utilizing this feature may have crossed it. This does not look that difficult, but poor soils or poor sight distance due to the alignment may have prevented getting a run at it.

Don't:
- Reduce maintenance level, quality, or frequency. The degree of maintenance must agree with the TMO. Arbitrarily reducing maintenance can lead to tread degradation, erosion, resource impacts, rider safety concerns, and risk.
- Reduce or remove drainage to increase challenge.
- Arbitrarily change the difficulty rating and signing without changing the TMO. The signing must agree with the TMO. If it doesn't, the agency is not managing its risk.
- Allow continued high-impact riding in natural areas not managed as open areas.
- Use unprotected wet area crossings that will develop into undesignated mud bogs.
- Design trails that will create unacceptable visual scars or be socially insupportable.
- Create a technical feature that is inconsistent with the TMO. This can trap riders, increase resource impacts, and increase agency risk.Remember that challenge is an expectation, risk is a surprise. Minimize the surprises.

Section 2: Using Existing Trails

Managers often ask, "Can I use exisitng trails?" The answer is the standard: "It depends." A designated trail system is usually comprised of routes that come from three sources: 1) user-created trails that become incorporated into the system; 2) roads, trails, skid trails, seismic lines, or other routes that are repurposed as OHV trails; and 3) purpose-built trails that have been designed for a specific use or activity. The problem routes are usually those that were incorporated under the first two categories. Planners and designers should use these trails judiciously because although they have low up-front costs, they have inherent problems and risk that can result in high long-term operational costs.

This trail provides a high degree of challenge, but the other issues are obvious.

Four Components of Sustainability

There are four components to trail sustainability: 1) resource sustainability, 2) political or social sustainability, 3) experience sustainability, and 4) economic sustainability. These are powerful. If a trail does not have all four components, it could fail.

Resource sustainability. Will the trail provide resource protection in the long term? This is the definition that most people use when referring to sustainable trails.

Experience sustainability. The agency can have a resource sustainable trail, but what if the riders don't like it? Will the trail provide the desired recreation experience in the long term? Will the experience stay at the same level in the long term?

Political or social sustainability. The agency can have a great trail that has both resource and experience sustainability but is in the wrong place and is unsupportable from a political or social standpoint. There could be visual impacts, noise impacts, or the social impact of "I don't want to see that activity there."

Managerial sustainability. There are several aspects of managerial sustainability. One aspect is economic sustainability. A trail in the wrong location can sometimes be mitigated by increasing maintenance and monitoring. But at some point, the cost of having the trail in that location may not be worth it. Another aspect is defensibility. Is the land manager in a position to be able to justify the trail in that location? Also are the skills of the maintenance and monitoring personnel suitable for the trail? Does the trail meet the needs of the riders?

A Case in Point...

When asked where there might be a place to have hillclimbs, the riders said: "Here, this is the perfect place for sustainable hillclimbs. They've been there forever and they're the greatest." They were right. There was durable soil, favorable climate, few ruts, almost no erosion, and high fun factor and challenge. Other than a visual scar, there were few adverse effects from years or decades of use. For all practical purposes, they had resource and experience sustainability.

Except those hillclimbs were located in a huge meadow that was determined to be a sensitive grassland environment; they were visible from a main recreation access road; they contributed noise impacts to residents; and they represented years of abuse and misuse to an intolerant community and media. They weren't politically sustainable and today they are closed and rehabbed.

Erosion

Erosion is an ongoing process. It can be managed, but never stopped. Some of the best trail and technical challenge opportunities have been created through erosion, so erosion isn't necessarily bad. It depends on where it is occurring and its effect on other resources. If other resource values are low and there is no stream connectivity, the movement of soil particles from point A to point B is not loss, it's relocation. If the land manager feels comfortable with the effects, keeping the erosion may be an option. Given the same scenario with the same manager in a different location, the answer could be different.

At least with what we can see here, this great challenging trail can still be drained pretty easily by flowing in the direction of the blue arrow. If this is open to OHMs and ATVs, it would be nice to define at least one alternative path through the boulders.

In looking at a heavily eroded trail, it is easy for a designer to give up and say: "There is nothing to be done with this except close it." That may be true, but some type of drainage needs to be installed just to close and rehab the trail, so if that effort has to be made anyway, perhaps it's worth keeping the trail, or at least portions of it. Here are some management options:

- Close and rehab the trail.
- Relocate the trail.
- Keep the trail as is and allow the trail to continue to degrade.
- Keep the trail as is and take steps to reduce further degradation.
- Keep the trail as is and restrict or regulate the type and volume of use.
- Use a mixture of all of the above.

Each situation is unique, so designers should start with an assessment. An engineer, soil scientist, hydrologist, botanist, or other specialists may need to be part of the team. It's not a perfect world and creating great trails is about making informed decisions. Here are some key questions to ask when assessing a trail:

- Does the trail still provide a desired recreation experience? Is it a high-quality experience?
- The trail is eroded, but how much will it continue to erode and at what pace?
- Is the trail down to bedrock? Is the bulk of the damage already done?
- Can the erosion be managed? Where is the water coming from? Can that water be diverted into natural drainages?
- Is the trail on the fall line or in a natural drainageway?
- Can the trail be drained? With deeply entrenched trails, this could be difficult and expensive.
- Does the water from the trail have direct connectivity to a stream?
- Where are sediments carried by the water being deposited?
- What is the risk to resources if the trail is kept as it is?
- What is the risk to the resources if the trail is drained?
- Is the trail or the project in a fish bowl of controversy?
- Is the trail or the manager's decision politically and managerally sustainable?

This trail provides a high degree of challenge, but the banks are being eroded by overland flow. Some sloping and armoring of the banks would help, especially at major drain points. It would also help to remove some of the rocks and trees to reduce the weight on the edge of the bank.

This assessment and any resulting action decisions should be well documented.

Options to Consider

The topsoil has eroded away, but what is left is a durable and challenging trail tread. At least in this trail segment, the erosion is either done or is manageable.

The answers to the above questions will determine the options for moving forward. Using a severely damaged existing trail is rarely the best choice, but in some cases, it may be the only choice. Heavily eroded trails essentially become stream channels by intercepting all of the water flowing overland from above. Correcting the water flow can be difficult and expensive, but not impossible. There are costs to implement these actions and costs to maintain them. Here are some things to consider:

- Try to restore the natural drainageways. Water needs to flow down the landscape, not down the trail.
- In areas with heavy overland flow of water, diversion ditches could be installed above the trail to intercept this water and lead it into the natural drainageway. This will significantly reduce the size of the tread watershed and help protect the banks of the trail from further erosion. Most likely, the diversion ditches would need to be lined with rock to dissipate energy and prevent scouring of the ditch.
- If the banks of the trench are eroding heavily and diversion ditches are not installed, apply a blanket of rock to the banks to resist further scour.
- Construct rideable check dams. These would fill up the trench and essentially create a rock rolling dip. These could be used to either force water off the trail or slow the velocity of the water and drop its load of sediment. The check dam rock would need to be heavy and angular to resist displacement by tire action.
- Pop the trail out of the trench occasionally. This forces water off the trail and down the trench. Then construct a dam of dirt and rock and drain the trench into a natural drainageway. The trail can then re-enter the trench until the next drainage opportunity. This must be done at regular intervals so that the natural drainageways do not become overloaded with the trail runoff.
- Excavate the lower edge of the entrenched trail to create a ditch. Line it with rock and drain it wherever possible.
- Manage the trail by closing it during periods of high rainfall or saturated soils to reduce impacts.
- Reduce further displacement and erosion by armoring the tread. This keeps tire action away from the soil and reduces the velocity and scouring forces of the water running down the trail.
- Use the portions of the trail that can be drained and relocate the portions that can't.

Ruts contribute to challenge and so does this clay soil. To stabilize this, explore options to drain the water off before it gets to this slope (arrows).

Talk about a durable tread. This trail has eroded down to bedrock, but bank erosion will still occur. Look for opportunities to drain the water off or line the bank edges with rock.

There are few options to “fix” a fall line trail. This is a drainage and it always will be. If this is a small watershed, an option could be to divert water from this drainage into the next one if that doesn’t overload the hydrology of the other drainage, then use this trail as is. Other options could be: close and relocate; or continue to use the trail as is if it is meeting the TMO.

Some soils scour very easily once water volume and velocity reach a critical point. Once started, the scour accelerates to create a ravine. Potential remedy: Find a point to drain the trench, then fill it up with cobble rock. Install an armored rolling dip (arrow). Find the source of all of this water and drain it off farther up the trail.

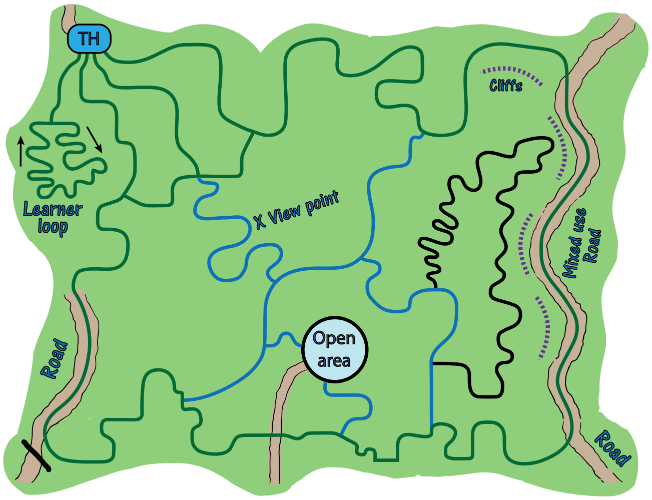
Though entrenched, this trail runs across the slope and there may still be opportunities to punch through the bank on the lower side to drain it.

There could be an opportunity here to pitch up out of the trench and force the water to drain down to the left.

How steep is too steep? This isn’t that steep, but it’s too steep for these soils in this climate. Add in too long and too straight and you get a trench. This needs to be analyzed, but now that it’s eroded, the residual grade may be sustainable. If not, trail hardening armoring would help. Look at draining water off above and below this section.

Section 3: A Different Approach to Challenge

So far, this chapter has discussed incorporating natural and manufactured features and designing for challenge. After designers have incorporated those features, they normally label the trail with a blue square (More Difficult), black diamond (Most Difficult), or double black diamond (Extremely Difficult). In reality though, only a percentage of the trail actually contains those challenge features, yet the whole trail is labeled to reflect the worst condition. In many cases, a black trail isn't all black, it's blue with a few black spots. Granted, there are those trails that are gnarly from start to finish and those should be labeled accordingly, but what about those that aren't consistently gnarly?



Here is a traditional trail plan with Green, Blue, and Black trails

Designers can install filters so that only riders with the proper skills can access a trail, but if only 20 percent of the trail is gnarly, there is 80 percent that could still be ridden by lesser skilled riders, but those riders can't access it. Is that the best utilization of a trail resource?

If designers don't install filters, what generally happens with the challenge features? The lesser skilled riders start looking for a way around the challenges. These are called easy-outs. Why this occurs relates directly back to the riders' feelings about safety and efficiency. The easiest and most comfortable line may not be the straight line. This can result in braided trails and resource impacts.

As with many challenge features, the less skilled or less comfortable riders start looking for a way around them.

There are three remedies for the problem of unskilled riders ruining or breaching technical features: design easy-outs, design technical options, or design with multiple lines.

Design Easy-Outs

If the tendency is to ride around a feature, why not design the feature with an easy-out so the trail team can control and manage the use? If all of the technical features on a trail had easy-outs, the overall difficulty rating may be lower and more riders of varied skills could utilize the trail. Easy-outs don't have to be easy, they just need to be easier than the challenge feature.

Here is another consideration: maintenance. If equipment is going to be maintaining the trail, how does it get over a challenge feature without damaging it? An easy-out can provide a bypass for the maintenance equipment as well as the riders.

Design Technical Options

Even better than designing easy-outs is to design the entire trail as green or blue with technical outs where the riders have a choice of staying on a less technical route or riding a more technical section. The technical sections can be very short to take advantage of a boulder feature, or longer for a rock garden, but they all loop back to the main trail. If the trail was a double track, there could be both single-track and double-track technical options. Here are some advantages of designing technical options rather than a technical trail.

- More riders can use the entire trail. In areas where trail development is limited, this could be a significant advantage.
- Better utilization of the land base because one trail can offer several challenge levels.
- A group of riders of varied skill levels can ride together. This extends time for camaraderie, bonding, social interaction, and it's especially good for families.
- Riders can choose the amount of challenge they are comfortable with on any given day or time; and it may depend on the make-up of the group.
- Less risk of resource impacts due to the creation of easy-outs because the main trail is the easy-out.
- Fewer tread impacts caused by under-skilled riders attempting higher-skilled features. This equates to less maintenance.
- Options, like an easy-out, could allow a bypass for maintenance equipment so the more technical lines do not get damaged.
- Better utilization of available features.
- With the lack of available natural features, manufactured features can be incorporated adjacent to the main trail.
- Higher fun factor and increased rider satisfaction.


This is a great example of designing a feature with an easy out.

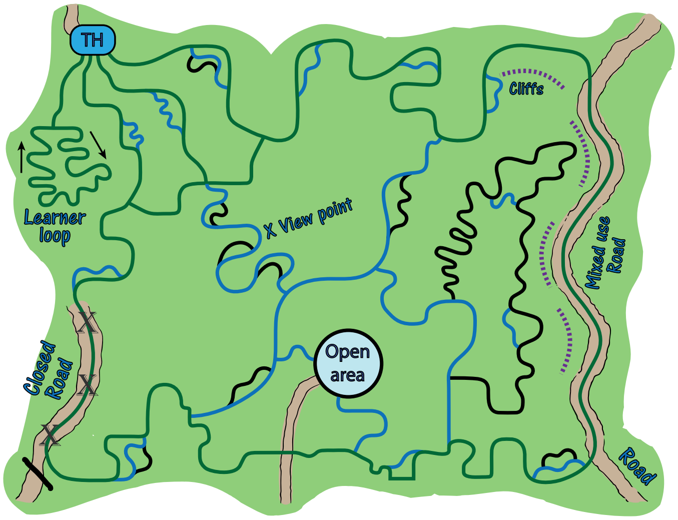

This was an error in planning and design. This is a nice hillclimb with durable soils and a great rock step-up near the top. For this reason, the trail was rated as Most Difficult, but the trail leading up to this feature was not difficult and the lack of entrance management lured under-skilled riders into the feature with no way around it, so braiding started to occur. Also, the trail on each side of this needed machine maintenance, so it wasn't long before the dozer found an easy way down the slope and of course the riders soon followed. This feature should have been initially designed with an easy-out so the agency could have controlled its location and better managed the operational use.


This rock step-up feature was the only technical area in this trail loop. Riders began to form an easy-out to the left of the area. A better solution would be to create a designed easy-out around the rock feature.

Design with Multiple Lines

Another technique from the mountain bikers is designing features with multiple approach lines, so one feature can offer several different challenge experiences depending on the riders' feelings of safety and efficiency on a given day. Providing challenge features with choices increases the fun factor and decreases tread impacts. Of course, not all features can have multiple lines, but this is a great technique that should be incorporated wherever possible by the innovative designer. Again, an advantage of multiple lines is that one of them could allow a bypass for maintenance equipment so the more technical lines do not get damaged.

It's short, but it takes advantage of a challenge feature without affecting the challenge level of the main trail.



The same trail plan with technical options has far more diversity.

The riders have a choice; smooth or rough. Signing is essential for rider information and risk management.

This rider actually had a choice of four lines over these boulders. It is far more fun to have a choice than be locked into just one line.

This was manufactured to provide a choice of at least three approach lines.

Climbing up this slab rock, riders will have an option of several lines and challenge levels.

A Look Back...

Here are some of the elements discussed in this chapter:

- A common dilemma is how to provide challenge and still maintain sustainability
- There are five main tools to help solve this dilemma:
    - Utilize natural features
    - Utilize design features
    - Utilize manufactured topographic features
    - Utilize natural topographic features
    - Utilize manufactured design features (man-made features)
- Maintain a variety of features and experiences. 100% gnarly is 0% fun.
- In order to protect resources, be consistent with the TMO, and manage risk; there are several things that should not be done when providing challenge
- There are four aspects to sustainability: resource, political or social, experience, and managerial. Without all four, a trail or project could fail.
- Erosion can be managed but not be stopped, and it can create challenging trail features
- In dealing with existing impacts, management has several options depending on resource values and political sustainability:
    - Close and rehab
    - Relocate
    - Keep the trail as is and allow the trail to continue to degrade
    - Keep the trail as is and take steps to reduce further degradation
    - Keep the trail as is and restrict or regulate the use
    - Use a mix of all of the above
- Taking a different approach to challenge can have many benefits, including better utilization of the trail resource
- Challenge feature easy-outs help protect resources while better managing the OHV use and providing a bypass for maintenance equipment
- Designing the trails with technical options gives the riders a choice of challenge based on their feelings of safety and efficiency on a given day. This allows for green, blue, and black challenge levels all on the same trail.
- Designing a challenge feature with multiple approach lines is a creative way to provide riders with choices, which can enhance their experience

Chapter Fifteen
Facility Needs and Design

Know How to Make It Go, or Know How to Ride? Get Trained

All trails start at a trailhead or other facility. Those facilities may be the first and only opportunity for the agency to interact or communicate with the riders; therefore, they serve as a welcome center for the customers. As such, they play a key role in OHV management and rider experience. Human feelings and perceptions are powerful elements in making a great trail great. When pulling into a facility, an impression will be made in the mind of the rider. First impressions are lasting impressions and they can form in less than one tenth of a second. That mental image will include feelings on several important components:

Outstanding design! This beautiful kiosk in this wonderful backdrop is setting the stage for the rider to have a WOW experience.

- Welcome. Do I feel welcome here?
- Accepted. Does the agency care about me and my activity?
- Care. Does this appear to be a well-managed and maintained facility and therefore trail system?
- Thoughtful. Has this been designed for my vehicle? Can I even get turned around?
- Safe. Is this a safe place for me and my equipment?

A negative answer to any one of these questions could trigger a negative impression of the site, the agency, and the experience the riders are about to have. A positive impression opens the riders' minds for receptive communication and acceptance of the rules, regulations, and expected etiquette. Being free of negativity as they start down the trail, the riders can absorb the experience without bias, which sets the stage and opens the door for a WOW experience at the end of the day.

When designing facilities, it's important to go back to the niche and vision for the project. Who are the customers? Where are they coming from? How many are there? What vehicle types will they bring? Will there be events? The answers to these questions affect the planning of the trail system as well as the design of the facilities. If the bulk of the customers travel less than 100 miles to ride, the trail will have predominantly day use. If customers travel more than 100 miles, the trail will become a destination where riders will spend a weekend, long weekend, or longer. From day use to destination, the vehicle type may change from pickups and trailers to motorhomes and toy haulers; the composition of the customers may change from individuals, buddies, or a family to groups of families, extended families, and clubs. This affects the number of people who could be at the facility at any one time and thus the size, design, and amenities of the facility. If the trail is a destination, riders will need overnight facilities like motels, RV parks, and campgrounds.

Many OHV riders travel and camp together.

OHV riders are not afraid to travel, and some travel long distances to explore different parts of the country and enjoy different riding experiences. Many travel in groups that range from a few people to 50 to more than 100. Get to know the customers and what they desire. If they have RVs, many desire a simple open area where their group can circle the wagons and camp together. These group sites often have no power, water, or sewer hookups. Others desire full hookups plus heated toilets and shower facilities. These are expensive, so don't build them if they aren't needed. Here is a key point: Most OHV riders would rather have a million dollar trail system than a million dollar campground.

Just as it is important to meet the riders' needs of quality and variety on the trails, it is important to meet their facility needs as well. Keep the design simple and basic initially, but have room and the infrastructure to allow for future development and expansion. It's a good strategy to implement the trails before the facilities, otherwise people have a place to park, but no place to ride. Then observe the use and needs of the facility and make adjustments to meet the needs of the customers.

> **Tip, Trick or Trap?**
>
> **Tip:** Most OHV riders would rather have a million dollar trail system than a million dollar campground

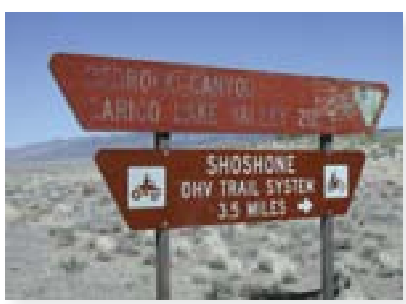
Trailhead and Staging Area Design Considerations

The difference between a trailhead and a staging area is that a trailhead provides trail access for casual riders and a staging area provides access to trails and other activities like MX tracks, endurocross or technical terrain tracks, training areas, and concessions. A staging area usually has a larger parking area and often is used to stage events, so there may also be a pit area, starting area, gas row, and spectator area. When not being used for events, staging areas often provide an open area for dispersed camping where there is plenty of room to circle the wagons. Most OHV parks have staging areas whereas most forest trails have trailheads.

This trailhead has a host of amenities including a gravel parking lot, kiosk, picnic tables, covered group picnic area, and accessible toilet.

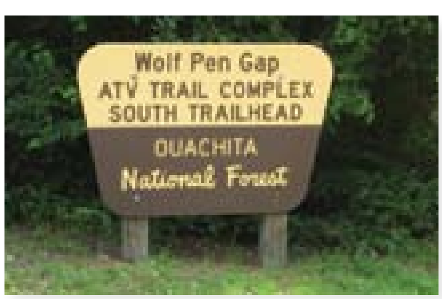
Other than size, both can have similar components. These include site signing, the trail access point, parking area, toilets, kiosks, loading ramps, and miscellaneous structures. For the most part, general design concepts will be covered, rather than specific design criteria.

Site Signing. As obvious as this component seems, there are too many OHV recreation sites that do not have an adequate identification sign out on the main road. Even though the site may be clearly visible from the road, someone who has never been there before doesn't know if this is the intended destination or if it's several miles farther up the road. Riders could also be arriving at night when the facility can't be seen from the main road. Ensure that the sign is clearly visible, is reflective, and the text is legible and sized for the speed of the vehicles on the road.



The letter size on this guide sign is commensurate with the 75 MPH speed on the highway. However the upper portion of the sign is no longer legible.

This guide sign is too high and too far off the road shoulder. It's not easy to see during the day and may not be visible at night.



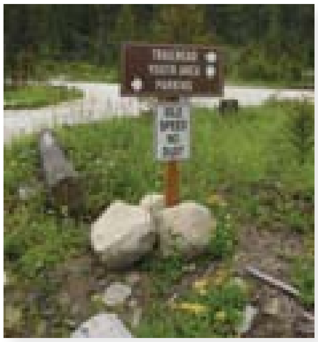
This recreation site sign looks professional and helps form the riders' first impression.

If the site is off the main road on a secondary road, there should be a guide sign on the main road and a site sign on the secondary road at the actual entrance to the facility.

Trail Access. This is the access point to the trail(s). It is preferable to have access to multiple trails rather than just one trail. This allows for quick dispersal, provides loop options, and reduces traffic volume and thus potential tread maintenance.

Even with no vehicles in this trailhead parking lot, the trail access point (arrow) is barely visible. There is a sign board there but nothing is posted on it.

Here are some key points on the trail access area:
- When pulling into a parking lot, especially a large one, a common problem is not knowing where the trail access point is and not being able to see it. Depending on the trailhead design, it could be blocked by vegetation or other vehicles. A site map or guide sign at the trailhead entrance can help remedy this.
- A lot of vehicles go through the trail access area, so barriers are often necessary to control and direct the use.
- Entrance management signing and vehicle width restrictors should be used here.
- This is the last opportunity to grab a map before hitting the trail(s), so a map box at this point is very handy.
- If there are poor soils, trail hardening is often required in this area due to the volume of traffic.

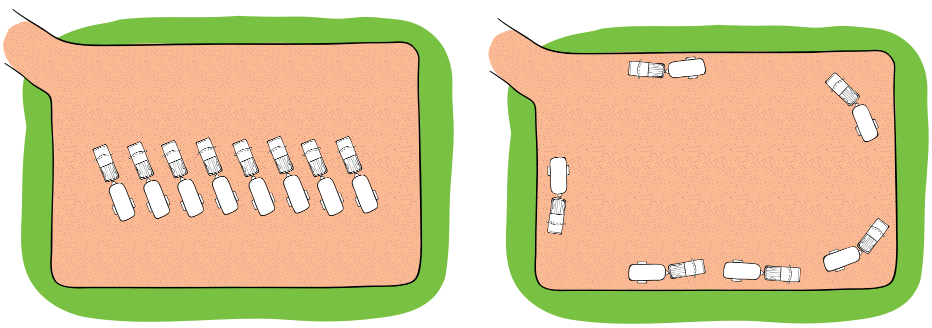


This guide sign at the trailhead entrance helps orient new visitors.

Well designed, this trail access gives the rider a choice of four trails. This adds variety and helps disperse the riders quickly.

Parking. When large vehicles with trailers need to be accommodated, managing traffic flow is very important to efficiently utilize the available space. The size and configuration of the parking lot is a huge factor in determining the riders' first impression of the site. Anyone with a trailer will park so they don't have to back up to get out. Design to minimize the need for backing.

Here are some thoughts on parking:
- The design of the parking lot should clearly indicate to the visitor how to park in it.
- Square parking lots with a single ingress or egress point are common, but do not function well. They have poor traffic flow and inefficient use of space. Since the design does not indicate how to park, the first vehicle can park anywhere, and if it parks in the wrong way, it can significantly reduce parking capacity.
- A square parking lot works better with an ingress point on one end and egress point on the other.
- Though often a necessity, minimize head-in, back-out parking. It is one thing to see a pickup coming before backing up and another to see a kid on a minibike, which could be traveling at a much faster speed. If head-in parking is provided, make the spaces



How parking was planned *How people really park*

With an unmarked parking lot, the first vehicle to park will determine the parking pattern for all of the other vehicles.

shorter so only vehicles without trailers can use them.

- Pull-through parking is preferred with separate ingress and egress points. This type of lot has flow, safety, and space efficiency.

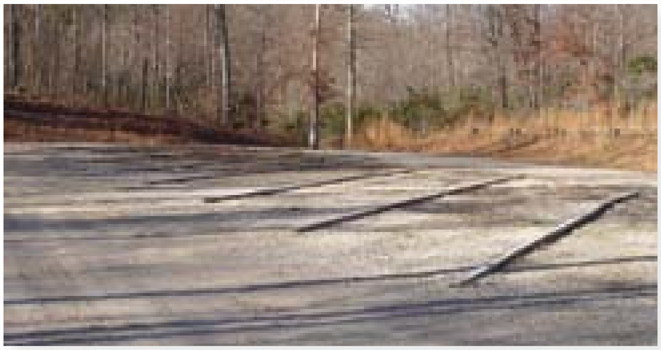
This rectangular parking lot is too narrow. With vehicles parked on both sides, another vehicle with a trailer will think twice about pulling in because he may not be able to get turned around.

Drivers have done a good job parking themselves in this postage stamp lot, but vehicles are oriented four different directions and the odds are high that someone can't get out or an emergency vehicle couldn't get in.

- Many people do not use or need a loading ramp because they have their own. Provide adequate parking length for the vehicle plus trailer, its loading ramp, and room for the OHV to navigate off and on that ramp without being in the travel lane. This space is significant.

This one way in, one way out, pull-through design has great flow. The angle of the sides "tells" the drivers the angle to park and there is a sign at the entrance to park in the center. There is now a kiosk at the trail access point where three trails take off.

- As far as capacity, bigger is usually better. However, with a small trail system, use levels can be controlled by limiting the parking lot capacity. However, this may cause riders to park outside of the lot along access roads, which can create its own set of safety and impact issues. Usually, barriers or restrictions are required to manage this use.



These treated timber parking delineators are expensive, inhibit parking lot maintenance, and don't work well to organize the parking. People will be driving over them and tripping over them. A Park in Center sign would help. The angle of the parking should be determined by the angle to the parking lot entrance. If it isn't, one row of timbers would be sufficient to guide the first vehicle.

Manage parking lot drainage through design. The low point of this lot is at the trail access point so all of the water flows down the trail. Attempts to harden it will be futile and the best option is to relocate the trail access point.

- Depending on the length of the design vehicle, the width of pull-through parking lots should be 100 feet minimum, but 110 feet is optimum. A pickup with a fifth-wheel toy hauler or a motorhome with a trailer can easily be 60 feet long or longer.
- Flares on the ingress and egress points should have a 35- to 50-foot radius.
- An all-weather surface improves functionality throughout the seasons and reduces dust.

This pull through lot is 110' wide. When there is an event, there is room to park along both shoulders and vehicles without trailers can double park in the center.

- Asphalt is nice, but large expanses tend to crack and require maintenance. Depending on temperature extremes, a flexible pavement may work better if there is a good base. One thing nice about a hard surface is that riders won't cut cookies on it.
- Do not stripe or otherwise mark the parking spaces. Each vehicle is different and requires a different amount of space.
- When calculating parking capacity, designers should remember that this isn't a grocery store parking lot with each vehicle squeezed in with the next. Without a parking attendant, riders will not park tight. Allow room for doors on each side to be fully open and room for people, gear, and OHVs to be unloaded without scratching the next vehicle. A good average is 15 feet in width per vehicle, but at a 60 degree angle, this equates to about 18 feet on the parking lot centerline (so a 500-foot long pull-through parking lot would have a capacity of approximately 28 vehicles).

Toilets. Nothing leaves a lasting impression more than a toilet that is clean and relatively odor free. Cleanliness is a maintenance issue, but odor is mostly a design issue. Too many toilets are located where it is convenient rather than where it will function the best. The critical design element for a sweet smelling toilet is airflow, which involves not only prevailing wind currents but thermal currents as well. Become knowledgeable of the science before siting a toilet. Air should move in the vent, down the riser, and up the vent stack. When users raise the toilet seat lid and a rush of nasty air hits them in the face, the airflow has not been managed correctly.

Porta-potties have had a urinal and a riser for years. Including one in the vault toilet makes sense, but there is also more to clean.

Here are some considerations:
- Vegetation management is often required to provide and maintain proper airflow.
- To increase thermal currents, maximize sun exposure to the vent stack.
- A solar-powered fan in the vent pipe can help manage airflow.
- To prevent people from parking, riding, or racing through the entryway, an L-shaped privacy screen is recommended.
- Site the toilet so air from the vent blows away from areas where people will congregate.
- There is a tendency to locate the toilet adjacent to the kiosk. From a privacy standpoint, this is undesirable. People tend to gather at the kiosk, but who wants a gathering next to the toilet?

This facility not only has an accessible path to the toilet, it has an accessible parking and unloading pad. Good design.

- A common game for kids is to lob rocks into the vent pipe. This can be prevented by installing a conical-shaped wire screen over the vent pipe. A flat piece of screen may not be visible by the kids and the cone shape deters needle and leaf build-up. The screen must have a big enough mesh so as not to impede airflow; do not use window screening. Also, the screen must be checked periodically to ensure that spider webs are not restricting the airflow.
- A tip for maintenance personnel: If they wouldn't be comfortable having their spouse and kids use the facility; clean it. No one else would want to use it either.
- Having a hand sanitizer dispenser is a welcomed amenity and shows that the agency is willing to take that extra step toward providing quality customer service.
- One of the benefits of OHV recreation is that many people with disabilities can participate in the sport and enjoy a quality outdoor experience. Because of that, the toilet and the pathway to it should be accessible. Better yet, include an accessible parking pad in front of the toilet.

Kiosks. The kiosk is the focal point of the trailhead. As such, it can be used to help draw attention to the trail access point. Unless there is a site host, the kiosk is the place for the agency to communicate with the riders and for the riders to gather the necessary information to plan their ride. Studies have shown that the period to have the riders' attention is very short, so focus the information on what is most important to the riders, not necessarily the agency. Key messages need to be limited in number, stand out, and be brief.

Here are some key points:

- Being a focal point, the kiosk should fit architecturally with the landscape. Utilizing native materials can help with this.
- Display posters in an organized, uncluttered fashion. Focus only on the most important messages.
- A map with a You Are Here indicator should be one of those important messages. Having it laminated is even better.
- Avoid displaying a bunch of 8 ½ x 11 inch pages of agency rules and regulations. Few people will ever look at them. If it is absolutely necessary that these be "posted," put them on the back of the kiosk, on one panel of a multi-panel kiosk, or on a separate kiosk.
- Reserve space for current condition posters like fire closure, weather closure, hunting season, and an event.
- Some kiosks have interpretive posters and messages. Due to the short attention that kiosks receive, these messages may be more useful out on the trail system where they can serve as a destination and extend recreation activity time.
- A polycarbonate cover helps protect posters from the weather and vandalism.
- On large trail systems with multiple access points, it can be helpful to have the site name on the kiosk so when riders arrive by trail from some other point, they can quickly ascertain their location.
- Be sure there is at least one map box stocked with maps.
- If there is an option, the kiosk and the posted materials will sustain less sun damage if the kiosk faces to the north or east.


This kiosk at a trailhead contains a laminated map of the trails, a quick reference of which vehicles are allowed on the trails, and other information the riders should know, all covered with a polycarbonate shield. The seasonal closure is clearly evident. This is a good example of a good looking, well-kept kiosk.


This facility has recently been constructed. There was room here to put more distance between the kiosk and the toilet.


Too much stuff. There might be some good information here, but no one is going to read through all of the fine print and agency regulations to find it.


A simple, but nicely arranged kiosk with key messages. Note the two map boxes and the name of the site.


Most agencies have kiosk height guidelines. Why have a kiosk if you can't read the information?

- A message board off to the side can be a handy feature for lost and found items and notes to help riders find others in their group. This can help reduce the proliferation of posting paper plates on trees or damaging signs and posters that are on the kiosk.
- A picture is worth a thousand words, so using posters with pictures that convey the desired or undesired behavior can save space, reduce verbiage, and be quite effective at delivering the message.

The vertical see-through slats are a nice design, but not functional. Wind and rain blowing through the slats rips and saturates posters.

This bear claw kiosk is a great design and certainly appropriate for the area: Bear Creek. The message board is a handy addition. Without it, paper plates get tacked up on the expensive kiosk panels.

Loading Ramps. Loading ramps have become almost a standard amenity at trailheads. However, when space is confined, they take up valuable real estate and can interfere with normal traffic flow. People got their vehicles loaded before they got to the trailhead, do they need a different way to unload them? Observe the use patterns and talk to the customers. This is one of those features that could be planned, but implemented at a later date if needed.

Here are some key considerations:

- Loading ramps are relatively easy to build and make great volunteer workday projects. As such, they make good match projects for grants.
- Many are constructed with two heights and this can be a nice feature.
- One of the biggest issues with loading ramps is that the kids or pit squids use them for jumps. This can be mitigated by installing a barrier behind the ramp so they can't get a run at it.
- Loading ramps and their approaches are subject to higher than normal physical forces and therefore higher levels of displacement. They should be hardened with rock or other material.
- For gravel parking lots, instead of installing a loading ramp, consider installing an accessible parking pad(s) of suitable width and length (16 x 40 feet minimum) to facilitate loading and unloading by the disabled. This should be signed for use by the disabled only.

This is a neat and compact trailhead that fits architecturally with the site. Without a barrier behind the loading ramp, it could be used as a jump.

This was built as a volunteer work party project using old railroad ties. It's not fancy, but it works. The barriers prevent kids from using it as a jump.

This is a nice ramp, but weather and tire action are eroding the approaches. They need to be hardened to keep it functional.

With the concrete and the railing, this ramp was expensive to construct. It is accessible, but the approaches in the gravel probably aren't. If the concrete truck is going to be there, why not pour a concrete parking pad and approach to the ramp?

Miscellaneous Structures. Some amenities can be desirable depending on the climate and use patterns of the site. A good time to flush out the need for these amenities is during the planning phase of the continuum, or by monitoring use patterns and implementing them after initial facility development. Miscellaneous structures include the following:

Concrete picnic tables are durable and they deter theft, but the shade moves and they don't. With no shade and smoke from the fire drifting toward the table, will it get used?

This metal table is also durable and could be anchored with a chain so it can be moved, but not easily stolen.

Desperate for relief from the heat, these riders sought the only shade…. Desirable? No.

This highly developed trailhead has several shaded picnic tables, accessible walkways, and interpretive signs. Great job!

Community kitchen structures like this are expensive, but provide a place for groups to get out of the sun or rain. Be sure to validate the demand before building one. The architectural design fits nicely with the industrial mining theme for this park.

This is a nicely designed trailhead with barriers to control and direct the use, a quality three-panel kiosk, two-hole toilet, and a welcome shade structure.

Picnic tables are relatively inexpensive and a nice amenity. Rather than pack food, many riders will come back to the trailhead for lunch before heading out for an afternoon ride. Sitting at a table usually beats sitting in the dirt or in the back of a pickup. The more time riders are at the trailhead for other activities like an MX track or youth training area, the higher the need for picnic tables.

The same for fire rings. Trailheads are mainly for day use, but some families will build a fire midday so the kids can roast marshmallows. There is a need to have a safe place for a fire and to manage where fire rings occur so they don't appear on the asphalt or scattered around on the gravel parking lot. If overnight use is allowed at the trailhead, tables and fire rings become a necessity.

Above, though the Stop sign gets your attention, it tends to shout at you and aesthetically doesn't fit.

Good design. The fee station is separated from the information kiosk in the background. The sign: "The fee you pay here stays here" is an outstanding message that customers appreciate. Compliance tends to increase when people know that fees come back to help them.

In the heat of the summer, just about everyone wants to take a break or eat in the shade, but there are many places that just don't have trees. Shaded picnic tables are one of those amenities that let riders know the agency cares. One issue is that the sun moves but picnic tables don't so the shade is not always where riders want it. Another issue is that picnic tables are expensive, so how many should be built? If the parking lot is full, not everyone can have a table in the shade, but even a couple is a nice touch. A community kitchen is more costly, but can accommodate more people. As with tables, if there are other activities occurring in and around the trailhead, there could be a demand for a covered eating or meeting area. Designers should scope it out before they incorporate it. A structure like this could be harder to justify in a grant request.

This three-panel kiosk separates fee requirements from other information.

In a user-pay society, fee stations are a necessity, not an amenity and a logical place for them is at the kiosk. The key point here is to not clutter the kiosk with OHV information and fee requirements. Focus the riders' attention on one, and then the other. Have a multi-panel kiosk or a separate kiosk with a panel dedicated to the fee requirements.

Campground Design Considerations

Variety has been stressed throughout this book, and it is applicable to campgrounds as well as trails. Customers arrive as individuals or in groups of all sizes, so the camping facilities should be designed to accommodate a range of group sizes and a range of vehicle types and sizes from tents to RVs. Many agencies have design guides for campgrounds; unfortunately, some of those focus on sites for tents and pickup campers but not on big rigs with trailers. Driving a big rig with a trailer through recreation facilities gives one an entirely different perspective on adequate road width, clearances, and turning radii. Navigating a big rig should be mandatory training for any recreation facility designer.

Just like a trail designer, a facility designer needs to understand: the riders and their needs, the range of transport vehicle sizes they will bring, and the group sizes possible. Keep the design considerations in mind to meet the needs of all the types of campers: the grade, turning radius, vertical and lateral clearances, back-in spurs, pull throughs, objects hidden from view, group sizes and areas, site protection, and the kiddie effect.

OHV riders often pull large toy-haulers. Campgrounds and parking areas need to consider the length of the vehicles, plus room to unload in the back.

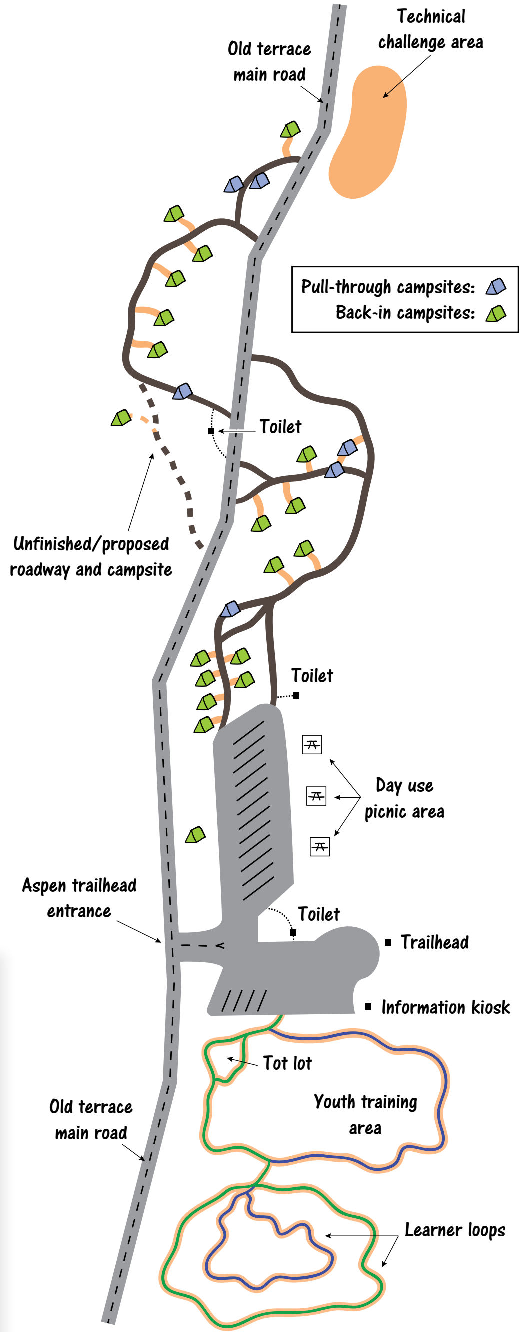
Notice how campers tend to block themselves in for additional privacy and security. Large sites provide capacity and configuration flexibility. This site is 30 x 44' deep.

This site is 40 x 50' deep and can be used by one vehicle or several as shown here.

Mix it up. Depending on the vegetation and other site constraints, designers should try to accommodate as many combinations of vehicles and types as possible. This would include spurs and pull-through spaces for a single vehicle and for two, three, four vehicles and up. Then configure their arrangement to be intermingled and best utilize the available space. All of the pull-through spaces don't have to be together, the single sites don't have to be together, etc.

Riders with tents are using this smaller 20 x 30' native surface site. Don't pave or gravel every section of the camping area.

It took a lot of time and effort to try to level this RV. The result? An unsafe condition and negative image of the agency.

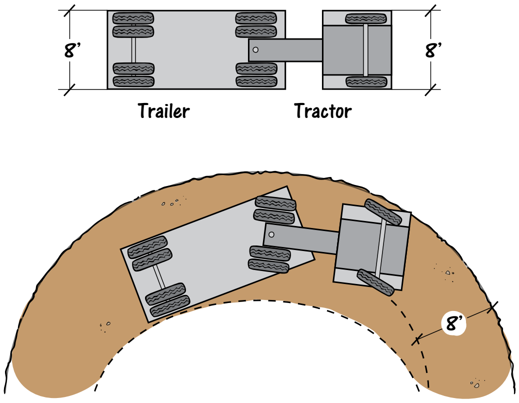


This OHV trailhead and campground complex is only half complete, but there is a good mix of amenities and of sizes, shapes, and type of camp spurs. Site constraints forced a long and narrow design

Grade. The engineers often want more grade than is necessary to drain the site. Design for the customers, not for the engineers. From a camper's perspective, there is nothing more frustrating than not being able to level up in a camp spur. RV refrigerators need to be close to level, but just as important the people want to be level. Whether riders are in a tent or RV, it is not comfortable spending the weekend off-camber.

If the spur slopes down at a 5 percent grade, a vehicle with a 200-inch wheelbase would need to raise the rear axle 10 inches. Few RVs can do that safely, and all RV manufacturers warn owners to never lift the front or rear tires off the ground since the vehicle could roll. Even on a gravel surface, water will run with a 1 to 2 percent grade.

Turning Radius. Two factors affect how sharp a curve is and how drivable it is: the curve radius and the length of the curve. The smaller the radius and the longer the curve, the sharper the curve will be. On any curve, the rear wheels of a vehicle do not follow the same path as the front wheels. The longer the vehicle (and trailer), the wider the offset between the front wheel track and the rear wheel track. This is compounded by the sharpness of the curve. Road designers compensate for this off-tracking by adding curve widening to the inside of the curve. This added lane width can be considerable (up to 20 feet), but in an effort to maintain a natural setting, road widths and clearing widths are often minimized in recreation sites. If sharp curves are designed into an OHV facility, curve widening must be factored into the road width. If it isn't, road damage, or worse yet, vehicle damage, can occur. Consult the agency road design guidelines or AASHTO Green Book guidelines.



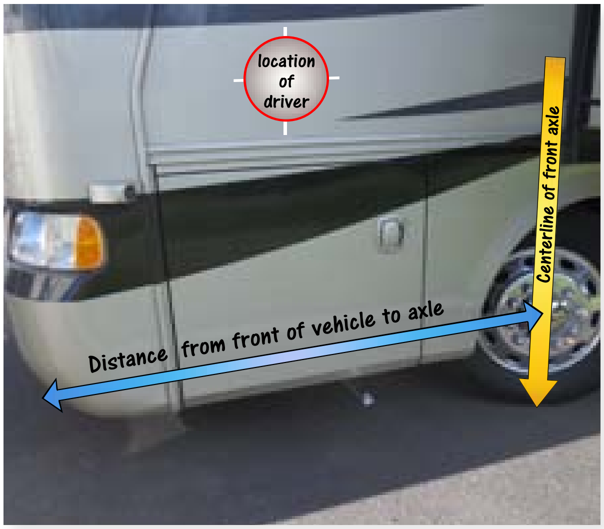
During facility construction, a good way to test the design is with a belly dump truck. If it can't negotiate the turns or the pull-through spaces or if it scrapes trees horizontally or vertically, fix the design.

The belly dump truck makes a good test vehicle for roads and spurs in a big rig OHV facility.

Vertical Clearance. It can be very disconcerting to drive through a campground road, hear limbs scrape the roof of a vehicle, and wonder if there will be damage to a clearance light, roof vent, an air conditioner unit, TV antenna, satellite dish, or the roof itself. A standard pruning height has been 14 feet, but many motorhomes are 12 feet high and fifth wheels can be 13.5 feet high. If the wind is blowing, the limbs are wet, or full of cones, a 14-foot height is not sufficient. A 15- to 16-foot pruning height is recommended.

Maintenance personnel need to be looking up when patrolling campgrounds. Broken limbs or debarked limbs are clear indications of inadequate clearance.

Lateral Clearance. Clearing width can become a factor on both roads and camp spurs. If curve widening has not been factored into the design, lateral clearance is an issue because the trailer is going to be off the road and scraping trees. With motorhomes and big trucks, the front wheels can be several feet behind the front corner; therefore, on a sharp curve, the front wheels could be on the road, but the front of the vehicle could be off the road. Without adequate lateral clearance, this could prevent a large vehicle from negotiating a sharp curve.



The front axle of this motorhome is behind the driver. The front tire could be on the edge of the pavement, but the front of the vehicle 5' off the pavement.

This slideout extends 36", but the storage bay door extends 52". Trees, bollards, or logs used to define the site can also restrict its use with inadequate lateral clearances.

The back of this motorhome extends 11' behind the rear wheels. If there is sufficient clearance behind the parking bumper and bollards or barriers are kept below 14", a 40' vehicle could fit into a 30' spur.

This site has good lateral clearances. Note that the rear of the 5th wheel is extended over the log barrier.

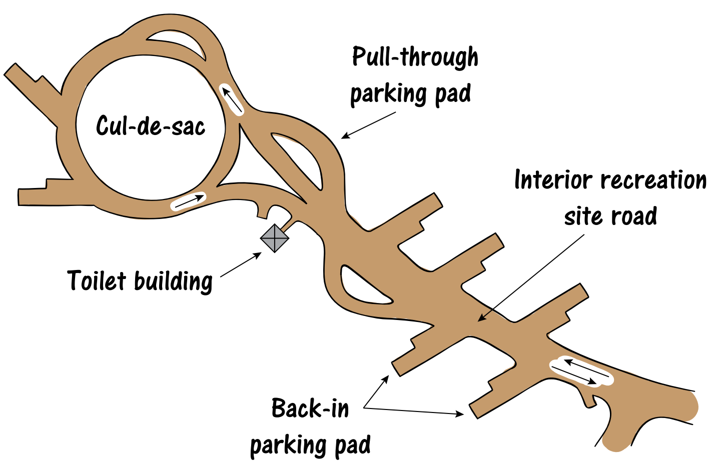
On camp spurs, there needs to be enough lateral clearance for awnings, slideouts, and slideout awnings. Storage bay doors can be 52 inches wide and extend beyond the slideouts. The total clear space required for a big rig with the patio awning out can be 22 to 25 feet.

Clearance in the back of the spur is important also. Most RVs have a rear overhang from the back axle to the rear of the vehicle. If trees are cleared and bollards or barriers are kept low enough, a long vehicle can fit into a fairly short site.

Back-in Spurs. Spurs utilize space more efficiently than pull-through sites, but big rig drivers will almost always choose a pull-through just to avoid backing up. Back-in spurs usually afford more privacy and in some ways more security because there is only one access point. The key to back-in spurs is their angle to the road. The smaller the angle, the easier the spur is to back in to. The spur angle should not exceed 60 degrees unless the road is very wide or there is another unoccupied site directly across from it. The reason for this is that without extra width, there is inadequate space for the front of the tow vehicle to swing out so the trailer can be straightened.

This spur is at a 90 degree angle to a road that is only 12' wide. Depending on the wheelbase of the vehicle combination, it is very difficult to back a trailer into this site. The first three bollards on the left side have all been hit.

Because the spur angle was sharp and the road had inadequate width, the front tire of this tow vehicle went off the road and over this culvert. This could result in damage to the road shoulder, culvert, and vehicle.



Whenever possible, avoid two-way campground roads. Traffic increases and safety decreases. With this design, every back-in spur is on the driver's blind side.

Given a choice, drivers of tow vehicles will choose a back-in spur on their left over one on their right. Why? Because the driver has a clear and close view of his mirror and a good line of sight down the tow vehicle and trailer, which makes backing up easier. Mirrors on the right are farther away and are often wide-angle, which makes the images smaller, harder to see, and harder to judge distances.

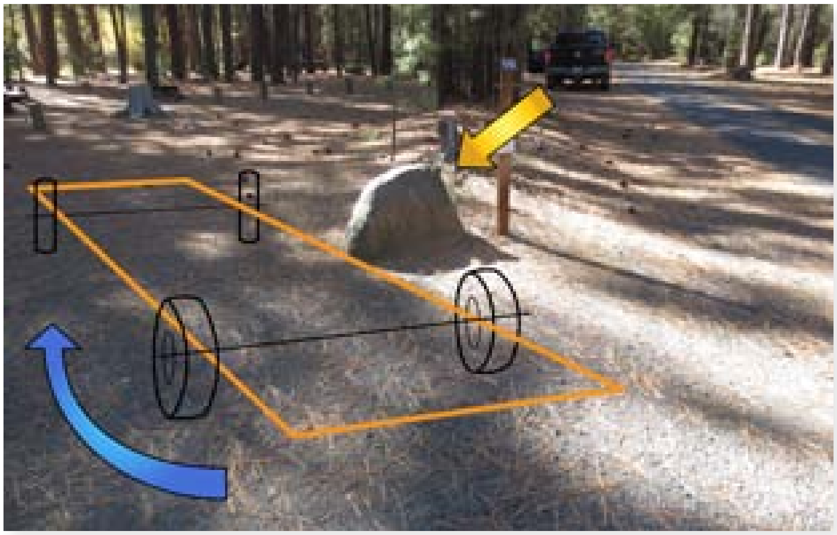
This pull-through has poor flow that can trap drivers. When pulling in from the upper end, the drivers are hugging the bollards on the left and watching the trees on the right (not shown) to make sure their trailers clear them. Then the radius of the bollards tightens up forcing the drivers to crank the wheel some more or back up. All three of the bollards in the foreground have been hit.

Pull-through spaces. The obvious advantage of a pull-through is that it eliminates backing in to a sometimes awkward spur. There are some vehicle combinations that cannot be backed up without unhooking, so those vehicle drivers will almost always choose a pull-through over a back-in.

A pull-through space can be designed for a single vehicle and trailer combination, the center can be widened out to accommodate two vehicles, or widened and lengthened to hold four vehicle combinations. Since pull-through spaces take up more space than spurs, designing them as mini-group sites can help make more efficient use of that space.

To accommodate big rigs, pull-through spaces need to flow well, so they're best designed as straight or on a long shallow curve. If the curve is too tight, a big rig with a trailer cannot pull in or pull out.

Objects Hidden from View. These are the bollards or boulders that designers place on the corners or edges of the site for enhanced aesthetics and confinement of the use. Unfortunately, when backing a trailer into a site, the drivers' eyes are focused on where the trailer is going, not on where the front of the tow vehicle is going. These objects become obstacles that are a hazard and are cursed by customers. Another factor is that the higher the drivers sit, the less visibility they have of the ground adjacent to their vehicles. Any objects placed in those locations are actually placed in the drivers' blind spots. Objects like this need to be either set back out of harm's way or be tall enough to be clearly visible by the drivers.



How could someone not see this rock on the right? Once committed to pulling in, the rock is on the blind side of the drivers and their eyes are focused on the stump ahead which is encroaching on the width of the pull-through. While tightening up their turn to clear the stump, off-tracking could put the trailers into the rock.

Group Sites and Areas. Having a group site(s) or large open area in which to circle the wagons is definitely an amenity that large families or groups will utilize. These can have utility hookups, but most groups can easily dry camp for a long weekend and would rather camp together than have utility hookups. Why do people circle the wagons? Camaraderie and just as in the old days: security; all of the OHVs, tools, and kids toys will be inside the circle.

The ability to circle the wagons enhances the experience of a group. Note the variety of vehicle types: toyhaulers, trailers, motorhomes, tents, and pop-up tent trailers.

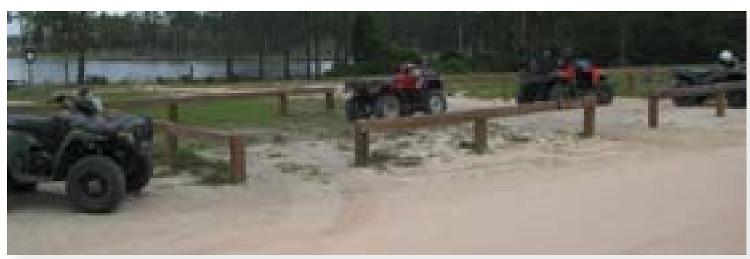
This unique design allows RVs to square the wagons while still having full utility hookups. Sites can be occupied individually or a group of four can camp together. Note the single fire ring in the middle.

This cable barrier helps control the spread of this dispersed site and deter the kiddie effect.

This large circular site with multiple utility hookups can be occupied by individuals or it can be reserved for a single group.

Site Protection. A concern with any developed or dispersed camp is limiting the spread of the site and protecting vegetation. People like to camp under the trees, but doing so can damage root systems, compact the soil, and affect water absorption. Barriers are often used to confine and control the use.

There is always a need for bollards or other barriers around campgrounds and trailheads. During construction, or as vegetation needs to be managed during the life of the facility, consider cutting the stumps a little higher and chamfering the tops. It's a nice touch and it provides a great natural barrier.



Innovative parking corrals are used to control access and protect this sandy environment from vehicle impacts.

While parking and camping is still allowed in the trees, barriers have been installed around other clumps of vegetation. The beneficial effect is obvious.

The Kiddie Effect. OHV riding and camping is a family activity and it's always great to see families having fun together. The bigger kids can usually go ride with their parents on the trails, but where do the little kids ride or learn to ride? Most often, they will end up riding around the camp or riding around the campground on the roads. They will ride all day long until they run out of energy or fuel. This constant noise and dust can be annoying to other campers but it can also present some safety concerns.

Left to their own devices, unsupervised and uneducated kids can do a lot of unintentional damage. They're looking for fun and can find that by riding a closed trail, a closed area, or by creating a trail between campsites.

A father leads his son around the campground. More often than not, the child is riding unsupervised.

This kiddie track is developing next to a large, regularly used dispersed camp.

In the vicinity of most dispersed kiddie-created camps that are regularly used by families, a kiddie-created track will soon develop. The kids need a place to ride, but these contribute to the spread of dispersed camps and impacts to vegetation and soils.

It is difficult to close off a trail or road adjacent to a dispersed camp. The chopped up road provides a great challenge for the kids.

Designers can manage the kiddie effect by incorporating tot lots, kiddie tracks, and youth training areas as part of their OHV facility design. Like play areas, these give the kids (and their parents) a designated, managed place for that activity. These facilities get the kids off the roads and away from the intimidation of older riders and bigger machines. Signing these areas as tot lots, kiddie tracks, or learner loops help to keep older kids and pit squids out of the area. Riders don't get any points for showing off in a tot lot.

Skill Development Area Design Considerations

Areas to develop skills should be associated with OHV trailheads, staging areas, and campgrounds. They help manage the use by providing a designated place for training, riding, and skill development. They also extend the recreation activity time because they provide activities other than just trail riding. These should be sited quite close to the trailhead or campground, but be located to minimize noise and dust intrusion to other recreationists.

Signed learner's loops help prevent the kiddie effect and keep pit squids out of the area.

Skill development areas include learner loops, kiddie tracks, tot lots, youth training areas, and technical terrain courses. All except learner loops provide spectator activities where riders and their family or group can participate or watch.

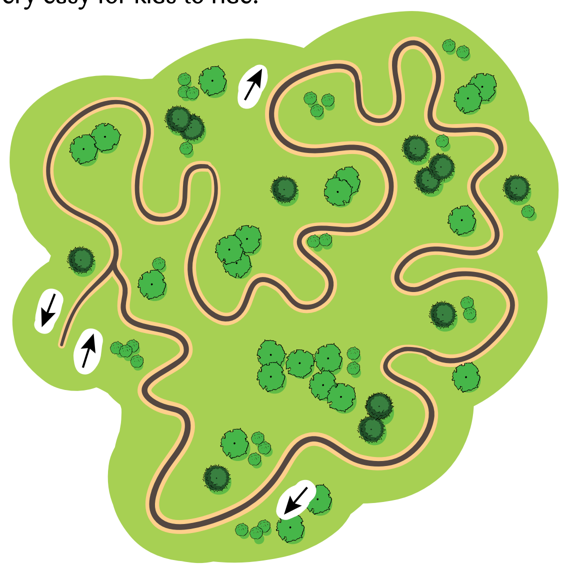
Learner Loops. A learner loop is a one-way training trail that teaches throttle, clutch, brake, and balance control. To accomplish that, these are often tight, technical, low-speed trails. In theory, they should prepare the rider to negotiate whatever can be expected on the trail system. If the trails have rocks and logs, the learner loop should have rocks and logs. If the area doesn't have those features, they can be imported. If the main trail has switchbacks, the learner loop should have a switchback if the terrain allows. If there are single- and double-track trails, there should be single- and double-track learner loops.

A learner loop isn't just for kids; it's for anyone who needs to develop their riding skills. They can be any length, but many are one-fourth to one-half mile long. These loops are dense so they can fit into a small area. If they are long enough, they can also serve as a warm-up loop.

This learner loop has an ATV trail going off to the right and a single track trail going straight ahead. Both were designed to be very easy for kids to ride.

The new training area at the El Mirage OHV Recreation Area has a training area, a tot lot, and a youth training area. All areas are well signed and there are age appropriate safety messages along the fences. This area was well designed and constructed.

A learner loop can also be designed as a play loop. It can be open and flowing or tight and technical, but the curves are usually highly superelevated to produce a high fun factor. Where possible, they play with the landscape to produce a roller-coaster ride. These teach skills, but the high fun factor can keep kids occupied for a long period of time.


Learner's loops teach the skills needed for the trail system.

Kiddie Tracks. These are usually a small oval track, fully enclosed with barriers or fencing, with a controlled access point. They are usually signed to limit the age and vehicle displacement (cc). The track usually has some mounds of dirt of varying heights or other obstacles, with easy-outs, to ride over. Some have shaded picnic tables or bleachers so parents can watch their kids play on the track. Size depends on available space, but a nicely sized track can fit on one-half acre.

Designers should keep the kiddie effect around dispersed camps in mind and manage the impacts by selecting a couple of the high-use sites and building a small kiddie track at them. The kiddie tracks should be shown on the map so families with small kids can find them. Then all undesignated tracks should be closed off and use directed to the designated sites.


Tread Lightly!'s Lightfoot has just enjoyed a ride at this kiddie track. This one is restricted to kids under 15, under 5'5" tall, they must be supervised, and speed is limited to less than 10MPH.


This kiddie track has shaded bleachers which provide a comfortable place for parents to supervise and interact with their kids.

Tot Lots. Tot lots are designed for the little kids just getting started. They are a simple oval track or may have a few easy curves. They are flat with no superelevation and no mounds so that a rider on a small 50cc bike with training wheels can easily navigate them. They are fully enclosed with a single access point and are signed to restrict engine displacement. Depending on soil type, a tot lot may need to be hardened since soft soils are difficult to ride with small tires and small engines, or by kids on their first ride.

A tot lot is a happy place as proud parents watch and photograph their kids. Without the intimidation of bigger bikes and kids, skills and confidence can develop quickly.

A tot lot can be any size depending on available space, but 50 x 100 feet is more than enough. They don't need to be very big because the machines and riders are so small. Also, a small track makes it easier for the parents to supervise and run alongside their youngster.

Youth Training Areas. All of the previous area can be called a youth training area (YTA) or be part of a larger training area. A YTA usually provides a range of activities to accommodate a wider range of ages and skill levels. Some have a tot lot; kiddie track; an ASI or MSF training area; a learner loop; and an obstacle area with mounds, rocks, logs, or other natural or manufactured features. All of this can be provided in less than 2 acres. They are fenced, signed, and have restricted access. Picnic tables in the shade give parents a place to watch their kids.

Technical Terrain Courses. A formal technical terrain course is called an endurocross track, and it is a competitive event track that is a spectator activity like MX, rock crawl, and trials. However, they can also be designed and used for casual recreation. These are technically challenging so they provide a much higher level of skill training than the other facilities above, but they are fun and definitely extend recreation activity time. One nice thing about them is that they can occupy almost any size or shape land parcel since a lot of obstacles can be positioned into a very small space.

The El Mirage Youth Training area has several skill building stations, each with an easy-out. Educational posters are placed on the fence surrounding the area.

Manufacturing challenge features are what a technical terrain course is all about, using whatever materials are available and creatively arranging them into a fun and challenging course. Materials can be rocks, logs, stumps, tires, culverts, concrete chunks; anything that can be ridden over and be durable. Unless obstacles are intended to move to increase difficulty, like a loose log run, features must be designed to be anchored or immobile. Like everything else, having a variety of features increases the challenge and fun.

Adding skill development areas can take little space, but they add tremendous value to a trail system. However, like the trail system, the development areas need to be designed correctly from the beginning, built with quality materials, and have regular maintenance.

Endurocross courses use a variety of obstacles to create a very technical course in a small area.

Concrete pipe, a short hillclimb with angled log obstacles, or a mound of logs can provide a tremendous amount of technical challenge and fun. When others in the group watch, their recreation activity time is being extended and enhanced.

Vertical and horizontal tires of various sizes are durable, cheap, and a blast to ride. A rock garden is a fun feature and this could be followed by a sand pit. The only limits are the designer's creativity and imagination.

This triangular log feature is very simple, but between the angles and the odd spacing between them, they are quite challenging to ride.

Where appropriate, a mud pit is a popular feature. Allowing legal, designated areas helps protect the resources where it isn't appropriate.

Trails riders can do some amazing things with their motorcycles. A small space and a little ingenuity is all it takes to make a great trials riding area.

Need more? Learn more here…

AASHTO Green Book, https://bookstore.transportation.org/collection_detail.aspx?ID=110&gclid=CNDwtbDgosECFVBffgodyioAQA

Park Guidelines for OHVs, George E. Fogg, NOHVCC, 2002

SST Installation Guide, USDA Forest Service, Technology & Development Program, http://www.fs.fed.us/t-d/pubs/pdf/03231303.pdf

A Look Back…

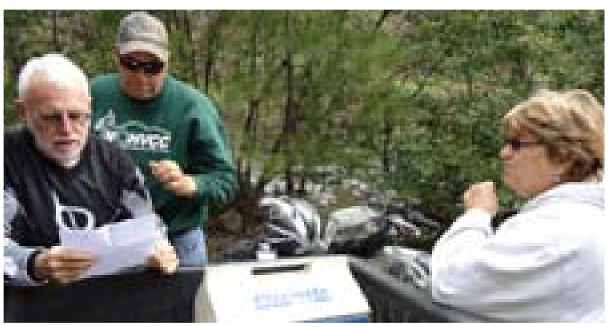
Here are some of the elements discussed in this chapter:

- OHV riders aren't afraid to travel, and they often travel in groups. Facilities need to accommodate a variety of group sizes.
- OHV facilities need to be designed for a variety of vehicle types, sizes, and combinations from pickups with tents to motorhomes with trailers.
- Designers must understand OHV riders' facility needs, use patterns, and the capabilities of their travel vehicles.
- Trailheads and staging areas have seven design components: site signing, trail access, parking, toilets, kiosks, loading ramps, and miscellaneous structures.
- Educated riders are responsible riders. A well-organized kiosk with key information and education messages is an important communication tool for the agency.
- Design considerations for campgrounds include: a variety of spur sizes and configurations, grade, turning radius, vertical clearance, lateral clearance, back-in spurs, pull-through spaces, hidden objects, group sites and areas, site protection, and the kiddie effect.
- Design considerations for skill development areas include learner loops, kiddie tracks, tot lots, youth training areas, and technical terrain courses. These provide designated, managed areas for skill development, training, and challenge.
- Skill development areas extend recreation activity time, enhance the OHV experience, and help manage the use.

PART THREE

Building a Great Trail

The largest growing demographic for OHV recreation is people over 50 years of age.



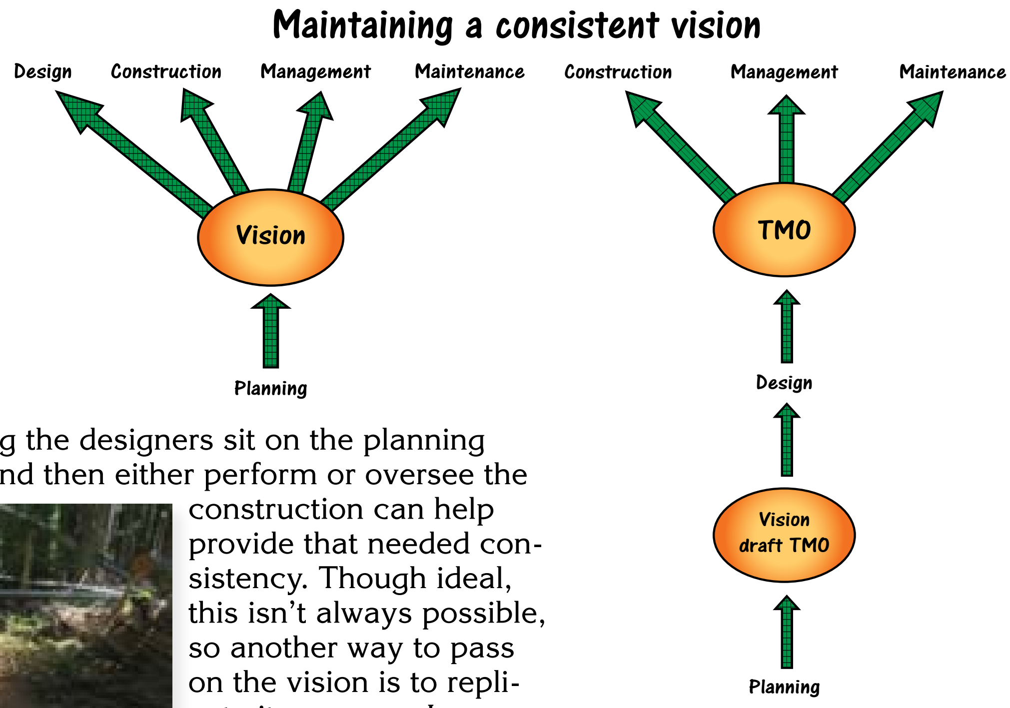
Chapter Sixteen
Construction

The Past is Not the Future

A plan and a design have been created with care. With construction, the vision becomes a reality. For the designers, after days, weeks, or months of scouting and flagging, there is nothing more gratifying than seeing the flagline become a trail and to finally ride it. It is a WOW feeling and hopefully a WOW experience. Construction is an anticipated time and one of excitement. Everyone on the project team becomes rejuvenated with the smell of freshly turned dirt, the clanging of tools, and the sound of equipment as a trail becomes inscribed on the landscape.


Construction is a time of excitement. But take time to get it set up before turning dirt.

This is a great moment in creating a great trail, but what happens after that moment may not be so great. There can be pitfalls; and when the vision in the project team's mind doesn't match the product on the ground, there are problems. Keeping construction flowing smoothly and avoiding potential problems starts before the dirt is turned in a process called preconstruction. Certainly one of the challenges throughout the continuum is maintaining a consistent vision: passing the torch from one component to the next. The obvious way to meet this challenge is to reduce the number of times the torch gets passed. Having the designers sit on the planning team, design the trails, and then either perform or oversee the construction can help provide that needed consistency. Though ideal, this isn't always possible, so another way to pass on the vision is to replicate it on paper. In preconstruction, maps, drawings, and specifications are written and assembled so that someone potentially unfamiliar with the project and the project area can look at the material and build the desired product on the ground. The process of transferring the vision is not an easy one, so investing time in developing a comprehensive construction packet can facilitate a smooth and complete flow of information and result in a great trail on the ground.




This is a new trail that was ridden in. The lack of a constructed tread has resulted in deep ruts created by compaction and displacement.

Section 1: Preconstruction

Determine Construction Option

One of the first tasks is to determine how the trails will be constructed, or even if they will be constructed. Whether a trail will be constructed by hand or machine-built has usually already been determined in the design and outlined in the final TMO.

Determine Construction Method

Once the decision has been made to construct the trails, there are four basic methods to accomplish that goal: force account, volunteers and groups, contract, and hybrid contract.

The **force account method** is when the agency performs the work with its own personnel and equipment. The agency must have skilled personnel and enough of them to efficiently perform the work. The other key ingredient is having the proper size and types of equipment to accomplish the construction tasks.

A crew of volunteers gets ready to work on trail maintenance

With the **volunteers and groups method**, a local club or organization takes on the construction of the project. Volunteer labor is often used as match dollars in grants, and many grantors require or will score an application higher if there is a volunteer component. There are also agencies and associations (like the Student Conservation Association) that have organized trail crews available for hire. With both of these, having skilled personnel, experienced supervision, and the proper equipment is essential.

The **contract method** is the most common option. A solicitation is prepared to hire a contractor to perform all or most of the work.

A **hybrid contract** is where the vendor is required to utilize and train volunteers to accomplish portions of the work. Though maybe not the most efficient, this method is popular because local enthusiasts receive necessary trail training that they can use later on for maintenance or implementation of another project. As with the volunteers and groups method, the volunteer component provides contributed funding, or match dollars, for grants.

Armed with a variety of tools, this paid crew from a local village is ready for construction.

The Preconstruction Packet

The construction method selected will determine the scope and complexity of the documents needed for the preconstruction packet. One of the documents that forms the foundation for all of the other preconstruction data is the trail management objective (TMO). Drafted after developing the concept plan and finalized after location and design, the TMO provides key information that triggers guidelines and parameters for design, construction, and maintenance. The TMO guides whether a rock gets taken out for a smooth tread or left as a technical feature. The TMO must be treated as a guideline and adjusted for regional and actual site conditions (there are too many variables with any trail to have a one-size-fits-all set of parameters). It shouldn't be used as an agency-wide standardized document. It is intended to be trail specific. Construction drawings and specifications are then drafted to convey the desired output to whoever is performing the work.

Pitfalls

If the packet is complete and well written, the vision can be adequately transferred to the contractor, but that doesn't always happen. Here's why:

Pinnacle Peak TR #801	
Trail Log	
Mile Post	**Description**
0.00	Begin construction at Pinnacle Peak trailhead. Install entrance management barriers and signing as per typical section EM1.
0.05	Install 18"x14' dual wall plastic culvert with headwall.
0.65	Construct armored rolling dip + lead-off ditch right.
0.86	Choke tread width down to fit between the two boulders. Do not disturb the boulders.
0.91	Cut danger tree 25' on left.
1.01	Construct turnout right.
1.22	Begin 6" compacted trail hardening rock.
1.29	End trail hardening rock.
1.35	Junction with TR#802 right. Construct T junction as per typical section JCT2.
1.41	Entering rock garden for 35'. Track equipment over this section and do not excavate rocks.
1.48	Outslope grade sag to drain left. Construct sump as staked.
1.52	Construct turnout left.
1.59	Do not disturb rock step-up. Construct easy-out on left as staked.
1.73	Junction with Road 2315-650. End construction.

A trail log is one useful piece of information for the preconstruction packet. More information is available at greatohvtrails.com

Lack of training. In general, it appears that there is a lack of training on preparing and administering an effective trail contract. In some cases, it has also become a very complicated and time-consuming process. Because of this, some agencies tend to avoid contracts or submit poorly crafted contracts.

Inadequate contract time. Often it takes longer than anticipated for agencies to prepare the contract, but still have a drop-dead date to expend grant funds and that results in a short contract performance time. A short contract time reduces the pool of available contractors and increases costs because the contractor loses flexibility to schedule this work with other projects or is forced to perform when weather or soil conditions may not be ideal.

Missing, incomplete, or inconsistent documents. If the agency doesn't have the time or the skills to craft a good contract, there can be errors. This leads to contract delays, perhaps change orders, and increased administration and contract costs. It takes time for a contractor to submit a bid. If the work to be performed is unclear, the bid cost will likely go up.

Using inapplicable terms or specifications. Using non-OHV terms like "freeride" or "coasters" indicates to a contractor that the agency really doesn't understand what it is doing or what it wants. This could increase bid costs. Because they are considered the standard, some contracts have requirements for tread outslope, the 50 percent rule, and the 10 percent average grade rule. Agency personnel should ensure that the terms used will provide the product they want before they automatically insert those terms into an OHV contract.

Inadequate cost estimate. Contracts often get cancelled when the bids exceed the agency's estimate. This adds time and cost to the whole contracting process and may delay the implementation of the project. Someone knowledgeable in trails, structures, equipment, and the sequencing and performance of trail construction should prepare cost estimates.

Cookie-cutter contracts. To save time or due to lack of training, cut-and-paste contracts are prepared, but no two projects are identical. The agency can individualize a project and transfer the vision in the supplemental contract clauses, special project specifications, project-specific drawings, and the trail log, but these typically receive the least attention in a cookie-cutter contract. These types of contracts can create poor communication, which can result in a higher bid cost, higher contract administration costs, and a product on the ground that may not be the desired product.

The cheapest isn't necessarily the best. There may be someone locally who is enthusiastic and inexpensive, but does just anyone with a skid loader understand the intricacies of trails and have the proper equipment to build a great trail? If the work goes out for bid, many agencies are required to accept the lowest bidder. The reason to have well-written specifications and drawings is to make it clear to all what the intent is and what constitutes an acceptable product. That helps put all bidders on the same page and helps narrow the range of bids.

Evaluation Criteria	
1.	Experience in performing mechanical OHV trail construction and reconstruction.
2.	Experience in operating a trail dozer with a blade of 48” or less. Operators must have 2000 hours minimum operating time.
3.	Demonstrate experience in operating in a variety of soil types and topography.
4.	Demonstrate understanding of the physical characterisitics necessary for a motorized trail to be rideable while protecting surrounding resources. These characterisitics include design (difficulty level, user needs, safety); engineering (inslope, outslope, tangents, circular curves, superelevation, drainage, “rideable flow”); resource protection (conserving soil, maintaining aesthetics, protecting vegetation, using care and discretion when parking or turning equipment, protecting sensitive plant populations and cultural resources).
5.	Actual OHV riding experience of the contractor and/or employee. (Riders generally have a better understanding of the items in #4.)
6.	Ability to follow and perform scheduled preventative maintenance on a trail dozer.
7.	Ability to recognize mechanical issues before they become mechanical breakdowns.
8.	Ability to train others in trail dozer operations.
9.	Member of the Professional Trailbuilders Association.

If the agency does not require accepting the lowest bid, it is very important to clearly describe how the bids will be evaluated. These criteria can be very specific, right down to the type (not brand) of equipment and its capabilities, experience in relevant motorized trail work, level of operator skills and training, etc. Spending time crafting the Evaluation of Quotes will provide flexibility in selecting the best bidder.

Section 2: Construction

The Construction Process

“Construction” means moving dirt and includes new trail construction, existing trail reconstruction, or trail relocation. Regardless of who does the construction, the nine-step process is, or should be, the same.

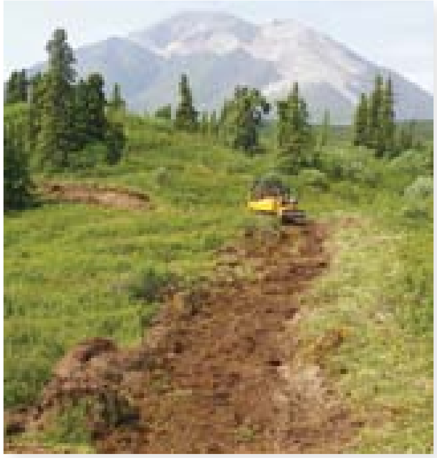
In remote areas, campsites for the crew are often required. These must be designated and approved in the preconstruction process.

Sometimes sizable areas are needed for staging equipment and materials.

Working ahead of the trail dozer, this crew has cleared the trees and heavy brush.

The dozer is removing the organic layer of vegetation and grubbing stumps. Note the high-cut stump for increased visibility and leverage.

An excavator is a good tool for grubbing and slash disposal because it can pluck stumps, scatter material without damaging other vegetation, and strategically place material to help control use.



This trail has been cleared and grubbed. Rough access is being pioneered in.

1. **Mobilization.** This is the movement of personnel, equipment, and materials to the job site. In remote areas, this can involve the establishment of base camps. Depending on the site location and complexity of the work, mobilization can be a substantial and costly task.

2. **Clearing.** This is the cutting of trees and heavy brush within the trail corridor (normally top of the cut to toe of the fill).

3. **Grubbing.** This is the removal of stumps and their roots.

4. **Slash disposal.** This entails the removal of all woody material from within the trail corridor.

5. **Pioneering.** The next step is to rough in a tread or create a bench for the equipment to work on.

6. **Structures.** Unless there is other access, work on non-tread structures like bridges, culverts, and retaining walls as soon as there is adequate access to get materials, personnel, and equipment into the site. Depending on the terrain, this could start as soon as the pioneering is completed. Other structures like rolling dips, ditches, and sumps occur during excavation and embankment since excavated structures are usually used as a source of borrow material to help raise the grade of the trail tread.

In most cases, access and work by heavy equipment must be sequenced and completed before the final trail prism can be shaped.

Once pioneered, the next passes build the cuts and fills to shape the trail prism and establish grade.

The slope board and sheepsfoot roller are good finish grading tools.

A 37" wide mini-excavator constructs a single track trail and it looks wide and rough.

Once riders have established a line, vegetation quickly re-establishes itself in the uncompacted portion and the trail now has a nice 18" natural-appearing tread.

7. **Excavation and embankment.** This is the process of establishing the grade and the desired trail prism. Cuts are excavated and fills or embankments are constructed.

The lack of pruning in the finish work has created poor sight distance at this trail junction. The ATV (arrow) is barely visible. The close decal spacing on the junction marker makes the numbers harder to read.

8. **Finish grading.** Often referred to as the last pass, this is the final shaping and compacting of the trail tread and any related tread structures. This work must be consistent with the TMO and trail log.

9. **Finish work.** This is all of the work that "makes it look pretty."

It includes:
- Final shaping and smoothing of cut and fill slopes;
- Pruning and lopping of roots protruding from the tread or cut slope;
- Installation of signing, cattle guards, fences, and gates;
- Constructing headwalls;
- Obliterating stockpiles, and equipment storage areas, staging and camping areas;
- Removing damaged vegetation;
- Closing undesignated areas;
- Final scattering of slash;
- Removing all flagging, stakes, or other construction controls;
- Seeding or replacing forest litter on all disturbed soil areas.

A new trail always looks rough and wide for the first year after construction. There has often been a lot of disturbance and it takes time for those impacts to heal. Once vegetation starts to re-establish and the unused portions of the trail tread and site get covered with forest litter, the trail will quickly appear to be narrower and more natural. However, this will only occur if the trail has been located, designed, and constructed properly.

Note: Though the process is the same for most trails, the sequencing of the process may not be the same due to the vegetation, topography, or complexity of the project. On many machine-built trails, grubbing, slash disposal, and pioneering occur simultaneously.

Management

No matter how the work is performed, there is a need for some level of construction oversight and project management. The agency usually provides this management, and the designers help to carry the project vision through construction. This work can also be outsourced to a contractor. Construction management includes project coordination, compliance inspection, documentation and reporting, information sharing, recognizing and avoiding pitfalls, and recognizing the need for change.

The project manager meets with a stakeholder to discuss maintenance of a road used by both parties. Meetings like this help foster relationships that are based on open communication and trust.

Project coordination. This can involve a multitude of tasks, including ensuring that materials and supplies are ordered and delivered so that the work can proceed in a timely fashion; sequencing the work so it flows smoothly and logically; scheduling, coordinating, and overseeing volunteer work parties or other trail crew work; ensuring that any required permits are secured; scheduling any required resource surveys; ensuring conformance with any seasonal work restrictions; meeting with stakeholders to discuss issues or concerns; ensuring that construction controls are in place or replacing any that are missing or damaged; renting or repairing equipment; and purchasing any necessary tools or supplies that are needed by the work crews.

Compliance inspection. Regular inspections help keep the projects running smoothly.

The inspector:
- Ensures the specifications are adequate to produce the envisioned product.
- Ensures the work meets the intent and project specifications.
- Coordinates necessary parties to resolve any discrepancies between the product and the specifications.
- Ensures workers are in compliance with any required safety certifications.
- Strives to increase safety awareness, conducts safety briefings, and discusses job hazard analyses (JHAs).
- Observes the work and discusses any unsafe practices or conditions.
- Ensures compliance with any required work shutdowns for fire, wildlife, weather, etc.

Documentation and reporting. There is a saying "If it isn't in writing, it didn't happen". Document the progress and quality of the work, preferably on a daily basis. Take photographs. There can never be enough photos. It may be several months later before the team discovers that it needed documentation regarding events on a particular day. Ensure that volunteer records or records of any other personnel, materials, or equipment that is used as match for grants are kept.

Information sharing. Everyone likes to be in the know, and some parties need to know what is happening with the project. Use photos to prepare regular project updates for management, advisory committees, grantors, stakeholders, or the media. Photos are a great tool to document the progress of the project, increase project awareness, and increase political and public support for the project or agency.

Recognizing and avoiding pitfalls. Experienced trail project managers know how the work should be performed and when it should be performed. When something is out of sync or is heading in the wrong direction, taking immediate action to discover the cause can avert downtime, accidents, or other delays in the work progress or quality.

Trail construction is fun and rewarding because the team can see the trail take shape on the ground, but it can also have inherent hazards and risks. It is important to take appropriate action to minimize those hazards and mitigate the risks. This is especially important for equipment operations. Workers need to be trained in how to safely approach and how far to stay back from working equipment.


The operator is looking down to see what might stop him if something happens on steep ground. With loose soils, a spotter needs to be on-site.

There are times when equipment can be working in precarious locations. Some agencies require spotters or equipment safety personnel to be on site any time the equipment is working, but certainly when the risk is high, a spotter should be on site as should the project manager.

The project managers also need to be aware of the resource concerns and values in the project area and to take appropriate action when those are encountered. It is not uncommon to suddenly see an unusual population of plants; discover a TES nest or den; or unearth a bone, tooth, or arrowhead. Someone needs to be watchful in these situations because there are often legal protection requirements and what happens next can delay or stop the project altogether. Being forthright about any discoveries can build trust and credibility with resource specialists.

Recognizing the need for change. Implementation is the last chance to get it right. In spite of all of the concerted efforts in planning, design, and preconstruction, sometimes the intent just doesn't fit the ground as anticipated. The project managers need to be on the alert for these situations so changes can be made early before large amounts of time, money, or materials are invested.

Pitfalls

Weather delays. Either extremely dry or wet weather can preclude effective or safe trail construction or even access to the project site. If contract time is inadequate to accommodate these delays, a contract modification may be required that could delay construction or increase costs.

Material delivery delays. Sequencing, poor project management, or inclement weather can delay the delivery of materials and supplies. Depending on the amount of other types of work to be performed, this could delay or stop the construction progress. If the agency was responsible for providing these materials, a delivery delay could result in a claim and increased contract costs.

Any delay in material delivery, project sequencing, or weather could impede the completion of this major structure and perhaps other trail or project work.

The trail was designed (flagline) to go up a rock step-up which would have been consistent with other features on this trail, but the builder chose to avoid it by moving off to the right and putting in a 90 degree turn above the tree. The result is a loss of a challenge feature, tread durability, and flow.

This chicane was not designed. It was created by the equipment operator who wanted to make the trail more challenging. This should not be done.

Tip, Trick or Trap?

Tip: Great trail construction isn't about how much dirt you move, it's about how much dirt you conserve

Creative license. There are times when the flagline needs to be changed, but there are also times when the crew leader or equipment operator takes creative license and arbitrarily changes the design. Unless the crew leader or operator is also the project designer, this is inappropriate. If the trail has been properly designed, there has been a thought process involving analysis and informed decisions for the location of every flag and every aspect of the design. But the worker may not know, understand, or agree with those decisions. Any changes should be discussed with and approved by the designer or project management.

Failure to adhere to specifications on a complex trail like this can result in structure failure, resource impacts, and the loss of a considerable investment.

Unskilled operators. Equipment operators can make or break a project and make the construction process a joy or a hassle. They can take a great trail design and build a poor trail or take a poor trail design and create a great trail.

Inexperienced work crews or contractors. When it comes to trail construction, there is no replacement for experience. Trails can be intricate and require a great deal of innovation, field design, and finesse. Having someone who knows what to do, when to do it, how to do it, and how to appropriately adjust it for the site is invaluable. No matter how good the drawings and specifications are, they can't teach someone how to do the work. A local crew may be inexpensive, but if they're inexperienced and make mistakes, the long-term costs of maintenance, repair, or replacement can far outweigh the initial construction savings. Comprehensive specs and drawings along with a well-written evaluation of quotes may help ensure an experienced contractor and a quality product.

The deeper the cut, the higher the likelihood of encountering solid rock. Having air tool capabilities makes this less of an obstacle.

Inadequate oversight or contract administration. It doesn't do any good to prepare a thorough preconstruction packet if that packet isn't effectively administered in construction. Inexperienced oversight and inspection can lead to as many problems as inexperienced workers or operators. Unskilled oversight, infrequent site presence, unfamiliarity with the process or the end product, or permissive inspection that allows non-conformance with the specifications can all lead to poor agency-contractor relations, claims, and a substandard product. It can be difficult to confront someone when the product or procedure is not meeting a specification, but a contract is a legal and binding document for both the agency and the contractor. Both parties are at risk of claims when there is non-compliance with the specifications. The contract administrator manages that risk.

Equipment down time is project down time. The project manager and operator discuss the source of and remedy for a hydraulic leak.

Inadequate documentation. When something goes wrong, there is an immediate need to find out why it went wrong. It takes time and effort. There can never be enough photos, and daily diaries can never be too thorough.

Preconstruction errors. Preconstruction is the communication bridge between design and construction. No matter who performs the construction, shortcuts taken in the preconstruction process can become very evident and costly in the construction process.

Unanticipated site conditions. Any time excavation is involved, there is a chance of encountering any condition that was not evident from surface investigation. This can result in a design change, contract modification, lost time, and lost progress on the project. This risk can be minimized by digging at least cursory test holes during the design process. Any subsurface information should be outlined in the preconstruction documents. Bid costs will likely rise when excavation is required and subsurface information is nebulous.

Equipment breakdowns. With equipment, the question is not if, but when, there will be a breakdown. They rarely occur at an opportune time or location. No one can afford to have back-up equipment or a warehouse full of parts on site, so equipment downtime can mean project downtime unless there are other types of work to be performed.

Accidents. Trail construction has hazards and risks, but certainly a nightmare for any project is to have a vehicle, equipment, or personnel accident. Regardless of fault, everyone loses when an accident happens. Lost time, lost money, personal injury, workmen's compensation, an investigation, or a damage claim can result; it's all ugly and uncomfortable. Projects and OHV programs have collapsed due to accidents. Work diligently to manage the risk.

Change Construction Method. How a trail is to be constructed affects how the trail is located. A hand-built trail is not located the same as a machine-built trail. It can be a mistake to take a trail that was intended to be machine-built and build it by hand. A hand crew will take the path of least resistance and go around trees, stumps, and rocks. This will alter the designed flow of the trail and possibly the drainage. Likewise, a trail that was designed for hand-build may squeeze between features or go over terrain that a machine cannot traverse. If the construction method is going to be changed, take the time to adjust the flagline first.

Great trails are created through planning, design and construction. Great trails are kept through great maintenance and management.

Post-construction Management

A trail is most susceptible to the forces of compaction, displacement, and erosion during the first year after construction. Protect the investment. Consider closing the trail immediately after construction and let it sit over the winter or whenever the wet season occurs. Sometimes demand and political pressures are so high that this option is not practical, so consider closing the trail until there have been a couple of wet weather events. These options are especially important if the trail has been constructed during the dry season and the tread and embankments are unconsolidated. The weather will help provide natural compaction and cohesion.

A speed event was conducted on this trail shortly after it was constructed. The result: deep ruts and failure of designed drainage. Weather events will help consolidate a new trail tread, premature speed events can destroy it.

If possible, the first use on a trail should be light and low impact so displacement is minimized and compaction can occur slowly and evenly over the whole tread surface. Severe impacts can occur if an event is scheduled during that first year. With most soil types, a newly constructed trail cannot sustain a high volume of use in a short period of time.

Don't schedule a speed event within the first year of constructing a trail.

A Closer Look...

There is a perception that since trails have a small footprint, they are simple: anyone can design one and anyone can build one. That misconception has resulted in poor riding experiences, erosion, visual scars, resource impacts, and ultimately closures. Though riders or the motorized use are often blamed for these impacts, it was the poor location, design, and construction that created them. With a closure, riders lose recreation opportunities which often are not replaced. What isn't often recognized is that a closure represents a failure by the agency to effectively provide for and manage the use. One of the purposes of this book is to help agencies avoid that situation by giving them the tools to create great trails, either by building new ones or fixing old ones. A great trail is a success story. It's a win-win for the environment, the agency, and the riders. We can achieve that success only by the effective and equal implementation of all five components of the Great Trail Continuum.

Need more? Learn more here...

Trail Construction and Maintenance Notebook, USDA Forest Service, Technology & Development Program, 0723-2806-MTDC, July 2007

Standard Specifications for Construction of Trails and Trail Bridges on Forest Service Projects, National Technology and Development Program, October 2014; http://www.fs.fed.us/recreation/programs/trail-management/trailplans/

A Look Back...

Here are some of the elements discussed in this chapter:

- Preconstruction is the bridge between planning, design, and construction
- Preparing a detailed, comprehensive preconstruction packet will help carry the vision forward into construction, facilitate the construction process, and help ensure a quality product
- The supplemental contract clauses, special project specifications, project-specific drawings, and the trail log are the key places to individualize the project and transfer important information to a contractor
- Recognize the common preconstruction pitfalls and invest the time and effort required to avoid them
- The construction process is essentially the same for every project: mobilization, clearing, grubbing, slash disposal, pioneering, structures, excavation and embankment, finish grading, and finish work
- Whether performed by the agency or contractor, good construction management and contract administration are essential to ensure proper sequencing of the work, quality control, conformance with specifications, and coordination and communication between the agency, stakeholders, and the contractor
- Good post-construction management of the trail by temporarily closing or limiting use will help protect the integrity of the new trail and facilitate the re-establishment of vegetation

Chapter Seventeen
Conversion and Closure Techniques

Constructing an OHV project often involves natural surface roads. Almost every OHV trail project includes these roads to some degree, whether it's using natural surface roads as trails or converting abandoned roads to trails. There are benefits and risks to both, but often it is easier from an environmental analysis standpoint to re-purpose an existing impact rather than create a new one.

Effective closure and rehabilitation techniques are essential to controlling and directing the use and providing resource protection. They are essential tasks when converting natural surface roads to trails. They also allow the managers to demonstrate the effectiveness of the program, which can reap significant political rewards that may garner support for the project, agency, and manager.

An excavator places debris and installs logs in a herringbone pattern to close off hillclimbs on a sensitive grassland. Note the hand-seeder and bucket of seed ready for immediate application.

Converting Natural Surface Roads to Trails

A road conversion is not a paper exercise. It is all too common for managers to take a natural surface road, delete it from the road inventory, add it to the trail inventory, put up a sign, and call it a new trail. This is really the first step, but it does nothing to address the inherent issues with roads nor does it address the lack in quality of the recreation experience. Not dealing with those issues will likely result in resource impacts and management problems if not management failure. The second step is to physically transform the road corridor into a natural-looking trail corridor with a fun, flowing trail.

With a little creativity, many natural surface (NS) roads and abandoned railroad grades can be converted into quality trails. Leaving roads as they are and calling them trails results in trails that are too straight, too fast, too boring (too easy), and have poor drainage and poor water management. The objective of a successful conversion is to transform those negatives into positives.

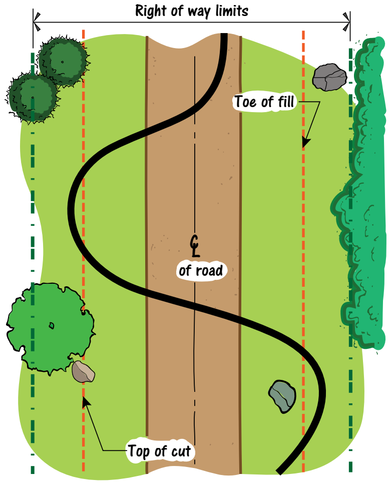
Field trips with stakeholders, media, and agency personnel are an excellent way to document progress on key issues and highlight your successes. They provide real-world perspective and foster communication and trust. The political power of these field trips cannot be overstated.

Here are some key points on how to accomplish a successful conversion:

- Determine the operating parameters: what is considered "the road"? Is it the physical road or is it the road right-of-way? The right-of-way is wider than the road and will give designers more options to be creative. If it's the road, then normally that definition should be from the top of the cut to the toe of the fill.
- As with everything else, provide variety. If some segments of the NS road provide a good experience and have sustainable elements, leave them as is and work on other segments.
- In the segments that are left in their current condition on the existing alignment, narrow up the roadbed to the designed trail width, if possible, to reduce the size of the tread watershed.

- To provide horizontal flow, create a serpentine alignment within the road corridor. The degree of sinuosity will depend on the intended difficulty level and the amount of available vegetation and topography to provide screening and relief.
- To create vertical flow and roll, take the trail up to the top of the cut and back down or better yet, take it to the top of the cut and down to the toe of the fill if the topography will allow. This provides drainage and reduces the size of the tread watershed. It also provides a roller-coaster effect that increases the fun factor.
- If the NS road prism is flat, a serpentine alignment will still help with drainage by reducing grade and increasing the number of turns. If the NS road has a ditch line, run the trail through the ditch for drainage. If there are no other options, install rolling dips.
- Remove culverts in minor drainages and replace them with armored drains. This will reduce potential maintenance problems, provide a drain by dipping down into the channel, make the trail appear more natural, and increase the experience of the rider.
- If there is latitude, leave the NS road occasionally to dive into adjacent thickets or rock piles. A thicket allows the designers to tighten the alignment and reduce speed. Rocks provide an opportunity to increase challenge and variety.
- Drag in rocks, logs, stumps, and brush to help define and protect the integrity of the serpentine design. Transplanting clumps of living vegetation provides a natural-looking barrier. The objective is to break up and disguise the old road corridor as much as possible.
- Seed all disturbed areas, including the new trailbed, with a mix designed for the region. In the east, this may consist of replacing forest duff, which contains seeds and natural mulch for protection, and in the west it usually requires the application of a seed mix. Seeding the trailbed

Strategically placing readily available material can produce a significant difference in the horizontal alignment.



Converting roads to trails

Just moving the alignment onto this old berm increases horizontal and vertical flow and provides two drainage points.

Removing culverts reduces maintenance, restores natural hydrology, provides a dip for trail drainage, and improves aesthetics.

A ditch is being cut along this trail to drain the trail tread and intercept water seeping out of the inside bank. Note that the excavated material is being used to raise the elevation of the trail tread.

Tip, Trick or Trap?

Trap: If road conversion is just a paper exercise, it will likely fail

helps stabilize the soil during the first season, allows rapid establishment of vegetation on any unused (therefore uncompacted) portions of the trailbed, and helps combat invasive species. This will also help the trail appear more natural.
- To provide a good seedbed, rip all unused and unvegetated portions of the old roadbed.
- In the right growing climate, even if no other work is done, just stopping vegetative maintenance will allow brush to start encroaching into the road prism. Usually, just removing full-size vehicle use will eventually allow re-establishment of vegetation in the unused portion of the roadbed.
- Install entrance management structures, signing, and filters as needed.
- An excavator is a versatile tool for conversions since it can build trail, rip and close the old surface, pluck and place stumps and rocks, transplant clumps of living vegetation, and drag in debris.

The designer took advantage of this old landing to leave the road corridor to provide sinuosity and drainage.

This is a poor example of road to single track conversion because it's too straight and boring, but it does demonstrate how vegetation will re-establish itself once full-size vehicle use is removed leaving a near-perfect tread width of 12". Unfortunately, most of the vegetation is invasive and the road corridor should have been seeded to help combat this.

This road was half-ripped and entrance management was installed to deter full-size vehicles. Nine years later, vegetation has re-established and the road looks like a trail. The landscape is dynamic and it is important for designers to possess long-term vision.

Here the trail pitches up to the top of the cut bank, around some trees, and then back down again. Though short, it provides diversity for the rider, sinuosity, and drainage.

Not desirable, but we don't operate in a perfect world. This is a steep road approach and erosion was an issue. To reduce the tread watershed and provide effective drainage, half of the road was converted to a ditch and the excavation was used to raise the grade of the remaining half. Water was diverted off the trail at the top of the hill and a culvert was installed under the road at the bottom of the hill. It's working well and it looks good.

An excavator is a good tool for conversions. Here it is digging a hole to place a strategic rock. Boulders appear more natural and are harder to displace if they are dug into the ground rather than placed on top of the ground.

Rocks define a serpentine corridor which slows the riders before approaching the bridge. In this wet environment, this old road corridor will quickly transform into a great trail.

This road to trail conversion is adjacent to a major trailhead and campground and the kiddies kept riding the ripped up portion. We finally installed these juniper posts to deter that activity and they worked. Utilize the 4E's to implement, evaluate, and adjust as necessary.

Nothing was done to this road except remove the full-size vehicle use and stop vegetative maintenance. In this good growing environment, it has quickly converted to trail width complete with leg slappers. It would have been better to have a serpentine alignment, but at least in this segment, the road corridor is obscured.

One nice thing about a roadbed is that it can provide a wide platform to accommodate creative design. This feature provides drainage, but it also provides three approach lines and three different experiences. If more native rock had been available, three levels of technical challenge could have been provided also.

This is a poor conversion of a road to a trail. The road goes right up the bottom of this draw, the fall line, and there is no drainage for ½ mile. Though the grade is low, there has been enough erosion for the trail tread to have dropped more than 2 feet in 15 years. This will continue unless the trail is relocated out of the draw. With this gentle topography, a serpentine trail crossing to both sides of the draw would have been far more sustainable and fun.

It isn't pretty, but stumps were available and the price was right. In a dry environment, it becomes more difficult to define and produce a serpentine alignment.

Tip, Trick or Trap?

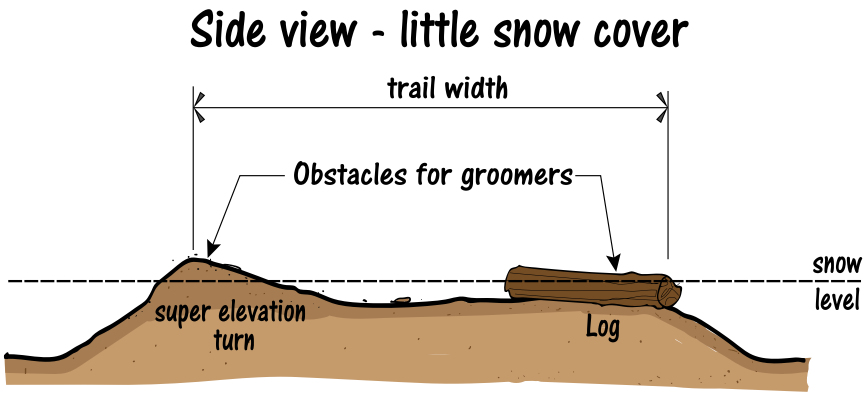
Tip: Ensure that the use pattern has been successfully changed before investing in expensive rehabilitation treatments like transplanting or native seed mixes

This is great use of an old roadbed and a good example of techniques to reduce the size of the tread watershed. Half of the old road has been turned into a ditch to lead water into the culvert. Then the designer pitched up onto the cut bank to create a grade reversal which also added flow. Excess road width on the left side was removed (arrow) and used as fill to build a bench for the trail on the old cutbank.

Using Snowmobile Routes and Trails as OHV Trails

Because they are existing infrastructure, there is a temptation to use snowmobile trails as multi-season trails. There are pros and cons to using snowmobile routes and trails that the managers must evaluate to make an informed decision.

Routes. Many snowmobile trails utilize existing roads. If that is the case, then the normal road risks need to be considered: too flat, too straight, too fast, too boring, poor drainage, and large tread watersheds. Because most snowmobile trails are groomed, the ability to convert a snowmobile trail to an OHV trail is normally limited. Snowmobile groomers are not able to make as sharp or tight turns as an OHV. In areas with marginal snow depths, the groomers will not lay down a trail that will cover up superelevated turns or other obstacles in the OHV trail.



Trails. If the snowmobile trail is an actual trail and not a route, then there is another set of considerations:

- Since snowmobiles operate over frozen ground, the trail may cross over surfaces that are not sustainable or available when the ground is not frozen. These can include wet areas, farm fields, or drainage ditches. Prior to opening a winter trail to summer motorized use, the trail tread must be reviewed during spring or wet conditions to verify its sustainability.
- To hold snow, snowmobile trails are often located in draws to provide shade. This works for winter use, but in the summer, those draws can be water courses with soil, riparian vegetation, and wildlife concerns.
- To hold snow, snowmobile trails are often located on north-facing slopes. These slopes may have water issues in the summer.
- Snowmobile trails are not usually designed for wheeled vehicles. A snowmobile trail goes over the ground and, for the most part, stumps and groundcover vegetation are not disturbed. An OHV trail lies on or in the ground. Snowmobile moguls get groomed out, but OHV ruts will channel water.
- Because they are groomed, snowmobile trails will have a wider corridor and flatter horizontal and vertical curves. This can compromise the trail experience and decrease challenge and flow.
- Drainage is normally less of an issue on snowmobile trails, so there can be long, steep grades and large tread watersheds that will be detrimental and not sustainable for an OHV trail.


The trailhead for this OHV trail is a snowmobile parking lot and access limitations forced co-location of the trails. A serpentine OHV trail meanders down this snowmobile trail corridor and it works well at this site. In 5 years, the Yield Ahead sign has not been hit by the groomer, but note how the Yield symbol has faded.

If the decision is to use a groomed snowmobile trail, then managers and designers can incorporate the same techniques described for natural surface road to trail conversions, but on a conservative scale. Whatever is done must not hinder grooming operations, including OHV trail signing. If winter signing is not applicable to summer use, then those signs should be covered or replaced with multi-use signs or changed to fit the season.

Effective Closure and Rehabilitation Techniques

There are political benefits of effective trail closure and rehabilitation. Past impacts need to be rectified to ensure future use. Although riders tend to see closure as a negative, a loss of riding opportunity whether it was good or bad, closures are usually a necessity for effective OHV management. The goal for an effective closure is to plan it and implement it so it changes from a lose-win to a win-win scenario.

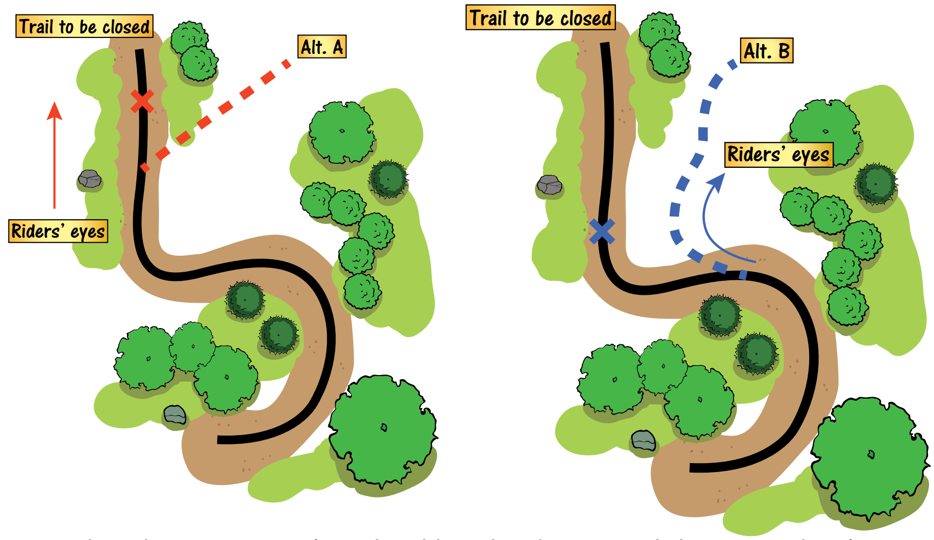
Whether closing a trail, trail segment, road, or area, the closure and subsequent rehabilitation process is essentially the same. To determine the best closure strategy, consider the intensity of use (high versus low), duration of use (historic versus recent), proximity to high traffic areas (trailheads, staging areas, destinations), visibility (who can see it, from how many vantage points, from how far away?), growing climate (wet versus arid), political climate (risk to public safety, agency risk, risk to resources to be protected), and management history (new program versus established program, good versus poor compliance or success).

Tip, Trick or Trap?

Tip: Avoid closing one trail before opening another

Below are the nine steps to success. Not all of these steps have to be implemented, but the chances of success will increase with an increase in the number of steps taken.

1. **Provide an alternate route.** Before starting closure and rehabilitation work, it is essential that the existing use is redirected.



Directing the riders' eyes away from the old road to the new trail alignment is key for increases compliance.

The best way to accomplish that is by:

- Providing an alternative route that still connects Point A to Point B, if possible;
- If circumvention is not possible, providing an attractive route(s) someplace else;
- Ensuring that any new trail is of a higher quality (longer, more fun, more challenging) than the one being closed; and
- Informing the riders of these changes before starting the closure process.

The key point is to not close a trail before opening another route and to try to give riders something more than they lost. When riders realize that they can still get to where they want to go or have a new higher quality opportunity, compliance with the closure will significantly increase.

2. **Manage the riders' eyes**. If managers don't want the riders to go somewhere, avoid focusing their eyes on that location. This is especially important for closures and rehabilitation. Focus the riders' eyes away from the corridor to be closed so the closure will be more effective.

3. **Restore natural drainage patterns.** If the trail to be closed is a fall line trail, water will run down it and not in the natural drainageways. Install lead-off ditches to intercept this water and direct it back into the natural drainage course.

4. **Install erosion control.** Controlling water volume and velocity is essential to effective closure and rehabilitation. Erosion control structures need to be installed to heal the impacts of past erosion and reduce the potential for future erosion.

Here are some considerations for erosion control methods:

Steep, unstable ground forced the trail to stay on the existing roadbed, but the designer has created a nice sinuous flow. Ripping the unused portion of the road increases water absorption and decreases the tread watershed.

- In deeper trenches, install check dams to help divert water into the lead-off ditches above.
- Between ditches or if ditches are not required, installing check dams in the trench at regular intervals will decrease the velocity of the water and allow it to drop its sediment load. The sediment provides a seedbed to aid in the re-establishment of vegetation. Eventually, the sediment will build up and help stabilize the sides of the trench.
- Check dams are normally made of logs or rocks, but sandbags and hay bales also work well. They are more temporary, but they usually last long enough for vegetation to get re-established.
- If check dams are not required, install soil, rock, or log waterbars at regular intervals.
- Placing logs or rocks in a herringbone pattern works well to control water and stabilize the erosion process. Using sandbags, hay bales, or straw wattles works well if native material is not available.
- Even just throwing woody debris into the trench will help.
- Placing logs at an angle across hillclimbs will serve as waterbars and help deter use.
- For roads, remove culverts and restore natural drainage channels.

It was a struggle to revegetate this road corridor. Seed was tried first and failed. Next transplanting was done and it failed also. Finally, a wildfire burned it and the next spring, it looked great.

5. **Rip or scarify.** Scarifying is scratching the surface and ripping is gouging the soil 12 to 18 inches deep. The goal is to break up the compacted soil to make it a good seedbed and to increase the soil's capacity to absorb water. Whether to rip or scarify depends on the soil type and depth of compaction. Whichever method is used, it is best to rip in a sinuous line rather than a straight line. This is accomplished by alternately locking one track and then the other. The "S" pattern improves the aesthetics of the product, loosens the soil better, produces smaller clumps of soil, reduces the potential flow of water down the ruts, and often drags in vegetation and debris from the sides of the road or trail.

6. **Disguise the corridor.** This involves dragging in rocks, brush, stumps, logs, and clumps of vegetation to break up the line of the old corridor and visually disguise it. At a minimum, this is done as far as the eye can see at the termini of the closure. But if the trail can be seen from other vantage points, then the whole length of the closure needs to be treated. As in road conversions, an excavator is a good tool to quickly accomplish this work. Don't go overboard with falling trees or piling brush to block the corridor. The goal is to make the corridor look natural and a mass of jackstrawed trees can actually draw attention to the corridor. That being said, it can be difficult to close and disguise a corridor that has been used traditionally by wildlife or livestock. In these cases, fencing or heavier debris placement is needed to discourage use.

Depending on the tree species and size (juniper works well), consider creating living barriers by making a backcut only and carefully pushing the tree over so it remains attached to the stump. The tree will stay green and provide more of a visual barrier to disguise the corridor, and a tree that is attached to the stump is much harder to move out of the way.

7. **Re-establish vegetation.** In most places, this is best done in the fall so the seed can germinate with the warmth and moisture of the spring; however, it is also best to seed or replace forest duff immediately after the ripping or scarifying. Some soils can form a crust that can inhibit the penetration of the seed into the soil and reduce germination success. Transplanting clumps of vegetation with the roots intact can provide an instant visual barrier that will last.

In some regions, seed doesn't take well and there can often be better success by transplanting native vegetation. This can be labor-intensive and expensive, but it can also make a great volunteer project.

Consult with a specialist to determine the best seed mix for the climate and region or if native seed mixes are required. If it is unclear if the use pattern has been changed, then seed with a quick-growing annual seed. This will supply the needed visual effect and soil stabilization in the short term until the more expensive treatments can be applied for the long term.

Fires can be devastating, but their heat releases seeds that have been buried dormant in the soil for years. That's why burned areas are so green the following spring. Fire can be a good tool to establish vegetation in difficult areas and to help hide visual scars on open slopes.

Adding straw or other mulch on top of the seed helps protect the seed from displacement during weather events and fosters germination by providing a cooler and wetter microclimate.

8. **Install signing and barriers.** Sometimes just the disguising will be enough to deter use, but signing and barriers are often needed for a site that is highly visible or has had a high level of traditional use. Sometimes a sign can be installed first and if that doesn't work, then back it up with a barrier. A good sign explains the closure, the reasoning for the closure, and redirects the riders to the new routes.

The living barrier is a great technique for a well-anchored, long-term visual obstruction. No undercut and the backcut is only deep enough to be able to push the tree over.

Here are some thoughts regarding signing and barriers:
- Always install the sign in the middle of the trail to be closed, not off to the side. The sign makes more of a statement and more of a barrier when placed in the middle of the trail.
- Whenever possible, drag in a log, brush, or even sticks and place them directly behind the sign. Though small, this creates an additional visual barrier, but more importantly it helps in managing the riders' eyes, which are usually scanning for the path of least resistance. A simple stick can turn the riders' attention elsewhere.
- Signing that explains the rationale for the closure can increase its effectiveness.
- It takes more time and money, but a manmade barrier is more effective at deterring use than natural debris. A tree can fall down and riders are used to seeing natural debris. When a conscious effort is made to install a barrier, it makes a stronger statement both visually and psychologically.
- Put debris behind a sign and a barrier in front of the sign.
- Barriers send a message, but they don't need to be a physical deterrent. Often a simple low barrier is equally effective and less visually intrusive than a multi-rail fence.
- Do not use tank traps as a barrier when closing roads. Ripping and debris are more effective and reduce agency risk.

• Rarely does installing only a sign alone work. Back up the sign with ripping, debris, or barriers.
• Don't invite failure or risk. Never install a fence or barrier across a trail that has not been ripped, blocked, and signed as closed.

9. **Utilize the 4Es.** Effective application of the 4Es is essential to the success of any closure effort.

Some key points are:
• Engineering is used in the design and placement of erosion control structures. It is also used in the design of the signing and barriers. Opening another, nearby route that is designed before the trail is closed will increase compliance.
• Educate the riders. Use posters on the kiosk; place notices in club newsletters, the media, the agency or trail system website; or use social media to inform riders of the closure and why the trail is being closed. They may not agree with it, but compliance will be better if they understand the rationale behind the closure.
• In some situations, enforcement may be needed, but again effective engineering and education will reduce the need for enforcement.
• Evaluation is critical. The site must be monitored for effectiveness and any breaches or missing signs must be fixed immediately. People sometimes initially push back, but persistence by the agency will usually squash that quickly since most people have better things to do. When dealing with the public, nothing is ever 100 percent guaranteed.
• Make necessary adjustments. As compliance is ensured and the vegetation is becoming established, consider removing the signs and then the barriers to avoid drawing attention to the site.
• Finally, document successes. What method(s) worked the best? Take before, during, and after photos. They can be a valuable tool to garner political support and to help ensure the acceptance and success of future actions. Conduct field trips with stakeholders, media, and agency personnel to highlight the management successes.

Expect setbacks, but use the 4Es to determine the cause and beef up the engineering, education, or enforcement to correct them.

An example of poor sign placement. Granted no one will run over this sign since it's protected by the tree, but with no ripping, disguising, or barrier, this closure is totally ineffective.

If the ATV wasn't in the picture, one would wonder which trail is closed, or maybe both are open and the sign means no cross-country travel. This sign fails to clearly communicate the intent of management.

This was a high-use, historic trail that went through several sensitive plant populations. A by-pass trail was constructed and in four years, there was only one breach which happened immediately after the closure. There was a Trail Closed sign, but the botanist recommended taking it down since the trail was healing up so well. A few years later, the barrier was removed as well. The small bitterbrush plants in the foreground were transplanted by hand.

An excavator has just finished scarifying, adding drainage, and scattering debris. The project manager followed by taking down stakes and flagging and seeding all disturbed areas.

This is the same site nine months later with 100% compliance. A good example of effective rehab and closure.

These are good, simple signs that are effective and to the point.

This is a sandy site that had been rehabbed two years earlier. The soil is stable and vegetation is starting to re-establish. The "path" on the outer edge of the trail has been made by cows. This will deter the revegetation and water may eventually run down that path. Rider compliance has been 100%.

It appears that use has been eliminated on this well-disguised road and the revegetation is well on its way. Depending on where the riders' eyes are focused, it may be time to consider taking down the sign since it is now drawing attention to a site that is pretty well camouflaged.

There are risks of using tank traps for closures. They make a poor closure device and invite failure. Once again, the road leading up to the structure and beyond it was not ripped or blocked. This road is adjacent to a subdivision where residents wanted OHV access to the forest. Converting this road to a trail may have been a better management strategy than trying to close it. When possible, work with human nature rather than against it.

Managing OHV use in the desert can be tough since it's physically possible to ride almost anywhere. Here, riders were short-cutting a curve in the trail, but after placing a simple row of rocks as a visual deterrent, there are no tracks on the short-cut. No signs and no expensive barriers were needed to change the use pattern.

Just above this site, a ditch was installed to direct water into the natural drainageway. Check dams were installed in the trench near an equipment access point. Woody debris was placed in a herringbone pattern between check dams. The treatment was a little overboard, but the political sensitivity was very high. The far left photo is how the area looked on the day of treatment. The left photo was taken two weeks later.

The woody debris effectively manages the riders' eyes at this site, but the signs give a mixed message. The area is closed, so stay on the closed trail? Stay on Trail or Stay Home should be used as an education sign on an open trail, not a closed one.

This low, simple barrier and some Area Closed signs have effectively protected this pumice flat with several populations of sensitive plants.

Review the considerations for developing a closure strategy. Obviously, just putting up a sign and a fence which is now cut was not adequate. Without an alternate route, trying to close a trail that appears open is difficult without ripping and blocking. The riders get blamed for these breaches, but poor management is equally at fault.

This is a good example of what not to do. Obviously, there had been an issue with OHVs riding through the creek, but a well-designed fence or barrier directing riders to the bridge would be far more effective and visually appealing than this clutter.

Before and five years later. Once a hot-bed of controversy, a major trail ran through this stream that feeds a community water supply. The access trail was effectively closed and rehabbed and the site has totally recovered. WOW. This book is about great trails, but a great trail is a package that includes not only the trail, but the successful management of the trail and the area around it.

Once in the dense trees all of these hill-climbs have been effectively blocked and rehabbed, but a lack of funding has prevented further work at this site adjacent to a prior staging area. The sign alone is ineffective and look at the amount of sedimentation. In an area dominated by OHV management success, this highly visible site gives the impression of failure and sends the wrong message to visitors on their way to the new trailhead.

This section of road has been effectively closed and around the corner, the rest of the road has been converted to a trail. Leaving the road marker here only invites a breach by a full-size vehicle.

Some areas require intensive techniques, but with the proper funding, materials, and expertise, successful closure and rehab can be achieved.

This more formidable barrier was destined for failure due to improper and ineffective closure techniques.

A Look Back...

Here are some of the elements discussed in this chapter:

- There are benefits and risks in converting roads to trails. If done properly, the risks are minimized and the benefits are maximized.
- Effectively converting a road to a great trail requires creativity and vision.
- The versatility of an excavator makes it a good machine for both conversion and closure.
- Before considering using snowmobile trails as OHV trails, understand the site and the risks to make an informed decision.
- Successful closure and rehabilitation techniques are essential to controlling and directing the use and providing resource protection.
- By demonstrating adept OHV management, there can be political benefits that can bolster project support.
- Effective closure includes implementing as many of the following steps as possible in a given situation:
    - Provide an alternative route. Avoid closing one trail before opening another.
    - Manage the riders' eyes.
    - Restore natural drainage patterns.
    - Install erosion control.
    - Rip or scarify.
    - Disguise the corridor.
    - Incorporate effective measures to revegetate the site (seeding, transplanting, burning, spreading forest litter, etc.).
    - Install signing and barriers. Do not install a fence across a trail that has not been ripped or blocked.
    - Utilize the 4Es.
- A great trail is a package; it's a composition of elements that includes not just the trail, but the successful management of the trail and the area around it.

PART FOUR

Preserving the Trail Continuum

OHV recreation is a great way for people with mobility disabilities to get into the great outdoors.

Chapter Eighteen
Managing and Maintaining a Great Trail

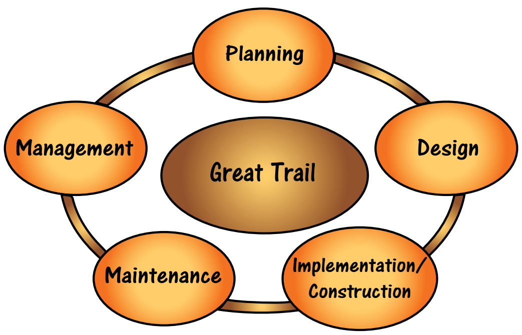
Manage for People, Not Machines

What keeps a great trail great? The answer is effective management and maintenance. Management and maintenance are not the night crew who has to clean up and fix errors made along the way; they are part of the team working as one to produce a great trail. Successful long-term management and maintenance have to be not only a consideration, but a driver in trail and program planning, design, and implementation.

Section 1: Management

One of the goals of this book is to provide proven tools that will result in durable, quality trails, instead of management nightmares. The entire team must understand all of the considerations in a given scenario and make informed choices. Sometimes, that process can be complex and sometimes there is not a clear choice between one option and another. Going through the thought process will almost always produce an outcome that is better for the riders, resources, and programs.

THE GREAT TRAIL CONTINUUM



Management Focus

There are four focal areas of management: managing the riders, the trail, the facilities, and the program.

1. **Managing the riders.** OHV recreation must be managed. To the extent possible, all team members do that by providing for the riders' needs through visionary planning, creative design, and effective communication. They enhance the recreation experience by managing the riders' eyes, providing a variety of experiences and challenges, maximizing recreation activity time, and delivering effective communication.

Wheelers line up to prepare for a run on a challenging trail.

This beautiful trail has the appearance of professional management and maintenance. Just the look of it enhances the quality of the rider experience.

2. **Managing the trail.** The trail tread and related trail structures are precious resources. Team members manage those resources through sound design. They protect those resources by managing the riders and attaining integrated resource management. They perpetuate those resources through effective maintenance. They protect resource values and the area surrounding the trail through quality design that manages the riders' eyes; incorporates the proper structures; effectively communicates with the riders; and utilizes proper closure, restriction, and control techniques.

3. **Managing the facilities.** Facility management includes providing and managing properly designed facilities in the right locations, with adequate capacities and appropriate amenities. For quality customer service, facilities need to have a professional appearance and be kept clean and functional. They also enhance the recreation experience and play an important role in communication that will aid in trail, rider, and program management.

Neat, clean, and functional, this trailhead provides good customer service and communication.

4. **Managing the program.** There cannot be a great trail without creating a great OHV program. The program consists of conducting timely assessments, ensuring adequate funding, having adequate staff with the necessary skills and training, obtaining the proper equipment, having routine materials and supplies available, obtaining storage and shop space, setting expectations for quality, establishing priorities, setting personnel performance standards and ensuring they are met, fostering a strong volunteer program, developing internal and external relationships, and establishing an effective O&M program.

With all four of these management focal areas, the one constant is the challenge of managing for change. For the rider, it's changes in the level of use, desired rider experiences, type of use and new vehicle types, and rider demographics. For the trail, it's tread degradation, structure deterioration, changes in resource values, changes created by other agency activities such as vegetation management and fire management, catastrophic events such as floods and wildfires, and constantly changing environment. For the facilities, it's changes in use levels, use types, or desired amenities (campground with showers versus day use). And for the program, it's changes in personnel, funding, internal and external politics, and upper level management priorities. The TMO provides the foundation for how a trail will be managed, but it needs to be modified as necessary to stay current with conditions.

Tip, Trick or Trap?

Tip: Trail data is a great management tool. Information has been added regarding trail data collection to the website at www.greatohvtrails.com.

The 4Es are a tool for adaptive management that can help the managers effectively adjust to many of those changes: implement, evaluate, make changes, re-evaluate. As long as there is a trail or an OHV program, this process should never stop.

Successful Management

The goal for managers is to avoid management nightmares. The managers can accomplish this by committing to quality, providing exceptional customer service, being pro-active, obtaining knowledge, conducting a status check, implementing recommendations, evaluating and adjusting, and sharing.

Commit to quality. The first step is for all levels of management to commit to providing high-quality OHV recreation opportunities that are supported by a quality OHV program. All personnel involved will need to commit to having great trails. This involves a commitment to adequate staffing and especially funding.

Provide exceptional customer service. There is a saying that positive attitudes equal positive programs. The public is not the enemy. The public and public service is why management and the agency exist and their attitude toward the public controls public perception. What agency wouldn't want that perception to be positive? There cannot be a great trail without having a great trail program. That program must be based on great customer service.

Tip, Trick or Trap?

Tip: Positive attitudes equal positive programs

Be pro-active, not re-active. Part of that commitment is to take a pro-active approach to OHV management. Dealing with issues now is better than dealing with a crisis later. That is the only way to successfully manage any resource.

Obtain knowledge. Often, agencies don't know how to provide for and manage OHVs and will shy away from them unless there is someone in the unit who is an enthusiast or activist. Managers shouldn't be deterred by this gap in knowledge, but should be challenged by it. Resourceful managers surround themselves with knowledge and if it isn't available in their unit, they seek it elsewhere. Books like this one can provide a wealth of information. NOHVCC Management Solutions (NMS) was developed to provide strike team support for managers in all levels of OHV implementation from trail management to program management. The tools are out there. Find them and use them.

Conducted as part of a NOHVCC conference, field workshops like this are great places to obtain knowledge.

Conduct a status check. Just like a doctor, the next step is to take the pulse of where the team is compared to where the team should be. This is done by conducting a formal assessment that will give the managers comprehensive information on the status of the trails and the program with detailed recommendations for adjustments. The assessment will help form the vision and provide direction for the agency. If this expertise isn't available within the agency, there are professional contractors who provide these services (NOHVCC Management Solutions, Professional Trailbuilders Association, and others).

Implement recommendations. Implementing recommendations may take some time since it may involve personnel training and acquisition; securing funding through grants or agency sources; planning, design, contracting, and implementation; and equipment and materials procurement. This is also a step that could test the agency's commitment and that is why a comprehensive assessment is necessary. It forms the purpose and need for the actions and gives the agency a firm foundation and justification moving forward.

Evaluate and adjust. The 4Es: is it working? Evaluate, adjust accordingly, and re-evaluate.

Share. An area that needs considerable improvement is the sharing of information, both what did work in a given situation and what didn't work. Some say sound is the number one issue for motorized recreation. While it is certainly a big factor, the bigger issue is fear: fear that the impacts of the past will be the impacts of the future and fear of the unknown that can keep managers and agencies from striking off into uncharted territory. Team members don't know OHVs; they don't understand OHVs; they don't know how to manage

Field workshops are also a great forum to share knowledge and lessons learned: both those that worked and those that didn't.

Tip, Trick or Trap?

Tip: The biggest issue for OHV recreation is fear

OHVs; and they don't fully know the impacts of OHVs. Team members have fears regarding impacts to resources, wildlife, and vegetation; erosion issues; sound issues, etc. Combating fear is what loops us back to surrounding ourselves with knowledge. The primary tool to fight fear is knowledge through education.

Only by sharing can we give others the knowledge and confidence to move forward in providing great trails. Conduct intra- or inter-agency workshops, field trips, or demonstration projects. Invite a state or provincial OHV program administrator to attend the agency's field trip or workshop (see the International OHV Administrators Association, inohvaa.org). Attend conferences like the annual NOHVCC or INOHVAA conference to share the agency's story. Bring in NOHVCC or other professionals for training. Or find another way to get training.

Whatever keyword used; sustainable, durable, quality; the key to creating and perpetuating great trails is knowledge.

Section 2: Maintenance

All trails need maintenance every year, even if it is only a check on the trail conditions. Proper trail location and design will certainly minimize the amount and rate of trail degradation, but effective maintenance is essential to repair the impacts of that degradation process. Maintenance is so important to the Great Trail Continuum; it can perpetuate a great trail, and the lack of it can destroy a great trail.

Maintenance Objectives

Not surprising, the goals of effective maintenance are the same goals used throughout each component in the continuum:

Tip, Trick or Trap?

Trick: After construction, reconstruction, or heavy maintenance, keep the trail closed for a couple of weather events

Provide exceptional customer service. There are many objectives, but most of them point back to the underlying objective of continuing to provide quality customer service.

Ensure continued resource protection. The theme throughout this book has been providing for the riders' needs while ensuring resource protection. Effective management and maintenance are essential to continuing that protection.

Protect rider safety and manage agency risk. This does not mean dumbing down the trail and removing challenge. Challenge is an expectation that is outlined in the TMO; risk is a surprise. If surprise moments arise, fix them.

Protect the investments made through planning, design, and implementation. A lot of time, effort, and money have been invested up to this point. Allowing the trail and its related structures to degrade, deform, or lose their integrity or functionality is a waste of that investment.

Most structures represent a considerable investment. To protect that investment structures need regular inspection and maintenance which should be identified in the annual maintenance plan. Many structures require eventual replacement which should be identified in the long-term maintenance plan in the budget.

Perpetuate the intended design. Maintenance protects the investments by perpetuating the intended design of the trail. Tread material will displace and erode away and rock used for cover or trail hardening will wear away over time. Keeping material and hardening to the intended shape and depth helps ensure that the trail will function as designed. Maintaining the integrity and function of structures helps sustain rider safety, resource protection, and rider experience.

Perform ongoing evaluation. Maintenance personnel are usually the people who are in the field the most; therefore, they become the eyes and ears for management. It is important that they keep an objective eye out to observe and report any subtle changes that may be occurring.

The Maintenance Process

Having a defined process helps the managers and maintenance personnel ensure that maintenance not only occurs but is timely and effective. Managers can increase accountability and quality by assigning the following steps to specific personnel.

Regular condition surveys will identify maintenance needs so they can be addressed before a structure deteriorates to the point that it is non-functional and a risk to the public and the agency.

Develop a maintenance plan. There are two parts to this. There needs to be a long-term programmatic plan that outlines maintenance objectives and how they will be accomplished. It also establishes personnel, equipment, and material needs so that the required funding level can be identified and management can begin securing sources for that funding. There also needs to be an annual maintenance plan that outlines specific maintenance items, who will accomplish them, and how they will be accomplished. This plan can be used as a tracking tool since items can be checked off as they are performed.

Tip, Trick or Trap?

Trap: Avoid having a backlog of maintenance. Once maintenance gets behind schedule, it's very hard to get back on track, so the backlog tends to grow rather than shrink.

Develop maintenance specifications. Many agencies have generic maintenance specifications, but if those are not available or if they do not meet the agencies' specific needs, then applicable specifications need to be written. The specifications are essential for accountability, quality control, and consistency in the maintenance performed. No matter who performs the work, everyone should have the same vision.

Perform condition surveys. Routine condition surveys or assessments form the backbone of the annual maintenance plan by identifying maintenance needs.

Set priorities. Items from the condition survey (or surveys) need to be prioritized and organized in a logical progression that will make efficient use of the personnel and equipment. Sometimes, the needs exceed the capabilities due to a lack of funding, equipment or material availability, or a suitable weather window. The items that don't make it on the annual plan become backlog maintenance items. These items should become maintenance priorities in the next annual plan. The danger of a backlog is that once a program gets behind, it is very difficult to catch up without an increase in infrastructure and funding. The goal of the long-range maintenance plan is to foresee heavy maintenance or replacement needs and get those into the program so there are no surprises or deficiencies in infrastructure when they arise.

Schedule work. The next step is to schedule the work, sequence it, identify who will perform it, and decide roughly when it will be accomplished.

Perform work. Performance of the work can be by volunteers, force account, contract, or a combination of all. No matter who does the work, there is a need for oversight and quality control. The maintenance objectives cannot be achieved without quality work.

Record and report. If it isn't in writing, it didn't happen. Recording the performance of maintenance helps managers and the maintenance personnel track accomplishments of the annual plan and ensure that other work stays on schedule. Progress reports are required for most grants, so accurate record-keeping facilitates the timely preparation of those reports. Sometimes, due to unusual weather conditions or other unforeseen priorities (fire emergencies, equipment breakdowns, etc.), work that is scheduled doesn't get performed or completely performed. It is important to record any deficiencies so that these work items don't get lost and forgotten. These items also get added to the backlog maintenance list and should be a priority in the next annual maintenance plan.

Required Skills for Maintenance Personnel

The skills maintenance personnel need are often underestimated and undervalued. Just like planning, location and design, and implementation, the required skill set is complex and diverse. Quality and efficiency are dependent on having personnel with journeyman-level skills and experience. Proficient maintenance workers should:

Understand the use. This includes the riders, their machines, their desired experiences, and the elements of challenge.

Understand the physical and natural forces. Many of the tasks and skills assigned to maintenance personnel require knowledge of engineering terms; horizontal and vertical alignments and how the alignments affect sustainability; the physical forces exerted by vehicles; and the natural forces of compaction, displacement, and erosion. Maintenance workers need to have at least a basic understanding of soils and know about tread watersheds, water sources, and the importance of water management.

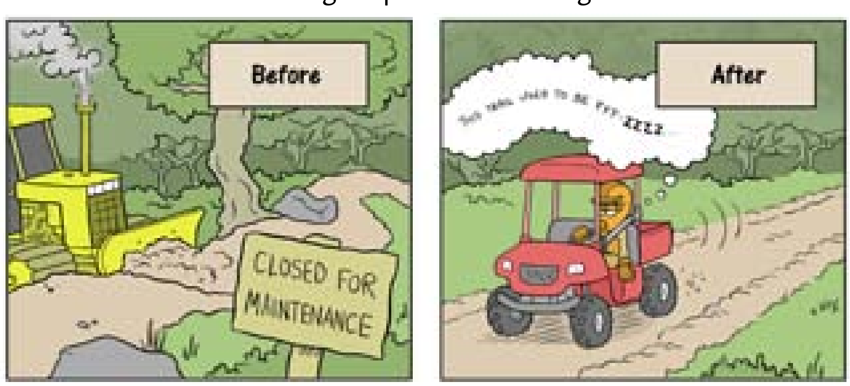
A sight like this is commonplace, but it represents a water management issue. It's important for maintenance personnel to recognize that it is an issue, determine the cause, and identify the solution.

Understand the equipment. Maintenance personnel need to know the types of maintenance equipment available and the capabilities of each. They must be proficient in each machine type they use.

The same site after the solution was implemented: an improvement for the riders, the resources, and a sign of professional management.

Understand TMO. Personnel must understand the TMO. Created in planning and fine-tuned in design, the TMO gives important guidance on the intended riding experience and challenge level. It provides consistency in the vision throughout the continuum. There should be a specific TMO for each trail since each trail is different. It's important not to over- or under-maintain a trail since that can change the experience and functionality of the trail. Since volunteers perform much of the maintenance work, maintenance personnel need to understand the TMO so they can transfer that vision to the volunteers. That is not an easy task and is often overlooked.

Understand the 4Es. Effective application of the 4Es is a fundamental principle in successful OHV management and maintenance. It is a process for recognizing an effect, determining the cause, applying the appropriate remedy, and evaluating its success.



It is important for management and maintenance personnel to understand the TMO for the trail so they don't unintentionally change the difficulty level or experience of a trail.

Recognize symptoms. Without an understanding of the physical and natural forces, maintenance personnel will not be able to detect symptoms before they become problems. Without a trained eye, they could overlook the rill that can turn into a rut and then into a ravine. This can lead to surprises, reactive maintenance, or heavier maintenance that may result in more work being added to the backlog list.

Identify the cause. Using the 4Es, the next step is to determine the cause: Here is a rill. Why is it forming? Where is the water coming from?

Identify the solution. Maintenance personnel need to understand the possible corrective actions and prescribe and implement the proper corrective action. What tools are required? What type of equipment? Who can best perform the work, volunteers, force account, or is the remedy beyond the capabilities on hand and a contractor is required?

Implement the solution. Finally, maintenance personnel need to be able to either perform or oversee the proper execution of the work. Timely implementation is the key to effective maintenance. Don't put it off. Stay on the pro-active side and avoid the re-active side that could add to the backlog.

Maintenance Frequency

Once a program has been in place for a few years, the frequency of required maintenance on each trail will become evident. A change in that frequency could be an indicator of something else going on.

Catastrophic events can be draining to maintenance resources. They will happen, so it is wise to set aside resources for them, if possible.

Weather conditions. Unusually wet or dry conditions that can inhibit effective maintenance work.

Catastrophic events. This could include wildfires, floods, and windstorms. These events can put a significant drain on maintenance and funding resources.

Level and types of uses. A trail can lose its sustainability if the level of use or type of use changed. It can make a difference if there are 10 vehicles per day or 100. If the vehicle type changes, the forces exerted on the trail tread can change, which can result in the need for more frequent maintenance.

Season of use. As a trail or trail system starts receiving more use, some riders will choose to ride midweek rather than the weekend or during the off-season when there are fewer riders. This can enhance the quality of the rider experience, but it can also create more tread impacts if the off-season is the excessively wet or dry season.

This road was starting to grow in and look like a trail, but cutting all of the saplings on the cutbank "to improve sight distance" changed that character in a matter of minutes.

Inattention to red flags. A deficiency in maintenance skills can produce a lack of cognizance of bigger issues and an understanding of what is really going on. Repeated or more frequent repair of the same problem on the same trail is an indicator of a bigger issue that more than likely involves:

- Large tread watershed
- Poor soils
- Poor location
- Poor design

Maintenance Tips

Here are some tips and tricks to help maintain the design and the quality of the experience.

Keep the trail treads narrow. Trails tend to widen out over time through use and maintenance, but it's important to keep the tread width as close as possible to the target design width in the TMO.

Doing this:

- **Reduces tread watershed.** Remember, managing water is a primary element in having a sustainable trail.
- **Enhances rider experience.** One of the fundamental principles for success is providing for the riders' needs. It is essential that the maintenance team keeps the quality of that experience.
- **Reduces speed.** Speed causes issues. Reducing speed reduces potential impacts and resulting maintenance. It enhances the seat time and rider experience.
- **Improves trail harmony.** A trail needs to feel like a trail and look like a trail, not a highway through the forest. Having the trail harmonize with the landscape contributes to the riders' overall perception of a great trail.

Trees are a valuable resource for many reasons. Rather than cut the tree, this one was notched to provide handlebar clearance. It keeps the clearing narrow and also increases the rider experience. Know your tree species. Some cannot tolerate a notch or a notch that is too deep.

This is a very common sight: riders cutting out deadfall, but is it cut out properly, wide enough, and is the slash disposed out of the way? Regular inspection by maintenance personnel will answer these questions. A maintenance tip hotline will give riders a medium to report this activity or report other trees that were too big to cut.

Train volunteers. Volunteers are a great asset but only if they know what they are doing. Volunteers need to be trained in proper maintenance techniques and in the importance of complying with the TMO. At a work party, hand out copies of the TMO and typical drawings or sketches of the work to be done.

Keep clearing narrow. Tight clearing has the same benefits as the narrow tread above and helps create a recreation experience, not a transportation experience.

Unnecessary risk. This log should be cut back at least another 4-5 feet. It would improve the aesthetics of the trail corridor as well.

The trail alignment here is pretty straight and there was no real need for any pruning, but wholesale pruning on both sides of the tree trunks created a very open trail corridor. The result? Increased speed and diminished experience.

Manage sight distance. Sight distance is a double-edged sword. Safety is often increased by pruning on the inside of curves so that riders can foresee oncoming traffic. This is good, but the downside is that when riders can see more, they tend to increase their speed, which negates the intent of the pruning. There are definitely places where pruning is desirable for safety, but consider the potential consequences before doing so. Selective pruning, the cutting of a few branches to create a sight hole through the vegetation, is better than wholesale pruning where everything is trimmed and the whole sight corridor is enlarged.

Manage aesthetics. If they have to be cut, prune limbs flush with the trunk. A professional looking trail enhances the riders' perceptions and can increase not only their experience but their compliance with rules and regulations.

Manage risk. This is perhaps the most important objective of maintenance. Trees fall down, treads saturate and fail, and structures break or fail. If something happens that creates an unsafe condition, fix it, mark it, or sign the trail as closed until the condition can be rectified. Logs that are suspended off the ground should be cut back well beyond the trail shoulder. Signs, especially warning and regulatory signs, need to be in place and legible. Prune encroaching limbs that obscure signs and impede adequate sight distance at road crossings, trail junctions, and other high traffic and high risk areas. Good customer service ties directly to how well rider and agency risk is managed.

Tip, Trick or Trap?

Tip: Use clear tape on all trail junction markers using decals

Maintain signs. Replace missing signs and signs damaged by the sun, vandals, or critters. Use a level for correct position when installing posts or signs. Bullet holes beget more bullet holes. A great trail should appear professional. Crooked or damaged signs indicate the agency doesn't care about the area.

Use clear tape. Applying clear plastic tape over the decals on route markers and junction markers can triple the life of the signs. It deters damage from critters, vandals, weather, and UV deterioration.

Trail groomers are an effective and often necessary maintenance tool.

Find the balance. The TMO provides general guidance, but there is a balance between over- and under-maintaining a trail. If possible, find that balance and stay there. This can be difficult in wet climates and deciduous forests with heavy undergrowth. Maintenance can also be complicated when it is performed by crews from an outside entity that are only on site for a periodic basis.

Broken or illegible signs need to be replaced.

Use the 4Es. The 4Es are important and relevant to all trails.

Avoid bias. Whether force account or volunteers perform the maintenance, everyone has personal bias. Those who don't like riding rocks, remove the rocks; and those who don't like riding over logs, cut out the logs. Try to avoid this bias by training personnel in proper techniques and by following the intent of the TMO.

A few well-placed saplings can deter cutbank riders. Back it up with signing if you need to send a stronger message.

Groomers. Trail groomers can be a very effective maintenance tool, especially on heavily used trails in poor soil types. Several light passes with a groomer are more effective than one heavy pass, plus it is much easier on the grooming and towing equipment.

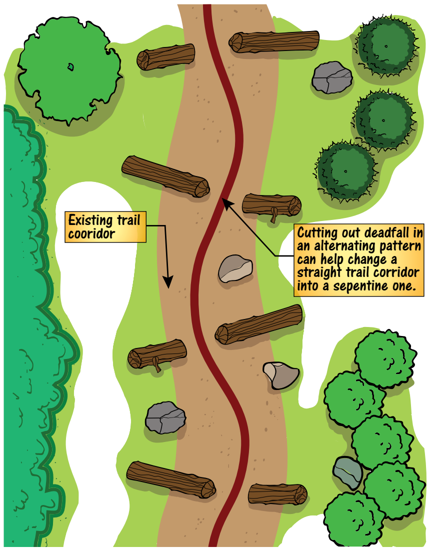
Temporarily close the trail. As in construction, it is beneficial to close the trail immediately after reconstruction or heavy maintenance. Letting the trail sit through several weather events allows natural compaction to occur and the maintenance efforts will last longer.

Manage road riders. Some riders have a tendency to leave the roadbed and ride up on the cut banks. This activity scars the landscape and scars the public's perception of OHV recreation. When cut bank riding occurs, signing alone generally is not effective, but signing and a few well-placed saplings on the cut bank will deter the use and send the message.

The top of this culvert has been damaged and will eventually break which compromises the integrity of the structure and increases agency risk.

Maintain cover. Most geotextiles cannot withstand direct tire contact and some are not UV stabilized. Metal and plastic culverts can be damaged when exposed to direct tire impact. It is important to maintain the designed cover of soil or rock over these installations.

Keep structures functional. This should be an obvious maintenance item, but in traveling around the country, the lack of structure maintenance is all too common and the impacts are evident: plugged culverts; cattle guards filled with dirt; lead-off ditches blocked with debris; breached rolling dips; broken gates, fences, and barriers; broken deck planks or rub rails on bridges and puncheon; and the list goes on. When structures are not functional, the objectives of maintenance are not being met and there is a breakdown in the program that managers need to fix.



Due to a lack of training or awareness, maintenance personnel have bladed out the rolling dip at the top of this steep hill allowing water to run down and erode the slope.

Keep facilities clean, functional, and professional. The role that facilities play in communication, effective management, and quality customer service is important. Having maps in the map box or a clean toilet with toilet paper, deodorizer, and hand cleaner sends a positive message to the riders and says a lot about the agency's commitment to quality.

Be proficient. Have a light hand when operating equipment. Spinning a machine around can tear up the trail tread and damage any underlying geotextiles. Steel grousers can break concrete pavers and damage wood decking. This can be avoided by running the equipment on old conveyor belts or wood planks. This takes more time and effort, but it's usually worth it to protect the investment and integrity of the structure. Use easy-outs or carefully find an obscure route around technical challenge features to preserve their integrity.

Leaving the tree down and routing the trail between the stump and the tree was a creative way for maintenance personnel to enhance the rider experience of this trail, while keeping to the TMOs.

Be creative. When converting a road to a trail, use material that blows down to increase the recreation experience. An uprooted stump can become a gateway. Blowdown trees can be cut out in an alternating pattern to create a serpentine alignment. Going up and around the end of a log can create a drain.

Fortunately, the shape still identifies this as a stop sign, but the lack of color and retro-reflectivity makes the sign ineffective and increases risk. In addition, what message does this send to the public? Perhaps it's okay to shoot and deface signs here. Is this the sign of a professional and quality program?

Set up a maintenance tip hotline. The riders are on the trail more often than anyone else, so make it easy for them to report trees down or other maintenance issues. This could be via a dedicated phone line with an answering machine, email, webpage, or social media; whatever would work the best for the area and clientele. A hotline keeps the riders involved and the agency informed. It's a win-win.

Be sociable. OHV recreation is a social experience and one objective is to have fun. It takes time for maintenance personnel to stop what they are doing, but if the riders want to talk, they should talk to them. In the process of promoting goodwill and customer service, it adds to the riders' overall experience and maintenance personnel can learn a lot about the riders' opinions of the trails, facilities, and program. If riders don't want to talk, a smile and a wave of the hand is still communicating positively with the public.

The trail that used to go up this draw is no longer discernable, but the barrier attracts the riders' eyes and indicates that something used to be there and could tempt off-trail use. Management would be better served to photograph this site to document the success of the closure and then remove the barrier.

Remove signs and barriers when no longer needed. As part of implementation or closure, sometimes a high level of barriers and signing is needed to control and direct use. Maintenance personnel should monitor these installations. Once the use pattern has been successfully changed or vegetation has become re-established, having these signs and barriers can actually draw unwanted attention to the site as well as detract from the aesthetics. Removing these barriers and signs when they are no longer needed will reduce maintenance and replacement costs, ensure resource protection, and increase the rider experience.

Even with goggles, this stob is a face and eye stabber. Riders will tend to reach up and break it off, but sometimes that can make the issue worse rather than better. Limbs tend to rise and lower as the weather and seasons change. Manage your risk by keeping the height of the trail corridor well-pruned.

Recognize when the fix is not the fix. Red flags could be indicators of a trail that isn't where it should be. Taking repetitive bandage actions can't turn a poor trail into a good trail. Over time, it can be more cost-effective to relocate the trail, even if it involves NEPA. This is a fix that is better for the riders, resources, management, and maintenance budget.

Monitoring occurred and off-trail use was discovered to be a fairly widespread issue. Putting up this bright orange closed tape as a barrier was cheap and fast, but it is UGLY. Worse than that, it's a bandage that doesn't address the real problem: lack of education, lack of patrolling, lack of enforcement, and lack of effective closure techniques. The aesthetics of the site was ruined, the rider experience was diminished, and the off-trail use is still an issue today.

The tape was put up, but never maintained or removed. Five years later, what remains is garbage and a testament to ineffective management.

Is this just a puddle or an indicator of something bigger? Upon inspection, the inlet of this culvert was obscured and completely plugged with debris. A lack of maintenance could cause this structure and the trail to fail.

A McLeod is a great maintenance tool. Sometimes, just taking the time to take a few swipes at a berm can keep drainage structures functional. It is important to have maintenance personnel trained to recognize seemingly minor issues before they become major problems and then be conscientious enough to stop their machine, get off, and do something about it.

A Final Thought

Change will always occur. But it is human nature to stay in the comfort zone and fear or oppose change. While that may be the safe place, it may not be the place that is the best for the resources and the riders, which is the underlying premise for this book. Managers should put on their objective hat and go out to look at their trails, facilities, and the quality of the recreation opportunities offered. They should look at them as their customers would look at them. After reading this book, why not do that and see what you see? Is your program at the level that it should be? If not, perhaps it is time for a change.

If people always do what they've always done, they'll never know what they could have done.

Use the tools in this book to manage change, but more importantly, to effect change.

Need more? Learn more here...

International Off-Highway Vehicle Administrators Association, inohvaa.org

National Off-Highway Vehicle Conservation Council, nohvcc.org

NOHVCC Management Solutions (NMS), nohvcc.org

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A Look Back...

Here are some of the elements discussed in this chapter:

- One of the goals of this book is to provide proven tools that will result in durable, quality trails, not management nightmares
- The four focal areas of management: the rider, the trail, the facilities, and the program.
- Successful management includes committing to quality, providing exceptional customer service, being pro-active, obtaining knowledge, conducting a status check, implementing recommendations, evaluating and adjusting, and sharing knowledge
- The key to creating and perpetuating great trails is knowledge
- The primary maintenance objectives are provide exceptional customer service; ensure continued resource protection; protect rider safety and manage agency risk; protect investments made through planning, design, and implementation; perpetuate the intended design; and perform ongoing evaluation
- The maintenance process includes develop a maintenance plan, develop maintenance specifications, perform condition surveys, set priorities, schedule work, perform work, and record and report
- The skill set for maintenance personnel is diverse and complex. It is often underestimated and undervalued.
- A change in maintenance frequency could be an indicator of unfavorable weather conditions, catastrophic events, changes in level and types of use, change in the season of use, inattention to red flags (large tread watersheds, poor soils, poor location, poor design)
- Twenty-three tips for effective maintenance

The result of creativity and artistic vision: a great location, great trail, and great experience.

Glossary

AASHTO – American Association of State Highway and Transportation Officials.

Abney – The predecessor of the clinometer; measures percent and degrees of slope. It is larger and requires both hands to use, but when calibrated properly, it can be more accurate than a clinometer and it doesn't require binocular vision to use.

abutment – The foundation or substructure that bears the weight of a structure.

agency – The entity responsible for managing or administering the project site.

All-Terrain Vehicle (ATV) – A motorized off-highway vehicle designed to travel on four low pressure tires, having a seat designed to be straddled by the operator and handlebars for steering control.

ASA – American Standards Association

belted waterbar – A strip of conveyor belt sandwiched between two pieces of treated lumber and buried in the trail tread with just the belting exposed. The belting is stiff enough to direct water off the trail, but is flexible enough so that vehicles can easily cross it.

Best Management Practices (BMPs) – State-of-the-art techniques or philosophies to help ensure resource protection, sustainability, and management success.

blowdown (windfall, deadfall) – Trees, limbs, or brush blown down or broken off by an event of nature.

bollard – A short wood or metal post buried in the ground and used as a barrier to block or delimit vehicle access. Some are placed and locked into receptacles so they can be removed to allow administrative access.

buffer zone – An area usually of a fixed width around a sensitive property where access or activities are restricted or prohibited.

control point – Points, lines, or polygons that affect where a trail is located. Positive control points are places where the trail has to go or the designer wants the trail to go (trail termini, saddles, cliffs, creek crossings, road crossings, viewpoints, features that will enhance the rider experience). Negative control points are places where the trail should not or cannot go (wet areas, flat areas, sensitive resource areas, fall lines, property or project boundaries, features that will detract from the rider experience).

critical vehicle – The vehicle used to design a structure or facility. Usually, it is the longest, widest, and heaviest vehicle expected to use the facility. Choosing the wrong critical vehicle can adversely affect the functionality of the facility.

curve – Any line that is bent into an arc and is not straight. Any three points not in a row define a curve.

curvilinear – A horizontal alignment that is predominately curves rather than tangents.

damp soil – Some of the voids between the soil particles contain water, but most do not. The dampsurface allows water to infiltrate during rain events rather than repel water like dry soil.

dense graded – A rock mixture where the voids between the bigger rocks are almost totally filled with progressively smaller particles; ie, few voids. Dense graded rock binds well, but doesn't drain well. It is great for tread surfacing or hardening.

double track (dual track) – A trail with or wide enough for two parallel tracks. Its wider tread is designed for vehicles with an axle and three or more wheels. ATV, ROV, and 4WD vehicles use double track trails.

dry soil – None or almost none of the voids between the soil particles contain any water. The surfaces of some super-dry soils will repel water.

dual sport bike – A street-legal motorcycle that is built for the trail as well as the pavement.

easy-out – A bypass or alternate route around a challenge feature. This helps protect the integrity of the challenge feature and allows a group of riders with different skill levels to ride together.

erosion – The removal of soil and rock particles by the forces of wind and water. It is a natural process that cannot be stopped but can be managed. The forces of vehicle tires can accelerate erosion, but sustainable design practices and techniques can mitigate those effects and decrease the rate of erosion.

exposure – An element in determining trail difficulty or challenge. Exposure is the risk of vehicle damage, personal injury, or death if the rider fails to negotiate the trail.

fall line – The direction or path that water takes to run down a slope. Trails located on the fall line will intercept water, which could lead to erosion. The steeper the grade, the more it approaches the fall line.

filter – A technical feature at the entrance of a trail that indicates the challenge and skill level required ahead. Those riders who cannot traverse the filter should ride another trail. Under-skilled riders can create severe impacts attempting to negotiate challenge features. A filter reduces use, protects the integrity of the trail, potentially increases rider safety, and helps the agency manage its risk.

flow – The rhythm of the trail created by repetitive horizontal and vertical undulations in the trail alignment that allow speed to be maintained without harsh braking or accelerating. It creates a smooth and fun trail experience.

flowmentum – Trail alignment that provides high flow and allows the rider to carry his or her momentum through curves or up short grades. Flowmentum increases the fun factor and can decrease tread impacts and maintenance costs.

forb – a broad-leaved herb growing in a field, prairie, or meadow.

four-wheel drive vehicle (4WD) – A full sized motorized vehicle, usually wider than 60 inches.

grade – The amount of elevation change between two points expressed as a percentage. Often referred to as rise over run, it is the elevation change between the two points divided by the horizontal distance between the two points.

grade break – The point where there is a change in the prevailing grade to either steeper or flatter grade. Both are places where there could be an opportunity to drain water off the trail.

grade reversal – Changing the vertical alignment of the trail from negative to positive grade for a sufficient distance and elevation to force water off the trail. As used in this book, a grade reversal is a natural feature designed into the trail layout. It does not refer to a drain dip or rolling dip constructed into the trail.

high-density polyethylene (HDPE) – A tough plastic used in plastic culverts, arches, and other materials. It is also a common substrate for signs.

horizontal alignment – The series of tangents and curves that form the plan view of the trail.

knick – A section of trail that is removed to allow water to drain from the trail tread.

line – A line is a connection between any two points. A line may also be the path of a trail or the path a rider takes (i.e. riders' eyes scan for the easiest line to follow in rough terrain).

linear – A horizontal alignment that is predominately tangents rather than curves.

Maintenance Level 2 (ML2) road – USDA Forest Service roads open for use by high-clearance vehicles and not suitable for passenger cars. Low traffic volume and low speed roads; surface smoothness is not a consideration.

Maintenance Level 3 (ML3) road – USDA Forest Service roads open and maintained for travel by prudent drivers in standard passenger cars. Subject to the requirements of the Highway Safety Act.

mitigation – An action taken to lessen or eliminate potentially adverse impacts from a management action, recreation use, or design choice.

mixed-use road – A road that is open for use by highway legal and non-highway legal motor vehicles.

motocross (MX) track – A closed course consisting of a compressed winding dirt track with hills, jumps, hairpin turns, and whoops.

NEPA – National Environmental Policy Act. The process of analyzing and evaluating the environmental effects of a ground-disturbing project on federal land.

NMS – NOHVCC Management Solutions. A consulting service of NOHVCC.

NOHVCC – National Off-Highway Vehicle Conservation Council.

OHM – Off-Highway Motorcycle. A motorcycle designed to be used off-highway. Also referred to as trail bike, dirt bike, or enduro bike. Can also be a dual-sport bike or a trials bike.

OHV – Off-Highway Vehicle. For the purposes of this book, OHV refers to an ATV, 4WD, OHM, or ROV.

OHV specialist – A person with knowledge and experience in OHV recreation, management, planning, project implementation, and operations and maintenance.

open graded – A rock mixture where the voids between the larger rocks are not filled with smaller particles. Being of fairly uniform size, open graded rock does not bind well, but does drain well so it is good for drainage structures like French drains.

Optimum Moisture Content (OMC) – The point where just enough of the soil voids are filled with water to make the soil bind together very well. The OMC will vary by soil type.

pistol-butted – A tree that is curved at the base similar to the curve of a pistol handle. This indicates unstable ground that has or is moving due to poor soils, high water content, or a combination of the two.

plasticity – Cohesive and able to be molded into a shape. In soils, plasticity relates to the clay content. The higher the clay content, the more plasticity the soil has.

poorly graded – A rock mixture that usually has a maximum size, but the percentage of smaller sizes is uncontrolled and inconsistent so some voids may be filled and others may not. Pit run material which is rock taken directly from the source and is not crushed or mixed is generally poorly graded.

PTBA – Professional Trailbuilders Association.

radius – The distance from the center of a circle to any point on the circle. The radius of a circle is half of the diameter.

Recreation Off-highway Vehicle (ROV) – often referred to as side-by-side or UTV (Utility Type Vehicle). Motorized off-road vehicles designed to travel on four or more tires, intended by the manufacturer primarily for recreational use by one or more persons and having the following characteristics: a steering wheel for steering control; a Roll Over Protective Structure complying with ANSI/ROHVA-1, an Occupant Retention System complying with ANSI/ROHVA-1; non-straddle seating; maximum speed capability greater than 30 mph; less than 80” in overall width, exclusive of accessories; engine displacement of less than 1,000cc; identification by means of a 17 character PIN or VIN.

Recreation Opportunity Spectrum (ROS) – A recreation planning land classification system that defines an area by the probable recreation experience it provides in terms of setting and level of development. The setting is measured by the number of people expected, producing different levels of solitude and the evidence of human use as shown by management activities and degree of development. There are six settings ranging from Primitive to Urban.

retroreflective – The ability of a surface to return light back to its original source. Retroreflective signs and pavement markings bounce light from vehicle headlights back toward the vehicle and the drivers’ eyes, making signs and pavement markings more visible, brighter, and easier to read for the driver.

rill – An eroded groove or channel created by moving water. Their size can vary from being barely visible to being several feet deep.

riparian – Relating to a habitat rich in flora and fauna that is adjacent to lakes, streams, and other bodies of water.

riparian zone – The vegetated area along water bodies that generally consists of trees, shrubs, and grasses that are the interface and transition between the upland and water environments. In some areas, policy and legislation set the width of the riparian zone.

road authority – The agency or entity who either owns the road or is responsible for its operation, maintenance, and management.

rock garden – A section of trail composed almost entirely of loose or embedded cobble rock or boulders. Removing one rock only exposes another rock so the rocks keep coming to the surface like flower buds in a garden.

rock gradation – The maximum size and the percentage of progressively smaller particle sizes in an aggregate mix. For example, a 2” minus aggregate will have a maximum size of 2” with a mix of smaller sizes. The percentage of each smaller size is often spelled out in the specifications for the mix.

rolling dip – A drainage structure usually added to an existing trail to reduce the size of the tread watershed. It involves excavating a sag and building up a crest to create a flattened or reversed grade to help drain water off the trail. To stay functional, a rolling dip requires regular inspection and maintenance.

saturated soil – All of the voids between the soil particles are filled and the soil is incapable of holding any more water. The soil is at its weakest point, has no bearing capacity, and turns into mud. Additional water can no longer infiltrate the soil, causing water to flow off or of pond on the surface. Since soil particles are in suspension, they can be carried off and lost.

scour – The removal of soil particles due to the velocity and volume of water.

serpentine (curvy, snaky) – Trails with back-to-back curves with short or no tangents. A serpentine alignment contributes to flow and fun factor.

single track – A narrow trail with only one track or tread to ride. Designed and intended for single-file motorcycle use.

slick rock – A term used to describe the red smooth slab rock in the canyon country of the southwestern United States. It is generally sandstone and it is not slick, even when wet.

splash erosion - Soil particles displaced by the impact of a drop of rain hitting unvegetated ground. These small displaced particles are then easily washed away during the rain event.

staging area – Similar to a trailhead except that in addition to providing access to trails, it can also provide access to other activities like MX, endurocross, training areas, and concessions. A staging area has a large parking area and is used to conduct events so there may be a pit area, starting area, gas row, spectator area, etc.

stakeholders – Individuals, groups, or entities that have a direct and active interest in the project site. This could include riding clubs, private inholders, range permittees, timber interests, mining interests, irrigation districts, other tenure holders, neighboring residents, utility companies with corridors through the project site, etc.

substrate – The base material used for signs; usually wood, plywood, fiberglass, polyplate, high-density polyethylene plastic, or aluminum.

superelevated turn – A curve where the outside of the tread is higher than the inside; banked or insloped. It offsets centrifugal forces and allows riders to carry their speed through a turn. It can reduce tread impacts from braking and accelerating and increase flow and fun factor.

tangent – A straight line or straight trail alignment. The line between any two points is a tangent.

TES – Threatened, endangered, and sensitive plant or animal species.

trailhead – An access point to a trail or trail system. Used predominately for casual or recreation use rather than competitive or event use. Common amenities include a parking area, kiosk, and toilet. Some have an adjacent campground or area for dispersed camping.

trail log – A list of construction details or work items that a designer prepares for the construction crew or contractor. The items are usually listed by mile point, GPS waypoint, or station (one station = 100 feet, so station 13+50 is 1350 feet in from the beginning of the project).

tread watershed – The area between tread drainage points that collects water onto or drains water into the trail. This includes the area of the trail itself and the area above the trail that topographically drains into this trail segment.

turnout – A designed and constructed area wide enough for two vehicles to pass. A turnout can be any length, but the minimum length is that which accommodates one designed vehicle. A turnout usually has ingress and egress transitions called tapers. A turnout can be desirable in areas of thick vegetation or steep topography.

vertical alignment – The series of tangents and curves that form the profile view of the trail.

waterbar – A drainage structure used to divert water off the trail tread. The trail is outsloped at a 30 to 45 degree angle followed by a barrier of dirt, rock, logs, or rubber belting material. Waterbars are high maintenance and are not recommended on OHV trails.

wet soil – The voids between the soil particles are filled beyond the OMC and there is too much water for bonding. The tread surface is easily rutted and surface ponding will occur.

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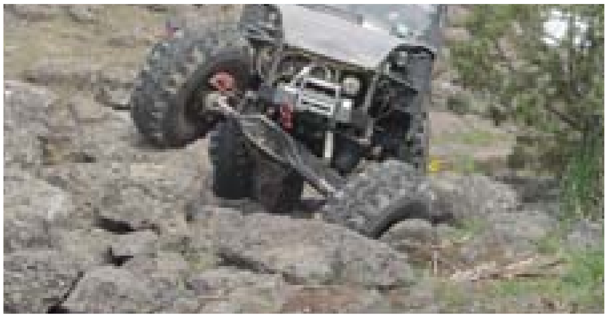

Off-highway vehicle riding is a great way to get into the outdoors

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About the Author

Dick Dufourd has been an avid motorized recreationist for more than 40 years and participates in every OHV segment from motorcycles to ATVs to snowmobiles to 4-wheel-drive vehicles. He has a strong recreation engineering background and spent 35 years with the USDA Forest Service where he gained extensive experience designing and building roads, trails, parking areas, and campgrounds. He became the Central Oregon Interagency OHV Program Manager where he was responsible for developing and managing summer OHV opportunities for the USDI Bureau of Land Management and the USDA Forest Service. This included implementing seven OHV trail systems with 640 miles of trail and eight designated play areas. He secured more than $3 million in grants, developed volunteer programs and trail patrol programs, designed an OHV specific cattle guard, and developed trail grooming drags and other equipment. As the OHV Master Performer for the USDA Forest Service in the Pacific Northwest Region, he was able to consult widely and gain additional experience.

In 2005, Dick retired and formed an OHV consulting business with his wife and partner of 40 years. Through RecConnect LLC, he has gained broad experience in feasibility studies, site assessments, safety assessments, signing, planning, trail and facility design, location, construction oversight, and project management and has now implemented more than 1,500 miles of OHV trails in the United States and Canada. That experience plus the ability to successfully identify and mitigate issues, work with multiple agencies, and work positively with stakeholders and the media has made Dick one of the top OHV authorities in North America.

A great trail lies lightly on the ground and flows and harmonizes with the landscape.

It is the path that takes us into the natural world and the pathway that links that world to our inner selves.

The End of a Great Trail