GREAT TRAILS

Providing Quality Trails
& Experiences - Field Guide

Produced by
NATIONAL OFF-HIGHWAY VEHICLE
CONSERVATION COUNCIL

Chapter 1
Principles of Sucessful OHV Management

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 first underlying principle is that OHV recreation needs to be managed. The use is not going to go away and it cannot be ignored.

>See Great Trails Page 1

The FOUR E's
- Engineering
- Education
- Enforcement
- Evaluation

Chapter 2
Planning the Foundation of a Successful Project

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.

>*See Great Trails Page 17*

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

Trail System Features:	Meet Riders' Needs:
Loops	Connectivity
Mileage	Seat time
Dispersal	Seat time
Scenic diversity	Variety
Terrain diversity	Variety

Chapter 3
Developing the Trail Concept Plan

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.

>***See Great Trails Page 33***

Conducting a Trail Inventory The inventory data will be displayed as points, lines and polygons.	
	Point data could be a control point, unique feature, nest site, etc.
	Line data could be fence lines, utility corridors, roads, trails, etc.
	Polygon data could be a management boundary, cultural site, non-native weed population, water feature, etc.

Chapter 3
Developing the Trail Concept Plan: 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.

Chapter 3
Developing the Trail Concept Plan: Desirable Features

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.

Chapter 3
Developing the Trail Concept Plan: Sample Difficulty Guidelines

Sample ATV Design & Difficulty Guidelines These sample 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 should roll and not be sustained	**Typical Grade**	<20%	<25%	<30%
	Max Pitch	Maximum grades are the exception, not the rule		
	Grade	15-20%	20-30%	30%
	Length	Variable 50’ – 100’ dependent on soils, use type, use intensity, and climate. As grade increases, length on grade should decrease		
Clearing	**Width**	60” – 72”	50” – 60”	50” Maximum
	Height	Seven feet	Six feet	Six Feet
	Helmet and leg slappers	Few	Many	Common

Chapter 3
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Any guideline should be adjusted to reflect local experience and actual site conditions.

		Easiest	More Difficult	Most Difficult
Tread		**Width, Minimum**		
	Sideslope <25%	60”	50”	50”
	Sideslope 25% - 70%	60” – 72”	55” – 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 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; 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 obstacles exceed 10”; obstacles on tangents and curves; tread plane very rough and irregular with long sections exceeding 25% outslope; noncircular climbing turns and switchbacks; long sections of very tight alignment with noncircular curves; entire trail may be soft sand, slippery clay, loose material or mud.

Chapter 3
Developing the Trail Concept Plan: Sample Difficulty Guidelines

Sample ATV Design & Difficulty Guidelines These sample guidelines are to assist in design, construction, and maintenance.
Any guideline should be adjusted to reflect local experience and actual site conditions.

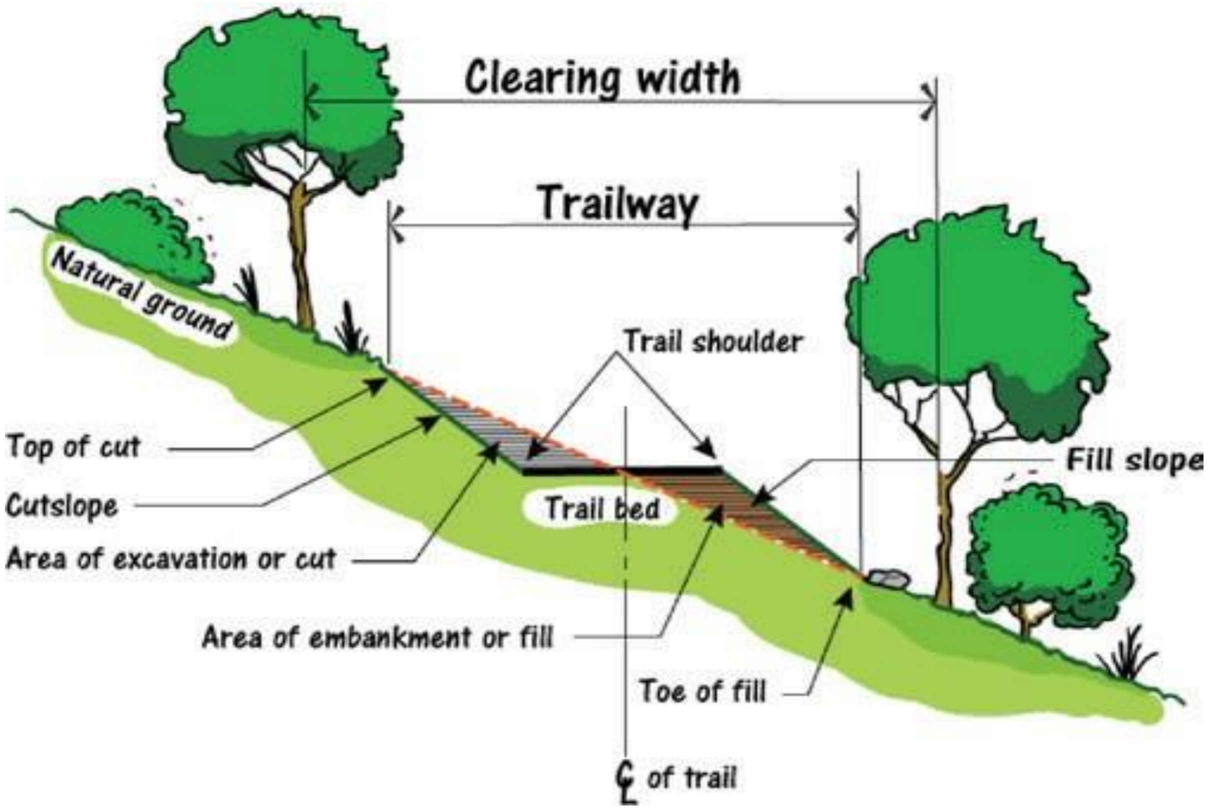
		Easiest	More Difficult	Most Difficult
Exposure		None	Some, potential injury	Could be common, potential for serious injury
Maintenance		Trails receive appropriate maintenance to remain within their TMO, maintain effective signing, and to protect resource values.		

Chapter 4
Engineering and the Natural Environment

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.

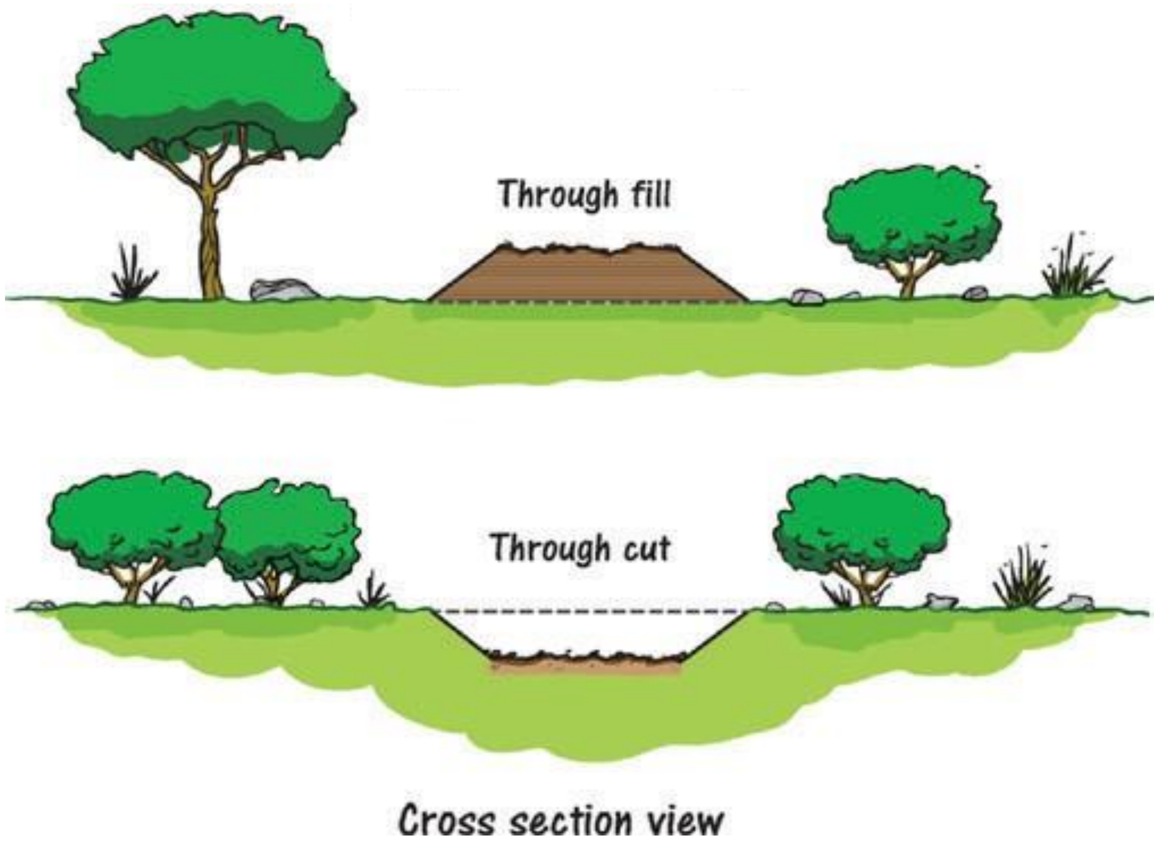
>***See Great Trails Page 51***

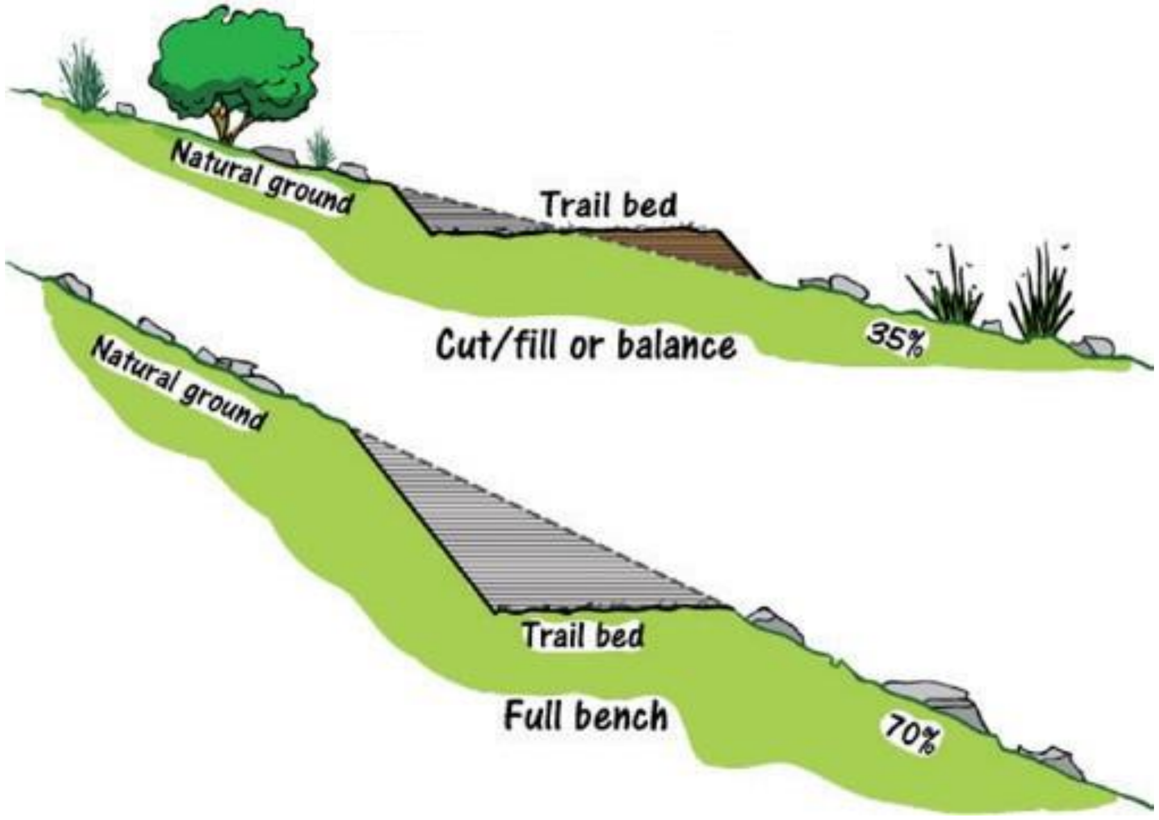
TRAIL TERMS



Chapter 4
Engineering and the Natural Environment

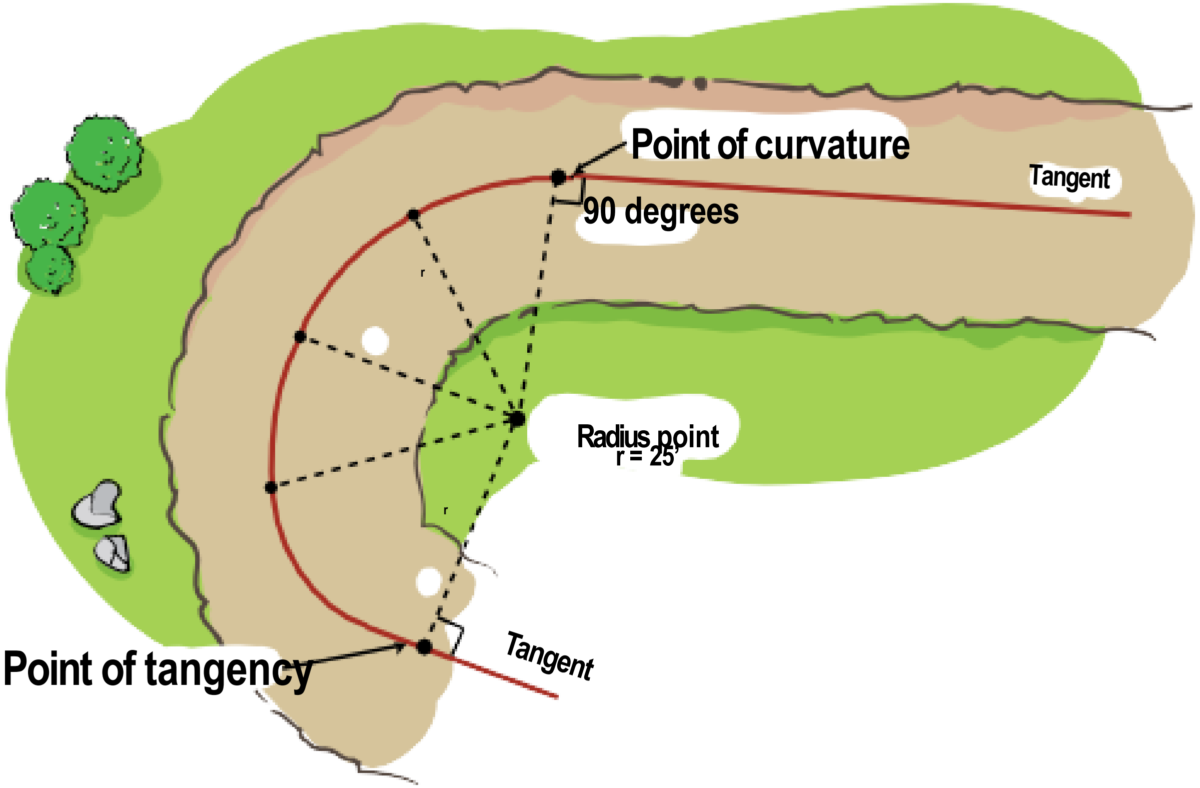
TYPICAL TRAIL PRISMS



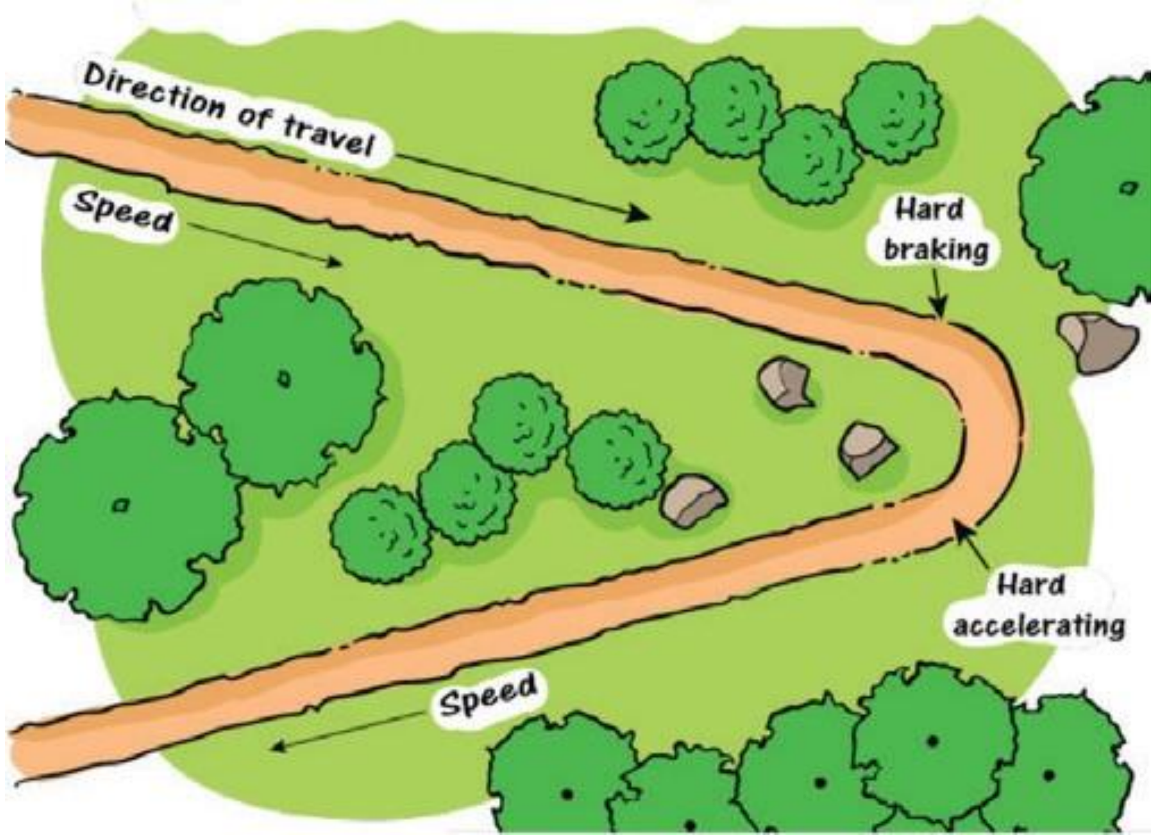


Chapter 4
Engineering and the Natural Environment

CURVES



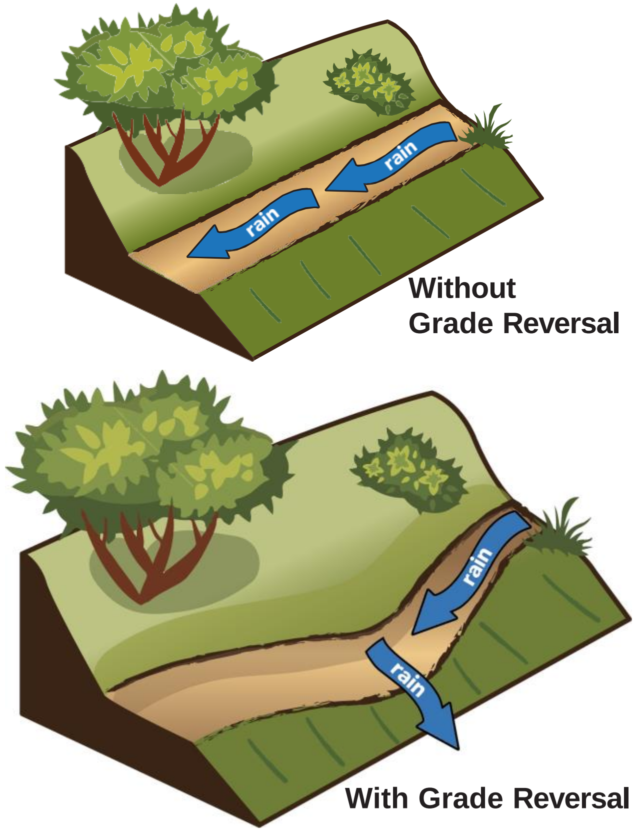
IMPACTS CREATED BY DESIGN



TRAIL ALIGNMENT, GRADE & DRAINAGE

GRADE REVERSALS

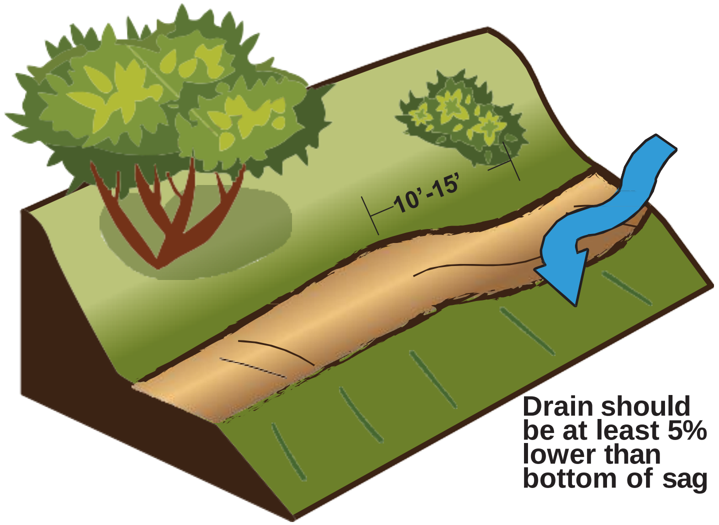
Rolling the grade by changing from negative to positive is 100% effective in stopping water flow down the trail. This is called a grade reversal and it is flagged into the trail location on new trails or the relocation of existing trails; therefore, it is a natural feature and not a man-made structure. 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.

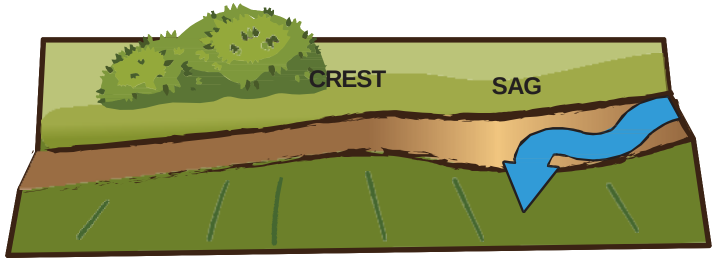


TRAIL ALIGNMENT, GRADE & DRAINAGE

Rolling Dips

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 man-made 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. It is imperative that the bottom of the sediment basin be at least 5% lower than the low point of the "sag." A sediment basin should be constructed instead of a lead off ditch to trap sediment from the trail so the rolling dip can be reconstructed on a regular maintenance cycle. Material should not be taken from the existing tread surface but from the sediment basin itself.



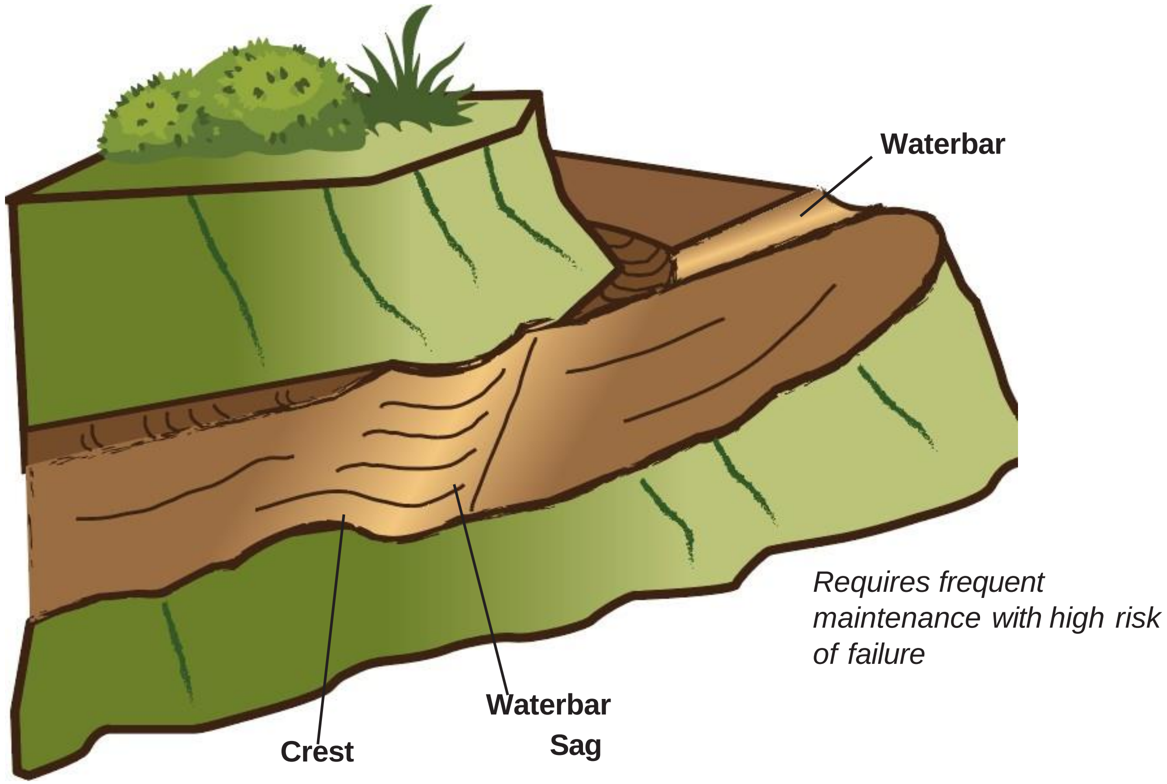


side view

TRAIL ALIGNMENT, GRADE & DRAINAGE

Waterbars

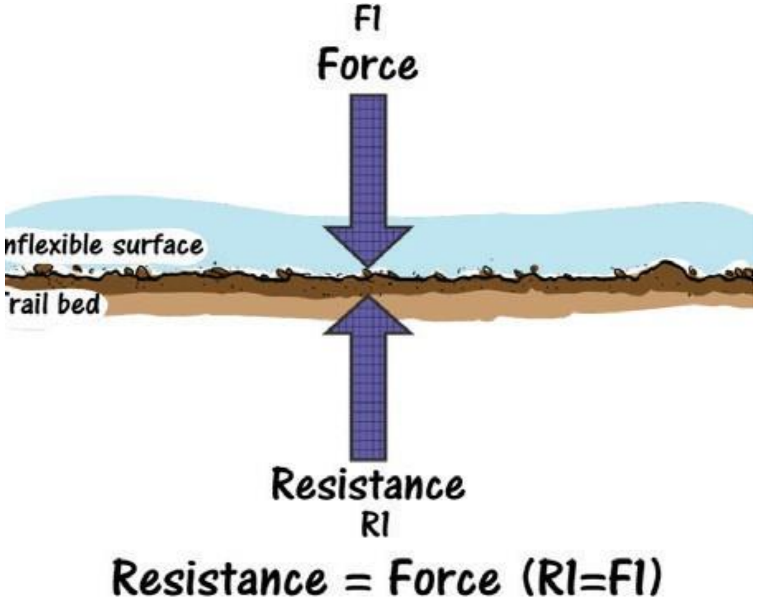
Waterbars, the last category, are also used on existing trails but are not effective on OHV trails. They are short rolling dips with only 2 to 5 feet from the sag to the crest. These create an abrupt hump in the trail and the force of the tires against this hump will cause rapid deterioration and failure of the structure.

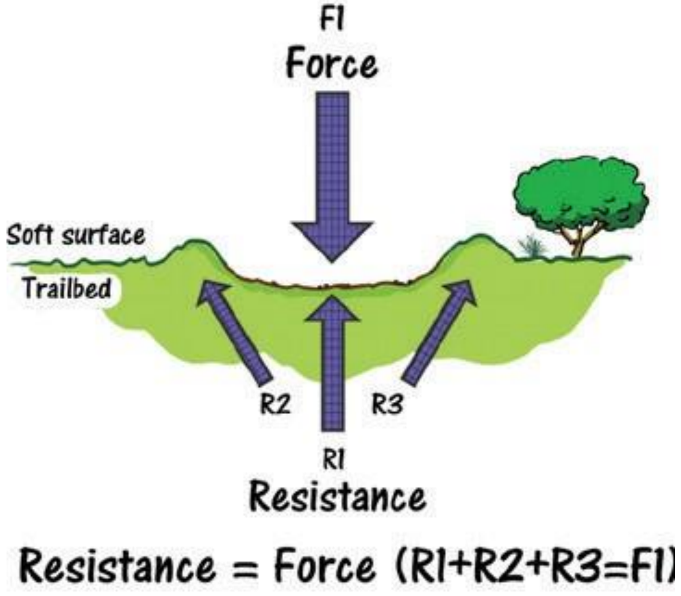


Chapter 4
Engineering and the Natural Environment

COMPACTION

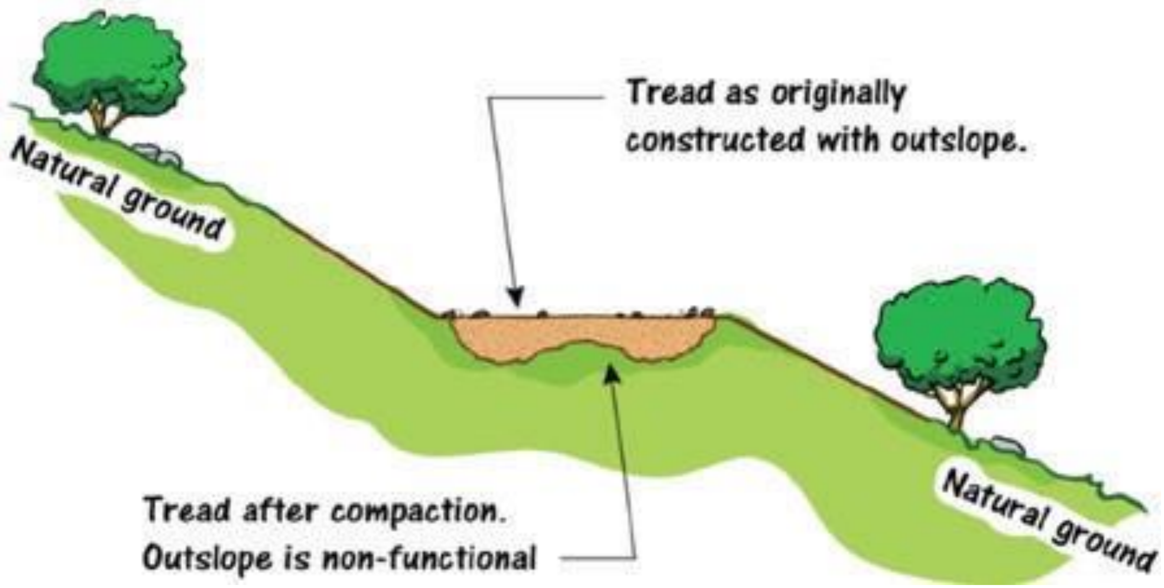
Compaction is the downward force of the vehicle onto the ground. The amount of this force is influenced by the weight of the vehicle, occupants and gear, the number of tires, and the size and inflation pressure of the tires. Compaction is measured as pounds per square inch (PSI). As the contact area of the ground increases, the PSI of contact decreases.

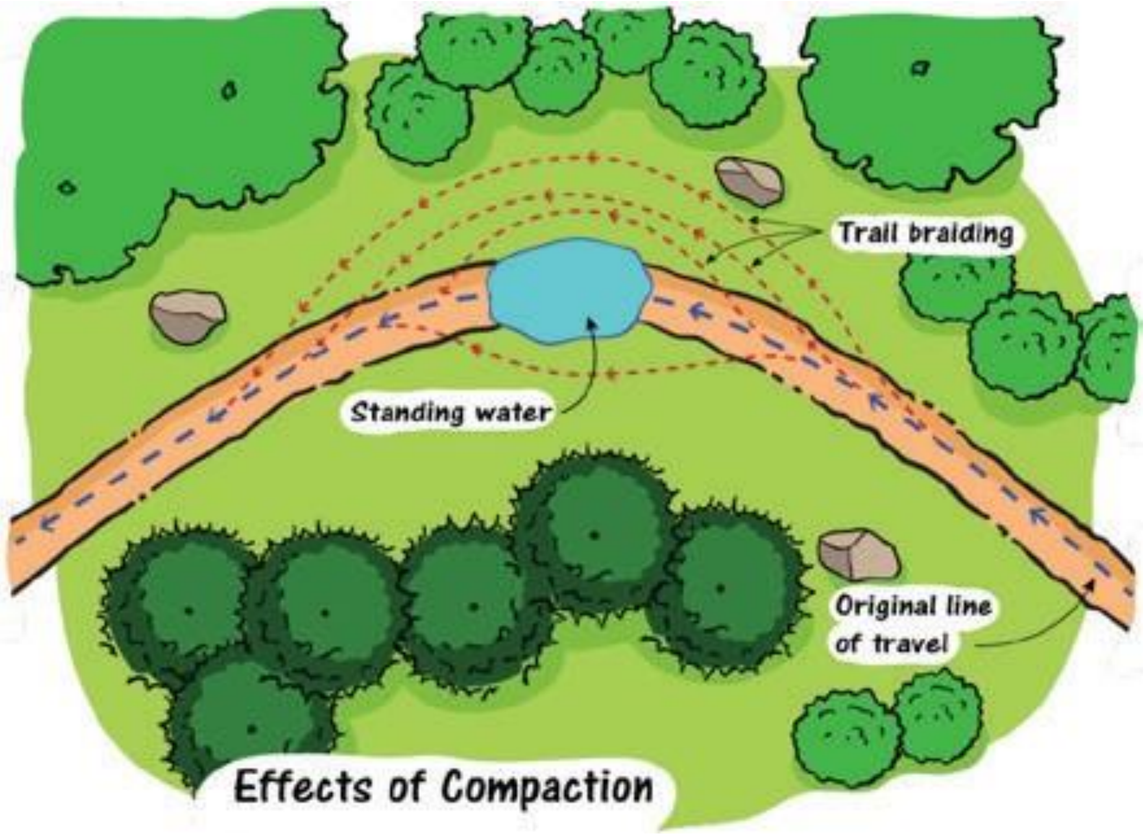




Chapter 4
Engineering and the Natural Environment

THE EFFECTS OF COMPACTION





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Engineering and the Natural Environment

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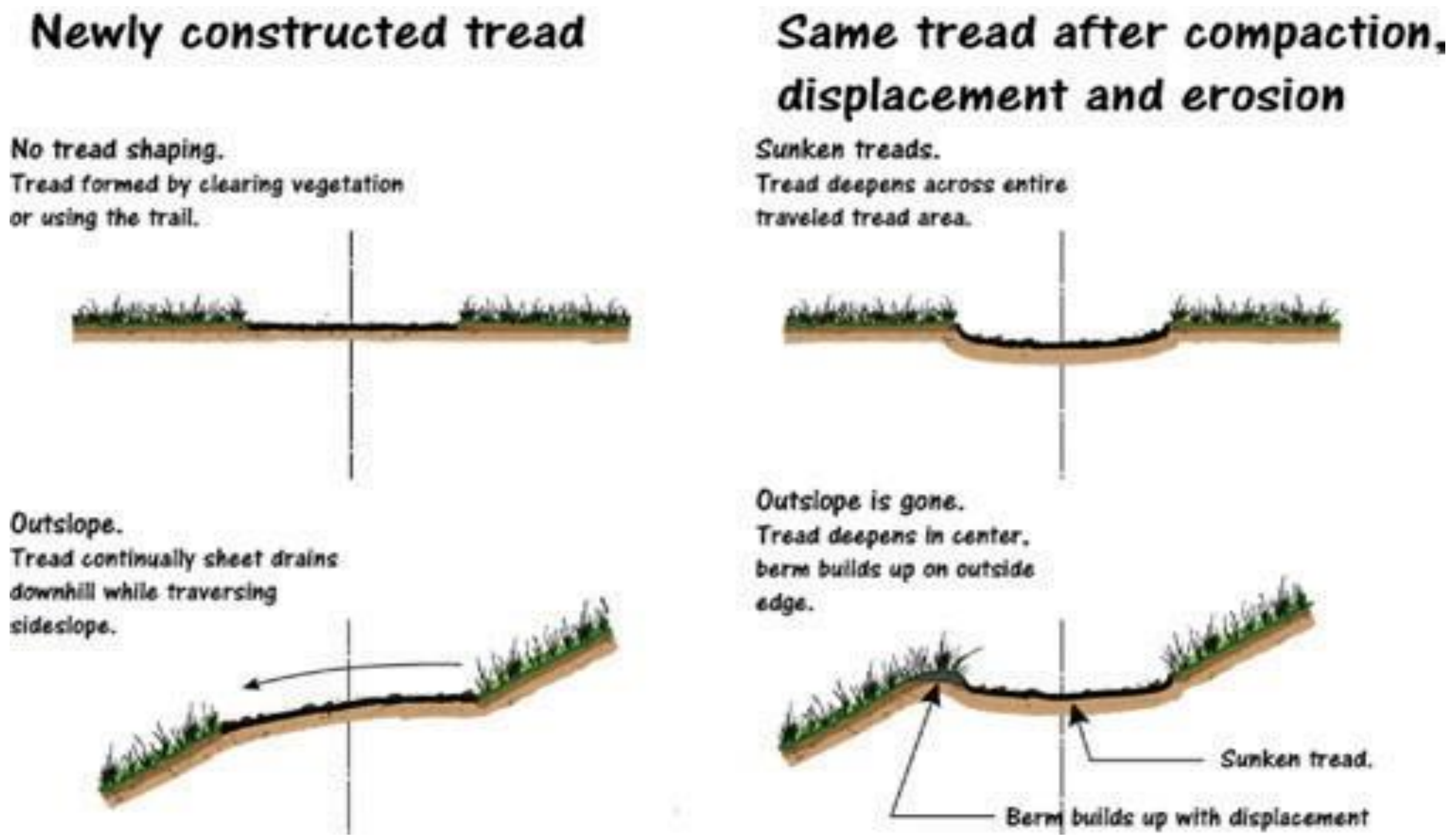

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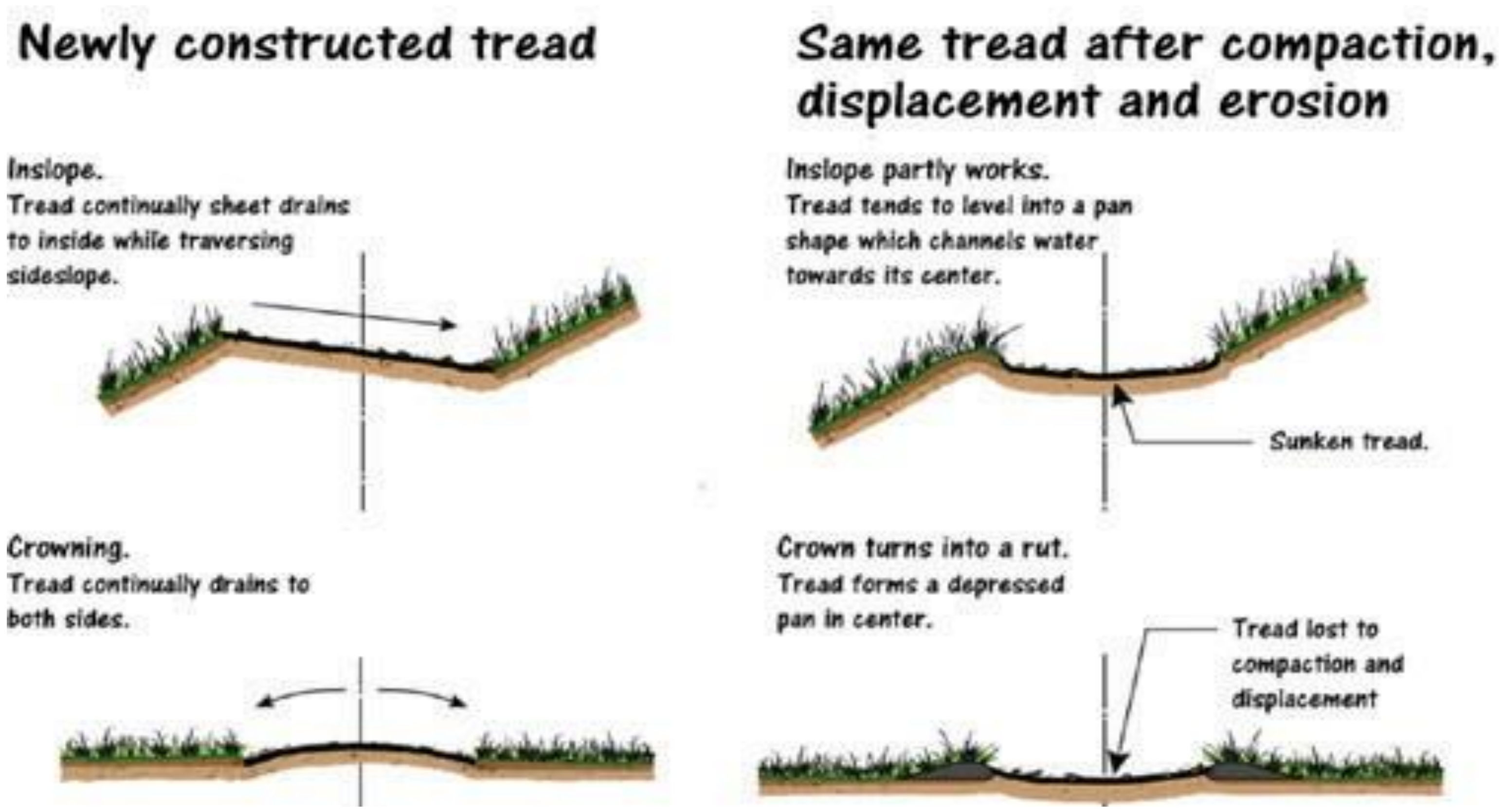

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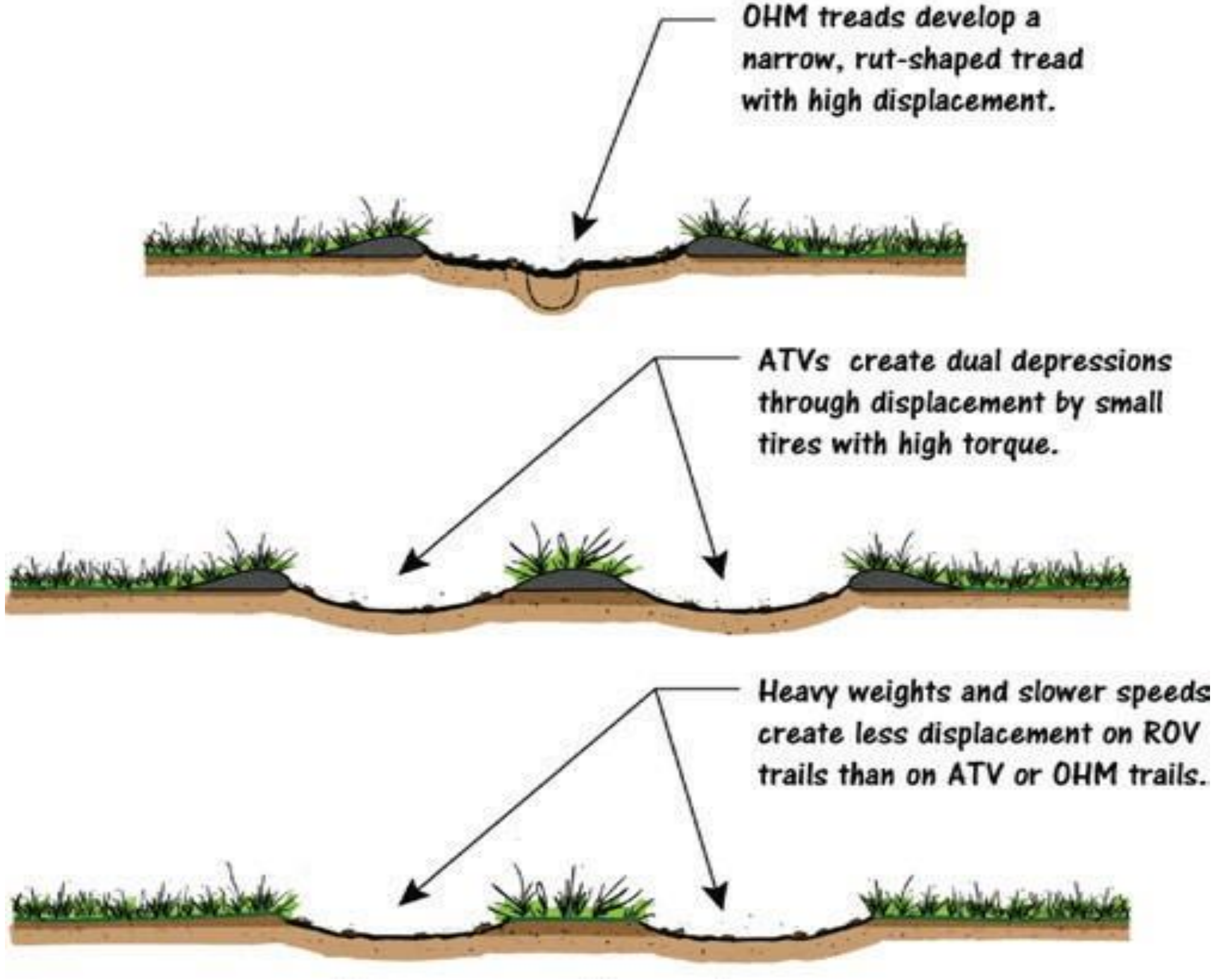
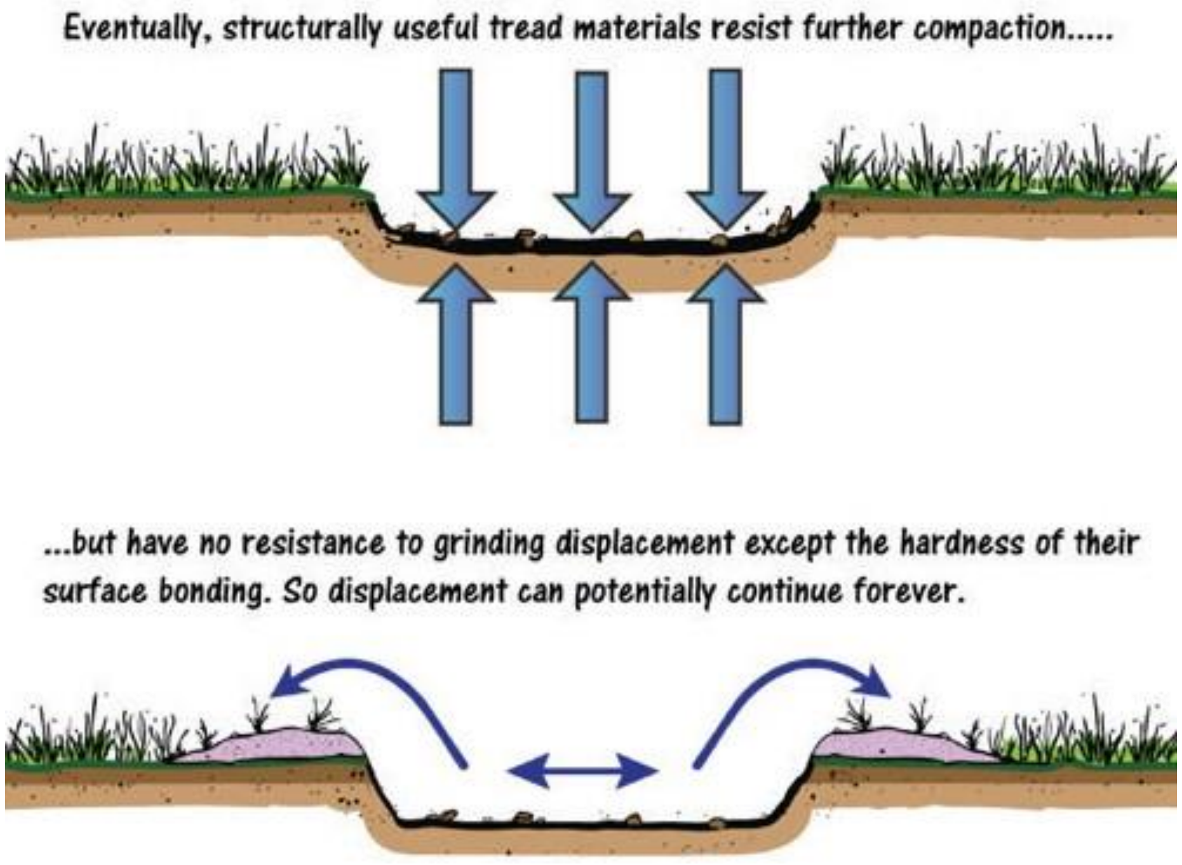


Chapter 4
Engineering and the Natural Environment

DISPLACEMENT

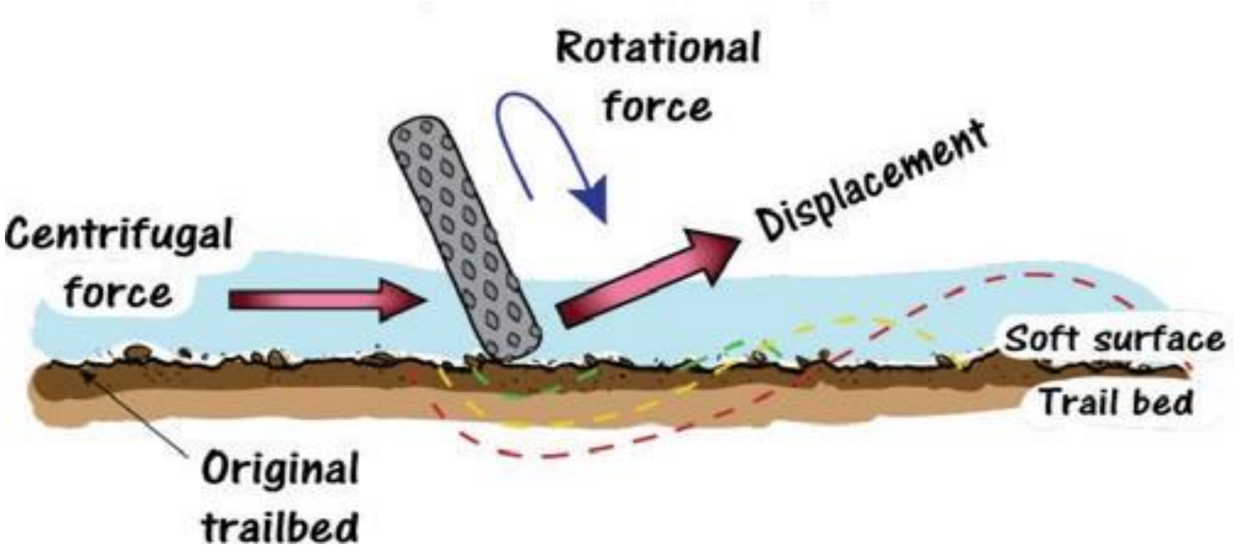
Displacement is the physical movement of the trailbed surface particles as a result of the ground contact and torque of the vehicle. The softer and less cohesive the trailbed surface is, the higher the potential for displacement. Displacement is a force caused from human and animal interaction with nature, 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.



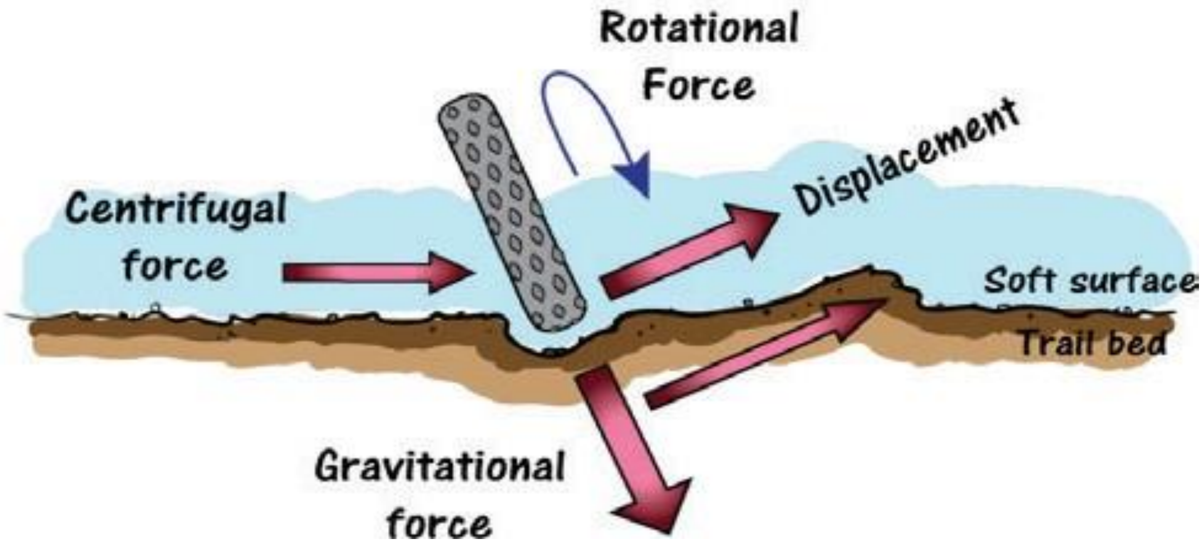
EFFECTS OF GRADE

Direction of travel

SUPER-ELEVATED CURVES



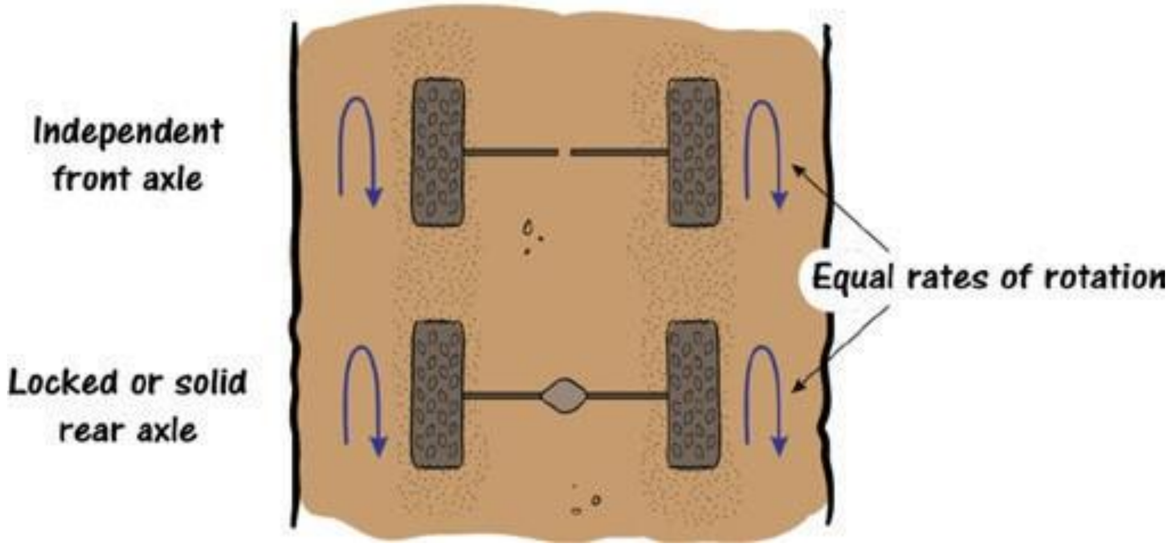
The development of superelevation



Forces exerted by a motorcycle on a flat curve

DISPLACEMENT BY FOUR WHEELED OHVS

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 must 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.

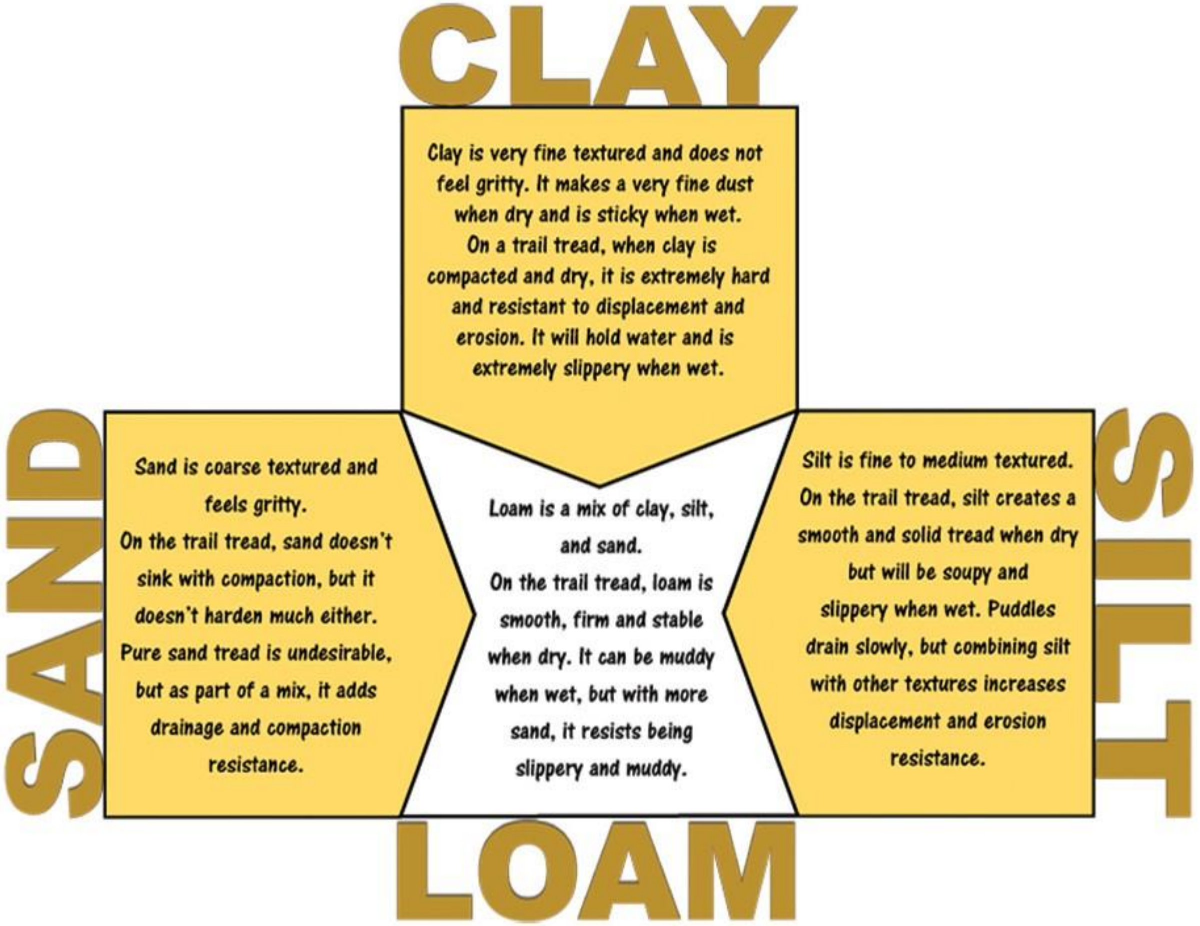


Four-wheeled vehicle on a tangent

Chapter 4
Engineering and the Natural Environment

EROSION AND SOILS

Erosion is the movement of the tread surface particles 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.



Chapter 4
Engineering and the Natural Environment

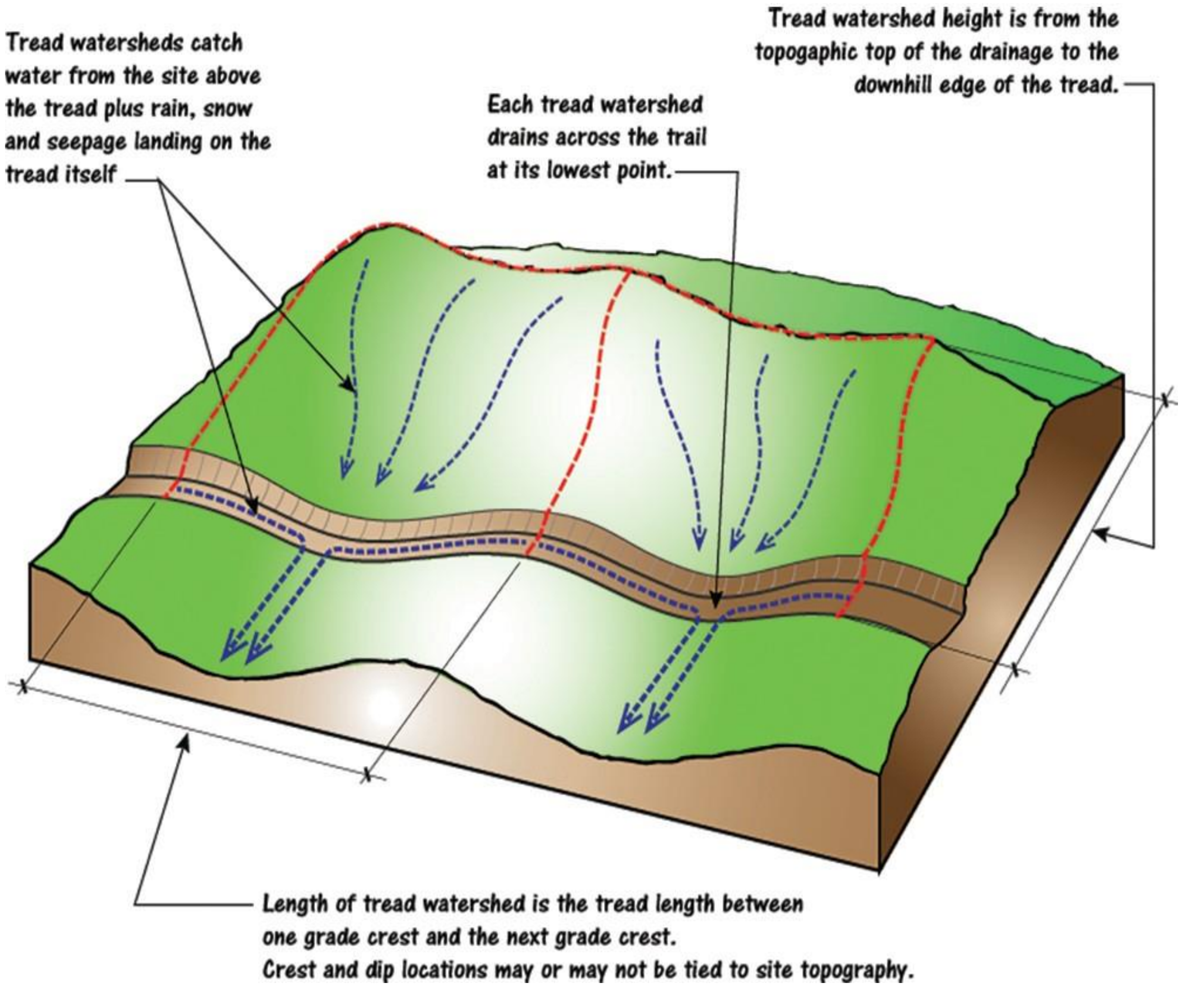
Erosion Risk Factors Some of the erosion risk factors are listed below:			
Factor	**Low Risk**	**Medium Risk**	**High Risk**
For the Tread			
Tread Grade	< 12%	12% - 20%	> 20%
Length of Tread Watershed	Short	Medium	Long
Tread Width	Narrow	Medium	Wide
Stability of Tread Material	High	Medium	Low
Tree Canopy 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.

Chapter 4
Engineering and the Natural Environment

TREAD WATERSHEDS

The tread watershed is the area from one grade crest to the next grade crest and all 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.



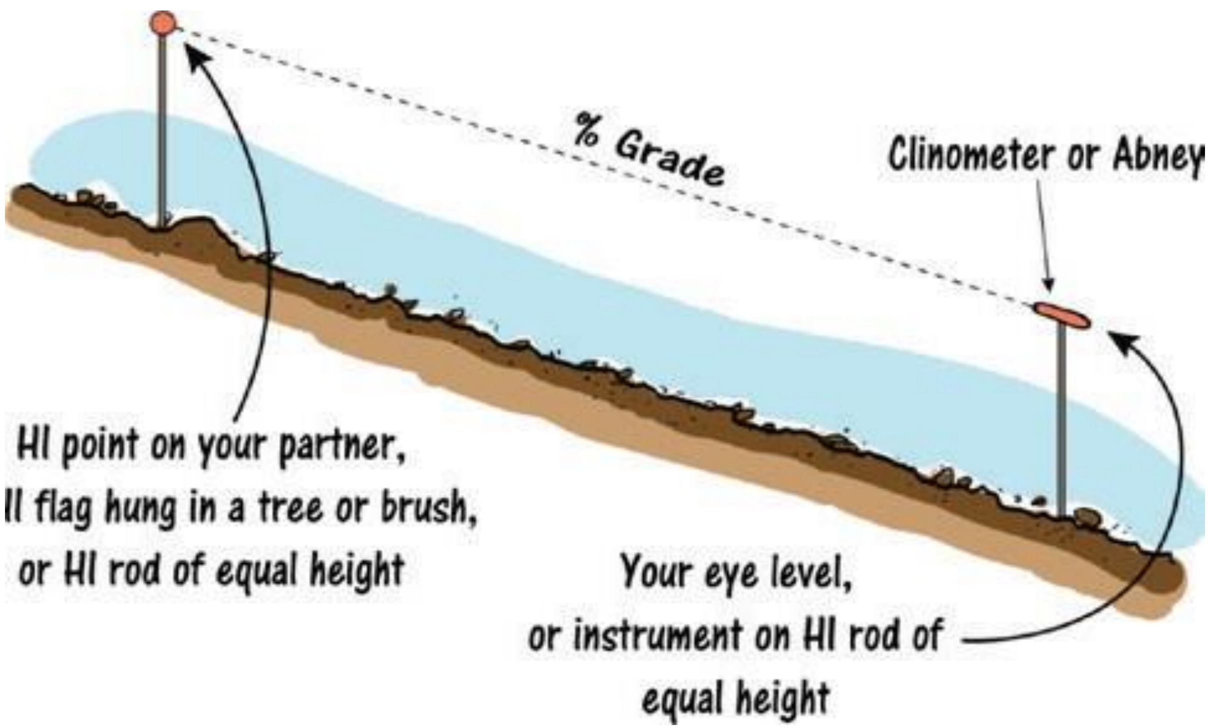
Chapter 5
Preparing for the Field

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.

>***See Great Trails Page 95***

DETERMINING GRADE

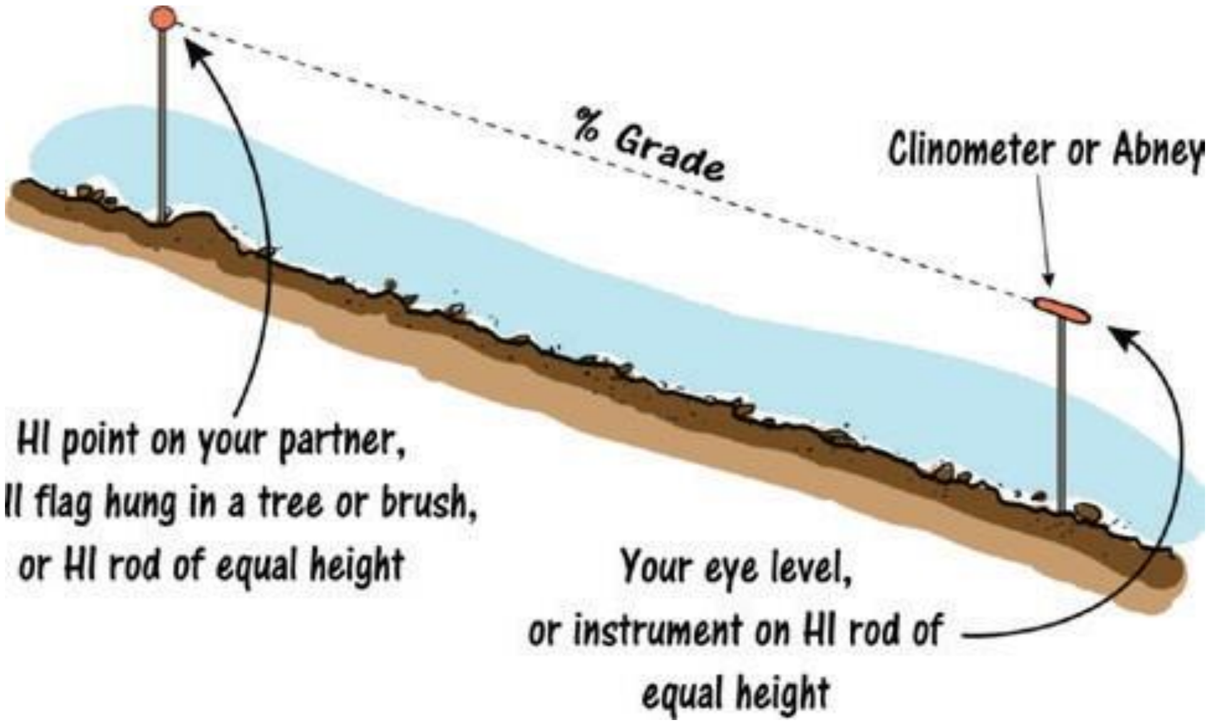
Two Person Method for Determining Grade: On flat ground, two people stand toe-to-toe in front of each other. Using a clinometer, one person puts the bubble on zero percent and notes the spot where that hits his or her companion (chin, tip of nose, hairline, etc.). That spot becomes the height of instrument (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.



Chapter 5
Preparing for the Field

DETERMINING GRADE

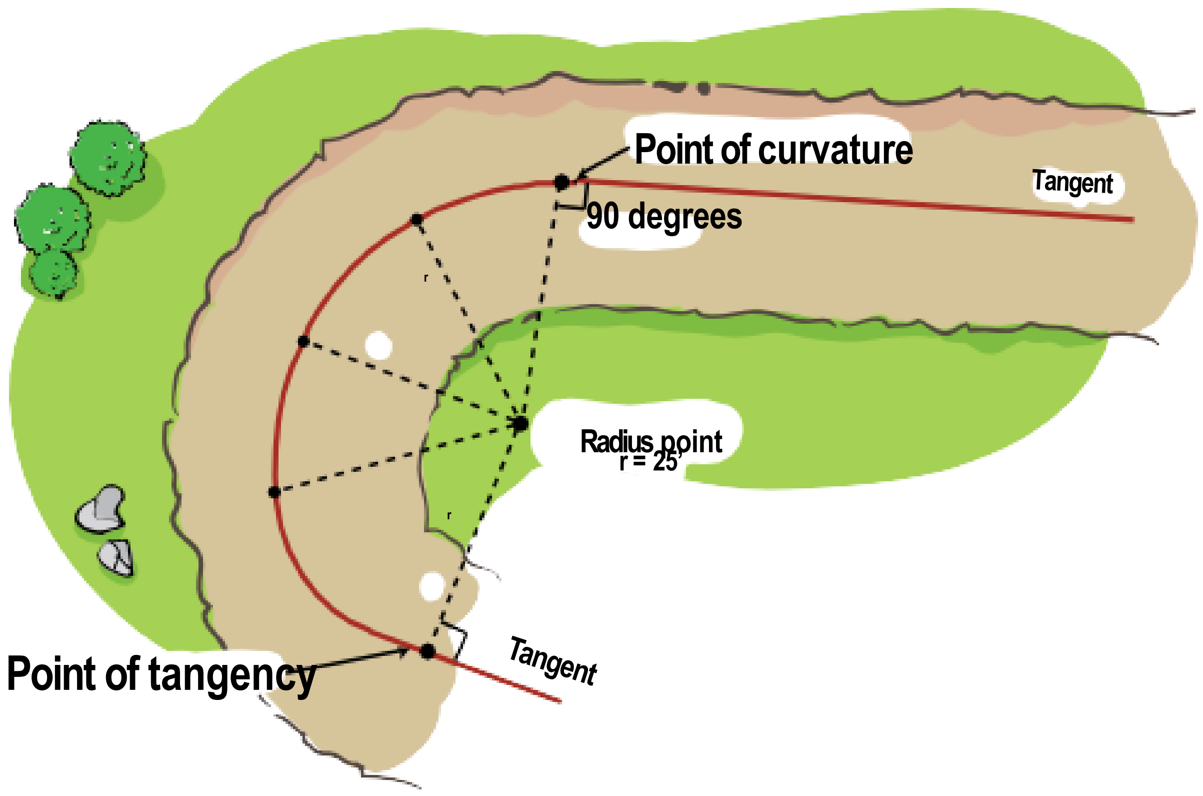
One Person Method for Determining Grade: At a starting point, tie a short flag at eye height on a tree limb or brush (this becomes the HI flag), move ahead and up or down the slope as needed, sight back at the HI flag with the clinometer or Abney and the result will be the difference in grade or slope 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.



DESIGNING CURVES IN THE FIELD

To determine a constant radius curve in the field:

- Determine the radius of the curve. A minimum of 8' is needed for a climbing turn.
- Have a partner stand at the center of the inside of
- the curve to hold a ribbon or string, or attach ribbon or string to a stick in the ground
- Walk out from the center of the inside of the curve
- holding the ribbon or string to the start of the curve and place the first pin flag
- Keeping the ribbon/string taut start creating the
- curve and place pin flags approximately every 3' until you reach the end of the curve"

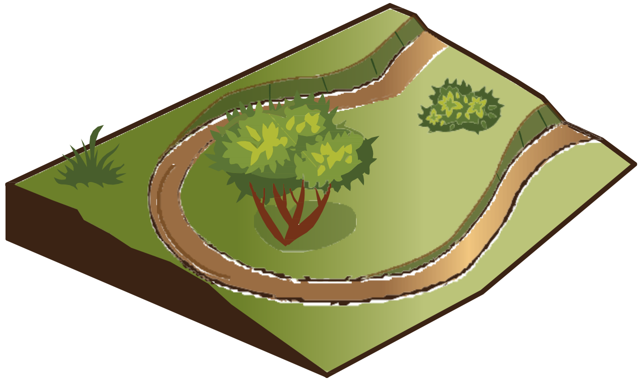


CLIMBING TURNS

A climbing turn is generally a turn with a radius of 8’ or more, while a switchback is a turn with less than an 8’ radius. If the side slope is less than 25% and there is room for a radius of more than 8’ then a climbing turn is almost always a better solution than a switchback as they are:

- Easier to construct and maintain
- Flow better and are easier to navigate for the rider
- Have less impact on natural resources

When constructing climbing turns, be sure to drain water before and after the corner. It is also imperative that the climbing turn has a constant radius. The larger the corner the better.

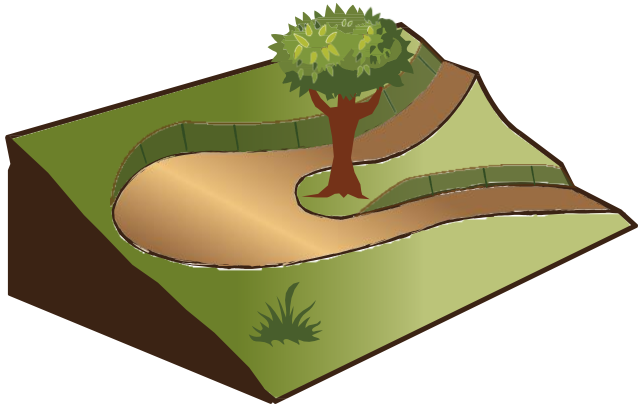


Chapter 5
Preparing for the Field

SWITCHBACKS

Switchbacks are sometimes necessary on steep side slopes or rocky terrain. They can be challenging to build and navigate as many OHV's have large turning radiuses. It is imperative that a large turning platform is constructed that allows the OHV's allowed on the trail to navigate the corner without backing up. Other considerations:

- Its imperative that switchbacks have a constant radius corner
- Drain before and after the switchback
- A large amount of excavation may be necessary to construct a switchback. A retaining wall or crib wall will often be necessary
- The flatter the landing, the easier it will be to navigate. This will require more excavation.



Chapter 6
Soil Stabilization and Hardening Techniques

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 these scenarios require some type of tread reinforcement.

>See Great Trails Page 95

Chapter 7
Tools in the Toolbox: Structures

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.

>See Great Trails Page 115

Chapter 8

Tools in the Toolbox: Operations and Maintenance

To develop an effective O&M program, amassing materials, supplies, tools, vehicles, and equipment is a must. Equipment is what puts the trail onthe 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?
- Who will operate, maintain, and repair it?

>***See Great Trails Page 145***

Chapter 9
Tools in the Toolbox: Communicating with the Public

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.

>***See Great Trails Page 161***

SIGNAGE: 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

SIGNAGE: SIMPLICITY AND CLARITY

- Keep it simple and avoid clutter
- The public spends little time reading signs, so make them count
- Use enough signs without over signing
- Use clear, concise messages
- Consider if the rider will understand the intent of the sign
- Whenever possible, use symbols rather than words

TIP: More signs do not equal more effectiveness

Chapter 9
Tools in the Toolbox: Communicating with the Public

SIGNAGE: 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.

SIGNAGE: CONSISTENCY AND PLACEMENT

- 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?
- Most OHV trail signs are viewed from a moving vehicle, so signs need to be sized and placed where they are readily visible.

Chapter 9
Tools in the Toolbox: Communicating with the Public

SIGNAGE: 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.

Chapter 9

Tools in the Toolbox: Communicating with the Public

SIGNAGE: MONITORING EVALUATION

- An annual monitoring 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?

Chapter 9
Tools in the Toolbox: Communicating with the Public

SIGNAGE: MAINTENANCE

1. Repair or replace signs as needed to maintain quality appearance and function.
2. Keep vegetation pruned back so the signs are visible.
3. Bullet holes invite more bullet holes.
4. Warning and regulatory signs must be in-place and legible.

SIGNAGE: 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.

SIGNAGE: LETTER AND SYMBOL SIZES

For motorized trails, the minimum letter size is 2 inches using an ASA Series C font and the minimum symbol size is 12 inches. Note: 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

SIGNAGE: SIGN SIZES

The minimum size for warning and regulatory signs is 12 x 12 inches. Smaller signs should not be usedunless the rationale is documented in the project file.

SIGNAGE: SIGN SHAPES AND MEANINGS

Image	Shape	Sign
	Octagon	STOP
	Equilateral triangle	YIELD
	Circle	Highway-rail grade crossing (advance warning)
	Isosceles triangle	NO PASSING
	Pentagon	School advance warning

Image	Shape	Sign
	Rounded pentagon	County route
	Crossbuck	Highway-rail grade crossing
	Diamond	Warning series
	Rectangle (and square)	Regulatory series Guide series Warning series Recreation symbols
	Trapezoid	Recreational and cultura interest area series National forest route

Chapter 10
Tools in the Toolbox: 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.

>***See Great Trails Page 177***

Sound Testing Guidelines:
Sound testing is commonly tested using the SAE J1287 Stationary Sound Test. It is important to research and receive training on this method in order to properly conduct OHV sound testing.

Chapter 11
Conducting 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.

>*See Great Trails Page 189*

Chapter 12
What Makes a Great Trail Great?

>See Great Trails Page 205

Chapter 13
Trail Location and Design

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?

Chapter 14
Designing for Challenge

Like any other modality, an integral part of trail riding is challenge: riders constantly push themselves to determine the capabilities of both of themselves and 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 providing for the riders' needs.

>***See Great Trails Page 225***

Chapter 15
Facility Needs and Design

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.

- ***See Great Trails Page 275***

References to Other Great Trails Chapters

Chapter 16: Construction – Page 297

Chapter 17: Conversion and Closure Techniques – Page 309

Chapter 18: Managing and Maintaining a Great Trail – Page 325

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