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.

Making Great Trails Requires:
- **Understanding**
- **Knowledge**
- **Engineering**
- **Passion**
- **Vision**
- **Creativity**
- **Conscientiousness**

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

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.

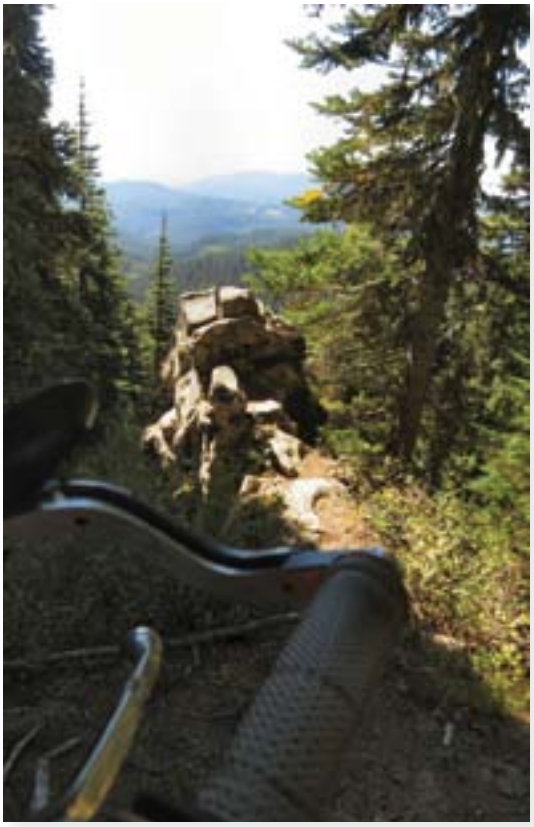
This isn't dramatic, but running the trail over this little rock knob creates a grade reversal and a varied experience for the rider. If this had been a more technical trail, the line may have crossed lower over the more jagged rocks if they were solid enough to withstand the use.

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.

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.

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.



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.

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 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.

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:

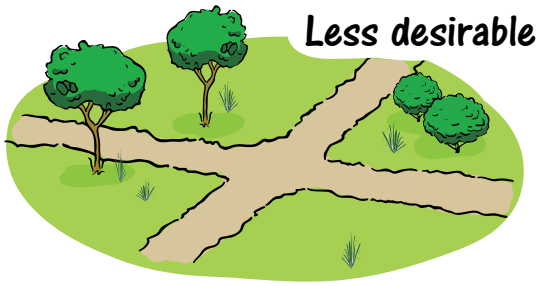
- A switchback consists of three parts: a lower approach, landing or turning platform, and upper approach.
- Like climbing turns, it is essential that switchbacks have a constant radius. Most do not and that is why they are difficult to ride.
- As in climbing turns, it is important that the trail is 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.

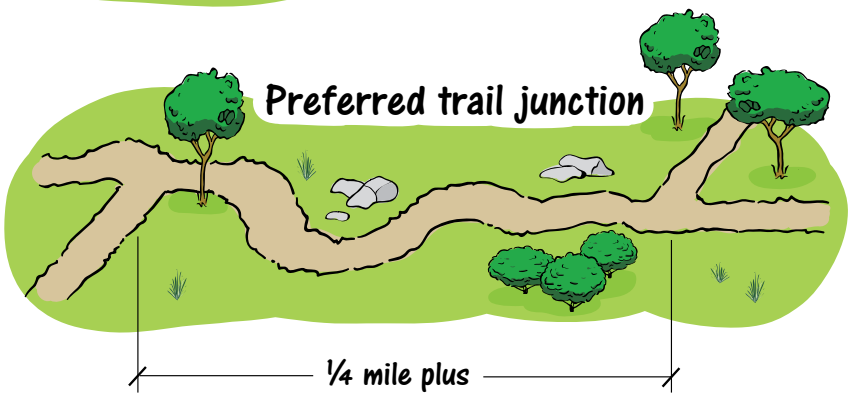
This structure has a nice circular curve, but no flattened approaches. Note the drain above and there's one below also which is good. It may have been better for drainage and rideability to use the top of the exposed rock as a flat area for the lower approach and part of the landing.

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.



Less desirable trail junction

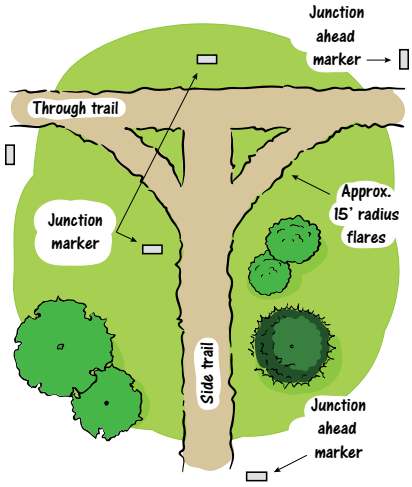
When possible, it is desirable to locate trail junctions or intersection points for loop trail systems at least ¼ mile apart.



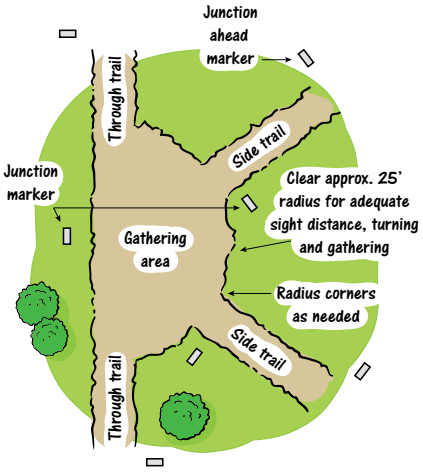
Things to keep in mind for trail junctions:

- 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.

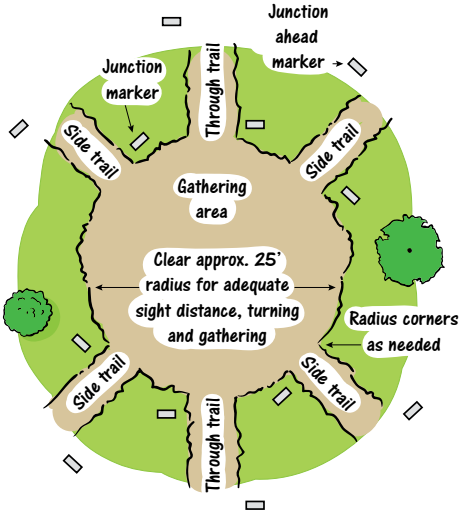
Typical T-junction



Typical half hub junction



Typical hub junction



- 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.

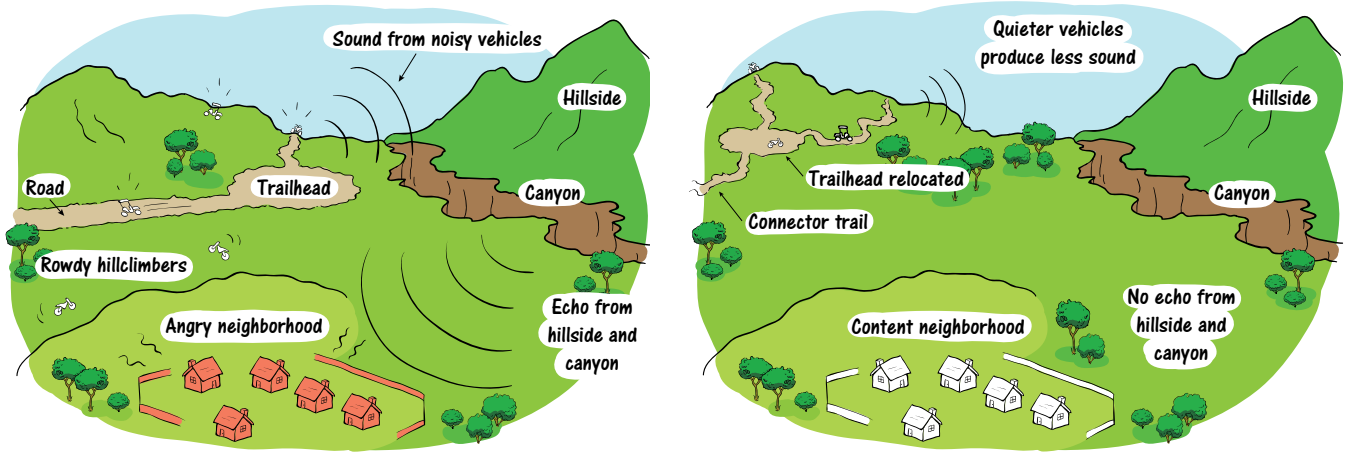
Sound Intrusion to Residents. Sound is produced by physical vibration that creates audible waves of pressure. Design can mitigate sound. Unwanted sound perceived as noise produces a negative psychological reaction. It cannot be mitigated outside of sound mitigations.

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.

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.

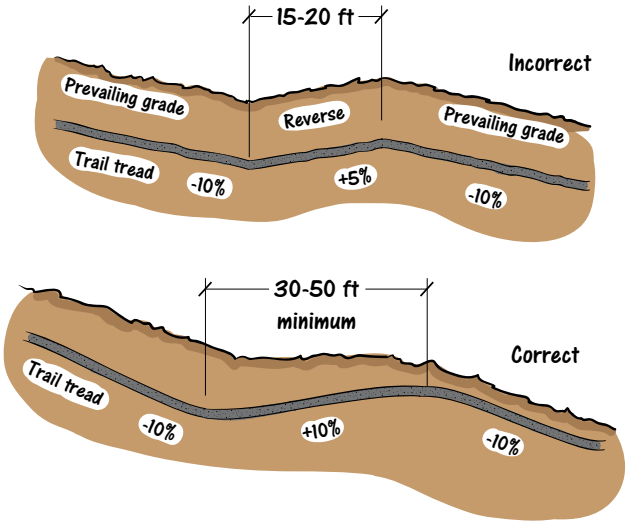
- Putting sound source a farther distance from NSPs. The amplitude (or intensity) of the sound wave decreases with distance.
- Placing berm of earth, a ridge, or dense standing vegetation between the sound source and the NSP can help block or reduce sound waves.
- Designing for the shape of the topography. 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.

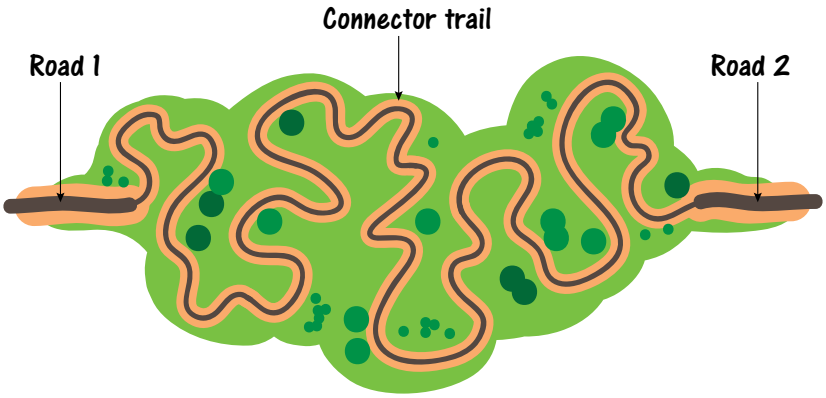
The setting is what is around the NS road. What is there for the riders to see and do the riders want to see it? Are their eyes confined to a corridor or are they open to a panorama? Is there scenic diversity? A high standard road tends to provide a transportation experience while a low standard road 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.