

# Trail Layout and Flagging

## Course Objectives

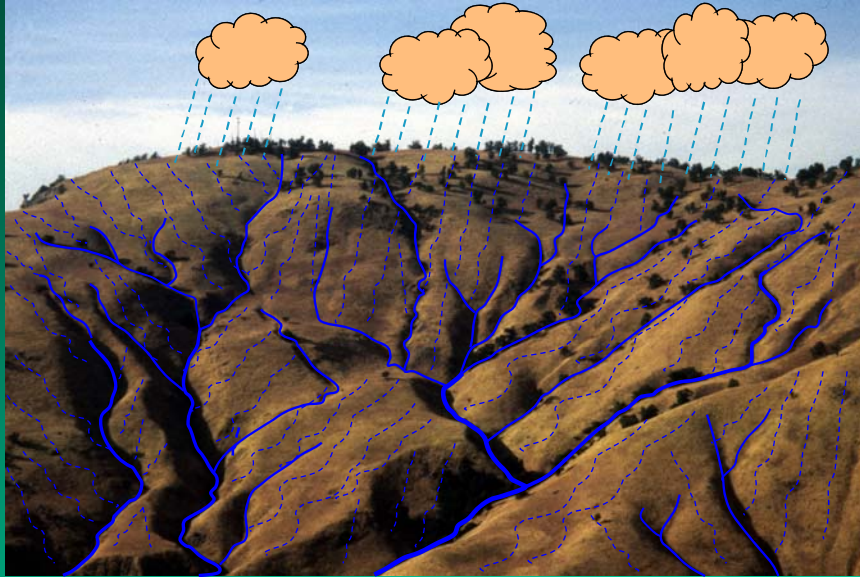
- Understand the Hydrologic Influences of Trail Alignments
- Learn the Process for Laying Out and Flagging Trails
- Understand the Layout Criteria for Designed Control Points
- Develop a Visualization of the Completed Trail
- Learn how to Determine Linear Grades Between Control Points
- Learn Flagging Between Control Points (segmenting)
- Develop Trail Structure Prescriptions and Cost Estimates for Building Your Trail

## Trail Layout Concepts and Process

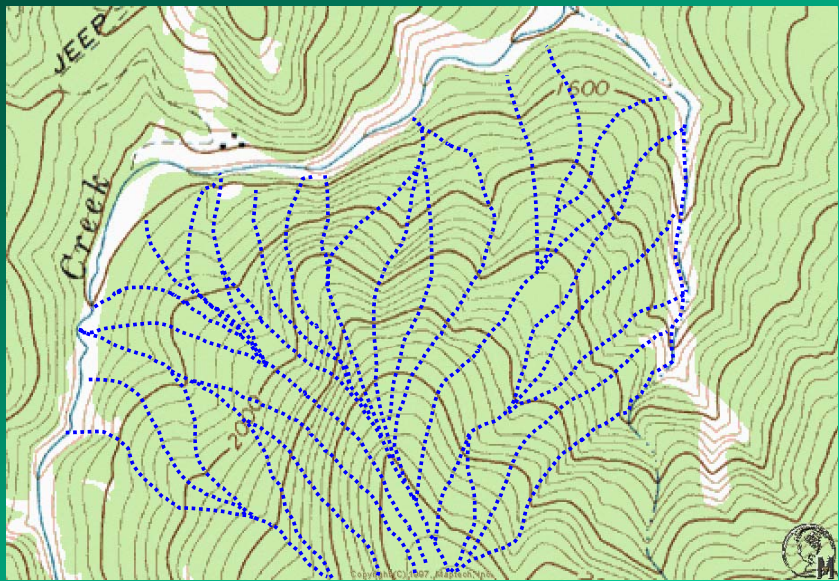
Water is the Most Influential Factor in  
Designing and Laying Out Trails



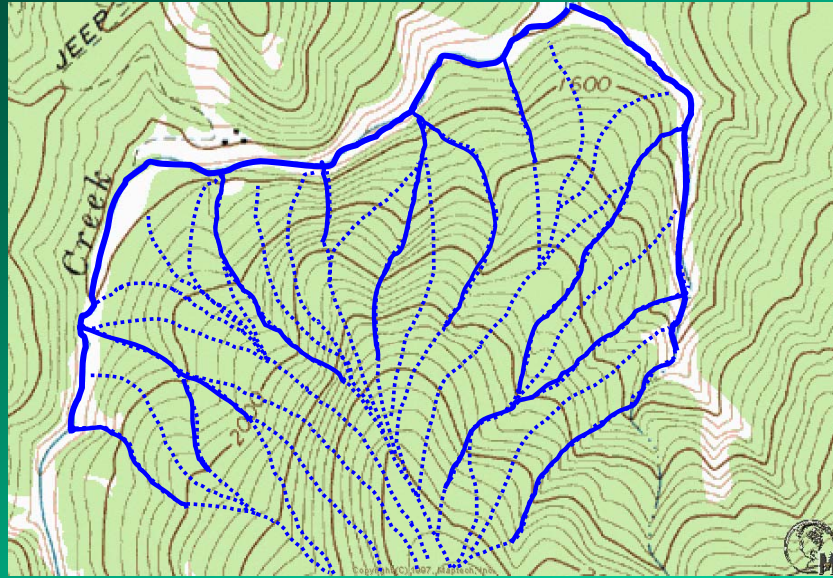
# Natural Runoff Patterns



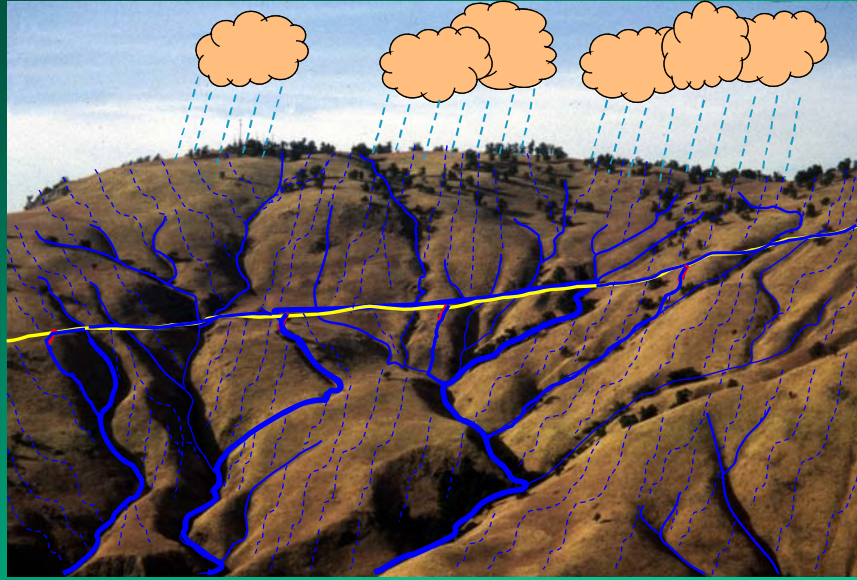
# Understanding Hydrologic Processes



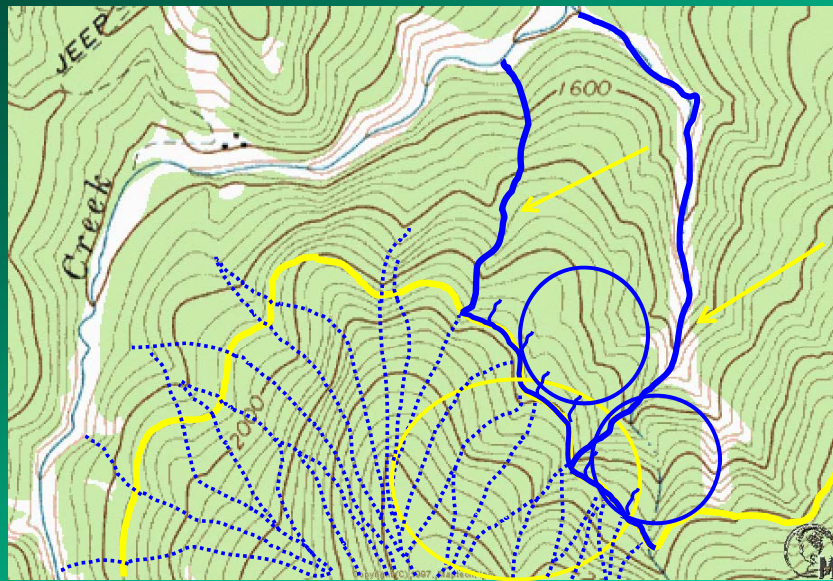
## Sheet Runoff Accumulation and Dendritic Drainage Development



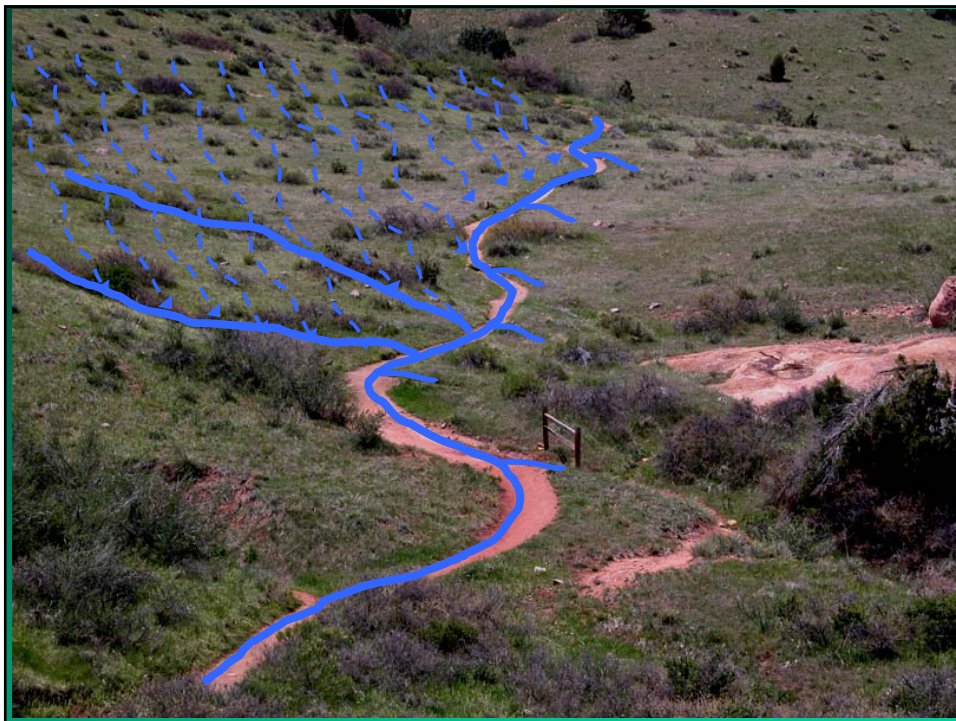
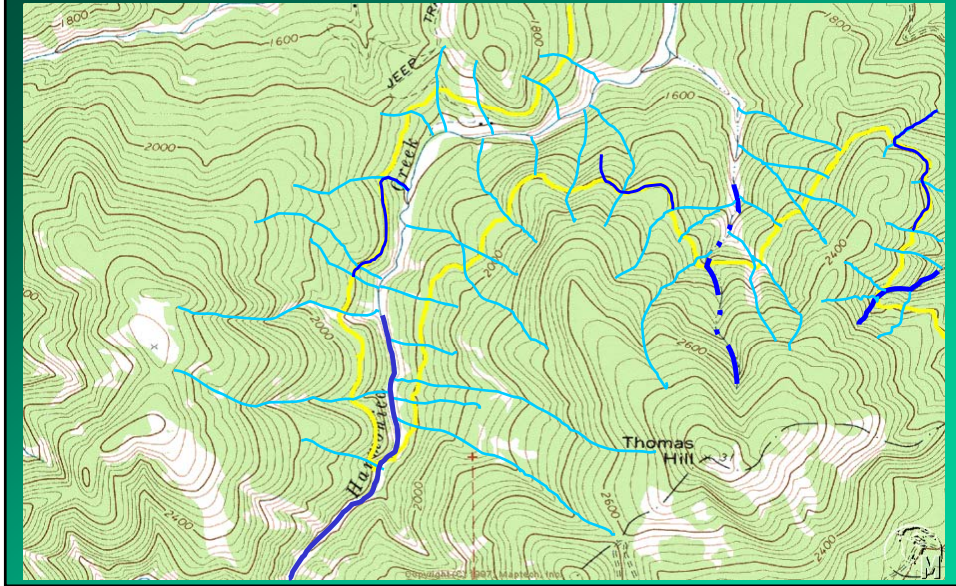
## Modified Runoff Pattern



## Interception and Diversion of Sheetflow



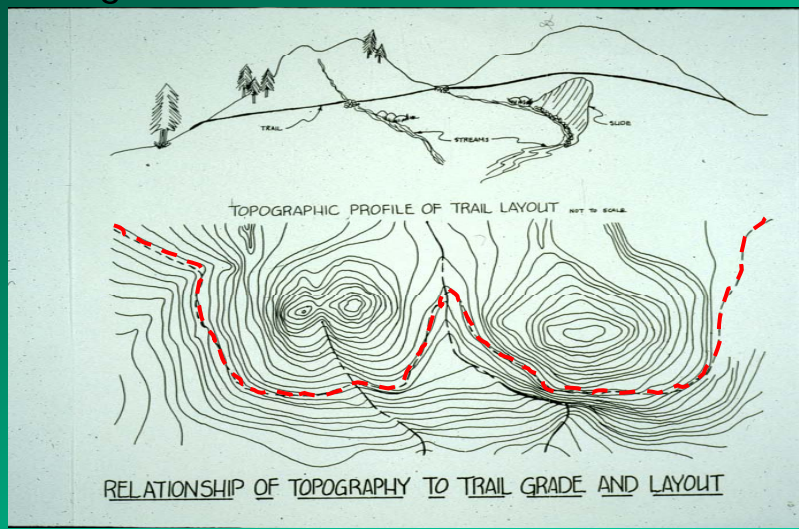
# Interception and Diversion of Ephemeral Drainages



As Water Accumulates It Gains Volume and Energy and Becomes an Erosive Force



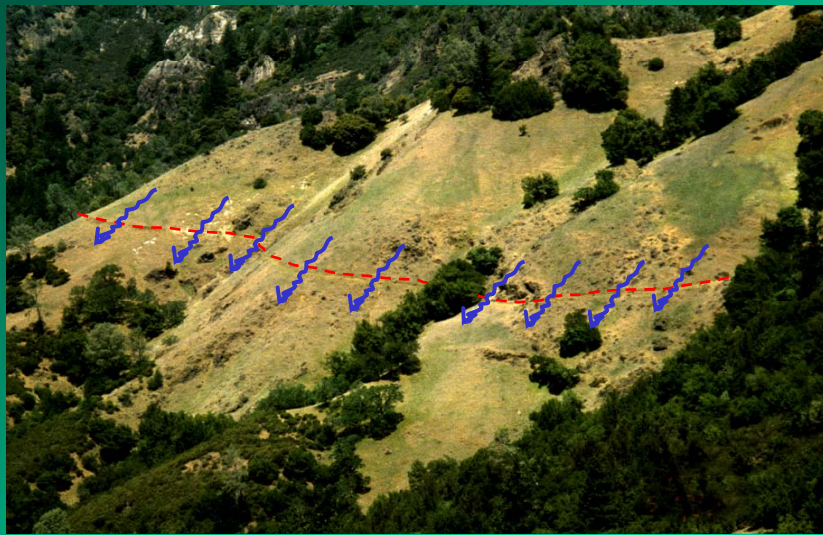
Laying Out Trails Following the Contour of the Land Helps Facilitate Natural Sheet Drainage



This Layout Process Is Called Curvilinear Alignment (Crossing Contour Lines at Flat or Oblique Angles)

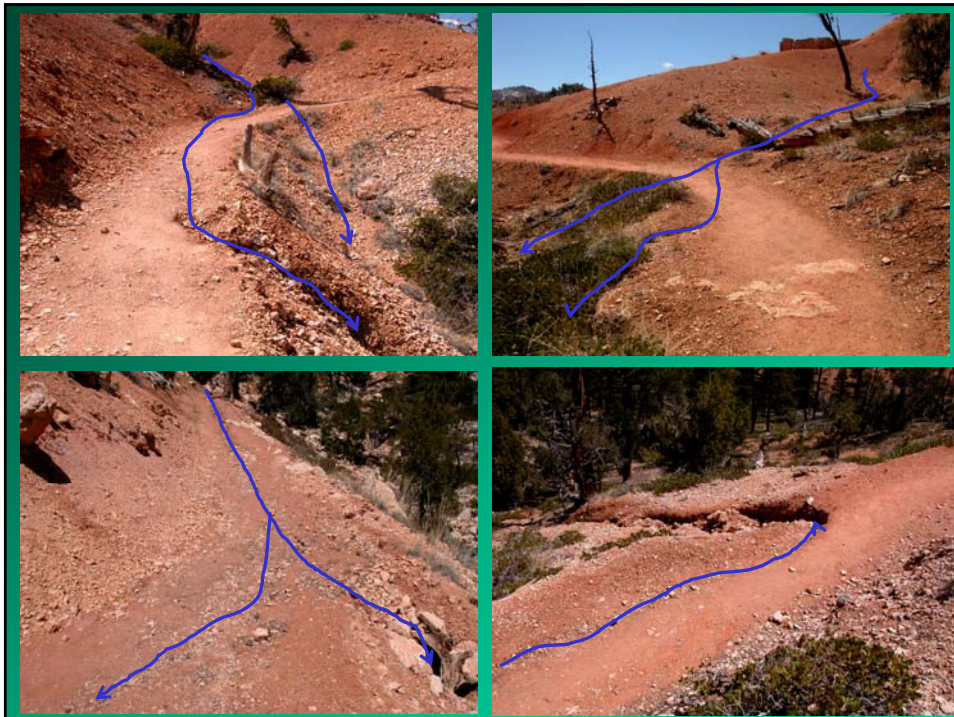


Curvilinear Layout Helps Keep the Trail Alignment Perpendicular to Natural Sheet Runoff





# Following the Contours of the Land Alone is not Sufficient for a Sustainable Trail





Curvilinear Layout Requires Closely Following the Landform Pulling in and out of all Swales and Crenulations



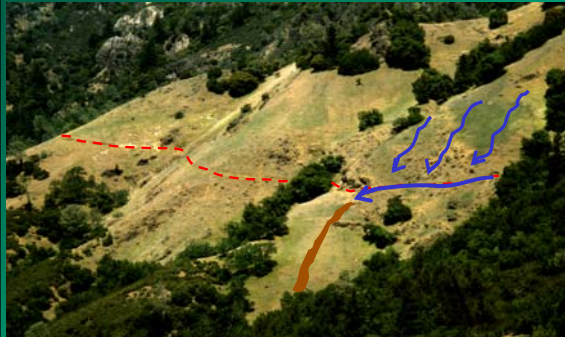
Curvilinear Layout Combined With Hillside Construction and Outsloping Prevents Water Diversions and Accumulation



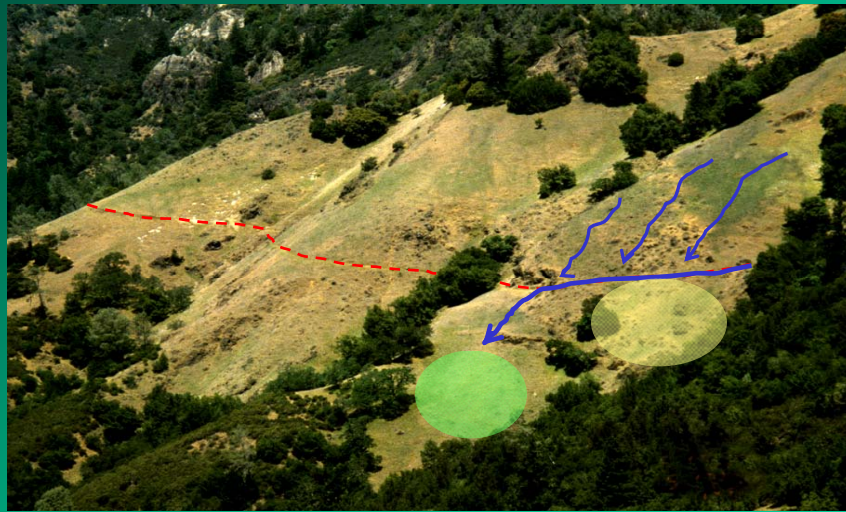
Trails on Gentle Side Slopes With Quarter to Half Bench Sheet Runoff less Efficiently



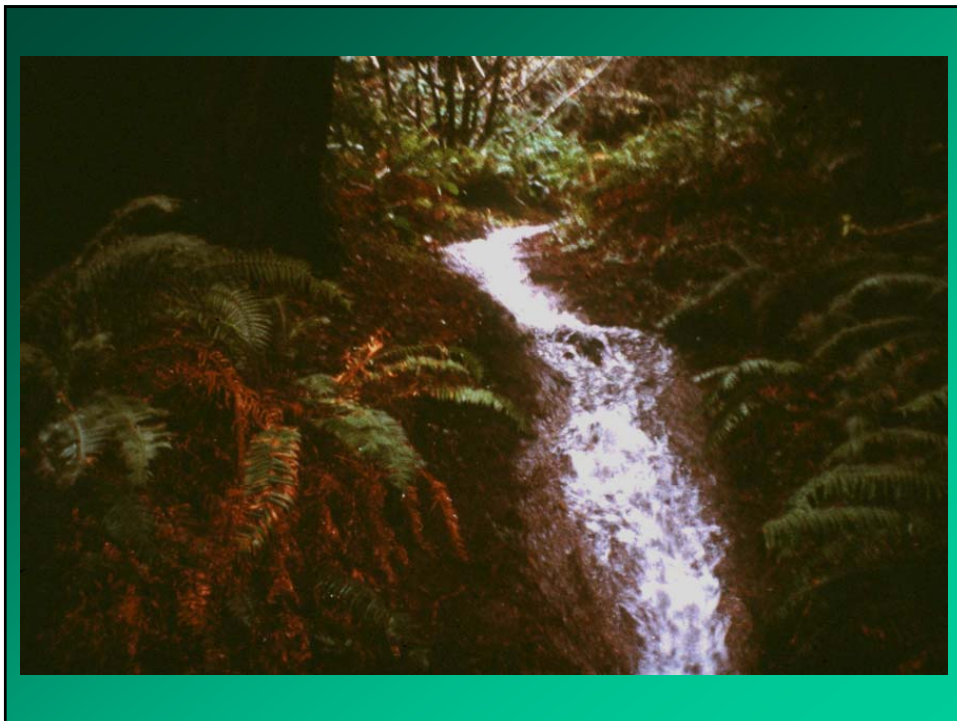
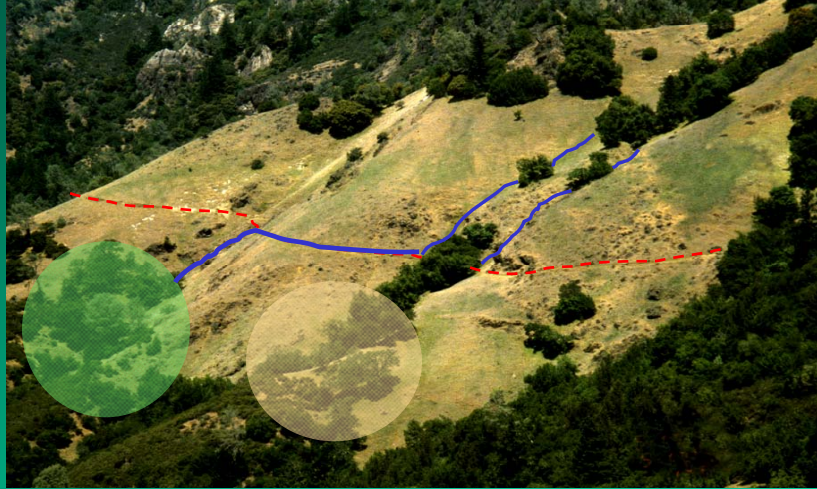
When Water Is Accumulated on the Trail and Arbitrarily Drained Off It Also Creates Erosion Below the Drain Point



These Drainage Designs can also Affect the Vegetation and Wildlife Communities Below by Changing the Amount of Water they Receive



The Worst Diversions Result in the Coupling of two Drainages Together, Causing the Dewatering of one and the Destabilization of the Other

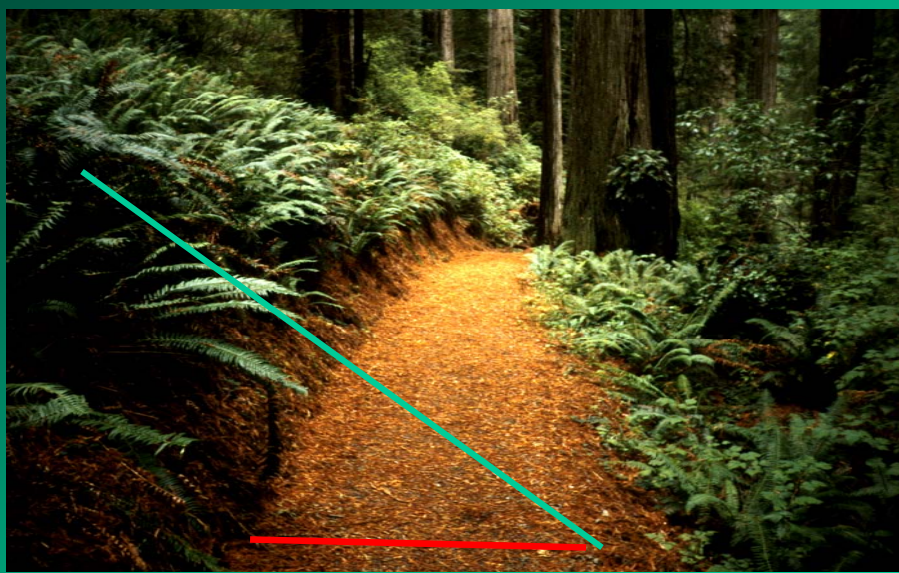




Layout Trails on Hill Sides to  
Provide a Fuller Native Bench



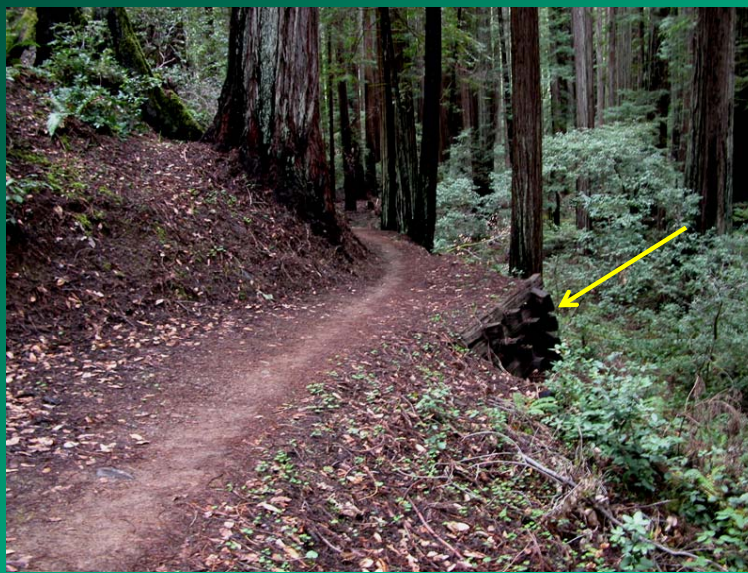
Fuller Trail Benches Facilitate a Stable  
and Durable Trail Tread Surface



When Possible Layout Trail Alignments Above Trees to Reduce Resource Impacts and Trail Structures



Retaining Walls are Usually Required When the Trail Passes Under a Large Tree





Retaining the Landform's Natural Drainage  
Patterns Is the Key to Sustainable Trails



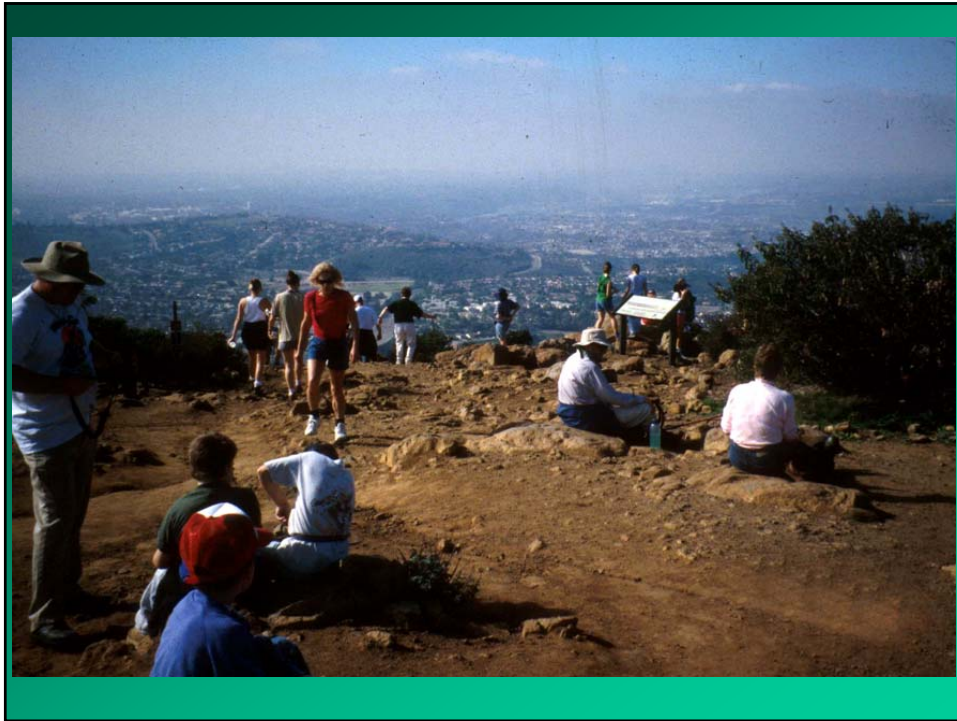
Prior To Laying Out a Trail the Design  
Standards and Appropriate Linear Grade  
Must be Identified

## Accessibility



## User Groups & Level of Use

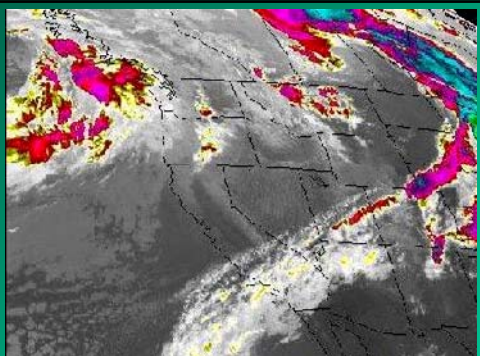
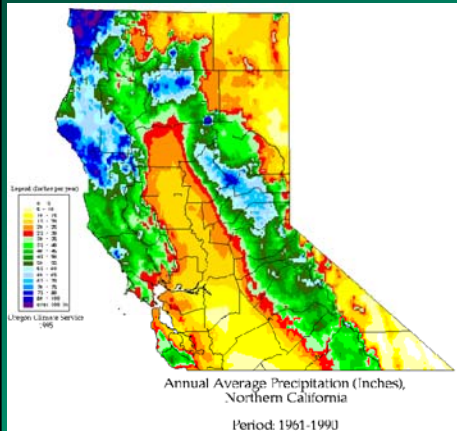




## Soil Strength and Durability



## Annual Rainfall



## Rainfall Intensity



## Canopy Cover



## Location on the Hillslope





### Percent of Hillslope

- User groups
- Amount of use
- Soil strength & Durability
- Annual rainfall
- Rainfall intensity
- Canopy cover
- Location on the hillslope
- Season of use

Linear grade

Cross slope

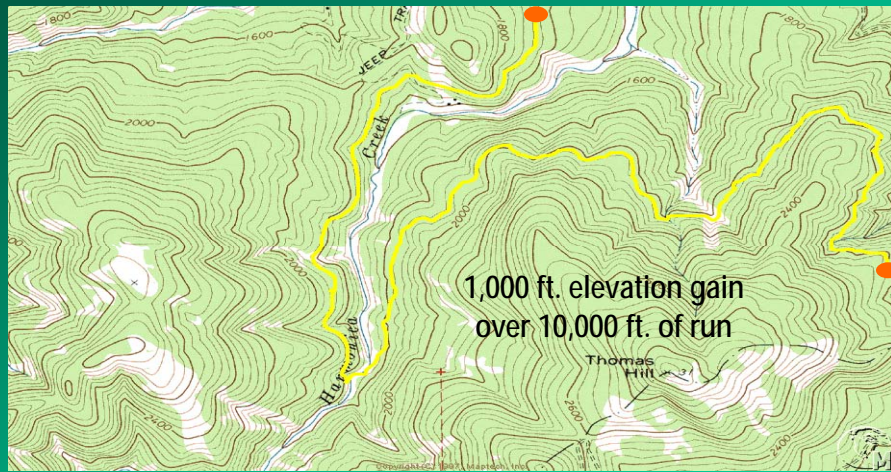
## Evaluation of Existing Trails



The Prescribed Linear Grade is Determined by Reconnaissance and Planning Efforts



Once the Prescribed Linear Grade Is Established It can be Compared to the Average Grade Between the Major Control Points



The Elevation Difference Between the Two Major Control Points Is Divided by the Linear Distance Between the Two Points to Determine the Average Grade : Example 1,000 Ft. of Elevation Divided by 10,000 Ft. of Linear Run = a 10% Average Grade. If the Designed grade is 8% then you Divide 1000 ft by .08 = ,12,500 of trail length or an additional 2,500 ft of trail



The Prescribed Linear Grade Is Used  
When Identifying Minor Control Points  
During Reconnaissance



During Reconnaissance the Trail Corridor can  
be Roughly Located by using a Clinometer  
and Shooting at Objects at Your own eye  
Level



To Check the Accuracy of Your Shot  
Locate an Object Next to Where you are  
Standing and Locate your eye Level



Once you Reach the Object you Shot at,  
Shoot back at the Known Location of your eye  
Level to Check Your Accuracy



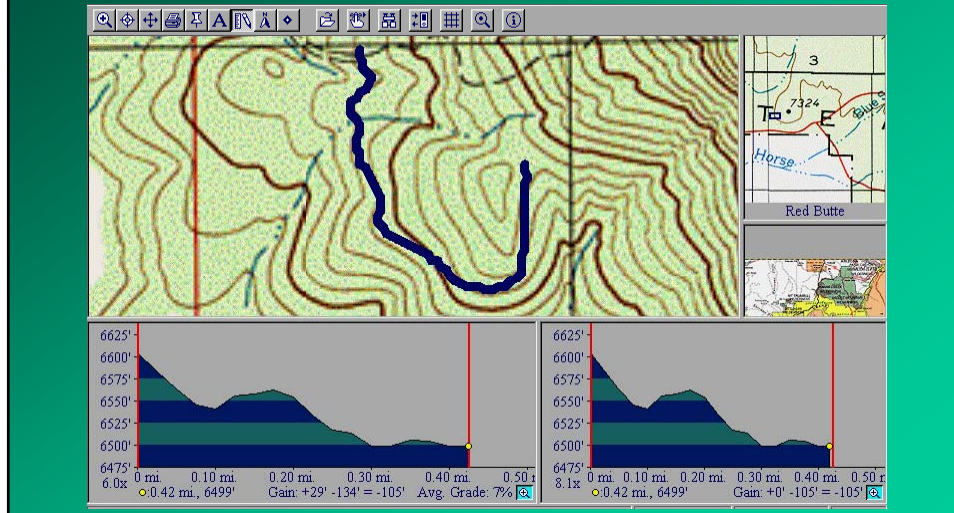
Elevations can be Taken with an Altimeter at each Control Point to Determine Elevation Differences



Control Point Locations and Elevations are Plotted on a Topographic Map



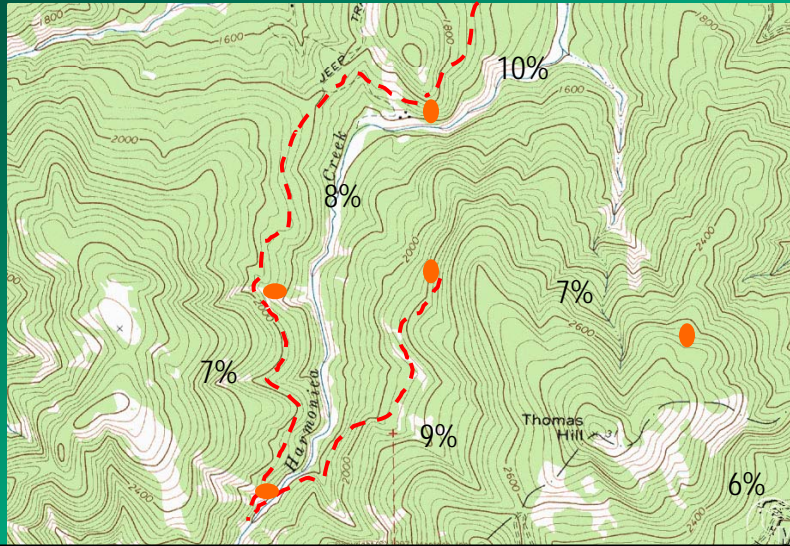
Control Points can also be Plotted on Electronic Maps to Determine the Elevation, Distance and Grade Between the Various Control Points



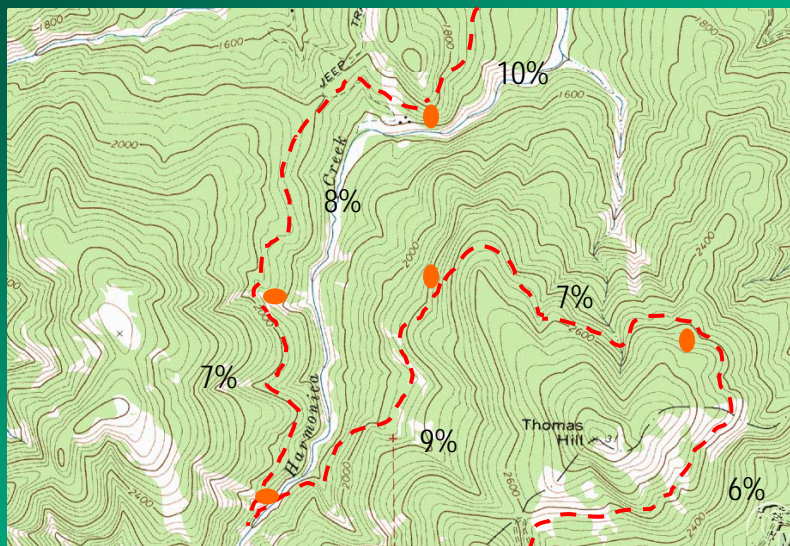
Traditional Linear or Blind Flagging Often Results in Unwanted Grade Adjustments

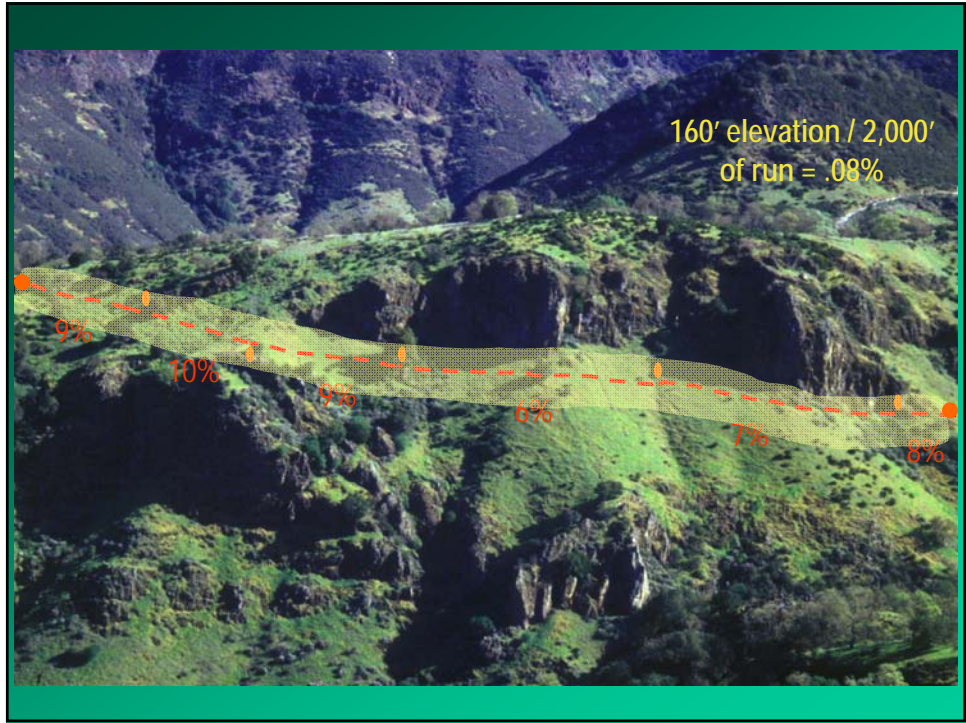


Layout is Performed Between Control Points to Eliminate Abrupt Grade Changes

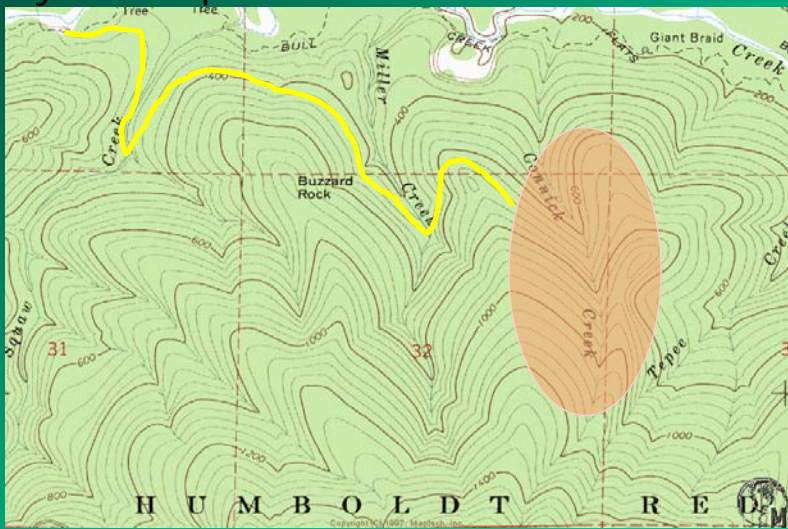


Flagging From two Control Points Back Towards the Center is an Effective Method

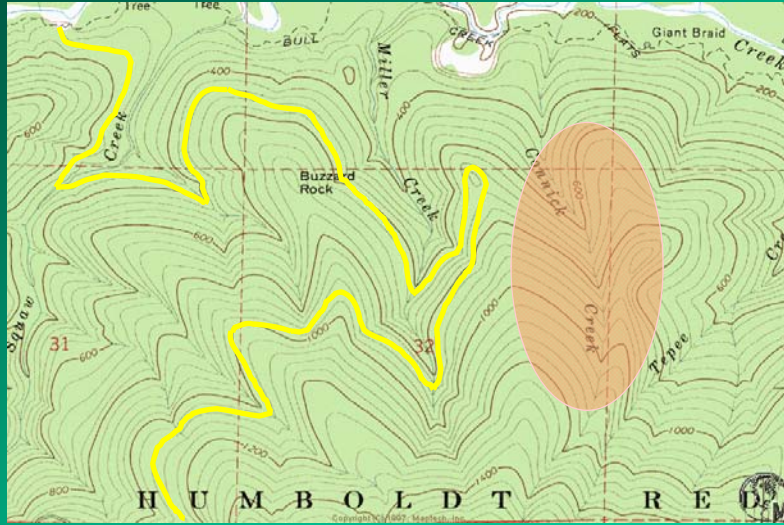




If the Average Linear Grade Exceeds the Prescribed Grade Additional Linear Run may be Required



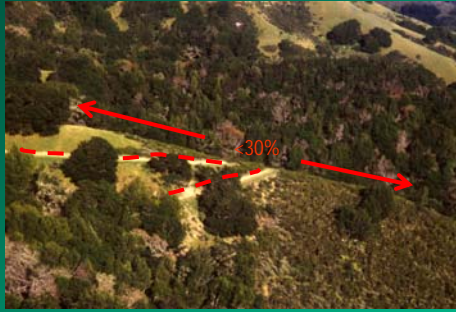
To Gain Additional Linear Run a Topographical Turn Should be Used First



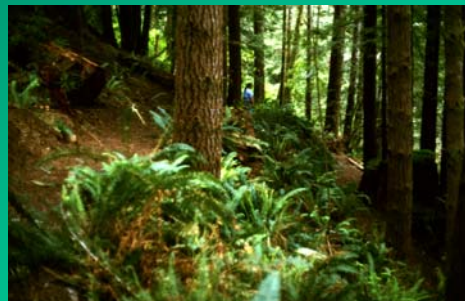
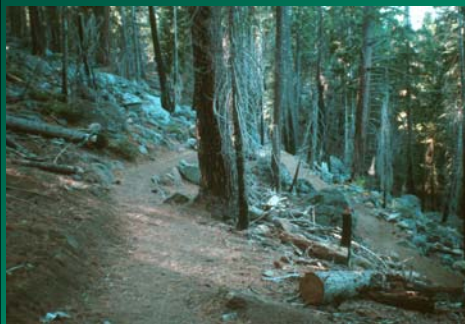




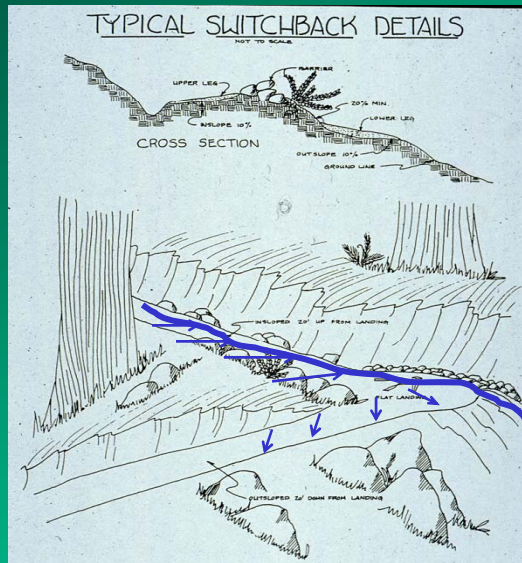
If a Topographic Turn Is Not Available Then a Climbing Turn or Switchback Can Be Used to Gain Linear Run



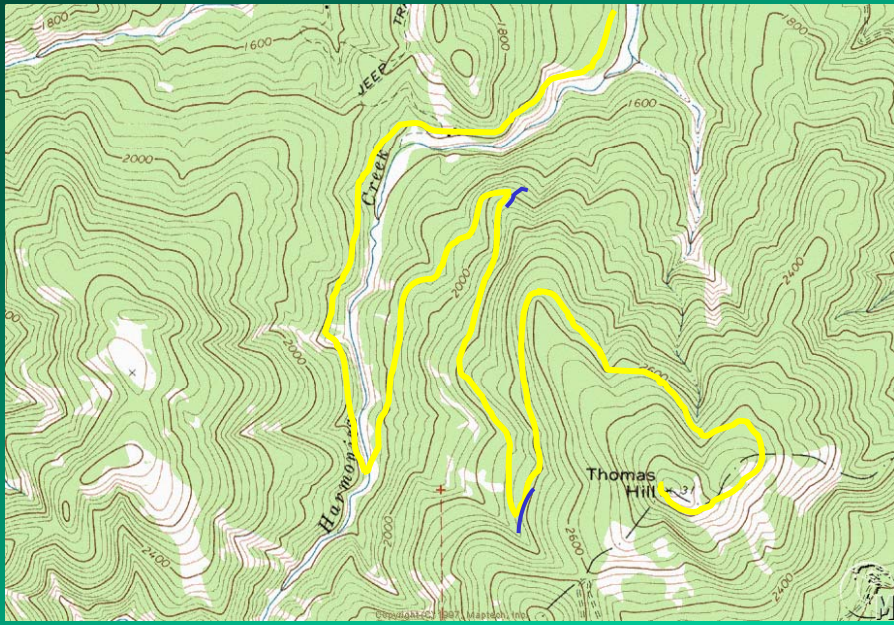
Climbing Turns and Switchbacks Need to Be Properly Placed and Located (control point)



Location Must Facilitate Drainage off of the Corner or Turn (Switchback/Climbing Turn Design)



## Use a Ridge Nose or a Swale/Drainage



There Must Be Good Separation Between the Two Legs to Prevent Cutting



Utilize a Break in Slope on the Hillside to Gain Vertical Separation Between the Legs



Utilize Trees, Rocks and Brush to Provide a Barrier Between the Two Legs. Proper Location will help Reduce Linear Grades



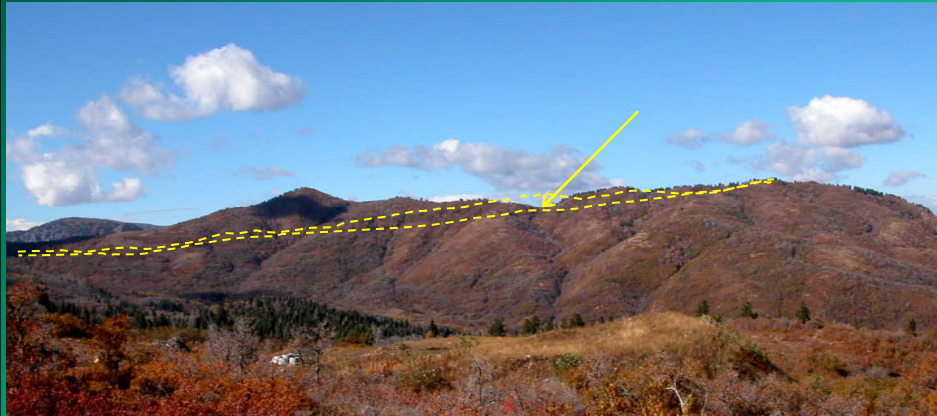
## Incorporating Vistas into Switchback Corners will Help Prevent Cutting



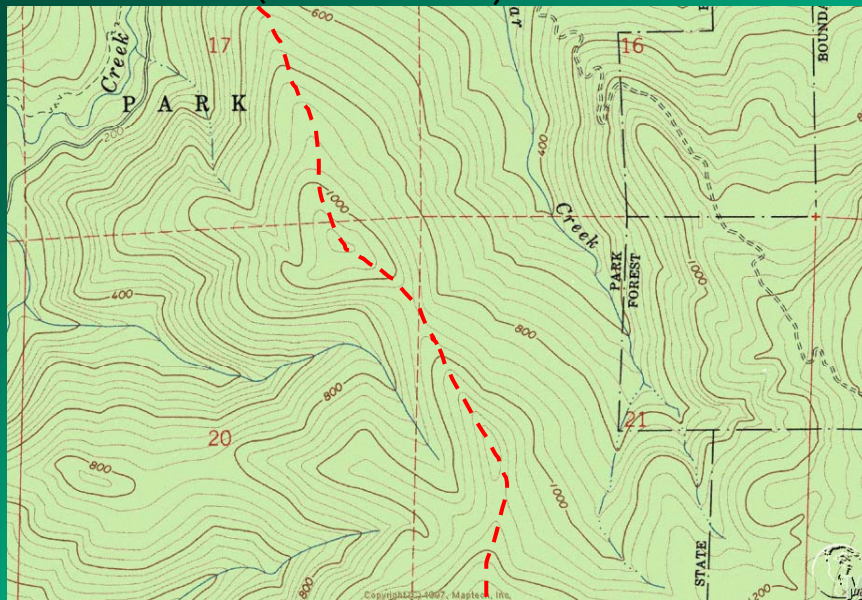
## When Using Multiple Switchbacks Maximize the Distance Between Each Switchback to Eliminate "Stacking"



## Topographic Features Such as Saddles can Also be Control Points

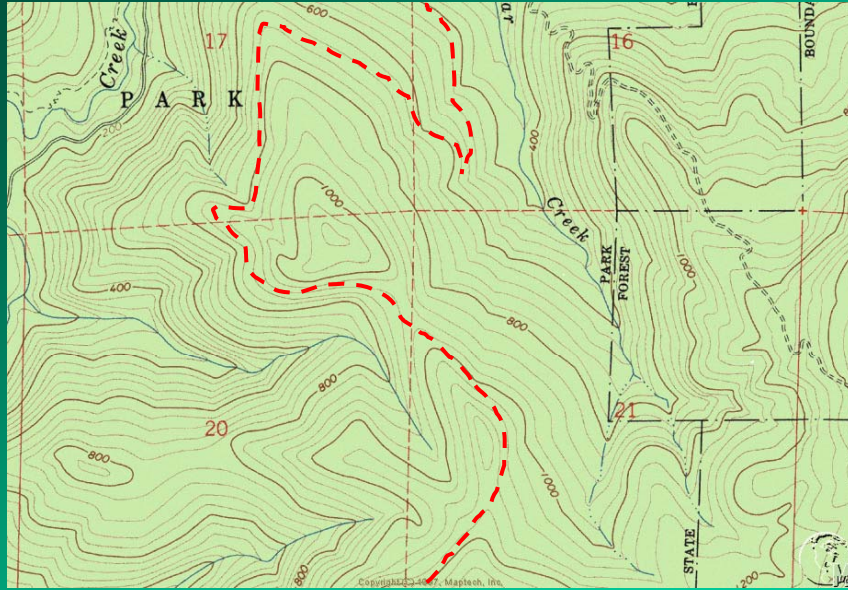


## Laying Out Trails on Top of Ridges Should Be Avoided (Control Point)





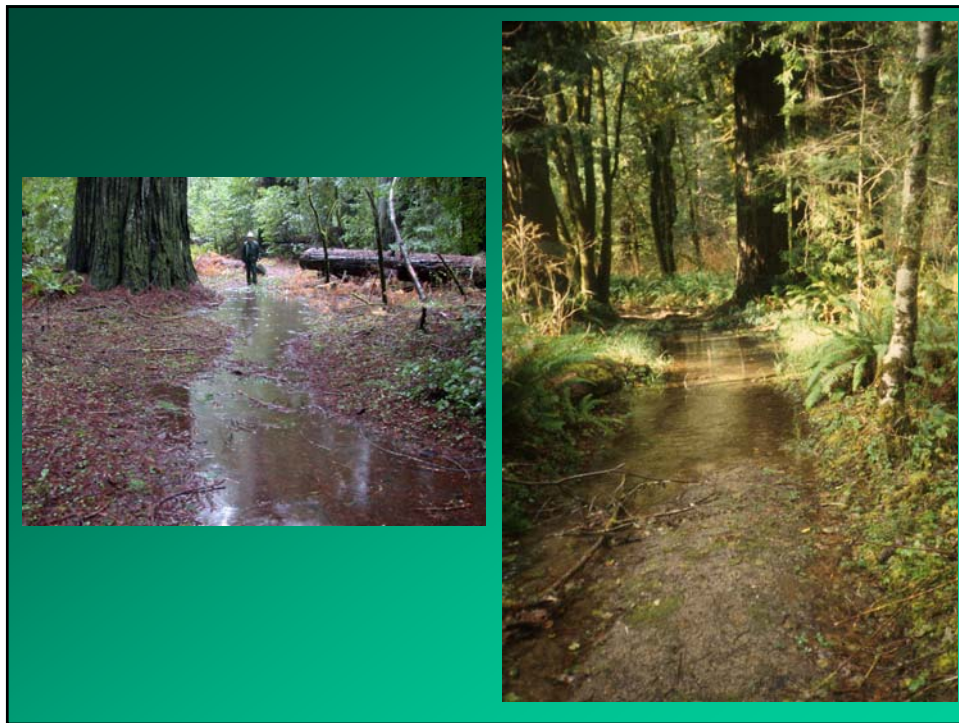
Place Them on the Side of the Ridge and Cross Over at Saddles to Provide Alternate Views



Flat Poorly Drained Land Should be Avoided (Control Point)







Meadows and Open Prairies Should Be Avoided, Trail Alignments Should Skirt the Edges If Possible (Control Point)



Drainage Crossings are Identified that Best Meet Proper Design Criteria (Control Point)



Drainage Crossings that Facilitate Instream Structures Require Moderate Gradients With (nick points) and Gentle Sloping Banks



Drainage Crossings that Require Bridges must be Evaluated for High Water Levels, Stream Bank Heights and Structural Stability

## The Flagging Process

Prior to Flagging Establish Horizontal Reference Points on Each Team Member Using a Clinometer or Abney Hand Level





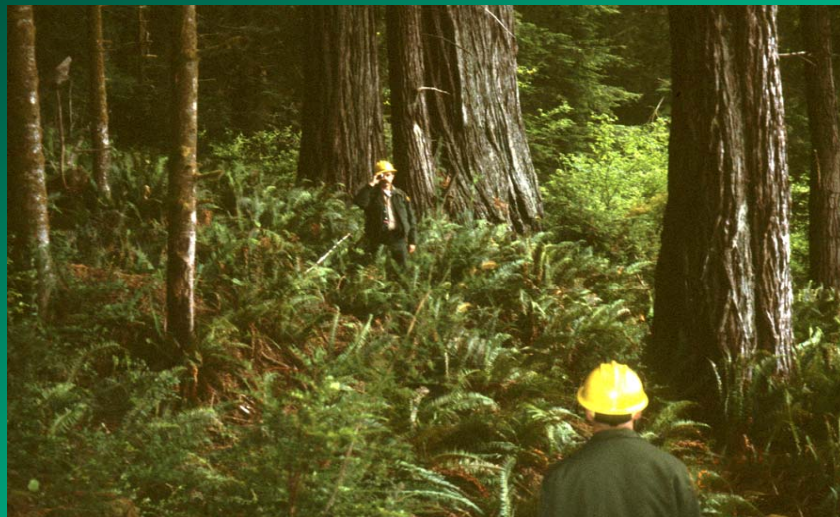
A Staff or Rod Can Also Be Used for Establishing a Horizontal Reference



## Establish Flagging Teams and Their Individual Roles



With a Two Person Team The Shooter takes the Front Position so the Shooter Can See the Upcoming Terrain



The Shooter Walks to a Location at the Approximate Prescribed Grade Staying on Contour



The Shooter Locates Their Reference Point on their Partner and Moves up or Down Slope to the Prescribed Grade



In Heavy Brush and Trees the Partner Uses Colored Flagging to Highlight Their Reference Point



Once on Grade the Shooter Hangs a Flag on Vegetation Marking Trail Grade





# Wire Flags Are Used in Open Areas

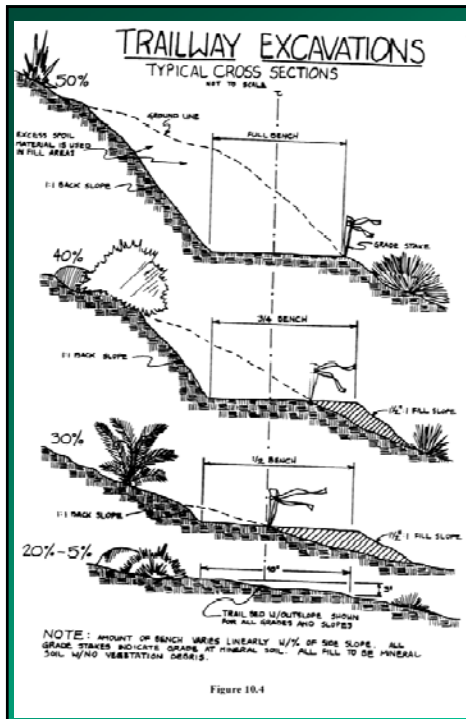


Figure 10.4



The Shooter Scuffs the Ground to Mark the Location Where They Were Standing



The Shooter Moves Forward for the Next Shot and the Partner Moves to Where the Shooter Previously Stood



## Be Careful Not to Shoot Across Topographic Features



## Monitor the Hill Slope for a Change in Grade and Adjust Linear Grade Accordingly



## When Natural Features (Rocks & Trees) Require Grade Adjustments the Flag Line Needs to Be Readjusted to even out the Grade





When Flagging in and out of a Stream, the Downhill Leg Needs to Level off or Climb for a Short Distance



The Initial Flag Line Should Be Loose Flagged. Tight Flagging Is Performed Once the Loose Flagging Is Completed



## Remove Unwanted Flag Lines to Eliminate Confusion Once Construction Begins



## Write Prescriptions for Additional Trail Structures



Trail Layout and Trail Structures Prescribed  
Should Always Consider Accessibility First



Identify Potential Sources for Native  
Construction Materials





# When Trail Structures are needed the Design and Materials Need to be Consistent with the Environment and Architecture



# Develop a Trail Work Log to Quantify Work and Produce Time and Cost Estimates

CONSTRUCTION ACTIVITY	TOTALS	UNIT	PER UNIT COST	TRAIL		MATERIAL COST INDEX	UNIT
				LABOR COST	MATERIAL COST		
Trail Brushing(1000)	0	3000	0.00	\$13.00	=	\$0.00	
Trail Brushing(2000)	0	2000	0.00	\$13.00	=	\$0.00	
Trail Brushing(3000)	0	1000	0.00	\$13.00	=	\$0.00	
Down Tree Removal 1'-3' chainsaw	0	2	hr	\$13.00	=	\$0.00	
Down Tree Removal 4'-6' chainsaw	0	6	hr	\$13.00	=	\$0.00	
Down Tree Removal 7'-9' chainsaw	0	12	hr	\$13.00	=	\$0.00	
Down Tree Removal 1'-6' crosscut	0	6	hr	\$13.00	=	\$0.00	
Down Tree Removal 4'-6' crosscut	0	40	hr	\$13.00	=	\$0.00	
Trail Maintenance	0	72	hr	\$13.00	=	\$0.00	
Trail reroute & Reconstruct (doser)	0	11.3	hr	\$13.00	=	\$0.00	
Trail reroute & Reconstruct (light)	0	7	hr	\$13.00	=	\$0.00	
Trail reroute & Reconstruct (med)	0	5	hr	\$13.00	=	\$0.00	
Trail reroute & Reconstruct (heavy)	0	4	hr	\$13.00	=	\$0.00	
Trail Hardening (soil) & Road Curb	0	68	sq ft	\$13.00	=	\$0.00	
Trail Hardening Material ( Road Curb)	0	1	sq ft	\$0.75	=	\$0.00	
Sign Installation	0	48	hr	\$13.00	=	\$0.00	
Trail Rehabilitation	0	100	sq ft	\$13.00	=	\$0.00	
Trail Repairs	0	100	sq ft	\$13.00	=	\$0.00	
Hand Rail Removal	0	30	lin ft	\$13.00	=	\$0.00	
Handing Wall Removal	0	3	cu ft	\$13.00	=	\$0.00	
Backpack & Climbing Tiers	0	48	hr	\$13.00	=	\$0.00	
Construction	0	24	sq ft	\$13.00	=	\$0.00	
Log Barrier Installation	0	2.5	sq ft	\$13.00	=	\$0.00	
Temporary Enclosure 6' x 6'	0	2.5	lin ft	\$13.00	=	\$0.00	
Material cost	0	cu yd	\$0.00	=	\$0.00		
Public Interpretation	0	sq ft	\$0.00	=	\$0.00		
Drainage Structures	0	4	cu ft	\$13.00	=	\$0.00	
Drainage Lintens	0	2	cu ft	\$13.00	=	\$0.00	
Quarry Rock 4'-8"	0	1	sq ft	\$22.00	=	\$0.00	
Curbcut Installation	0	1	lin ft	\$13.00	=	\$0.00	
Curbcut 10'	0	1	lin ft	\$7.50	=	\$0.00	
Fabric for Curbcut and Benches	0	1	sq ft	\$0.00	=	\$0.00	
Retaining Wall Construction	0	1	cu ft	\$13.00	=	\$0.00	
Structural Multi-use	0	1	cu ft	\$13.00	=	\$0.00	
Riprap	0	1	cu ft	\$13.00	=	\$0.00	
Concretoy wall/Signpost	0	2	lin ft	\$13.00	=	\$0.00	
Non-Structural (single tier)	0	4	cu ft	\$13.00	=	\$0.00	
Rock for dry rock structures	0	1	cu yd	\$40.00	=	\$0.00	
Bridge Abutments/Monitor	0	1.5	cu ft	\$13.00	=	\$0.00	
Monitor Wall	0	1.5	cu ft	\$13.00	=	\$0.00	
Rock for mortared walls	0	cu yd	\$40.00	=	\$0.00		
Mortar	0	34	lb bags	\$0.00	=	\$0.00	
Wood	0	1	sq ft	\$13.00	=	\$0.00	
Standard Structural	0	1	sq ft	\$13.00	=	\$0.00	
Log crib	0	2.5	sq ft	\$13.00	=	\$0.00	
Turquoise Wall	0	5	lin ft	\$13.00	=	\$0.00	
Bridge Footings	0	1	sq ft	\$13.00	=	\$0.00	
Wood structure	0	1	lin ft	\$2.00	=	\$0.00	
Rebar for Turquoise Wall	0	1	lin ft	\$0.30	=	\$0.00	

After the Trail Alignment has Been Brushed it will Need to be Re-flagged



## Good Trail Layout Follows a Process

- Identify user groups and design standards
- Perform reconnaissance to evaluate the landform
- Careful observation of the land is required
- Develop a thorough mental image of the land
- Identify linear grade limits of the landform
- Identify major and minor control points
- Determine linear grades between minor controls
- Locate the best possible trail route
- Flag between the control points
- Identify local material sources, develop prescriptions for trail structures and develop work logs and cost estimates

## Good Trail Layout Follows a Process

- Trail layout and design requires the knowledge and application of a variety of disciplines