Construction

Planning	Design	Construction	Maintenance
• Objectives: Style, Audience, Skill Level, Connections • Bike-Specific vs. Bike-Friendly Multi-Use • Resources, Funding, Volunteers • Permission, Permitting, contracts	• Maps, Grades, Half-rule, Specs, Flow • Scouting, Natural Terrain, Natural Forces, Control Points, Flagging, Sightlines • Documentation	• Trail Corridor, Outslope, Full Bench, ½-Bench, Switchbacks, Grade Reversals • Dealing with Running Water • Crossing Flat/Wet Areas • Tools & Work Safety	• Brushing, clearing • Re-benching • Trail Widening • Drainage, nicks, grade reversals • Choke points • Re-routes

Bike-Friendly Techniques

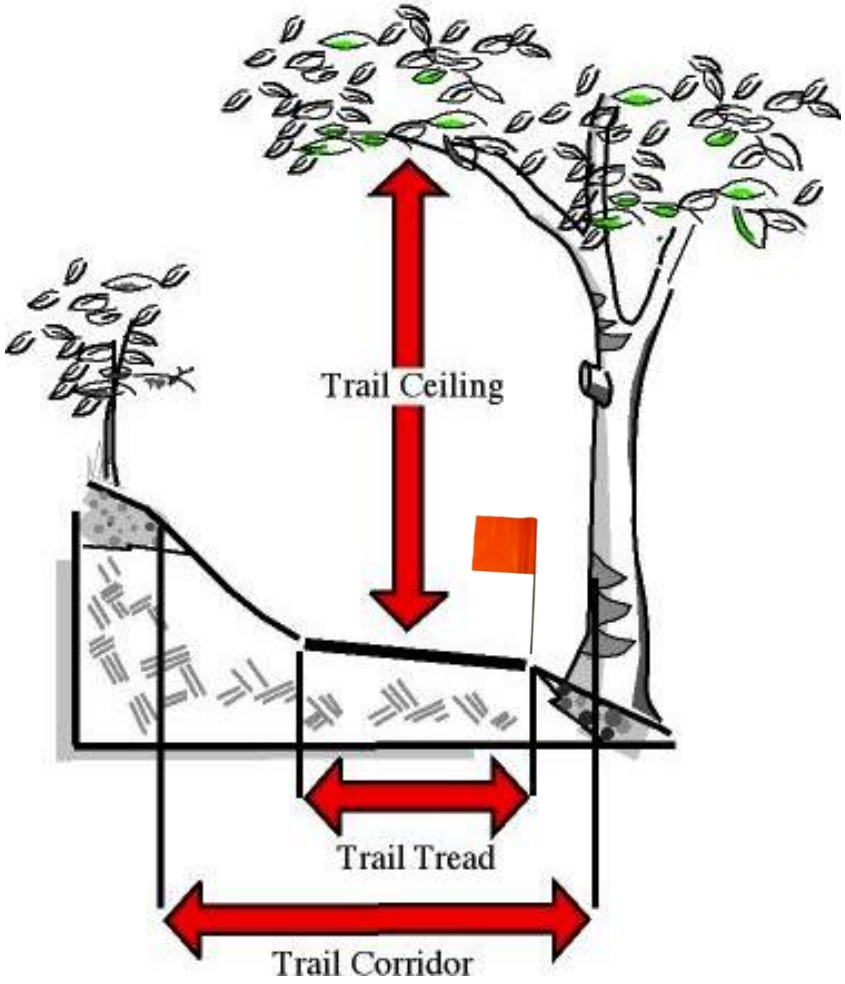
PNW Techniques

Tools, Special Considerations

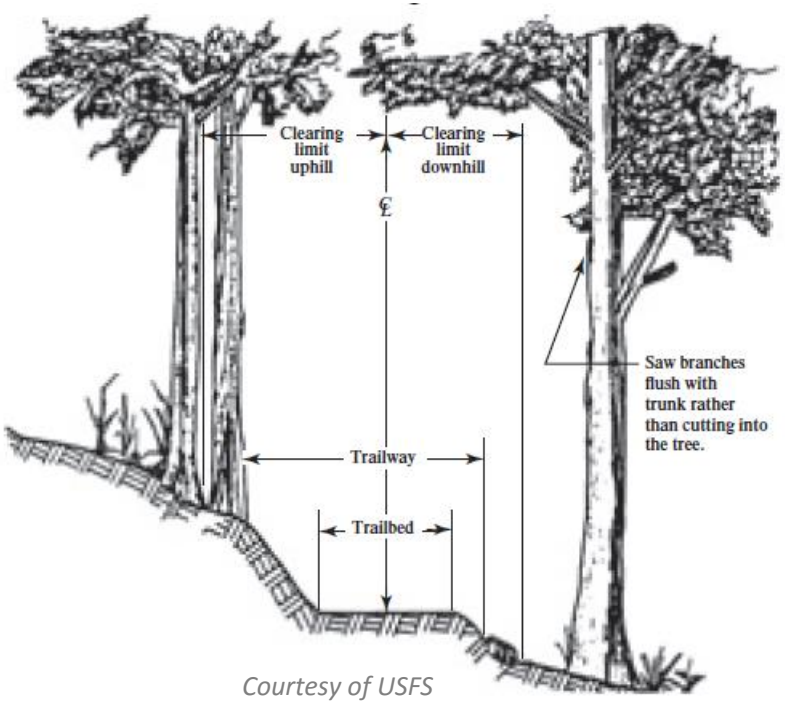
Trail Construction – Agenda

- Before You Dig
  - Clearing the Trail Corridor
  - Understanding Dirt
  - Intro to Full Bench, Partial Bench, Outslope & Sheet Flow
- Construction
  - Full Bench Detailed Steps
  - Partial Bench & Retaining Walls
  - Grade Reversals, Dips, Knicks & Rolling Contour Trails
  - Switchbacks
- Dealing with Running Water
  - Rock Armored Fords
  - Bridges
- Crossing Flat/Wet Areas
  - Rock Armoring
  - Turnpikes & Causeways
  - Boardwalks
- Tools & Work Safety
- Video

Before You Dig: Clearing the Trail Corridor

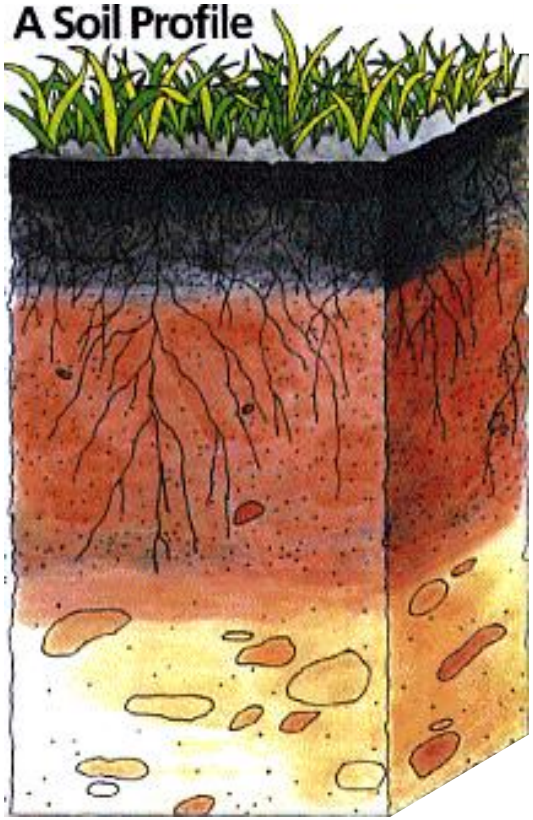


Courtesy of IMBA



Courtesy of USFS

Before You Dig: Understanding Dirt



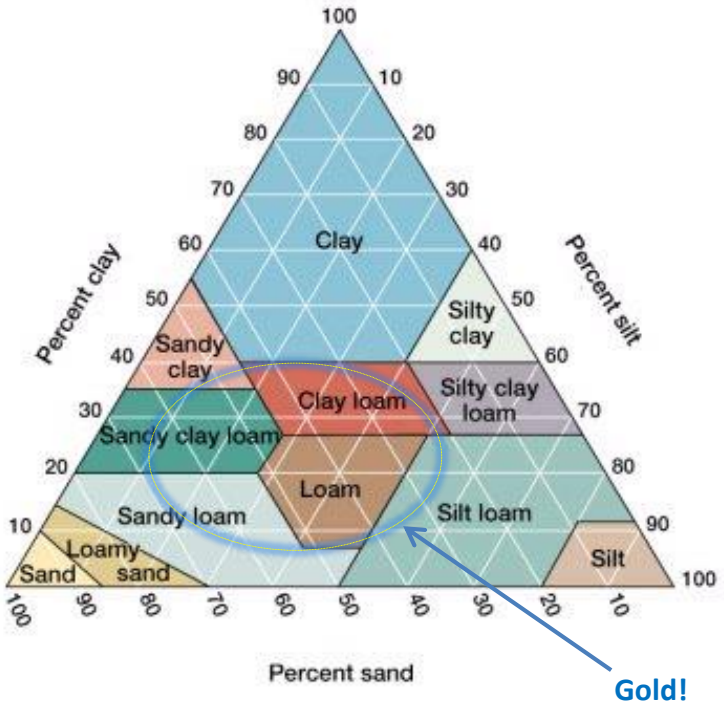
Duff Layer
(organic)

Mineral Soil
(mix of sand, silt, clay and leaching from organic layer)

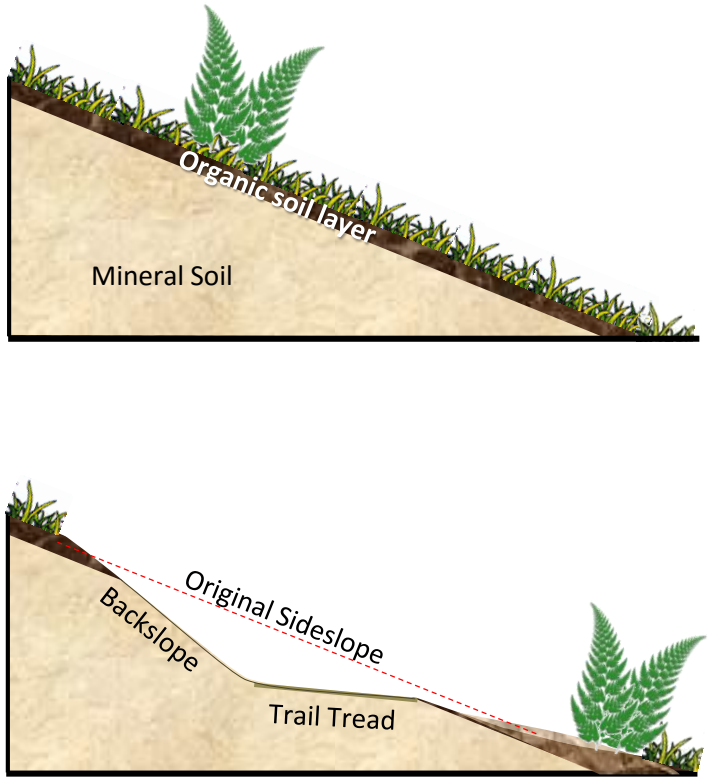
Mineral Soil
(pure mix of sand, silt, clay and rocks)

Ultra simplified!

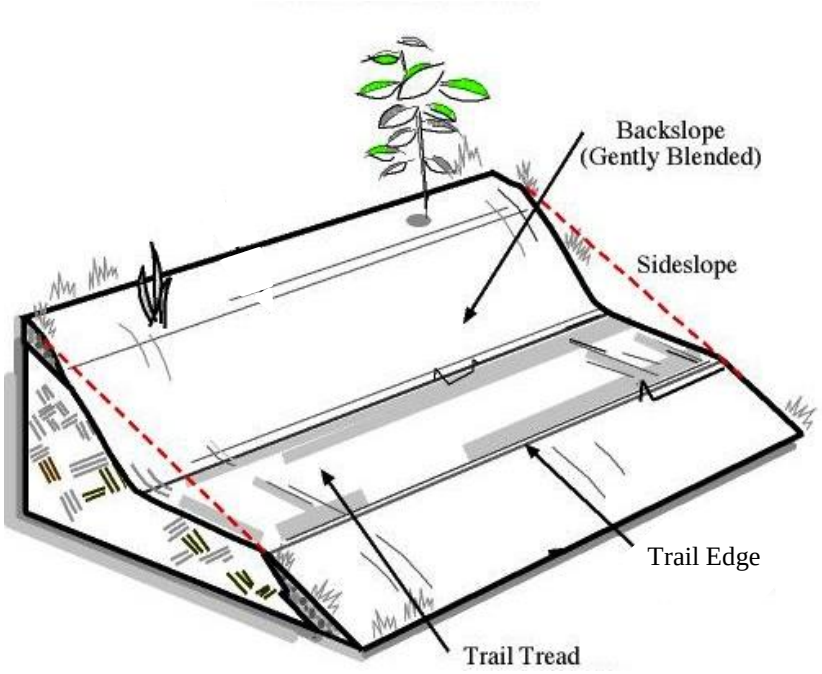
Loam: soil composed of sand, silt and clay



Full Bench Construction: What is it?

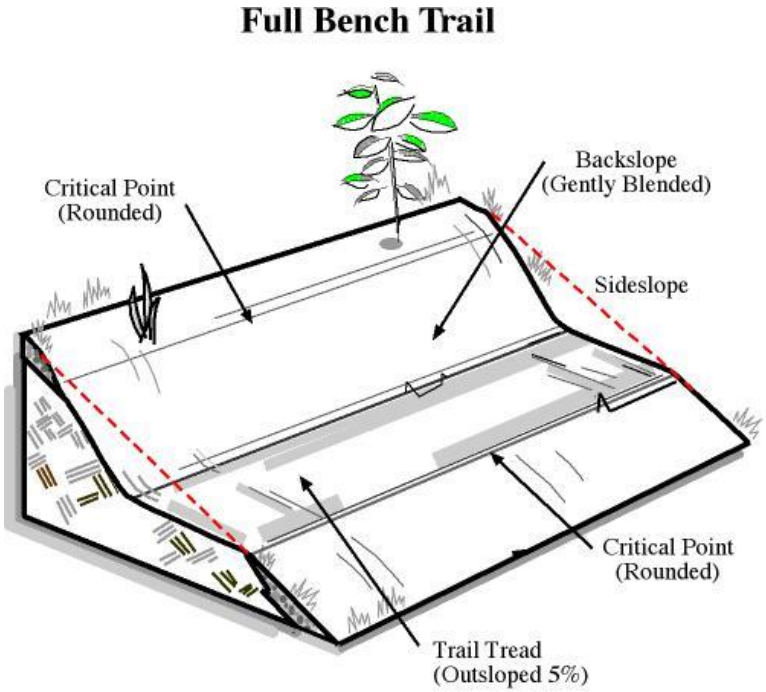


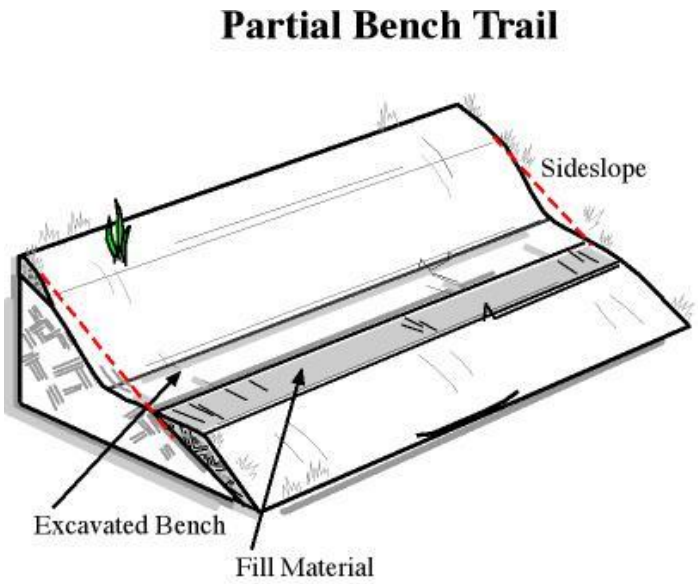
Dig down to mineral soil bench for entire trail width

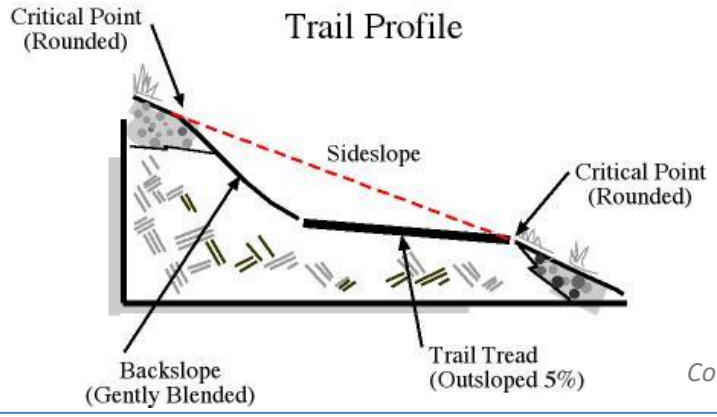


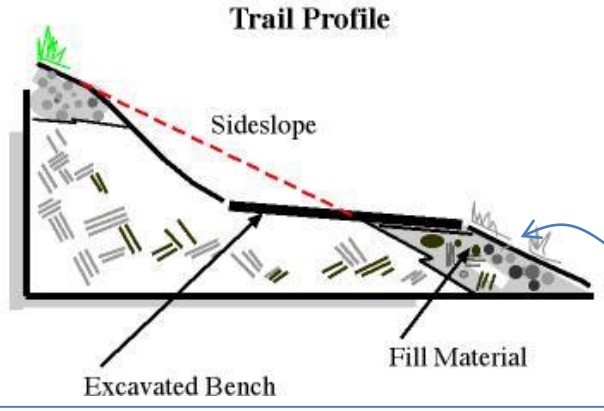
Courtesy of IMBA

Full vs. Partial Bench





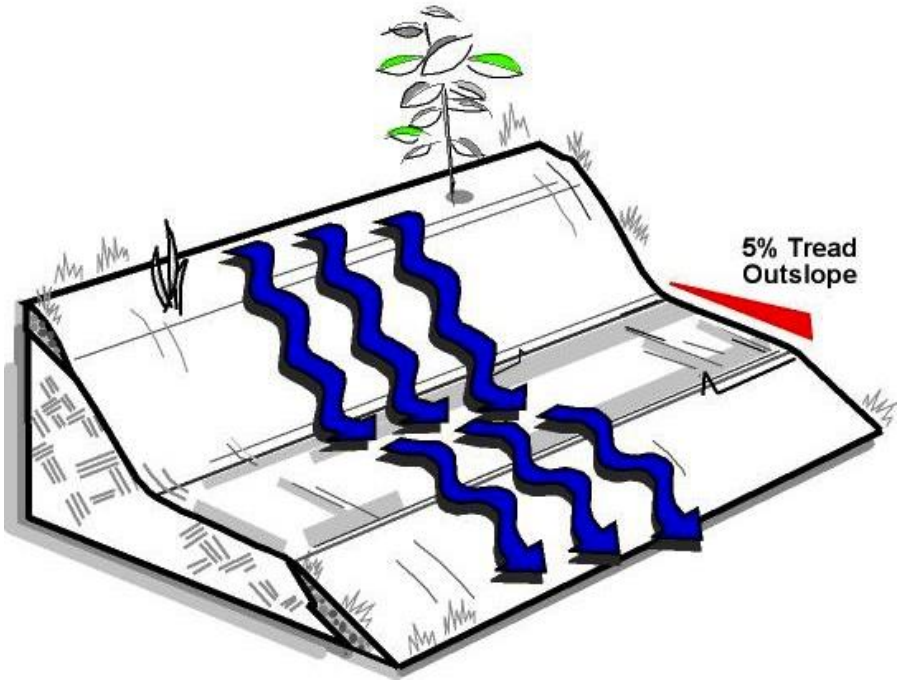




Optional: retaining wall

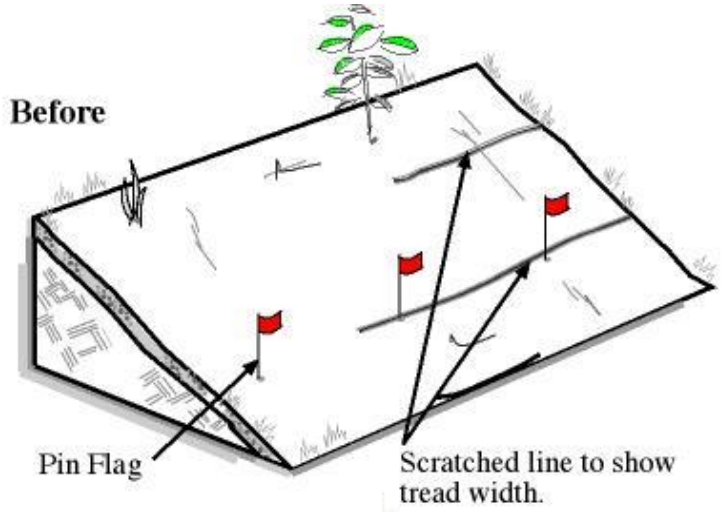
Courtesy of IMBA

Outslope & Sheet Flow



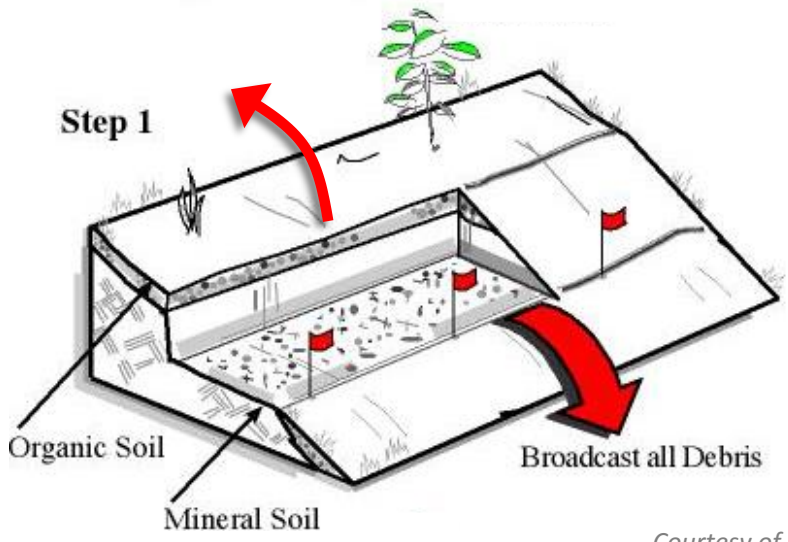
Courtesy of IMBA

Full Bench Trail Construction – Step 1



Before:

Pin-flag final trail alignment and lightly clear trail corridor



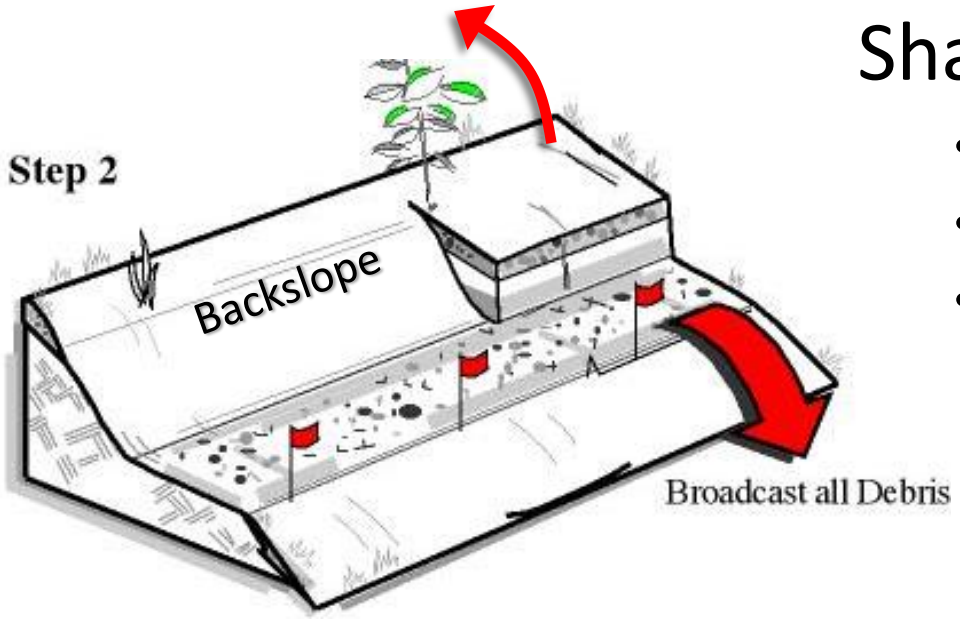
Step 1:

Dig down to mineral bench

- Broadcast debris as far from trail as possible
- Broadcast uphill if traversing gradual terrain
- Start on low side and dig in!

Courtesy of IMBA

Full Bench Trail Construction – Step 2



Step 2:

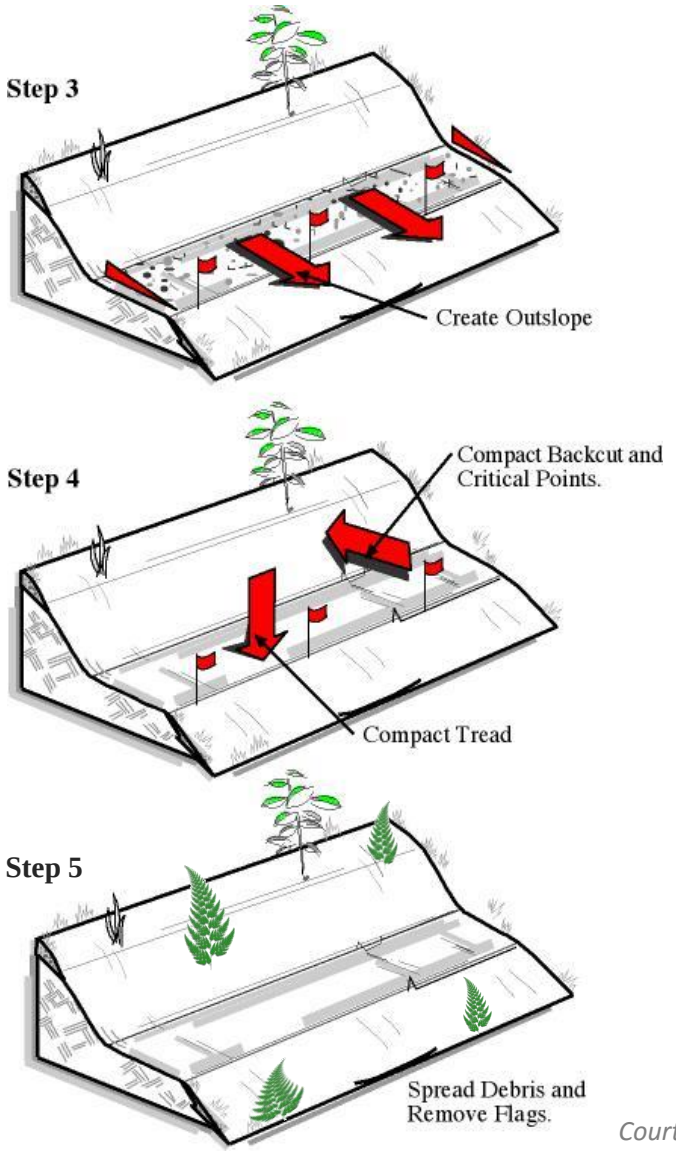
Shape back slope 1:1

- Tamp down trail first
- Broadcast debris far
- Keep organic off trail tread

Steps 1 & 2 = Bulk of the work.

Courtesy of IMBA

Full Bench Trail Construction – Steps 3-5



Courtesy of IMBA

Step 3:
Create Outslope (5%)

Step 4:
Compact tread and back slope

Step 5:
Remove flags, clean-up and green-up

Finished Trail

Finished Trail

Tiger Mt De-Duffication

Soil Profile

Duff Layer (organic)

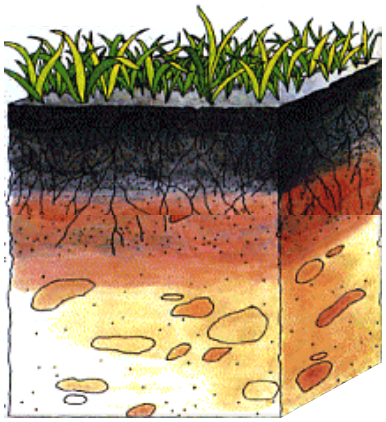
Leached Mineral Soil (mix of sand, silt, clay and leaching from organic layer)

Mineral Soil (pure mix of sand, silt, clay and rocks)

Thickness of Duff and Leached Layers Varies Greatly!

Remove the Duff Layer !

Leave the Leached Mineral !



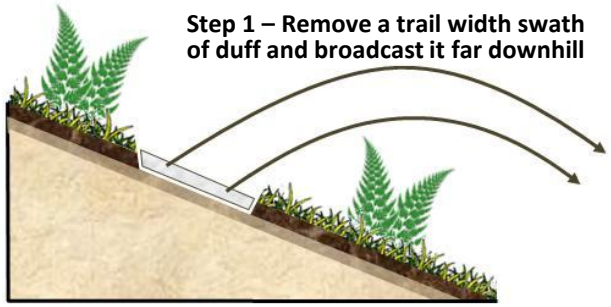
Duff Layer

Thin or almost no Leached Mineral

Mineral Soil

Tiger Mt De-Duffication

Steps

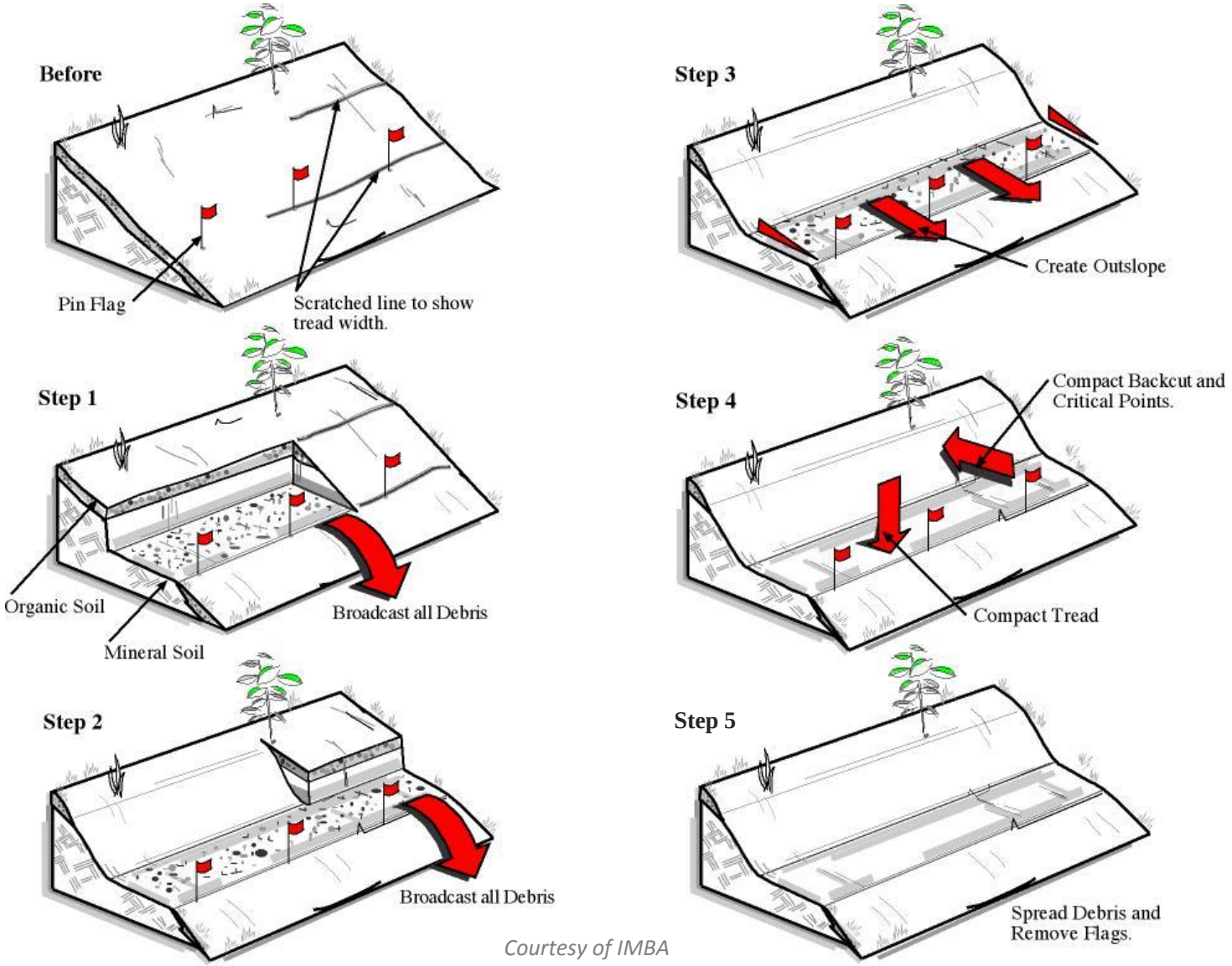


Tiger Mt De-Duffication

Pay Attention To…

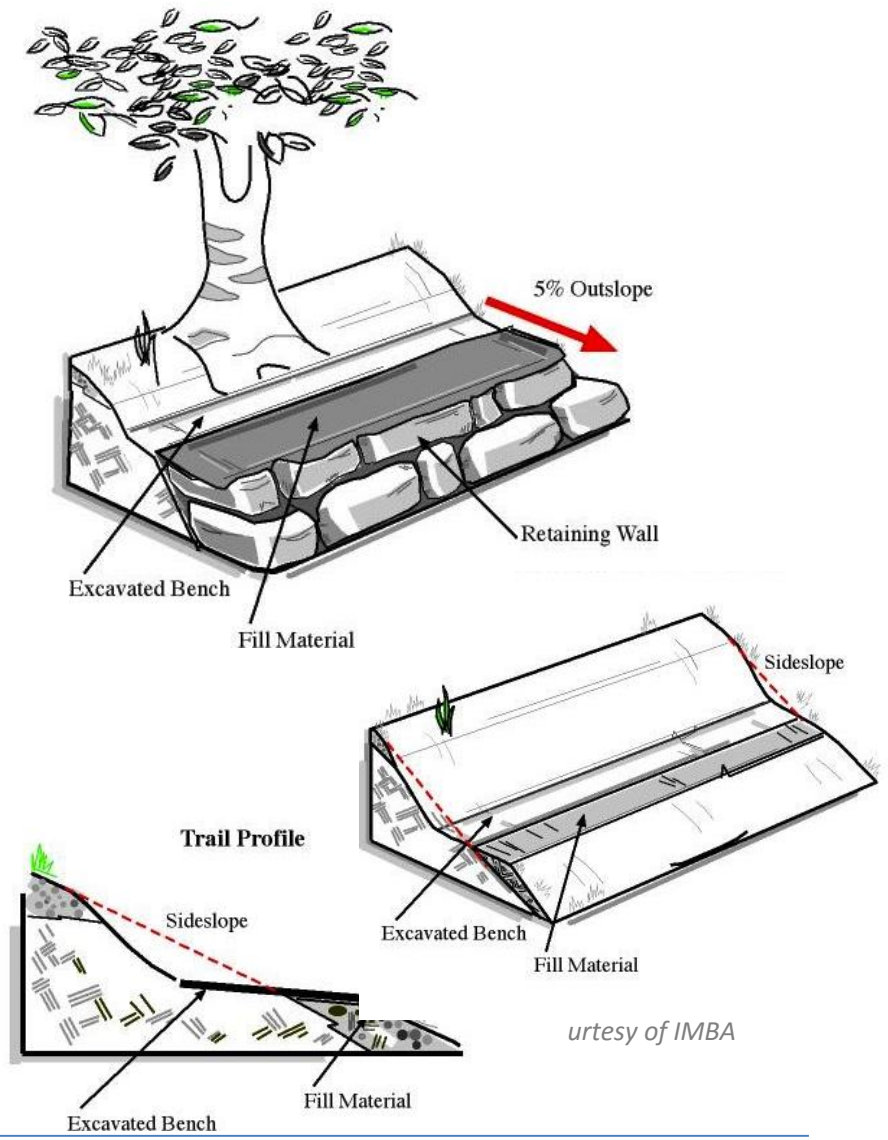
- **No trail benching or trail shaping**
  - We're just removing duff today.
- **Slope of exposed mineral should match slope of side hill when done**
- **Spread out**
  - Each person work ~10 ft long sections of trail at a time
- **Broadcast duff far downhill (>20 ft)**
  - As far as possible.
  - Most common mistake is leaving duff piled up on the downhill side of the trail.
- **Remove duff in steps**
  - Remove ~6 inches deep along your entire 10 ft long trail section.
  - Then go back over it and remove more until you hit mineral.
- **When in doubt, stop!**
  - Ask or move on to a new 10 ft section.
  - We can easily remove more duff later.
  - It's much more difficult to add mineral back if we've gone too deep.
- **Leave roots bigger than your thumb**
  - Chop out roots smaller than your thumb.
- **Transplant ferns uphill if you can**

A few questions and challenges



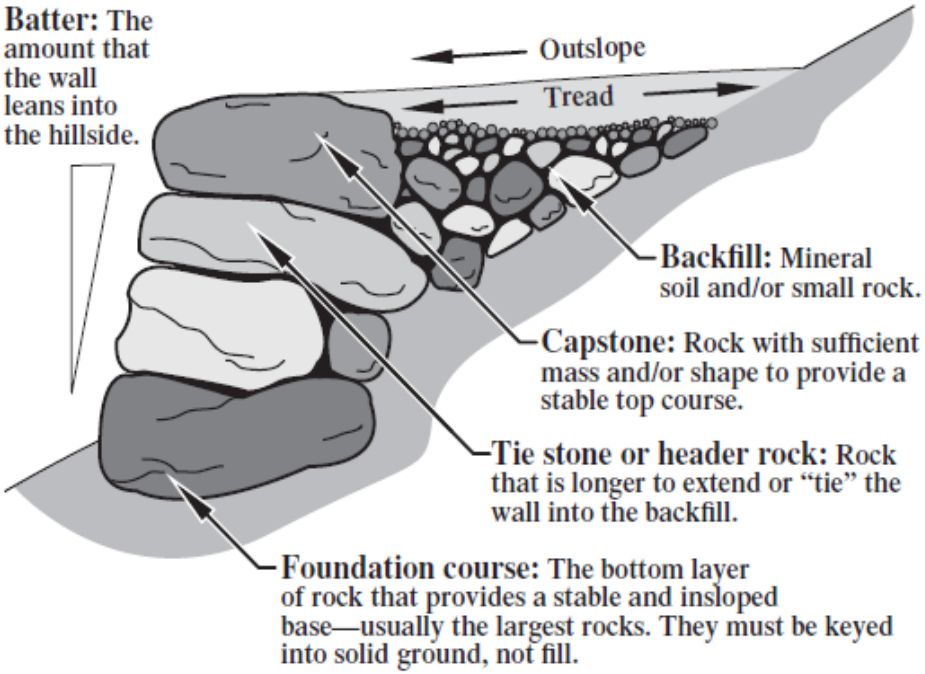
Courtesy of IMBA

Partial Bench



urtesy of IMBA

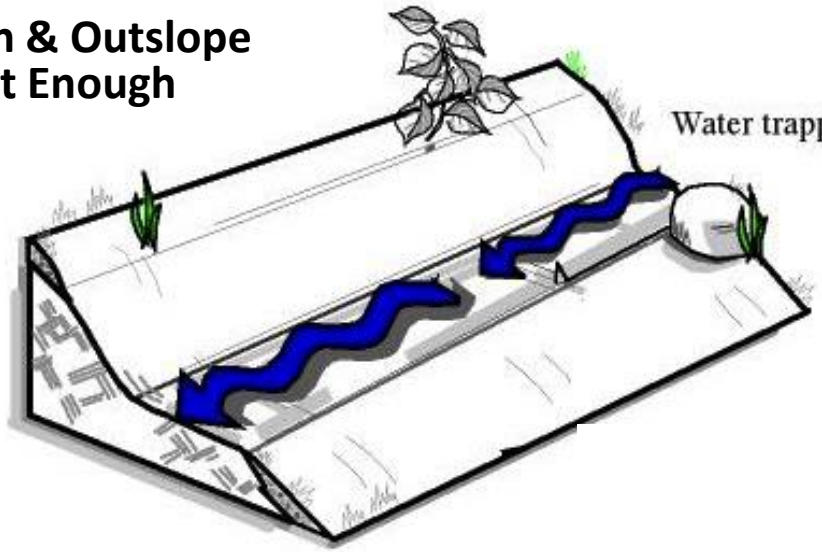
Retaining Walls

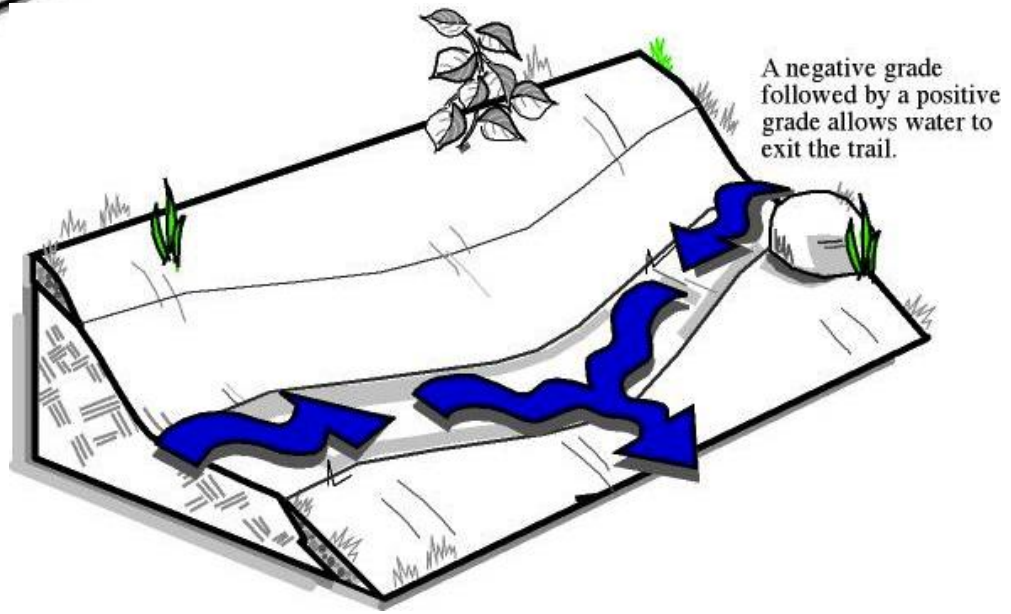


Courtesy of USFS

Grade Reversals

Bench & Outslope Aren't Enough

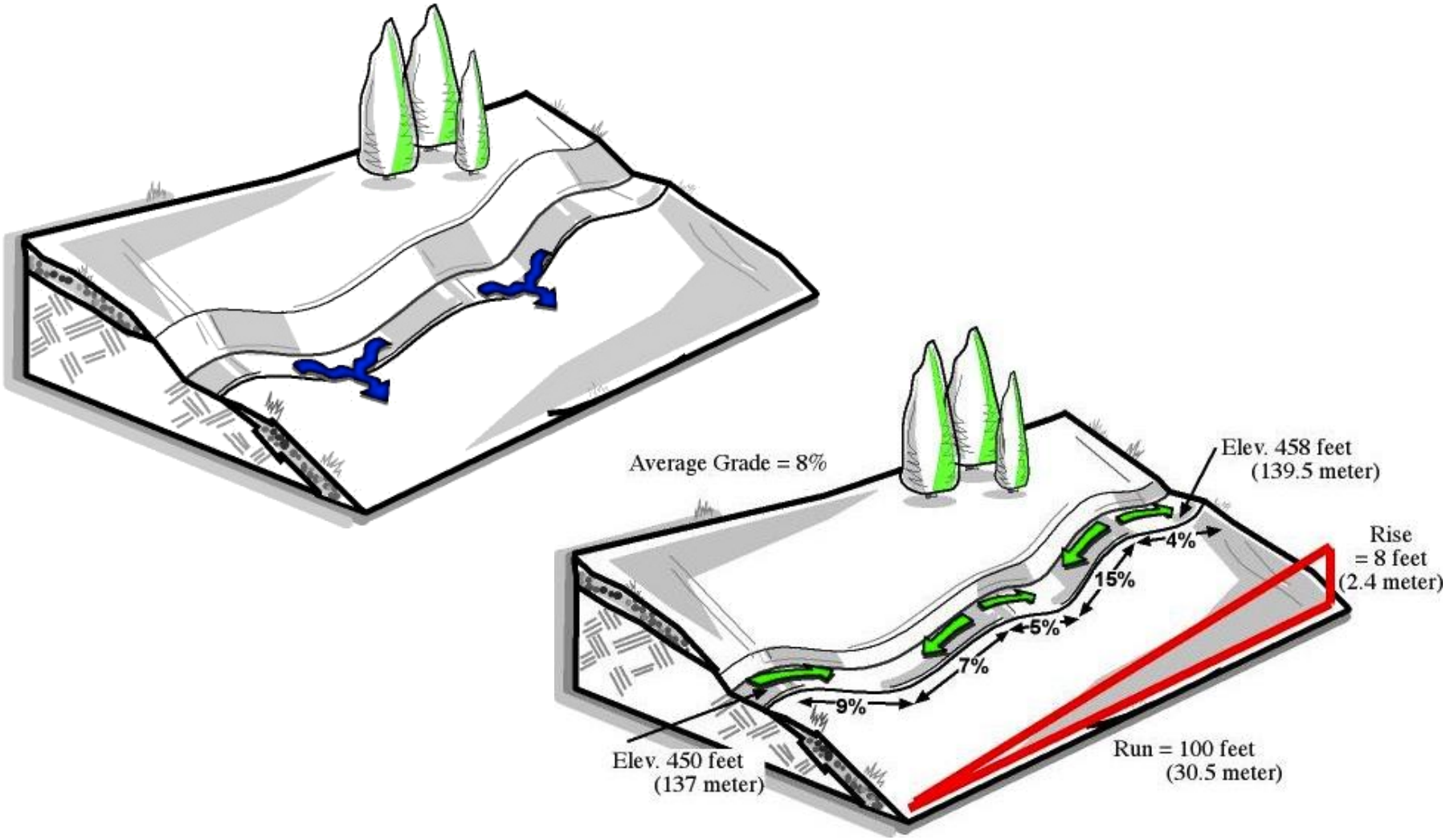




Regular and Frequent
Grade Reversals
Are Required

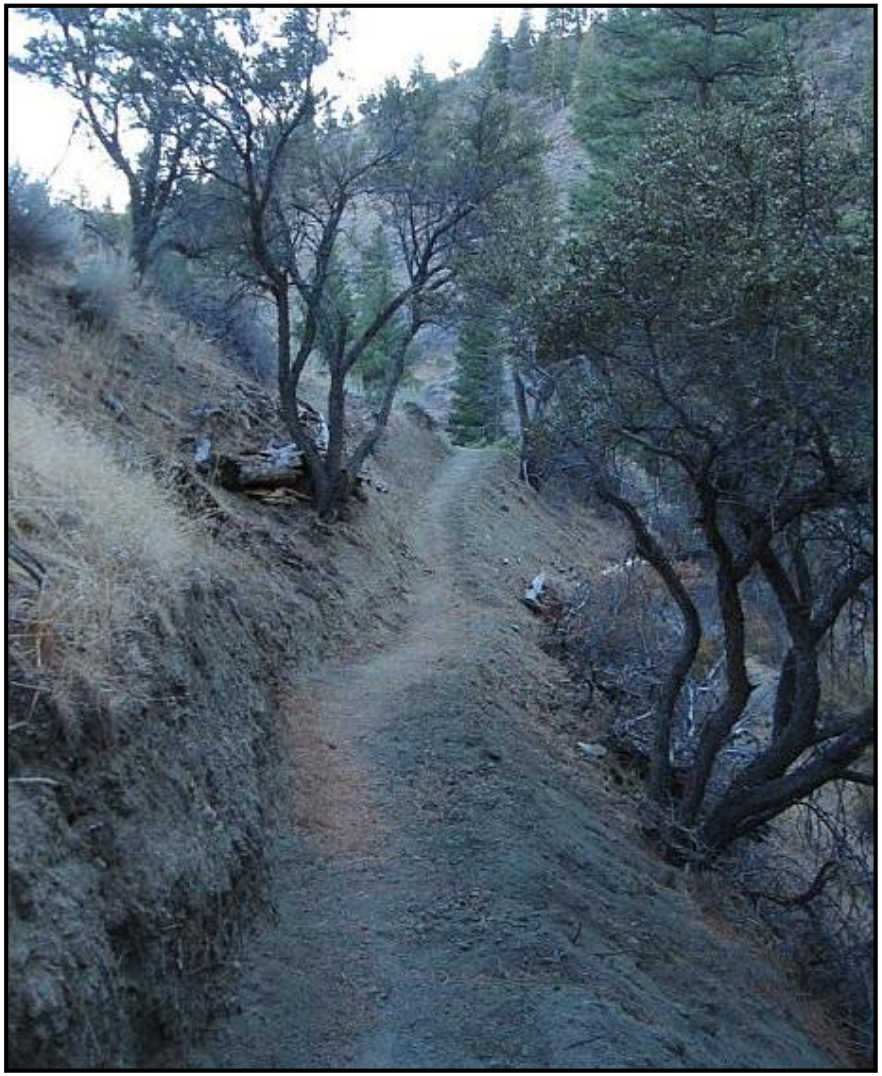
Courtesy of IMBA

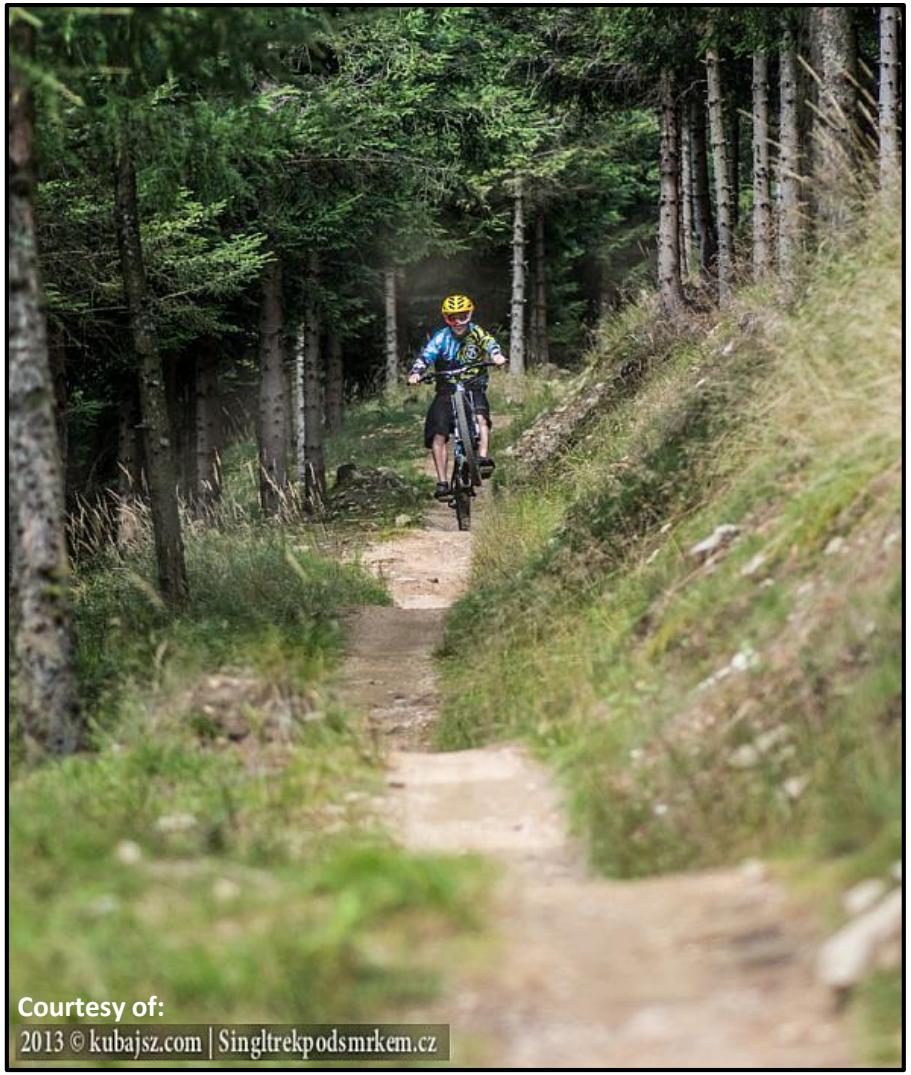
Rolling Contour Trail



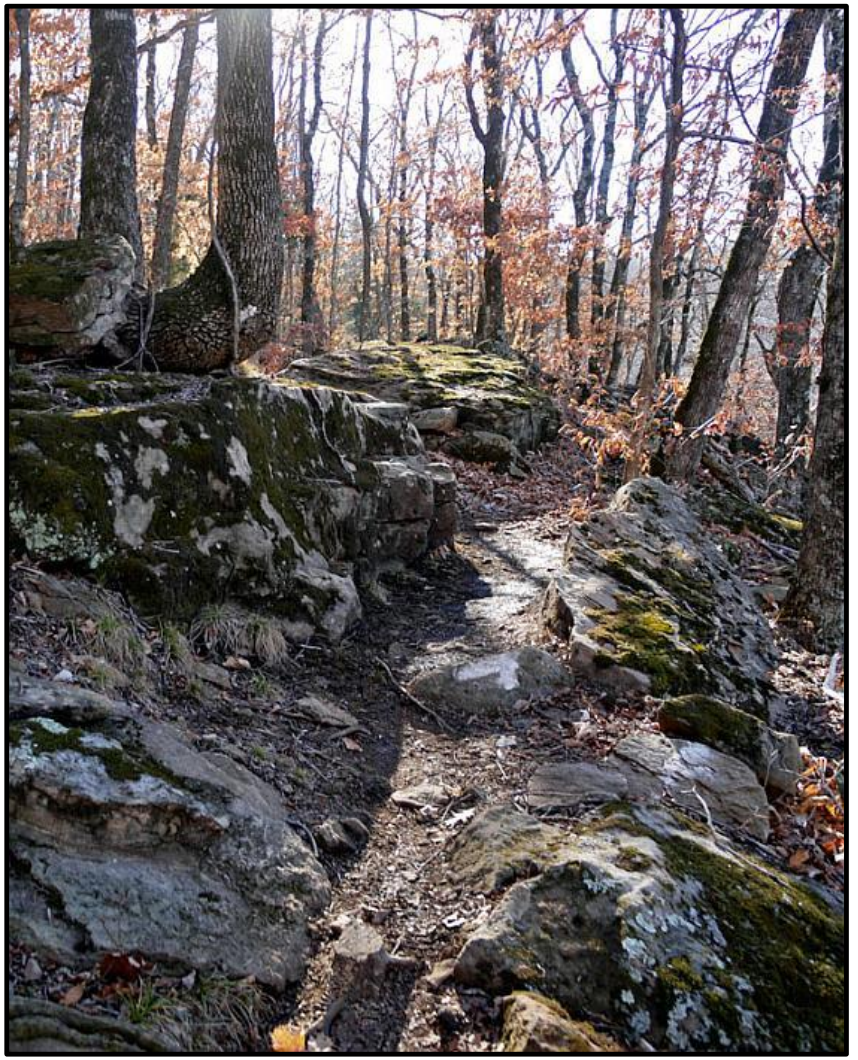
Courtesy of IMBA

Finished Trail





Alternative to Rolling Contour

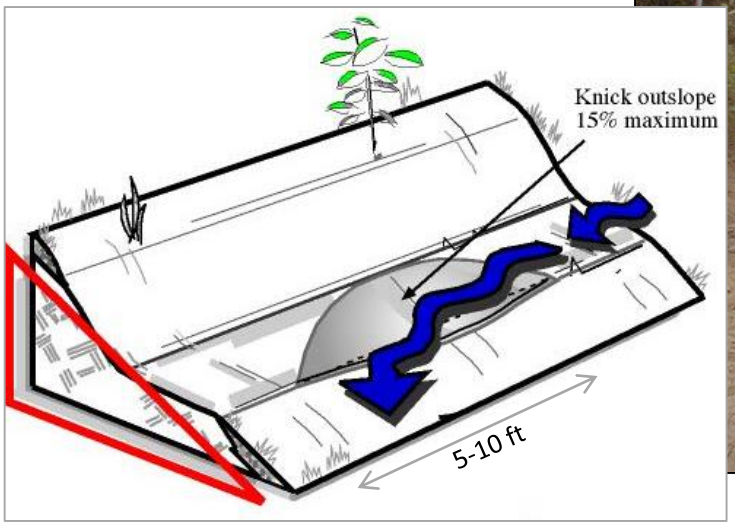


Knick

We don't mean this guy:

Courtesy of Nick Nolte

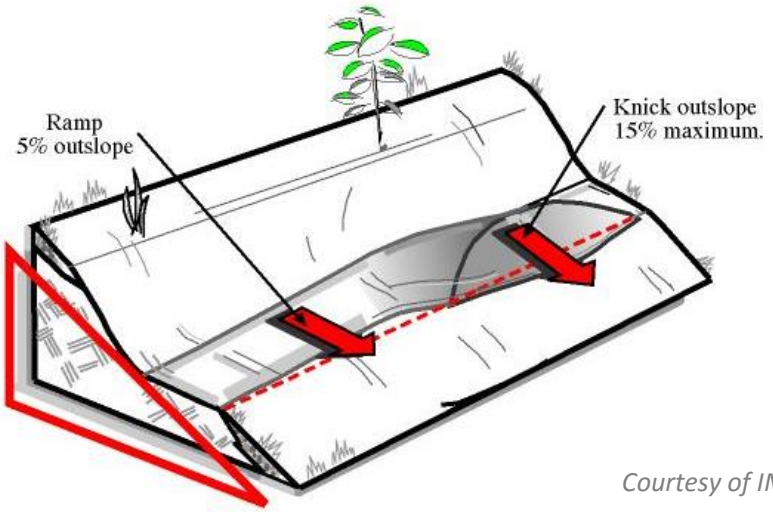
We mean this :



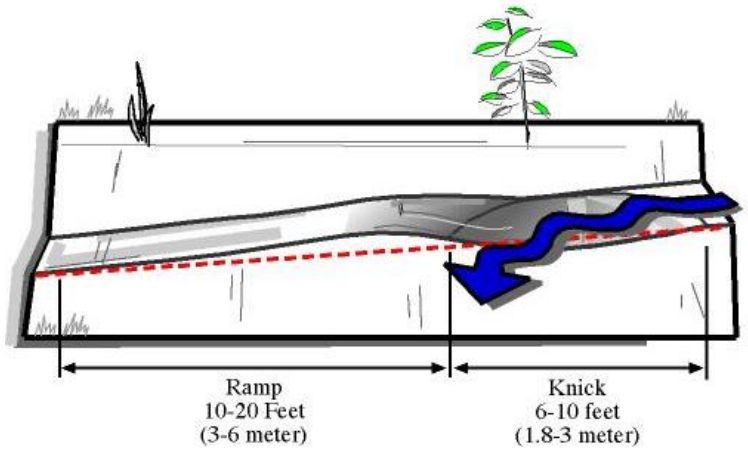
Courtesy of IMBA

Rolling Grade Dip

Knick with a short grade reversal

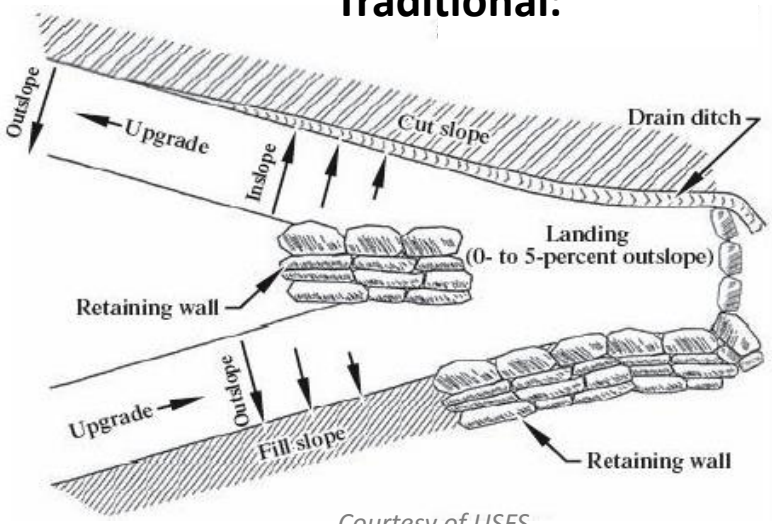


Courtesy of IMBA



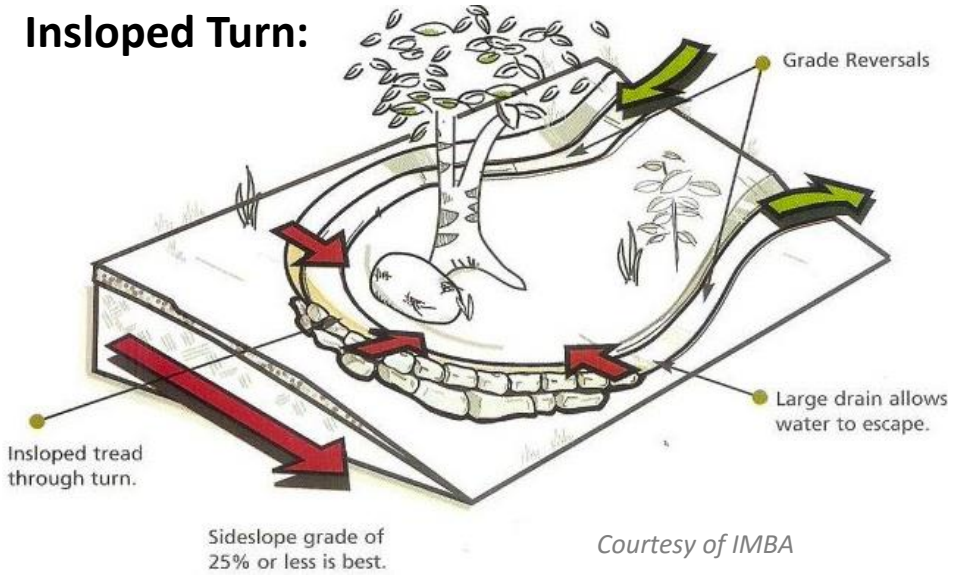
Switchbacks

Traditional:



Courtesy of USFS

Insloped Turn:



Courtesy of IMBA

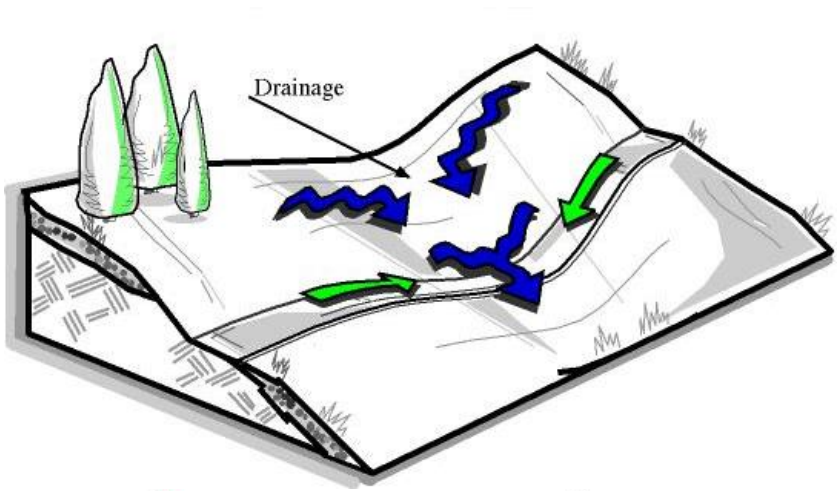
- Wider turn
- Banked sides
- Grade reversals on both sides
- Holds water off tread thru turn!
- Lower the grade on uphill side &raise the grade on downhill side
- Vary difficulty via turn grade & obstacles

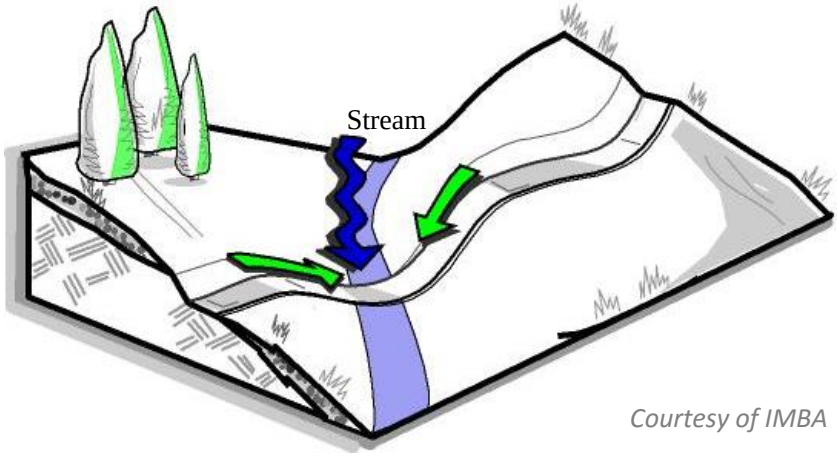
Switchbacks

Dealing with Running Water

Cross Drainages, Streams and Seeps with an exaggerated grade reversal

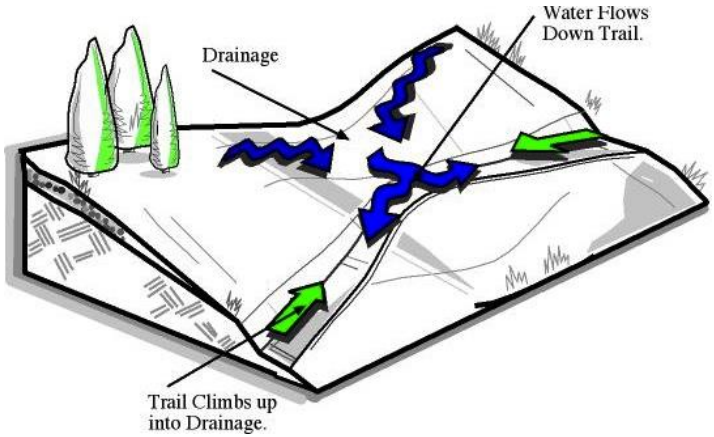
Proper Drainage & Stream Crossing



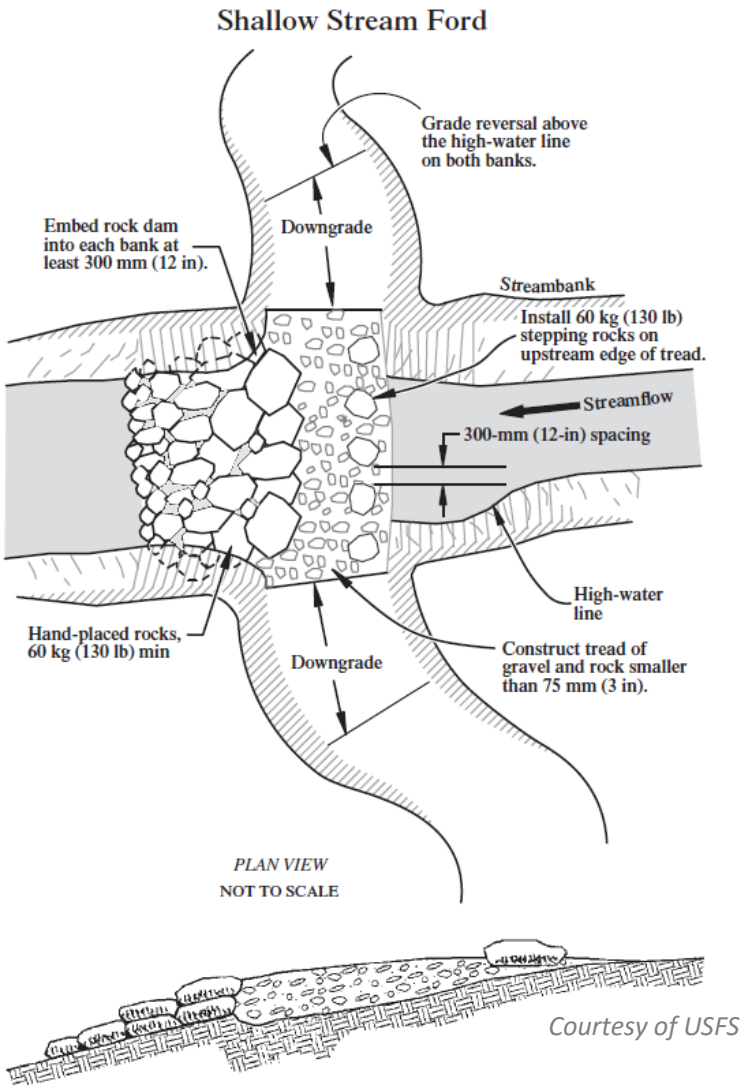


Courtesy of IMBA

Improper Drainage Crossing

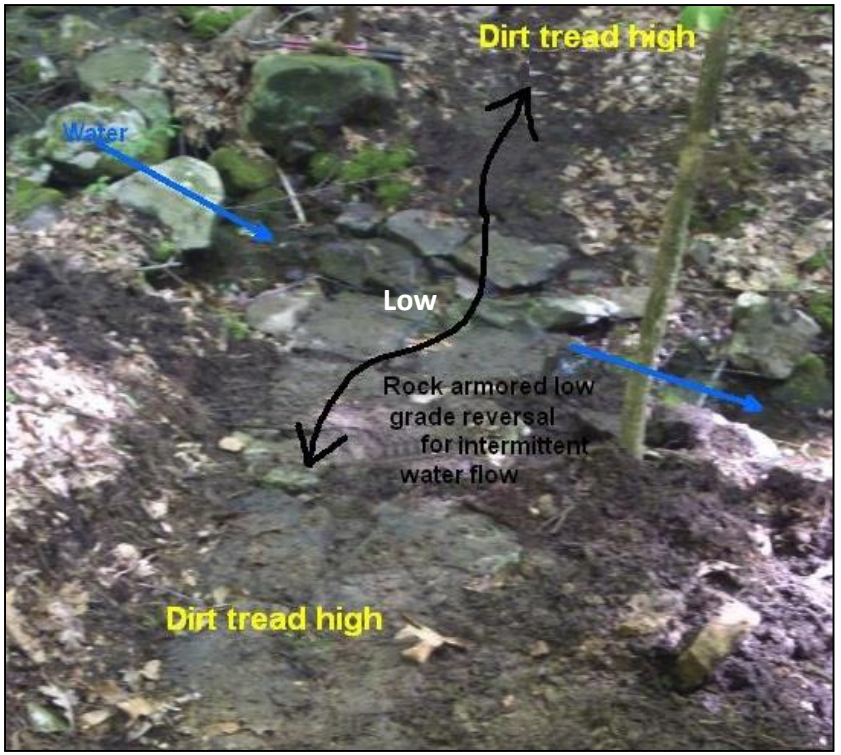


Rock Armored Crossing



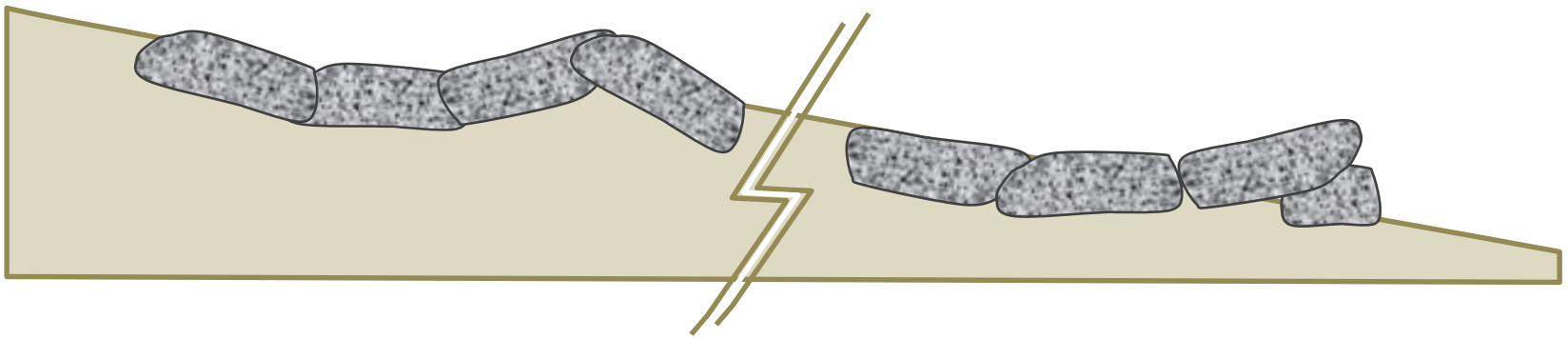
Courtesy of USFS

#2: Armor the crossing with Rock
(aka shallow stream ford, rock armored crossing, splash crossing)

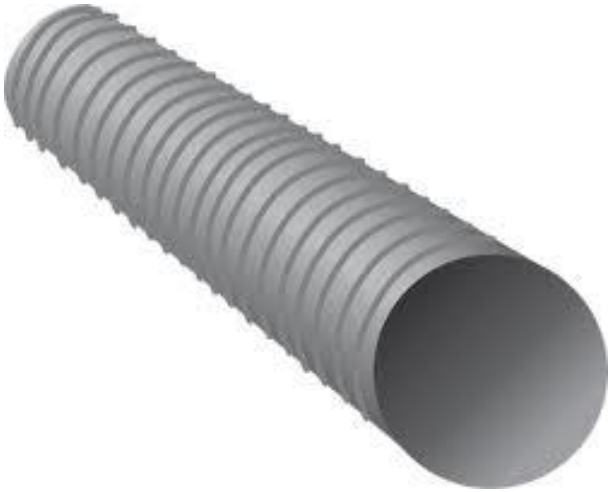


Examples of Rock Armoring

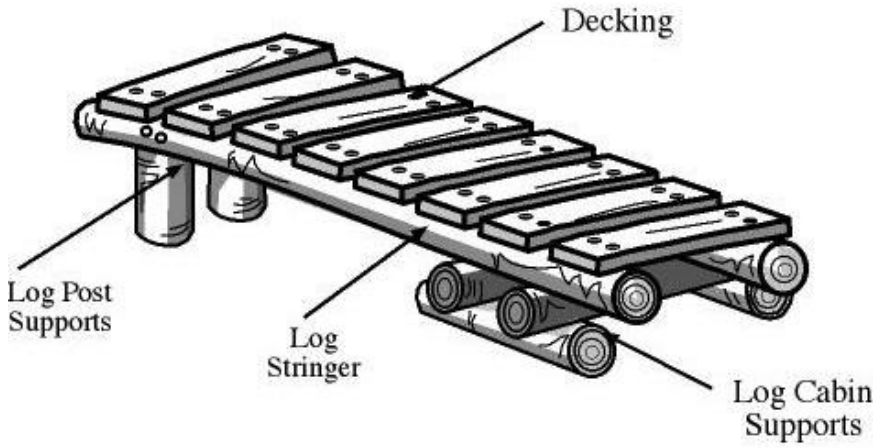
Making Rock Armoring Fun to Ride

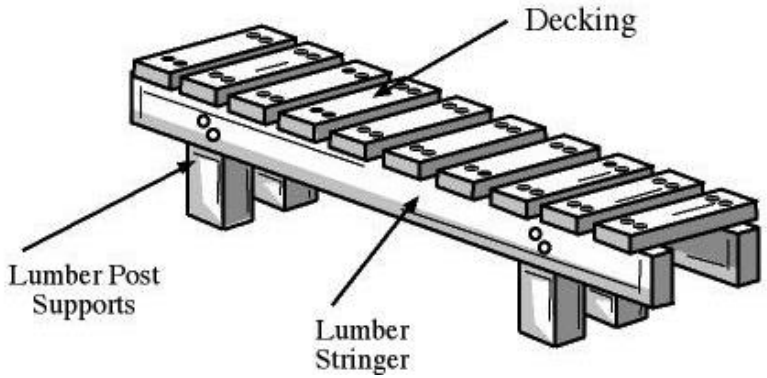


When to Use Culverts



Last Resort: Bridges





Traction!

- Rough sawn, split or scored cedar decking
- Gap between decking (watch dog paws)
- Other ways to Texture (e.g. Tolt river bridge vert 2x4s)

Other

- Preference: Flat & Straight
- Chicane on both sides

Some of the above may conflict with other trail users (equestrians, stock animals and dogs may not be compatible with gap between deck boards).

Bridges

Bridge Decks

Traction:

- Rough sawn, split or scored cedar decking
- Pultruded fiberglass grating
- Gap between decking (watch dog paws)
- Other ways to Texture:
  - Tolt river bridge vert 2x4s)
  - Expanded Metal
- Preference: Flat & Straight
- Chicane on both sides

Crossing Flat/Wet Areas

“So what’s wrong with a little mud?!”

Crossing Flat/Wet Areas

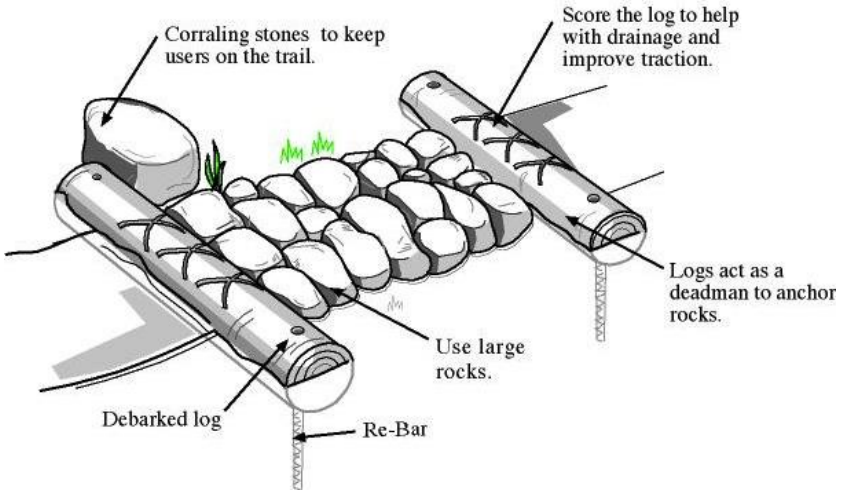
Problems:

- Standing water& mud
- Trail widening
- Erosion
- Wetland requirements
- Negative user experience
- Propagation on high traffic trails

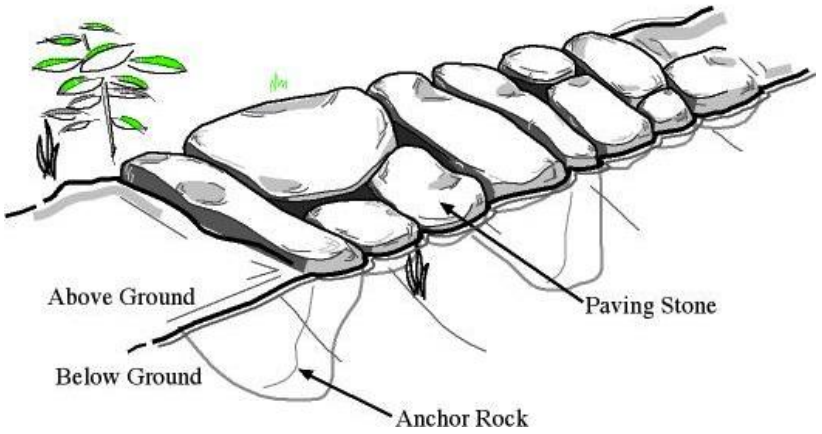
How do we deal with it?

Rock Armoring Flat Sections

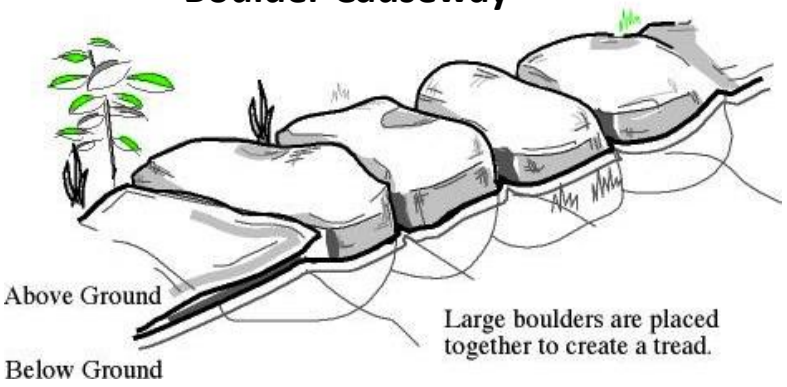
Appalachian Armoring



Flagstone Paving

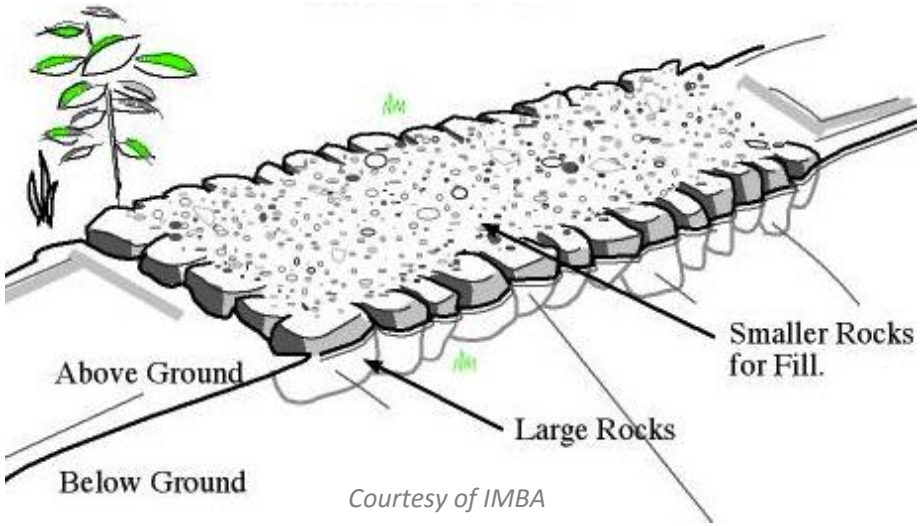


Boulder Causeway

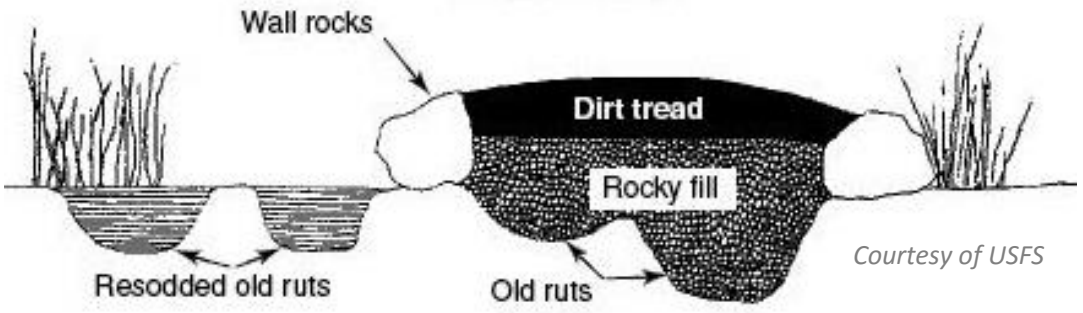


Courtesy of IMBA

Turnpikes & Causeways

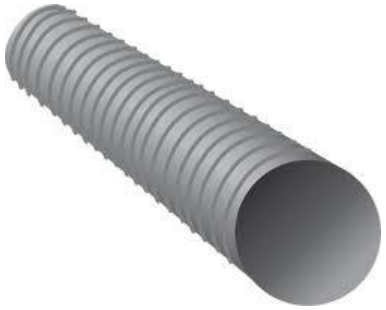


Courtesy of IMBA

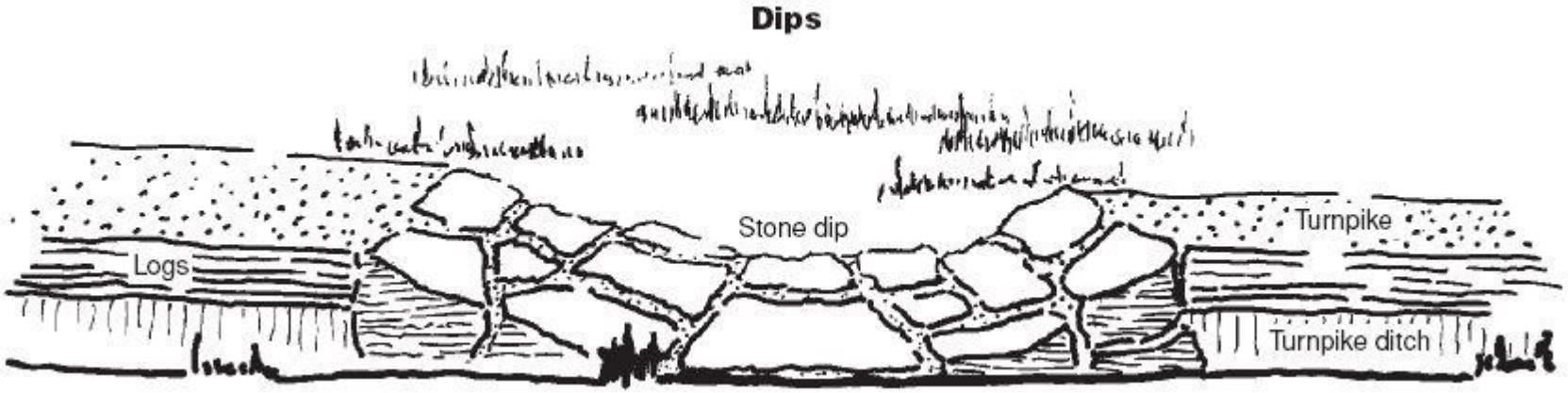


Courtesy of USFS

Armored Dip Vs. Culvert

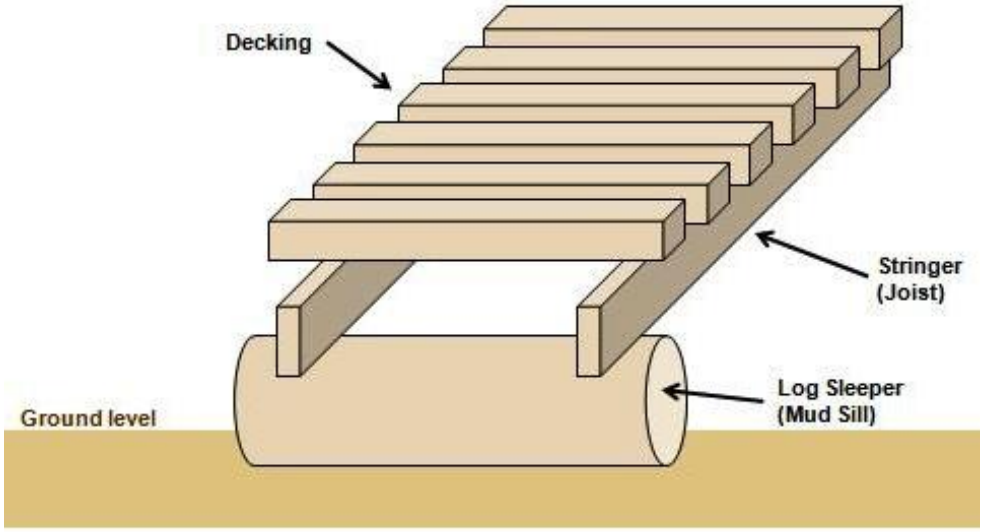


For turnpikes and causeways, culverts are often used. Consider an armored dip instead.



Courtesy of USFS

Puncheon (Boardwalk)



Considerations for Puncheons/Boardwalks

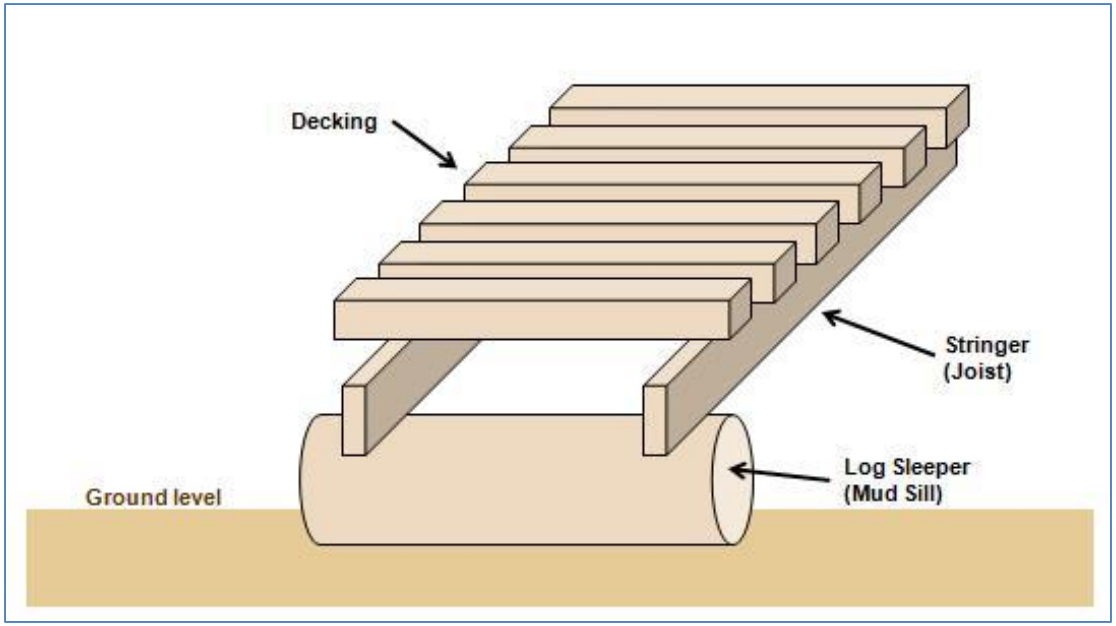
Traction!

- Rough sawn, split or scored cedar decking
- 1.5” gap between deck boards (watch dog paws)
- Other ways to Texture (e.g. Tolt river bridge vert 2x4s)

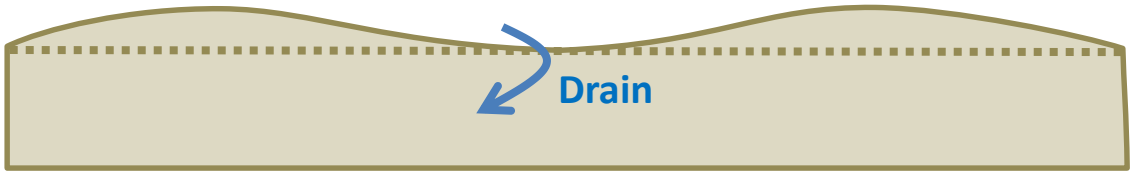
Other

- Straight & Flat
- Chicane before entrance

Some of the above may conflict with other trail users (equestrians, stock animals and dogs may not be compatible with gap between deck boards).



Rollers



- Gets water off the trail faster – tires compact the lows
- Very effective for high bike traffic trails (e.g. Duthie Hill)
- Requires extensive drainage channels, borrow pits and re-planting
- May not be user-friendly for everyone

Tools Required

- Clearing/Brushing: loppers, pruning saw, chainsaw, Brush cutter
- Trail Tread: Picks, Hoes, Pulaskis, Shovels, McLeods, mini excavator
- Drainage and Water Issues: Buckets, Wheelbarrows, rock bar, Peavey, draw knife
- USFS Online Trail Construction and Maintenance Handbook:

http://www.fs.fed.us/t-d/pubs/htmlpubs/htm07232806/toc.htm

http://www.fs.fed.us/t-d/pubs/pdfpubs/pdf07232806/pdf07232806dpi72.pdf

Work Party Safety

- Circle of blood
  - 2 arms lengths
- Business End of the Tool
  - Awareness, transport, usage, setting it down
- Eyes, ears, head
  - Often overlooked
- Solid Footing
- “All Hands” or “All Tools”
  - Never mix
- Bee Stings & Allergies

Video#2: New Silent Swamp Trail at Tiger Mt

- http://youtu.be/1v_7ynAZ4Sc

Video by Kevin Philbin