Sustainable Trails: Pathways to Nature

Workshop by:

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Mass Audubon

Overview

- Why be concerned about sustainability of trails?
- What is a sustainable trail?
- Assessment of existing trails
- Design
- Permitting
- Implementation
- Construction
- Maintenance

Warmer Planet = Weirder Weather

- **More extreme weather events.** Northeastern US saw a 55% increase in the amount of rain or snow falling in the heaviest 1% of storms between 1958 and 2016

- **More precipitation overall.** Some models project monthly precipitation between December and April will increase 1 inch by the end of this century

- **Impacts on trails**
  - More erosion
  - More wet areas & wet areas that don't dry out

What is a Sustainable Trail?

US Forest Service Definition – a Sustainable Trail will

- Withstand the impacts of normal use & natural elements
- Cause negligible soil loss or movement
- Encourage users to stay on trail by providing an enjoyable experience
- Not adversely affect area's natural or cultural resources
- Require minimal maintenance

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Wildlife & Trails - Principles

- Leave untouched large, undisturbed areas of habitat
- Route a trail around the edge of an area of high quality, rather than through its center
- Reduce the contribution of trails to habitat fragmentation
- Avoid areas that are habitat for threatened, endangered, or other species of concern
- Consider reducing or eliminating trails especially in sensitive areas
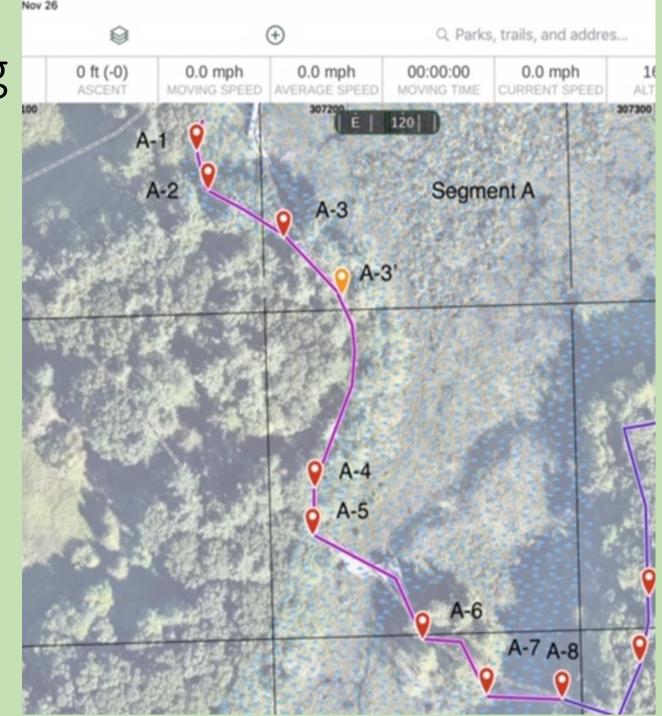
Broadmoor's Trails

- 800 acres in Natick & Sherborn
- 9 miles of trails + 1/3 mile of All Persons Trail
- Trails open since 1968
- 30,000+ visitors per year and rising
- Series of older trails, some newer boardwalks, and old farm cart paths – forming loops that return to single entrance
- Many water features
  - Vernal pools, wetlands, streams with beavers and the Charles River

Assessment of Existing Trails

- Before anything else, evaluate your existing trails

- Identify problem areas and potential remedies

- Broadmoor's assessment done by Peter Jensen – professional trail builder

- Evaluated every segment of trail system

- Lots of staff & volunteer input to develop remedies

Assessment

Post 5 to Post 7

This trail segment is approximately 0.21 miles long and provides trail connection to the old sawmill site. Much of the trail is wood chip covered and provides viewing opportunities of Mill Pond. There are several trail construction needs along this section of trail.

Trail Segment	Sign Post #5 to #7	
Length:	414 feet (0.08 miles)	
Distance	Reference Point	Work Needed Comments
0	Sign Post #5 - This section is located on an old road.	Fill old road bed above with tread surfacing (approximately 4.5 cubic yards).
40		Install drainage diversion to the left. Estimate 12 yards of material to create diversion.
185	Old mill stones on the left.	
215	Center of stone bridge	Install approximately 9 cubic yards of fill to create drainage away from center of bridge.
265		Fill tread
272	Sign Post #6 on the left.	
295	Drainage ditch on the left side of old road.	Clean ditch.
325	Existing culvert under old road.	Clean out culvert. Add approximately 4 yards of surfacing to treadway ahead to pitch water into ditch on the right. Clean 40 feet of ditch ahead on the right.
365		End ditch cleaning.
414	Sign Post #7 on the right.	END OF SECTION WORKLOG

Post 5 to Post 7 -

ESTIMATED COST:	$3,060	Materials, Labor, & Equipment
PLAN/DESIGN	Field layout of drainage diversions and resurfacing of old road.	
PERMITTING NEEDED	YES	Wetlands permit - RDA
MATERIALS :	Tread surfacing.	
EQUIPMENT:	Haul vehicle, loader to spread, hand tools to finish	
LABOR TYPE(S)	Contractor, staff	

Treatments

- Abandon trail? Relocate?

- Add a structure …
  - Bridge, boardwalk
  - Drainage diversion
  - Stone steps
  - Cribbing

- Harden the tread/resurface

- Remediate …
  - Correct outslope
  - Remove berm/slough
  - Add grade reversals

Relocate

Relocation downsides:
- Lots of work & planning
- Requires many tools
- Potential habitat impacts
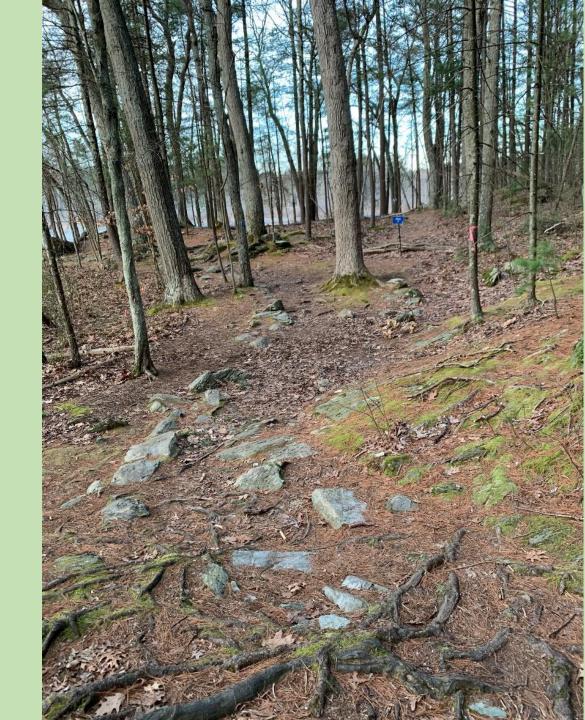- Poor planning = net negative financial/environmental/work cost

Relocate if:
- Current trail is beyond repair
- Alt route improves experience, habitat, maintenance hours/cost, etc.

Understanding Effects that Influence Alternatives

- Natural Impacts
  - water, wind, gravity

- Use
  - muddy trails, going around obstacles
  - compaction
  - creating shortcuts

- Poor Trail Design
  - fall line trails,
  - path not intended for current user type (old cart path)
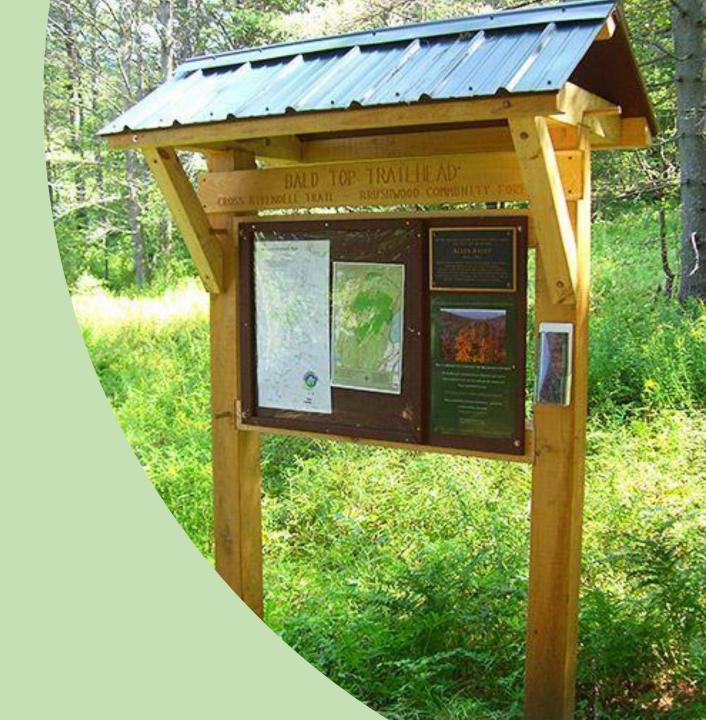
- Lack of/or improper maintenance

When Considering A New Trail…

- Why do you need a new trail?
- How does it contribute in a new way to the user experience or provide a critical connection?
- What will the trail be used for and what is the need that it fulfills?
- Is the trail to be designed to accessibility standards?
- Who will design and build the trail?
- How will it be funded?
- Who will maintain the trail?

Goals for Designing Trails

Layout & Experience

- Trail Users?
- Starting & Orientation
- Safety
- Destinations/Viewpoints/ Connections
- Loops
- Activity Areas
- Quiet/Contemplative Areas
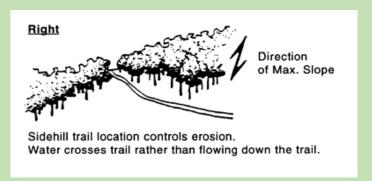
Basic Design/Assessment Principles

- Visually pleasing route
  - Has scenic & other points of interest
- Diversity of views & experiences
  - A variety of geographic, vegetative, and cultural features
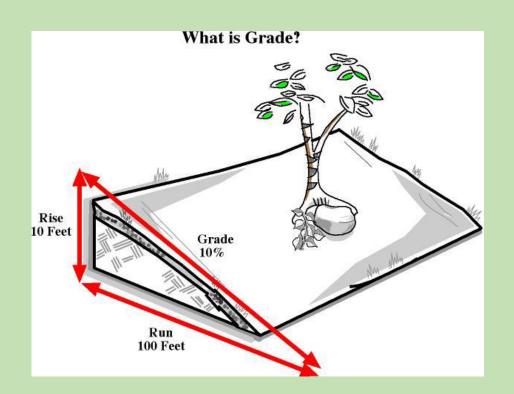- Integrates existing trails when possible if they meet or can be modified to meet the basic standards

- Makes connections
- Avoids adjacent development
- Designed for intended users & intensity of use
- Protect natural & cultural resources
- Long-term sustainability

Basic Sustainable Trail Design Standards

What is Grade?

Rise 10 Feet

Grade 10%

Run 100 Feet

- Slope or Grade
  - At what slope does water begin to form rivulets down an existing trail on a similar substrate?
  - Subtract 2 to 4% from that & build to that slope
  - Think in terms of mini-watersheds

Wrong

Direction of Max. Slope

Trail grade too steep and erosion will occur.
A water course will form and cause gullying.

Right

Direction of Max. Slope

Sidehill trail location controls erosion.
Water crosses trail rather than flowing down the trail.
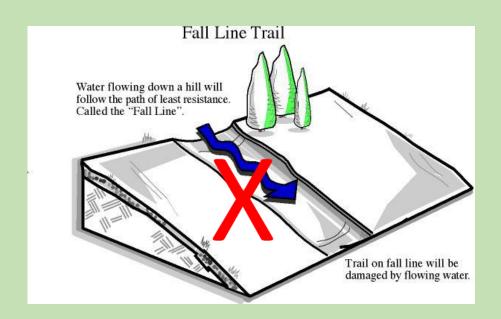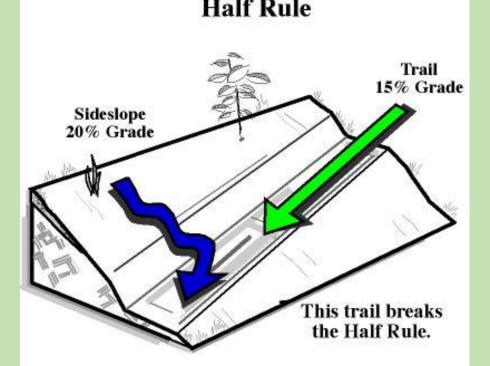
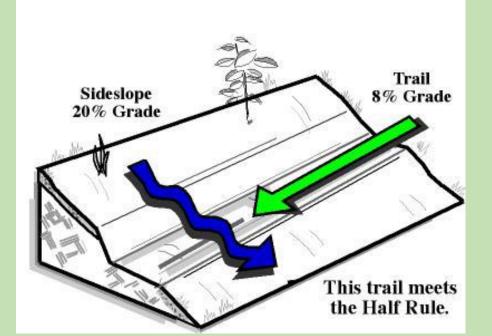# Sustainable Trail Guidelines

http://www.crgov.com/DocumentCenter/View/1430/Sustainable-Trail-Development-Guidelines-?bidId=

1. The Half Rule

- Do not exceed half the grade of the sideslope the trail is traversing
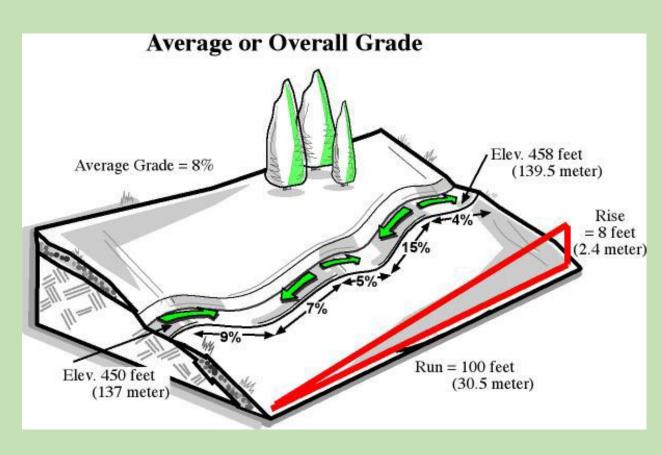
Sustainable Trail Guidelines

2. The Ten Percent Average Guideline

- The trail's average grade should be 10% or less
- Short sections can exceed 10% as long as the Half Rule is still used (15% trail grades can be used for short sections as long as the sideslope is greater than 30%)

Average or Overall Grade

Average Grade = 8%

Elev. 458 feet (139.5 meter)

Rise = 8 feet (2.4 meter)

4%

15%

5%

7%

9%

Elev. 450 feet (137 meter)

Run = 100 feet (30.5 meter)

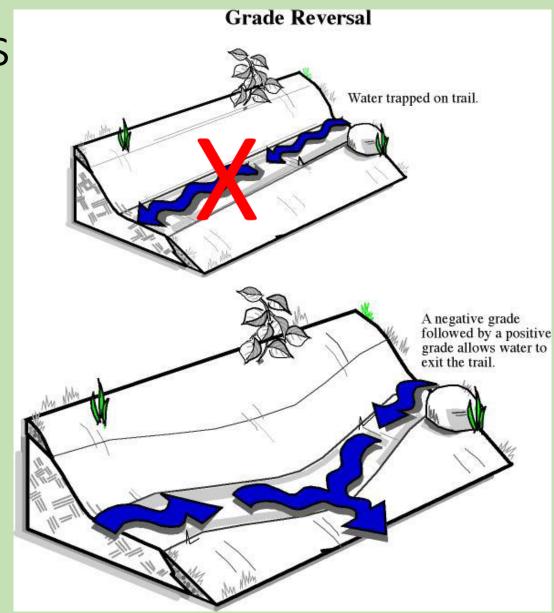# Sustainable Trail Guidelines

3. Maximum Sustainable Trail Grades

- Maximum grade, usually around 15% to 20%, is the steepest allowable grade based on several site-specific factors, which include:
  - The Half Rule
  - Soil types
  - Rock
  - Rainfall
  - Grade reversals
  - Types of users
  - Number of users
  - Difficulty level

Sustainable Trail Guidelines
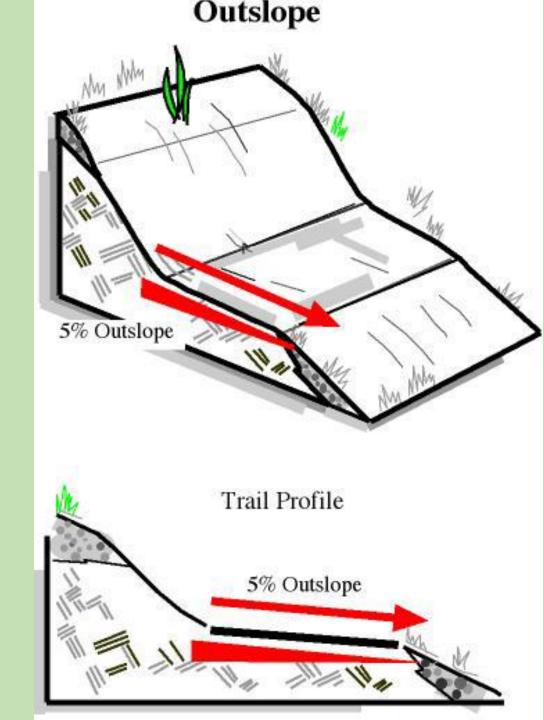
4. Grade Reversals

- Area where a trail levels out or dips for about 10 to 50 feet before rising again (can be much shorter)
- Recommended every 20 to 50 feet
- Grade reversals also make a trail more enjoyable

Grade Reversal

Water trapped on trail.

A negative grade followed by a positive grade allows water to exit the trail.

Sustainable Trail Guidelines

5. Outslope

- The outer edge of the trail's tread should be slightly lower than inside edge by 5%
- Outslopes encourage water to sheet across the trail rather than traveling down the trails center
- Outslopes can be difficult to maintain in loose soils. Constant use tends to compact the center of the trail and push soils to the sides
- Frequent grade reversals are essential to drain water from the trail in this situation

Outslope

5% Outslope

Trail Profile

5% Outslope

Permitting for Trails

- Why do you need permits? Wetlands Protection Act (WPA) and local bylaws require permits for any work:
  - In a wetland
  - Within 100 feet of a wetland
  - Within 200 feet of a perennial stream
  - In the 100-year floodplain
  - Within mapped rare species habitat

- Who issues permits?
  - Local Conservation Commission (under both MA WPA and local bylaws)
  - Mass. Natural Heritage and Endangered Species Program (NHESP)
  - US Army Corps of Engineers (for fill in wetlands)

- EXEMPTIONS FROM WPA
  - Unpaved pedestrian walkways less than 3 feet wide for public access on conservation property in buffer zone and riverfront [310 CMR 10.2(2)(a)]

Roadmap Permitting Process

Are your trails in jurisdictional areas? → Evaluate Impacts, Develop Permit Approach → Design Trails – Avoid, Minimize, Mitigate

Prepare and File Permit Applications → Hearing and Review Process → Permits Issue and Recorded

Complete the Work → Close Out Permits

Design for Permitting

- Goal – design trails to meet all performance standards, minimize impacts to extent practicable, mitigate for unavoidable impacts

- Strategies for Minimization:
  - Can work in a resource area be avoided by relocating the trail?
  - Can impacts be minimized by reducing trail width?
  - Can impacts be minimized by using bog bridge, boardwalk, puncheon bridge rather than at-grade construction?

Basic Permitting Considerations

- How long will it take?
  - Preparing permit applications
  - Filing
  - Hearings
  - Issuance of permits

- 4-6 months

- How much will it cost?
  - Abutter lists and notifications
  - Printing and mailing
  - Filing fees
  - Registry of Deeds fees

$500-$5,000

(not including consultant or design costs)

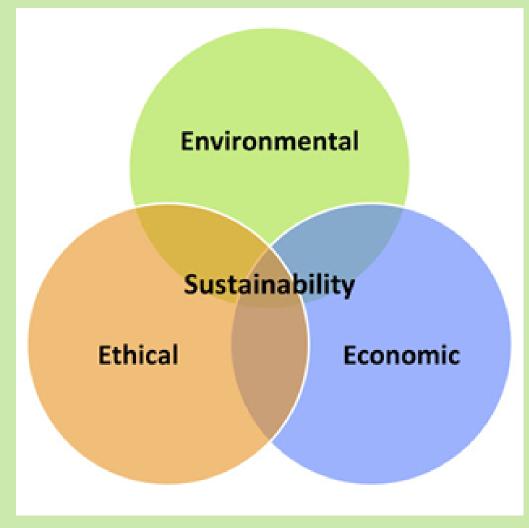# Strategies for Permitting Trail Maintenance

- Just do it!
- File Request for Determination of Applicability
  - Generic – for all maintenance
  - Request Conservation Commission to determine that Trail Maintenance activities don't require an Order of Conditions
  - Valid for 3 years

- File Notice of Intent for Generic Order of Conditions
  - Generic – for all maintenance
  - Commission issues conditions for types of work, notifications, etc.
  - Order should include Special Condition in Perpetuity allowing maintenance activities in accordance with general conditions

Implementation, Construction and Maintenance

1. Work Plans
2. Tools
3. Construction
4. Maintenance
5. Cost & Funding

Three E's of Sustainability

Photo Credit: http://statesustainabilityindex.com/three-es-of-sustainability/

- Environmental:
  - Does it harm habitat, natural resources, etc.?
  - Science and hippy things!
- Ethical:
  - Does it harm community?
  - What are the means?
- Economic:
  - Does it harm your wallet?
  - Long-term financial responsibility

Sample Work Plans:
Transitioning From Assessment to Actual Work

	Trail	Location	Type	Priority	By	Materials Ordered	Notes	Start	Finish
2	Marsh Trail		Relocation	1	Broadmoor	NA			
3	Marsh Trail - Mill Pond Trail	Post 4 Connection	Relocation	2	Broadmoor	NA			
4	Main Trail	Post 3 - 12	Relocation	3	Broadmoor	NA			
5	**Glacial Hill Trail**	**Indian Brook Trail Connection**	**Relocation**	**4**	**PSJ&A, Broadmoor**	**NA**	**Training Session - scheduled 6/6**	**6-Jun**	
6	Indian Brook Trail	Vernal Pool	Relocation	5	Broadmoor	NA			
7	Quacking Frog Trail	2 locations + connect to Orchard	Relocation	6	Broadmoor	NA			
8	Mill Pond Trail	various	Relocation	8	Broadmoor	NA			
9	Charles River Trail	various	Relocation	TBD	Broadmoor	NA	PSJ&A to do worklog		
10	Hemlock Trail	all	Relocation	TBD	Broadmoor	NA	do after training session on stonework		
11	Little Farm Pond	various	Relocation	TBD	Broadmoor	NA	PSJ&A to do worklog		
12	Boundary Trail	center section	Relocation	TBD	Broadmoor	NA	PSJ&A to do worklog		
13	Glacial Hill Loop	all	Relocation	TBD	Broadmoor	NA	PSJ&A to do worklog		
14	Glacial Hill Trail	Post 7 to 12	Relocation	TBD	PSJ&A	NA	2020		
15	**Glacial Hill Trail**	**Fanger Corner**	**Puncheon Bridge**	**1**	**PSJ&A, Broadmoor**		**Training session - scheduled 8/8**		
16	Mill Site Bridge	Post 4-5	Bridge	2	PSJ&A		2019		
17	Blueberry Swamp	Extend boardwalk	Puncheon Bridge	3	Broadmoor		WG to investigate helical support feasibility		
18	Glacial Hill Trail	Indian Brook Bridge	Bridge	4	PSJ&A		2020		
19	Glacial Hill Trail	Site I, between Post 12 & 13	Puncheon Bridge	5	Broadmoor		after Indian Brook Bridge completed		

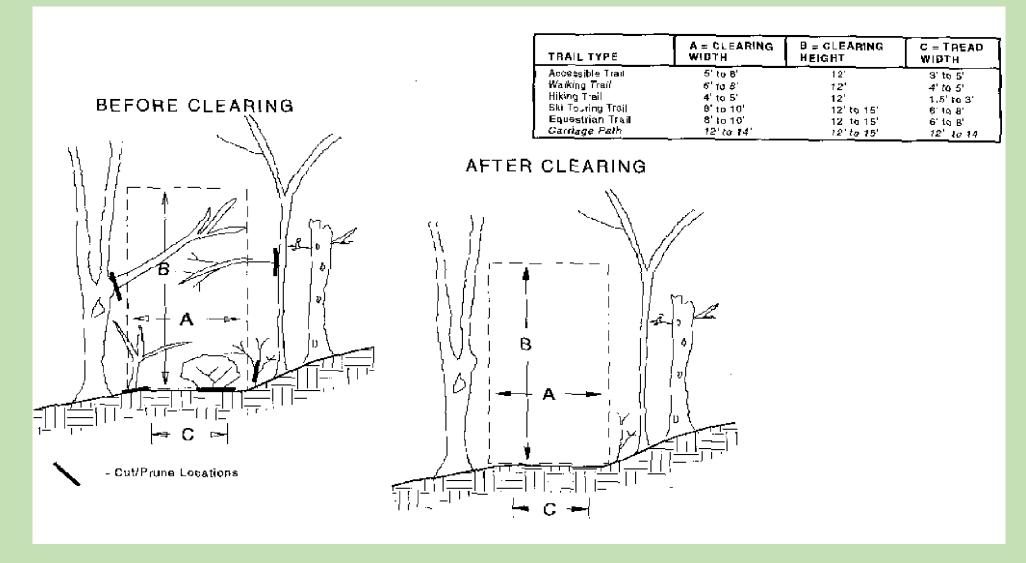# Potential Tool List for Manual Trail Work

- Clinometer

- Heavy duty rake

- McLeod (or sharp hoe)

- Mattock

- Wheelbarrow and/or bags for duff

- Pole saw/pruner
  - Use with hard hat and safety glasses

- Pruning saws

- Chainsaw

- Rock bars

- Rock Slings

- Shovels or pitchforks

- Loppers
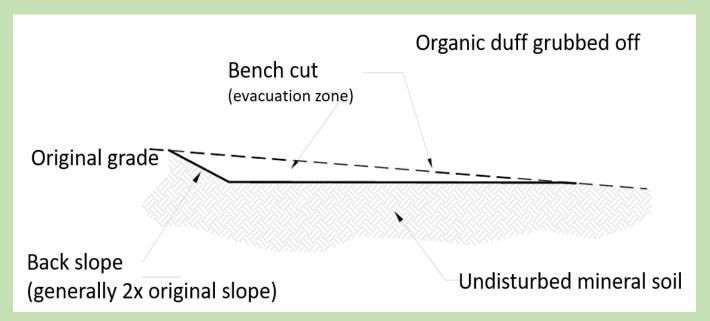 - Designate separate loppers for roots

Macleod

Clinometer

Electric Pole Saw

Cutter Hoe

Cutter Mattock

Mechanical Pole Saw

Rock Bar

Construction of New Trail

Clearing & trimming

Note: Also Important for on-going maintenance

BEFORE CLEARING

AFTER CLEARING

- Cut/Prune Locations

TRAIL TYPE	A = CLEARING WIDTH	B = CLEARING HEIGHT	C = TREAD WIDTH
Accessible Trail	5' to 8'	12'	3' to 5'
Walking Trail	6' to 8'	12'	4' to 5'
Hiking Trail	4' to 5'	12'	1.5' to 3'
Ski Touring Trail	8' to 10'	12' to 15'	6' to 8'
Equestrian Trail	8' to 10'	12 to 15'	6' to 8'
Carriage Path	12' to 14'	12' to 15'	12' to 14'

New/Relocated Trail

Full bench cut

Organic duff grubbed off

Bench cut
(evacuation zone)

Original grade

Back slope
(generally 2x original slope)

Undisturbed mineral soil

Typical Sidehill Construction

Full Bench:
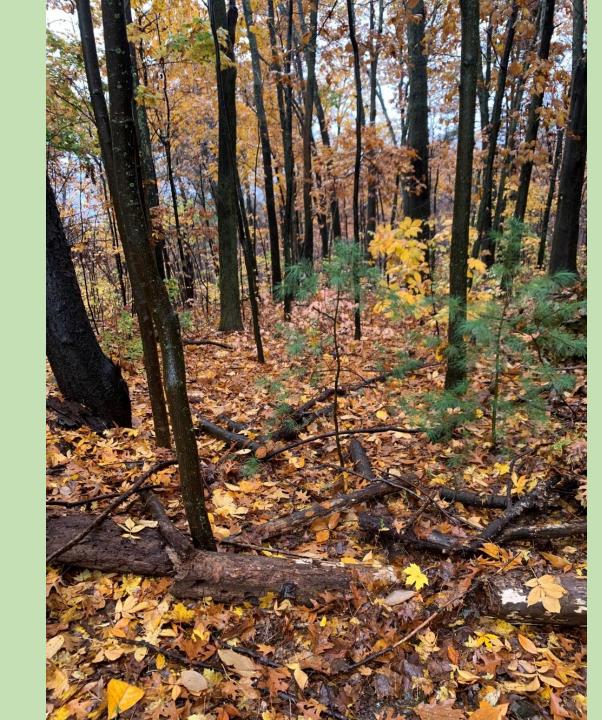Entirely cut out of
exisitng slope.

Cut

Fill

1/2 Bench:
Half cut and half fill.

Brushing in old trails

- Make it look natural!
- Duff as base layer
- Brush/leaves as second layer
- Create physical barriers
  - Small pines act as great natural barriers

Key Maintenance Goals

- Monitor trails **often**
- Address trail issues ASAP (usually a quicker/cheaper fix)
- Prioritize:
  - What needs immediate attention vs. what can wait (safety concern? rapid degradation?)
- Cost and logistics
  - major factors in developing priorities

- Categorize:
  - Basic maintenance vs. large project (everything in between)

- Also consider:
  - A trail user's options (other trails w/same or similar destination)
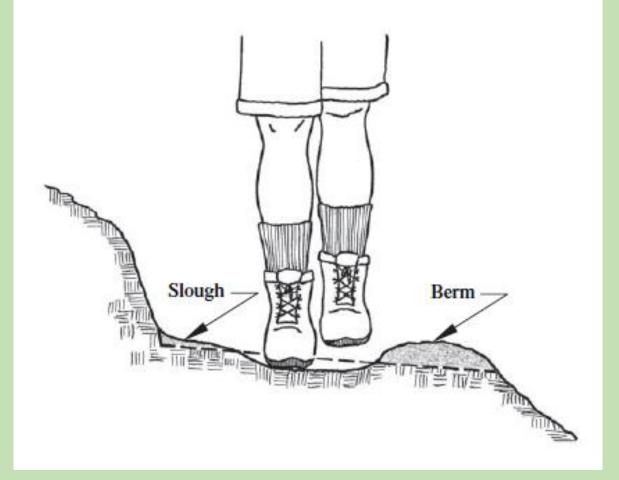 - Tendencies (social trails, diversions)
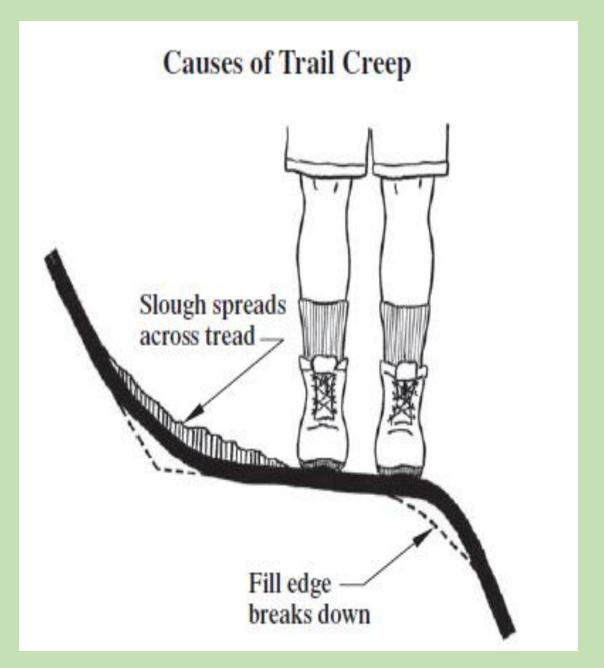
Routine Maintenance

- Maintain drainage
  - Contours of tread surface
    - Outslope, Crown, Grade Reversals
  - Drainage structures
    - Culverts, Water Bar
  - Remove debris

- Keep users on the trail!
  - Remove obstacles (in trail and overhead)
  - Keep trail defined
  - Maintain trail signs, markers and maps
  - Remove slough and berm build up

Slough and Berms

On hillside trails, *slough* (pronounced *sluff*) is soil, rock, and debris that has moved downhill to the inside of the tread, narrowing the tread. Slough needs to be removed (figure 30). Doing so is hard work. Slough that doesn't get removed is the main reason trails "creep" downhill.

Slough — Berm —

Causes of Trail Creep

Slough spreads across tread —

Fill edge breaks down

Cost & Funding

- Broadmoor Trails is a $420,000 project (raised from individual donors, foundations, etc.)
  - A portion to create endowment for on-going maintenance
- Received on-going permit for maintenance (in perpetuity)
- DCR Grant paid for 3 workshops & the purchase of several tools

- Cost breakdown:
  - Tools
  - Permitting
  - Staff
  - Trail consultant
- Other costs to consider:
  - Surveying is expensive
  - Broadmoor was permitted to use GIS and GPS

Review/Conclusion

- Sustainability is multifaceted
- Evaluate what you've got
- Plan and design
- Get permits
- Make a workplan to implement the design
- Implement the workplan
- Do it well!!!
- Celebrate your successes!

People make it possible:

- Volunteers
- Trail Professionals
- Camp Groups
- Corporate Groups
- Workshops
- Donors

People are your greatest assets!

More Resources

- USDA Trail Construction and Maintenance Notebook (PDF at fs.fed.us)
- IMBA/Colorado Gov: Sustainable Trail Development: A Guide to Designing and Constructing Native-surface Trails (PDF at crgov)
- Trail Solutions: IMBA's Guide to Building Sweet Singletrack
- Pennsylvania Trail Design & Development Principles Guidelines for Sustainable, Non-motorized Trails (PDF at dncr.pa.gov)
- AMC's Complete Guide to Trail Building and Maintenance
- Americantrails.org
- Trailbuilders.com
- Tools: Rogue Hoe, forestry-supplier.com

Thank you!

Ongoing Trail Workshops with MAS Broadmoor Wildlife Sanctuary:

May 21:   Maintenance and Construction
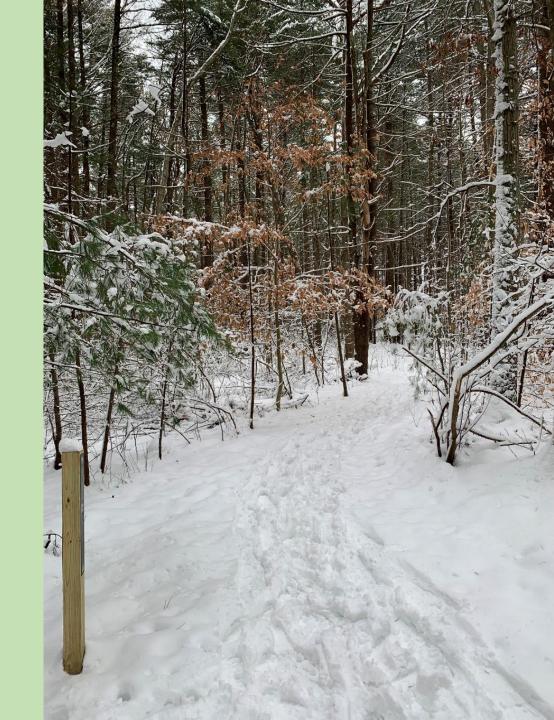   with Hands-on Segment

June 11:   Boardwalks – Repair, Replace
                   & New Construction – Hands-on

Dates are subject to revision. More will be scheduled.

Sign Up at https://www.massaudubon.org/get-outdoors/wildlife-sanctuaries/broadmoor/programs-classes-activities

Questions?

Contact Information

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- Bill Giezentanner, Broadmoor Volunteer
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