



**Centre for
Trail Excellence**

Climate Smart Trails

A Practical Guide and Toolkit



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About Us

About Trans Canada Trail

Trans Canada Trail is the organization that advocates, stewards and champions Canada's nationwide trail system, providing leadership and guidance, funding and resources, outreach and engagement.

About the Centre for Trail Excellence

The Centre for Trail Excellence is an initiative led by Trans Canada Trail to ensure Canada's trail sector has access to the funding, research and resources necessary for developing and maintaining exceptional trails.

About McElhanney

McElhanney is a multi-disciplinary consulting firm with a specialty in trails and outdoor recreation infrastructure. McElhanney works on trails in challenging environments across Canada and developed this resource in partnership with TCT.

Indigenous Land Acknowledgement

Trans Canada Trail acknowledges that the Trans Canada Trail is situated on the traditional territory of First Nation, Inuit and Métis peoples from coast to coast to coast. Trans Canada Trail also acknowledges that the Trail includes land and water routes that were created and used, both historically and presently, by Indigenous peoples as seasonal travel and trade routes. We support community efforts to sustain a relationship with Indigenous peoples based on respect, dignity, trust and cooperation, in the process of advancing truth and reconciliation.





Introduction

Introduction

Trails are an essential part of communities across Canada. They provide opportunities for recreation, support active transportation, connect people to nature, and contribute to tourism and local economies. In many regions, trail networks also function as important community infrastructure, providing access to natural areas, supporting land stewardship, and strengthening connections between communities and landscapes.

At the same time, changing climate conditions are placing increasing pressure on trail systems. More intense rainfall, flooding, wildfire, drought, freeze thaw cycles, and variable snowpack are accelerating trail damage and increasing maintenance demands. Many trail systems were originally built for historical climate conditions and are now experiencing more frequent erosion, structural failures, and unexpected repair costs.

This resource was developed by the Trans Canada Trail and McElhanney. It brings together practical guidance, field ready tools, and climate informed trail management practices that support more resilient trail systems.

The guide focuses on how trail groups can reduce climate risks through better planning, thoughtful design, consistent inspection, and proactive maintenance. While climate change cannot be eliminated, many climate related trail failures can be prevented through informed decision making and early action.

This resource is intended for trail managers, land managers, volunteer trail organizations, municipalities, park agencies, and partner organizations responsible for planning, building, maintaining, and managing trail systems. The guidance is designed to support both experienced practitioners and community groups working to improve the long term resilience of their trails.

By applying the approaches outlined in this guide, trail groups can help ensure that trail systems remain safe, durable, and sustainable as environmental conditions continue to change.



Using This Resource

Using This Resource

This resource provides practical guidance and field ready tools to help trail groups plan, design, manage, maintain, and repair trails in a changing climate. It is intended as a quick reference that supports climate resilient trail decision making and day to day trail management.

The guidance in this document is designed for trail managers, volunteers, land managers, and partner organizations responsible for developing and maintaining trail systems. The tools can be used when planning new trails, upgrading or rebuilding existing routes, carrying out routine inspections and maintenance, or responding to climate related damage. Applied together, these tools help trail groups make informed decisions, apply best practices consistently, and reduce the likelihood of recurring climate related failures.

The guide is organized into four sections, each addressing a different aspect of climate resilient trail management.



Why Trails Need to Change

This section explains how climate change is affecting trails across Canada and why trail systems must adapt to new environmental conditions. It outlines the types of climate impacts currently affecting trails, the growing financial costs associated with climate related damage, and the role trails can play as resilient community infrastructure. Recognizing trails as infrastructure, rather than simply recreational amenities, supports their integration into broader climate adaptation, asset management, and community resilience strategies.



Climate Resilient Trail Planning, Design and Management

This section focuses on how early decisions about trail location, alignment, design, and materials influence long term trail performance. It introduces a climate resilience hierarchy that prioritizes eliminating exposure through planning, reducing risk through design and material choices, and managing remaining impacts through operational practices. The guidance in this section supports the development of trails that are better able to withstand changing climate conditions while reducing long term maintenance demands and lifecycle costs.



Trail Maintenance and Climate Risk Management

This section provides practical tools to support routine trail inspection, maintenance, and early response to climate related impacts. Four maintenance tools, Trail Inspections, Structural Reviews, Vegetation Maintenance, and Tread Maintenance, help trail groups identify issues early, prioritize work, and maintain trail durability over time. When applied consistently, these practices help prevent minor issues from escalating into costly reconstruction projects.



The Climate-Smart Trail Cycle

The Climate Smart Trail Cycle provides a simple, repeatable framework that brings together the planning, design, and maintenance practices described in this guide. It helps trail managers identify climate related risks, prioritize vulnerable trail segments, select appropriate responses, monitor trail performance, and adapt management approaches over time. By applying this cycle consistently, trail systems can be managed proactively and improved continuously as climate conditions evolve.

Why Trails Need to Change

Climate Impacts on Trails in Canada

Climate impacts on trails are the ways changing weather patterns and environmental conditions affect trail treads, structures, and surrounding landscapes. These impacts increase erosion, flooding, instability, vegetation hazards, and the frequency of damage, which often overwhelm traditional trail design and seasonal maintenance cycles.

For this guide, climate impacts are grouped into the categories below, based on common trail damage trends in Canada and widely recognized climate-related hazards:



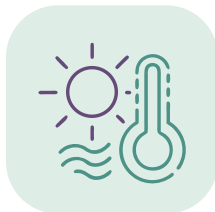
Flooding and Extreme Rainfall

More frequent and intense rainfall is increasing trail washouts, saturated soils, drainage failures, erosion, and damage to crossings and structures.



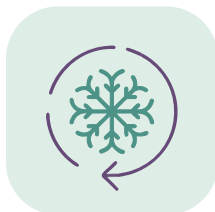
Wildfire

Wildfire is increasing direct burn damage, hazard tree risk, corridor closures, and post fire impacts such as erosion, debris flows, and slope instability.



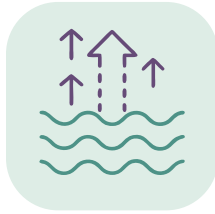
Permafrost Thaw

Warming conditions are driving permafrost thaw that causes ground settlement, heaving, loss of bearing capacity, and instability to trails, crossings, and structures in northern regions.



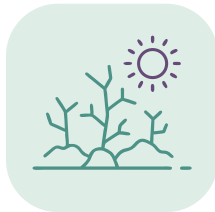
Freeze–Thaw Cycles

More frequent freeze thaw conditions are accelerating tread breakdown, loosening trail surfacing, and increasing wear, movement, and damage to trail structures.



Sea Level Rise

Rising sea levels and stronger coastal storms are increasing coastal trail flooding, storm surge exposure, shoreline erosion, and undermining of trail tread and structures.



Drought

Hotter and longer dry periods are increasing dust, tread loosening, soil shrinkage and cracking, vegetation stress, reduced ground cover, and elevated wildfire risk along trail corridors.



Wind

Stronger wind events are increasing blowdown, falling hazard trees, corridor obstructions, and damage to trail infrastructure, resulting in higher safety risk and access disruption.



Variable Snowpack

More variable winter conditions are increasing heavy snow loading, mid winter thaws, ice formation, rapid melt runoff, and drainage overwhelm that can damage tread and structures.

What is the Cost of Climate Impacts on Trails

Climate change is steadily increasing the financial and operational pressures on trail systems across Canada. More frequent extreme weather events are resulting in higher maintenance demands, recurring damage cycles, and growing strain on both staff and volunteer resources. Instead of predictable seasonal maintenance, trail managers are increasingly faced with unplanned, large scale repair efforts following wildfire, flooding, windstorms, and rapid thaw events. These impacts often extend beyond tread repair to include bridges, boardwalks, signage, access points, and environmental remediation requirements.

Across Canada in recent years, climate-related damage to trail infrastructure has resulted in repair costs reaching into the millions of dollars for single events or regional systems. When examined collectively, reconstruction and major repair costs for damaged trails commonly range from approximately \$75 to over \$150 per metre of trail, depending on terrain, materials, and the need to replace structures such as bridges, boardwalks, or retaining features.

When these costs are applied across larger trail networks, the financial implications become significant. Individual climate events have required millions of dollars in repair work across affected trail systems, including debris removal, slope stabilization, tread reconstruction, bridge replacement, and environmental restoration. These figures highlight how climate-related damage represents a real and growing financial liability for trail managers and land management agencies.

Importantly, these costs largely reflect reactive repair work. In many cases, damage occurred because trails were not originally designed with climate considerations such as hydrology, soil stability, or changing precipitation patterns in mind. Where trails are properly sited, drained, and constructed using climate-appropriate design standards, the cost of repairs following extreme weather events can often be substantially reduced.

Despite the growing financial impacts, there is currently limited research specifically examining climate-related maintenance and repair costs for trails. Maintenance budgets and damage costs are also frequently underreported or inconsistently tracked. Many trail systems have historically relied on volunteer labour or minimal operational budgets, meaning the true cost of ongoing maintenance is often not fully captured in agency reporting.

Trails as Climate and Community Infrastructure

Across Canada, trails are increasingly being recognized as essential community infrastructure rather than solely recreational amenities. When planned intentionally, trail networks strengthen climate resilience by managing stormwater, reducing wildfire risk, and supporting ecological connectivity—all while remaining accessible public spaces.

As climate change intensifies floods, fires, and extreme weather, trails complement traditional infrastructure in multiple ways. Their distributed networks can absorb and slow runoff, reduce erosion, break up continuous wildfire fuels, and provide shaded, low-stress corridors during heat events. Trails often require fewer hard materials than roads, allowing them to function as green infrastructure that supports biodiversity and landscape stability. When transportation routes are disrupted, well-designed trails can continue to provide safe connections for evacuation, emergency access, utilities maintenance, and everyday mobility, strengthening redundancy across community systems.

Recognizing trails as infrastructure allows them to be embedded in climate adaptation, emergency management, and asset management frameworks. This shift supports more resilient design standards, coordinated governance, and access to climate and disaster-mitigation funding. Framed this way, trails become multi-purpose systems that protect communities, support landscapes, and enhance quality of life in a changing climate.

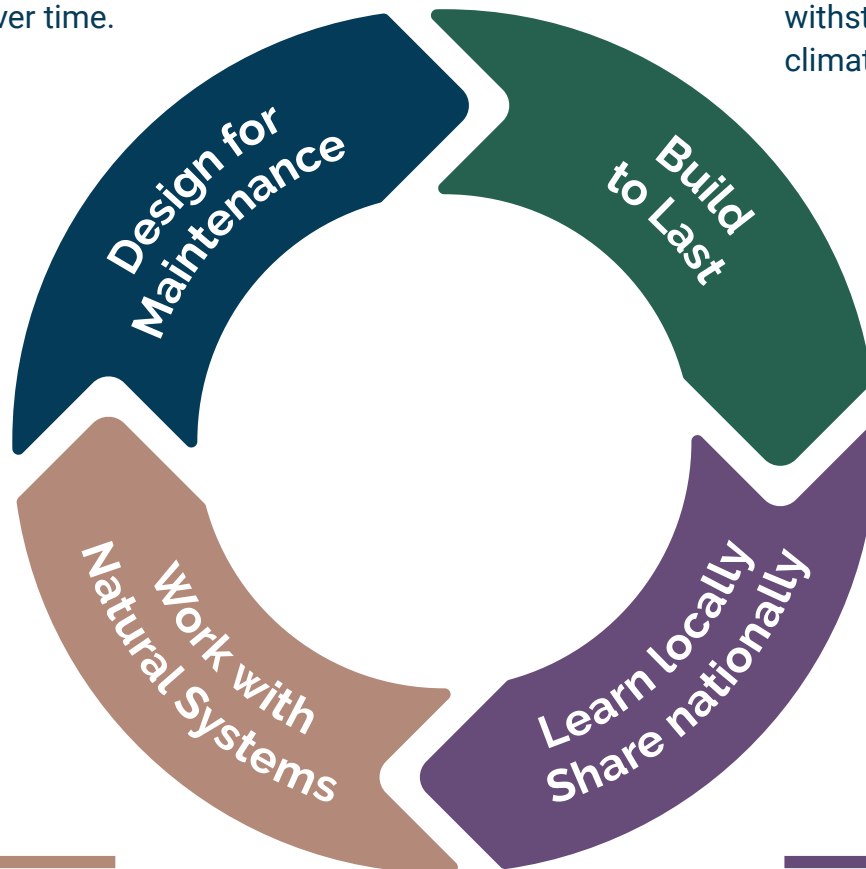


Guiding Principles for Climate-Resilient Trails

These principles provide consistent direction for planning, designing, and maintaining trail systems in a changing climate:

Build trails and structures that are easy to inspect, repair, and adapt over time.

Prioritize durable materials and stable alignments that withstand future climate stresses.



Align layouts and drainage with landforms and hydrology to reduce long-term impacts.

Use monitoring and local knowledge to guide decisions and share lessons broadly.

Climate-Resilient Trail Planning, Design & Management

Purpose of this Section

This section explains how planning, design, material selection, and management decisions can reduce trail vulnerability before failures occur. It applies to new trails, rebuilt trails, and existing trails that have been damaged or exposed by climate-related impacts such as flooding, wildfire, erosion, permafrost thaw, freeze-thaw cycles, drought, and severe storms.

Many climate-related trail failures are not simply the result of poor maintenance. They often begin with avoidable exposure, inadequate planning, inappropriate trail design, unsuitable material selection, or insufficient operational management. As storm intensity increases, wildfire frequency expands, and seasonal conditions become less predictable, early decisions carry greater long-term financial, operational, and safety implications.

Climate resilience is achieved primarily through avoidance of exposure, not reactive repair.

This section applies a climate resilience hierarchy, modeled on hazard management principles:

- 1. Eliminate Exposure**
through planning
- 2. Mitigate Risk**
through design and materials
- 3. Manage Remaining Impacts**
through operations

The objective is to reduce vulnerability at the highest level possible before relying on ongoing intervention.

The Climate-Resilient Trail Planning, Design and Management Checklist in [Appendix A](#) supports consistent application of this hierarchy.



Eliminate Exposure – Planning

Planning is the most effective tool for achieving climate- resilient trails. In this context, planning refers to the early stages of trail development or redevelopment, when key decisions are made about trail location, alignment, user type, and overall network layout, before detailed design or construction begins.

Once constructed, trail alignments are difficult and costly to relocate. As a result, planning decisions can lock in exposure to climate risks, such as flooding, erosion, wildfire, or unstable slopes, for decades. Careful planning therefore provides the greatest opportunity to avoid high- risk areas and reduce long-term vulnerability.

Trail location is the strongest predictor of long-term performance. Trails placed within wet areas, floodplains, unstable slopes, thaw sensitive ground, or post fire terrain instability zones will experience repeated failure regardless of construction quality.

Planning should prioritize locating trails on stable landforms, well- drained soils, and natural benches, and aligning routes with existing drainage patterns wherever possible. Using the landscape's natural stability and drainage capacity reduces the need for engineered solutions and long-term intervention. Where possible, exposure to climate sensitive areas such as flood prone terrain, unstable slopes, or thaw sensitive soils should be avoided during alignment selection.

In some landscapes avoidance may not be feasible. In these cases suggest, risk should first be minimized through careful alignment and then mitigated through appropriate design strategies. For example, in permafrost regions thaw settlement can continue for years after disturbance, making it important to minimize ground disturbance, preserve insulating vegetation layers, and limit thermal exposure during alignment selection.

Climate informed planning prioritizes avoidance of:

- Persistent wet areas, depressions, and saturated soils
- Floodplains and water accumulation zones
- Unstable or erosion prone slopes
- Slope aspect depending on climate
- Permafrost zones where thaw settlement is likely
- Post fire debris flow corridors
- Freeze thaw transition zones prone to soil movement



The **Climate-Resilient Trail Planning Checklist** can be found in **Appendix A**.

Mitigate Risk - Design and Materials

Where exposure cannot be eliminated, design must reduce the likelihood and severity of failure. Climate resilient trail design focuses on managing water, stabilizing soils, and selecting materials that perform under expected stress conditions.

Design decisions should align with the Trail Management Objective (TMO), which defines the intended trail experience, user type, difficulty, and management standard for a trail. The TMO establishes the performance expectations that guide alignment, construction methods, and long term maintenance requirements.

Design Principles

- Apply proper **Bench Cut** construction on side slopes to create stable tread platforms
- Maintain consistent **outslope** (3–5%) so water drains off the trail tread rather than flowing down the trail.
- Apply the **Half Rule** to limit trail grade relative to side slope. The trail grade should not exceed half of the hillside's side slope (e.g., a 20% side slope allows a maximum 10% trail grade).
- Install effective **Grade Reversals** and **Rolling Grade Dips** to interrupt concentrated water flow
- Use **Raised Tread** in flat or chronically wet areas
- Reinforce high flow crossings with **Rock Armouring**
- **Avoid** alignments that naturally channel water down the tread
- **Harden** trail surfaces in high use or erosion prone areas using durable materials such as rock or aggregate
- In **freeze thaw environments**, drainage design and tread shaping must account for seasonal expansion and contraction cycles that weaken soil cohesion and accelerate surface breakdown.
- In **post wildfire landscapes**, trail design should incorporate slope stabilization and erosion protection measures capable of withstanding high intensity rainfall events and increased sediment movement.



Figure 1. Sloughing, Rock Armouring, Freeze Thaw Environments, Burn Scar (from left to right)

Trail Management Objectives

Trail classification is commonly documented through a standardized framework known as a Trail Management Objective (TMO). Each trail within a network is assigned a TMO, typically recorded using a structured form or spreadsheet. TMOs represent the formal outcome of the trail classification process and serve to clearly define the trail's intended purpose and the desired user experience. TMOs contain user-facing information like trail name, difficulty, length and permitting activities. They also contain management-facing information such as level of service, inspection frequency and trail design parameters.



The **Design and Materials Checklist** can be found in **Appendix B**.



Material Selection

Materials should be selected to match site specific climate stressors and environmental conditions. Choosing appropriate materials improves durability, reduces maintenance requirements, and lowers long term lifecycle costs.

Key considerations include:

- Use durable, locally appropriate materials such as rock where possible. Rock based construction can provide long term stability and reduce the need for replacement of vulnerable structures.
- Use erosion resistant surfacing materials in high rainfall or high use areas, such as well graded aggregate, crushed rock, or stabilized mineral soils.
- Install rock armouring or hardened surfaces where seasonal water flow, seepage, or concentrated runoff is expected.
- Select fire resistant materials in wildfire prone regions, such as rock, mineral soils, steel components, or treated structural timber where appropriate.
- Evaluate the use of raised trail structures or boardwalk systems in persistently wet or thaw sensitive terrain, while ensuring foundations and support systems are designed for expected ground movement.
- Ensure structural materials and components are rated for expected snow loads in regions with significant winter accumulation.
- Consider long term exposure to moisture, ultraviolet radiation, freeze thaw cycles, and seasonal variability when selecting materials.

Material selection directly influences trail durability, inspection frequency, and long term operational costs. Short term savings in material choice often result in higher long term maintenance and replacement requirements.

Manage Remaining Impacts – Operations

Where exposure cannot be eliminated through planning, and risks cannot be fully mitigated through design and materials, operational management strategies may be required. Inspections and maintenance form a core part of this management approach and help identify when operational controls are necessary to protect trail infrastructure and user safety.

Operational tools may include temporary or seasonal closures, adjustments to trail classification, and adaptive responses to repeated climate related impacts. Closures may be implemented for a variety of reasons, including wet conditions, freeze thaw cycles, wildfire impacts, or major storm events that temporarily increase trail vulnerability.

Operational management tools may include:

- Seasonal closures during wet periods to prevent tread damage
- Freeze thaw closures to reduce soil disturbance during spring melt cycles
- Temporary closures following major storm events or flooding
- Converting vulnerable bridge crossings to armored fords where appropriate
- Adjusting trail classification to reflect durability limits
- Reclassifying high risk segments as climate exposure changes

These actions should align with the Trail Management Objective (TMO) for each trail, ensuring that operational decisions remain consistent with the intended trail experience, durability expectations, and management capacity.



The Operations Checklist
can be found in
Appendix C.

Climate resilience hierarchy – Final Guidance

The climate resilience hierarchy can be summarized as follows:

- 1. Avoid the hazard through planning**
- 2. Reduce exposure through resilient design and materials**
- 3. Manage what remains through adaptive operations**

The most cost effective resilience strategy is almost always the elimination of exposure during planning. As decisions move down the hierarchy, lifecycle costs, maintenance requirements, and operational complexity increase.

Operational management includes inspections, maintenance, and adaptive management actions that respond to changing conditions and emerging risks. The following sections describe recommended approaches to trail inspections and maintenance practices that support long term climate resilience.

Climate resilient trail systems are not created through reactive repair alone. They are achieved through deliberate planning, disciplined design, and proactive management that anticipates changing environmental conditions over decades.





Trail Maintenance and Climate Risk Management

Purpose of this Section

This section provides guidance for maintaining trails in a changing climate. Its focus is on protecting trail function, safety, and durability under increasingly variable and extreme weather conditions.

As climate impacts intensify, routine inspection and early intervention are the most effective ways to prevent escalating damage and rising repair costs. What begins as minor drainage failure, soft tread, or early structural wear can quickly develop into significant erosion, instability, or safety hazards following heavy rainfall, freeze thaw cycles, drought, wildfire, or wind events.

These tools help you identify issues early, prioritize resources effectively, and reduce the likelihood of repeat failures. When applied consistently, they strengthen long term resilience and support responsible stewardship of your trail system.

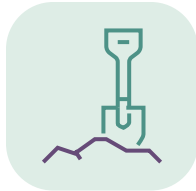
Use this section when your objective is to:

- Maintain existing trails
- Respond to storm or climate related damage
- Prepare for seasonal transitions
- Plan volunteer or annual maintenance programs



How to Use these Tools

Four (4) practical tools are provided to support on-the-ground maintenance and monitoring:



Trail Inspections

A high-level assessment of overall trail condition, identifying trail sections with faulty tread, corridor, or infrastructure to determine where maintenance is needed.



Structural Inspections

Focuses on visually assessing built trail features such as bridges, boardwalks, and retaining structures for evidence of climate related damage or environmental stress, including flooding, scour, freeze thaw effects, wildfire exposure, and storm related impacts.



Vegetation Management

Focuses on managing trail corridor vegetation by identifying and addressing hazard trees, storm damage, accelerated vegetation growth, invasive species spread, and reduced sight lines. Vegetation management also helps reduce wildfire risk where encroaching vegetation or dry grasses near the trail corridor may be ignited under hot and dry conditions.



Tread Maintenance

Supports evaluating and preventing trail surface problems such as erosion, drainage failures, cupping, sloughing, and widening, and selecting appropriate maintenance actions.

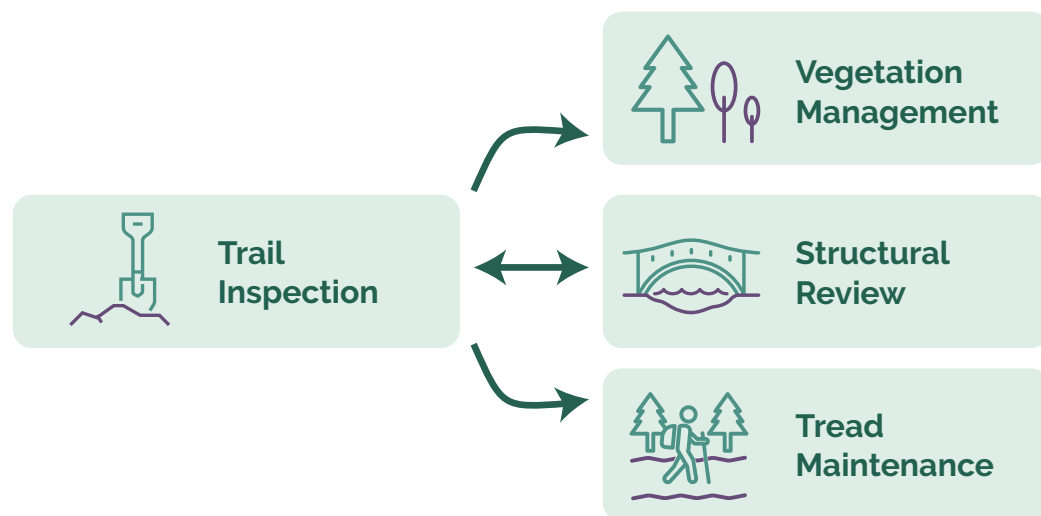
These tools are designed to function together as an integrated maintenance framework.

A typical workflow is as follows:

1. **Trail Inspections** are conducted first to assess overall trail conditions and identify sections requiring attention.
2. **Structural Reviews** may occur at the same time as trail inspections, focusing on bridges, boardwalks, and other built features to identify visible signs of damage or environmental stress.
3. Inspection findings guide **Vegetation Management** and **Tread Maintenance** activities, helping prioritize where work is needed most. Maintenance actions are then completed, followed by documentation of work performed, structures referred for further assessment, and observations that inform future monitoring.
4. Where a trail inspection or structural review identifies concerns related to load bearing elements, foundation movement, or structural integrity, the structure should be referred to a **qualified professional for a formal structural inspection**. Note, volunteer inspections support early detection but do not replace professional review where required.

By following this sequence, trail groups can move from observation to action in a systematic and defensible manner.

Consistent application establishes a baseline understanding of trail condition, improves public safety, and strengthens resilience to future climate impacts.



Trail Inspections

A trail inspection is an assessment of the full trail corridor used to evaluate current condition and identify areas requiring maintenance attention, corrective work, or ongoing monitoring.

As rainfall intensity increases, freeze thaw cycles become more frequent, wildfire exposure expands, and storm events intensify, trails experience accelerated drainage failure, tread softening, erosion, debris loading, and structural stress. These impacts often begin as small, localized deficiencies. Regular trail inspections allow managers to detect trail deterioration early, prioritize corrective action, reduce long term repair costs, and prevent minor issues from escalating into major infrastructure failures.

Trail inspections form the foundation of proactive and climate informed trail management, enabling early identification of climate related impacts and guiding timely maintenance and adaptation decisions.

Inspection frequency should align with your Trail Management Objectives (TMO) and formal risk management policies. Any inspection schedule that is adopted should be realistic and achievable within available capacity.

Establishing inspection frequencies that cannot be consistently met may create unnecessary liability exposure in the event of an incident. Trail organizations are encouraged to define clear, defensible inspection intervals and to document compliance with those standards.

When to Inspect:

- Regularly or on a schedule
- At seasonal transitions (following spring melt, fall storms)
- After major weather events (heavy rain, flooding, wildfire, windstorms)
- More frequently on high-use or high-risk trails

Who Should Inspect

Trained volunteers or staff. Trail-level inspections may identify visible signs of climate-related deterioration; however, structural integrity assessments must be completed by qualified engineering professionals.

Trail inspections should be carried out by trained staff, or experienced volunteers who understand sustainable trail design principles and basic trail function. Individuals conducting inspections should be capable of recognizing drainage failures, erosion patterns, surface instability, vegetation related hazards, and emerging climate related impacts. Inspectors should also be able to assess conditions objectively, document observations clearly, and distinguish between routine wear and issues that require escalation or professional review.



What to Look For

Water and Drainage Impacts	• Pooling water on the tread or signs that water is flowing down the trail rather than shedding off it • Cupped tread where the centre of the trail is lower than the edges and holding water • Rutting caused by concentrated runoff or saturated soils • Erosion channels or rills forming along or across the tread • Washed out sections following heavy rainfall or rapid snowmelt • Sediment deposits on the trail surface following storm events • Soft, saturated, or persistently muddy areas
Slope Stability and Soil Movement	• Tread sloughing or downhill edge creep due to unstable or saturated soils • Indicators of slope instability such as slumping, side slope erosion, or soil movement beneath the tread • Roots or rocks becoming exposed as tread material erodes
Storm and Wildfire Impacts	• Windthrow, fallen trees, or debris accumulation following storm events • Indicators of wildfire related instability such as soil loss, reduced vegetation cover, or increased erosion potential on adjacent slopes
Vegetation and Corridor Changes	• Rapid vegetation growth narrowing the trail corridor following wet growing seasons
Freeze–Thaw and Permafrost Conditions	• Rutting or surface disturbance associated with freeze–thaw cycles and saturated soils • Surface cracking, heaving, or settlement that may indicate frost action or permafrost thaw
Drought Conditions	• Dry, dusty, or cracking tread surfaces that may signal loss of soil cohesion during prolonged dry periods

Each observation should include location, severity, and recommended action. Accurate documentation supports prioritization and long term monitoring.



The **Trail Inspection Form** can be found in **Appendix D**.

Structural Reviews

Structural inspections evaluate built trail features such as bridges, boardwalks, stairs, retaining walls, and drainage structures.

Climate change increases structural stress through flooding, debris loading and impact, freeze thaw movement, heavier snow loads, wildfire exposure, and permafrost melt. As ground conditions destabilize and weather extremes intensify, minor deterioration can accelerate quickly and may develop into significant structural or safety hazards if not identified and addressed early.

Routine structural inspections support public safety and responsible asset management.

Review Levels

- **Structural Review (Visual Screening)**
Conducted by trained volunteers or staff to identify visible signs of deterioration or environmental damage.
- **Structural Inspection (Professional Assessment)**
Conducted by a qualified professional when structural concerns are identified or where required by asset management policies.

Who Should Inspect

- Trained volunteers or staff.
- Volunteer inspections do not replace professional structural assessment.

When to Review:

- Conduct structural reviews at the same frequency as trail inspections.
- Higher risk structures may require more frequent review depending on exposure, structure type, and public use.

What to Look For

Structural reviews focus on simple observable conditions, including:

- Structure no longer level or signs of shifting or settlement
- Erosion or soil loss around posts, footings, or abutments
- Foundations exposed or undermined following heavy rainfall or flooding
- Cracked, warped, or separating boards
- Rot or soft wood caused by prolonged moisture exposure
- Debris buildup or lodged material against the structure following flooding
- Charred or fire damaged structural members following wildfire exposure
- Loose fasteners or separating joints
- Damage caused by falling trees or large debris

Where safety concerns are identified, **access should be restricted and escalation procedures initiated** until the structure can be further assessed or repaired.

Please note:

This checklist does not replace a professional structural assessment. The Structural Inspection Checklist provided in this resource is intended as a high-level visual assessment tool to support trail associations, volunteer groups, and trail stewards in identifying visible signs of wear, damage, or instability in trail structures. It is not a substitute for a professional structural assessment which should occur at a scheduled interval for each structure that required engineering.



The **Structural Review Checklist** can be found in **Appendix E**.

Vegetation Maintenance

Vegetation maintenance supports safe and functional trail corridors by responding to climate driven vegetation change, storm damage, and wildfire risk. Vegetation growth and disturbance patterns are increasingly influenced by changing weather conditions, longer growing seasons, and more frequent storm events.

Climate focused vegetation maintenance aims to manage vegetation in ways that support trail durability and user safety. In some environments this may involve increasing sunlight and airflow to help the tread dry more quickly, while in other locations maintaining canopy cover can provide shade, reduce soil drying, and protect trail surfaces. Vegetation management should therefore respond to local site conditions and climate pressures rather than applying a single approach.

Proactive vegetation maintenance helps protect users, maintain corridor visibility, preserve drainage function, and reduce wildfire and storm related hazards that can affect trail alignment and tread stability.

Vegetation should be managed regularly, ideally during the growing season or following major weather events. High use or high risk trails may require corridor checks several times per year, while remote or low use routes may only require work following inspections or reported issues.

Who Should Maintain

- Trained volunteers or trail crews
- Individuals familiar with safe tool use and hazard identification
- Certified professionals for hazard trees or complex removals

Routine vegetation work can be completed by volunteers under the supervision of trained volunteers or staff. Hazard trees or complex removals should be handled by certified professionals.

When to Maintain:

- During the growing season
- After windstorms or heavy snowfall
- After wildfire events
- After trail inspections identify vegetation concerns
- Following freeze thaw cycles where vegetation damage or blowdown has occurred



Figure 2. Overgrown Tread (left), Overgrown Corridor and Tree Down (right).

What To Do

- Limb trees to a consistent height to maintain corridor clearance and improve visibility.
- Remove deadfall and storm debris following wind, snow, or storm events, and scatter or remove cut material so it does not create fuel buildup along the trail edge.
- Identify and mitigate hazard trees that threaten the trail corridor, including standing dead, leaning, fire damaged, or storm weakened trees. Large or unstable trees should be handled by certified professionals.
- Manage understory vegetation within the corridor to reduce wildfire fuel continuity where appropriate and limit ladder fuels that allow fire to move from ground vegetation into the canopy.
- Maintain clear sightlines along the trail corridor by trimming vegetation that obstructs visibility around corners, intersections, or steep grades.
- Mow tall grasses along trail shoulders where ignition risk from trail users or equipment may occur.
- Remove invasive species in accordance with regional best practices and monitor treated areas for regrowth.
- Stabilize exposed cut and fill slopes through seeding or other erosion control measures where vegetation has been lost.

- Address exposed roots or unstable soils caused by erosion, drought, or vegetation loss by stabilizing surrounding soils and correcting drainage issues contributing to soil loss.
- Monitor areas affected by wildfire or prolonged drought where vegetation loss may expose soils to erosion and slope instability.
- Maintain drainage corridors by removing vegetation that blocks ditches, swales, culverts, or natural water flow paths.

Vegetation maintenance activities should focus on reducing climate exposure and improving corridor resilience.

Vegetation work should prioritize fuel reduction, storm resilience, and drainage function.

Please note:

This checklist is intended for field crews performing work such as clearing corridor encroachment, removing downed trees, addressing hazard trees, restoring sightlines, controlling invasive species, and correcting vegetation impacts on tread or drainage. At each identified location, staff or volunteers should confirm the issue, apply the appropriate actions from the checklist, and ensure the corridor is restored to its intended width, height, and safety standards.



The **Vegetation Maintenance Checklist** can be found in **Appendix F**.



Figure 3. Tree down (left), Tree trimming (right).

Tread Maintenance

Tread maintenance includes preventative and corrective actions that maintain the shape, stability, and drainage function of the trail surface. Climate change is increasing the frequency and intensity of conditions that affect trail tread, including heavier rainfall, rapid snowmelt, freeze–thaw cycles, drought, wildfire disturbance, wind events, and permafrost thaw in northern regions.

While water remains a primary driver of tread deterioration, trail surface failures often result from both climate pressures and user impacts acting together. Increased precipitation can saturate soils, freeze–thaw cycles can weaken soil structure, wildfire can remove stabilizing vegetation, and drought can cause soils to dry and lose cohesion. When these stresses occur on a poorly drained or improperly shaped tread, erosion, rutting, sloughing, and surface breakdown accelerate.

Regular tread maintenance restores proper drainage, stabilizes soils, and reduces the likelihood of costly reconstruction. The objective across all conditions is to maintain proper tread shape so water and surface runoff are directed off the trail rather than along it.

Maintenance frequency should align with inspection findings and the Trail Management Objective (TMO) for the trail. Regular review prevents minor issues from developing into major tread failures.

Who Should Maintain

- Trained volunteers or trail crews
- Staff familiar with drainage and sustainable trail construction
- Experienced trail builders for complex repairs

Basic tread reshaping and drainage correction can be completed by volunteers under the supervision of trained volunteers or staff familiar with sustainable trail construction practices. More complex work, such as major regrading, rock armouring, or stabilization of unstable soils, should be supervised by experienced trail builders.

When to Maintain:

- Following trail inspections that identify drainage failure, tread instability, or erosion
- After heavy rainfall events or rapid snowmelt
- After freeze–thaw cycles that weaken soils or cause tread deformation
- Following wildfire events where vegetation loss increases erosion risk
- After storm events that deposit debris or alter drainage patterns
- Where repeated failures are observed in the same trail segment



Figure 4. Cupped and Channeling (left) Sloughing (right).

What to Do and How to Do It

- If **cupping** is present, restore outslope so water sheds off the tread instead of collecting in the centre. Compact the entire tread surface after reshaping to stabilize soils and reduce future cupping.
- If **water is flowing down the tread**, install or re-establish a grade reversal or rolling grade dip (RGD) to redirect water off the trail.
- If **outslope has been lost**, reshape the tread to restore cross slope and proper drainage. For gravel trails, an outslope of approximately 4% is a practical drainage target.

- If **erosion is occurring at water crossings**, reinforce the area with a rock armoured crossing to protect the tread from scour and seasonal flow damage.
- If **sloughing is occurring on the downhill edge**, re-bench the tread, stabilize the edge, rebuild tread width, and correct the drainage issue contributing to soil saturation.
- If **soft or saturated areas persist**, improve drainage first. If drainage corrections are insufficient, consider armouring the tread or installing raised tread.
- If **braiding or widening** is occurring due to mud, correct the drainage problem, restore the intended alignment, and close and rehabilitate informal bypass routes.
- If **drainage features are not functioning**, rebuild or tune grade reversals, rolling grade dips, and drainage outlets so water exits the trail corridor completely.
- **Clean culverts, ditches, and drainage channels** to ensure water flows away from the trail rather than along the tread.
- **Inspect and clean rock armoured dips** to remove sediment, debris, or vegetation that may reduce drainage performance.
- **Tune up rolling grade dips and grade reversals** to maintain their ability to shed water off the trail.
- **Stabilize backslope and ditch areas**, particularly following wildfire or vegetation loss, where exposed soils may erode or collapse into the trail corridor.
- **Compact the tread** after reshaping, re-benching, or drainage repairs to stabilize the trail surface and reduce future rutting or erosion.



The **Tread Maintenance Checklist** can be found in **Appendix G**.



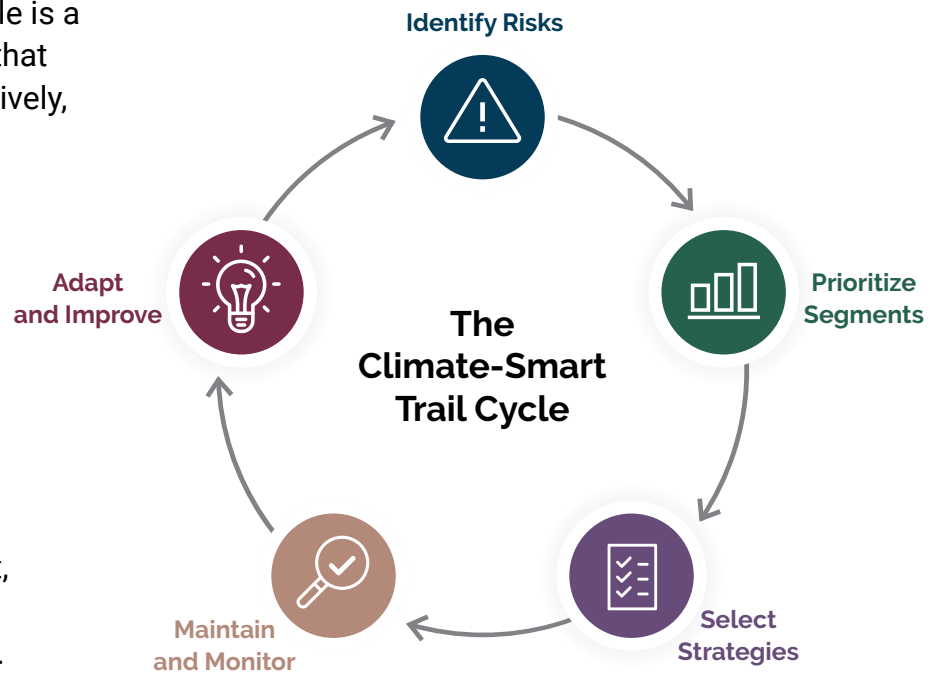
Figure 5. Puddle (left), Trail Widening (right).

A photograph of two hikers, a man and a woman, walking away from the camera on a rocky, moss-covered trail in a dense forest. The man in the foreground is wearing a dark jacket, shorts, and a large black backpack. The woman ahead of him is wearing a green backpack and dark pants. The forest is lush with green moss on the rocks and trees, and sunlight filters through the canopy.

The Climate-Smart Trail Cycle

The Climate-Smart Trail Cycle

The Climate-Smart Trail Cycle is a simple, repeatable process that helps trail groups act proactively, before weather events cause damage, while also responding effectively when impacts do occur. By identifying risks early, choosing effective actions, maintaining trails ahead of seasonal change, and adjusting approaches over time, this cycle ensures trail decisions remain consistent, transparent, and focused on long-term climate resilience.



Identify Risks

The first step is to identify climate-related vulnerabilities using the tools described throughout this guide. Information gathered through Trail Inspections, Structural Reviews, Vegetation Maintenance observations, and the Climate-Resilient Trail Planning Checklist helps identify how changing environmental conditions are affecting trail performance.

Inspections are most effective when conducted before seasonal transitions or major weather events. Early identification allows drainage deficiencies, localized erosion, vegetation hazards, or structural stress to be addressed before they escalate into larger failures.

Risk identification should focus on conditions such as:

- Drainage failures or water flowing along the tread
- Soil instability, erosion, or slumping
- Vegetation hazards or wildfire exposure
- Structural damage or deterioration
- Repeated damage following storms or seasonal weather events

Prioritize Segments

Once risks are identified, trail managers evaluate and rank trail segments based on urgency and overall importance within the trail system. Not all issues require the same level of response, and clear prioritization ensures that limited resources are directed toward the areas most vulnerable to climate impacts.

Prioritization combines field observations with management considerations such as available funding, volunteer capacity, trail classification, and overall trail management objectives.

Trail managers may consider factors such as:

- Severity of current damage
- Likelihood that conditions will worsen under future climate events
- Environmental sensitivity of the surrounding landscape
- Importance of the trail segment within the network

Select Strategies

After priorities are established, trail managers select the most appropriate response using the practices described throughout this guide. In many cases, corrective maintenance such as restoring drainage, stabilizing tread, or addressing vegetation hazards will resolve the issue. In other situations, more substantial actions may be required.

The objective is to address the underlying cause of vulnerability, rather than repeatedly repairing visible symptoms.

Effective strategies may include:

- Restoring tread shape and drainage features
- Stabilizing slopes or reinforcing crossings
- Vegetation management or hazard tree removal
- Upgrading materials or reinforcing structures
- Rerouting vulnerable trail segments
- Applying seasonal operational controls

Maintain and Monitor

Once strategies are implemented, continued maintenance and monitoring confirm whether the intervention is performing as intended. Regular inspections document trail conditions, track recurring issues, and record the performance of previous repairs.

Monitoring transforms routine inspections into a long-term trail management practice that supports informed decision-making.

Monitoring activities may include:

- Documenting trail conditions during inspections
- Recording locations of recurring issues
- Tracking the performance of previous repairs
- Identifying segments requiring repeated maintenance

Adapt and Improve

Climate conditions will continue to evolve, and trail management practices must adapt accordingly. Trail managers should periodically review inspection and maintenance records to identify patterns and opportunities for improvement.

Repeated failures in the same location, underperforming materials, or increasing maintenance demands may indicate that adjustments to trail alignment, design approaches, or operational practices are necessary.

The Climate-Resilient Trail Management Cycle is an ongoing feedback loop that helps trail managers continuously improve how trails are planned, maintained, and managed in response to changing environmental conditions.

Adaptive management actions may include:

- Refining maintenance practices
- Improving drainage or tread design
- Modifying trail alignments or rerouting segments
- Adjusting trail classifications or user expectations
- Applying seasonal closures or operational controls



Appendices

Purpose: Support early-stage planning decisions that reduce long-term climate risk and maintenance costs.

How to Use: Use during trail planning, routing, or major upgrades.

Common Practice

- ☐ Trail avoids flat and wet areas where possible
- ☐ Trail is aligned primarily on side slope
- ☐ Trail is safe for intended users
- ☐ Site conditions support long-term sustainability

Flood and Heavy Rain

- ☐ Trail is located outside floodplains and historic channels
- ☐ Alignment avoids areas prone to flash flooding or debris flow
- ☐ Water crossings occur at stable, narrow channel locations

Wildfire

- ☐ Trail is located near or integrated with firebreaks where appropriate
- ☐ Emergency access routes are available or planned

Freeze Thaw Cycles

- ☐ Trail avoids depressions where water collects
- ☐ Alignment avoids frost susceptible soils or includes mitigation

Sea Level Rise

- ☐ Trail avoids current and future inundation zones
- ☐ Alignment allows for shoreline movement
- ☐ Retreat or alternate alignments are identified

Drought

- ☐ Trail avoids soils prone to breakdown in dry conditions

Wind

- ☐ Trail avoids high exposure wind corridors where possible

Snowpack Variability

- ☐ Trail avoids avalanche terrain and unstable slopes
- ☐ Seasonal routing or closures are considered

Purpose: Ensure trails are built to withstand future climate conditions.

How to Use: Use during design and construction. Confirm key decisions before building.

Common Practice

- ☐ Trail follows half rule
- ☐ Trail maintains consistent outslope
- ☐ Grade reversals are incorporated
- ☐ Soil conditions are understood
- ☐ Local materials are used where practical

Flood and Heavy Rain

- ☐ Drainage is built into trail design
- ☐ Raised tread is used in flat or wet areas
- ☐ Crossings are armored or stabilized
- ☐ Structures are sized for future conditions

Freeze Thaw Cycles

- ☐ Drainage prevents water accumulation
- ☐ Design accounts for spring melt
- ☐ Materials resist cracking and movement

Permafrost

- ☐ Elevated or low-impact structures are used where needed
- ☐ Ground disturbance is minimized

Drought

- ☐ Materials resist drying and cracking
- ☐ Shade and vegetation are considered

Wind

- ☐ Structures are anchored and durable
- ☐ Corridor allows for debris clearing

Snowpack Variability

- ☐ Structures account for snow load and movement
- ☐ Drainage accommodates snowmelt

Purpose: Support ongoing trail management under changing climate conditions.

How to Use: Use for annual planning, inspections, and operations decisions.

Common Practice

- ☐ Monitoring plan is in place
- ☐ Recurring issues are tracked over time
- ☐ Maintenance response reflects risk and trail use

Inspection Frequency and Timing

- ☐ To best manage trails for climate resilience, trails are to be formally inspected at least annually
- ☐ Additional inspections occur after major weather events
- ☐ High risk areas are inspected more frequently
- ☐ Informal inspections can be completed any time

Recording and Tracking

- ☐ Inspection and maintenance records are stored consistently
- ☐ Recurring issues are used to identify larger problems

Climate Response

- ☐ Trails are temporarily closed when conditions create risk or damage
- ☐ Rerouting is used where impacts cannot be managed through maintenance

Purpose: Document trail issues clearly and consistently.

Key Principle: Focus on describing problems clearly, not rating them.

Trail Information

Trail Name:

Date:

Trail Inspector:

Phone:

Email:

Trail Issue Catalogue

Issue #	Description of Issue	Location (km from Trailhead or Lat / Long)
1		
2		
3		
4		
5		

Issue #	Description of Issue	Location (km from Trailhead or Lat / Long)
6		
7		
8		
9		
10		
11		
12		
13		
14		

Additional Notes: Provide detailed observations, patterns, or concerns

Photos: Take photos of both issues and areas in good condition and tag photos with GPS location

Map: Attach map showing issue locations

IMPORTANT: This is a basic visual check only. Apply the following checklist to evaluate the condition of built trail infrastructure, if you are **NOT** able to check a box the structure is likely faulty, and the inspector should inform the trail manager or a professional engineer:

Structure Information

Trail name: _____

Location: _____

Structure type: _____

Foundations

- ☐ Structure are level and stable (no noticeable tilting or sinking)
- ☐ Foundations are firmly in the ground with no visible movement when stepped on
- ☐ No sign of washout, erosion, or exposed footing around base
- ☐ Wood at ground contact is solid (no soft, crumbly, or rotting material)
- ☐ Metal connections are intact and not excessively rusted
- ☐ Surrounding soil or rock is stable and not undermined by water

Notes:

Decking

- ☐ Decking boards or surface materials are secure and do not move
- ☐ No broken, cracked, warped, or missing boards
- ☐ Surface provides good footing (not excessively slippery, loose, or polished)
- ☐ Gaps or edges do not pose tripping or wheel-catch hazards
- ☐ No excessive sagging when weight is applied

Notes:

Railing

- ☐ Railings are solid and do not wobble when pushed
- ☐ Rails are at consistent height and securely attached
- ☐ No broken, missing, or sharp components
- ☐ Spacing prevents users or equipment from slipping through
- ☐ Kick rails or curbs (if present) are intact
- ☐ No corrosion, rot, or fire damage

Notes:

Load Bearing Elements

- ☐ Structural members appear straight and uncracked
- ☐ No visible splitting or deformation
- ☐ Connections (bolts, screws, brackets) are present and tight
- ☐ No sounds or movement when crossing the structure
- ☐ No visible fire, flood, or impact damage

Notes:

Signage

- ☐ Signage is clear and visible and does not exhibit fading
- ☐ Signage posts at ground contact are solid (no soft, crumbly, or rotting material)

Notes:

Photos and Maps: Include photos and map location for any issues

Purpose: Provide clear, practical actions to manage vegetation and maintain safe, functional trail corridors under changing climate conditions.

How to Use: Use this tool in the field. Complete actions within your training and report larger issues.

Deadfall and Storm Debris

- ☐ Remove fallen trees and branches from the trail corridor
- ☐ Cut material into manageable pieces and move it off the trail
- ☐ Scatter or remove debris to prevent buildup along the trail edge
- ☐ Report large trees or hazards requiring equipment
- ☐ Prioritize clearing after major wind, snow, or storm events

Corridor Clearing and Overgrowth

- ☐ Clip vegetation to maintain approved trail width and sightlines
- ☐ Remove vegetation blocking signage, intersections, or visibility
- ☐ Stack cut vegetation away from the tread
- ☐ Increase clearing frequency where vegetation growth is accelerating due to longer growing seasons

Drainage and Vegetation Interaction

- ☐ Remove vegetation blocking ditches, swales, and natural drainage paths
- ☐ Keep culverts and drainage corridors clear
- ☐ Ensure vegetation does not redirect water onto the trail surface during heavy rainfall

Invasive Species

- ☐ Remove invasive species using regional best practices
- ☐ Monitor treated areas for regrowth
- ☐ Increase monitoring in disturbed or post storm areas where invasive species establish quickly

Slopes and Soil Stability

- ☐ Stabilize exposed cut and fill slopes using vegetation or erosion control methods
- ☐ Address areas where vegetation loss has exposed soil
- ☐ Prioritize areas where erosion is increasing due to heavy rainfall or prolonged dry conditions

Roots and Soil Exposure

- ☐ Stabilize exposed roots and surrounding soils
- ☐ Address drainage issues contributing to soil loss
- ☐ Focus on areas where increased runoff is exposing roots and weakening the tread

Drought and Fire Risk

- ☐ Remove dry grasses and fine fuels along trail edges where appropriate
- ☐ Maintain low vegetation height in high use areas
- ☐ Reduce ignition risk in dry conditions, especially during periods of high fire danger

Purpose: Provide clear, practical actions to maintain trail tread and drainage under increasing climate pressures.

How to Use: Follow these actions in the field. Do not complete work beyond your training. Report larger issues.

Standing Water and Drainage

- ☐ Clear leaves, sediment, and debris from the tread
- ☐ Clean drainage features such as grade reversals and rolling grade dips
- ☐ Lightly reshape tread and restore outslope
- ☐ Prioritize areas where water is flowing down the trail instead of shedding off

Cupping and Rutting

- ☐ Remove loose material blocking drainage
- ☐ Restore tread shape and outslope
- ☐ Compact the tread after reshaping
- ☐ Focus on areas where rainfall or snowmelt is accelerating tread deformation

Erosion and Tread Loss

- ☐ Return displaced material to the tread as suitable and compact to maintain trail integrity
- ☐ Improve drainage upslope to reduce water flow
- ☐ Reinforce tread with rock where necessary
- ☐ Inspect after heavy rainfall or rapid snowmelt for erosion and sediment buildup

Drainage Features

- ☐ Remove sediment, leaves, and debris
- ☐ Clear inlets and outlets completely
- ☐ Restore feature shape if trained
- ☐ Report features that are no longer effective
- ☐ Ensure water exits the trail corridor fully and does not continue along the tread
- ☐ Rebuild or adjust features that no longer handle current water volumes

Soft or Saturated Tread

- ☐ Improve drainage before attempting repairs
- ☐ Use armouring or raised tread where necessary

Identify and address root cause of issue before maintaining tread condition

Slope Instability and Tread Movement

- ☐ Rebuild tread where sloughing or edge failure is occurring
- ☐ Stabilize the downhill edge through proper compaction of placed materials
- ☐ Address drainage issues contributing to instability
- ☐ Monitor areas showing soil movement, slumping, or saturation

Trail Widening and Braiding

- ☐ Define the main tread clearly
- ☐ Close and restore informal side paths where appropriate
- ☐ Remove obstacles that cause users to leave the trail

Surface Stability and Compaction

- ☐ Maintain a stable and consistent tread surface
- ☐ Prioritize compaction after repairs to reduce future erosion during heavy rain



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