



Wildfire Mitigation Plan

North Star Electric Cooperative

August 2026





Revision History

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Table of Contents

1	Executive Summary	1
2	North Star Electric Cooperative Overview.....	3
2.1	Wildfire History	3
2.2	Wildfire Mitigation Plan Objectives.....	4
3	Wildfire Risks and Drivers	5
3.1	Minnesota Wildfire Risk Considerations.....	5
3.2	Ignition Tracking	5
3.3	Wildland-Urban Interface Exposure	5
3.4	Electric Infrastructure Risk.....	6
3.5	Social Vulnerability	6
3.6	Economic Impact.....	7
3.7	Emergency Preparedness and Resource	7
4	Wildfire Preventative Strategies.....	8
4.1	Weather and Condition Monitoring.....	8
4.2	Fuel and Vegetation Management.....	8
4.3	Inspection and Corrective Responses	9
4.4	System Protection	10
4.5	System Hardening	10
4.6	Stakeholder and Member Engagement	11
4.7	Mutual Aid	12
4.8	Public Safety Power Shutoff (PSPS) Considerations	12
5	Wildfire Risk Assessment Findings.....	15
6	Wildfire Mitigation Plan	22
6.1	Short-term (1-2 years) Roadmap	22
6.2	Medium-term (2-5 years) Roadmap.....	23
6.3	Long-term (5+ years) Roadmap.....	24

1 Executive Summary

North Star Electric Cooperative (North Star) has developed this Wildfire Mitigation Plan (WMP) in collaboration with PSE Engineers and Consultants to proactively address the growing threat of wildfires across our four-county service territory. The WMP provides a framework for identifying wildfire risks, reducing ignition potential, protecting public safety, and strengthening system resilience in an era of increasing fire danger.

Purpose of the Plan

The purpose of this plan is to:

1. Enhance the safety of North Star's members, employees, and communities.
2. Protect critical electric infrastructure that supports homes, farms, schools, and businesses in North Star's service territory.
3. Reduce the potential for electrical equipment to ignite wildfires.
4. Support long-term system resilience and reliability in alignment with North Star's ongoing planning efforts.

Overview of Wildfire Risk

While the risk of widespread wildfire has not traditionally been high in Minnesota, the wildfire environment has shifted dramatically due to rising temperatures, drier summers, and increased fuel loads from beetle-killed forests. Wildfire seasons are longer, ignition risks are greater, and more communities are exposed through growth into the wildland–urban interface (WUI). The early springtime period between when snow melts and before vegetation greens up can be a particularly dangerous period. It should also be noted that 90% of Minnesota fires are caused by humans, according to the Minnesota Department of Natural Resources.

The National Interagency Fire Center (NIFC) has nearly 400 wildfire events in Minnesota in May of 2026 alone, though none of these have burned any appreciable acreage¹. North Star recognizes that even one utility-caused ignition could have catastrophic consequences for lives, landscapes, and local economies.

Key Strategies and Investment Areas

This WMP outlines preventative strategies and investments, including:

- Weather and Condition Monitoring – Incorporating seasonal wildfire forecasts, daily condition checks, and adaptive substation protection settings during high fire risk periods.
- Fuel and Vegetation Management – Expanding right-of-way (ROW) clearances, implementing a hazard tree program, and improving documentation to reduce fuel around electrical assets.
- System Protection – Utilizing fast trip curves, Hot Line Tag (HLT) when needed, and planning for advanced high-impedance fault detection.

¹ <https://data.cincinnati.com/wildfire-history/?page=1&query=minnesota%20wildfire>



- System Hardening – Replacing aging conductor, deploying covered conductor in high-risk corridors, and evaluating additional hardening measures such as fire-resistant poles and selective undergrounding.
- Public Safety Power Shutoffs (PSPS) – Evaluating PSPS as a last-resort risk reduction tool, including criteria for use, communication protocols, and community impact mitigation.

Roadmap for Implementation

The plan provides a phased roadmap of actions over the short term (1–2 years), medium term (2–5 years), and long term (5+ years). Each action identifies responsible parties and estimated costs, ensuring accountability and transparency.

Risk Assessment Findings

The wildfire risk on the North Star system was evaluated using the geography of the territory as described in detail in Section 5. This assessment finds the following:

- 75% of North Star’s overhead spans (primary and secondary) have “Very Low” or “Low” wildfire risk
- 582 overhead spans (2.77% of the system) are classified as “High” risk.
- 28 spans (0.13% of the system) are classified as “Extreme” risk.
- The Risk Assessment results are based on nearby fuel (vegetation), terrain slope, and terrain aspect (the direction the slope is facing), and do not consider climate conditions or weather. While it may seem alarming that some spans are classified as High or Extreme wildfire risk, it must also be noted that North Star’s service territory is heavily wooded and has a lot of sloped terrain but is also generally less dry than many other parts of the United States. The Assessment findings should be interpreted that if North Star’s territory does experience a hot, dry period where overall fire risk becomes higher, the feeders that include high- and extreme-risk spans should be monitored closely and possibly placed in one-shot protection mode to limit the risk of ignition.

Commitment to Safety and Reliability

Wildfire preparedness is both an operational responsibility and a community partnership. By investing in prevention, hardening, and preparedness, North Star is taking a proactive stance to protect our members, employees, and the broader community. The WMP reflects our long-standing commitment to safety, reliability, affordability, and resilience—values that guide every decision we make in service to our members.



2 North Star Electric Cooperative Overview

North Star Electric Cooperative (North Star) is an electric cooperative in the State of Minnesota serving a major portion of the rural areas of Lake of the Woods and Koochiching counties and smaller portions of Roseau and St. Louis counties. More than 5,600 member owners work with our team for power in their homes, schools, farms and other small businesses.

Located in northern Minnesota along the Canadian border, the Lake of the Woods is a four-season destination known for its world-class fishing and remarkable range of outdoor experiences. Beyond its legendary walleye waters, the region offers exceptional birding along the Rainy River, scenic boating and paddling routes, historic sites that tell the story of the Northwoods, and seasonal traditions like wild blueberry picking beneath wide-open skies.

North Star serves a broad and diverse territory with over 6,900 active services and a system that includes 974 miles of overhead distribution line and 485 miles of underground distribution line. Incorporated in 1937, the Cooperative has grown into a modern utility guided by our 7-member Board of Trustees and operated by a team of 21 full-time employees.

This scale of operations underscores the importance of a robust wildfire mitigation strategy. With hundreds of miles of overhead line and assets extending across forested, agricultural, and rural communities, North Star must proactively manage vegetation, system protection, and emergency preparedness. The Cooperative's strong governance structure and dedicated workforce provide the foundation for implementing the Wildfire Mitigation Plan, ensuring both technical rigor and community-centered resilience.

2.1 Wildfire History

Wildfire preparation requires year-round activities for North Star. No matter the season, we continuously take action to mitigate wildfire risk to help ensure reliable and safe service to our members and communities. We are continually evaluating data driven steps to develop the best program resulting in safe, reliable, and affordable operation of the electric system, therefore, reducing outages, wildfire risk and rates.

Wildfires are no longer confined to the western United States. Traditionally associated with dry, fire-prone regions like California, wildfires are now affecting areas across this country, including Minnesota. This shift in increased wildfires is driven by rising temperatures, prolonged droughts and changing weather patterns, which are creating conditions ripe for fires in regions that historically saw fewer of them. As a result, more communities are now facing growing threats from wildfires, prompting a need for broader awareness and preparedness nationwide.

North Star is working to reduce the risk of wildfires throughout our service territory. Through regular vegetation management, grid maintenance and hardening practices, we are proactively working to reduce risks and improve the reliability of our local system.

2.2 Wildfire Mitigation Plan Objectives

North Star, in collaboration with PSE Engineers and Consultants, has developed a data-informed, community-focused Wildfire Mitigation Plan (WMP) to proactively reduce wildfire risks across our four-county service territory. The plan is designed not only to safeguard North Star's electric infrastructure but also to protect the communities, landscapes, and economies that depend on it. By integrating engineering analysis with stakeholder input, North Star's WMP enhances infrastructure safety, strengthens coordination with regional partners, and improves resilience to evolving wildfire threats.

This initiative directly advances overall system planning, specifically our commitment to "proactively plan to mitigate national, state and local concerns for potential health, safety and financial impacts of wildfires." The WMP provides a framework for identifying wildfire exposure and implementing cost-effective, science-based mitigation measures across Lake of the Woods, Koochiching, Roseau and St. Louis counties. Key factors considered include topography, fuel loads, climate trends, vulnerable populations, and the distribution of electric infrastructure assets.

The primary goals of the WMP are to:

- Prepare for emergencies by developing protocols, training, and coordinating with local fire districts, emergency managers, and state/federal agencies.
- Protect public safety through timely communication, community outreach, and operational practices that reduce hazards to members and first responders.
- Protect public infrastructure through the increase in defensible space and by removing highly combustible fuel in high-risk locations.
- Reduce fire ignition risk by hardening infrastructure, managing vegetation near distribution lines, and inspection technologies to detect potential threats.
- Enhance system resilience by investing in equipment, sectionalizing capabilities, and redundant pathways that allow faster restoration during and after wildfire events.
- Understand the value of power being on during a fire event to allow rural homeowners, usually served from a private well, to maintain water flow for fire suppression on their property – often desired to supplement fire agency efforts
- Maintain reliability so that North Star can continue to deliver safe, affordable, and dependable power wildfire activity potentially increases.

The WMP ensures that wildfire preparedness is not only an operational priority, but also a shared responsibility among cooperative members, local governments, and regional partners. This proactive posture enhances long-term system reliability, protects public health and safety, and strengthens the cooperative's ability to serve our members in an era of rising climate and wildfire challenges.

3 Wildfire Risks and Drivers

3.1 Minnesota Wildfire Risk Considerations

Minnesota's wildfire risk has grown in recent years and continues to increase. A combination of increasing temperatures and drier fuel has created an environment where fires ignite more easily, spread more quickly, and burn with greater severity. Minnesota's 4.2 million acres of forests are experiencing widespread stress impacts from drought, disease and insect infestations, leaving dead or dying trees that serve as highly combustible fuel.

Population growth and development patterns are also driving expansion into wildland-urban interface (WUI) areas, placing more homes, businesses, and infrastructure at direct risk. These conditions have transformed wildfire from a seasonal hazard into a year-round risk with continued consequences for utilities, communities, and the state's economy.

3.2 Ignition Tracking

North Star maintains detailed outage records that include details of location, cause, equipment involved, and notes from crews and dispatch involved with the restoration. Ignition and fire are both possible causes and results of electrical equipment failures, so it is critical to track any ignitions caused by electrical failures and any fires that threaten North Star's infrastructure.

In the past five years, North Star has recorded eighteen (18) outages with a cause description of "FIRE." Most of these have been attributed to meters or transformers, sometimes also citing consumer breakers or wiring as points of failure. Several of these have been associated with distribution poles and fused cutouts, which are often susceptible to tree contact and can easily spread sparks and embers from significant height when burning that can cause further ignitions.

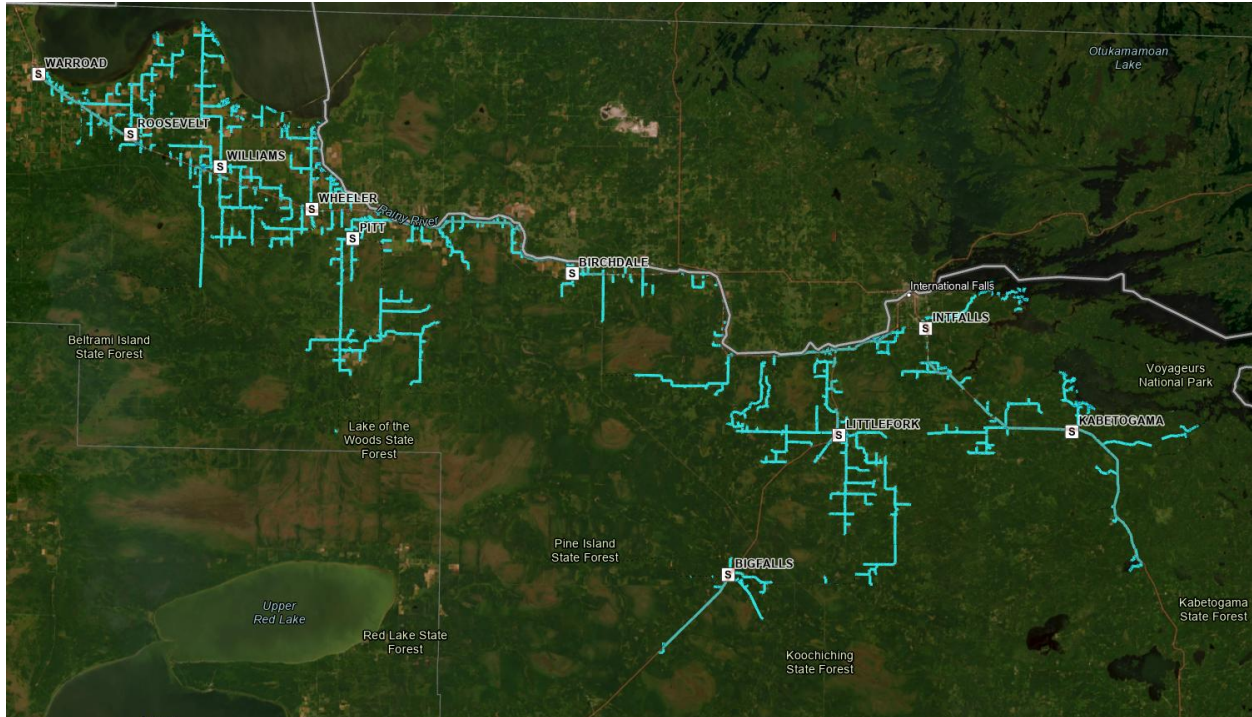
3.2.1 Downed Line Tracking

Power lines broken or otherwise downed can pose a significant ignition risk if not quickly de-energized by a protective device. Downed lines can also be an indicator of frequent tree contact. North Star does not appear to specifically track downed conductors in its outage records.

3.3 Wildland-Urban Interface Exposure

The wildland-urban interface (WUI) is the zone where human development meets flammable vegetation and is one of the greatest areas of concern for wildfire impacts. North Star's service territory includes varying levels of WUI exposure. Communities often have dispersed housing patterns, limited evacuation routes, and nearby forests, which increase both fire ignition potential and the difficulty for suppression.

Distribution and service lines frequently cross or border high-fuel landscapes. A single pole failure, downed line, or tree contact event can have devastating consequences in these settings, quickly escalating into structure losses and community displacement. The WMP places emphasis on assessing and mitigating WUI exposures to reduce the likelihood of catastrophic outcomes.



3.4 Electric Infrastructure Risk

North Star's electric system includes distribution assets that cross mountainous terrain, valleys, agricultural zones, and forested lands. Risk factors to infrastructure include:

- Vegetation contact or close proximity with overhead lines and poles.
- Aging equipment (e.g., older transformers, insulators, and conductors) prone to failure under heat or stress.
- Extreme weather such as high winds, lightning, and snow-to-thaw cycles that increase stress on assets.
- Remote accessibility, which delays detection and response when incidents occur.

North Star has identified specific vulnerabilities in pole-mounted equipment, long rural feeders, and assets in heavily forested terrain. Infrastructure hardening strategies such as pole replacement, use of covered conductors, advanced fuses, and sectionalization are key tools to address these risks.

3.5 Social Vulnerability

Some populations are more vulnerable to wildfire due to socioeconomic or demographic factors. North Star's service area includes low-income households, agricultural workers, elderly populations, and rural residents who may have fewer resources to prepare for or recover from wildfire events. Many communities rely on limited health services, broadband access, and transportation options, creating challenges for evacuation, emergency response, and long-term recovery.



The WMP integrates social vulnerability mapping to identify communities with elevated risk profiles. Prioritizing these communities ensures that wildfire mitigation not only protects infrastructure but also advances equity, safety, and resilience for all members.

3.6 Economic Impact

Wildfires have significant direct and indirect economic costs for North Star and our members. Direct impacts include infrastructure damage, service interruptions, and emergency restoration expenses. Indirect impacts include lost productivity, agricultural losses, disrupted tourism, and long-term effects on property values.

Wildfires can threaten croplands, irrigation systems, ranching operations, and recreational amenities, creating ripple effects across the service area. The WMP considers the importance of proactive investments in mitigation that reduce the likelihood of large-scale, high-cost events.

3.7 Emergency Preparedness and Resource

Effective wildfire mitigation requires emergency preparedness and coordination with partners at the local, state, and federal levels. North Star works closely with county emergency managers, volunteer fire departments, and regional mutual-aid networks to share information and plan coordinated responses which strengthens our ability to respond rapidly and effectively when wildfire events occur. North Star's preparedness strategy emphasizes:

- Pre-positioning crews and materials during high fire risk periods.
- Ensuring mutual-aid agreements are up to date.
- Training staff on incident command and emergency protocols.
- Training emergency responders on North Star infrastructure and how to handle powerlines during a wildfire.

Developing clear communication channels with members for warnings, Public Safety Power Shutoffs (PSPS), or restoration updates

4 Wildfire Preventative Strategies

North Star has adopted a proactive approach to wildfire prevention that combines weather awareness, equipment operations, vegetation management, infrastructure hardening, and community coordination. These strategies are designed to reduce the probability of ignitions, limit the spread of fire when it occurs, and minimize impacts on cooperative members and critical facilities. Preventative measures are guided by lessons learned from past outages, state and federal best practices, and ongoing engagement with regional partners.

4.1 Weather and Condition Monitoring

4.1.1 Current Practices

North Star does not currently consider or integrate real-time weather conditions in its operations.

4.2 Fuel and Vegetation Management

Vegetation management is one of the most effective strategies for reducing wildfire risk associated with electrical infrastructure. North Star's service territory includes a mix of forested lands, rangeland, agricultural fields, and rural communities which present unique vegetation challenges. By maintaining clearances around energized lines, removing hazard trees, and addressing brush and other fuels, North Star reduces the likelihood of tree or branch contact with energized equipment and minimizes the potential for ignition.

4.2.1 Current Practices

North Star's existing vegetation management approach ensures safe clearances, hazard tree mitigation, and cyclical right-of-way (ROW) maintenance. Key practices include:

- Clearance of 15 feet (on each side) is maintained between primary lines and any vegetation (per RUS guidance)
- Clearance of 3 to 5 feet is maintained (on each side) of service and secondary wires (600V and below) and guy wires.
- Normal right-of-way clearing occurs on a ten-year cycle.
- Any hazard trees that could strike primary or service lines must be either removed or safety zone topped (height reduced below strike potential). If immediate work is not possible, hazard trees are documented and flagged for follow-up.
- Any limbs or vegetation entering right-of-way from trees based outside the right-of-way are trimmed back to the edge of the right-of-way.
- Any trees planted in right-of-way are removed as soon as possible.

Full removals under lines are prioritized when permission can be obtained.

4.2.2 Planned Updates



Moving forward, North Star's goal is to install underground cable where possible, both for new installs and for replacement of overhead lines. This will eliminate the risk of fire ignition from vegetation encroachment in these corridors.

4.3 Inspection and Corrective Responses

Inspection and corrective responses are critical elements of wildfire prevention. Electrical equipment that is aging, damaged, or improperly functioning poses a higher risk of failure, and in fire-prone environments, such failures can translate into ignition.

4.3.1 Current Practices

North Star's current inspection and response practices include scheduled patrols, targeted inspections, and the use of specialized technologies:

- **Overhead Lines & Poles – Routine:** North Star Crews visually assess conductors, insulators, crossarms, and surrounding vegetation during annual routine inspections, typically in the first quarter of the year. Detailed inspections are performed periodically by a third-party pole testing company.
- **Underground Lines & Equipment – Routine:** Underground lines are inspected with a comprehensive visual check of all components every 8-10 years. These inspections may also involve thermographic inspections (using infrared cameras to identify hot spots indicative of deterioration) and detailed visual inspection of padmounted equipment such as transformers, pedestal and switches.
- **Special Inspections:** Additional inspections are performed after severe weather events to assess and repair damage, and following any reports of issues from the public or from internal systems or processes.
- **Substation monitoring:** Certain high-risk substation components are evaluated using infrared (IR) cameras, which help detect "hot spots" indicative of deteriorating connections, failing insulation, or potential overloads. Early detection of such conditions reduces the likelihood of equipment failure leading to ignition.

When issues are detected through patrols or inspections, North Star implements corrective responses ranging from immediate repair (e.g., hardware replacement, hazard tree trimming) to scheduling prioritized maintenance within a short turnaround.

4.3.2 Planned Updates



By combining traditional patrols with new monitoring tools, North Star is strengthening our ability to detect risks before they lead to failures, ensuring that corrective measures are applied quickly and effectively. This proactive inspection strategy directly supports the cooperative's overarching wildfire mitigation goals of reducing ignition potential, protecting member safety, and maintaining system reliability.

4.4 System Protection

System protection is essential to minimizing the risk of electrical faults leading to wildfire ignitions. North Star employs a combination of fast trip settings, advanced recloser technology, and SCADA integration to ensure that faults are detected quickly and cleared before they can cause heating, sparking, or ember generation.

4.4.1 Current Practices

Fast Trip Curves: All hydraulic and most electronic reclosers are set to use fast trip curves for their first operation, ensuring rapid clearing of faults. This minimizes the energy released during fault events and reduces ignition risk.

High-Impedance Fault Sensitivity: North Star uses a 40-ohm impedance for calculating minimum fault currents to ensure that high-impedance faults are detected and cleared. High impedance faults (such as broken conductors laying on the ground, tree limbs contacting lines under certain conditions, failed insulators causing current flow through pole hardware, etc.) can persist long enough to cause ignitions if protective device pickups are not sensitive enough to detect them.

Hot Line Tag (HLT) Mode: During line work: It is North Star policy to place reclosers into HLT mode whenever personnel are working on energized lines in a zone of protection. This causes reclosers to trip instantaneously, providing maximum safety for crews.

Expulsion Fuse Risks: A large portion of the North Star system is still protected by expulsion fuses. While reliable and economical, these devices expel hot gases during operation, which can ignite vegetation if clearances are insufficient. This further shows the importance of maintaining strict ROW management and vegetation clearance during high fire danger conditions.

Arc Flash Hazard: North Star's latest arc flash hazard assessment was completed in 2026. Based on North Star protection settings and working practices at the time of study completion, the highest available incident energy available on the primary overhead system at 15 inches from energized equipment is 10.8 calories per square centimeter for horizontal electrodes (for an arc that would persist for two full seconds), or 6.1 calories per square centimeter for vertical electrodes. It is possible that this level of heat energy persisting for two seconds could ignite nearby vegetation before the first protective device operation, particularly if another heat source is nearby (e.g. embers from something already burning). This applies only on two North Star feeders (Kabetogama feeder 1 and Williams feeder 4) whose feeder reclosers do not use fast curves. North Star's protection practices are intended to minimize risk to line workers by interrupting faults as quickly as possible even when HLT is not in use.

4.5 System Hardening

System hardening reduces ignition risks by improving the durability, reliability, and fire resistance of overhead infrastructure. North Star's hardening strategy focuses on replacing vulnerable assets and integrating modern materials that reduce the likelihood of conductor failures or vegetation contacts.

4.5.1 Current Practices

- **Conductor Replacement:** North Star replaces approximately five miles of small and aging overhead conductor each year. Older and undersized conductors are more prone to mechanical failure (e.g., breakage under wind, ice, or thermal stress) and thus creates higher wildfire ignition risk. Replacing these assets strengthens reliability while reducing exposure to failure-related sparks.

4.5.2 Planned Updates

As part of our long-term wildfire mitigation and capital planning efforts, North Star will continue to:

- Install underground conductors in place of overhead wherever possible.

4.6 Stakeholder and Member Engagement

North Star and PSE have coordinated with various agencies in the development of this Plan, including County-level emergency management offices, local Highway Patrols and Sheriff's offices, state and local agencies covering natural resources, Tribal councils, and Minnkota Power Cooperative.

Written agency feedback on the Plan document has been incorporated where appropriate. Verbal feedback and discussion during the stakeholder meeting was largely focused on increasing engagement between North Star and agencies, on identifying critical loads and customers, and on developing notification protocols for wildfire-related events.

4.6.1 Agency Engagement

North Star will take several actions to increase engagement and coordination, including:

- Develop a notification list and protocol for land managers, emergency managers, and other relevant agencies for wildfire-related actions and events

4.6.2 Critical Loads

North Star maintains a list of critical loads served by its system. To date, these have not been prioritized in any way.

North Star will work to create a prioritized list of these critical loads that can be used in restoration procedures following a system-wide wildfire event, and to work toward maintaining service to the highest degree possible during high-risk periods.

4.6.2.1 Medical Necessity

The Cooperative has customers that rely on electric service to power critical medical devices. North Star has a list of these customers with medical necessity note on their information in CIS, but knowledge of such necessity is dependent on the customer providing it when applying for service or later. Each county's Public Health Department also maintains a list of people with accessibility and/or functional medical needs; North Star's GIS team incorporates this data into its map and updates it annually, but this is also dependent on people notifying their Health Department.



North Star will continue to improve its knowledge of customers with medical necessities, through several possible avenues:

- Bill inserts asking members to notify the Cooperative of critical medical devices
- Social media campaign(s) asking for notifications and updates

North Star will also evaluate methods of sharing emergency medical information with first responders and other agencies; this may involve distribution of a consent form to members with medical devices and addition of a consent section to the application for service.

The goals of these actions are:

- Develop a critical, multi-channel notification protocol for those with medical equipment for PSPS events
- Ensure that all relevant parties are aware of those people with mobility or functional limits who may not be able to evacuate on their own during a wildfire event
- Ensure that all relevant parties are aware of those people who rely on uninterrupted electric service to power lifesaving or life-maintaining medical devices so they can be addressed quickly if PSPS is necessary

4.7 Mutual Aid

If a wildfire event were to occur, mutual aid agreements are in place between all Minnesota Cooperatives and Minnkota Power Cooperative (G&T) such that support would be available for emergency response and power restoration. North Star also has contractors that would be available for this purpose.

North Star has provided mutual aid assistance to other cooperatives in recent years and is prepared to do so in future events.

4.8 Public Safety Power Shutoff (PSPS) Considerations

Public Safety Power Shutoffs (PSPS) are a wildfire risk reduction tool used by utilities in high fire threat environments to proactively de-energize portions of the electric grid during periods of extreme fire danger. While disruptive, PSPS events can be an effective last line of defense to prevent catastrophic wildfire ignitions caused by electrical equipment.

4.8.1 Current Position

At present, North Star does not have a formalized PSPS program, as our wildfire risk profile has historically been addressed through protective settings, vegetation management, and system hardening. However, increasing fire risk across Minnesota and recent experiences in peer cooperatives have prompted North Star to begin evaluating the role of PSPS in our wildfire mitigation strategy.

4.8.2 Considerations for Implementation

If North Star were to adopt PSPS as a formal practice, there are several criteria to consider before implementation:



1. Determine Triggering Criteria such as:

- National Weather Service Red Flag Warnings or Extreme Fire Danger ratings.
- Sustained high winds (e.g., above 30 mph) combined with low relative humidity (<15%).
- Real-time observations of local fuel conditions (e.g., heavy drought stress, active fire nearby).
- Equipment or line conditions that increase ignition potential (e.g., temporary ROW encroachment).

2. Scope and Duration Criteria such as:

- PSPS would be limited to targeted circuits or feeders where risk is greatest, minimizing disruption.
- Duration would be kept as short as safely possible, with re-energization occurring immediately once conditions subside.

3. Member and Community Impacts such as:

- Recognizing that outages impact residents, farms, schools, hospitals, emergency responders, and businesses, North Star would carefully weigh the risks of keeping lines energized against the consequences of a shutoff.
- Critical facilities (e.g., hospitals, water systems, public safety facilities) would be identified and prioritized for notification, backup power coordination, and rapid restoration.

4. Communication and Notification Considerations such as:

- Establish multi-channel notification protocols (phone, text, email, website, social media, and local radio) to inform members of potential PSPS events in advance.
- Coordination with county emergency managers, fire districts, and first responders to align messaging and response actions.

5. Operational Readiness:

- Internal procedures would be developed to document decision-making, chain of command, and post-event review.

By carefully evaluating PSPS while continuing to prioritize vegetation management, inspection, and system hardening, North Star ensures it has a comprehensive toolbox of strategies to mitigate wildfire ignition risk. Any future PSPS policy would be implemented with the cooperative's core principles in mind: safety, reliability, transparency, and community trust. The table below summarizes the key benefits and challenges associated with adopting a Public Safety Power Shutoff (PSPS) program.

PSPS Benefits	PSPS Challenges
Reduces ignition risk during extreme fire danger by removing electrical sources of sparks.	Causes power outages that disrupt daily life for homes, farms, and businesses.
Protects communities and natural resources from catastrophic wildfire damage and liability.	Impacts critical facilities (hospitals, water systems, emergency responders) unless backup power is available.

Demonstrates proactive risk management and alignment with emerging wildfire best practices.	Requires significant investment in communication systems and member outreach to avoid confusion and mistrust.
Can be implemented quickly with North Star's existing SCADA control of feeder reclosers.	May generate member dissatisfaction if events occur frequently or with limited warning.
Provides an additional "last line of defense" when other measures (vegetation, hardening, inspections) are not sufficient.	Risks economic disruption to agriculture, tourism, and small businesses during outages.

5 Wildfire Risk Assessment Findings

The assessment evaluated wildfire exposure across Lake of the Woods, Koochiching, Roseau and St. Louis counties in the cooperative's territory, incorporating topography, fuel loads, vulnerable communities, and the location of electric infrastructure.

Data Sources and Rationale

The wildfire risk model was built using topographic and vegetation data, processed into derivative surfaces and weighted indices. Each input was chosen because of its demonstrated influence on fire behavior, as supported by wildfire science literature and national data programs.

Digital Elevation Model (DEM) - A basic map of land height. It shows how hills and valleys affect vegetation, climate, and the way fire moves across the land.

Source: USGS 3DEP (1/3 arc-second, ~10m resolution).

Why used: Provides the foundational topographic surface from which slope and aspect are derived. Elevation influences fuel type, microclimate, and fire spread potential.

Slope (derived from DEM)

Source: Derived from USGS DEM using GIS spatial analyst tools.

Why used: Fires spread more rapidly upslope, compared to flat land, due to convective heating of fuels above the flame front. Research shows fire spread can be multiple times faster on slopes of 15–35% compared to flat terrain.

Aspect (derived from DEM)

Source: Derived from USGS DEM using GIS spatial analyst tools.

Why used: Aspect influences solar exposure and fuel dryness. In the Northern Hemisphere, south-facing slopes are generally warmer and drier, making them more prone to ignition and sustained burning.

Weighted Slope

Source: Reclassified slope values.

Why used: Risk values were highest for moderate–steep slopes (15–35%) where spread potential is greatest, with lower risk assigned to flat terrain and very steep slopes where fuels are less continuous. This weighting aligns with fire behavior modeling literature.

Weighted Aspect

Source: Reclassified aspect values.

Why used: South-facing slopes were weighted higher to reflect their greater flammability due to higher solar radiation and lower fuel moisture.

Source: LANDFIRE 2022 Remap — Fire Behavior Fuel Model 40 (FBFM40).

Why used: Fuel models describe vegetation type and density, which strongly determine fire intensity and spread. Forests sustain higher intensity burns, while grass/shrub fuels ignite quickly and spread rapidly.

Weighted Fuel Model

Source: Reclassified LANDFIRE fuel model values.

Why used: Fuel types were converted into ordinal risk classes to allow integration with slope and aspect. Forests and dense shrub fuels received higher weights, while non-fuel surfaces such as urban and barren areas were weighted lowest.

Composite Risk Surface

- We layered together slope, sun exposure, and vegetation to make a single map showing where fire risk is highest. The composite output highlights areas where topographic conditions and fuels converge to create elevated wildfire potential. It enables prioritization of risk at the asset level when intersected with utility infrastructure data.
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Supporting Statistics and Visualization

While slope, aspect, and fuels formed the composite risk model, the results are further contextualized through visualization of related statistics:

- **Wildland–Urban Interface (WUI):** Overlaying risk surfaces with WUI boundaries highlights where fire exposure coincides with population centers and infrastructure.
 - **Substation and Feeder Statistics:** Aggregating risk scores by substation area and feeder line provides a utility-focused perspective, identifying high-risk circuits or assets.
 - **Additional Metrics (optional):** Other layers, such as historic fire perimeters or accessibility, may be incorporated to refine prioritization.
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Analysis Process

We used GIS mapping software and coding tools (Python Jupyter Notebook) to create a step-by-step process that can easily be updated when new data comes out. By combining the scripting power of Python with ArcGIS Pro's spatial tools, we created a workflow that is both powerful and user-friendly. Importantly, it can be reused and adapted across different study areas, allowing the utility to re-run the process when new datasets are released, or when weighting strategies are refined. This ensures that the wildfire risk model is not a one-time product, but a repeatable process.

1. **Data Acquisition:**

- USGS DEM and LANDFIRE FBFM40 datasets were acquired from authoritative federal sources.

2. **Pre-Processing:**

- DEM was projected and clipped to the utility boundary.
- Slope and aspect rasters were derived from DEM.
- Fuel models were clipped and reclassified to ordinal risk categories.

3. **Weighting:**

- Slope and aspect were reclassified with emphasis on conditions most conducive to fire spread (moderate slopes and south-facing aspects).
- Fuel models were reclassified to distinguish between high-intensity forest fuels, rapid-spread grass/shrub fuels, and low-risk non-fuel areas.

4. **Composite Model:**

- Weighted slope, weighted aspect, and weighted fuels were combined in a GIS environment using weighted sum analysis to produce a composite wildfire risk surface.
- In the subsequent charts, the higher the value, the higher the risk (i.e., 3 on the scale has the highest risk).

5. **Validation and Statistics:**

- Risk outputs were summarized by operational boundaries (substations, feeders).
- Overlay with WUI provided population and infrastructure context.

Vegetation Corridor Influence

Vegetation clearance along utility corridors plays a critical role in mitigating wildfire risk. The width of the corridor determines how effectively vegetation is separated from conductors, reducing the chance of ignition from sparks, equipment failure, or falling branches.

A 30-foot corridor may provide adequate clearance under normal conditions, but in areas of dense fuel, steep slopes, or prevailing high winds, this width may not be sufficient to slow or prevent fire spread. In contrast, a 60-foot corridor creates a more robust buffer, increasing the distance between fuels and electrical assets and reducing the likelihood that fire will bridge across the cleared zone. Wider corridors also improve access for inspection and suppression activities, supporting faster and safer emergency response.

Using GIS, these corridors can be modeled spatially by buffering line segments at different widths and overlaying them with fuel model, slope, and aspect data. This allows us to identify areas

where a 30-foot corridor intersects with high-risk conditions and flag them for potential expansion to 60 feet. By comparing corridor scenarios across the entire network, utilities can prioritize which sections of line present the greatest residual risk and where vegetation management resources will have the most impact.

This analysis provides a data-driven approach to right-of-way management, ensuring that corridor expansion decisions are based on quantifiable fire behavior drivers rather than uniform prescriptions.

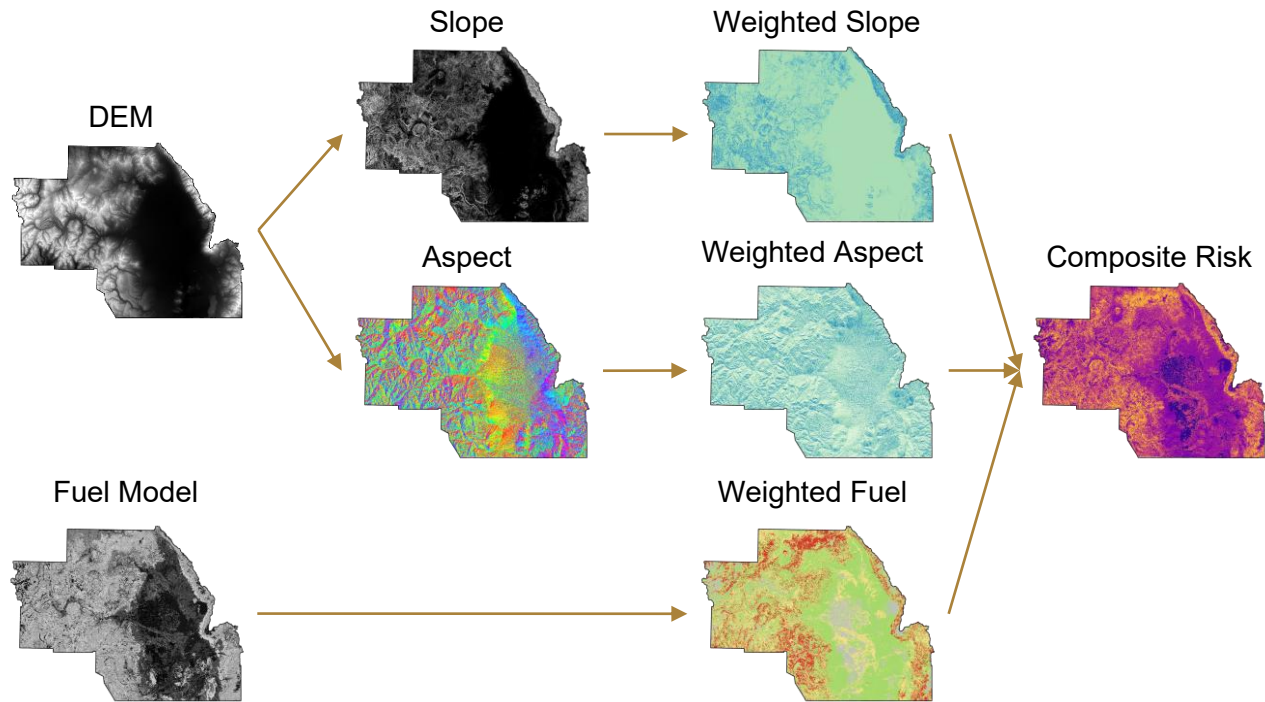


Figure 1: GIS process for generating composite risk output

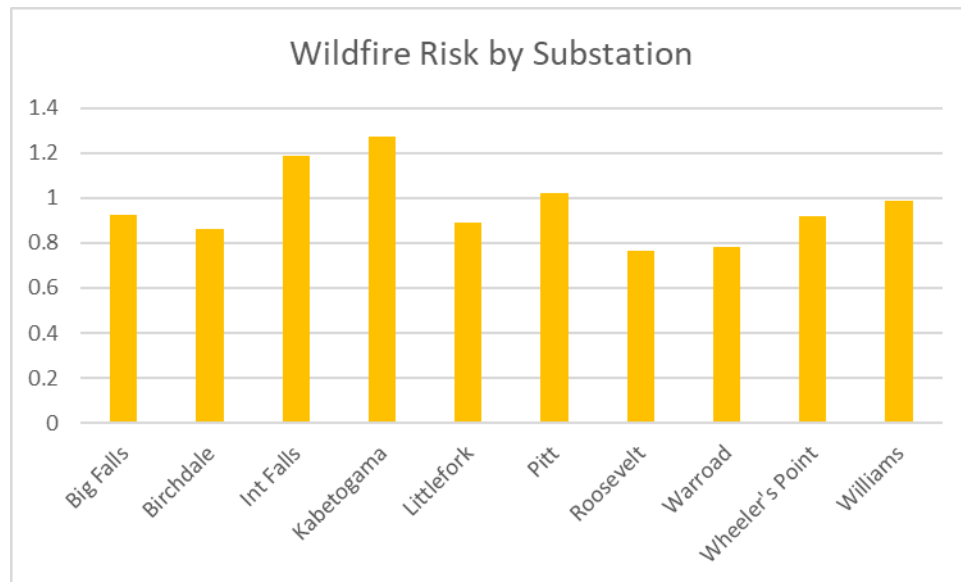
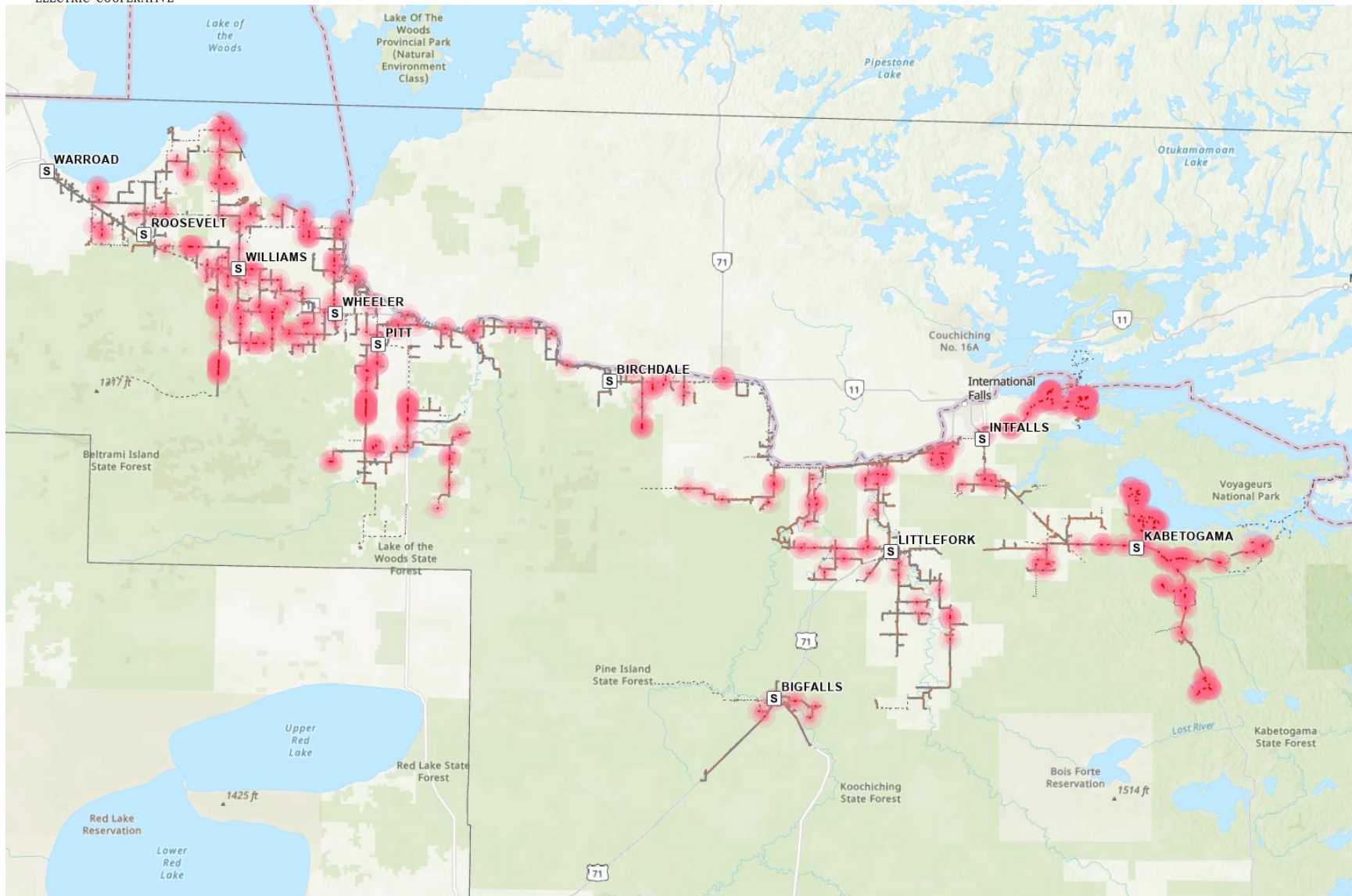




Figure 2 Example Corridors



6 Wildfire Mitigation Plan

This Wildfire Mitigation Plan (WMP) outlines a phased roadmap for North Star to minimize wildfire ignition risk, enhance infrastructure resilience, and strengthen community preparedness. The roadmap is structured across short-term (1–2 years), medium-term (2–5 years), and long-term (5+ years) actions. Each phase identifies priority mitigation activities, responsible parties, and estimated costs to ensure that implementation is both actionable and measurable.

6.1 Short-term (1-2 years) Roadmap

Focus: Immediate actions to reduce near-term wildfire risk, improve system monitoring, and establish foundational programs.

Action	Timeline	Responsible Party	Estimated Cost Range
Add risk assessment map and real-time weather data to GIS map and begin having dispatch evaluate daily conditions.	0-6 months	GIS Dept.	
Prioritize North Star's list of critical and high-risk customers and begin work on plans to maintain service to the degree possible, and for priority restoration following any PSPS	0-6 months		N/A
Develop notification protocols for local/regional agencies and the general public for wildfire-related events	6-12 months		
Update and train on emergency communications protocol for wildfire alerts.	1-2 years		N/A
Offer training to emergency personnel on North Star infrastructure	1-2 years		N/A
Conduct outreach with local emergency personnel teams	1-2 years	Covered by Training above	
Develop pilot PSPS decision protocol (draft criteria and notification systems).	1-2 years		N/A

6.2 Medium-term (2-5 years) Roadmap

Focus: Expansion of system hardening, advanced detection tools, and formalization of wildfire-specific operating practices.

Action	Timeline	Responsible Party	Estimated Cost Range
Replace hydraulic OCRs with electronic reclosers in high priority (forested) areas.	2-5 years	Engineering Manager	\$250K
Evaluate advanced high-impedance fault detection (e.g., SEL Arc Sense) on key feeders.	2-5 years	Engineering Manager	N/A
Implement GIS-based vegetation risk mapping integrated with inspections.	2-5 years	GIS Dept	N/A
Evaluate PSPS pilot outcomes and refine program for targeted implementation.	4-5 years		N/A
Conduct annual wildfire training exercises with county fire districts.	2-5 years		N/A

6.3 Long-term (5+ years) Roadmap

Focus: Large-scale infrastructure modernization, advanced analytics, and comprehensive wildfire mitigation integration into capital planning.

Action	Timeline	Responsible Party	Estimated Cost Range
Incorporate daily weather data into GIS risk assessment code & develop an algorithm to achieve automated protection profile changes and/or PSPS	5-10 years		N/A
Convert high-risk overhead segments to underground where feasible.	5-10 years		\$125,000/mile
Develop cooperative-wide PSPS policy.	8-10 years		N/A
Expand mutual-aid partnerships and shared resource agreements for wildfire response.	5-6 years		N/A
Incorporate wildfire risk modeling into long-term capital investment plan.	8-10 years		N/A