Outdoor Heritage Fund Grant Application

Instructions

After completing the form, applications and supporting documentation may be submitted by e-mail to ndicgrants@nd.gov. It is preferred that only electronic copies are submitted.

You are not limited to the spacing provided, except in those instances where there is a limit on the number of words. If you need additional space, please indicate that on the application form, answer the question on a separate page, and include with your submission.

The application and all attachments must be received by the application deadline. You may submit your application at any time prior to the application deadline. **Applicants are strongly encouraged to submit applications prior to the deadline for staff review in order ensure that proposals will be complete when submitted on deadline date.** Incomplete applications may not be considered for funding.

Please review the back of this form to determine project eligibility, definitions, budget criteria, and statutory requirements.

Project Name: TRPL Prairie Enhancement Land Management Phase 1

Name of Organization: Theodore Roosevelt Presidential Library Foundation

Federal Tax ID#: 47-1324043

Contact Person/Title: Kelli Gardner, Corporation and Foundation Relations Associate

Address: 350 Third Ave

City: Medora

State: ND

Zip Code: 58645

E-mail Address: kelli@trlibrary.com

Web Site Address (If applicable): https://www.trlibrary.com/

Phone: 203-470-8504

List names of co-applicants if this is a joint proposal

MAJOR Directive:

Choose only one response

O **Directive A**. Providing access to private and public lands for sportsmen, including projects that create fish and wildlife habitat and provide access for sportsmen;

O **Directive B**. Improving, maintaining and restoring water quality, soil conditions, plant diversity, animal systems and by supporting other practices of stewardship to enhance farming and ranching;

☑ **Directive C**. Developing, enhancing, conserving and restoring wildlife and fish habitat on private and public lands; and

O **Directive D**. Conserving natural areas and creating other areas for recreation through the establishment and development of parks and other recreation areas.

Additional Directive:
Choose all that apply

O **Directive A**.
☑ **Directive B**.
O **Directive C**.
☑ **Directive D**.

Type of organization:

O State Agency

O Political Subdivision

O Tribal Entity

☑ Tax-exempt, nonprofit corporation.

Abstract/Executive Summary.
Summarize the project, including its objectives, expected results, duration, total project costs and participants. (no more than 500 words)

The TRPL is pursuing an ambitious and significant prairie restoration project, which consists of collecting seed of local genetic origin for over 100 species of plants indigenous to the TRPL site, but for which seed volume and local genetics is limited. Many of these plants are not commercially available and are diminished in number in the western ND wild. After these seeds are collected, they will be cleaned and tested and then planted in nurseries in order to produce hearty native plants. Some of these plants will be transferred as plugs to the TRPL site while others will have their seeds harvested and then those seeds will be broadcast on site. This will result in a landscape that is populated with all native, genetically sourced plants. A project like this has never been done before in ND. These native seeds will be available for others going forward. Our big picture objectives will be to restore and replenish the native ecosystems of the existing Badland plant communities, increase the availability of indigenous seed with local genetics of western ND prairie, create an outdoor public space that will provide opportunities for recreation and renewal for local communities, and finally, be a living classroom and sustainability exemplar to inspire, educate, and motivate others to find ways to live more sustainably. Expected results for this project are a restoration of ecological balance and

increased biodiversity of the grassland landscape with healthy soils that supports human use as well as animal biodiversity, habitat, and livestock grazing and engaged local community and stakeholders, who find that the TRPL is not only a good neighbor but an accessible and restorative place to recreate. There will be a trailhead on site that will connect with the Maah Daah Hey Trail for hikers, horseback riders, and mountain bikers. We expect the TRPL to be among the most visited public parks in ND (all outdoor spaces at TRPL will be open to the public) and one of the most sustainable museums in the world. Another result of this project is the contribution of research about western ND prairie plants and availability of local and indigenous seed, which is currently not commercially available. Project duration for this phase is June 2023 to August 2024. Total project costs for this first phase are $1,345,185 which includes growing the native plants, weed control on site, restoring the firebreak scar, creating the trailhead structure and berm and the crushed aggregate trail, and installing wildlife-friendly cattle fencing. There are many who are participating in this important work. Local landowners, Theodore Roosevelt's Ranchlands, and the United States Forest Service are all important partners for collecting the local, indigenous plants. NDSU Research Extension Center in Hettinger will house and cultivate the native plants. RES, our ecologists, along with Snøhetta and Confluence make up our site design team. JE Dunn is our construction manager and will manage the installation of the plants. We hope the Outdoor Heritage Fund will be a partner in this project.

Project Duration:
Indicate the intended schedule for drawing down OHF funds.

This project is focused on the first phase of work in enhancing and replenishing the land surrounding the TRPL as we prepare for and begin construction. This phase of enhancement work will occur primarily between June 2023 and August 2024. Of course, these efforts in responsible and sustainable land management will be ongoing and a key aspect of the TRPL's day-to-day operations. We anticipate needing the majority of the requested funds in late summer 2023.

Amount of Grant request: $939,105

Total Project Costs: $1,345,185
Note: in-kind and indirect costs can be used for matching funds.

Amount of Matching Funds: $406,080
A minimum of 25% Match Funding is required. Indicate if the matching funds will be in-kind, indirect or cash. Please provide verification that these matching funds are available for your project. Note that effective as of July 1, 2015 no State General Fund dollars can be used for a match unless funding was legislatively appropriated for that purpose.

Amount of Match	Funding Source	Type of Match (Cash, In-kind or Indirect)

$2,480	Billings County	In-kind
$3,600	NDSU	In-kind
$400,000	TRPL	cash
$		
$		
$		

Certifications

☑ I certify that this application has been made with the support of the governing body and chief executive of my organization.

☑ I certify that if awarded grant funding none of the funding will be used for any of the exemptions noted in the back of this application.

Narrative

Organization Information – Briefly summarize your organization's history, mission, current programs and activities.

Include an overview of your organizational structure, including board, staff and volunteer involvement. (no more than 300 words)

We are building a presidential library and museum for Theodore Roosevelt in Medora, ND. Our mission is to explore the life, legacy, and enduring relevance of our 26th president. We have a vision for a presidential library that speaks to the staggering beauty of the Western American landscape, 19th-century American virtues, and fully interactive and digital 21st-century presentation. This is a concept that we hope will inspire bold action and fearless participation *in the arena* and challenge all of us to dare greatly, think boldly, live passionately, and care deeply, just like TR. Practical progress toward realizing the TRPL includes raising over $200M since 2018, unlocking a $50M endowment from the North Dakota Legislature to support our ongoing operations, the retaining of our architect Snøhetta, our decision to construct the facility as part of the Living Building Challenge, a carbon-neutral designation, and the official acquisition of 93.8 acres of land adjacent to Theodore Roosevelt National Park in Medora in June 2022. The dramatic landscape of the Badlands, striking in natural beauty, was

restorative to TR. Our design concept marries with the Badlands topography and facilitates a conservation ambition, while also including a contradiction like TR—landscape in harmony with a bold vision. It promotes biodiversity, conservation, and stewardship of the land. Deep in our conceptual thinking is a model of self-reliance that uses no more than it takes. It is a concept that leapfrogs baseline building code specifications as well as best practices of peer institutions, boasting the top category LEED Platinum certification. Upon opening, we expect net-zero energy, carbon emissions, and water with full habitat restoration. By 2032, we aim to achieve net-zero waste as well. Groundbreaking for the building is expected in 2023 and the anticipated grand opening is on July 4, 2026—the 250th anniversary of America. We have 15 board members, 16 full-time staff, 4 part-time staff, and 1 very-involved volunteer.

Purpose of Grant – Describe the proposed project identifying how the project will meet the specific directive(s) of the Outdoor Heritage Fund Program

Identify project goals, strategies and benefits and your timetable for implementation. Include information about the need for the project and whether there is urgency for funding. Indicate if this is a new project or if it is replacing funding that is no longer available to your organization. Identify any innovative features or processes of your project. Note: if your proposal provides funding to an individual, the names of the recipients must be reported to the Industrial Commission/Outdoor Heritage Fund. These names will be disclosed upon request.

For tree/shrub/grass plantings: provide a planting plan describing the site design, planting methods, number of trees/shrubs by species and stock size, grass species and future maintenance. A statement certifying that the applicant will adhere to USDA-NRCS tree/shrub/grass planting specifications along with the name of the governmental entity designing the planting may be substituted for a planting plan.

For projects including Section 319 funding: provide in detail the specific best management practices that will be implemented and the specific projects for which you are seeking funding.

For projects including fencing: A minimum cost share of 40% by the recipient is preferred. Include detailed information on the type of fencing to be installed, whether funding is requested for boundary fencing, new or replacement of existing fencing, and/or cross fencing.
~~~

Theodore Roosevelt had a powerful vision of sustainability in his time: he embraced conservation and helped to expand the nation's national parks, forests, and bird reserves. To be truly sustainable today, however, we must—as TR would—dare to go above and beyond. The TRPL will enhance conservation practices in North Dakota, both through our own sustainable choices and ongoing operations as well as through the model of sustainability we will provide to others. Recognizing the prime importance of the Badlands to TR's story, we begin from the premise that the Library is the landscape and cannot be thought of as separate entities. This concept promotes biodiversity, conservation, and stewardship of the land upon which the Library is built. The TRPL was specifically designed to function in harmony with the unique ecology surrounding it. As part of those efforts, the TRPL is embarking on a prairie enhancement and land management program that will enhance habitat for pollinators and wildlife and improve soil conditions. The site design is focused on managing the land to restore and replenish native ecosystems. Practices such as grazing and prescribed burns will be designed into the Library's calendar as regular ecological events. This environmental stewardship will help manage invasive species, encourage biodiversity, and promote healthy ecosystems across the site for visitors to observe and enjoy. The design of the Library will be carefully planned to minimize negative impact to the landscape and existing site systems.
~~~

In this first stage of work we are focusing on restoring indigenous plants to our site and preparing the land for grazing. Decades of human activity have diminished the diversity of native ND Badlands prairie species, including rare and endangered plants. Moreover, we have found that very few of these native species are even available for purchase commercially. And the few that are available, have not been grown in western ND; plants grown from these seeds would be native to North Dakota's Badlands but not genetically related. Therefore, the TRPL, in partnership with ecologists and local stakeholders, is collecting and cultivating native seeds to grow these unique plants on site, helping to restore ecological balance and increase biodiversity in this striking grassland landscape.

Enhancement of the grasslands at TRPL will improve habitat for many bird species that Theodore Roosevelt observed during his time in North Dakota. Roosevelt described the North Dakota state bird, the Western Meadowlark, as "The meadow lark is a singer of a higher order, deserving to rank with the best. Its song has length, variety, power and rich melody; and there is in it sometimes a cadence of wild sadness, inexpressibly touching." Unfortunately, the meadowlark is declining at a rate of 1.3% annually in North Dakota. It is listed as a Species of Conservation Priority in the North Dakota State Wildlife Action Plan (https://gf.nd.gov/wildlife/swap), the state's principal document for safeguarding rare and declining species. Meadowlarks are synonymous with cattle pastures. Prescribed grazing at TRPL will be crucial to maintaining healthy grasslands and grassland structure that meadowlarks prefer for nesting.

Another endemic grassland bird which has declined significantly but may benefit from the grassland enhancement efforts at TRPL is the Sprague's Pipit. This species, which breeds only in a small portion of the Northern Great Plains, has declined 75% since 1970 (Rosenberg et al. 2016, https://partnersinflight.org/resources/the-plan/). The pipit is a secretive, nondescript, small grassland bird that is not readily seen like the Western Meadowlark. However, the bird's song is unmistakable, and unforgettable to those who have witnessed it. During Roosevelt's time, the Sprague's Pipit was referred to as the Missouri Skylark. His description perfectly describes this legendary bird "Sometimes in the early morning, when crossing the open, grassy plateaus, I have heard the prince of them all, the Missouri skylark. The skylark sings on the wing, soaring overhead and mounting in spiral curves until it can hardly be seen, while its bright, tender strains never cease for a moment."

Other birds listed as Species of Conservation Priority in the North Dakota Wildlife Action Plan that may benefit from grassland enhancement at TRPL include: American Kestrel, Baird's Sparrow, Bobolink, Chestnut-collared Longspur, Grasshopper Sparrow, Lark Bunting, Loggerhead Shrike, Long-billed Curlew, Sharp-tailed Grouse, Sprague's Pipit, Upland Sandpiper, and Western Meadowlark. Other reptile, mammal and insect Species of Conservation Priority include Plains Spadefoot, Short-horned Lizard, Big Brown Bat, Little Brown Bat, Long-eared Bat, Long-legged Bat, Merriam's Shrew, Northern Long-eared Bat, Merriam's Shrew, Sagebrush Vole, Swift Fox, Townsend's Big-eared Bat, Western Small-footed Bat, Monarch Butterfly, and Regal Fritillary.

We understand that this prairie enhancement work is a long-term project that will be ongoing for many years and require the support and insight of local and expert partners. Following the advice and feedback we received from the Outdoor Heritage Fund Advisory Board last Fall, TRPL has decided to focus our efforts on moving the native seed development forward with our partners. Since last fall, TRPL managed to collect and clean the seeds from the Little Missouri Badlands region through the help of many volunteers and the support of a few generous benefactors. We have also found a capable and knowledgeable partner in Ben Geaumont. Dr. Geaumont will own and grow the native plants at the NDSU Hettinger Research Extension Center until they are ready to be harvested for healthy seed to be planted on site.

What we are asking Outdoor Heritage Fund's help with in this phase of work is the following:

1. Help supporting the vital work of NDSU in housing and cultivating the native plants (specifically: labor and transportation of the plugs to the NDSU facility), as well as supporting the production of new plugs for recovering crop loss at NDSU in 2024.
2. Help supporting construction of the trailhead that will connect to the Maah Daah Hey Trail for hikers, horseback riders and mountain bikers.
3. Preparing and seeding areas of TRPL's site that need attention before construction, specifically restoring the scar resulting from the fire break (earthwork, grading, seed purchase, labor, irrigation) and creating and planting the trailhead berm (seed purchase and earthwork), which will protect the site from artificial light spilling into the landscape.
4. Weed control (herbicide) on TRPL's site to protect the native plants when they are installed.
5. Installing wildlife-friendly cattle fencing, both permanent and temporary that will be necessary to implement our long-term grazing plan, which is vital to prairie management and ongoing maintenance of a healthy ecosystem.

The work outlined here will all take place approximately between June 2023 and August 2024.

The TRPL will not only be a place where visitors can learn about and from the life and lessons of Theodore Roosevelt, it will also be one of the most sustainable museums in the world. Central to our sustainability goals is to lead by example and be a resource for others. We will educate our visitors about our ongoing prairie enhancement and sustainable land management techniques, serving in a sense as a small nature center. All of TRPL's outdoor spaces, including our large, occupiable, green roof, will be publicly accessible year-round upon opening. The vision for the TRPL is bold, innovative, and transformative—especially for North Dakota. As a result, there is an urgency for enthusiastic local support. Outdoor Heritage Fund's partnership is vital to the success of the project.

Is this project part of a Comprehensive Conservation Plan? ☑ Yes ☐ No.
YES
If yes, provide a copy with the application.
Note: Projects involving buildings and infrastructure will only be considered if part of a Comprehensive Conservation Plan. Please refer to the "Definitions" section at the back of the form for more details.

Management of Project – Provide a description of how you will manage and oversee the project to ensure it is carried out on schedule and in a manner that best ensures its objectives will be met.
Include a brief background and work experience for those managing the project.

We have a talented collection of partners who are helping us achieve this work. Our site design team is made up of Resource Environmental Solutions (RES), Confluence, and Snøhetta. RES is the nation's largest ecological restoration company. Confluence is a landscape architecture, planning, and urban design firm. Snøhetta is a world-renowned Norwegian and U.S. based architecture and design firm. Together, these three teams have designed and will implement our prairie enhancement project. In addition to our site design team, JE Dunn is our construction manager, and Sherwood and AE2S are our civil engineers.

Benjamin Geaumont is our partner at NDSU and prairie enhancement consultant. He has been a wildlife and range science research assistant professor at the Hettinger Research Extension Center since 2011. Originally from Deering, New Hampshire, he holds a BS degree in Biology from Keene State College and MS and PhD degrees in natural resources management from NDSU. After completing his PhD, he worked as a post-doc at the HREC. In 2011, a multiple land use position was funded by the

ND legislature as part of the Soil Health Initiative. He applied and was offered the job which is his current position. Geaumont is responsible for the development of the Multiple Land Use program at the HREC which includes conducting research projects, writing manuscripts, mentoring both undergraduate and graduate students, as well as securing funds for future research projects. Geaumont's main research goal is to provide stakeholders with information to help them better manage the land for multiple uses; essentially providing applicable knowledge that will be useful for the management of natural resources. With a limited land base and many demands placed upon it, the idea behind the research is to help meet these demands through applied research.

These teams are overseen by TRPL's Design and Construction team led by Tony Erickson and Ken Vein. Tony is our Associate Director of Design and Construction. He has 18 years of experience in the design and construction industry. Over the past 9 years, Tony served as facility manager of a large healthcare system, where he managed over 500 million dollars of capital projects. Ken Vein is our Director of Design and Construction. For nearly 20 years, Ken served as a Senior Leader and as Administrative Director of Plant and Facilities for Altru Health System in Grand Forks, ND. Before that, Ken was the City Engineer and Public Works Director for the City of Grand Forks. He also served as program manager for the construction of the Alerus Center and Tri-Chair for Recovery following the devastating Red River flood in 1997. During flood recovery, Ken oversaw rehabilitation of all public infrastructure and implementation of permanent flood protection, working directly with the Corps of Engineers, FEMA, and Geological Survey. TRPL is coordinating all the partners on this project and ensuring consistent progress through regular meetings and tracking of project milestones. This prairie enhancement project is occurring simultaneously with the construction of the TRPL building and is a key part of that larger project. Before TRPL opens, we plan to add a full-time position that will be dedicated to overseeing our ongoing sustainable land management work.

Evaluation – Describe your plan to document progress and results.

Please be specific on the methods you will utilize to measure success. Note that regular reporting, final evaluation and expenditure reports will be required for every grant awarded.

As the TR Library has many precedent-setting sustainability goals that we are pursuing, evaluation of our success and documentation of our progress and process is a top priority. We hope to achieve and go beyond LEED Platinum, SITES Platinum, and the full Living Building Challenge Certification—all of which require detailed evaluation and reporting and will be clear markers of achieving our sustainability goals.

For our native plant project, we have specific goals and expectations, which have been laid out for us by our ecologists. These goals pertain to the native plant project as a whole and not just the phase 1 work that we have focused this application on.

Seed Collection (2023, 2024) - The measure of success is to meet the target seed quantities and number of native species with wild seed collections spanning two years. We need 700-800 pounds of pure live seed for all plantings, with about 30 percent of that in the first phase of the project. We are striving to collect 100-150 species of plants native to North Dakota rangeland and that grow near the Library site. The actual quantities and number of species depend on the amount of rainfall, plant distribution and rarity, and other uncontrollable factors.

Expansion of Seed Availability (2023, 2024) - The measure of success is to meet the number of live plants needed to establish nursery beds at NDSU nursery facilities, in order to harvest in 2023 and 2024 additional quantities of seed of species that are hard to collect or that make up an important component of the seed mixes being planted at the Library site. We are targeting 30-35 species of native North Dakota rangeland plants, with the goal of providing about 35,000 live plants to be installed in

NDSU nursery beds. The harvested amount from mature nursery beds is estimated to be 100 pounds per acre of nursery beds, and the nursery beds may occupy up to four acres of ground. However, harvest depends on weather conditions and the speed at which the beds mature, so the actual amount harvested from beds may be less than the estimated amount.

Native Prairie Seeding and Planting at the Library site (2024, 2025) - The measure of success is to seed the required acreage and plant the required number of live plants in order to complete the planting plans at the Library site. Approximately 33 acres will be seeded in the first phase of the Library project, and at least 200,000 live plants will be installed on the roof, in the stormwater management areas, and other special locations of the site. Standard requirements for survivorship have not been set, but typically live plant survival should be greater than 90% at one year after planting, and seeded areas should support at three years after seeding over half the species that were planted.

Financial Information

Project Budget – Use the table below to provide an itemized list of project expenses and describe the matching funds being utilized for this project.
Indicate if the matching funds are in the form of cash, indirect costs or in-kind services. The budget should identify all other committed funding sources and the amount of funding from each source. **A minimum of 25% match funding is required.** An application will be scored higher the greater the amount of match funding provided. (See Scoring Form.)

Certain values have been identified for in-kind services as detailed under "Budget Information" at the back of this form. Refer to that section and utilize these values in identifying your matching funds. **NOTE: No indirect costs will be funded. Supporting documentation for project expenses, including bids, must be included or application will be considered incomplete.**

Project Expense	OHF Request	Applicant's Match Share (Cash)	Applicant's Match Share (In-Kind)	Applicant's Match Share (Indirect)	Other Project Sponsor's Share	Total Each Project Expense
Weed Control	$5,000	$ 5,000	$2,480	$	$	$12,480
Firebreak Scar	$35,951	$30,000	$	$	$	$65,951
Native Plants at NDSU	$123,087	$	$3,600	$	$	$126,687
Trailhead Structure	$413,819	$200,000				$613,819
Trailhead Berm	$97,002	$50,000				$147,002
Crushed Aggregate Trail	$242,334	$100,000	$	$	$	$342,334
Cattle Fencing	$21,912	$15,000	$	$	$	$36,912
	$	$	$	$	$	$
Total Costs	$ 939,105	$ 400,000	$6,080	$	$	$1,345,185

Note: Costs for seeding, fencing, pipelines, wells, and cover crops cannot exceed NRCS Field Office Tech Guide without justification. Projects involving perimeter fencing must follow NRCS eligibility standards.

Budget Narrative – Use the space below to provide additional detail regarding project expenses.

Weed Control:
Prairie Land Consulting out of South Dakota will be providing us with the herbicide necessary to eradicate noxious weeds (as dictated by ND State Law). They will spot spray in the spring (not in budget) and again in the fall of 2023, and continue in subsequent years. The estimated cost for the fall is $10,000, which includes both the cost of the chemical as well as the labor.
Billings County provided $2,480 of in-kind support in the form of the labor and supplies necessary to collect and release the beetles on TRPL's site as biocontrol agents. Labor: 7 people for 4 hours at $15/hour ($420). Supplies: $200. This will be done 4 times June-July 2023-2024.

Restoration of Firebreak Scar:
We have contracted with Midwest Erosian Control, located in Dickinson, ND, to do this work. Breakdown of costs: $58,462 for the specialized labor to do the earthwork. $3,589 to purchase the native seed (for about 1 acre of land). $3900 for the labor for establishment and irrigation.

Native Plant Nursery at NDSU:
We have contracted with Dr. Ben Geaumont and his team at NDSU Hettinger Research Extension to house and cultivate the native plants until they are ready to be harvested for healthy seed that will be planted on site. Our ecologists, RES, collected, cleaned, and propagated the wild collected seed. In June these plugs will be transported from the RES Greenhouse in Wisconsin to NDSU. This transportation cost is $19,000. We are purchasing these plugs from RES (36,000 plugs) for $28,529.12. NDSU labor for 2023-2024 is $60,000. We are estimating a need for a 30% refill to cover crop failure, which would be $15,558 paid to RES for purchase and shipment of these plugs. NDSU has offered labor and land in-kind: Dr. Geaumont's consulting on the project (approximately 80 hours at $30/hour) for $2,400. NDSU is not charging us for the use of the land where the native plants will grow approximately 2 acres for 12 months between 2023 and 2024, (estimating $50/acre/month): $1200.

Trail, Trailhead and Berm:
Trailhead structure cost breakdown: Excavation $12,614, Structure $83,047, Enclosure $460,168, Carpentry $20,418, Roofing $34,295, Paint $3,277.

Trailhead Berm cost breakdown: Fill $53,363, Planting Soil Type 1 $25,900, Plug Mixture Type 3: $67,739. We have contracted with Midwest Erosian Control, located in Dickinson, ND, to do this work.

The Crushed Aggregate Trail will cross the property to join up to the Maah Daah Hey Trail: $342,334.

Wildlife-Friendly Cattle Fencing:
We will install 8,372 ft of linear foot barb wire to help facilitate our grazing plans. The supplies for fencing is $30,092. The labor to install fencing is $6,820. A TRPL benefactor will pay $15,000 of the fencing.

TRPL's Match Share
With generous support from our benefactors, TRPL will manage to cover $400,000 (i.e., 30% of the total project cost) of this first phase of prairie enhancement work. In the budget above we have spread this out across the budget items, but this can be allocated however best to suit all parties.

Sustainability – Indicate how the project will be funded or sustained in future years.
Include information on the sustainability of this project after OHF funds have been expended and whether the sustainability will be in the form of ongoing management or additional funding from a different source.

The TRPLF believes that "nonprofit" is a tax status, not a business plan. Not only are we the beneficiaries of a $50M sustaining endowment set up by the State of North Dakota to help with ongoing operating costs, but we are also counting on various revenue streams, from venue rental to corporate sponsorships, to offset future fundraising efforts in the long term. Our long-term plan for sustaining our land management and prairie enhancement work does involve future fundraising, but specifically to sponsor an Ecology Enhancement Endowment fund. This endowment would provide ongoing support for continued landscaping costs, including an onsite ecologist and/or an interpretive guide, as well as groundskeeping, composting programs, and educational programs related to Land Ecology Enhancement. Our plans to fundraise for this endowment reflect how vital we feel ecological enhancement and education are to our mission and sustainability ambitions.

Partial Funding – Indicate how the project will be affected if less funding is available than that requested.

If we receive only partial funding for this project from the OHF, we will likely continue with the project but may have to do it on a smaller scale and/or over a longer period of time, unless other funding can be secured. We would be so grateful for the contribution of the Outdoor Heritage Fund. We are eager, in fact, to involve every North Dakota-focused funder, as we understand our project to be beneficial for the entire state, and beyond. Moreover, Outdoor Heritage Fund's endorsement and partnership will no doubt attract more North Dakota benefactors to this important work.

Partnership Recognition - If you are a successful recipient of Outdoor Heritage Fund dollars, how would you recognize the Outdoor Heritage Fund partnership? * ***There must be signage at the location of the project acknowledging OHF funding when appropriate.***

We would honor and recognize a gift from the Outdoor Heritage Fund with physical naming in both signage on site as well as in our related publicity materials. While we would need to work out specifics in terms of location of this signage and wording, with full funding the Outdoor Heritage Fund would be an important supporter of the first stage of our prairie enhancement and land management work. TRPL would be honored to have the Outdoor Heritage Fund as a named supporter of our project that we believe is vital to the conservation efforts of the state of North Dakota.

Awarding of Grants - Review the appropriate sample contract for your organization on the website at http://www.nd.gov/ndic/outdoor-infopage.htm.

Can you meet all the provisions of the sample contract? ☑ Yes ☐ No YES

If there are provisions in that contract that your organization is unable to meet, please indicate below what those provisions would be:

~~~~~~~~~~~~~~~~

ABOUT OHF:

The purpose of the North Dakota Outdoor Heritage Fund is to provide funding to state agencies, tribal governments, political subdivisions, and nonprofit organizations, with higher priority given to projects that enhance **conservation** practices in this state by:

Directive A. Providing access to private and public lands for sportsmen, including projects that create fish and wildlife habitat and provide access for sportsmen;

Directive B. Improving, maintaining and restoring water quality, soil conditions, plant diversity, animal systems and by supporting other practices of stewardship to enhance farming and ranching;

Directive C. Developing, enhancing, conserving and restoring wildlife and fish habitat on private and public lands; and

Directive D. Conserving natural areas and creating other areas for recreation through the establishment and development of parks and other recreation areas.

EXEMPTIONS

Outdoor Heritage Fund grants may not be used to finance the following:

- Litigation;
- Lobbying activities;
- Any activity that would interfere, disrupt, or prevent activities associated with surface coal mining operations; sand, gravel, or scoria extraction activities; oil and gas operations; or other energy facility or infrastructure development;
- The acquisition of land or to encumber any land for a term longer than twenty years; or
- Projects outside this state or projects that are beyond the scope of defined activities that fulfill the purposes of Chapter 54-17.8 of the North Dakota Century Code.

OHF funds may not be used, except after a finding of exceptional circumstances by the Industrial Commission, to finance:

- A completed project or project commenced before the grant application is submitted;
- A feasibility or research study;
- Maintenance costs;
- A paving project for a road or parking lot;
- A swimming pool or aquatic park;
- Personal property that is not affixed to the land;
~~~~~~~~~~~~~~~~

- Playground equipment, except that grant funds may be provided for up to 25% of the cost of the equipment not exceeding $10,000 per project and all playground equipment grants may not exceed 5% of the total grants per year (see Definitions/Clarifications for how this will be calculated);
- Staffing or outside consultants except for costs for staffing or an outside consultant to design and implement an approved project based on the documented need of the applicant and the expenditures may not exceed 5% of the grant to a grantee if the grant exceeds $250,000 and expenditures may not exceed 10% of the grant to a grantee if the grant is $250,000 or less (see Definitions/Clarifications for how this will be calculated);
- A building except for a building that is included as part of a comprehensive conservation plan for a new or expanded recreational project (see Definitions/Clarifications for definition of comprehensive conservation plan and new or expanded recreational project); or
- A project in which the applicant is not directly involved in the execution and completion of the project.

The goal of the Industrial Commission is that at a minimum 15% of the funding received for a biennium will be given priority for recreation projects that meet Directive D.

The following projects are not eligible for funding, unless there is a finding of exceptional circumstances by the Industrial Commission include:

- Construction or refurbishment of indoor/outdoor ice rinks,
- Construction or refurbishment of indoor/outdoor athletic courts and sports fields,
- Other substantially similar facilities.
- Infrastructure that is not part of a comprehensive conservation plan.
- Projects not meeting a minimum funding request of $2,500.

Budget Information

In-kind services used to match the request for Outdoor Heritage Fund dollars shall be valued as follows:

• Labor costs	$15.00 an hour
• Land costs	Average rent costs for the county as shown in the most recent publication of the USDA, National Agricultural Statistics Services, North Dakota Field Office
• Permanent Equipment	Any equipment purchased must be listed separately with documentation showing actual cost. (For example: playground equipment)
• Equipment usage	Actual documentation
• Seed & Seedlings	Actual documentation
• Transportation	Mileage at federal rate
• Supplies & materials	Actual documentation

More categories will be added as we better understand the types of applications that will be submitted. We will use as our basis for these standards other State and Federal programs that have established rates. For example, the North Dakota Nonpoint Source Pollution Management Program has established rates. If your project includes work that has an established rate under another State Program, please use those rates and note your source.

Definitions/Clarifications:

Building - Defined as “A structure with a roof either with walls or without walls and is attached to the ground in a permanent nature.”
Comprehensive Conservation Plan - Defined as “A detailed plan that has been formally adopted by the governing board which includes goals and objectives--both short and long term, must show how this building will enhance the overall conservation goals of the project and the protection or preservation of wildlife and fish habitat or natural areas.” This does not need to be a complex multi-page document. It could be included as a part of the application or be an attachment.
New and Expanded Recreational Project means that the proposed building cannot be a replacement of a current building. The proposed building must also be related to either a new or expanded recreational project--either an expansion in land or an expansion of an existing building or in the opportunities for recreation at the project site.
Playground equipment calculation - Only the actual costs of the playground equipment (a bid or invoice showing the amount of the equipment costs must be provided) - cannot include freight or installation or surface materials or removal of old equipment, etc.
Staffing/Outside Consultants Costs - If you are requesting OHF funding for staffing or for an outside consultant, you must provide information in your application on the need for OHF funding to cover these costs. For example, if you are an entity that has engineering staff you must explain why you don’t have sufficient staff to do the work or if specific expertise is needed or whatever the reason is for your entity to retain an outside consultant. If it is a request for reimbursement for staff time then a written explanation is required in the application of why OHF funding is needed to pay for the costs of that staff member(s)’ time. **The budget form must reflect on a separate line item the specific amount that is being requested for staffing and/or the hiring of an outside consultant.** This separate line item will then be used to make the calculation of 5% or 10% as outlined in the law. Note that the calculation will be made on the grant less the costs for the consultant or staff.
Maintenance – Activities that preserve or keep infrastructure in a given existing condition, including repairs. Repair means to restore to sound condition after damage, to renew or refresh; except repairs due to damage caused by Acts of God.

Scoring of Grants

Oral Presentation. Please note that you will be given an opportunity to make a ten-minute Oral Presentation at a meeting of the Outdoor Heritage Fund Advisory Board. These presentations are strongly encouraged.

Open Record. Please note that your application and any attachments will be open records as defined by law and will be posted on the Industrial Commission/Outdoor Heritage Fund website.

All applications will be scored by the Outdoor Heritage Fund Advisory Board after your ten-minute oral presentation. The ranking form that will be used by the Board is available on the website at http://www.nd.gov/ndic/outdoor-infopage.htm .

Awarding of Grants

All decisions on requests will be reported to applicants no later than 30 days after Industrial Commission consideration. The Commission can set a limit on duration of an offer on each application or if there isn’t a specific date indicated in the application for implementation of the project, then the applicant has until the next Outdoor Heritage Fund Advisory Board regular

meeting to sign the contract and get the project underway or the commitment for funding will be terminated and the applicant may resubmit for funding. Applicants whose proposals have been approved will receive a contract outlining the terms and conditions of the grant.

Responsibility of Recipient

The recipient of any grant from the Industrial Commission must use the funds awarded for the specific purpose described in the grant application and in accordance with the contract. The recipient cannot use any of the funds for the purposes stated under Exemptions on the first page of this application.

If you have any questions about the application, the Commission can be reached at 701-328-3722 or outdoorheritage@nd.gov.

Revised: November 4, 2019, April 12, 2023

TRAILHEAD

We are submitting this as our Comprehensive Conservation Plan

THEODORE ROOSEVELT PRESIDENTIAL LIBRARY

ADAPTIVE LAND MANAGEMENT PLAN

NOVEMBER 23, 2022

DRAFT

PREPARED FOR:

JLG ARCHITECTS ON BEHALF OF THE

THEODORE ROOSEVELT PRESIDENTIAL LIBRARY FOUNDATION

SUBMITTED BY:

RESOURCE ENVIRONMENTAL SOLUTIONS, LLC

THEODORE ROOSEVELT PRESIDENTIAL LIBRARY

ADAPTIVE LAND MANAGEMENT PLAN

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

The consultant team is grateful for input on content by Kurt Marsh and Matt McMahon of the lead design firm, Snøhetta. Steve Apfelbaum, founder of Applied Ecological Services, was a key member of the site inventory team and participated in the post-fire assessment field work and analysis. We thank the Theodore Roosevelt Presidential Library Foundation for providing results of biological assessments from early in the project and for advancing other research needed to complete this work.

Prepared for:

JLG Architects on behalf of the Theodore Roosevelt Presidential Library Foundation

124 N 3rd Street

Grand Forks, ND 58203

Prepared by:

Resource Environmental Solutions, LLC

Kim Alan Chapman, PhD

Doug Mensing, MS

Citation: Resource Environmental Solutions. 2022. *Theodore Roosevelt Presidential Library Adaptive Land Management Plan.* Theodore Roosevelt Presidential Library Foundation, Medora ND.

THE THEODORE ROOSEVELT PRESIDENTIAL LIBRARY SITE AND THE LIVING BUILDING CHALLENGE

As part of its mission to embrace and communicate the legacy of Theodore Roosevelt, the Theodore Roosevelt Library Foundation (TRLF) is pursuing the Living Building Challenge (LBC), administered by the International Living Futures Initiative (ILFI). LBC is among the most rigorous of sustainability programs in the world, encompassing the entire spectrum of human development activity in relation to local culture, economy, and the natural world.

In constructing the TRPL, the TRLF aims to:

- Honor the site's past and present as a productive cultural landscape.
- Engage the local community and stakeholders.
- Restore and enhances ecological health and biodiversity.
- Foster education in sustainable grassland Land Management and Environmental Sciences.
- Design a landscape that provides access and calls attention to the site's unique ecologies and terrains, and encourages visitors to slow down, look closer, and immerse themselves in the beauty of the Badlands.
- Contribute to the net positive water imperative by managing stormwater and restoration of degraded grassland to improve grassland vegetation and soil-water storage.

All projects pursuing LBC certification must define an LBC project boundary that represents the scope of work and potential construction site disturbance, so that these environmental impacts can be avoided and/or properly mitigated. The LBC boundary determines the "Project Area" used for calculations to determine compliance with certain LBC imperatives.

The LBC project boundary reflects the current scope of work in the SD base project together with the modified property ownership boundary, approximately 90 acres in total (Figure 1). The diagram also shows two potential options for the Theodore Roosevelt Presidential Library (TRPL) LBC project boundary.

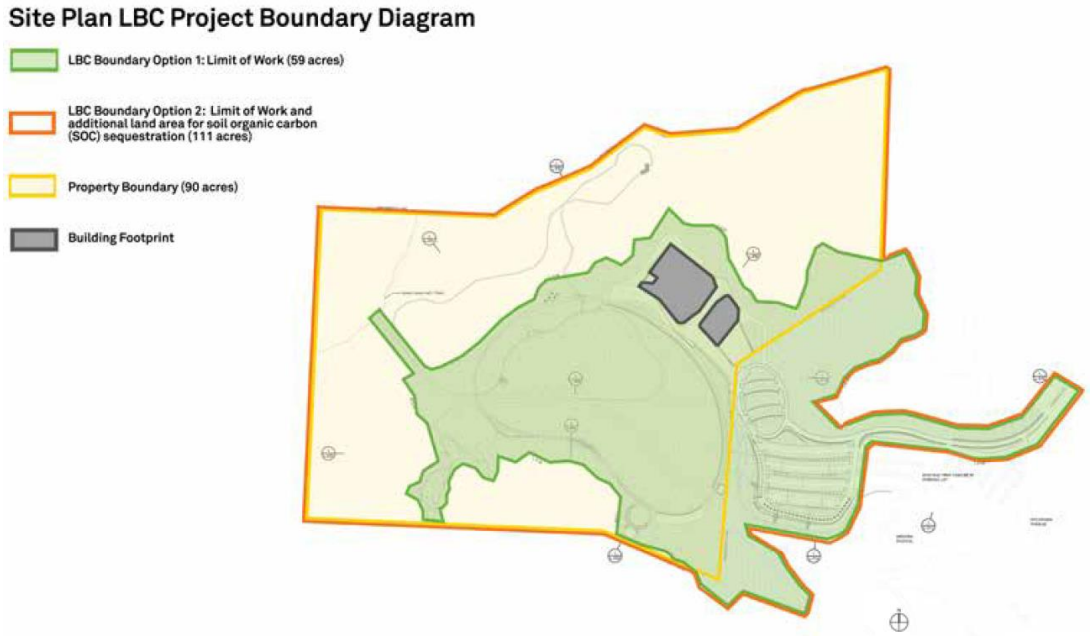

Figure 1 TRPL Site Living Building Challenge, Proposed Project Boundary

The TRPL Project team proposes "L2-Rural Zone" due to the history of farming, ranching and fire suppression on the site and prior ILFI clarification that open range land is considered prime agricultural land. This Transect is comprised primarily of land that used for agriculture and food production, plus outlying areas of towns.

The Living Building Challenge consists of seven performance categories or “Petals”. All LBC projects must address the seven Petals through the Core Imperatives. Land Management is related to Ecology of Place (01), Net Positive Water (06), and Net Positive Carbon (08)

TRPL takes an ecological approach to land management by following these principles:

1. Design for a sustainable, native, regenerative, resilient, biologically rich and abundant landscape with healthy soils, which supports human use, biodiversity, wildlife habitat, and livestock grazing.
2. Connect the project culturally and ecologically to the larger regions – the Little Missouri Badlands and watershed, the Northern Great Plains, and grasslands worldwide.

The Living Building Challenge Criteria

The LBC criteria related to Land Management are summarized below.

Imperative 01 – Ecology of Place

- Protect wild and ecologically significant places and encourage ecological regeneration and enhanced function of the communities and places where projects are built.
- Avoid building on pristine greenfield, wilderness, prime farmland or in a floodplain.
- Preserve thriving vibrant ecological environments and habitats.
- Demonstrate a positive contribution to the ecology of a project’s place and restore or enhance the ecological performance of the site towards a healthy ecological baseline.
- Assess cultural and social equity factors and needs in the community and consider those identified needs to inform design and process decisions.
- Use no petrochemical fertilizers or pesticides in the operations and maintenance of the on-site landscape. (ILFI indicated an exemption may be allowed to establishment a healthy landscape.)
- The TRPL site and Adaptive Land Management Plan will create and maintain an ecologically healthy and resilient landscape that responds to the community, provides access, and calls attention to the site’s unique ecologies and terrains.

Imperative 06 - Net Positive Water

- 100 percent of a project’s water needs must be met through captured precipitation or other natural closed-loop systems; all grey- and black-water must be treated and managed on-site through reuse, infiltration, or closed-loop system; and a one-week supply of potable must be stored on site for water resilience.
- The TRPL site and Land Management Plan will contribute to this requirement by managing stormwater with natural systems and restoring degraded grasslands to improve grassland vegetation and soils, and runoff infiltration and water storage.

Imperative 08 (I08) - Net Positive Carbon

- The facility and grounds must meet an exemplary standard for energy efficiency and carbon emissions management. The project strives to achieve holistic carbon neutrality over the long term, accounting for operational carbon, embodied carbon, and site sequestration.

- The project must supply 105% of annual energy usage with on-site renewable energy systems (12-month, verified performance); purchase a one-time offset for the embodied carbon in structural and interior materials and construction emissions; and implement a resilience strategy for one-week, emergency habitable operation supported by battery storage.
- The TRPL site and Land Management Plan will contribute to this requirement by sequestering carbon in the soils under a modified grazing-fire management regime; RES is providing a carbon sequestration methodology for review by ILFI and a third-party reviewer; if implemented, this is intended to reduce the amount of a one-time offset purchase for embodied carbon.

EXISTING CONDITIONS

Landscape Context

The TRPL site is located near the Little Missouri River just west of Medora, North Dakota. The site falls within the Little Missouri Badlands ecoregion, a highly dissected landscape forming a belt 300 km long and 15 to 40 km wide along the Little Missouri River in southwestern North Dakota. Adjacent land use includes ranching, urban development, agricultural practices, energy development and recreation.

Figure 2 Typical Badlands landscape (photos by RES & Snohetta)

Regional Climate and Seasonality

The region is part of a continental climate with long, cold winters and short, hot summers. Temperature ranges from 116° F to -40° F and annual precipitation is 15-16 inches. Weather includes violent thunderstorms, hailstorms, blizzards, and occasionally tornadoes.

Geology, Landforms & Soils

The site is underlain by weathered bedrock of the Sentinel Butte Formation, consisting of sandstone, siltstone, claystone, and lignite in layers several hundred feet deep. The rock of the Little Missouri Badlands is 55-65 million years old, deposited as sea bottoms during the Paleocene Epoch. The lowest exposed rock is the Bullion Creek Formation—a light, yellowish, soft sandstone seen in low creek valleys and near the Little Missouri River. Above this is the Sentinel Butte Formation, consisting of bluish gray silts and clays. This is the rock exposed at the TRPL

site. The Badlands began forming only 600,000 years ago, during the Pleistocene Ice Age. When continental glaciers arrived, a change in drainage patterns accelerated local erosion in the soft bedrock of the Bullion Creek and Sentinel Butte Formations (Godfread 1994). Erosion and alteration of the Badlands landscape continues today due to rain and melting snow, wind, frost-heave, and other forces (Bluemle 2016).

Groundwater & Water Features

There are no open water features on the TRPL site. Groundwater does not support open water systems on the Library site, but salty seepage areas—"saline seeps"—are present at many locations at the base of the blufftop. There are no floodplains in or around the site. The Little Missouri River lies to the east. It flows northward past Medora and through the Theodore Roosevelt National Park and enters the Missouri River in central North Dakota.

Vegetation, Land Cover, Land Use

Land cover includes relatively natural, usually vegetated, areas or habitats (e.g., forests, prairies, old fields, water bodies) and altered cultural areas (e.g., turf, cropland, impervious surfaces). Land use refers to practices on the land, such as timber harvesting, agriculture, and residential development. Land use influences land cover, but land cover mapping is preferred for assessing and managing natural resources.

Historical Vegetation & Land Use. The TRPL site was very likely dominated by mixed-grass prairie in the late 1800s. Shrubland was likely present in woody draws and on steep north-facing slopes. Wetlands in general were rare and saline seeps uncommon. Until the late 1800s, indigenous people managed the landscape's vegetation and wildlife through repeated use of fire that cleared brush and maintained grasslands. Non-native shrubs, grasses, and forbs—invasives that moved into the Badlands since the late 1800s—have affected the structure, function and species composition of native ecosystems.

Trends in Vegetation & Land Use. European settlement in western North Dakota began in the 1870s and accelerated in the 1880s, introducing an agricultural lifestyle based on livestock and crop production. This settlement resulted in fire suppression, which eliminated a rejuvenating disturbance that had operated for several thousand years. Grazing shifted from short, intensive episodes with long rest periods, to season-long continuous grazing every year. Native grasslands have been adversely affected by this management change. Trees and shrubs have colonized and spread, native grass dominance and forb diversity have declined, and invasive plants have been allowed to gain a foothold and spread. The landscape continues to evolve as the climate, natural disturbances, and land use practices change over time.

Existing Land Cover. The TRPL site supports several ecological land cover types that provide wildlife habitat and act as a large pool of species for replenishing local plant communities as needed (Table 1, Figure 3).

Table 1. Ecological Land Cover Classification of the TRPL Site

RES Name	TRPL Site Location	USFS Name	Acres (In Site Bdy.)	Acres (In Site Layout)
Disturbed Prairie	Plowed ungrazed on blufftop	Western Wheatgrass - Crested Wheatgrass	0.4	10.6
Mixed-grass Prairie/Invasives	South-central plateau (lower ground)	Western Wheatgrass - Blue Grama - Threadleaf Sedge	10.4	10.5
Mixed-grass-Bluegrass Prairie	west and north sides of blufftop plateau	Western Wheatgrass - Blue Grama - Threadleaf Sedge	21.5	23.5
Fractured Bedrock Prairie	Eroding blufftop edge, sparse vegetation cover	Little Bluestem - Grama Grass - Threadleaf Sedge	6.1	6.1

RES Name	TRPL Site Location	USFS Name	Acres (In Site Bdy.)	Acres (In Site Layout)
North Slope Mixed-grass Prairie	Northerly-facing slopes	Little Bluestem - Grama Grass - Threadleaf Sedge	7.3	9.5
Woody Draw	Valley bottoms with watercourses; lower slopes of north-facing side valleys	Green Ash - Elm – Box-elder / Chokecherry	12.1	12.8
Valley/South Slope Mixed-grass Prairie	Southerly-facing slopes and narrow valleys	Western Wheatgrass - Green Needlegrass	17.8	20.5
Badlands Vegetation	North and south edges and west quarter of site	Badlands Sparse Vegetation	16.4	19.1
Mesic Prairie	Future Conditions: In parking lots and roads, and near building	Prairie Cordgrass - Sedge	N/A	N/A
Saline Seep	Southwest corner of site at base of bluff	Saltgrass - Foxtail Barley Great Plains Saline Marsh Division	0.9	0.9
Developed Land	East of Library site boundary	N/A	N/A	6.3

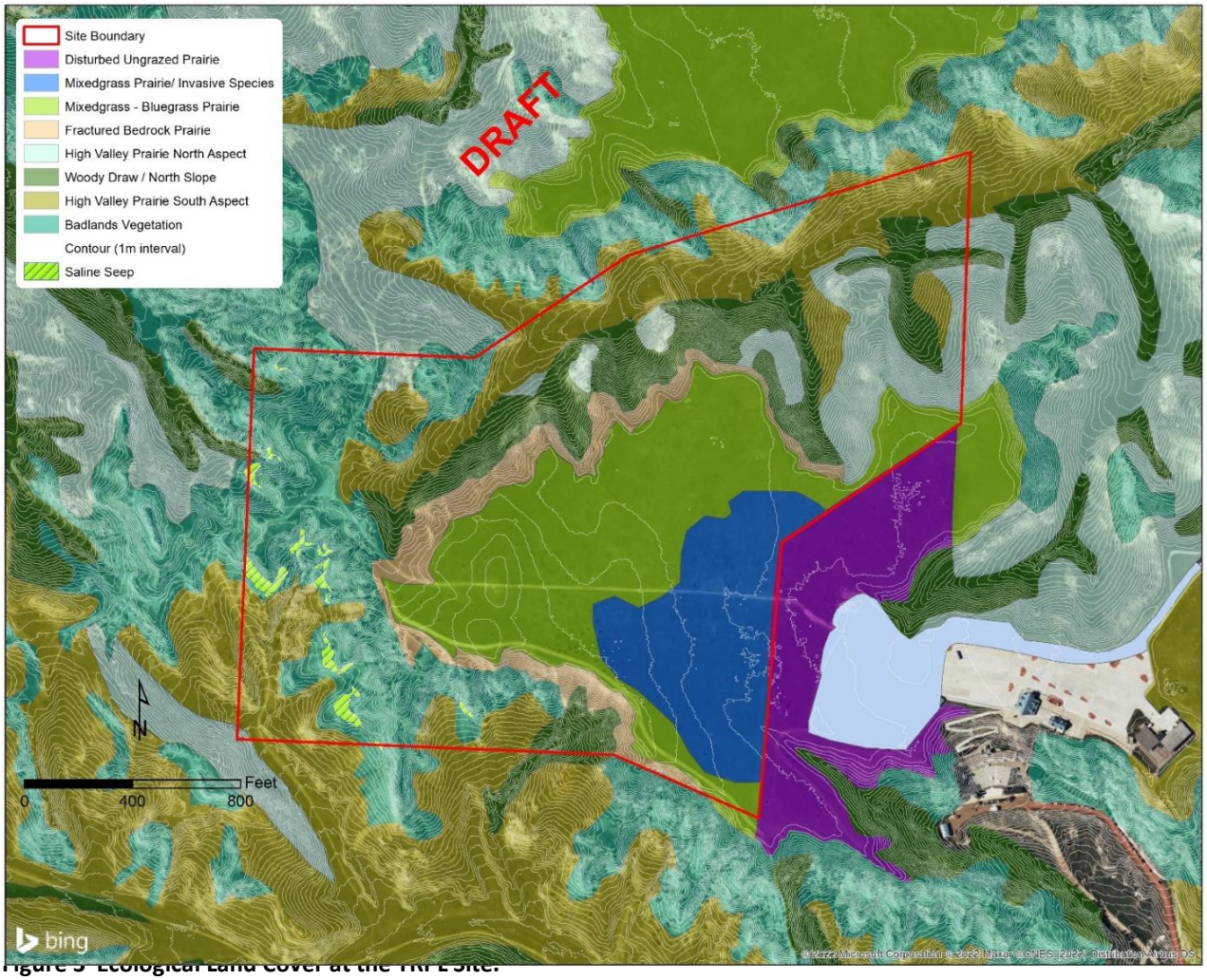

Figure 3 Ecological Land Cover at the TRPL Site.

LAND MANAGEMENT AREAS

Land management will focus on six kinds of areas. Each area is defined by its vegetation, function, location, and management practices. As decisions about the management regime are being refined, the information below is subject to change. Establishing dominance by native plant species is the goal of land management.

1. Grassland. Areas where the final condition is grassland where grazing and fire management can be practiced.

2. Woody Draws. Areas where the final condition is woodland where fire management and possibly grazing can be practiced.

3. Stormwater Management Areas. Areas near impervious surfaces where management excludes prescribed burning and grazing.

4. Rooftop. The roof of the Library building, where management excludes prescribed burning and grazing, but may include haying.

5. Lawns. Areas subjected to frequent foot traffic.

6. Temporary Disturbed Area. Areas that are disturbed and required rapid revegetation; usually replanted with a more durable planting palette.

1. Grassland Management Areas

These included current land cover of: Disturbed Prairie, Mixed-grass Prairie/Invasives, Mixed-grass - Bluegrass Prairie, Fractured Bedrock Prairie, North Slope Mixed-grass Prairie, Valley/South Slope Mixed-grass Prairie.

Disturbed Prairie, Mixed-Grass Prairie/Invasives

Areas will be seeded with the Mixed-Grass Restoration Mix in a complete replacement of disturbed areas with high diversity native plants. Long term management will involve grazing biomass to 50% biomass removal once a year and burning every 10 years. The outcome of management should be a nearly weed-free prairie with no trees or shrubs at end of year 3 after seeding.

Mixed-Grass - Bluegrass Prairie

Areas will be seeded with the Mixed-Grass Enhancement Mix intended for overseeding in existing prairie on level blufftop locations. Long term management will involve grazing to 50% biomass removal once a year and burning every 10 years. The outcome of management should be higher plant species diversity and no trees and few shrubs at end of year 3 after seeding.

North Slope Mixed-Grass Prairie, Fractured Bedrock Prairie

This area will be seeded with the North Slope Prairie Enhancement Mix intended for overseeding in existing prairie on northerly slopes. Long-term management will involve grazing to 50% biomass removal once a year and burning every 10 years. The outcome of management should be higher plant species diversity at end of year 3 after seeding.

Valley/South Slope Mixed-Grass Prairie

This area will be seeded with the Valley & South Slope Prairie Mix intended for overseeding in existing prairie in valley bottoms and on southerly slopes. Long term management will involve grazing to 50% biomass removal once a year and burning every 10 years. The outcome of management should be higher plant species diversity at end of year 3 after seeding.

2. Woody Draw

This area will be seeded with the Woody Draw Mix intended for ground-seeding in ravine bottoms where naturally heavy tree and shrub cover and fire-sterilized areas occur. Long term management will involve grazing to 50% biomass removal once a year and burning every 15-25 years. The outcome of management should be nearly continuous native groundcover at end of year 3 after seeding; good graminoid and forb diversity; canopy cover of trees and shrubs 75-100 percent.

3. Stormwater Management Areas

Stormwater Management Areas include rock swales and mesic prairie areas. Each area will be planted using live plants from their respective species mixes, Stormwater Rock Swale Mix and Stormwater Mesic Prairie Mix. Stormwater rock swales will be largely rock lined and planted with native shrubs, grasses, sedges and showy forbs. They function to carry stormwater runoff from parking lots, roadsides and impervious surfaces. Mesic prairies are large depressions in the stormwater management system, primarily in and around parking lots and the turnaround near the TRPL building. Long-term management includes hand removal of vegetation at end of growing seasons, inspections and repairs after large storm events. The outcome should be nearly continuous diverse native plant cover by end of the second year after installation.

4. Rooftop

This area will be planted using the Library Roof Mix. Live plants will be installed to establish a green 100,000 sf roof over the Library. Long-term management includes haying the roof once each a year (all cut material removed) to make next year's growth appear uniform and to maintain proper soil conditions for growth and flowering. The outcome should be continuous native cover and good native plant diversity, with complete season of bloom from May through October.

5. Native Lawn

Native lawn will receive heavy foot traffic by people. It will be seeded with the Lawn Mix for bare ground seeding of grasses and sedges that withstand human trampling. Long-term management includes overseeding as needed to restore native dominance and cover and mowing if desired to make vegetation uniform. The outcome should be nearly continuous low-stature graminoid cover, with self-healing capacity for minor damage.

6. Temporary Disturbed Ground

After initial restoration is completed, any future disturbed areas will be seeded with the Temporary Disturbed Soil Mix intended for low-cost bare ground seeding to provide temporary and quick-establishing cover where prairies are damaged. The temporary disturbed ground mix is an emergency mix, not intended for long-term cover and replaced in the next growing season. The outcome of applying the mix should be 75% cover by native plants and <5 percent by invasive plants at the end of the growing season.

ECOSYSTEM APPROACH

The land management approach recommended here is an "ecosystem approach". In brief, this entails first using less expensive, nature-based methods to restore ecological processes and the vegetation structure and composition appropriate to an ecosystem and its location. This often involves replacing dominant invasive vegetation with native species of the target plant community. Typical tools include prescribed fire, restoration of hydrological regimes, biocontrol, and physical removal of invasive vegetation by haying, mowing or grazing. Only then is targeted herbicide application considered, combined with other interventions like seeding and planting. An ecosystem approach is designed to tap into nature's self-healing capacity, improve a plant community's ecological health and resilience, and do this using lower cost, nature-based solutions.

An ecosystem approach puts plant communities on a trajectory that is consistent with the trajectory prior to its disruption, making plant communities more adaptable to future change—to be resilient, in other words.

Actions that restore processes and structures are implemented first because these may restore vegetation structure and increase species diversity without seeding and planting. If that fails to restore the desired structure and biodiversity, seeding and planting become necessary.

The implementation sequence in an ecosystem approach is:

- Restore natural disturbance regimes (e.g., fire, flooding, grazing).
- Introduce biocontrols (i.e., natural enemies or predators of plants) where available and feasible.
- Remove and control invasive trees and shrubs physically.
- Install native trees and shrubs as needed to restore vegetation structure.
- Remove and control invasive herbs physically.
- Install herbaceous seeds and plants as needed to restore vegetation structure.
- Use herbicides sparingly and only when other methods fall short of goals.
- Add diversity if plant community does not respond.
- Monitor ecosystem response at all stages in the process and adaptively manage.

These actions occur in the initial restoration and short-term management phase. Once established, management enters the long-term phase. "Adaptive management" is structured decision-making given uncertainty of outcomes. It reduces uncertainty by using a cycle of planning, implementation, monitoring, evaluation, adjustment, and further implementation. Adaptive management, used in the best restoration programs, begins in the initial restoration phase and continues indefinitely during the long-term management phase.

Initial Restoration and Short-Term Management Phase

Ecological restoration has short- and long-term management phases. The short-term phases are often labor-intensive and costly (Figure 3). A significant investment is necessary for three or more years. Tasks often include re-introducing natural disturbances like fire and intensive-long rest grazing; re-establishing natural hydrological cycles; using biocontrol, physical methods, and herbicides to control invasive plant species; and seeding and planting native vegetation. The time required depends on starting condition, weather, response of vegetation, site size, and unique factors, such as access. After establishment, activities shift to long-term management.

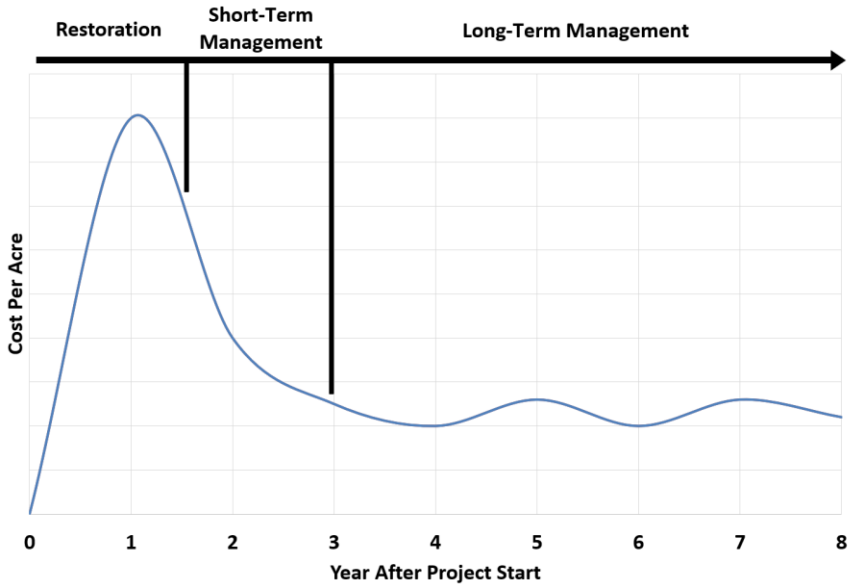

Figure 4 Generalized costs of restoration and management over time

Planting a new prairie or wetland is usually called "restoration" or "re-creation", whereas "enhancement" describes activities where natural conditions exist and improvement can occur with less effort. For instance, enhancement might entail removing invasive shrubs and overseeding native grasses in an existing woodland.

Long-Term Management Phase

The TRPL construction schedule indicates long-term management of the land could begin in summer 2025 (Appendix B). Although it has a lower per-acre cost, long-term management is often neglected, putting the expensive restoration investment at risk. Monitoring and management occurs each year in the best restoration programs. Monitoring can be as simple as a "walkabout"—systematically walking and inspecting the site to identify issues that must be addressed in next year's annual work plan. Or it can be a research program, quantitatively documenting ecosystem response to restoration and management and publishing the findings.

Land managers are focused on a few long-term management tasks.

- Maintain disturbances (e.g., fire, flooding) that perpetuate a diverse, resilient plant community.
- Selectively remove or control invasive plants (e.g., precise mechanical removal or spot-herbiciding).
- Re-seed disturbed or poorly developing areas.
- Re-plant tree, shrubs, and herbaceous plants that have died.

Most North American ecosystems need disturbances that remove dead plant material, stimulate flowering and seed production, or create microhabitats for plants and animals to perpetuate themselves. Controlled or prescribed burns are a common tool to mimic the former North America fire regime in prairies, savannas, wetlands, and some forests and woodlands. Harvesting hay mimics fire effects, as does grazing, to a lesser extent.

Some people argue that nature has been around a very long time and can take care of itself. Others think that more important issues and problems face us and that managing natural ecosystems does not merit the expense. While these are valid views, they are not the whole story.

Studies over the last half century clearly demonstrate that, without ecological stewardship, natural resources change in ways do not always benefit people or support ecosystem services (Alstad et al. 2016, Le Maitreet al. 1996, Leach

and Givnish 1996). A common problem in unmanaged grasslands, for instance, is invasion by non-native leafy spurge (*Euphorbia esula*), Canada thistle (*Cirsium arvense*), Kentucky bluegrass (*Poa pratensis*), smooth brome grass (*Bromus inermis*) and crested wheatgrass (*Agropyron cristatum*). When these non-native species invade natural areas, a cascade of negative effects follows. Another problem is accumulation of dead leaf litter due to fire suppression and too-light grazing.

Some of the more severe effects of not managing land or managing it without attention to ecological conditions, are that native plants are displaced, soil chemistry and plant composition change, and ground vegetation is shaded—leading to species loss, reduced biodiversity, additional invasions, and lower resilience during periods of extreme weather, for instance. Floral resources for pollinators are eliminated, reducing the amount and variety of food for wildlife and further depressing wildlife populations.

Large, protected and ecologically complex natural areas may resist these trends, but without proper management even here quality declines over time. With some level of consistent management, the situation can be stabilized and even improved. This management plan identifies and prioritizes management actions to improve the health and resilience of natural areas and resulting ecosystem services and recreational benefits at the TRPL site.

Ecosystem Services

Natural areas are vital to a community and visitors for many reasons. For example, natural areas absorb and store carbon from the air, helping to reduce greenhouse gases. Wetlands and forests in river and stream floodplains help reduce downstream flooding. Prairies, savannas, and forests on the landscape absorb huge quantities of rainfall, which in turn reduces the amount of runoff and sediment that reaches a watershed's rivers, streams and lakes. Schools, organizations, and families can learn about the natural world in natural areas; these are formative moments for children who otherwise spend much time making virtual connections indoors. Natural areas make life better because people can stroll, bike, take in the scenery, or simply relax in a natural setting.

Scientists call the benefits that natural resources provide "ecosystem services" (Figure 3). Ecosystem services support life on Earth—and they save people money over the long term by using nature to provide services that people would pay for by constructing infrastructure. A milestone scientific study completed in 2005, called the Millennium Ecosystem Assessment, summarized the state of ecosystem services worldwide (Hassan et al. 2005). Since then, dozens of scientific papers have been published demonstrating the financial savings of healthy ecosystems. For instance, building flood control structures or rebuilding after floods would be more costly without floodplains and the natural capacity of watersheds to absorb and regulate the water moving through them.

Besides supporting and regulating the human environment, the TRPL site will serve recreation and promote people's well-being. Research in the last 20 years has demonstrated a strong link between time spent in or near nature with better physical and mental health. Even viewing nature out a window can improve test scores in school children or elevate moods in adults. Of course, people love to fish, hike, bike, ski, picnic, camp, and be with family in nature. Just sitting still or within sight of nature can nourish the spirit and reduce stress.

TRPL's character also emerges from its natural resources. Natural resources create a sense of place that attracts people and businesses and convinces them to remain in an area. Healthy ecosystems not only a signal that ecosystem services are operating, but also that society and the economy are being supported and enriched. By protecting and managing TRPL's natural resources, the level of ecosystem services be stable and even improve.

Figure 5 Ecosystem services that support life on Earth. Source: Metro Vancouver Regional Planning 2018

Evaluation of Ecosystem Recovery Potential

This evaluation was performed to meet the Living Building Challenge. The TRPL site was evaluated by comparing its attributes to a reference system, the Theodore Roosevelt National Park. RES ecologists completed the Evaluation of Ecosystem Recovery proforma based on their knowledge of both sites, quantitative sampling at both sites, and understanding the goals, objectives and site-specific indicators for the TRPL project (Appendix E).

From this evaluation, a Long-Term Recovery Wheel was generated (Figure 4). This evaluation relies on a five-star rating system, assigned to six attributes of ecosystems (Table 2) and 18 sub-attributes (Appendix G).

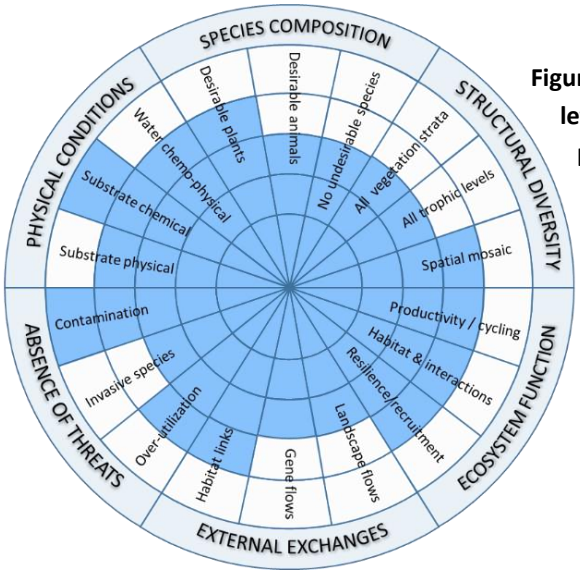

Figure 6 Recovery Wheel showing potential future recovery levels for the TRPL site under modified land management practices. (See Existing Conditions Report for current recovery wheel levels.)

RES Ecologists also complete a Recovery Wheel for the Performance Period (Figure 7, Appendix F). This period is expected to conclude at the end of 2027, after four years of ecological restoration and implementation of a new grazing regime of intensive short periods of grazing followed by a long rest period—called "adaptive multi-paddock (AMP) grazing".

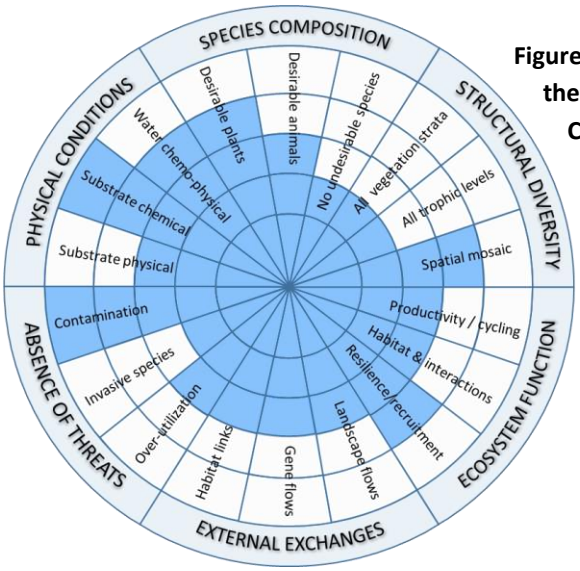

Figure 7 Recovery Wheel showing the status of the TRPL site at the end of the Performance Period in late 2027. (See Existing Conditions Report for current recovery wheel levels.)

Table 2. Key ecosystem attributes to evaluate baseline conditions (McDonald et al. 2016).

Attribute	Description
Absence of threats	Direct degradation drivers (e.g., overgrazing, contamination inputs, potential for invasive species introduction) are low or close to absent.
Physical conditions	Environmental conditions (including the physical and chemical conditions of soil, water, and topography) required to sustain the ecosystem are present.
Species composition	The native species characteristic of the appropriate ecosystem are present, whereas invasive species are minimal or effectively absent.
Structural diversity	Appropriate diversity of key structural components, including demographic stages, faunal trophic levels, vegetation strata, and spatial diversity are present.
Ecosystem function	Appropriate levels of growth and productivity, nutrient cycling, decomposition, habitat, species interactions, and types and rates of disturbance are present.
External exchanges	The ecosystem is appropriately integrated into its larger landscape or aquatic context through positive abiotic and biotic flows and exchanges.

LAND MANAGEMENT PRACTICES

Several land management practices are expected to be used in different management areas at the TRPL site.

- Integrated Pest Management (all management areas)
- Short-and Long-Rotation Fire Management (grassland management areas, woody draws)
- Grazing (grassland management areas)
- Haying (green roof, grassland management areas)
- Mowing (pavers, lawn, stormwater management areas)
- Seeding and Plant Installation (all management areas)

1. Grassland Management Areas

Grazing. The grazing concept for the TRPL site envisions a grazing-fire management regime to replicate the northern Great Plains conditions for over ten thousand years—to which plants, animals, and other life forms are adapted. This will be a change from the season-long continuous grazing with limited fire practiced widely since the 1880s.

Reasons and outcomes for this change are first and foremost to make the site safe—by reducing the accumulated dead plant materials resulting from no fire and too-light grazing. Maintaining and increasing biodiversity is an anticipated outcome of this change, together with additional atmospheric carbon incorporated into the soil and the improvement of nutrient cycles. There is an educational component, illustrating the region's ecological and cultural history, the adaptive use Native Americans made of these processes and the region's changing resources.

A grazing regime that replicates the occasional use by bison herds resulted in rapid plant removal, trampling and nitrogen-rich waste elimination. Grazing will not manage tree and shrub vegetation in woody draws and on northerly slopes; fire is used for this purpose. The buildings, road, and infrastructure are excluded, leaving some sixty acres of land on the blufftop and in valleys to manage with grazing. The easily eroded badlands slopes and fractured bedrock prairie are unlikely to attract grazing animals due to steep slopes and sparse vegetation.

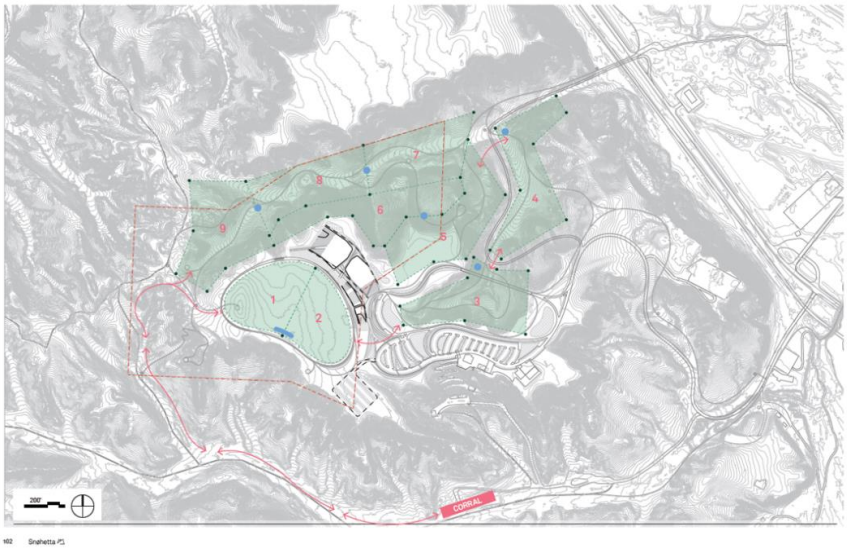

Figure 8 Illustrative concept for AMP grazing (subject to change)

An illustrative grazing concept explains how such a grazing regime would work (Figure 8). The actual grazing regime will be developed in later design, requiring discussions with grazers regarding the details of

implementation. The grazing regime ideally will achieve multiple goals of biodiversity protection and improvement, ranch operation efficiency, and education. Livestock would be driven from a corral to the entrance to pasture 1. When about 50 percent of biomass is removed or trampled—the utilization target—livestock are moved to pasture 2 and so forth until all pastures have been grazed. Livestock are then driven back to the corral.

A small herd of heifers, possibly with calves, is envisioned, which will reach the utilization target in each pasture in very few days. Grazing pressure, in pounds of animal per acre, must be high to replicate the effect of transient bison herds. Each pasture is not grazed long as the herd rotates through. Fire is introduced every 10 years to reduce dead leaf litter and set back trees and shrubs which often are not affected by grazing animals.

A perimeter fence and easily-installed electrified polywire fences would be used to define temporary pastures. Only two pastures would exist at any one time, built just before livestock arrive and removed after they leave. The next pasture is constructed before livestock are moved into it using the polywire from the pasture fencing being dismantled. Moving pasture fences takes less than an hour.

This is not traditional grazing where livestock grazes a large pasture continuously until up to 90 percent of the above-ground biomass is consumed. AMP grazing asks the grazer to monitor the effect of livestock on the vegetation each day. NDSU Extension has developed a Grazing Stick, an idea tool to measure biomass removal. (See https://www.ag.ndsu.edu/livestockextension/grazing-management-folder/range-and-pasture.)

A key difference between traditional rotational grazing and AMP grazing is the amount of biomass removed and the time required to graze it. In rotational grazing livestock are allowed to graze until biomass is mostly removed. Despite rest, removing over half the top of a plant stresses its root systems. The plant cannot photosynthesize enough sugar to keep all the roots alive. When roots die back, above-ground parts of the plants also die back, reducing plant cover and root competition, and opening grazed land to weed invasion. Forage quality suffers, too, as livestock avoid poor quality plants like Canada thistle and leafy spurge and concentrate on higher food-value plants. This leads to a change in biodiversity as "increasers" become numerous and "decreasers"—a significant part of a prairie's biodiversity—dwindle. A grazer who follows an adaptive management cycle—design, implement, assess, adapt—by watching the effect of livestock grazing on vegetation, will achieve the desired outcomes more often than a grazer who does not.

Prescribed Fire Management. Grasslands worldwide have always burned, North American included. The grasslands and woodlands of the Great Plains in the continent's center have experienced fires set by Native Americans for over 10,000 years—and lightning strikes for millennia before that. Native Americans used fire as a tool to attract and drive game and clear travel routes, among other reasons. The animals and plants of the Great Plains have been winnowed over time to respond positively to fire—increasing flowering and germinating seedlings on bare ground after fire. Fire reduces dead leaf litter, stimulating plant growth earlier in the year as sunlight warms the exposed soil. The pulse of nutrients released by fire are quickly taken up by plants.

Interestingly, a large wildfire burned the site and hundreds of acres around it on April 1, 2021. Areas dominated by the non-native crested wheatgrass and Kentucky bluegrass initially saw a reduction in the abundance of those species, with increases in blue grama, side oats grama and western wheat grass. However, the plentiful rain in early 2022 and throughout the growing season favored the quick spring growth of Kentucky bluegrass (*Poa pratensis*) over large areas on the western blufftop; in 2022 it was also evident that the wildfire also killed most of the little bluestem (*Schizachyrium scoparium*) that had characterized the western blufftop.

Grassland restorationists have taken advantage of the benefits of fire since the 1930s when Aldo Leopold, among others, began experimenting with prescribed burning in existing and created prairies. In the ninety years since, ecologists, range managers, and grassland restorationists have learned how to plan and safely carry out prescribed

burns. More recently, researchers have combined fire with grazing ("patch-burn grazing") to further replicate the natural disturbance regime that shaped the ecology, plants and animals of Great Plains grasslands.

Climate, fire, and grazing are the three big disturbance factors that historically shaped the landscape. All affect the diversity and health of plants and animals across the Great Plains. While the climate is not controllable, grazing effects can be managed by the style of grazing, the season of use, and the type of animal. Fire can also be managed by the frequency and season of burning, and by weather conditions. These disturbances are interacting forces rather than independent factors (Weir et al. 2013).

A combination of grazing and burning has been shown to reduce woody vegetation invasion. Cattle have been used to enhance the effectiveness of a follow-up burns by knocking down dead standing fuels and creating openings in woody areas where grasses can grow (Smith et al. 2007). Restoring the fire-grazing interaction is one management strategy that could decrease the likelihood of wildfires (Kral-O'Brien et al. 2020, Winter et al. 2012).

Prescribed Burning in North Dakota. Individuals planning a prescribed burn should follow a Prescribed Burn Plan (Appendix D) developed by a qualified individual. This plan outlines the environmental conditions under which the burn can safely be conducted. A local Natural Resources Conservation Service (NRCS) or North Dakota Forest Service office can assist in developing a prescribed burn plan.

There are several factors to consider before carrying out a prescribed burn. These include fuel character on the day of the burn (amount, type, moisture content), wind (speed, direction, potential for change), relative humidity, air temperature, soil moisture, slope of the area, smoke management measures, and notifications of neighbors, and police and fire department (NRCS 2012). A permit may be needed.

Prescribed burns should not be conducted when the Rangeland Fire Index is in the Very High or Extreme category. The local sheriff's department or the National Weather Service posts a Rangeland Fire Index each day. Fire weather forecasts also can be obtained from the National Weather Service (http://www.crh.noaa.gov/bis/ or http://gacc.nifc.gov/nrcc/predictive/weather/weather.htm).

Management of Sharp Tailed Grouse. A mating or dancing ground (lek) of sharp-tailed grouse (*Tympanuchus phasianellus*) once existed on the south side of the blufftop. This bird uses vast grasslands with scattered brush and very few trees. Mating and courtship occur on the leks, a central focus of the local grouse population and part of the home ranges of individuals using the lek (Danzl 2018).

Sharp-tailed grouse begin breeding near the TRPL site in March or April (Drummer et al. 2011). Sharp-tailed grouse prefer leks with short, sparse vegetation of grass, forbs, and some shrubs (Danzl 2018). Changes in vegetation structure or other changes may cause birds to abandon a lek (NRCS 2007 and Prose 1987). Disturbance by people can cause birds to not reproduce despite a lek's existence (Landel 1989, Connelly et al. 1997, Baydack et al. 1987).

Fire creates and maintains sharp-tailed grouse habitat. Grouse need cover and food provided by a variety of grasses, sedges, forbs, and shrubs (USDA 2007, Sexton 1979, Grange 1948). Severe fires in fall may eliminate valuable spring cover (Grange 1948). Spring fires stimulate flowering, seed and fruit production, and top-kill shrubs that may have become too dense. Considerations for managing leks are presented in Appendix C.

Seeding and Plant Installation. Lists of native species under consideration for use in the project are organized in the 100% Design Development Documents by land cover type and moisture tolerance. Species lists were developed by RES ecologists based on field observations during site visits and descriptions of native plant communities in the T. Roosevelt National Park South Unit (Von Loh et al. 2007).

All grasslands areas will be seeded with native forbs and graminoids. Disturbed Prairie and Blufftop Mixed-grass Prairie/Invasives areas will be seeded with the Mixed-Grass Restoration Mix intended for complete replacement of

disturbed areas by a high-diversity mixed-grass prairie. Other grassland management areas will be overseeded with enhancement mixes designed to increase plant species diversity and abundance by three years after seeding.

Native seed mixes require specific conditions for germination. Installing seed materials at inappropriate times can cause delays in seed germination and significantly reduce the viability of the plantings. For this reason, the specified permanent seed mixes should be installed when site conditions are appropriate for equipment operation and proper seed-soil contact.

Seed in restorations is usually provided as pure live seed (PLS) and genetic origin reported. All native and live seed material must have a genetic source origin within a 150-mile radius of the project site to ensure genetic adaptability to local climate and soil conditions.

2. Woody Draws

During an April 1, 2021, wildfire, woody draws, north slopes, and the edges of the blufftop prairie lost most of their juniper cover (*Juniper communis, J. horizontalis, J. scopulorum*). Post-burn observations in May found native shrubs resprouting: rose (*Rosa sp.*), skunkbush sumac (*Rhus trilobata*), chokecherry (*Prunus virginiana*), golden gooseberry (*Ribes aureum*) and snowberry (*Symphoricarpos orbiculatus*).

This area will be seeded with the Woody Draw Mix intended for bare ground seeding in ravine bottoms with naturally heavy tree and shrub cover and bare soils mineralized by intense fire. Woody Draws are the only places considered for shrub planting, besides near the building and parking lots.

Initial concept for management is to include woody draws in a grazing regime and carry out a prescribed burn once every 10-25 years. Implementing this management regime aims to establish nearly continuous native groundcover by the third year after seeding, with good graminoid and forb diversity.

3. Stormwater Management Areas

Stormwater Management Areas include rock swales and mesic prairies near impervious surfaces. Each area will be planted using live plants, according to planting palette Stormwater Rock Swale and Stormwater Mesic Prairie respectively. Local rock, native grasses, sedges and forbs will be installed in the conveyance swales of parking lots, roadsides and impervious areas. Mesic prairie will be planted in large depressions of the stormwater management system and in the parking lot and turnaround area near the building.

Long term management for both areas will include vegetation mowed and hand-removed at the end of each growing season; and inspections and repairs after large storm events. The outcome should be nearly continuous diverse native plant cover by the end of the second full growing season after installation.

4. Rooftop

RES recommends haying the green roof with a walk-behind tractor (single-axle / 2 wheeled version of a 4-wheel farm tractor). Walk behind tractors can operate the three implements necessary to hay a green roof (mower, hay rake and hay-baler). The operator will cut the hay using a sickle bar or disc mower attachment. After the hay dries properly, a hay rake is used to rake the hay into 'windrows', which allow more efficient gathering (by hand, or using a Hay-Baler). Some of the clippings are left behind to return to the soil as fertilizer while the rest is removed for hay. A bale wrapper can be fitted to the walking tractor, to convert green hay into "haylage" (silage) bales.

Aesthetically hay would be harvested at the end of the growing season, but for optimal forage quality hay should be harvested at the ideal nutrient and moisture range for the type of storage structure being used and livestock being fed (USDA 2010). To allow adequate recovery after hay harvest the TRPL may limit harvest to once every two years.

After mowing, one or more passes are made with a tedder, to fluff up and allow the hay to dry. At least one pass with a rake is needed, then one with the baler. Bales must be removed immediately to allow new growth to begin. Periodically allowing full flowering and seed set by plants on the roof will enable seed to be blown into the surrounding landscape.

To protect nesting birds haying should be postponed until after July 15 and haying begun in the center of the roof to flush birds towards the perimeter. Cutting towards the base of the roof, where it meets the ground, is an additional precaution that can protect nesting birds.

5. Native Lawns

Lawns will be seeded using the Lawn Mix, a bare ground mix of grasses and sedges that can withstand human trampling. Long term management includes overseeding as needed to restore native dominance and cover and mowing if desired to make vegetation uniform.

Integrated Pest Management

RES encourages employing an Integrated Pest Management (IPM) approach (Appendix A). All control measures (mechanical, cultural, biological, and chemical) are considered and used as appropriate. The combination is determined by the vulnerabilities of the invasive plants being controlled.

Spot herbicide application will be employed during the establishment period, when the ecosystem is actively being restored to bring back the dominance by native plants. During long-term management, however, herbicides will not be used except as a last resort after other methods have failed to control an aggressive invasive plant.

Herbicides with petrochemicals listed on published ingredients are on the LBC Red List (version 4.0). LBC would like to significantly curb or eliminate these items. Red List represents the "worst in class" materials, chemicals, and elements known to pose serious risks to human health and the greater ecosystem.

ILFI provided a list of herbicide products (Appendix A) that were submitted in 2018 by another LBC applicant. At that time, ILFI reviewed the published manufacturer ingredient lists for each product listed to determine compliance with LBC's Red List of approved herbicides from previous project. RES evaluated whether the approved products below would be effective controls for three problem species at the TRPL: crested wheatgrass (*Agropyron cristatum*), Canada thistle (*Cirsium arvense*) and leafy spurge (*Euphorbia esula*)(Appendix A).

Invasive plants create a seedbank that germinates for years. Increasing native plant cover and root density is the most effective way to suppress the germination and growth of invasive plant seedlings.

Erosion Management – IN DEVELOPMENT

- Grading and Soil Preparation
    - Addressing Soil Compaction
- Preparing for Seed Installation
- Seed Installation
    - Temporary Stabilization of Disturbed Ground
- Final Stabilization Measures
    - Straw, Hydromulch, Erosion Control Blanket, Coir Rolls & Mats, Encapsulated Soil Lifts, Scour Protection
- Vegetation Establishment Maintenance

Adaptive Management

Restoration and management plans need to be flexible. Restoration is often not implemented according to plan because timing of funding may not align with field operations, the response of ecosystems may force adjustments in technique, and the management needs of an ecosystem may change in as new threats and conditions arise. New scientific findings and insights also change restoration plans and management practices. For these reasons, a land management plan should be viewed as a starting point in a process of restoring biodiversity and natural processes to natural areas, subject to amendment as conditions and information change.

Figure 9 Adaptive management cycle. Source: Conservation Measures Partnership 2022

Regular monitoring and reporting provide feedback on a restoration program's effectiveness. Monitoring also generates information to justify changes in the plan. Adaptive management is an approach to structured decision making in the face of uncertainty, with an aim to reducing uncertainty over time by using a cycle of planning, implementation, monitoring, evaluation, adjustment, and further implementation (Figure 6). Adaptive management is used in the best restoration programs, begins during initial restoration work, and continues indefinitely as natural areas are managed into the future.

INDICATORS OF ECOLOGICAL HEALTH AND RESILIENCE

General ecological health and resilience indicators help guide restoration and management actions for a given location at a given time. They help by identifying the point at which the expected outcome is achieved. Overall that outcome is to establish an ecologically healthy, relatively low-maintenance native plant community or ecosystem. Indicators chosen for the TRPL site are:

- Percent bare ground. The amount of bare ground in rangeland indicates the effect of grazing and is related to ecological processes such as runoff infiltration rate, plant cover, soil microbial activity, and germination of seedlings.
- Percent native plant cover. The amount of ground blanketed by native plant cover indicates the effect of grazing and suitability of habitat for many wildlife species. A higher percentage of native plant cover generally results in greater abundance of nectar, pollen, seeds, fruits, and insect life that provide much of the food at the lower levels of the food chain in grasslands.
- Percent invasive plant cover. The invasive plants at TRPL generally reduce the livestock forage value of the rangeland by competing with other more palatable species.
- Number and abundance of native plant species. In general, a high number of plant species distributed evenly across a landscape, results in a greater variety of food and animals using that landscape. Supporting rare plant species is also a way to preserve biodiversity in the Little Missouri Badlands region.
- Number and abundance of bird and butterfly species. Birds and butterflies indicate the suitability of habitat for two large groups of animals. Moreover, they are easy to detect, and most are easy to identify, making it possible for volunteers to carry out annual censuses of these species.
- Amount of soil organic carbon (SOC). Soil organic carbon accrues in grassland soils at different rates, depending on many factors, but most importantly, on the grazing regime. One grazing regime in particular, adaptive multi-paddock (AMP), results in higher rates of SOC accrual in soils than the current continuous grazing practice or other grazing practices such as reduced stocking or rotational grazing. Measuring SOC indicates the effectiveness of the grazing regime at replicating the historically high levels of SOC accrual that occurred in North American grasslands.
- Area of actively eroding locations. Several ravines are actively eroding, head-cutting into the nearby bluffs because the vegetation cover is too sparse. It is expected that changing the grazing regime and overseeding with native species will reduce water runoff by increasing the organic matter content in soils, which creates greater soil porosity and higher soil infiltration rates.

MONITORING – IN DEVELOPMENT

Seeing the trends in ecological health and resilience indicators requires regular monitoring. This can be a rapid, simple assessment or quantitative sampling and analysis. Scheduling a monitoring visit each year, followed by a management plan for the coming year, protects the restoration investment and ensures that a plant community continues its a trajectory to greater ecological health.

Monitoring is best conducted by a qualified biologist, ecologist, or other professional able to identify native plant species and recognize undesirable plant species for treatment. In seeded areas, vegetation monitoring is done in the growing seasons, when vegetative cover is well developed and weeds can be readily identified and controlled. Measuring the indicators above will help establish whether trends in vegetation, soils and wildlife are positive, negative, or neutral.

REFERENCES & RESOURCES

Alstad, A.O., E.I. Damschen, T.J. Givnish, J.A. Harrington, M.K. Leach, D.A. Rogers, D.M. Waller. 2016. The pace of plant community change is accelerating in remnant prairies. *Science Advances* 2:e1500975.

Baydack, R.K. and Hein, D.A. 1987. Tolerance of sharp-tailed grouse to lek disturbance. *Wildlife Society Bulletin* 15:535-539.

Bluemle, J. 2016. *North Dakota's Geologic Legacy: Our land and how it formed.* North Dakota State University Press, Fargo ND.

Connelly, J.W. and C.E. Braun. 1997. Long term changes in Sage Grouse *Centrocercus urophasianus* populations in western North America. *Wildlife Biology* 3: 229–234.

Conservation Measures Partnership. 2007. Open standards for the practice of conservation, Version 2. Accessed January 2021 at: www.conservationmeasures.org.

Danzl, M.R. 2018. A review of the state of sharp-tailed grouse with management considerations in Minnesota and North Dakota. M.S. Thesis, North Dakota State University, Fargo ND.

Drummer, T.D., R.G. Corace, and S.J. Sjogren. 2011. Sharp-tailed grouse lek attendance and fidelity in Upper Michigan. *Journal of Wildlife Management* 75:311-318.

Godfread, C. 1994. The Vegetation of the Little Missouri Badlands of North Dakota. Leafy Spurge Strategic Planning Workshop, Dickinson ND. North Dakota State University Extension (Fargo) and T. Roosevelt National Park, Medora ND.

Grange, W. 1948. Wisconsin grouse problems. Project S-R, Federal Aid for Wildlife Research, Wis. Conservation Dept., Madison WI.

Hassan, R., R. Scholes, and N. Ash. 2005. *Ecosystems and Human Well-being: Current State and Trends, Volume 1, Findings of the Condition and Trends Working Group of the Millennium Ecosystem Assessment.* Island Press, Corvella WA.

Kral-O'Brien, K.C., Sedivec, K.K., Geaumont, B.A. and Gearhart, A.L. 2020. Resiliency of native mixed-grass rangelands and crested wheatgrass pasture lands to spring wildfire. *Rangeland Ecology and Management* 73:119–127.

Landel, H. 1989. A study of female and male mating behavior and female mate choice in the Sharp-tailed Grouse, *Tympanuchus phasianellus jamesi*. Ph.D. Dissertation, Purdue University, West Lafayette IN.

Leach, M.K. and T.J. Givnish. 1996. Ecological determinants of species loss in remnant prairies. *Science* 273:1555-1558.

Le Maitre, D.C., B. W. Van Wilgen, R. A. Chapman and D. H. McKelly. 1996. Invasive plants and water resources in the Western Cape Province, South Africa: modeling the consequences of a lack of management. *Journal of Applied Ecology*. 33: 161-172.

McDonald, T., J. Jonson and K.W. Dixon. 2016. National standard for the practice of ecological restoration in Australia. *Restoration Ecology* 24:4-32.

Prose, B. L. 1987. Habitat suitability index models: plains sharp-tailed grouse. Biological Report 82 (10.142). U.S. Department of the Interior, Fish and Wildlife Service, National Ecology Center, Washington DC.

Sexton, D.A. and M.M. Gillespie. 1979. Effects of fire on the location of a sharp-tailed grouse arena. *Canadian Field-Naturalist* 93:74-76.

U.S. Department of Agriculture. 2007. Fish and Wildlife Habitat Management Leaflet Number 40. Sharp-tailed Grouse (*Tympanuchus phasianellus*). USDA, Natural Resources Conservation Service, Washington DC.

U.S. Department of Agriculture (USDA). 2010. Conservation practice specification forage harvest management – 511. Accessed Feb. 9, 2022 at: https://efotg.sc.egov.usda.gov/references/public/ND/511_specs.pdf.

Von Loh, J., Cogan, D., Butler, J., Faber-Langendoen, D., Crawford, D., and Pucherelli, M.J. 2007. USGS-NPS Vegetation Mapping Program: Theodore Roosevelt National Park, North Dakota. Retrieved from USGS: http://biology.usgs.gov/npsveg/thro/throrpt.pdf.

Weir, J.R., S.D. Fuhlendorf, D.M. Engle, T.G. Bidwell, D. Cummings, D Elmore, R.F. Limb, B.W. Allred, J.D. Scasta and S.L. Winter. 2013. Patch burning: integrating fire and grazing to promote heterogeneity. E-998, Oklahoma Cooperative Extension Service. Oklahoma State University, Stillwater OK.

Winter, S. L., S. D. Fuhlendorf, C. L. Goad, C. A. Davis, K. R. Hickman, and D. M. Leslie. 2012. Restoration of the fire-grazing interaction in *Artemisia filifolia* shrubland. *Journal of Applied Ecology* 49:242–250.

APPENDIX A – EVALUATION OF HERBICIDES FOR USE AT TRPL DURING ESTABLISHMENT PHASE

RED LIST APPROVED SPECIES

Lisa Carey Moore (ILFI staff) provided a list below of herbicide products that were submitted by another LBC project in 2018 (Table 1). At that time, ILFI reviewed the manufacturer's ingredient lists for each product to determine compliance with LBC's Red List of approved herbicides from previous project. RES reviewed these approved products for their effectiveness at controlling three problematic species at the TRPL site: crested wheatgrass (*Agropyron cristatum*), Canada thistle (*Cirsium arvense*), leafy spurge (*Euphorbia esula*).

Table 1. ILFI-Approved Herbicides and Suitability for Use at TRPL Site

Lontrel	Selective post-emergent herbicide that controls certain broad-leaf weeds in turf and certain ornamental plantings, such as conifers and non-leguminous woody species, in landscapes and nurseries. Lontrel can be used on warm-season and cool-season turf grasses. **Can be used to control Canada thistle.**
Oryzalin	These herbicides are selective and used as a pre-emergent applied herbicide for the control of broadleaf weeds and annual warm season grasses. **Can be used as a pre-emergent to control leafy spurge.**
Fusilade	Selective post emergent turf and ornamental herbicide that controls a long list of both perennial and annual grass weeds in a variety of turf and landscape areas. **Not suitable for TRPL.**
Gallery	Pre-emergence product for control of broadleaf weeds in established areas of turfgrass, landscape ornamentals, field grown ornamentals, container grown ornamentals, groundcovers/perennials, ornamental bulbs, non-cropland, and Christmas tree/conifer plantations. **Not suitable for TRPL.**
Image	Post-emergent herbicide that can be used on southern turf grass and selected ornamentals. **Not suitable for TRPL.**
Katan	Katana Turf Herbicide is a selective herbicide that controls a broad range of broadleaf weeds in zoysia grass, buffalo grasses, bermudagrass, centipede grass, seashore paspalum and other warm-season turfgrass. **Not suitable for TRPL.**
Q4	Selective pre-emergent control of grass and broadleaf weeds that are in established turfgrass**. Not suitable for TRPL.**
Resolute	Selective pre-emergent control of grass and broadleaf weeds that are in established turfgrasses, sod nurseries, field-grown, landscape and container ornamentals; established wildflower and perennial plantings; and Christmas tree farms. **Not suitable for TRPL.**
RoundUp	**NOT ON ILFI APPROVED LIST. Strongly recommended for use at TRPL during 5-year restoration and establishment phase of project, but not thereafter. Effective on Canada thistle and crested wheatgrass.**
2,4-D	**NOT ON ILFI APPROVED LIST. Strongly recommended for use at TRPL during 5-year restoration and establishment phase of project, but not thereafter. Effective on leafy spurge. See below memo regarding IPM approach to leafy spurge control.**

In addition, RES strongly recommends that glyphosate (trade name RoundUp) be approved for use during the restoration and establishment period (years 1-5) because it is an effective control for Canada thistle, leafy spurge and crested wheatgrass. Due to its effectiveness, short residence time in the soil, and low risk at the concentrations used in ecological restoration, it is widely used in ecological restoration. (Reported risks of cancer and damage to the environment from glyphosate are based on its use at higher agricultural concentrations and in broadcast spraying of cropland.) RES strongly recommends that 2,4-D also be approved for use during the

restoration and establishment period because it is an effective control for leafy spurge and does not harm native grasses; this would preserve the surrounding grass matrix to compete with and suppress leafy spurge seedlings.

Experienced, trained restoration workers can apply both herbicides discretely with minimal drip or drift. They would not, however, be used beyond the restoration and establishment period, when carrying out long-term management activities.

Land management at the TRPL site will use an Integrated Pest Management (IPM) approach in which biocontrol , mechanical removal, and cultural practices are employed before chemicals are used. Each invasive plant species is evaluated for life history traits that are vulnerable to attack, and specific controls are prescribed in a holistic sequence. Successful IPM requires several years and managers must be flexible in their use of control tools. The effect of a control tool should be evaluated each year and the next year's work planned based on the response of the invasive plant to the control.

Soil disturbance should always be avoided as that creates opportunities for weed seeds in the soil seed bank to germinate. Control measures should always be implemented before plants produce seed, to reduce the seed rain that replenishes the soil seed bank. Ideally managers should strive to detect new colonies of invasive plants and control them while they are small. In addition, managers should avoid spreading invasive plant seed by washing boots and tools and cleaning vehicles, equipment and animals that have been within infested areas. Weed control measures will be communicated to the US Forest Service and Medora Foundation.

If herbicides must be used, they will be applied at rates recommended for site conditions and specified on the product label. Herbicides will be used during the restoration and establishment period, to re-establish the native plant cover and biodiversity that has been lost due to continuous grazing. This period can last up to five years, or until 2028. Thereafter, in long-term management, an IPM approach would employ mechanical removal, biocontrol, and cultural practices first, and use limited quantities of herbicides in discrete areas only if other techniques failed and the risk of invasive plant expansion on the site was severe enough.

PROBLEMATIC INVASIVE PLANT SPECIES AT THE TRPL SITE

Leafy spurge is one of the most aggressive and damaging weeds in the northern Great Plains, preventing grazing on tens of thousands of acres of rangeland.

- Fairly successful biological control is available (flea beetles). Control is never fully achieved, however, due to fluctuations in beetle abundance from year to year. Biological control is most effective in combination with one or two other techniques.
- Mechanical control (mowing, hand-pulling, tilling) typically is not successful because the entire root system must be removed. Mechanical methods can even increase plant density if root fragments remain.
- Sheep or goats can be confined to areas with high leafy spurge density and reduce the plant's cover. Multiple grazing episodes are needed in a single year to kill plants. Native plants will be subject to the same grazing pressure, which will also kill them.
- Because other methods will not eliminate spurge, and because spurge can quickly return to areas from which it was removed, herbicide application is strongly recommended to kill the remaining plants.

Crested wheatgrass crowds out native plants; it grows in tight bunches that leave little room for other plants.

- No insect biological control agents are available.

- Palatability to livestock means grazing can be used before seed production begins. Mowing can occur prior to seed production and will deplete the plant's root energy reserves. Repeated mowing or grazing is not recommended due to its impact on native plants.
- Crested wheatgrass is distinguishable from native grasses.
- Dense stands can be controlled with glyphosate when the plants are 8-15 cm tall and before seed formation. Up to three years of spot application are required to eliminate crested wheatgrass.
- An effective petrochemical-free herbicide does not exist to manage crested wheatgrass.

Canada thistle quickly spreads via vegetative shoots and seeds, forms dense stands, and is not eaten by livestock.

- Biological control is practiced in North Dakota, but is not suitable for large infestations or landscape-level control.
- Cutting thistles prior to late-June flowering is key to preventing spread. Canada thistle flowers after cutting, however, so cutting must be repeated from mid- to late summer. Equipment used must be inspected and thoroughly cleaned to ensure that seeds are not being spread elsewhere.
- Increasing the cover of competitive native plant species together with mechanical control will suppress Canada thistle. Native plants that germinate and grow quickly (i.e., early successional species) can be seeded and used to control thistle where native plant cover is sparse or soil has been disturbed.
- Herbicide application is optimal in fall when Canada thistle is building root mass (rather than growing stems, leaves and seeds). Systemic herbicides are carried with sugar into the roots. Lontrel is an ILFI approved herbicide. Table 2 identifies a list of herbicides that are recommended to be effective against Canada thistle by North Dakota State University.

Other major problematic species at the TRPL site are Kentucky bluegrass (*Poa pratensis*), smooth brome grass (*Bromus inermis*), and yellow sweet clover (*Melilotus officinalis*). As these are widespread and firmly embedded in the mixed-grass prairie community, TRPL will control them by improving range quality using AMP grazing and overseeding with native plant seed mixes.

BIOLOGICAL CONTROL AGENTS

Leafy Spurge Biological Control

Effective and well-established biocontrol agents include the black flea beetle and leafy spurge beetle (*Aphthona A. nigriscutis, A. lacertosa*) and the longhorn stem/root-boring beetle, *Oberea erythrocephala*.

Aphthona adults feed on leafy spurge foliage larvae feed on the roots. Larvae feed on both the fine feeder roots used by the plant to absorb water and nutrients and the storage tissue of the root crown. This feeding both destroys root tissue directly and causes the plant to be more susceptible to other methods of control, such as herbicides and infection from soil borne pathogens. Research at North Dakota State University found flea beetle establishment was best on silt loam, silt clay loam, clay loam and clay soils with an organic matter content of 6 percent to 9.5 percent.

Flea beetles were least productive in fine sand to loamy fine sand soils with an organic matter content of 1 percent to 3 percent. In addition, the release area needs to be well-drained and not subject to frequent prolonged flooding or standing water, which will kill the larvae. Generally, flea beetles have not been very successful in controlling leafy spurge growing along waterways, in shaded areas or in very sandy soil.

Black Flea Beetle (*Aphthona nigriscutis*) (photo by Noah Poritz). Native to Europe and adapted to drier sites and sandier soils, the black flea beetle has been most successful in establishing and controlling leafy spurge in dry, open, sandy-loam sites. It has performed poorly in high-density leafy spurge infestations on clay soils. Wild populations in North America are 85-99 percent female. Collect this beetle in July to allow females to mate with the low number of males; otherwise most females will be unmated and the released population may fail.

Near Edmonton, Canada, leafy spurge cover decreased from 40 to 1.7 percent five years after the black flea beetle was released. At two sites in North Dakota, black flea beetle and leafy spurge beetle reduced leafy spurge cover from 45 to 7 percent over three years and reduced stem density nearly 40-fold.

Herbicides combined with black flea beetles or leafy spurge beetles or with the gall midge (*Spurgia esulae*) controlled leafy spurge better than either method alone. It is necessary to employ the biocontrol separately from herbicide application to avoid harming the flea beetle population.

Leafy Spurge Beetle (*Aphthona lacertosa*) (photo by Noah Poritz)**.** Native to Eurasia on loamy to loamy-clay soils, in dry or wet habitats, its effect in North America at controlling leafy spurge is best on moderately dry to moist sites. The leafy spurge beetle has a broad ecological amplitude, enabling it to persist and control spurge over a larger range of habitats than the black flea beetle.

Longhorn Beetle (*Oberea erythrocephala*) (photo by Noah Poritz). The longhorn beetle is native to Eurasia where it feeds within the stems and roots of spurge. Adults appear in June and July and feed on young leaves, flowers and stems for two weeks before laying eggs. Adult beetles girdle the upper stem, chewing a hole just above the girdle where they insert an egg and seal it with latex.

During the next month, larvae mine down the stem into the root crown and roots. Larvae feed on the crown and roots until March or April the next year and pupate in the root crown in May. The beetle is most effective in sunny areas near streams and on the banks of large rivers. It is less reliable as a biocontrol than the two flea beetles.

Crested Wheatgrass Biological Control

No insect biological control agents are available.

Canada Thistle Biological Control

Two biological control agents were introduced and a third accidentally introduced. None are effective at reducing the weed on a large scale.

Memo

To: Amy McCann, Tony Erickson, T. Roosevelt Presidential Library

Cc: Kurt Marsh, Matt McMahan, Snohetta

Doug Mensing, Matt Lasch, Ryan Templeton, RES

Fr: Kim Chapman, RES

Re: Leafy Spurge Control at TRPL

Dt: 10/6/2022

No: RES 104838

Issue

- Leafy spurge (*Euphorbia esula*), a North Dakota-listed noxious weed that reduces the economic value of rangeland, grows at the TRPL site.
- Leafy spurge grows in small patches of <10 square meters and larger patches covering a quarter acre or more. See Figure 1 below for details.
- Controlling leafy spurge is essential to optimally using the TRPL site for grazing and so that the site can serve as an example of good range management.
- Leafy spurge is difficult to control due to its deep and extensive root system. It is not harmed by fire and resprouts from roots. Once established, it expands colonies by root growth and seed, which can be ejected from the seed pod up to 15 feet from the mother plant. Germination is high and seed remains viable in the soil for up to ten years.
- Different methods are used to control leafy spurge. Each method has its pros and cons.
- The more aggressive the control measures, the more damage that will occur to native plants. Accepting some leafy spurge—rather than total eradication—increases options for treatment, especially biocontrol which generally does not eradicate leafy spurge but, of the tools discussed below, has the least impact on native plants.

Control Tools

- **Pasture Management.** Establishing and maintaining a dense cover of native vegetation, with its equally dense root mass below, reduces the density of leafy spurge through competition for light, water, and nutrients. Dense native plant cover is more resistant to leafy spurge invasion than pasture with sparser vegetation. Continuous grazing with insufficient rest between grazing episodes weakens root systems, producing sparser vegetation generally and creating opportunities for leafy spurge germination. Close-cropping of pasture also weakens root systems. Short periods of intensive grazing that remove no more than half the plant biomass, followed by a long period of rest, is the best way to maintain dense native vegetation, promote root growth, and in turn create resistance to leafy spurge invasion.
- **Biological Control.** Larvae of the black flea beetle (*Apthona nigriscutis*) and of the leafy spurge beetle (*A. lacertosa*) feed on roots of leafy spurge, damaging them and reducing the vigor of plants. They are the most successful leafy spurge biocontrol species in North Dakota. If burning, mowing or herbicides are used in combination with beetles, do not use these techniques during the growing season (May-September) when adult beetles are active. Biocontrol avoids harm to all other plants

and the general environment, but a few years are needed for the beetles to establish control over leafy spurge. Also, since the beetles rely on leafy spurge for survival, their population will fall if they successfully and dramatically reduce leafy spurge cover. This can set in motion a boom-bust cycle of rising beetle abundance followed by rising leafy spurge abundance. In years of low leafy spurge abundance, other measures may be used to drive the spurge abundance lower. In general, however, if biocontrol is used without other measures, some leafy spurge will persist. In healthy range, however, competition from native plants will help keep spurge density and abundance low.

- **Herbicide Control.** A few to several applications of a systemic herbicide for up to three years can greatly reduce or even eliminate leafy spurge. Among several herbicides recommended (imazapic, picloram, glyphosate, dicamba), the broadleaf herbicide 2,4-D may be most effective at reducing leafy spurge with the fewest side effects. It has among the shortest half-lives of the widely used herbicides. It targets broadleaf plants, leaving native grasses largely unharmed. While potentially toxic to mammals, birds and fish (but not honeybees), the risk can be managed by careful application at the lowest concentration possible. Spot-spraying is most effective. While there is a risk of drip and drift with spot-spraying, a careful operator working under ideal weather conditions can minimize side effects. Spot-spraying uses less herbicide than wick-application (though wick-application is more targeted). If wick-application is used to minimize drip and drift, the style of wick should be appropriate for the plant's growth form—sparse, short leaves and a narrow, flexible stem. It may not be possible to wick-apply using an ATV if the spurge height is equal to that of surrounding vegetation. Using a hand-held wick-applicator is more time-consuming than spot-spraying and ATV wick-application. Lastly, a prescribed burn prior to herbicide application will stimulate growth of leafy spurge and remove dead thatch, making herbicide application more effective. If thatch is minimal due to a prior fire and grazing, then there is less benefit from a prescribed burn before herbicide application.
- **Mechanical Control.** Mowing or burning combined with herbicide application can reduce the density of leafy spurge. Mowing or burning alone will not reduce density unless repeated multiple times in a growing season—but many native plant species will be harmed by frequent mechanical control because the roots will be starved of nutrition from photosynthesis by the leaves. Hand pulling individual stems of young plants, or clipping individual older plants, can reduce leafy spurge growth temporarily, but to be effective the practice must be repeated three or four times in a growing season until the spurge no longer resprouts.
- **Grazing.** Goats or sheep grazing in confined pastures can reduce leafy spurge density; cattle and horses avoid leafy spurge. Allow the animals time to eliminate leafy spurge seed from their digestive tract before moving them off the site. The animals may need to graze each pasture several times before leafy spurge is noticeably reduced. However, the frequent, close grazing required to control leafy spurge will negatively affect many native species as well.

Recommended Approach at TRPL Site

Small Patches

- **Pasture Management.** 2023. Rest the pasture to increase the density of native plant cover and allow native plant root systems to expand.
- **Herbicide Control.** June 2023. Spot-spray 2,4-D herbicide at lowest effective concentration to individual plant stems and leaves of leafy spurge. (Wear gloves and mask. Wash clothes after applying herbicide.) Observe effect two weeks later. If effect is weak, re-apply in October 2023.
- **Herbicide Control.** 2024. Repeat herbicide application on surviving individuals.

Large Patches

- **Pasture Management.** 2023. Rest the pasture to increase the density of native plant cover and allow native plant root systems to expand.
- **Biological Control.** June-July 2023. Collect beetles from off-site areas and release them in June-early July in the dense patches outside the limits-of-work line (see Figure 2 below). Large patches lie

a) west and north of the proposed building and downslope and b) in the grasslands of the valley north of the building and on adjacent grassy slopes (not shown in Figure 2).

- **Biological Control.** June-July 2024. Check effect of beetles on leafy spurge. If the beetles are effective, some reduction in density should be seen; two years after introducing beetles, leafy spurge stem density may be 50 percent lower than the initial density. If effect is weak, collect and release a second round of beetles in June-early July 2025 in the dense patches.
- **Herbicide Control.** June 2023. Spot-spray 2,4-D herbicide at lowest effective concentration to scattered individual plants and plants at the edges of the large patches. (Wear gloves and mask. Wash clothes after applying herbicide.) Observe effect two weeks later. If effect is weak, re-apply in October 2023. Herbicide in combination with flea beetles is more effective than flea beetles alone.
- **Herbicide Control.** 2024. Repeat herbicide application on surviving individuals.
- **Pasture Management.** 2024. Consider using sheep in small pastures around leafy spurge patches. Sheep in combination with flea beetles are more effective than flea beetles alone. Time the grazing to not fall within the time that the herbicide remains active, to minimize risk to grazing animals.

Figure 1. Leafy spurge concentrations on the TRPL site

Leafy spurge at TRPL is concentrated around the proposed building location, with scattered small colonies elsewhere on the blufftop. Blue dots represent large patches and purple dots small ones of less than 10 square meters each. Leafy spurge also grows in small and large patches in the valleys south and north of the blufftop and along the north edge of the blufftop, extending downhill towards the woody draw.

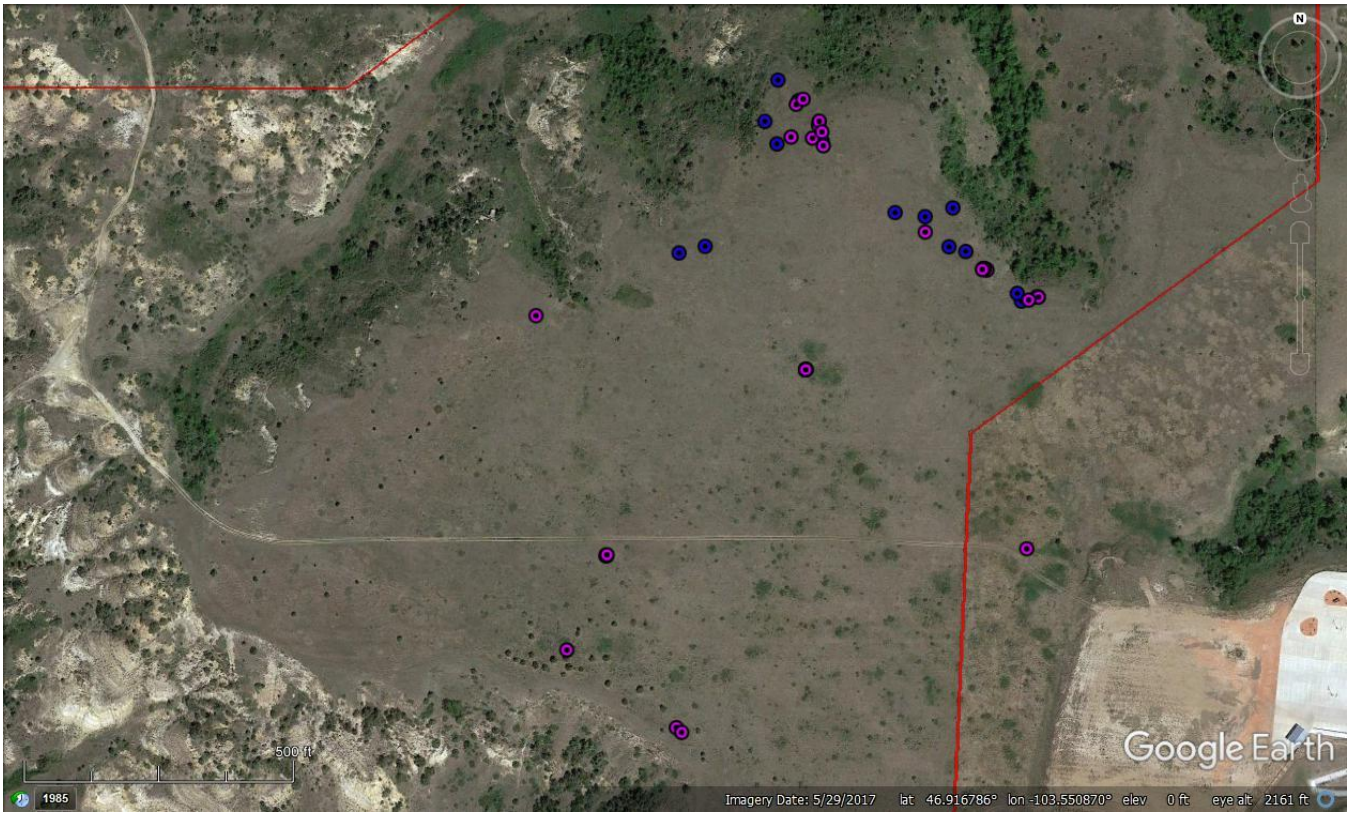

Figure 2. Limits-of-work line at the TRPL site

Limits-of-work line is shown in red. Areas inside this line are expected to be graded, excavated and disturbed during the construction of the building and other infrastructure. Leafy spurge control is not needed inside the limits-of-work line.

APPENDIX B – SCHEDULE OF PLANT PROCUREMENT AND CONSTRUCTION (CURRENT 7/20/2022)

Project Phase			DESIGN DEVELOPMENT & CONSTRUCTION DOCS (TO JULY 2023)				BIDDING - AUG-OCT	CONSTRUCTION (TO DEC 2025)											July 4 Opening
LOD = Limits of Disturbance			2022				2023				2024				2025				2026
Plant Material	**Area Involved**	**Activity**	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Native seed	All restoration & enhancement zones & native lawns	Seed Procurement		Assess commercial availability						Assess commercial availability									
				Wild collect seed June-Oct				Wild collect seed June-Oct											
						Clean, test & tag bagged wild harvest seed - Nov-Feb				Clean, test & tag bagged wild harvest seed - Nov-Feb									
		Grow Seed in Nursery Beds						Nursery bed planting (live plugs of key forbs) - May				Nursery bed planting (live plugs of key forbs) - May							
													Harvest, clean, test & tag bagged						
		Installation							Installer quals & product meet performance standards		Drill restoration seed mix in disturbed areas - March				Drill? key forb seed from nursery beds into disturbed areas - March				
									Installer quals & product meet performance standards		Broadcast enhancement seed mix in existing prairies - March				Broadcast key forb seed into existing prairies from nursery beds - March				
												Year 1 Establishment Maintenance -				Year 2 Establishment Maintenance -			
		Long Term Maintenance																	Long-Term Maintenance Begins	
Native live plants	Library roof, stormwater mesic prairies & bioswales; building grounds, trail verges, etc.	Procure Seed to Grow Live Plants												Use wild harvest, commercial purchase, & nursery bed harvest						
		Test Mock-Up			Secure live plants & build mock-up				Evaluate performance				Evaluate performance							
		Plant Growing (Greenhouse)												Grow live plant plugs - Dec-Mar		Quality acceptance by owner				
		Installation														Live plug 50s (72s?) 9" o.c. w/irrigation - April-May				
																Year 1 maintenance			Year 2 maintenance	

APPENDIX C – SHARP-TAILED GROUSE AND LEK HABITAT

Sharp tailed grouse (*Tympanuchus phasianellus*) are found on vast grassland areas with various amounts of interspersed brushy components and few trees present. Mating and courtship occur on congregating areas called leks. These areas are a focal element of their local population centers and occupy a portion of their relatively large individual home ranges (Danzl 2018).

Vegetation

The plains grouse is typically found in medium to tall grasslands for courtship and nesting. Aldrich (1963) details Lek habitat as including a variety of open cover of rolling knobs and hills with nearby grass, herbs, and shrubs for feeding and roosting. Higher elevation areas are selected to increase visibility from male to male when establishing territories, approaching females within the lek, and from predators (Manske and Barker 1987). Close proximity of concealment cover is necessary and should include a variety of grass structure including short grasses and interspersed bunchgrasses (Danzl 2018).

Sharp tailed grouse prefer leks sites with short, sparse vegetation such as grasses, weeds, forbs, and some shrubs. Sparse and open vegetation on leks enables aggressive displays by males and minimizes predation. Sparse shrubs providing escape cover from predators, are often found adjacent to leks. Leks are sometimes associated with recently burned or grazed sites. Changes in land use on a lek resulting in taller, denser vegetation have been shown to cause eventual abandonment of the lek. An excess of woody cover can adversely affect leks (Prose 1987). Leks cover a relatively small area ranging from the size of a small house to a baseball diamond. Lek locations are generally traditional from year to year, providing the habitat is still suitable. Lek locations may change if a lek is covered with water, or if taller, denser vegetation develops (NRCS 2007).

Manske and Barker (1987) detail vegetation at lek sites in southeast North Dakota as consisting mainly of blue grama (*Bouteloua gracilis*), needle and thread (*Hesperostipa comata*), sun sedge (*Carex inops/heliophila*), big bluestem (*Andropogon gerardii*), little bluestem (*Schizachyrium scoparium*), and switchgrass (*Panicum virgatum*). Females select the nest site in grassland with brushy cover, usually less than a mile from the lek, in a place with vegetation at least 3 inches high (Manzer et al 2005).

Breeding Season

In the region sharp-tailed grouse begin their breeding season in early spring during the month of March or April (Drummer et al. 2011).

Management of Leks

Maintain low and open grass on lek sites, and mow or burn over mature vegetation within a half-mile radius. Several land management practices are detrimental to sharp-tails: tree planting, primarily conifer and hybrid poplar plantations; allowing brush to grow to trees; extensive agricultural development; fire suppression; and insecticide application. Additional threats to sharp-tail habitat include urban sprawl and associated development (USDA 2007).

Fire is an important factor in creating and maintaining sharp-tailed grouse habitat. Fire helps to maintain early successional stages of grasses, sedges, forb, and shrubs, all of which provide cover and food for sharp-tailed grouse [Grange 1948]. Sharp-tailed grouse need open habitat with good horizontal visibility for lek sites, so fires that reduce tall cover would enhance lek availability and quality [Sexton 1979].

Fire is considered beneficial to sharp-tailed grouse, severe fire may eliminate valuable cover essential for nesting, roosting, hiding, and feeding. Severe fires in autumn may eliminate the entire winter food and cover resource, making winter survival in that area nearly impossible (Grange 1948).

Disturbance

Early experiments by Baydack & Hein (1987) revealed that female grouse are more susceptible to human presence on leks than are males. Female sharp-tailed grouse in Manitoba, Canada, avoided disturbed leks, while males returned to their lek soon after a disturbance had ceased. Females tend to visit leks 1–10 times within a breeding season and may attend more than one lek (Landel 1989, Connelly et al. 1997). As a result, disturbance may result in the reproductive failure of local leks.

References

Aldrich, J.W. 1963. Geographic orientation of American Tetraonidae. Journal of Wildlife Management 27: 529-545.

Baydack, R.K. & Hein, D.A. 1987: Tolerance of sharp-tailed grouse to lek disturbance. - Wildlife Society Bulletin 15: 535-539.

Connelly, J.W., and C.E. Braun. 1997. Long term changes in Sage Grouse Centrocercus urophasianus populations in western North America. Wildlife Biology 3: 229–234.

Danzl, M.R. 2018. A Review of the State of Sharp-Tailed Grouse: With Management Considerations in Minnesota and North Dakota. Master of Science, University of North Dakota.

Drummer, T. D., R. G. Corace Ii, and S. J. Sjogren. 2011. Sharp-Tailed Grouse Lek Attendance and Fidelity in Upper Michigan. Journal of Wildlife Management 75:311-318.

Grange, W. 1948. Wisconsin grouse problems. Proj. S-R, Fed. Aid Wildl. Res., Wisc. Cons. Dept., Madison 318 pp.

Landel, H. 1989. A study of female and male mating behavior and female mate choice in the Sharp-tailed Grouse, Tympanuchus phasianellus jamesi. Dissertation, Purdue University, West Lafayette, Indiana, USA.

Manske, L.L. and W.T. Barker. 1987. Habitat usage by prairie grouse on the Sheyenne National Grasslands. pp. 8-20. In: A. J. Bjugstad, editor. Prairie Chickens on the Sheyenne National Grasslands. General Technical Report RM-159. Fort Collins, CO: U. S. Department of Agriculture, Rocky Mountain Forest and Range Experiment Station.

Manzer, D.L. and S.J. Hannon. 2005. Relating grouse nest success and corvid density to habitat: A multi-scale approach. Journal of Wildlife Management 69:110-123.

Prose, B. L. 1987. Habitat suitability index models: plains sharp-tailed grouse. Biological Report 82(10.142). Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service, National Ecology Center. 31 p.

Sexton, Donald A.; Gillespie, Murray M. 1979. Effects of fire on the location of a sharp-tailed grouse arena. Canadian Field-Naturalist. 93:74-76.

U.S. Department of Agriculture. 2007. Fish and Wildlife Habitat Management Leaflet Number 40. Sharp-tailed Grouse (Tympanuchus phasianellus). Natural Resources Conservation Service (NRCS).

APPENDIX D – SAMPLE WILDFIRE PROTECTION PLAN OUTLINE – IN DEVELOPMENT

Example Wildfire Protection Plan Outline

1. Regional Wildfire Risk

2. Wildfire Risk at the Prineville-Millican Solar Energy Facility

3. Wildfire Protection Measures at the Prineville-Millican SEF

- 3.1 Fire Break Establishment and Maintenance
  - 3.1.1 On the Site
  - 3.1.2 Off the Site
- 3.2 Fuel Management
  - 3.2.1 On the Site
  - 3.2.2 Off the Site
- 3.3 Other Land-Based Measures

4. Wildfire Condition Monitoring and Early Wildfire Detection

5. Municipal and Agency Wildfire Coordination

- 5.1 Regulatory Requirements
- 5.2 Resource Sharing

6. Prineville-Millican Wildfire Action Plan

- 6.1 Wildfire Protection Strategy
- 6.2 Wildfire Response Coordination
  - 6.2.1 Equipment
  - 6.2.2 Water Sources
  - 6.2.3 Access
- 6.3 Documentation and Reporting

7. References

8. Attachments

- 8.1 Project General Land Cover
- 8.2 Emergency Management Plan
- 8.3 County Fire & Rescue Letter of Approval

Available Fire Protection Best Practices

Source: North Dakota Forest Service – Community Wildfire Planning

https://www.ag.ndsu.edu/ndfs/documents/community-fire-planning-guidance.pdf

- Six steps to create a comprehensive, workable wildfire plan. By following these steps, communities should be able to: achieve wide stakeholder involvement, assess vulnerabilities to the community's current resources and infrastructure, identify areas that need improvement, and implement an emergency response and hazard mitigation plan. This document lists available grants and publications to create a fire prevention plan.

STEP 1 – IDENTIFY STAKEHOLDERS

The effectiveness of a wildfire plan in making significant changes in a community depends on the support of the people who live and work there. Involving a broad range of appropriate stakeholders in the planning process helps the plan address all of the relevant issues and gain greater acceptance from the community. A governmental entity or a commission appointed by a governmental entity should take the lead in the planning process since the local government is the only entity legally able to make decisions on public safety and spending.

STEP 2 – DESCRIBE THE COMMUNITY

Identifiy the area the wildfire plan will affect, as well as resources that can be used to achieve the goals of the plan.

1. Planning Committee Members List

List the names, affiliations and phone numbers of the planning committee members.

2. Population

Provide information regarding the population of the area covered by this plan, both rural and municipal. The area the plan will affect should correspond to the fire protection districts that surround the community.

3. Estimated Property Values at Risk

Provide an approximation of the estimated current values of residential and commercial property covered by the plan (the county assessor should be able to assist with this information). List the number of structures affected.

4. Economic Values at Risk

Describe how the loss of businesses and homes would affect the local economy (tourism, lost pasture land, out-migration)

5. Natural Resources at Risk

Describe the natural resources at risk in the surrounding area, such as parks, lakes, rivers, conservation areas, and wildlife refuges.

6. Historical Structures and Sites at Risk

List any historical structures and/or culturally significant sites.

7. Commercial Entities

List the contact information, location, and potential need for wildfire risk assessment for commercial entities.

8. Formal Associations

List the contact information for civic groups, churches, volunteer organizations, and so forth.

9. Media Support

List the contact information for local media, such as newspapers, television and radio.

10. Schools

List the contact information for all public and private schools.

11. Transportation

List the contact information for any railroad, highway, or other public transportation.

12. Restrictive Covenants, Ordinances, etc.

Describe any pertinent restrictive covenants, ordinances, or other regulations that concern or impact wildfire. For example, list any regulations regarding building construction materials, burning permits, vegetation removal, tree trimming requirements and so forth.

STEP 3 – INFRASTRUCTURE ASSESSMENT

An infrastructure assessment evaluates conditions that may improve or hamper emergency response during a wildfire. The community should work with the municipal and rural road superintendents and utility companies to complete this section.

- Access/Community Location
- Roads
- Driveways
- Structures
- Bridges and culverts
- Utilities
- Wild Fire Risk

STEP 4 – WILDFIRE MITIGATION

State the goals of the community, identifies specific actions needed to meet these goals, identifies timelines for achieving the goals, and lists responsible parties, resources and priorities.

STEP 5 - WILDFIRE RESPONSE

List emergency support equipment and identifies what the emergency support units require to safely and efficiently respond to a wildfire.

STEP 6 – MAPS

Identify areas that contain hazardous fuels, infrastructure that will not support emergency vehicles, evacuation routes and so forth. The maps provide emergency response personnel with crucial information needed during an incident, such as the exact location of transportation routes and critical facilities

Source: National Wildfire Coordinating Group: Wildland Urban Interface Wildfire Mitigation Desk Reference Guide (2019)

Provides basic background information on relevant programs and terminology for those, whether community members or agency personnel, seeking to enhance their community's wildfire mitigation efforts

- Provide a reference to assist with integrating wildland urban interface mitigation principles into national wildland fire training;
- Promote common wildfire mitigation language and culture;
- Establish an authoritative source for wildland urban interface mitigation information; and
- Provide consistent definitions for use by all media.

NFPA (National Fire Protection Association). 2013. Community wildfire safety through regulation: A best practice guide.

https://www.ag.ndsu.edu/ndfs/documents/community-fire-planning-guidance.pdfces guide for planners and regulators. National Fire Protection Association Quincy, MA.

Guide for planners to reduce the danger of wildfires and involve the community in the decision making. Best practices included in this guide are provided below.

Best practice

Defensible Space

Reduce the flammable vegetation that fuels wildfires and you directly reduce the risk of wildfire. Studies show that keeping wildfire 100 – 200 feet away from structures should protect them from ignition in most cases. Defensible space is intended to create this low-fuel buffer and is often divided into the following three zones:

Update Weed Ordinance

Vegetation that is deemed a wildfire hazard is declared a nuisance and the landowner will be given a warning or citation and given a fixed time (e.g., 30 days) to reduce their vegetation, usually consistent with the defensible space requirements above. This approach is entirely dependent on proactive enforcement because compliance is not linked to any permit or regular compliance process

Fire-Resistant Roof

Require Class A or B roofs in the highest risk areas, Class B in moderate risk areas, and Class C in lowest risk areas. Some communities ban all wood roofing materials even though Class A wood shake roofs are available.

Additional Approaches

Community Scale WUI Tools	
Hazard mapping	Conduct hazard assessment (risk of wildfire) and risk assessment (risk of loss of structures or life).
Zoning overlays	Consider using existing zoning overlays for wildfire purpose or develop new overlays applicable to known wildfire areas.
Restriction of sensitive or hazardous uses	Restrict land uses with vulnerable populations (hospitals), large populations (stadiums), or flammable materials (gas stations) in wildfire risk areas.

Neighborhood/Subdivision Scale WUI Tools	
Residential clustering requirements	Require new lots in subdivisions to be located away from wildfire hazard areas, and allow smaller lots if necessary to avoid economic harm to the landowner
Water supply	Require firefighting water supply. Provide hydrants with adequate pressure and volume or a year round water source of 4,000 – 5,000 gallons in the form of a dry well, cistern, pond, or swimming pool.
Density reductions in high hazard areas	Reducing permitted development density in high wildfire hazard areas. Transfer of Development Rights (TDR) programs may also be useful.

Proper access	Require adequate road (20 to 28 ft.) and driveway (12 ft.) widths and clearance (13.5 ft. vertical and 10 ft. horizontal) to accommodate fire-fighting equipment. Limit grade of roads to 10 -15% and require multiple access points for larger developments.
Signs	Require that street signs and address markers be noncombustible, easy-to-read, and well-located. Dead-end roads should be clearly signed.

Individual Site Scale WUI Tools	
Site-specific hazard assessment	Require or allow landowners to perform wildfire hazard assessment of their own property to confirm or establish wildfire hazard level. Use that analysis as the basis for project site design.
Location of accessory structures and flammable materials	Require accessory structures to be separated from other structures (e.g., 30 ft.). Require wood piles and gas tanks to be located 20-30 ft. from primary structure. Fences must be of non-flammable material – or at least within a minimum distance from the structure
Fire-resistant landscaping	Ensure that only fire-resistant landscaping is allowed in hazard area.

Building Scale WUI Tools	
Siding	Require one-hour fire resistant materials, or brick, stone, stucco, or large timber siding, and generally prohibit metal siding in most fire hazard classifications.
Windows	Require or encourage double-paned or small-paned windows.
Eaves and soffits	Require eaves and soffits to be covered and boxed in or covered with mesh that will not allow embers into attic.
Gutters	Require designs that do not collect leaves/needles (and require regular cleaning).
Attic vents	Require mesh coverings with a maximum mesh size of 1/8 inch, or install approved ember-resistant vents.
Chimney spark arresters	Require spark arresters on all chimneys
Decks and porches	Require that under-deck areas of structures 3 ft. or less above the ground be enclosed with wire mesh or fire resistive material. Require that structures farther from the ground be enclosed with a solid fire resistive skirt, and ensure that these features be constructed of heavy timber or other fire resistant material.

APPENDIX E – LONG-TERM RECOVERY OF TRPL SITE WITH ECOSYSTEM MANAGEMENT

ATTRIBUTE CATEGORY	RECOVERY LEVEL (1-5)	EVIDENCE FOR RECOVERY LEVEL
ATTRIBUTE 1. Absence of threats		
Over-utilization	4	Shift to AMP grazing with periodic prescribed fire at 10-25 yr return interval
Invasive species (external)	3	Informal agreements with USFS and Medora Fdn. To manage leafy spurge, Canada thistle, crested wheatgrass on lands surrounding Library site
Contamination	5	No change from baseline condition; spills and other contamination during construction will be avoided
ATTRIBUTE 2. Physical conditions		
Substrate physical	4	Shift to AMP grazing prescribed fire will reduce erosion and rate of gully formation; no plans for structural stabilization
Substrate chemical	5	No change from baseline condition; spills and other contamination during construction will be avoided
Water chemo-physical	4	Shift to AMP grazing with prescribed fire will increase infiltration rates and reduce sheet-flow runoff and associated erosion; bioswales and mesic prairie detention basins reduce runoff from parking lots; building's green roof self-regulates its runoff
ATTRIBUTE 3. Species composition		
Desirable plants	4	Will seed or plant 100 species of native plants on Library site; forbs diversity and abundance will increase; overall vegetation cover in pastures expected to increase despite grazing
Desirable animals	3	Grassland butterfly numbers expected to increase as abundance of forbs increases; more vegetation cover may attract grassland bird species
No undesirable species	3	Shift to AMP grazing with fire expected to control Kentucky bluegrass; IPM approach to control leafy spurge, Canada thistle, yellow sweet clover; herbicide use will be limited to initial establishment period and not used for long-term management
ATTRIBUTE 4. Structural diversity		
All strata present	3	Good herbaceous cover and biological soil crust (BSC) well developed; tree canopy limited to woody draws
All trophic levels	3	Some change from baseline; more insects and small mammals will benefit reptiles and passerine bird community; raptors less favored due to high visitation by public; large ungulates limited to cattle, horses, deer
Spatial mosaic	4	Some change from baseline: mesic prairie basins for stormwater management add new plant community to site, but near cars and building and less useful to some species
ATTRIBUTE 5. Ecosystem function		
Productivity, cycling etc	4	Expect increase in root grown, soil microbial diversity, carbon sequestration rate and stocks and soil infiltration rate, and reduced runoff
Habitat interactions	4	AMP grazing with with fire and overseeding will increase forb and pollinator abundance, greater abundance of dung beetles and other insects overall; supporting higher trophic levels
Resilience, recruitment etc	4	AMP grazing with fire re-establishes historical disturbance regime to which species on site are adapted; resilience during and after drought expected to be better than at present; plant germination rates expected to increase
ATTRIBUTE 6. External exchanges		
Landscape flows	3	No change from baseline condition, unless USFS changes management practices on lands to west and south
Gene flows	3	No change from baseline conditions; seed collection ongoing to use locally-adapted genetic materials within 150 miles of site
Habitat links	4	Collaboration occuring with North Dakota State University; National Park Service collaboration may also occur.

APPENDIX F – PERFORMANCE PERIOD RECOVERY OF TRPL SITE WITH ECOSYSTEM MANAGEMENT

ATTRIBUTE CATEGORY	RECOVERY LEVEL (1-5)	EVIDENCE FOR RECOVERY LEVEL
ATTRIBUTE 1. Absence of threats		
Over-utilization	3	Shift to AMP grazing with periodic prescribed fire at 10-25 yr return interval results in some recovery of native species cover
Invasive species (external)	2	Informal agreements will have just gotten underway with USFS and Medora Fdn. To manage leafy spurge, Canada thistle, crested wheatgrass on lands surrounding Library site
Contamination	5	No change from baseline condition; spills and other contamination during construction will be avoided
ATTRIBUTE 2. Physical conditions		
Substrate physical	3	Shift to AMP grazing prescribed fire will begin to reduce erosion and rate of gully formation; no plans for structural stabilization
Substrate chemical	5	No change from baseline condition; spills and other contamination during construction will be avoided
Water chemo-physical	4	Shift to AMP grazing with prescribed fire will increase infiltration rates and reduce sheet-flow runoff and associated erosion; bioswales and mesic prairie detention basins reduce runoff from parking lots; building's green roof self-regulates its runoff
ATTRIBUTE 3. Species composition		
Desirable plants	4	Will seed or plant 100 species of native plants on Library site; forbs diversity and abundance will increase; overall vegetation cover in pastures expected to increase despite grazing
Desirable animals	3	Grassland butterfly numbers expected to increase as abundance of forbs increases; more vegetation cover may attract grassland bird species
No undesirable species	2	Shift to AMP grazing with fire expected to begin to control Kentucky bluegrass; IPM approach to control leafy spurge, Canada thistle, yellow sweet clover; herbicide use will be limited to initial establishment period and not used for long-term management
ATTRIBUTE 4. Structural diversity		
All strata present	2	Herbaceous cover and biological soil crust (BSC) will improve; tree canopy limited to woody draws
All trophic levels	2	Some change from baseline; more insects and small mammals will benefit reptiles and passerine bird community; raptors less favored due to high visitation by public; large ungulates limited to cattle, horses, deer
Spatial mosaic	4	Some change from baseline: mesic prairie basins for stormwater management add new plant community to site, but near cars and building and less useful to some species
ATTRIBUTE 5. Ecosystem function		
Productivity, cycling etc	3	Expect first evidence of increase in root grown, soil microbial diversity, carbon sequestration rate and stocks and soil infiltration rate, and reduced runoff
Habitat interactions	3	AMP grazing with with fire and overseeding beginning to increase forb and pollinator abundance, greater abundance of dung beetles and other insects overall; supporting higher trophic levels
Resilience, recruitment etc	4	AMP grazing with fire re-establishes historical disturbance regime to which species on site are adapted; resilience during and after drought expected to be better than at present; plant germination rates expected to increase
ATTRIBUTE 6. External exchanges		
Landscape flows	3	No change from baseline condition, unless USFS changes management practices on lands to west and south
Gene flows	3	No change from baseline conditions; seed collection ongoing to use locally-adapted genetic materials within 150 miles of site
Habitat links	3	Collaboration occuring with North Dakota State University; will seek collaboration with National Park Service

APPENDIX G – RECOVERY SCALE TO MEASURE RESTORATION PROGRESS (MCDONALD ET AL. 2016).

Attribute	*1-star*	*2-star*	*3-star*	*4-star*	*5-star*
Absence of threats	Further deterioration discontinued and site has tenure and management secured	Threats from adjacent areas beginning to be managed or mitigated	All adjacent threats being managed or mitigated	Larger scale threats starting to be managed or mitigated	All threats managed or mitigated to high extent
Physical conditions	Gross physical and chemical problems remediated (e.g. pollution, erosion, and compaction)	Substrate chemical and physical properties (e.g. pH and salinity) on track to stabilize within natural range	Substrate stabilized within natural range and supporting growth of characteristic biota	Substrate maintaining conditions suitable for ongoing growth and recruitment of characteristic biota	Substrate exhibiting physical and chemical characteristics highly similar to that of the reference ecosystem with evidence they can indefinitely sustain species and processes
Species composition	Colonizing indigenous species (e.g. ~2% of the species of reference ecosystem); no threat to regeneration niches or future successions	Genetic diversity of stock arranged and a small subset of characteristic indigenous species establishing (e.g. ~10% of reference); low threat from exotic invasive or undesirable species	A subset of key indigenous species (e.g. ~25% of reference) establishing over substantial proportions of the site, with nil to low threat from undesirable species	Substantial diversity of characteristic biota (e.g. ~60% of reference) present on the site and representing a wide diversity of species groups; no inhibition by undesirable species	High diversity of characteristic species (e.g. >80% of reference) across the site, with high similarity to the reference ecosystem; improved potential for colonization of more species over time
Community structure	One or fewer strata present and no spatial pattering or trophic complexity relative to reference ecosystem	More strata present but low spatial pattering and trophic complexity relative to reference ecosystem	Most strata present and some spatial pattering and trophic complexity relative to reference ecosystem	All strata present Spatial pattering evident and substantial trophic complexity developing, relative to the reference ecosystem	All strata present and spatial pattering and trophic complexity high Further complexity and spatial pattering able to self-organize to highly resemble reference ecosystem
Ecosystem function	Substrates and hydrology are at a foundational stage only, capable of future development of functions similar to the reference	Substrates and hydrology show increased potential for a wider range of functions including nutrient cycling, and provision of habitats/resources for other species	Evidence of functions commencing, e.g. nutrient cycling, water filtration and provision of habitat resources for a range of species	Substantial evidence of key functions and processes commencing including reproduction, dispersal, and recruitment of a species	Considerable evidence of functions and processes on a secure trajectory toward reference and evidence of ecosystem resilience likely after reinstatement of appropriate disturbance regimes
External exchanges	Potential for exchanges (e.g. of species, genes, water, and fire) with surrounding landscape or aquatic environments identified	Connectivity for enhanced positive (and minimized negative) exchanges arranged through cooperation with stakeholders and configuration of site	Connectivity increasing and exchanges between site and external environment starting to be evident (e.g. more species, flows, etc.)	High level of connectivity with other natural areas established, observing control of pest species and undesirable disturbances	Evidence that potential for external exchanges is highly similar to reference and long term integrated management arrangements with broader landscape in place and operative

Note: This five-star scale represents a cumulative gradient from very low to very high similarity to the reference ecosystem. It provides a generic framework only; requiring users to develop indicators and a monitoring metric specific to their system and ecosystem type.

APPENDIX H – LAND MANAGEMENT AREAS AT THE TRPL SITE