Environment and Natural Resources Trust Fund
2018 Request for Proposals (RFP)

Project Title: **ENRTF ID: 031-A**

Measuring the Impact of Perennial Urban Green Space Management on Soil Ecosystems

Category: A. Foundational Natural Resource Data and Information

Total Project Budget: $ 177,346

Proposed Project Time Period for the Funding Requested: 3 years, July 2018 to June 2021

Summary:

Analyzing soil ecosystems impacted by previous land-use management of four urban green spaces (golf course, community park, home lawn, agricultural field) utilizing detailed soil testing, metagenomic analysis, and GPS modeling.

Name: Brian Horgan

Sponsoring Organization: U of MN

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Saint Paul MN 55108

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Web Address

Location

Region: Metro

County Name: Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, Washington

City / Township:

Alternate Text for Visual:

The visual aide contains images that represent the four soil sampling areas (golf course, home lawn, community park, and agricultural field), a map of the proposed sampling locations, and images of the proposed methodologies.

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	_____%

TITLE: Measuring the Impact of Perennial Urban Green Space Management on Soil Ecosystems

PROJECT STATEMENT:

Why: In the next 25 years, the Twin Cities will add approximately 1 million new residents. This rapid growth places significant pressure to develop green space into residential or commercial uses. Current research indicates that urban green space provides significant value to society through contribution of ecosystem services (ES). These urban green spaces (parks, cemeteries, home lawns, and golf courses) sequester carbon into the soil, capture stormwater, filter and return water to aquifers, cool urban areas counteracting the heat island effect, provide habitat for pollinators, birds, and other wildlife, produce mental health benefits, among other valuable functions. Golf courses are a significant component of the urban environment, comprising 10% of the urban green space in Hennepin and Ramsey Counties alone. Golf courses are perceived to be inefficient users of space and resources when compared against public parks. The main goal of this project is to collect and examine soil data of different managed urban green spaces to better understand the carbon and nitrogen dynamics of these different ecosystems, to improve their fertilizer management practice and to increase their value to society. We have a unique opportunity at the University of Minnesota to examine how different management strategies of green space result in different soil ecosystems as well as different levels of carbon sequestration potential (a critical process for combating climate change). The University of Minnesota Les Bolstad Golf Course is adjacent to a residential community, several parks, and agricultural fields, therefore an ideal location for researching this topic. We wish to examine how these land uses differ in management strategy and the resulting impact on the soil ecosystems. The University of Minnesota Les Bolstad Golf Course (18-hole public facility) was established in 1929 and will be undergoing a renovation starting as early as summer 2019. The renovation includes an important regrading of the site that will result in a significant disturbance of the soil's physical and chemical properties. This is a unique research opportunity to examine the soil carbon and nitrogen cycles and assess the microbial community after 90 years of urban management before its complete renovation.

Goals: Our research goals will be to study the relationship between soil carbon sequestration, potential greenhouse gas emissions, nitrogen mineralization rates, fungal and bacterial community structures with the various long-term management programs of urban green spaces such as a 90-year-old golf course (green, fairway and rough), several residential lawns, a community park and an agricultural area.

How: This research project will be divided into two activities. Activity 1: Soil profiles of the University of Minnesota Les Bolstad Golf Course (fairways, greens, rough areas) will be compared to other nearby areas with similar soil types but different management strategies (the location of the soil sampling can be found in the attached map). Soil core samples will be collected and then assessed for soil carbon, total nitrogen, pH, mineral composition and organic matter. Additionally, we will utilize a tool developed by the University of Minnesota Natural Capital Project called the InVEST model designed to map and value ecosystem services using satellite imaging and data, which will be used to compare the carbon sequestration potential of land management strategies. Activity 2: During 2019, nitrogen mineralization will be estimated, using arginine ammonification and potential nitrogen mineralization assays, for two different urban green spaces (golf course and home lawns). Bacterial and fungal amplicon sequencing will be done for the highest nitrogen mineralization rate and bioinformatic tools will be used to study the diversity of the community and to correlate it to measured soil parameters (pH, Total C, Total N, mineral-N and organic matter, N mineralization associated gene copy number). Also, PICRUSt analysis will be performed to predict the potential function of the microbial communities under different management practice. Altogether, this project will lead to a better understanding of land management for differing green spaces in the urban environment. Finally, we will communicate our results to stakeholders through public field days, presentations, and research publications. This research will ultimately help make future land use decisions to maximize soil ecology.

II. PROJECT ACTIVITIES AND OUTCOMES

Activity 1: Soil ecosystem comparison of six different long term perennial grass management strategies **Budget: $72,452**

We will assess soil profiles and soil nitrogen content of perennial grass systems including a golf course (fairways, greens, roughs) and surrounding land uses (agricultural field, urban lawn, parkland). Models will be used to estimate carbon sink capacity of these different ecosystems.

Outcome	Completion Date
1. Soil profile of golf course (fairways, greens, rough areas), agricultural land, home lawn, and community park.	*September, 2018*
2. Comparative study of six locations using the InVEST model	*December, 2019*

Activity 2: Nitrogen mineralization and microbiomes analysis of urban green spaces Budget: $104,894
We will estimate the nitrogen mineralization rate for 2 different urban green spaces (University of Minnesota Les Bolstad Golf Course and nearby home lawns for 6 time points). Soil microbiome analysis will be conducted for all locations at the time point of highest nitrogen mineralization rate. Bioinformatic tools will be used to understand how management practices affect nitrogen mineralization and microbial communities.

Outcome	Completion Date
1. Nitrogen mineralization assay	*September, 2019*
2. Amplicon sequencing and microbiome analysis	*March, 2020*
3. Data presentation to public (UMN field days), creation of visual materials, and scientific publications	*June, 2021*

III. PROJECT STRATEGY

A. Project Team

This research team is composed of experts in turfgrass research and management and nitrogen and carbon cycling. Specific team member background and responsibilities include: **Brian Horgan** (Project Investigator, unpaid), Professor and Extension Turfgrass Specialist (Department of Horticultural Science, University of Minnesota), will be the principal coordinator over each research activity and personnel. **Eric Watkins** (Co-Project Investigator, paid), Professor in turfgrass breeding and genetics (Department of Horticultural Science, University of Minnesota), will participate in the supervision of the different activities of the proposed project. **Parker Anderson** (Project Director, paid), Researcher 5 (Science of the Green Initiative, Department of Horticultural Science, University of Minnesota), will coordinate the schedule of the project and manage research activities and personnel. Parker will develop the GIS maps using the InVEST model analysis of the collected data and create the visuals for presenting the results. **Jon Trappe** (Project Director, paid), Postdoctoral Research Associate (Department of Horticultural Science, University of Minnesota), will assist Parker Anderson in analyzing outcome 1-2 from Activity 1. His focus will be on the carbon cycle and soil carbon storage. **Florence Sessoms** (Project Director, paid), Researcher 5 (Department of Horticulture, University of Minnesota), will be responsible of soil sampling and nitrogen mineralization assay (outcome 1, Activity 2), DNA extraction and further microbiome analysis (outcome 2, Activity 2). Dr. Sessoms will present the Activity 2 results to the public during the UMN field days (August 2020) and will be in charge of writing a scientific publication with the microbiome analysis.

B. Project Impact and Long-Term Strategy

Urban green spaces (presence of parks) are important for carbon storage and the overall well-being of urban populations, yet they are often overlooked when discussing solutions to environmental challenges. This project will fill critical gaps in the scientific literature on the importance of managed green space areas for carbon storage and nitrogen mineralization, and it will affect future land use decisions in the urban environment. Secondly, protecting or restoring soil in the urban environment will continue to be a perennial issue with local and global implications. We have a unique opportunity during the conversion of a large urban green space to better understand how urban green spaces should be managed to benefit urban environments. Our long-term strategy is to visualize the amount of time necessary for remodeled urban green space to reach its full potential as an environmental asset to society.

C. Timeline Requirements

Activity 1 is expected to start in May 2018 (spring soil sampling) and finishes (complete data analysis) in June 2019. Activity 2 will start in May 2019 and will finish in March 2020. Results will be presented to the public at the University of Minnesota Field Day in August 2020 and shared with the scientific community through peer-reviewed publications to be completed by June 2021.

2018 Detailed Project Budget

Project Title: Measuring the impact of perennial urban green space management on soil ecosystems

IV. TOTAL ENRTF REQUEST BUDGET 3 years

BUDGET ITEM	AMOUNT
Personnel:	$ -
B. Horgan (Project Investigator, 12 mo. Appointment at no cost). E. Watkins (Co-Project Investigator, 9 mo. Appointment), partial summer salary support + fringe + 3% inflation. Watkins (summer salary for one week per year (.23 FTE/yr)): $7,682 + $2,573.	$ 10,255
Partial salary support for F. Sessoms (Project DIrector), who is conducting research for Activity 2: (30%) + fringe + 3% inflation yrs 1 and 2, (10%) + fringe + 3% inflation yr 3, $36,828 + $12,337 (3.6 FTE yrs 1 & 2; 1.2 FTE yr 3). Partial salary support for P. Anderson (Project Director) as coordinator for Activities 1 and 2: (30%) + fringe + 3% inflation yrs 1 and 2, (10%) + fringe + 3% inflation yr 3 , $38,293 + $12,828 (3.6 FTE yrs 1 & 2; 1.2 FTE yr 3). Partial salary support for J. Trappe (Project Director), who is conducting research for activity 1 (25%) + fringe + 3% inflation yrs 1 and 2, (10%) + fringe + 3% inflation yr 3 , 30,680 + 6,565 (3.0 FTE yrs 1 & 2; 1.2 FTE yr 3).	$ 137,531
One part-time summer undergraduate to assist with on-site assessment and soil sampling in Activity 1, $5,760 ($12/hr, 30 hrs/wk/, 16 wks/yr, 1yr, (3.7 FTE yr 1))	$ 5,760
Equipment/Tools/Supplies:	
Soil probes, sampling equipment, envelopes, office supplies, reagents, cuvettes, lab supplies, etc.	$ 2,500
Total assay and DNA extraction for Activity 2	$ 6,100
Research analytic lab, Amplicon sequencing for Activity 2	$ 9,700
UMN Soil analysis lab - ammonium analysis for 2000 samples for Activity 1	$ 5,400
Travel:	
Vehicle expenses to visit soil sampling locations in Activity 1; help defray costs of UMN leased vehicle mileage and gas = $100.	$ 100
Additional Budget Items:	
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 177,346

V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ To Be Applied To Project During Project Period	N/A	N/A
Other State $ To Be Applied To Project During Project Period	N/A	N/A
In-kind Services To Be Applied To Project During Project Period	N/A	N/A
Funding History	N/A	N/A
Remaining $ From Current ENRTF Appropriation	N/A	N/A

Measuring the Impact of Perennial Urban Green Space Management on Soil Ecosystems


AGRICULTURE


GOLF COURSE


COMMUNITY PARK


HOME LAWN

GOALS:

Our research goals will be to study the relationship between soil carbon sequestration, potential greenhouse gas emissions, nitrogen mineralization rates, fungal and bacterial community structures with the various long-term management of urban green spaces such as a 90-year-old golf course (green, fairway and rough), several residential lawns, a community park and an agricultural area.

ACTIVITY 1:

Soil ecosystem comparison of six different long term perennial grass management strategies

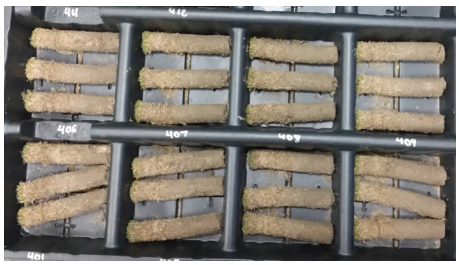
ACTIVITY 2:

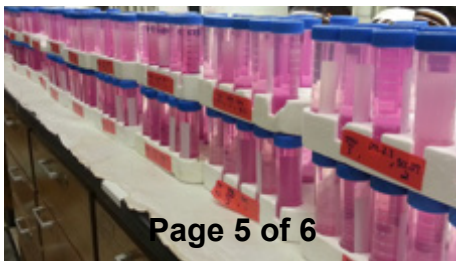
Nitrogen mineralization and microbiomes analysis of urban green spaces and development of visual materials and publication.


SOIL PROFILE

Golf courses are a significant component of the urban environment, comprising 10% of the urban green space in Hennepin and Ramsey Counties alone.

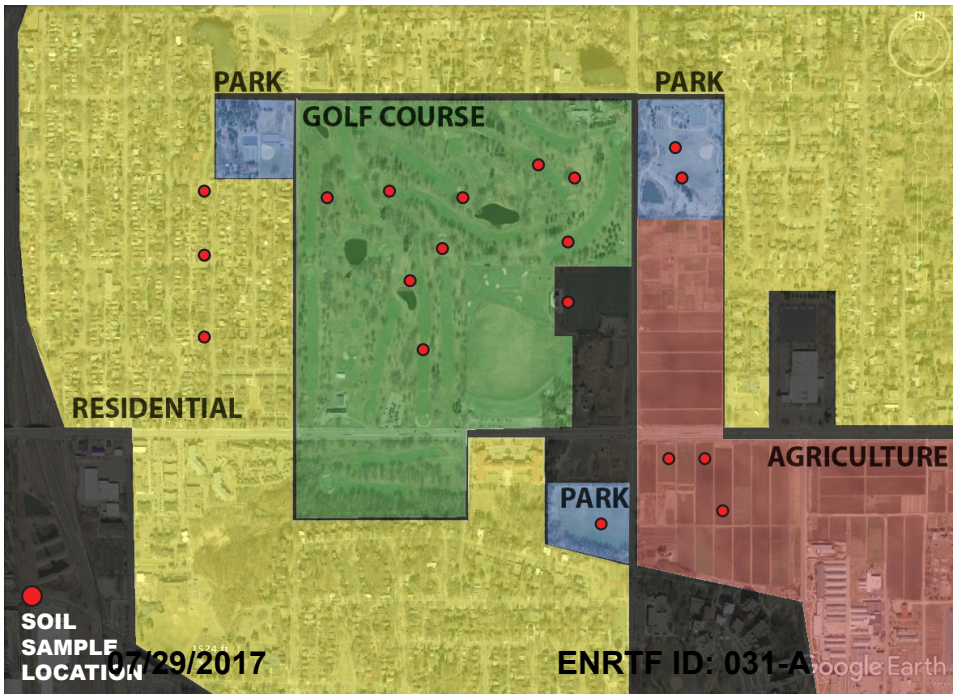
SOIL SAMPLING





SOIL SAMPLING: Three replicates per land use (18 locations)

1. Golf course fairway
2. Golf course green
3. Golf course rough
4. Community park
5. Agricultural field
6. Residential lawn



07/29/2017

ENRTF ID: 031-A

Project Manager Qualifications and Organization Description

Dr. Brian Horgan
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Dr. Horgan's research interests focus on the fate and transport of pesticides and nutrients, water conservation strategies, and low-input turfgrass systems. Horgan's most recent award recognizing excellence in the turfgrass industry was the prestigious Minnesota Golf Course Superintendents Association President's Award. He is past chair of the National Turfgrass Evaluation Program advisory committee, science editor for Turf News, and past chair of the Turfgrass Science division of the Crop Science Society. In addition to his participation in various state and regional turf conferences within the United States, Horgan has taught soil fertility and plant nutrition in Sweden, Norway, Turkey, Hong Kong, China, and New Zealand. He has taught for the GCSAA since 2006.

Dr. Horgan is responsible for the creation of the Science of the Green Initiative, a research initiative within the University of Minnesota Department of Horticultural Science focused on the long-term sustainability of the golf industry, exploring the role golf courses play in ecosystems and how science and design can be utilized to increase the ecosystem services and value that golf courses provide society.

In addition, Dr. Horgan outreaches to the community as a Turfgrass Extension Specialist. The position gives him opportunity to interact with the industry and facilitate educational programs designed to meet the needs of the state. He is a faculty advisor to the student chapter of the Golf Course Superintendents Association of America (also known as Turf Club).

Turfgrass Science Research Lab, Department of Horticultural Science, University of Minnesota
The University of Minnesota's Turfgrass Science Program conducts field-based research and offers education and consultation to both turfgrass professionals and homeowners. The Turfgrass Science Research Lab consists of seven faculty and extension positions, six full-time research staff, and six graduate students. Over forty peer-reviewed journal articles have been published in the last 10 years.