**PROPOSAL INFORMATION**

Project Title: Development of a Site Specific Management Plan for Campus Grass Areas and Campus Intramural Athletic Fields

**PRINCIPAL STUDENT INVESTIGATOR (PROPOSER) INFORMATION**

Name: Chase Straw  
Email: cmstra4@uga.edu  
Phone: 502-229-9838  
Degree Program / Graduation Date: Doctor of Philosophy in Crop and Soil Sciences / December 2017

**FACULTY / STAFF SPONSOR INFORMATION**

Name: Dr. Gerald Henry  
Email: gmhenry@uga.edu  
Phone: 706-542-0898  
Title / Department: Associate Professor – Environmental Turfgrass Science, Dept. of Crop and Soil Sciences

**ADDITIONAL PROPOSAL INFORMATION**

The proposal includes the following fields (check all that apply):

- [ ] Academics / Education
- [ ] Research
- [ ] Service & Outreach
- [x] Campus Operations

**Summary of Budget:**

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<td>Equipment</td>
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Development of a Site Specific Management Plan for Campus Grass Areas and Intramural Athletic Fields

Chase Straw, Graduate Student, and Gerald Henry, Associate Professor
Crop and Soil Sciences Department

Project Overview:

Turfgrass managers aspire to produce uniform conditions that are aesthetically pleasing (e.g. for enjoyment in a social environment, such as grass areas on campus) and also meet the requirements for use (e.g. a strong, durable turf used for athletic play). Therefore; these aspirations often lead to uniform management of the entire turf area, although not all locations within the area may need it. Primary turf management, aside from required mowing, typically includes the frequent use of inputs such as water, fertilizers, and certain forms of cultivation (often aerification). For improved efficiency of these inputs in highly maintained turfgrass areas, spatial evaluation of surface and edaphic properties is necessary to provide valuable insight on the effectiveness of current management practices. Results from such evaluations can assist in applying inputs only where, when, and in the amount needed to foster a more sustainable turfgrass management approach. This project will have three primary objectives:

1. Conduct a performance test on all large grass areas on campus and intramural athletic fields.

2. Determine status of each irrigation system on all large grass areas on campus and intramural athletic fields through analysis of collected soil moisture data. Then work with Facilities Management Division and the UGA Turf Club to fix/adjust individual irrigation heads that are not working properly.

3. Develop a site specific management plan for large grass areas on campus and intramural fields to reduce the application of necessary turfgrass inputs.

Background Information:

The term “performance testing” (i.e. site assessment) is receiving increasing attention as a method to quantify the performance of turfgrass properties. Performance testing involves collecting data samples at multiple locations across an area to better understand the variability of the property of interest. Current and previous sampling procedures are designed to be “low technology” (the use of handheld devices at 8-15 locations) to enable wide usage; however, a consequence of making data assessment easier to conduct and interpret can mask detailed variability across the entire area.

Variability of a property in space is better explained using geostatistics. Geostatistics provide a number of statistical techniques to evaluate spatial data which has been utilized in environmental science fields such as mineral resource mapping and precision farming in agriculture. Global Positioning Systems (GPS) enable the data to be geo-referenced (i.e. record of longitudinal and latitudinal location) and imported into Geographic Information Systems (GIS) where geostatistics can be implemented for data analyses and to create spatial maps.

GIS is more common in agriculture to implement the precision agriculture (PA) concept. PA involves applying inputs, such as water, fertilizers, and pesticides, only where, when, and in the amount needed by the plant. As a parallel to PA, the concept of precision turfgrass management (PTM) is gaining increasing attention for enhanced input efficiency and management decisions in turfgrass. PTM was developed and based on the
premise of site-specific management. To a certain degree, complex turf sites already use some degree of PTM. For example, on athletic fields, management can differ significantly depending on turf species, soil class, field usage, level of athletic play, and the sport itself being played. However, the evolution of PTM is based on acquiring detailed site information, through intensive data sampling, to offer an even more precise and efficient management of inputs, such as sub-areas within a sports field, than is currently practiced now. Performance testing can be viewed as the site assessment referred to in the PTM concept.

Mobile sampling devices were first engineered for intense data sampling in agriculture. For turfgrass, a mobile data acquisition device was not available until 2005 when the first unit was developed; now named the Toro Precision Sense 6000 (PS6000). The PS6000 was engineered for rapid sampling on complex turfgrass sites for simultaneous measurements of soil moisture, soil compaction, and plant performance all while using GPS to geo-reference longitudinal and latitudinal location of samples.

To our knowledge, the PS6000 is the first and only mobile multi-sensor device, with GPS capability, for use on turfgrass sites. The PS6000 that is currently in Athens is one of only two units being utilized in the United States. The University of Georgia and The Toro Company have been collaborating on conducting non-funded research with the unit since 2012 and plan to continue working together for the next few years; therefore, the unit can be utilized now to test the previously mentioned areas on campus.

Figure 1. The Precision Sense 6000 (PS6000)

Contribution to Improve Stewardship of Natural Resources and Advancing Campus Sustainability at UGA:

Our project will have direct correlation with Strategic Direction VII from the University of Georgia’s 2020 Strategic Plan. The plan involves “efforts to significantly reduce energy and water use,” and wishes to prioritize “the use of natural resources as efficiently as possible,” as well as “integrate sustainability into the student experience in the classroom and beyond.” Data collected from our research will highlight any trouble locations within a turfgrass area to focus inputs only where, when, and in the amount needed. This in turn will enhance the efficiency of the turfgrass management and also provide a more safe and enjoyable environment for students who utilize these areas.

List of partner organizations or departments:

- Dr. Gerald Henry; University of Georgia, Dept. of Crop and Soil Sciences
- Tim Culp - University of Georgia, Horticulturist; and Joe Morgan - University of Georgia, Intramural Field Maintenance
- The Toro Company
- University of Georgia Turfgrass Club
Sustainability Grant Application – Compliance Form

Please answer all of the following questions, and explain in full where required.

Will this project require compliance review in any of the following areas?
*Please place an “X” on the appropriate line to indicate “Yes” or “No” for all three compliance areas.*

1. **Animal Use**
   - ___ Yes
   - _X_ No
   If “Yes,” please reference the section and page number in the proposal describing animal use:

2. **Biohazardous Materials**
   - ___ Yes
   - _X_ No
   If “Yes,” please reference the section and page number in the proposal describing biohazardous material use:

3. **Human Subjects**
   - ___ Yes
   - _X_ No
   If “Yes,” please reference the section and page number in the proposal describing human subject use:

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For more information contact:
Animal Care and Use, [http://www.ovpr.uga.edu/acu/index.html](http://www.ovpr.uga.edu/acu/index.html)
706-542-5933

For more information contact:
706-542-9876

For more information contact:
706-542-5318

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**Name:** Chase Straw

**Title:** Graduate Research Assistant

**Date:** 10/17/12

__X__ By placing an “X” on this line, I certify I will fulfill all requirements pertaining to compliance if this grant is approved.
Complete all sections.

### I. Personnel **,**

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<th>Number</th>
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<td>2.</td>
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<td>3.</td>
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<td>X6, $100 each</td>
<td>$600</td>
</tr>
<tr>
<td>2. Gas</td>
<td>Equipment operation</td>
<td>$300</td>
</tr>
<tr>
<td>3. Flags</td>
<td>Flag irrigation heads and passes made</td>
<td>$100</td>
</tr>
<tr>
<td>4. Foamer</td>
<td>To track path with unit</td>
<td>$100</td>
</tr>
<tr>
<td>5. General Maintenance</td>
<td>Oil changes, breakdown issues, misc.</td>
<td>$400</td>
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<td>6.</td>
<td></td>
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<tr>
<td>7.</td>
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<td><strong>Total Cost:</strong></td>
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*Acceptable personnel funding include: 1) hiring outside consultants or contractors to perform required project tasks, 2) UGA Facilities Management Division staff labor charges for project implementation, 3) UGA student workers managed by participating UGA department to perform required project tasks.

**If more space is needed, please attach a separate document listing specific items and their costs.

Note: All Campus Sustainability Grant funds must be expended before June 30th.
Specific aims:

**Conducting the performance tests:**

The PS6000 will be used to simultaneously measure soil moisture, soil compaction, and plant performance on all study areas. The PS6000 is equipped to attach to the hitch of a utility vehicle and measurements are made approximately every 8 ft. while traversing an area at a speed of 2 mph. Passes are typically made 8 ft. to 16 ft. apart; therefore, measurements are collected using a sampling grid that can result in ~1,000 - 1,200 samples for a standard size soccer field. To ensure straight passes, flags are typically used as guides. A foamer is equipped on the unit to mark previous passes (Figure 2). Data is recorded using an on-board computer and displayed in a spreadsheet format once obtained from the unit.

Specifically, two custom stainless steel probes are installed on the units sampling head, and attached to a sensor, to measure soil moisture and soil compaction 4 in. into the ground. The sampling head and sensor is mounted on the end of an arm that is attached to one end of a shaft on the PS6000 (Figure 2). When the PS6000 is moving forward, the wheel-driven shaft rotates, resulting in the arm moving in a circular fashion. As the arm moves, the sensor’s probes enter the soil and a plate passes by a proximity switch that triggers the data loggers to take a measurement. This process is controlled by a clutch switch from a user interface display. The clutch switch is powered on once the PS6000 is making a pass within the test area, and switched off when turning between passes outside the test area. Once the clutch is on, continuous measurements are made without the PS6000 stopping.

Plant performance is measured from two GreenSeeker RT100 active sensors that are mounted to the back of the PS6000 and measure normalized difference vegetative index (NDVI) (Figure 2). The sensor emits light pulses every 100 ms and outputs an averaged value every second. NDVI sensors are equipped with internal light emitting diodes and a photodiode optical detector that measures the reflectance of red (R = 660 nm) and near-infrared (NIR = 770 nm) spectra used to calculate a vegetative index \( \text{NDVI} = \frac{(R_{770} - R_{660})}{(R_{770} + R_{660})} \). Healthy plants have greater NIR and lower R reflectance than plants under stress. NDVI has been shown to be significantly associated with visual turf quality, density, and shoot tissue injury. A NovAtel GPS, attached to the PS6000, is used to gather latitude and longitude information for all the data (Figure 2).

![Figure 2. Sampling components of the PS6000.](image-url)
**When performance test will be conducted:**

To perform a test on irrigation system efficiency we will need to collect soil moisture data after an irrigation event. Therefore, for each area, coordination of irrigation with Facilities Management Division will need to be done prior to data collection. Testing of large grass areas on campus will be coordinated with Tim Culp and likely conducted when students are away for holidays and in between semesters. Testing of intramural fields won’t be an issue, because large quantities of students are generally not always on them. Coordination with Joe Morgan of individual field closings on days of testing will be done in advance. Temporary signage will be posted at the current testing site to convey the research that is being conducted and to show the collaboration between all involved divisions and departments.

A standard size soccer field typically takes about an hour for data collection with the PS6000. Complete data collection of all areas will also be highly dependent on weather, the lead student proposer’s class and work schedule, and the availability of student worker help. It is likely that data collection will be done in increments, i.e. a few areas per week. Therefore, completion will take 1-2 months.

**Data analysis:**

The ArcGIS version 10.2 GIS and mapping software (ArcMap) will be used to develop, display, analyze and interpret data from the PS6000. An interpolation method, called kriging, will be used to create continuous surface maps of the data for visual assessment (Figure 3). Kriging makes predictions on the values for unmeasured locations in the study area based on measured values.

**Figure 3.** An example of the kriging process on a soccer field with soil moisture data. On the left are sample locations with each dot representing an individual soil moisture sample taken from the PS6000. On the right is a continuous surface map of soil moisture across the entire field that was generated from the data for visual assessment. The dark blue areas represent high soil moisture and the light blue areas represent low soil moisture.

A continuous surface map of all areas will be created. Each irrigation head within an area will also be geo-referenced and implemented into the maps for further visual assessment (Figure 4). Using the raw data and surface maps, trouble locations (i.e. too high or too low soil moisture, soil compaction, and plant performance) within each area will be identified. This information will allow us to see what areas inputs should be focused more toward and aide in developing a site specific management plan.
Figure 4. An example of an irrigation head not working properly. The red area represents extremely low soil moisture next to an irrigation head (the black dot). The continuous surface maps allow us to show an approximate distribution around all individual heads. In this example, the irrigation head is not rotating properly causing ununiformed distribution of water.

Implementation:

The soil moisture maps from after an irrigation event will allow us to identify potential irrigation deficiencies of individual irrigation heads. These specific heads will be monitored and if changes need to be performed, the UGA Turfgrass Club is willing to assist. Coordination with these fixes will be made with Tim Culp and Joe Morgan of Facilities Management Division.

Furthermore, a detailed site specific management plan will be provided for all study areas. This will entail a write-up of detailed site information and recommendations for areas in need of specific management attention. Continuous surface maps of all areas and study variables will also be provided. Soil moisture maps will provide insight on irrigation system efficiency, soil compaction maps will show where areas may be too hard and cultivation practices may need to be geared more towards, and plant performance maps can show where fertilizers may or may not be needed. Additionally, much of the three components are highly dependent on one another. For example, an area of low plant performance may be due to low soil moisture and high soil compaction. Therefore, comparing the three variables in each area will be important to determine an underlying cause for any issues.

Merit and feasibility of implementing the project with available resources:

- Funding will allow us to hire two part-time turfgrass student workers to assist in preparing, conducting, and analyzing the project. The complete implementation of the project is extremely labor intensive and will be impossible to complete with only one person. Data collection requires detailed preparation and extremely intensive analysis. Additionally, this will give the students an opportunity for experience in a new research area in our field.

- Six soil moisture probes will be purchased for the Precision Sense 6000. Two probes are used on the unit at a time during testing to collect soil moisture and compaction data. It is recommended to use new probes for every 16-18 times the unit is used so that the probes do not wear down and cause inaccurate readings.
• Irrigation flags will be purchased to flag the location of irrigation heads on the field during testing and to also as a guide for the passes that will be made with the unit. It is extremely important to drive the unit straight during data collection; therefore, flags are used as a guide at the ends of the areas being tested to ensure straight passes.

• Foamer will be needed in the Precision Sense 6000 to track our path during testing so we do not overlap passes. This is useful so a pass is not accidently duplicated.

• Funding for general maintenance is important, but difficult to predict. The unit is towed with a lawn mower that we own. A study of this magnitude requires many hours of towing. Various things occur with equipment - oil changes, flat tires, belt attention, etc. Furthermore, the PS6000 requires certain maintenance at various times, such as greasing of the gears, so funding would be used in such case for supplies.

• A handheld Garmin GPS unit is needed geo-reference each individual irrigation head in the test areas. This is critical to determine the distribution of water for each irrigation head.

**Time frame for completing all aspects of the proposal:**

All research and analysis will be completed by June 1st, 2015. Adjustments to deficient irrigation heads will be made soon after, once they have been identified. A site-specific management plan will be developed by June 30th, 2015 and provided to Tim Culp and Joe Morgan for implementation. We will continue to monitor input use, and attempt to quantify the reduction of inputs due to the implementation of the site-specific management plan. If need be, it may be possible to create surface maps in the future to determine the effectiveness of the proposed site-specific management plan.
Communications Plan

- **Sports Turf Managers Association Conference January 2016**

  The Sports Turf Managers Association (STMA) Conference is a nationwide conference typically held annually in January. Sports turf managers ranging from park and recreation to professional athletic team field managers will be in attendance from all parts of the nation. The implementation of a site-specific management has never been done in the turfgrass industry; therefore, there is an opportunity to showcase the University of Georgia as one of the first universities to implement such a plan. We will attempt to present our work with this project in hopes that others will see the benefit in reducing inputs in turfgrass management.

- **Georgia Sports Turf Managers Association 2016**

  The Georgia Sports Turf Managers Association is an affiliate of the STMA for the state of Georgia. This association holds multiple annual events and field days across the state of Georgia for local sports turf managers to further their education with various topics involving athletic field maintenance. Presentation opportunities of our project will be available to inform Georgia sports turf managers UGA’s involvement with site-specific management and campus sustainability. These presentations will raise awareness of opportunities to enhance sustainability on athletic fields throughout the state.

- **Georgia Urban Ag Council EDGE Expo**

  The Georgia Urban Ag Council EDGE expo merges three dynamic industry associations, the Metro Atlanta Landscape and Turf Association, Georgia Turfgrass Association and Georgia Sod Producers Association, resulting in the exciting transformation of the annual Turfgrass Institute & Trade Show. The EDGE Expo “brings together industry experts along with the latest tools, techniques and trends needed by anyone working in any segment of the green industry”. Once we complete our project we would present our results at the expo to further promote sustainably in turfgrass.

- **University of Georgia Turfgrass Field Day August 2016**

  The University of Georgia Crop and Soil Science Department hosts a turfgrass field day every August at the Griffin campus. Turfgrass managers from all over Georgia and surrounding states are in attendance. The field day showcases research that is being conducted at the university in all aspects of turfgrass. At 2012’s field day we introduced the PS6000, in 2016 we would like to show actual data that we collected from areas on campus and also how the data can be useful in determining sustainable management practices.

- **University of Georgia Public Affairs**

  We will attempt to promote the communication of our research and its direct application at UGA with UGA Public Affairs (i.e. UGA magazine, UGA Research publications, UGA homepage).
• **UGA Turfgrass Science Twitter**

The UGA Turfgrass Science twitter account has close to 500 followers of turfgrass professionals all across the country. There will be multiple tweets during the progress of our project to communicate the implications of our work and to show that UGA is at the forefront of a more sustainable turfgrass management approach.

• **Athens-Banner Herald**

We will contact the Athens-Banner Herald about the work we are doing and try to reach out to the local community the key points of the project as well as general management of turfgrass inputs. For example, general home lawn maintenance and encouraging a more site-specific input regime at the home lawn level.
Faculty / Staff Sponsor Letter of Support

University of Georgia
CAMPUS

Dear Members of the Selection Committee,

Chase Straw is currently pursuing a PhD in the Department of Crop and Soil Sciences under my direction here at the University of Georgia. I am writing this letter of support for his proposal titled “Development of a Site Specific Management Plan for Campus Grass Areas and Campus Intramural Athletic Fields”. I am an Associate Professor in the Department of Crop and Soil Sciences and my area of expertise is environmental turfgrass science.

Chase recently finished his MS degree here at UGA in May of 2014 focused on “Geospatial Evaluation of Surface and Edaphic Characteristics of Community Athletic Fields”. He has an undergraduate degree from the University of Kentucky in Turfgrass Science with an emphasis on Athletic Field Management. Chase was able to obtain lots of hands-on experience in this field while interning with the Boston Redsox and the Cincinnati Bengals during his undergraduate career. He recently began his PhD during the summer of 2014 here at UGA where he will continue to focus on athletic field management with an emphasis on “best management practices” to ensure the appropriate use of limited resources (i.e. water, fertility, etc.) while producing a high quality playing surface.

A large portion of my research focus is on water-use efficiency and spatial mapping. Currently we have a project titled “Morphological and Physiological Response of Bermudagrass and Zoysiagrass to Soil Moisture and Mowing Height” that was funded by the Georgia Golf Course Superintendents Association to examine the amount of water necessary to maintain high quality bermudagrass and zoysiagrass. Previous research in my program has also focused on the spatial variability of soil moisture on golf course fairways, response of turfgrass species to acute drought conditions, and the effect of turfgrass irrigation practices on nutrient leaching.

I have been working with the Toro Company over the past few years on a mobile multi-sensor data collection device called the Toro Precision Sense 6000. This equipment allows us to quickly and accurately obtain geo-referenced soil moisture, soil compaction, and plant performance data over a given area and create maps specific to each environmental variable. We conducted irrigation system audits at the Sanford Stadium, the Turner Sports Complex, and Foley Field in cooperation with Kenny Pauley and UGA Athletics in 2012. Soil moisture maps generated from our data collection were used to install a new irrigation system in Sanford Stadium that has saved them over a million gallons of water per year.

We have been working with Joe Morgan, Intramural Field Maintenance and Tim Culp, Horticulturalist, to find suitable sites to further test the Toro Precision Sense 6000 on campus. Sampling the intramural fields at the intersection of East Campus Rd. and College Station Rd. will add to the data set for Chase’s research here at UGA, while providing feedback for field management adjustments and increased turfgrass sustainability. Toro will allow us the use of their equipment; however, we are responsible for expendable items such as soil moisture probes, gas, foamer, etc. associated with the operation of the equipment. Hourly student labor will be needed to calibrate and run the equipment, flag irrigation heads, geo-reference irrigation heads, and analyze data.
This project will be a cooperative effort on behalf of the Department of Crop and Soil Sciences, UGA Turf Club, and UGA Intramural Sports/Grounds Maintenance. Students, faculty, and staff will be involved in the conduction and success of this project. My ultimate goal is to incorporate this project into the learning experience for undergraduate students in my Turfgrass Physiology and Ecology course taught in the spring of 2015. Thank you for consideration.

Sincerely,

Gerald Henry, PhD
Associate Professor – Environmental Turfgrass Science
Athletic Association Endowed Professor
Undergraduate Turfgrass Management Coordinator
University of Georgia
Dept. of Crop and Soil Sciences
3111 Miller Plant Science Bldg.
Athens, GA 30602
To Whom It May Concern,

I am writing to inform you that the UGA Grounds Department of FMD is working in partnership with Chase Straw, Graduate Student, and Dr. Gerald Henry, Associate Professor Crop and Soil Science Department, on the development of a site specific management plan of campus grass areas and intramural athletic fields. The UGA Grounds Department aspires to produce turfgrass that is healthy and aesthetically pleasing, yet requires the least amount of outside inputs as possible. We are always striving to improve our cultural practices and watering efficiency to produce a more sustainable turfgrass. The UGA Grounds department believes that through mapping the turfgrass areas under our care we can gain insight on the effectiveness of current management practices. The results of such mapping can assist us in applying inputs on a need to basis and not just taking a “blanket” approach of turfgrass management. The data received from this procedure should help the UGA Grounds Department in developing a more sustainable approach to our turfgrass management.

Thank You,

Tim Culp
Horticulturist, Grounds Department
Facilities Management Division
University of Georgia
Office: 706-542-5164
tculp@uga.edu
To Whom It May Concern:

On behalf of the University of Georgia Turf Club, I would like to express my support for Chase Straw’s grant proposal. Not only does this project have multiple beneficial research applications, but it will also aid the UGA Facilities Management Division in maintaining more sustainable management practices throughout the university’s campus. This is a fantastic opportunity for the members of the University of Georgia’s Turf Club by giving them some practical experience working with irrigation components while helping Chase with his research. Overall, this is a great opportunity to improve the sustainability and education quality of the University of Georgia.

Sincerely,

Erick Begitschke
University of Georgia Turf Club President
References


