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TURF MANAGEMENT AT AHUSKA PARK IN THE CITY OF MONONA

Photo by Stephanie Nelson / UW-Madison

SOIL SCIENCE 332: TURFGRASS NUTRIENT AND WATER MANAGEMENT

FALL 2016

UNIVERCITY BETTER PLACES TOGETHER

MONONA

June 9, 2017

TABLE OF CONTENTS

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Professor Doug Soldat

Jake Anderson, Parks & Recreation Project Lead

Any other participants that helped in researching turf management at Ahuska Park

ABOUT THIS REPORT

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This report was produced in collaboration with the Soil Science Department in the College of Agricultural and Life Sciences and the UniverCity Year at UW-Madison.

EXECUTIVE SUMMARY

Ahuska Park in Monona, WI includes six acres of athletic fields including a baseball diamond, a soccer pitch, and a football field. Our goal is to help the City of Monona to improve the playing conditions at the park, maintain safe playing surfaces, and ensure that the practices employed are safe to the public, and the environment (and in compliance with regulations) while staying within the Monona Parks and Recreation Department budget. In the following report, we evaluate the current maintenance practices, and provided guidance on future nutrient management decisions, irrigation practices and infrastructure, and pest management, and pest management at Ahuska Park. Next, we propose science-based recommendations on how each of these areas can improve and provide justification of why. Below is a brief summary of the opportunities we have identified.

Maintenance Practices

General Observations

- Overall current management is good
- Poor soil texture (silty clay loam) is creating management difficulties

Recommendations

- Topdress football field with sand instead of compost
- Mow with a lightweight mower, dedicated to the site. Develop standards for operating mowers and other maintenance vehicles during wet conditions.
- Maintain a consistent mowing height and rotate blades frequently to keep them sharp.
- Broadcast perennial ryegrass during times of heavy use.
- Add a plant growth regulator to paint to reduce number of paint applications.
- Change $250 "painting" charge to "maintenance" charge

Fertilization Program

Current Observations

- Nitrogen deficient turfgrass
- Football field unable to recover as quickly as desired

Recommendations

Plan 1: Increase nitrogen, select less expensive products-

- 4.5 Lbs N / 1000ft 2 / per year (all athletic fields)
- Use of feed grade urea and coated urea particles
- Total cost $1,617

Plan 2: Increase nitrogen, select least expensive products

- 4.5 Lbs N / 1000ft 2 / per year (all athletic fields)
- Feed grade urea plan
- Total cost $621

Irrigation Practices

Current problems

- Time consuming (8 hours to water one field and takes 2 people)
- Lacks uniform distribution of water (CU = 57% meaning need to irrigate twice as much to achieve a uniform distribution)

Proposed solutions

- Install a drip irrigation system
    - Level Spreader with Sand Cap System and Drip Irrigation: Total cost $269,160.50 to $308,160
    - Sand Cap System with Drip Irrigation: Total Cost $59,160 to $99,160
    - Drip Irrigation Only: Total Cost $23,160

MAINTENANCE REPORT

Evaluation of the current conditions and the maintenance practices at Ahuska Park, have led us to recommend some changes to meet the stated goals. A discussion of current practices and our findings will hopefully be helpful in understanding our recommendations and implementing these changes.

Photo by Jeff Miller/UW-Madison, © Board of Regents of the University of Wisconsin System.

Soils Report

Soil plays an important role in all aspects of our overall plan for Ahuska Park. Quality soil reduces maintenance headaches, reduces runoff of stormwater and pollutants, and makes for a better playing surface. After pulling several deep cores from the fields in the fall of 2016 (Figure 1), we found the soil texture to be primarily silty clay loam (28% Clay, 56% Silt, and 16% Sand). This soil texture is compacted easily because of the size of the particles and the pore spaces associated with the soil. Pore spaces help with the infiltration of water and oxygen to the turf roots. The advantage of having a high silt/clay soil is that it is very stable when dry, however the disadvantage is that there will be very low water infiltration rates. Saturated field conditions will decrease soil stability. The football field has a 12" layer of the silty clay loam on top of a sand layer (depth of sand unknown). We surveyed the football field with a device called a cone penetrometer and found that the soil is not compacted (Figure 2), indicating excellent traffic and soil management, despite having a soil texture predisposed to compaction.

Athletic Field Usage

The usage rates of the three athletic fields vary throughout the year. We discovered that the soccer field has the highest traffic/usage of the three fields. The high usage can be attributed to the many soccer games and practices throughout the year as well as football and baseball teams using the soccer field as a warm-up area. The football field hosts youth and adult football games throughout the fall and spring. In the spring there is sometimes a need to move the soccer games to the football field because the soccer field is usually too wet to play. Mr. Anderson had mentioned that the football field typically gets about 35-40 events per year. The baseball field is an area where usage/traffic does not play a major role in the quality of the turf as baseball is a relatively low impact sport. However, as the City of Monona grows, demand for the fields is expected to increase the number of events and add stress to the turf and soil at the Park.

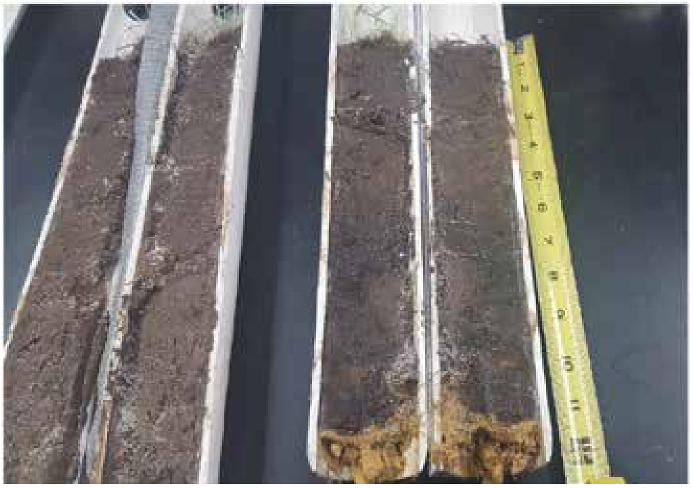


Figure 1. Soil cores taken from the football field at Ahuska Park. Shows 12" Silty Clay Loam topsoil over the original sand field.

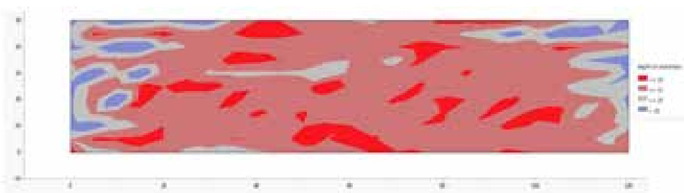


Figure 2. Map of soil compaction using a penetrometer.

Discussion of Current Practices

Mowing is a form of stress that is often neglected. At Ahuska Park, mowing is currently being done 1 to 2 times a week as dictated by growth, weather, and available labor. The primary mower used on the parks around Monona is a TORO Groundsmaster 4000-D, which is a wide area mower that has a 11 foot width of cut. This mower weighs nearly 4,000 lbs., which translates to 12-18 psi. The turf is mowed at a height of 2 ½, which is ideal for this situation, the mower blades are typically sharpened once a month. However, it can be difficult for Mr. Anderson to get needed maintenance on his mowers as there is only one mechanic for the parks department. The football field occasionally is mowed by a volunteer with a smaller mower with a 52" deck. The mowing height is lower with the mower, which likely adds stress to the turf. We recommend that the mowing height be raised to match the normal height of cut for improved turf quality.

Maintenance practices, including mowing, often represent an important source of traffic and can create mechanical damage to the turf and soil in certain conditions. For example, some rutting was observed this fall (which was extremely wet) on the soccer and baseball fields, we also observed some other ruts that look like they were made by a larger vehicle. Performing maintenance when soil conditions are wet is often necessary but leads to compaction of the soil and rutting. Having protocol in place for dealing with wet soils may be beneficial to field conditions. In addition, if mower blades are dull over the season with use, by fall leaf damage evident as a result of dull blades. This can lead to increased water loss, higher disease pressure, and decline in aesthetics and function. (Steinegger, D. H.; Sherman, R. C.; Riordan, T. P.; Kinbacher, E. J. 1983. Agronomy Journal. May/June. 75(3): p. 479-480.)

Cultivation and Topdressing

Hollow tine cultivation is performed at least once a year with the goal of performing it more often as time and budget allows. After cultivation the fields are being topdressed with Purple Cow compost at a quantities of 50 yards on the football field, 40 yards on the baseball field, and 20-30 yards on the soccer field. Collectively the topdressing uses 110 yards of compost annually for all three fields. This is a major expense on the parks budget, costing $3,600 per application. Based on our observations of the soil cores, we feel this process has yielded little beneficial results for the soil texture. The goal of the compost topdressing program is to improve the root zone by improving the soil near the surface. However, the football fields do not show a visible accumulation of organic matter from the Purple Cow topdressing (Figure 1).

Overseeding and Seed Selection

Currently the fields are seeded with a Kentucky bluegrass, perennial ryegrass seed mixture. 50/50 mix on the baseball outfield and soccer fields, being applied at a rate of 4lbs. per 1000 sq.ft., this application costs $370 annually. An 80/20 (KBG/PR) mixture is used on the football fields as well as the infield of the baseball field, each applied at a rate of 3lbs. per 1000 sq.ft. The cost of this application is $879 annually. Both are applied with a slit seeder that is rented form FS for $140. The soccer and baseball fields are overseeded in fall with the football being seeded in spring, the timing of the seeding is determined by usage of the fields and the weather. The total cost of the current annually seed application is $1,389.00 per season.

Recommendations and Justification

Usage Recommendations

In order to make the fields sustainable for the future we have some suggestions for field use restrictions. We recommend that you continue prohibiting play when overly wet, drought stressed, etc. There appears to be an opportunity to spread traffic around the field by moving soccer goals occasionally, and creating a designated area other than the three fields where teams can warm up to minimize excess traffic (Figure 3). It is also important to continue with the practice of restricting unofficial play from the athletic fields as much as possible. We also recommend establishment of paths/routes for heavier equipment and trucks out to the fields for maintenance work. In wet conditions, maintenance vehicles should be restricted to these paths to minimize potential damage to these areas and off of any areas of play. Under dry conditions, it may be permissible to drive off paths.

Figure 3. Shows rotation of soccer field and warm up area to manage traffic.

Mowing

No other maintenance practice is more important than mowing. Improper mowing can induce turf stress and lead to decreased density, more weeds, and drought because of root system damage. We feel the current height of 2 ½ inches is optimum for the fields and general areas at Ahuska Park. Frequency of mowing is another important part of the management plan, it is imperative to adjust the frequency based on the rate of turf growth.

When mowing, it is important to never take off more than ⅓ of the grass blade per cut. Optimum temperature and moisture conditions often result in turf that needs to be mowed more than once a week – which is logistically challenging. However, research out of UW-Madison and University of Nebraska have shown that grasses with more than 50% of the grass blade removed, the plant enters a stress state and grows even more rapidly which can lead to a thinning stand of turf if mowing is not adjusted to keep up with growth (Soldat, D. 2015. The Grass Roots. May/June. 44(3): p. 26-27) .

In addition to following the 1/3 rule, having sharp mower blades all season long is expected to increase turf health and density. We recommend that the Parks and Recreation Department have another set of sharpened blades that he can be quickly changed out when leaf fraying is observed (Figure 3).

It is likely that mower blades will need to be sharpened several times a year for optimum performance. In addition to harming the turf quality, dull blades also put more stress on the mowing equipment as it requires greater power (and more fuel) to turn the blades. A possible solution to making sure that the Monona Parks Department has blades that are sharp enough to make a clean cut is to have an extra set of blades that can easily be interchanged. The quote we received from Reinders for a new set of blades which would cost $129.50 for 7 blades on the TORO Groundsmaster 4000-D. We understand that there is a lot of grass that is maintained throughout the entire city of Monona, however one suggestion to ensure an optimal cut on the athletic fields is to designate one mower to mow the fields. By doing this we hope to eliminate potential sticks and other material that could disrupt the sharpness of the mowing blades. As we mentioned earlier the 4000-D model applies 12-18 pounds per square inch to the soil surface, and could potentially cause problems on the turf when conditions are as wet as this fall was. The use of John Deere out-front mower could eliminate the damage caused to the field when soil moisture is high, simply because these mowers are almost 2,000 lbs lighter than the TORO, and would exert 8-10psi. to the playing surface.

Figure 3. Shows torn leaf blade as result of dull mower blades.

Cultivation and Topdressing

Core cultivation is a critical process that can alleviate soil surface compaction and improves the water infiltration through the soil. The fields at Ahuska park have at least 12 inches silty clay loam, which has naturally poor drainage and is subject to compaction. The fields have been topdressed with Purple Cow compost after aeration, core sampling observations were not able to identify any layer or compost accumulation in the cores. However, our evaluation of the fields showed the silty clay loam soil to be minimally compacted, a testament to the quality of the current cultivation practices. We recommend the addition of deep tine aeration, to alleviate any formation of hardpan at a three inch depth by current cultivation practices. The core cultivation or deep tine aeration should be followed by a medium to coarse sand topdressing at a depth of 0.25 inches in the spring and fall in place of the current compost topdressing practices. A drag mat should be used to smooth out the surface and help incorporate the sand into the aeration holes. Additional core cultivation should be done throughout the season, as play and conditions allow ideally, fields while under heavy use should be core aerated and drug every three to four weeks, or as often as time and budget allows. The cores should be dragged with a drag mat to break up and incorporate the cores into the field. We feel that the sand topdressing program coupled with the current core cultivation practices will continue to make soil compaction less of an issue over a three year period, as well as improve drainage on the fields, increase the availability of water to the turf, and increase the number of games the field can handle. While sand topdressing may be a beneficial practice on all of the fields, we are only recommending it on the football field for now because of the cost. However, discontinuing the compost applications will provide a $3,600 savings in the budget , this will offset some of the suggested sand topdressing program that will cost an estimated $4,250. This program should be employed for three years, at which point the field's soil properties and management practices should be reassessed and adjusted if necessary.

- Baseball field

  Aerate with deep tine aerator or core cultivation, spring and fall. Core cultivate once in June or after spring baseball and drag cores.

- Soccer field

  Aerate with deep tine aerator or core cultivation, spring and fall. Core cultivate in June, and August, and drag cores.

- Football field

  Aerate with deep tine aerator or core cultivation, spring and late fall. Topdress with 0.25 inches of sand. Core cultivate, in early August, mid September, and early October, and drag cores.

Overseeding and Seed Selection

The Premium Athletic Field Gold, and Grand Slam Seed mixes currently being used at Ahuska Park are providing the playing surfaces on the baseball and football fields with a healthy and dense stand of turf. Applications of seed are done with the use of a slit seeder. The soccer field sees the most traffic and is subject to water runoff from the surrounding fields creating wet conditions and in some cases standing water. This causes some excess wear on the soccer field, which may benefit from the use of the 80/20 Premium Athletic Field Gold seed mix to establish a higher percentage of Kentucky bluegrass in the field. Kentucky bluegrass is a rhizomatous grass, it's spreading characteristics may help the field repair itself to some extent. This would increase the amount of premium seed needed by about 115 lbs., and additional cost of $337.00. Rotating practice and warm-up off one side of the soccer field at a time, or limiting warm up to behind the soccer field may help with seed establishment, and give a window to aerate as well. Overall the seed mixture and seeding rates of 3lbs. per 1000 sq.ft. for the 80/20, and 4lbs. per 1000 sq.ft. for the 50/50 mix are good for the playing surfaces and we recommend continued use. Broadcast applications of 100% perennial ryegrass blends can be used if the fields are starting to show significant wear, applications of this should be done at a rate of around 5lbs. per 1000 sq.ft. and applied prior to use in order to help obtain good seed to soil contact.

Field Painting

Field painting represents a significant portion of the budget at Ahuska Park, lining the field costs an estimated $120, per application not including labor. We recommend mixing a plant growth regulator, such as Primo Maxx with your paint, at a rate of 1oz. per gallon of paint applied. The growth regulator will slow the growth of the turf under the paint, and will dramatically increase the longevity of the lines, and thus reducing the frequency that the fields have to be painted, and saving paint and labor. If someone on staff is able to obtain a pesticide applicators license, mixing Primo Maxx, or similar product, following label directions may provide a worthwhile cost savings, and reduce the amount of man hours spent painting the field per year. The cost of Primo Maxx is $304 per gallon or $2.35 per oz. A generic product will cost $220 per gallon or $1.72 per ounce. Using 5 ounces per pail of paint will only increase the cost of paint from $40.00 per 5 gallon pail to $51.75 per pail using Primo Maxx. However, this practice may double the life of the paint, reducing product and labor costs.

"We recommend mixing a plant growth regulator, such as Primo Maxx with your paint, at a rate of 1oz. per gallon of paint applied. The growth regulator will slow the growth of the turf under the paint, and will dramatically increase the longevity of the lines, and thus reducing the frequency that the fields have to be painted, and saving paint and labor."

-Soils 332 students

NUTRIENT MANAGEMENT REPORT

Photo by Bryce Richter/UW-Madison, © Board of Regents of the University of Wisconsin System.

The state of Wisconsin currently has guidelines and laws that require all nutrient applications be recorded and follow regulations in accordance to the NR 151, which states in chapter 13 "The application of lawn and garden fertilizers on municipally controlled properties, with pervious surface over 5 acres each, shall be done in accordance with a site specific nutrient application schedule based on appropriate soil tests. The nutrient application schedule shall be designed to maintain the optimal health of the lawn or garden vegetation." Ahuska Park totals 6 acres as mentioned before and thereby needs to have a nutrient schedule based on soil test.

Our report below will focus on the current nutrient application schedule as compared to four other options (all compliant) that have different pros and cons, but will in general meet the agronomic, economic, and environmental goals of Ahuska Park. The nutrient management plan is included as an appendix to this report.

Background

The soccer field has the highest traffic out of the three fields followed by the football field and the baseball field. The soccer field also appeared to have the worst turf quality due to the high use of the field and lack of drainage on the field. The football field predominantly down the middle of the field had a thinner stand of turf. The general wear pattern of a football field is between the hash marks in the middle of the field. The majority of the traffic on the field is concentrated to this area and requires more inputs in order to provide acceptable turf quality. The baseball field appears to have good turf quality except for a few areas in the infield where the majority of wear occurs. Nitrogen requirements are partially determined by use and wear patterns. Taking this into account a fertilizer plan can be developed to access these issues and provide a consistent stand of turf across an entire athletic field.

Currently the fertilization of the athletic fields is done by an outside contractor, Conserv FS based in Woodstock, IL. The plan from Conserv FS consisted of a total of 3.66 pounds of nitrogen per year applied to the three athletic fields and is detailed out in the table below. We found the current plan to be in compliance with the NR-151 technical standard guidelines, although a written plan didn't exist.

Month	Fertilizer	Lbs N / 1000ft^2	Cost
May/June	30-0-5 50%XRT	1	$535
Early August	30-0-5 50% XRT	1	$468
September	25-0-5 33% XRT	1	$535
October	28-0-6 All Mineral	0.66	$396
Total		3.66	$1934

Table 1. Current nutrient application schedule at Ahuska Park in Monona WI.

Soil Test Results

Soil testing was done by Conserv FS this year on the athletic fields at Ahuska Park and the data from these chemical tests were made available to the students in Soil Science 332. However, the soil samples were analyzed using the Bray extractant which is less desirable than the Mehlich-3 for making fertilizer recommendations to turfgrass areas. Therefore, Mehlich-3 soil testing was done by the class to have the most up to date soil nutrient analysis for all athletic fields at Ahuska Park. Table 2 shows the results of the Mehlich-3 soil tests taken on October 4, 2016. The samples analyzed by Rock River Laboratory Inc.

Field	Soil pH	Organic Matter %	Mehlich-3 Phosphorus (ppm)	Mehlich-3 Potassium (ppm)	Mehlich-3 Calcium (ppm)	Mehlich-3 Magnesium (ppm)
Football	7.0	4.4	55	139	2654	731
Baseball	7.6	4.8	38	119	4895	751
Soccer	7.6	7.9	39	117	6129	663

Table 2. Soil testing results from athletic fields at Ahuska Park in Monona WI.

For the purpose of this report and the technical standard report applications of nutrients will be based on the Minimum Levels for Sustainable Nutrition Soil Guidelines (MLSN) developed by PACE Turf. Using these levels we see that our soils on all athletic fields are above these levels for all nutrients in question, including phosphorus. These results suggest that additions of potassium, phosphorus, calcium, and magnesium are unnecessary. Unfortunately, soils tests are unable to predict nitrogen availability from the soil. Therefore nitrogen recommendations are based on other factors including grass species, soil type and condition, traffic and use patterns, and climate and edaphic factors.

Future

Based on quotes we have received from various companies in the area we have found that Conserv FS provides the lowest agronomic plan based on soil test results. Our recommendations will include using both their fertilizer products and applicators. There are two nutrient plans we are recommending for Ahuska Park. Based on our observations and research increasing the total amount of nitrogen applied to each field is the focal point of each plan. The lack of nitrogen on the athletic fields is the biggest issue on these fields and in order to address this problem more nitrogen is needed.

Fertilizer Plans and Proposals

Plan 1

Plan 1 is a recommendation that is increasing the total amount of nitrogen applied to all athletic fields. The nutrient management plan will continue to us Conserv FS as an outside contractor. The increase of nitrogen applications and overall amount will help recovery on the playing surfaces and potentially the reduction of the disease rust that was prevalent on the football field in particular. The result of the soil test shows that there is no need for additional phosphorus applications to the field given the Mehlich 3 guidelines. To supplement an additional application of nitrogen without increasing cost greatly using feed grade urea. A fifty pound bag of urea only cost $11.50, this is extremely cost effective while providing adequate fertility. The table below comprises the fertilizers used and when they are to be applied as well the total cost of products and applications. Applications of fertilizer should not be made with turf has gone dormant in order to reduce the risk of runoff and leaching.

Athletic Fields	Mid May	Mid June	Early Aug.	Sept.	Oct.	Total N
Football	30-0-5 50%XRT 1 lbs /1000ft²	46-0-0 Urea 1 lbs /1000ft²	30-0-5 50%XRT 1 lbs /1000ft²	25-0-5 33%XRT 1 lbs /1000ft²	46-0-0 Urea 0.5 lbs /1000ft²	4.5 lbs /1000ft²
Baseball	30-0-5 50%XRT 1 lbs /1000ft²	46-0-0 Urea 1 lbs /1000ft²	30-0-5 50%XRT 1 lbs /1000ft²	25-0-5 33%XRT 1 lbs /1000ft²	46-0-0 Urea 0.5 lbs /1000ft²	4.5 lbs /1000ft²
Soccer	30-0-5 50%XRT 1 lbs /1000ft²	46-0-0 Urea 1 lbs /1000ft²	30-0-5 50%XRT 1 lbs /1000ft²	25-0-5 33%XRT 1 lbs /1000ft²	46-0-0 Urea 0.5 lbs /1000ft²	4.5 lbs /1000ft²

Table 3. Fertilizer plan for all fields provided by FS Conserve including application cost $1,617 total

Plan 2

Plan 2 is a recommendation that uses only a urea based nitrogen source. By using only this fertilizer source cost can be drastically cut compared to the other fertilizer recommendations and can provide similar results to turf quality. Again by applying more nitrogen than the current nutrient management plan an already good program can be improved upon by adding an additional pound of nitrogen per year to all of the fields. Applications of fertilizer should not be made with turf has gone dormant in order to reduce the risk of runoff and leaching.

Athletic Fields	Mid May	Mid June	Early Aug.	Sept.	Oct.	Total N
Football	46-0-0 Urea 1 lbs /1000ft²	46-0-0 Urea 1 lbs /1000ft²	46-0-0 Urea 1 lbs /1000ft²	46-0-0 Urea 1 lbs /1000ft²	46-0-0 Urea 0.5 lbs /1000ft²	4.5 lbs /1000ft²
Baseball	46-0-0 Urea 1 lbs /1000ft²	46-0-0 Urea 1 lbs /1000ft²	46-0-0 Urea 1 lbs /1000ft²	46-0-0 Urea 1 lbs /1000ft²	46-0-0 Urea 0.5 lbs /1000ft²	4.5 lbs /1000ft²
Soccer	46-0-0 Urea 1 lbs /1000ft²	46-0-0 Urea 1 lbs /1000ft²	46-0-0 Urea 1 lbs /1000ft²	46-0-0 Urea 1 lbs /1000ft²	46-0-0 Urea 0.5 lbs /1000ft²	4.5 lbs /1000ft²

Table 4. Fertilizer plan for only applications of Urea $621 total

Summary

Both fertilizer plan recommendations provide adequate nitrogen to the turfgrass but in different forms and with different cost associations. Calculating the cost per pound of nitrogen for both plans there is a significant difference between the two plans. When applying one pound of 30-0-5 the cost per pound of nitrogen applied is $1.75. Compare this to applying one pound of feed grade urea the cost per pound of nitrogen is $0.53. This is a significant reduction in cost and is partially why the cost difference between the two plans are so great. While the first plan my cost more in total the relative cost per pound of nitrogen applied is quite good compared to similar fertilizers on the market.

Photo by Jeff Miller/UW-Madison

IRRIGATION REPORT

Photo by Jeff Miller/UW-Madison, © Board of Regents of the University of Wisconsin System.

Data, Methods and Interpretation

In order to evaluate the moisture levels of the soils in the field, readings were taken in a grid pattern every 5 yards with a soil moisture probe. Readings for the volumetric water content were taken as percentages, and graphed onto the image below:

The moisture readings from the football field were taken after several weeks of heavy rain, and reflect the current natural drainage and moisture patterns of the field. While the moisture distribution in the field is non uniform, it shows that surface drainage is adequately directing the flow of water towards the end zones and away from the center of the field. According to Mining Education Australia (available at http://mea.com/au under soil moisture content), a moisture content of 20% to 30% for sandy soils will allow adequate moisture to plants without drowning them, while a content closer to 50% is more common in clay soils. Based on the soil composition of the field, an acceptable moisture content in this case would be between 30% and 35%. As illustrated in the water content map, the center of the field was on average 5% to 7% above this range, while some parts of the end zones were 10% or more above the acceptable range. A large portion of the field in the 0 to 30 yard lines on both sides, is within the prescribed range; and only two small areas contain less than 30% moisture. Based on this information, the use of different irrigation techniques or the substitution of a more uniform soil is recommended in order to have more uniform soil moisture in the 30% to 35% volumetric water content range.

We evaluated the current distribution of water of the current irrigation system, which is a water wheel that is dragged from one end of the field and is slowly reeled backwards, by performing an irrigation audit.

Figure 5 above shows that the distribution of water is not ideal. The area within a small 20 foot radius of the irrigation cannon received the most water while the area outside of the radius receives adequate to hardly any water. Drought has been an issue on the football field and originally it was thought that sandy soil was draining the water too rapidly. However, from our soil analysis, we know that the soil is actually a silty clay loam. Due to

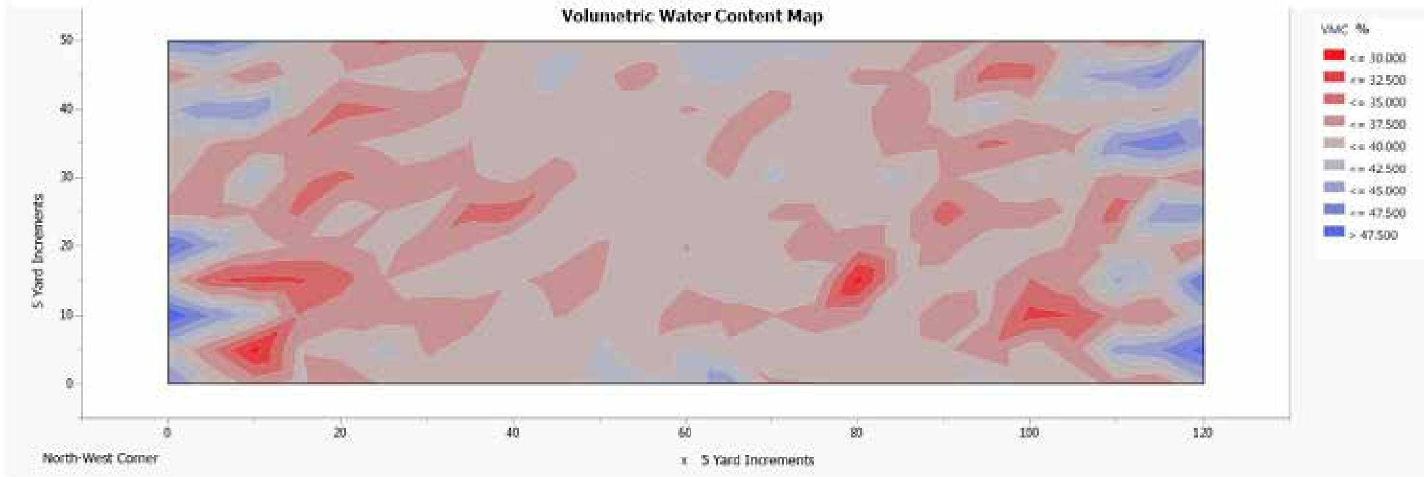


Figure 4: Shows the distribution of soil moisture on the football field. Red indicates areas with less moisture, and blue represents areas with more moisture.

"Based on this information, the use of different irrigation techniques or the substitution of a more uniform soil is recommended in order to have more uniform soil moisture in the 30% to 35% volumetric water content range."

-Soils 332 students

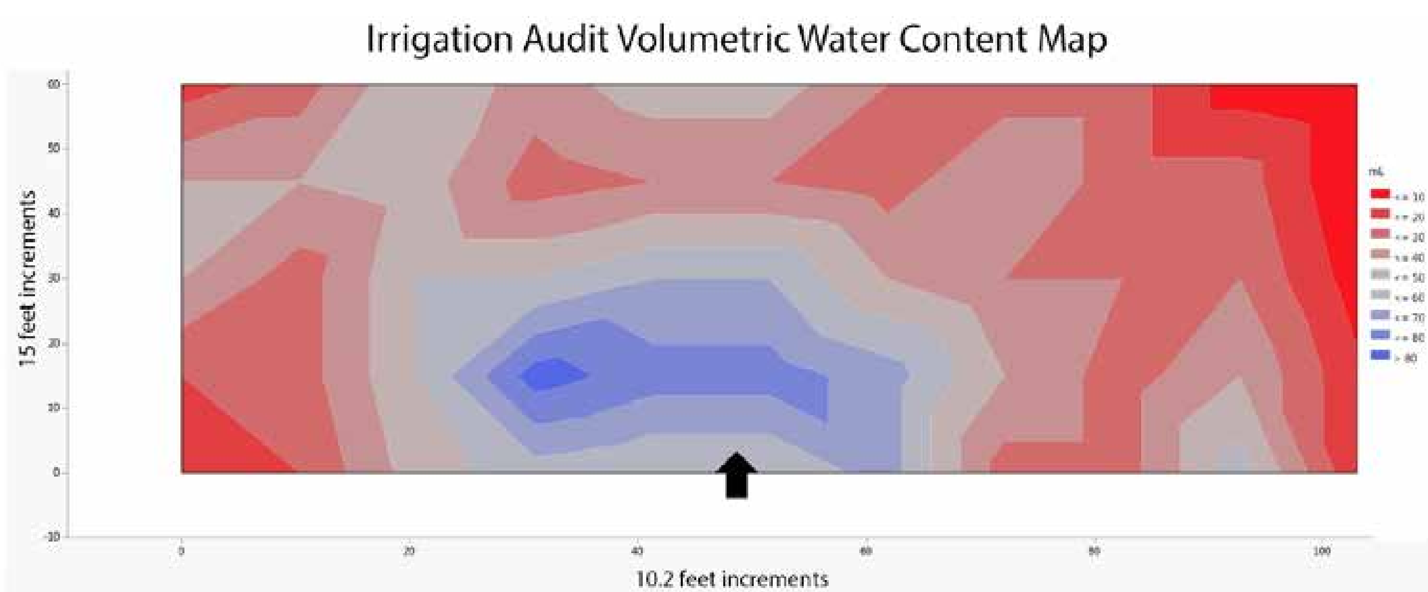


Figure 5: Map of our irrigation audit showing the distribution of water. Irrigation was run for 10 minutes at 180 degrees. The black arrow indicates where the irrigation cannon was located. For this audit, we did not allow the cannon to move backwards. The areas in blue indicate high levels of moisture and areas in red indicate low levels of moisture.

the uneven application of water from the current irrigation system, the soil is absorbing too much water in some locations, while it is absorbing almost no water in others. We calculated the Distribution Uniformity Coefficient (CU), which measures how uniformly water is applied expressed as a percentage, that equaled 57%. This means that almost twice as much water would have to be used in order to achieve a uniform application, which would cost more money and require more time and labor. The minimum recommendation is that the CU should be at least 80%, meaning that an increase in irrigation efficiency is possible, and is the key to saving time and limiting cost. It takes two people to set up the water wheel and it takes 8 hours to irrigate one field.

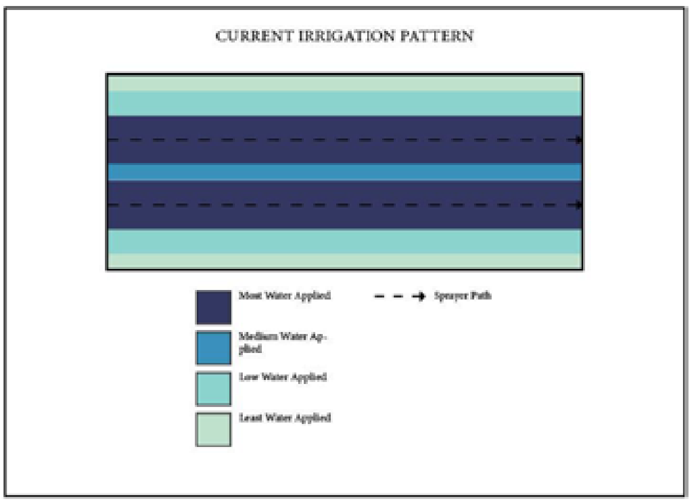


Figure 6: Water Application of Current System. This figure shows a hypothetical distribution of water based on the irrigation audit data in Figure 5.

Figure 7: Aerial image of the football field from showing the irrigation patterns of the wet and drought areas.

Due to the lack of a uniform distribution of water and the high cost of time and labor, we are proposing a new irrigation system to be installed on the football field to irrigate the turf evenly and optimize growing conditions. While there are clear up-front costs to our proposed systems, they will significantly reduce the labor and water cost of irrigating the field each season.

Proposals and Justifications

We are proposing drip irrigation as the only irrigation option in all three of our proposals. Being on a landfill site, the field is expected to shift and settle. Using a traditional irrigation system would run the risk of pipes breaking and having to readjust sprinkler heads regularly. This would cause a greater expense in budget and cause a greater increase in time for employees. Drip irrigation utilizes pipes that are flexible and can move with the landscape, avoiding the stresses of the landscape shifts. This type of irrigation also allows the water to be applied directly to the root zone of the turf as well as irrigating in more uniformly manner. Drip irrigation can be purchased installed by Reinders, Inc. We contacted them to appraise the price of the system and the estimated price of the drip irrigation system is $23,160.50.

Below are our three irrigation/drainage proposals

1. Level Spreader with Sand Cap System
   Total Cost: $269,160.50 to $308,160.50
   Cost by Component:

   - Drip Irrigation: $23,160.50
   - Gabion Baskets: $125,000.00
   - Non-woven Geotextile: $9,500.00
   - Stone Fill (RipRap): $75,500.00
   - Sand Cap System: $36,000.00 to $75,000.00

This is the most expensive system, but will be the most effective and draining the field and providing uniform water to the plants. This system will have a 12” deep sand cap, which will contain a drip irrigation system at 6” depth. Underneath the sand cap, there will be 1’-6” of crushed stone (5” to 10” in diameter) retained within gabion baskets. The gabion baskets will be FF size, woven wire, Midwest Gabion Baskets (3' x 1.5' x 12'). All of the stone structure will be lined with typar, in order to prevent sand and soil from filling the pore space between the stones, which will preserve the structure's integrity and functionality. The crushed stone will provide pore space for excess water to move through quickly, which will greatly improve drainage on the field while allowing for water to enter subsurface flow more quickly. The woven wire gabions can flex with the field if the landfill continues to settle unevenly, and they will help preserve the stone's pore space in the event of rise and fall of the material; as opposed to scattering and loss of pore space in a system without the wire retention. The sand cap system will also help to improve drainage on the field, and will allow for more uniform moisture. These methods of improving drainage will allow for the field to receive plenty of water from storms without becoming oversaturated, and combining it with drip irrigation will allow for additional water to be applied directly to the' root zone of the plants as needed without worrying about a non-uniform application.

2. Sand Cap System
   Total Cost: $59,160.50 to $99,160.50
   Cost by Component:

   - Drip Irrigation: $23,160.50
   - Sand Cap System: $36,000.00 to $75,000.00

This option is much less expensive that option 1, and will has many of the same benefits. It is a combination of drainage pipes and sand to allow for drainage and a stable playing surface. This option is not an entire renovation either which means the field is not completely out of play. It involves digging small trenches to put the drain pipes in and then filling the trench with sand. Next, the field is topdressed with sand to build up a sand layer that will allow water to drain into the trenches. Having a sandy soil is great for athletic fields because it is resistant to compaction and allows water to move through the soil profile quickly to avoid ponding on the surface. More detailed information can be found on the PDF from Michigan State. http://msue.anr.msu.edu/uploads/236/68678/Sand-Cap-Athletic-Fields.pdf.

3. Drip Irrigation Only
   Total Cost: $23,160.50
   Cost by Component:

   - Drip Irrigation: $23,160.50

This option is the least expensive because it does change or add any new soil to the existing field. Drip irrigation will be the only thing installed on the field. This will provide a better irrigation system than the current system. Time will also be saved as the drip irrigation system will be automatic allowing employees to use their time more effectively elsewhere. However, this option does not renovate the current soil profile so compaction, water retention due to clay, and wet spots will continue to persist.

Soil Moisture Monitoring Recommendations

Due to the cost invested in all of these proposals as well as the importance of applying the proper amount of water to the turf on athletic fields, we recommend purchasing a moisture probe such as the Field Scout TDR 300 Field Moisture Meter from Spectrum Technologies. This particular probe costs $1100.00, and will allow maintenance crews to accurately monitor moisture across the field. The probe data could be tracked over time to help improve the overall efficiency and cost of irrigating the field, and could be used to determine when to run the system and when to skip a watering sequence. In addition, the probe data could be combined with graphing software in order to get a visual representation of the effect of irrigation on the field, which would be useful to identify any problems which occur with the irrigation system itself or with the structure of the soils or systems applied to the field.

Photo by Jeff Miller/UW-Madison

CONCLUSION

In conclusion, the overall maintenance at Ahuska Park was excellent. However, we have identified some opportunities for improving turf health, playing conditions, and safety in the areas of general maintenance, fertilization, and irrigation practices. We think these recommendations will help the park remain an asset to the community as population and use increases. We hope that many of these recommendations can be employed as early as next season. If questions arise, don't hesitate to contact our professor, Dr. Doug Soldat.

Photo by Jeff Miller/UW-Madison, © Board of Regents of the University of Wisconsin System.

APPENDIX

Appendix

1. NR151 Report Ahuska Park
2. MLSN
    a. https://www.paceturf.org/PTRI/Documents/1202_ref.pdf
3. Michigan Sand Cap

TURFGRASS NUTRIENT MANAGEMENT PLAN FOR AHUSKA PARK

Site: **Ahuska Park**
Location: **400 E Broadway Monona, WI 53716**
Owner: **City of Monona**
Land Manager: **Jake Anderson**
    Mailing address: 1011 Nichols Road Monona, WI 53716
    Phone: 608-222-4167

Nutrient Management Planner: **Ron Townsend and Logan Mohr**
Credentials: **UW Madison Turfgrass Students**
Date Created: **11/3/16**
Updates:

TABLE OF CONTENTS

NARRATIVE DESCRIPTION (this should be the last section that you write)

GOAL:

To minimize entry of sediment and nutrients into water resources while maintaining high quality turfgrass.

SITE DESCRIPTION:

Ahuska park is located in Monona, Wisconsin. It consists of three athletic fields for a total area of six acres; baseball diamond, football field, and soccer field. The soccer field has the highest traffic out of the three fields followed by the football field and the baseball field. The soccer field also appeared to have the worst turf quality due to the high use of the field and lack of drainage on the field. The football field predominantly down the middle of the field had a thinner stand of turf. The general wear pattern of a football field is between the hash marks in the middle of the field. The majority of the traffic on the field is concentrated to this area and requires more inputs in order to provide acceptable turf quality. The baseball field appears to have good turf quality except for a few areas in the infield where the majority of wear occurs.

The football field in particular was thought to be a sand based field. Upon further evaluation using the USDA soil survey (figure 3) the survey reveals that the majority of the park is a form of muck. Soil cores taken from the football field show that the field is not a sand based field but rather a silty clay loam soil. These findings were confirmed by sending the soil cores for texture analysis by Rock River Laboratory in Watertown WI.

CHARACTERISTICS OF FERTILIZED AREAS

Site:	Ahuska Park
Location:	Football Field
Size:	2.71 acres
Age:	10 years
Grass species:	Kentucky Bluegrass/ Perennial Ryegrass
Root zone or soil type:	Silty Clay Loam
Traffic:	High
Max. allowable N/year:	8 lbs/1000ft^2
Soil Test P Level:	55 ppm (Mehlich 3)
Max. allowable P_2O_5/year:	0 lbs/1000ft^2

Site:	Ahuska Park
Location:	Soccer Field
Size:	1.61 acres
Age:	10 years
Grass species:	Kentucky Bluegrass/ Perennial Ryegrass
Root zone or soil type:	Silty Clay Loam
Traffic:	High
Max. allowable N/year:	8 lbs/1000ft^2
Soil Test P Level:	39 ppm (Mehlich 3)
Max. allowable P_2O_5/year:	0 lbs/1000ft^2

Site:	Ahuska Park
Location:	Baseball Field
Size:	2.43 acres
Age:	10 years
Grass species:	Kentucky Bluegrass/ Perennial Ryegrass
Root zone or soil type:	Silty Clay Loam
Traffic:	High
Max. allowable N/year:	8 lbs/1000ft^2
Soil Test P Level:	38 ppm (Mehlich 3)
Max. allowable P_2O_5/year:	0 lbs/1000ft^2

Site:	GROUNDWATER MANAGEMENT AREAS
Location(s):	No groundwater areas are located on this site in reference to the site map located in the appendix on page 14.
Size:	N/A
Restrictions:	Fertilizers with 50% or more slow-release N can be used in accordance with the rest of the nutrient management plan. Fertilizers with less than 50% should be applied at rates of 0.25 lbs N/1000 sq. ft.

Site:	TYPE I SURFACE WATER MANAGEMENT AREAS (Areas with slopes >10% within 1000 feet of lake, pond (with an outlet) or wetland; or areas with slopes >10% within 300 feet of a perennial stream or river)
Location:	There are no areas located on the site in which fertilizers will be applied and are considered Type I areas.
Size:	N/A
Restrictions:	Fertilizers with 50% or less slow-release N can be used in accordance with the rest of the nutrient management plan.

Site:	TYPE II SURFACE WATER MANAGEMENT AREAS (Areas within 20 feet of lake, pond (with an outlet), river, stream or wetland)
Location:	There are no areas that will be fertilized on this site within 20 feet of type II areas.
Size:	N/A
Restrictions:	Only foliar (liquid) N and P applications are allowed, except on greens and surrounds where drop spreaders may be used. No more than 2 lbs N/1000 sq. ft. can be applied annually.

Fertilizer Spill Response Plan

If a spill occurs, take appropriate cleanup actions.

Spills involving over 250 lbs of dry or 25 gallons of liquid fertilizer must be immediately reported to the WDNR

24-hour spills hotline: 1-800-943-0003

Spills of lesser amounts are exempt from the reporting unless the spill had adversely impacted or threatens to adversely impact the air, lands, or waters of the state either as a single discharge or when accumulated with past discharges.

General Fertilizer Application Schedule
2016

Frequency of fertilization equipment calibration
Before each application

General Nutrient Application Schedule – Nitrogen/Phosphorus (lbs/1000 ft^2)

Location	April	May	June	July	Aug	Sept	Oct	Nov	Total
Football	X	1/0	1/0	1/0	1/0	1/0	0.5/0	X	4.5/0
Baseball	X	1/0	1/0	1/0	1/0	1/0	0.5/0	X	4.5/0
Soccer	X	1/0	1/0	1/0	1/0	1/0	0.5/0	X	4.5/0

Spreader Calibration Table

Date	Fertilizer Grade	Intended N Rate	Width of Drop Spreader of HALF throw pattern of rotary	Calibration Distance	Fertilizer needed per calibration area[1]	Fertilizer needed per 1000 ft^2	Operator
	$N\text{-}P_2O_5\text{-}K_2O$	lbs/1000ft^2	feet	feet	lbs	lbs	

[1] **To calculate the amount of fertilizer needed follow these calculations:**

Step 1: Multiply calibration distance x width of drop spreader (or half throw pattern of rotary) (50 x 3 = 150 ft^2)

Step 2: Divide intended N rate by the percentage of N in the fertilizer (0.25/0.30) = 0.833, this is the amount of fertilizer you'll need per thousand square feet, put this number in the second to last column

Step 3: Divide 1000 ft^2 by the answer to Step 1 (1000/150 = 6.67)

Step 4: Divide the fertilizer needed per 1000 ft^2 by the answer to Step 3 (0.833/6.67 = 0.125) this is the weight of fertilizer that should be applied in your calibration area to achieve the proper fertilization rate. If your scale only displays grams multiply by 454 (0.125 x 454 = 56.7 grams)

ACTUAL FERTILIZER APPLICATION RECORDS

Area______________________________

Date	Applied to	N rate (lbs/M)	P_2O_5 rate (lbs/M)	Fertilizer Grade	N source	SRN (%)	Liquid/Granular	Applicator

Figure 1. Groundwater map of Monona and parts of Madison WI

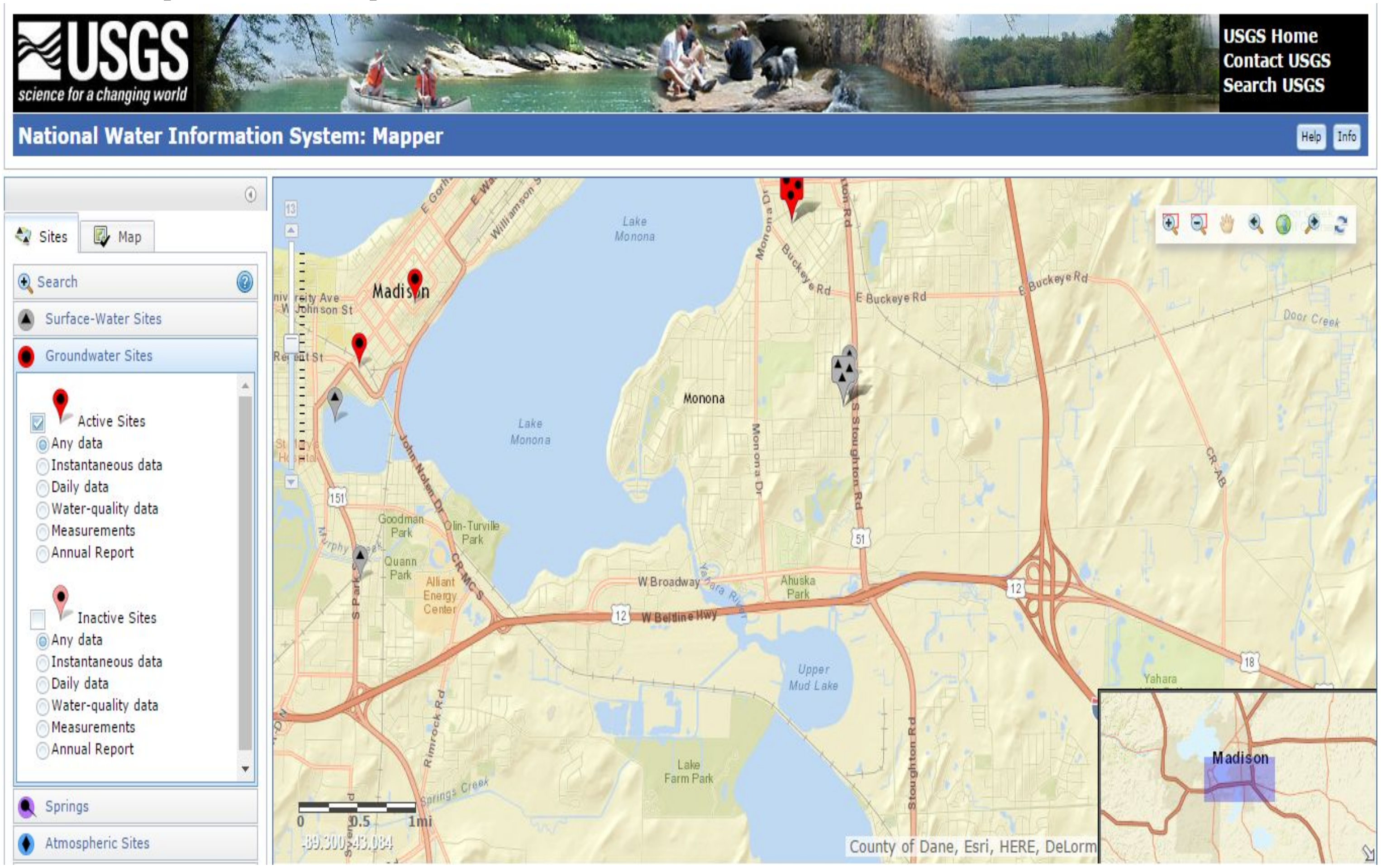
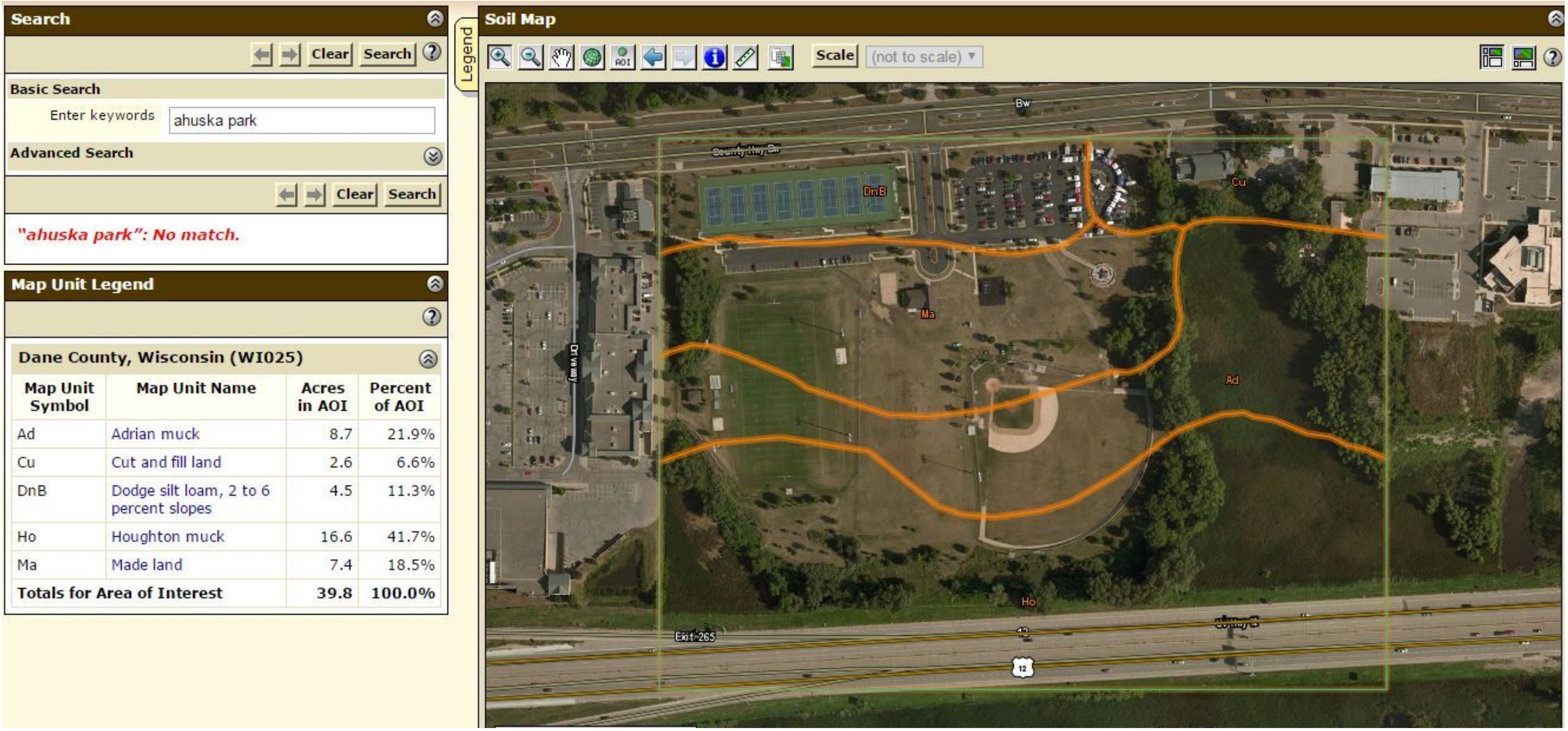


Figure 2. Site map of Ahuska Park in Monona WI

Figure 3. Soil survey map of Ahuska Park in Monona WI.



Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Ad	Adrian muck	8.7	21.9%
Cu	Cut and fill land	2.6	6.6%
DnB	Dodge silt loam, 2 to 6 percent slopes	4.5	11.3%
Ho	Houghton muck	16.6	41.7%
Ma	Made land	7.4	18.5%
Totals for Area of Interest		**39.8**	**100.0%**

Figure 4. Soil core taken from the football field.

ROCK RIVER LABORATORY, INC.
AGRICULTURAL ANALYSIS

Soil Test Report - Field: 200 (Football)

Account: 1906
UW Soil Science - Doug Soldat
244 King Hall
Madison, WI 53706

Report For:
Doug Soldat

Lab #193910
County ADAMS
Received 11/1/2016
Slope 0%
Field
200 (Football)
Acres
Plow Depth 7.0
Soil Name
unknown
Previous Crop

Nutrient Recommendations

Cropping Sequence	Yield Goal (per acre)	Crop Nutrient Need (lbs/acre)			Fertilizer Credit (lbs/acre)				Nutrients to Apply(lbs/acre)		
		N	P2O5	K2O	Legume N	Manure N	P2O5	K2O	N	P2O5	K2O
Corn, grain	171-190 bu	*	0	50	0	0	0	0	*	0	50
Soybean, grain	56-65 bu	0	0	85	0	0	0	0	0	0	85
Alfalfa, seeding	1.5-2.5 ton	0	0	105	0	0	0	0	0	0	105
Alfalfa, established	5.6-6.5 ton	0	0	360	0	0	0	0	0	0	360

*For information on the new N application rate guidelines for corn see http://uwlab.soils.wisc.edu/pubs/MRTN
There is no lime recommendation.

Laboratory Analysis for Field 200 (Football), Lab No 193910

Sample Num	Soil pH	Om %	P ppm	K ppm	60-69 Lime Req(T/a)	Ca ppm	Mg ppm	Est Cec	B ppm	Mn ppm	Zn ppm	Sulfate-S ppm	Texture Code	Sample Density	Buffer Code
1	7.0	4.4	55	139		2654	731	24					2	0.95	N.R.

Additional Information, Secondary & Micronutrient Recommendations

N.R.=Not required for calculation of lime requirement when soil pH is 6.6 or higher.
Starter fertilizer (e.g. 10+20+20 lbs N+P2O5+K2O/a) is advisable for row crops on soils slow to warm in the spring.
Because of very high P levels, P2O5 applications from fertilizer or manure should be reduced and crops with a high P removal should be grown.
If alfalfa will be maintained for more than three years, increase recommended K2O by 20% each year.
Recommended rates are the total amount of nutrients to apply (N-P-K), including starter fertilizer.
Year 1: If corn is harvested for silage instead of grain apply extra 90 lbs K2O per acre to next crop.
Ca - H Mg-H
%Base Saturation: Ca 67.6% Mg 30.5% K 1.8%
Response to added Ca is unlikely.
Response to added Mg is unlikely.

Test Interpretation for Field 200 (Football), Lab No 193910

Crop Name	Very Low	Low	Optimum	High	Very High	Excessive	Very Low	Low	Optimum	High	Very High	Excessive
Alfalfa, established	P						K					
Rotation pH	pH											

ROCK RIVER LABORATORY, INC.
AGRICULTURAL ANALYSIS

Soil Test Report - Field: 201 (Soccer)

Account: 1906
UW Soil Science - Doug Soldat
244 King Hall
Madison, WI 53706

Report For:
Doug Soldat

Lab #193910
County ADAMS
Received 11/1/2016
Slope 0%
Field
201 (Soccer)
Acres
Plow Depth 7.0
Soil Name
unknown
Previous Crop

Nutrient Recommendations

Cropping Sequence	Yield Goal (per acre)	Crop Nutrient Need (lbs/acre)			Fertilizer Credit (lbs/acre)				Nutrients to Apply(lbs/acre)		
		N	P2O5	K2O	Legume N	Manure N	P2O5	K2O	N	P2O5	K2O
Corn, grain	171-190 bu	*	0	50	0	0	0	0	*	0	50
Soybean, grain	56-65 bu	0	0	85	0	0	0	0	0	0	85
Alfalfa, seeding	1.5-2.5 ton	0	0	105	0	0	0	0	0	0	105
Alfalfa, established	5.6-6.5 ton	0	0	360	0	0	0	0	0	0	360

*For information on the new N application rate guidelines for corn see http://uwlab.soils.wisc.edu/pubs/MRTN
There is no lime recommendation.

Laboratory Analysis for Field 201 (Soccer), Lab No 193910

Sample Num	Soil pH	Om %	P ppm	K ppm	60-69 Lime Req(T/a)	Ca ppm	Mg ppm	Est Cec	B ppm	Mn ppm	Zn ppm	Sulfate-S ppm	Texture Code	Sample Density	Buffer Code
1	7.6	7.9	39	117		6129	663	45					2	0.94	N.R.

Additional Information, Secondary & Micronutrient Recommendations

N.R.=Not required for calculation of lime requirement when soil pH is 6.6 or higher.
Starter fertilizer (e.g. 10+20+20 lbs N+P2O5+K2O/a) is advisable for row crops on soils slow to warm in the spring.
If alfalfa will be maintained for more than three years, increase recommended K2O by 20% each year.
Recommended rates are the total amount of nutrients to apply (N-P-K), including starter fertilizer.
Year 1: If corn is harvested for silage instead of grain apply extra 90 lbs K2O per acre to next crop.
Ca - H Mg-H
%Base Saturation: Ca 84.2% Mg 15.0% K 0.8%
Response to added Ca is unlikely.
Response to added Mg is unlikely.

Test Interpretation for Field 201 (Soccer), Lab No 193910

Crop Name	Very Low	Low	Optimum	High	Very High	Excessive	Very Low	Low	Optimum	High	Very High	Excessive
Alfalfa, established	P						K					
Rotation pH	pH											

ROCK RIVER LABORATORY, INC.
AGRICULTURAL ANALYSIS

Soil Test Report - Field: 202 (Baseball)

Account: 1906
UW Soil Science - Doug Soldat
244 King Hall
Madison, WI 53706

Report For:
Doug Soldat

Lab #193910
County ADAMS
Received 11/1/2016
Slope 0%
Field
202 (Baseball)
Acres
Plow Depth 7.0
Soil Name
unknown
Previous Crop

Nutrient Recommendations

Cropping Sequence	Yield Goal (per acre)	Crop Nutrient Need (lbs/acre)			Fertilizer Credit (lbs/acre)				Nutrients to Apply(lbs/acre)		
		N	P2O5	K2O	Legume N	Manure N	P2O5	K2O	N	P2O5	K2O
Corn, grain	171-190 bu	*	0	50	0	0	0	0	*	0	50
Soybean, grain	56-65 bu	0	0	85	0	0	0	0	0	0	85
Alfalfa, seeding	1.5-2.5 ton	0	0	105	0	0	0	0	0	0	105
Alfalfa, established	5.6-6.5 ton	0	0	360	0	0	0	0	0	0	360

*For information on the new N application rate guidelines for corn see http://uwlab.soils.wisc.edu/pubs/MRTN
There is no lime recommendation.

Laboratory Analysis for Field 202 (Baseball), Lab No 193910

Sample Num	Soil pH	Om %	P ppm	K ppm	60-69 Lime Req(T/a)	Ca ppm	Mg ppm	Est Cec	B ppm	Mn ppm	Zn ppm	Sulfate-S ppm	Texture Code	Sample Density	Buffer Code
1	7.6	4.8	38	119		4895	751	37					2	0.99	N.R.

Additional Information, Secondary & Micronutrient Recommendations

N.R.=Not required for calculation of lime requirement when soil pH is 6.6 or higher.
Starter fertilizer (e.g. 10+20+20 lbs N+P2O5+K2O/a) is advisable for row crops on soils slow to warm in the spring.
If alfalfa will be maintained for more than three years, increase recommended K2O by 20% each year.
Recommended rates are the total amount of nutrients to apply (N-P-K), including starter fertilizer.
Year 1: If corn is harvested for silage instead of grain apply extra 90 lbs K2O per acre to next crop.
Ca - H Mg-H
%Base Saturation: Ca 79.1% Mg 19.9% K 1.0%
Response to added Ca is unlikely.
Response to added Mg is unlikely.

Test Interpretation for Field 202 (Baseball), Lab No 193910

Crop Name	Very Low	Low	Optimum	High	Very High	Excessive	Very Low	Low	Optimum	High	Very High	Excessive
Alfalfa, established	P						K					
Rotation pH	pH											

710 Commerce Drive
PO Box 169
Watertown WI, 53094
Phone: 920-261-0446
Fax: 920-261-1365
www.rockriverlab.com

Date: 11/7/2016

Dealer: Doug Soldat

Sample ID	%Clay	%Silt	%Sand	Textural Class
203 (football)	27.8	56.0	16.2	Silty Clay Loam

Minimum Levels for Sustainable Nutrition Soil Guidelines

The Minimum Level for Sustainable Nutrition (MLSN) Guideline is a new, more sustainable approach to managing soil nutrient levels that can help you to decrease fertilizer inputs and costs, while still maintaining desired turf quality and playability levels. The MLSN guidelines were developed in a joint project between PACE Turf and the Asian Turfgrass Center. All soil analyses were conducted at Brookside Laboratories, New Bremen, OH.

	MLSN Soil Guideline
pH	>5.5
Potassium (K ppm)	37
Phosphorus (P ppm)	21
Calcium (Ca ppm)	331
Magnesium (Mg ppm)	47
Sulfur as sulfate (S ppm)	7

Nitrogen requirements are best determined based on **turf growth potential**, which incorporates site-specific weather and turf type to calculate nitrogen demand (Gelernter and Stowell, 2005. Golf Course Management, p. 108-113, March, 2005).

How the guidelines were developed

From a database of over 17,000 soil samples, we selected 3,721 that were classified as having:

- not poor performing turfgrass
- pH 5.5 - 8.5: to avoid aluminum toxicity at pH less than 5.5, and to avoid alkalinity hazard at pH greater than 8.5
- total exchange capacity <6 cmol/kg

A log-logistic model provided a significant fit of the data, and was used to identify the concentration (in ppm) of each nutrient that 10% of the soil samples fell below, but were still performing well. This 10th percentile value is the MLSN soil guideline shown above.

For more information, see the Facebook MLSN page at: www.facebook.com/mlsnturf

PACE TURF

ATC ASIAN TURFGRASS CENTER

Analytical methods used to develop the Minimum Levels for Sustainable Nutrition Soil Guidelines

Electrical conductivity (1:2) converted to saturated paste equivalent, 1:2 soil method. Reference: Soil, Plant and Water Reference Methods for the Western Regions S-2.210, 2003. Values converted to saturated paste equivalent using following equation:

*Saturated paste equivalent EC dS/m = 2.1 * (1:2 EC dS/m) + 0.5)*

pH (1:1 in water). Reference: McLean, E.O. 1982. Soil pH and lime requirement. in Page, A.L. ed. Methods of soil analysis, part 2. Agronomy Monograph 9, 2nd ed. American Society of Agronomy and Soil Science Society of America, Madison, WI; pp. 199-223.

Mehlich III extractable sulfur, calcium, magnesium, potassium, sodium and phosphorus. Reference: Mehlich, A. 1984. Mehlich-3 soil test extractant: a modification of Mehlich-2 extractant. Comm. Soil Sci. Plant Anal. 15:1409-1416.

Sustainability Metrics

Decreases in these 7 inputs can document your progress towards sustainability

The goal of "sustainable turf" is a worthy one, but there has been too little technical discussion of what it means, how it can be achieved, and how to measure progress towards sustainability. We have selected the seven parameters below because reductions in each can produce significant improvements in costs and environmental inputs, and because each can be easily quantified:

1. **Reduce number of total maintained acres**. Reduce turf or heavily landscaped acres, and you will reduce water, equipment, manpower, fertilizer and pesticide inputs.
2. **Reduce total water used**. Accomplish this by switching to reclaimed water, improving irrigation efficiency, reducing turf acres.
3. **Reduce total nutrients applied**. Get more efficient with nitrogen, phosphorus, potassium and other key elements. The MSLN guidelines can help you here.
4. **Reduce total pounds and toxicity levels of pesticides applied.** Implement an IPM plan and track reductions in total pounds on the ground. You can also document incorporation of safer, Class 3 pesticides and biocontrol approaches, and decreases in more toxic Class 1 and Class 2 pesticides.
5. **Reduce manpower costs**
6. **Reduce fuel use costs and volumes**
7. **Reduce electrical use costs and kWhs used**

PACE TURF

ASIAN TURFGRASS CENTER

Sand Cap Build-up Systems for Michigan High School Fields

A.R. Kowalewski and J.N. Rogers, III
Department of Crop and Soil Sciences
Michigan State University
January 2008

> Researchers propose a cost effective solution for failing native soil athletic fields across Michigan.

The typical Michigan high school athletic field serves as a focal point for social gatherings and adds to a sense of community pride. It is typically one of the few fields in town with lights, making it host to a variety of after school and work events including football, lacrosse, soccer, cheerleading, and band. Therefore, having an aesthetically pleasing and functional high school athletic field is often important to a variety of members in the average community.

The Problem

In order to have a significant number of events on a natural grass playing field and provide reasonable playing conditions throughout the fall, regardless of weather, the root zone must be primarily sand based. Unfortunately, the majority of Michigan's high school athletic fields are constructed on native soil. These fields rely on surface drainage during periods of heavy rainfall, failing to provide adequate drainage of surplus water. Saturated field conditions substantially reduce soil cohesion, adversely affecting traction and stability. Reduced stability in combination with heavy use in the typical fall athletic season, results in turfgrass failure, decreased overall playability and diminished visual aesthetics.

The Solutions

Current solutions to this problem include complete field conversion to a synthetic or sand-based turfgrass system. The first, most expensive, option is the installation of a synthetic athletic field ranges from \$600,000 – 1,000,000. The second option is a conventional sand-based field with a gravel drainage layer will cost from \$400,000 - 600,000, and take your field out of play for half of the year. This involves excavating 12-16" of soil and installing drain tile, a 4" gravel layer and a 12" sand based root zone. The

> FAQ # 1: I have a field that drains poorly, what are the current renovation options?
> 1) Synthetic Field – \$600,000 - 1,000,000
> 2) Conventional Sand-Based Field – \$400,000 - 600,000
> 3) Sand-Capped Field - \$150,000 - 300,000
> **4) Sand-Cap Build-Up Field \$36,000 - 75,000 (proposed method discussed below)**

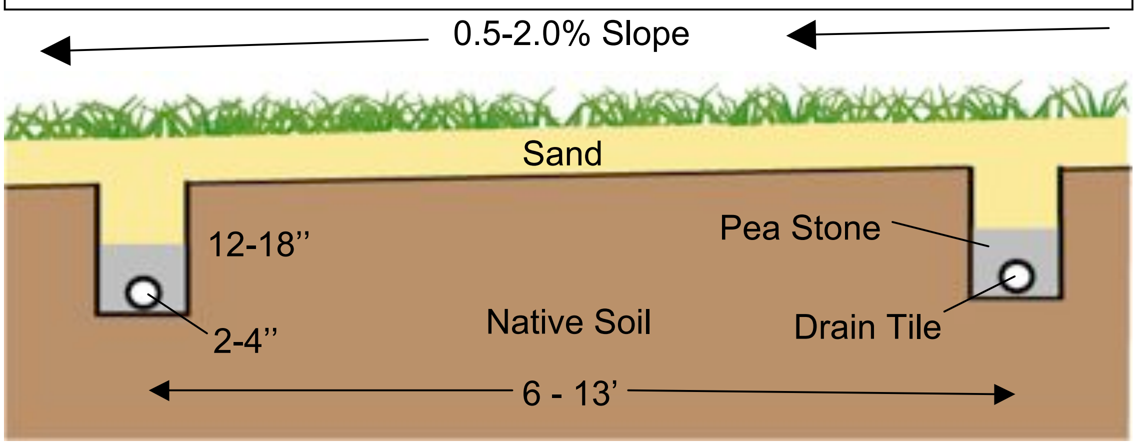
third option for sand based athletic fields is the sand cap model, which has been employed many times in Michigan under the direction and guidance of Dr. John N. Rogers and MSU in the last 7 years, and can cost from $150,000 - 300,000. This method is less expensive because only a small layer of topsoil (2-5") is removed from the field, and replaced with a 5-6" layer of specifically blended high sand-based root zone material. This sand material should be well-graded, particles distributed across a range of sizes, to maximize soil stability, and should contain approximately 90% sand. The turfgrass is then reestablished from seed. It is critical to use seed rather than sod, because sod place over sand will create a perched water table, which will significantly inhibit soil infiltration. Installing an extensive drain system with drain lines running the length of the field spaced every 8-20' is also necessary. (New irrigation systems are usually automatic additions in these new fields, and are highly recommended because of the reduced water holding potential of the sand-based system.) This option also takes a field out of play the same amount of time. The major difference in cost between the conventional sand-based field and the sand cap is due to hauling off of the extra material during excavation as well as the total amount of material to bring the field back to grade.

Sand-Cap Build-Up System

The fourth, least expensive, option for sand based fields is a "sand cap build-up system" (SCBUS), which can be done in four simple steps. The concept behind the SCBUS is to combine the advantages of the sand cap system (drainage and sand root zone playing surface) while providing almost uninterrupted availability. The idea is to cut drains in the existing field [running lengthwise on 6 - 13' centers depending on the surface grade and slope (see **Renovation Flow Chart: pg 7**)], put drain tile in the lines, back fill with pea stone and then sand, or a coarse sand alone (Image 1 and 2: pg 8).

Sand-Cap Build-Up System
Step 1. Install drain lines
(6' spacing, running length wise)
Step 2. Repair irrigation system
Step 3. Renovate field
(core cultivation, and over-seeding)
Step 4. Begin sand topdressing.
(well-graded sand-based material)

Following drain tile installation, repeated sand topdressing will produce a sand-based system, capable of rapid drainage.



FAQ #2: Will this renovation process take my field out of play?

No, your field is never totally out of play. This process does not remove your existing turf, but rather amends it. However, it will require regular topdressing for more than a year to produce a sufficient system.

At this time it is important to correct any low spots (wet spots) in the existing slope by leveling them with topsoil; soil removed during drain line installation would be perfectly appropriate. Subsequent repair to any irrigation line damage is necessary. Then begins an aggressive sand-based topdressing program during the summer with a "specific high sand-based material" (approximately 90% well-graded sand). Sand topdressing would be coupled with your annual field renovation program (including reseeding, cultivation, etc). The goal would be to add at least 2" of topdressing as fast as possible without compromising fall time playing quality. This means that the topdressing program would begin in early June and go only through early August. Adding 1" would not be an issue to surface stability in this time frame. During this period it is also important to regularly clean and maintain irrigation heads to prevent sand from damaging the system. The topdressing stops in early August to allow settling prior to usage in the fall. **During the first year your field may not reach the level of sand necessary to prevent saturated surface conditions, particularly in low lying areas.** The drain tiles will prevent standing water from developing providing you with a system that is better than your original conditions. The next spring the topdressing process would begin again to add the rest of the material, further increasing drainage capacity. At the end you would have a well drained, stable, sand-based field at a fraction of the cost required for other renovation processes.

FAQ #3: Who can do this renovation process?

This is a job someone on staff can do, acting as the general contractor and sub-contract out the drain installation and irrigation repair. They can order the sand topdressing from a reliable source (provided below). Finally, the act of applying the topdressing can be done by in-house staff (with minimal training) or contracted out.

FAQ #4: What about the drain spacing and depth of root zone specifications? Are we a guinea pig?

The drain spacing of 6' centers is about extensive as possible and should be more than adequate. A research project to investigate the optimum spacing was started in 2007. Investigation is exploring wider spacing in an effort to provide potentially lower costs to installation, while maintaining adequate drainage. Preliminary research has shown that when an inch of topdressing has been applied 13' drain spacing will provide the same benefits as 6' spacing at a lower cost of installation. The depth of root zone is actually a little easier to manipulate, simply by the nature of the method of application (topdressing rates can be increased or decreased), and therefore is even less of a concern. Preliminary findings also suggest that as little as ½ inch of cumulative topdressing sand will substantially decrease surface soil moisture, therefore improving surface stability. However, greater sand depths will not only improve drainage, but will also provide a deeper, none restrictive rooting media.

FAQ #5: Has this been done to athletic fields in Michigan?

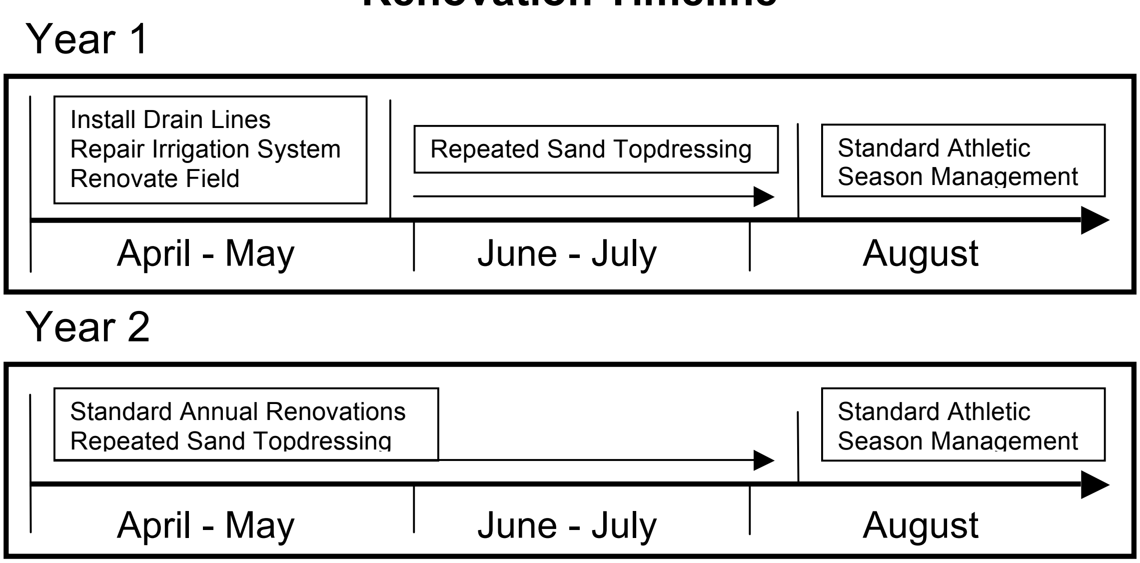
Yes, currently two high schools (Okemos and Grand Blanc) began this process in 2007, but this process has been going on with native soil golf course putting greens for the last 30 years. For this reason, the feasibility is not a question. It makes sense and it has been done in other areas of turf for many years. One big plus is the specific sand based root zone which will be topdressed on the fields. This specific sand has been providing exceptional performance on Michigan fields for the last 10 years. The advantage of this process is that in the end you have transformed your poorly drained native soil field to a stable, well-drained sand-capped field.

The SCBUS will not only reduce the annual repair costs required for a native soil field, but also reduce the initial cost of field renovation. To install the drainage and backfill a field with 6' centers (would approximately have thirty 400' x 4" drain lines @ $4-5/linear foot) would cost $48,000-60,000 installed, while a field with 13' centers $22,400-28,000. Then topdressing would begin on the field during the summer with each inch of material costing about $9,000 (labor and materials).The sand is added on a weekly basis and the existing grass grows up through the sand profile. This option is considerably less expensive than the first three options. It will likely take more than one year to get 2" of material built up, but you also have the option of adding more than 2" if the situation calls for it in the future.

Research

The SCBUS is a natural extension and combination of two currently proven applications. First, the use of repeated sand topdressing in order to develop a sand-based profile has proven to be successful in the golf course industry for over 30 years. Second, sand-based athletic fields are widely used in Michigan and proven to provide a superior playing surface in comparison to native soil fields.

Renovation Timeline



Sand-Cap Build-Up System

Step 1. Install drain lines – Renovation Services & Drainage Specialist
Step 2. Repair irrigation system – Renovation Services & Turf Suppliers, etc.
Step 3. Renovate field – Renovation Services, Turf Supplies, etc. & Turf Equipment Suppliers
Step 4. Begin sand topdressing – Sand Topdressing Sources

Research on this renovation process is currently be conducted by Alexander R. Kowalewski, PhD student, to provide a scientific justification for the procedure. Funding will be sought through sources within the state to carry out his specific research project. If you choose to move forward with a project of this nature please contact John N. Rogers, III or Alexander R. Kowalewski for progress monitoring through updates and possible visitations.

Preliminary Research Findings

Preliminary findings from research conducted in 2007 it appears that as much as ¼" of topdressing can be applied at once and 1" of topdressing can safely be applied over a one month period without being detrimental to turfgrass health or stability (Image 3: pg 8). A drain tile spacing of 13', which will substantially reduce installation costs, is adequate to provide sufficient drainage when 1" of sand topdressing has been applied. Findings also suggest that as little as ½" of topdressing, in combination with drain tiles, will substantially increase field surface drainage.

Resources

There are several excellent sources in the area to service your athletic field needs. They are provided below. When you call these companies, they will direct you to a specific sales person in your area. These resource contacts are of particular importance because they are familiar with the specifications and recommendations stated in this document and/or are in regular contact with Dr. John N. Rogers, III.

Contacts

Dr. John N. Rogers III
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Crop and Soil Sciences
160A Plant and Soil Science Building
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(517)-355-0271x1136
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East Lansing, MI 48824
(517)-355-0271x1137
kowalew8@msu.edu

Researchers and resources mentioned in this document are in no way, shape or form liable for personal injury, misinterpretation of information and recommendations, or detrimental field conditions resulting from deviation from the above described renovation processes and procedures.

Renovation Services

Davey Golf Pontiac, MI 248-332-6690	**Sports Turf Specialists** 281 Taft St. Zeeland, MI 616-866-7395	**Turf Services, Inc** 17205 148th St. Spring Lake, Mi 616-842-4975
Country Club Turf 4137 W. Michigan Ave. Jackson, MI 49202 517-750-7513	**Contractors Landscape** 3681 Frost Road Webberville, Mi 48892 517-775-8787 eeeverett@core.com	

Turf Supplies, etc.

Rhino Seed and Turf Brighton, MI 800-482-3130	**Turfgrass, Inc** P.O. Box 667 S. Lyon, MI 48178 248-4371427 1-800-521-8873 Fax: 248-0437-5610	**Verdicon, Inc** Dave Polen, Sales Rep 586-839-8930

Turf Equipment Suppliers

Toro Equipment Spartan Distributors Auburn Hills, MI 800-822-2216	**John Deere Equipment** Weingartz 39050 Grand River Farmington Hills 888-4-JD-TURF	**Jacobsen Equipment** W. F. Miller 25125 Trans X Novi, MI 800-555-8189

Sand Topdressing Sources		Drainage Specialist
Osborn Industries 5850 Pardee Taylor, MI 48180 313-292-4140	**J.W. Surge Industries** Muskegon, MI 231-740-0682	**Water Management** 1596 S. College Rd. Mason, MI 48854 517-628-8001

Renovation Flow Chart

The following flow chart is designed for making renovation decisions prior to the initiation of the renovation process based on a variety of possible existing field conditions.

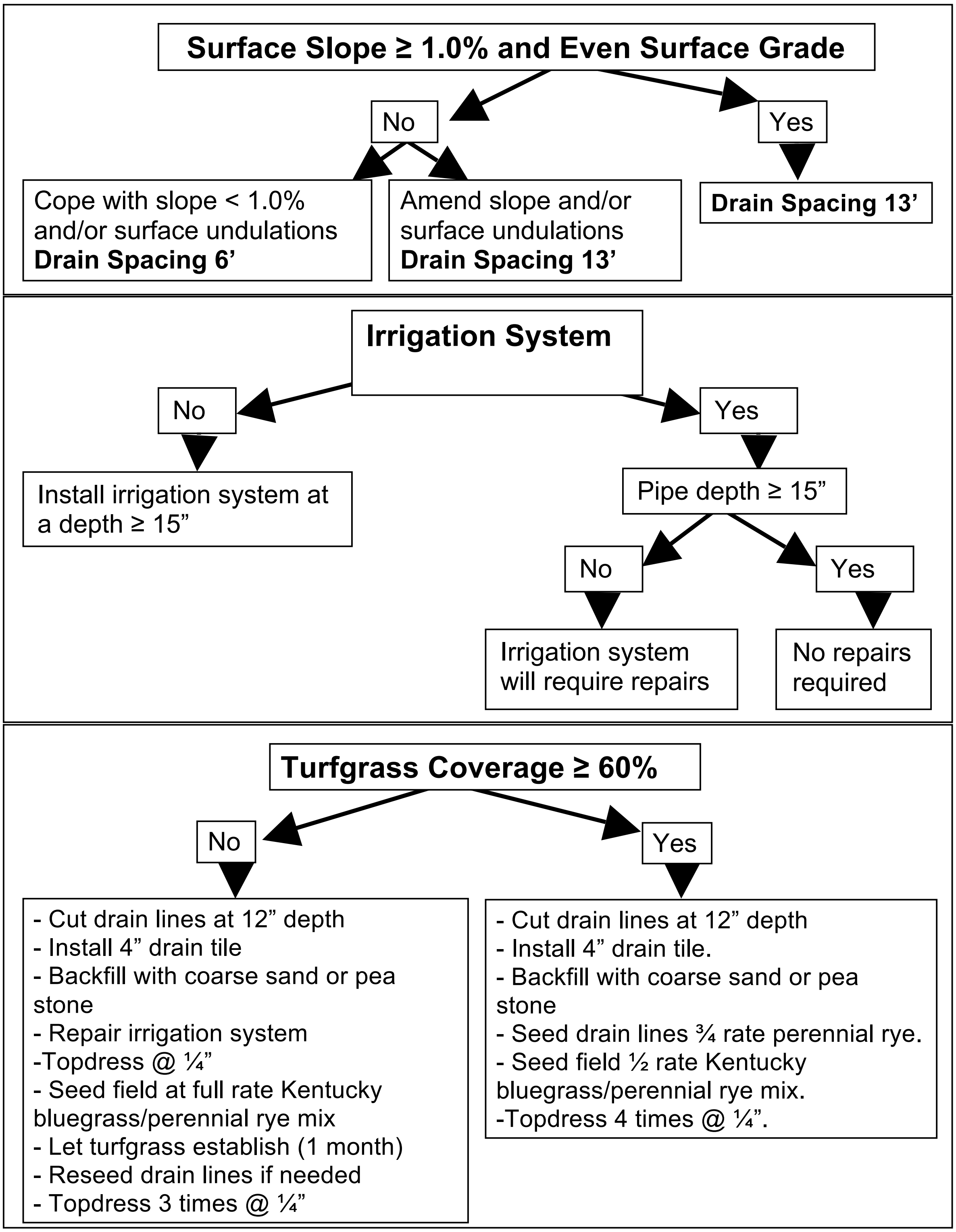

Image 1: Cutting drain lines, installing drain tiles, and backfilling lines with a sand-based root zone material, Grand Blanc High School, Grand Blanc, Mich., Water Management Inc., May 2007.

Image 2: Grand Blanc High School athletic field after the drain line installation process, Grand Blanc, Mich., Water Management Inc., May 2007.

Image 3: Four sand-based topdressing applications applied to a newly established turfgrass stand over a one month period at ¼ inch per application, providing a 1 inch of sand-based root zone material, research plots at the Hancock Turfgrass Research Center, East Lansing Mich., August 2007.

ABOUT THE UNIVERCITY YEAR

UniverCity Year is a year-long partnership between UW-Madison and one community in Wisconsin. The community partner identifies sustainability and livability projects that would benefit from UW-Madison expertise. Faculty from across the university incorporate these projects into their courses with graduate students and upper-level undergraduate students. UniverCity Year staff provide administrative support to faculty, students and the partner community to ensure the collaboration's success. The result is on-the-ground impact and momentum for a community working toward a more sustainable and livable future.

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