Sustainable Turf Management for City of Watertown Athletic Fields

2015 – 2016

Prepared by

Joey Brettingen, Ryan Schwab, Shay Lunseth, and Yinjie Qiu
Students in HORT 4062: Turfgrass Weed and Disease Science and HORT 4063: Turfgrass Science
Instructor: Eric Watkins

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Resilient Communities Project
University of Minnesota
330 HHHSPA
301—19th Avenue South
Minneapolis, Minnesota 55455
Phone: (612) 625-7501
E-mail: rcp@umn.edu
Web site: http://www.rcp.umn.edu

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Introduction

There are no plans for new field construction for the City of Watertown and the soccer program is expanding. The development of single family homes is increasing; thus it is important for the soccer fields to be maintained at an acceptable standard to match the demand. The overall health of the soccer fields needs to be improved. Once doing so, the desired turf stand will be able to thrive. There are four major areas that need attention for the city soccer fields, school soccer fields (**Figure 1**) and city baseball fields. We will be focusing on the soccer fields due to severity of turf issues. The topics we will be addressing are (1) aeration, (2) irrigation, (3) grass species selection, and (4) fertilization.

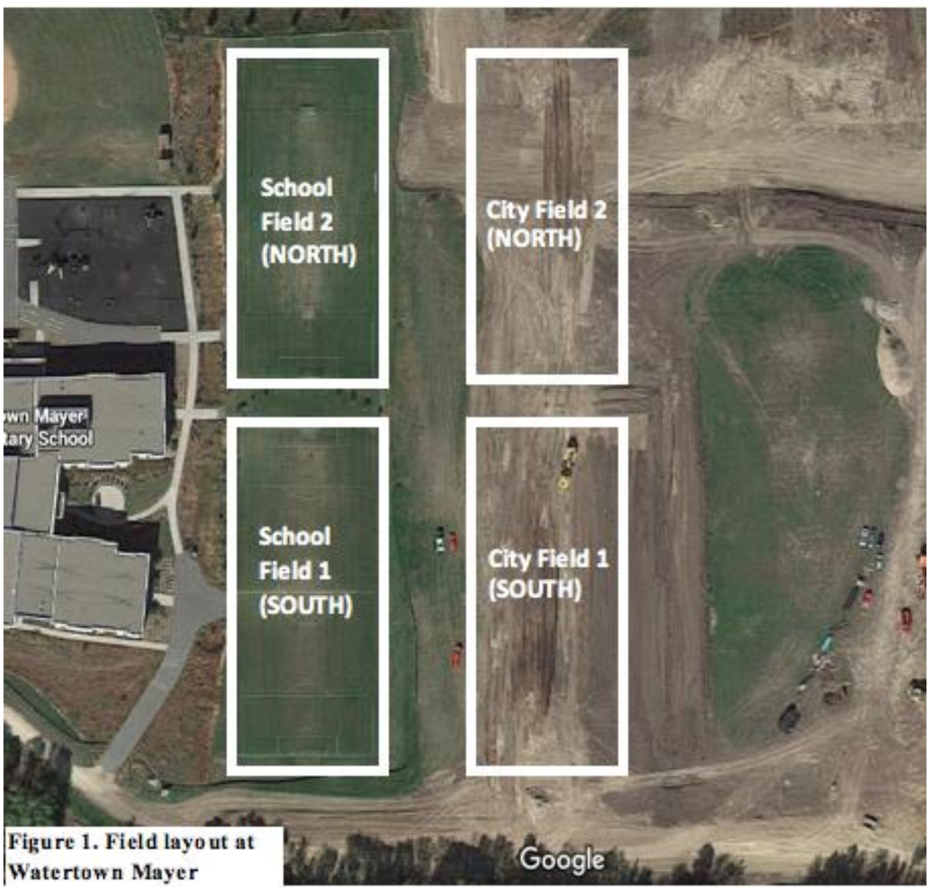

Figure 1. Field layout at Watertown Mayer

Aeration Program

Current System and Issues

Currently, the school and city soccer fields at Watertown Mayer Elementary have an annual core aeration program set in the fall. It is unclear if this is noticeably enhancing the function of the playing surfaces. Core aeration is beneficial as it can increase water infiltration, reduce runoff, and relieve compaction (Anderson et al., 2014; Rice and Horgan, 2011; Klingenberg et al., 2013). However, with constant play from spring to fall, the benefits of this annual practice may not be serviceable for the whole growing season.

The lower elevated school soccer fields as well as the higher city fields have flaws that could be reduced or eliminated with a more intensive aeration program. Water infiltration is lacking on both school fields, which can be assumed by recurring standing water and wet playing surfaces (**Figure 2**). Contributing factors to this problem include over-irrigation, runoff, and a native soil type. The soil on the city fields is very compacted. It takes much effort and weight to penetrate a soil probe into the top four inches. Compaction could have occurred over time through compressive forces of heavy or frequent traffic. Traffic refers to any plant stress causing wear damage to the turf such as creating divots as well as increasing the density of the soil. Examples of traffic include gameplay and the maneuvering of vehicles.

Figure 2. Standing water in the center of School Field 2

Both the saturated soil found on the school fields and the compacted soil of the city fields discourage turfgrass root growth. Native soil types as the ones present in both school fields, do not drain quickly. A flush of moisture will cause the soil to become saturated for extended periods. The excessively wet condition promotes shallow rooting (Jordan et al., 2002), in turn decreasing surface stability (**Figure 3**). Compaction found in localized spots in the school fields and throughout most of the city fields also promotes shallow rooting, as well as a decrease in root densities (Lipiec et al., 2003). Additionally, compaction, especially in the rootzone can lead to poor water absorption, resulting in runoff during rain events. No clear paths of water movement are visible on the slopes between city fields and school fields, but it is possible that the water from above is running off into the lower elevated school fields due to compaction.


Figure 3. Surface stability is lost when the native soil is water saturated

An assessment of compaction was performed on Saturday, April 30th. The assessment included soil penetration tests in the top six inches, as well as Clegg surface hardness tests. Twenty-five points on each of the four soccer fields were chosen for evaluation. The soil penetration tests were performed using a ½ inch cone penetrometer, which gave the pounds per square inch (psi) needed to get 6 inches deep into the soil profile. Pressure values recorded may correlate with soil bulk density, reduced infiltration, compaction, and root stress levels. Three nearby points were tested at each of the 25 designated test locations of each field. Of the three values, only the middle value was recorded, while the highest and lowest were thrown out. The surface hardness tests were performed similarly with the lowest and highest values unrecorded.

Surface hardness tests were carried out using a Clegg hammer that measures the impact force (gmax) of the surface with a weighted missile. Hard surfaces may occur over time with traffic increasing the soil's bulk density, which can be stressful for young plant development and is a player safety issue. Firm surfaces are needed for predictable gameplay, but hard surfaces over 100 gmax are linked to increases in player injury, in particular concussions (Serensits, 2014).

Results from the compaction tests (**Figure 4**) helped pair a numerical value with what we observed visually on the field. Compacted areas on the school fields tended to be concentrated near the goals and down the centers. High penetration values seemed to be along the west side of the School Field 1, which is likely from traffic moving on and off the playing surface from the school's entrance paths. Overall, the school fields had low surface hardness values (gmax) as they were very spongy from soil saturation. Of the four fields, City Field 1 was most compacted. This field noticeably had the thinnest turfgrass stand, and had a higher percentage of weeds compared to the others (**Figure 5**).

Figure 5. Thin turfgrass stand on City Field 1

Recommendations

1. **Increase core aeration:** We suggest core aeration to be performed in both the spring and fall. Aeration in the spring and fall works best as the turfgrasses are actively growing during these seasons. After snowmelt and with spring rain events, it is important to aerate in the spring. Spring aeration can be performed anytime after snowmelt while the turfgrass is actively growing. Fall aeration is recommended in September before fall overseeding. This should temporarily increase water infiltration and relieve

compaction, that'll promote turfgrass root growth and development as well as enhance playability. Problem areas such as the areas that tend to have standing water, or compacted areas highlighted in **Figure 4** can be aeration more frequently as well. It is safe to aerate every two to three weeks if needed, however it is appropriate to allow the cores time to break down before gameplay.

2. **Topdress sand after aeration**: Incorporating sand into the soil system will increase the drainage of the fields, especially if practiced over time. Sand will also decrease the risk of weed encroachment associated with a spring aeration. Once the sand is spread, it is suggested that it is groomed into the aeration plugs. Depending on the diameter and depth of the cores, the amount of USGA topdressing sand needed will range from 24.61-99.64 tons (**Table 1**). Application can be performed annually in the spring with the city's broadcast spreader, but may be quicker if larger drop or broadcast spreaders are available.
3. **Hire one time deep tine services**: Since soil penetration was high in areas as deep as 6 inches, it is suggested that the fields be deep tined in the spring. This will reduce the bulk density of the soil in areas where turfgrass roots should be reaching. Deep tine aeration will also increase drainage deep into the soil profile, allowing the fields to infiltrate spring rains easier. Deep tining allows the solid tines to penetrate 6-8 inches deep.

Other Considerations

1. **Perform around soccer schedule**: Aeration should be strategically performed around the field's game or practice schedules. Open holes can negatively affect gameplay.
2. **Overseed with topdressing:** Overseeding (see section 3 below) can be performed after aeration and with sand topdressing to ensure good seed to soil contact.

3. **Deep tining concerns:** Deep tining may not be available if irrigation lines and valves are within 6-8 inches deep. Contractors may be unwilling to deep tine if soil is rocky.

Estimated Costs

Table 1. Estimated costs of aeration recommendations

Increase core aeration	Additional labor costs
24.61 tons of USGA sand for topdressing (10 holes/ft^2, 1/2” diameter & 2” deep core)	$332 + delivery costs & labor for application
99.64 tons of USGA sand for topdressing (12 holes/ft^2, 3/4" diameter & 3” deep core)	$1,345 + delivery costs & labor for application
Deep tine contractor	$800-1200 per field

Water Use and Irrigation Practices

Current System and Issues

The school and city soccer fields at Watertown elementary currently have a very basic irrigation schedule. The system is run each day for about 15-30 minutes per zone. There are 12 zones total and the water is pumped from a storm water retention pond near the site. Two of the main issues with the fields that we noticed were the top city fields which were very compact and relatively dry, while the lower school field seemed to be very soggy in most areas. We have concluded that these problems are due to 1) the upper soccer fields are very compact, which results in a lack of water infiltration and increase in water runoff (Rice and Horgan, 2011) to the lower field making it very soggy and 2) the amount of water that is being put on the fields is in great excess (30 min run time each day) which the soil profile cannot handle resulting in the runoff and soggy playing surface of the lower field.

Recommendations

1. **Increase in aeration practices**: This area was discussed in detail in the previous section, but it is important to be reminded of how important aeration can be for water infiltration. It is understood that an aeration program is currently in place once a year in the fall for the soccer fields. This is a good practice, however, more aeration could be performed to increase the water infiltration by reducing the compaction and lowering the runoff potential of the upper playing surfaces. Another one or two aerations per year could be very beneficial, especially since the fields are getting used so often. If full field aeration is not possible in the spring or summer due to high demand or budget issues, a more focused aeration approach could be taken. For instance, we noticed standing water in areas on the lower fields and even the upper fields this spring that had standing water. This could be due to localized compaction where a goalie would play, for example. With the more focused aeration approach, actions could be taken to target these localized regions **(see maps)** of the fields to increase water infiltration by opening up the soil profile through aeration.
2. **Use less water**: It is alarming to see the irrigation schedule for the fields running about 15-30 minutes each day. Though it may seem necessary to water every day, it most certainly is not. One of the reasons for the standing water could be from simply putting too much water on the fields and not giving it a chance to ever dry out. This irrigation schedule must be altered. There are two types of watering techniques that are frequently referred to in turf 1) shallow and frequent and 2) deep and infrequent. The irrigation

technique present at the soccer fields would be considered shallow and frequent with the system being run everyday. Deep and infrequent watering can be described as putting down the necessary amount of water for the turf, but all at once or a couple times weekly. The main difference between the two techniques is what happens below ground; the roots. This image shows the rooting structure of deep and infrequent on the left and shallow and frequent on the right.

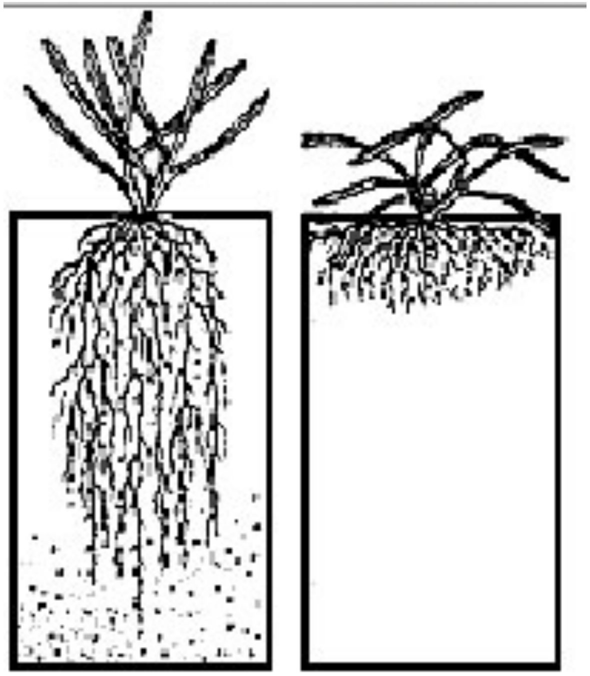

Figure 6. Deep and infrequent root system (left) versus shallow and frequent (right)

Studies have shown that deep and infrequent watering can not only cut water use in half, but can also improve the quality and health of the turf stand (Fu and Dernoeden 2009). The reason that deep and infrequent watering works, is because it forces the roots to explore deeper into the soil profile for water versus shallow and frequent watering that provides water at the surface at all times making the roots content and giving them no reason to explore. The deeper and more extensive root system allows the plant to be more resilient to stresses like wear and drought in the summer months. Water use becomes less because the roots are trained to find available water deeper within the soil versus roots that are only in the top two inches and cannot use that available water lower in the profile. **We suggest that the irrigation system be moved to a deep and infrequent schedule to promote a more resilient turf plant, while reducing overall water use.** Using the deep and infrequent technique will also help with standing water issues on the soccer fields. Water less often will give it a chance to infiltrate into the soil before more water is applied.

Other Considerations:

1. **Check the irrigation system each spring to make sure it is working properly**. Not sure if there is a company that comes in and does this, but it is very important to make sure that there are not heads that are malfunctioning and wasting water by spraying in the wrong direction all over the parking lot. Go zone-to-zone checking each head. Routine walk through of irrigation systems typical of this size can cost between $100-$600 depending on parts and repairs needed.
2. **Check to see how much water the system is putting down each cycle**. It is suggested to put about ¾ of an inch to an inch of water per week to maintain healthy turf. Set out a bunch of empty tuna cans over the field and run the system. For the deep and infrequent technique, we would suggest two run cycles per week at about a half an inch per cycle (fill the cans half full per cycle). Make adjustments as necessary to the heads based on results.
3. **Be conscious of the rain provided by natural rainfall**. Get a rain gauge and connect a rain sensor to the irrigation system if there is not one in use already. Rain sensors can be added on to the existing irrigation system for a very small cost: $20-25 for a wired one

and $50-60 for wireless. The ¾ to 1 inch per week can come from a combination of both Mother Nature and the irrigation or just one or the other. Sometimes the irrigation may not even have to be used due to rainfall making up the total one inch in a week. Running the irrigation system from the "off" position and only turning it on when needed can be beneficial that the fields are not being over watered.

Seeding and Grass Species Selection and Repair

Current System and Issues

The school and city soccer fields were established with primarily Kentucky bluegrass *(Poa pratensis*) and very little perennial ryegrass (*Lolium perenne*). Kentucky bluegrass on the fields was most likely established from the sod laid in this area six years ago. Perennial ryegrass may be establishing slowly from the city's overseeding program of a JRK Seed Athletic Mix. Unfortunately, these two grass species are not being supported and weeds have encroached. Low phosphorus levels may be contributing to the thinning turf areas. Young plants need this nutrient to develop. If it is sparse or out of the immature root's reach, then establishment will be difficult. The most important surface issue to address is the weedy-type tall fescue bunches throughout. With its bunch-type growth, it may negatively affect playability and safety (**Figure 7**). Balls will not predictably roll over a patch of this type of tall fescue, and it may cause a tripping hazard for players. Wear found on these two fields is primarily due to gameplay and practices that don't allow them much scheduled

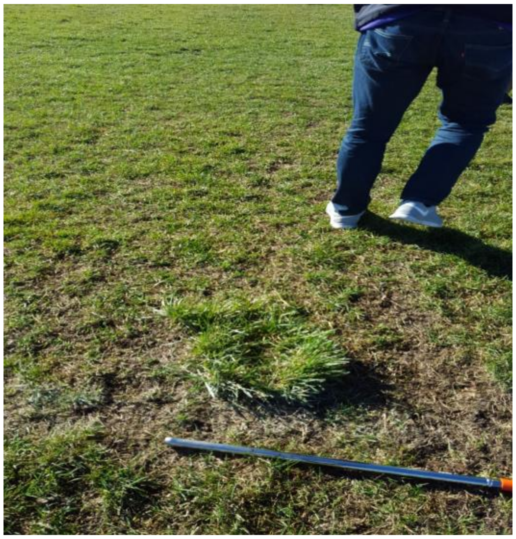

Figure 7. Tall fescue bunches

rest for turfgrass recovery. For this reason, the soil is exposed, allowing weeds like unwanted weedy-type tall fescue onto overplayed surfaces.

Recommendations

1. **Eradicate weedy-type tall fescue**: Spot-apply glyphosate (RoundUp) to eradicate weedy-type tall fescue bunches. This will need to be completed during a period of time that children and pets can stay off for 24-hours, as well as a day that temperatures do not exceed 85 degrees Fahrenheit (approximately August 19th).
2. **Establish new grass:** Three days later (approximately August 22nd), slit-seed entire field with a more appropriate grass species mix for the field purpose. We would recommend a combination of turf-type tall fescue and Kentucky bluegrass. This mixture will be more easily supported with the current management practices, as well as make a good playing surface for soccer and other sports. Tall fescue is low-maintenance, as well as heat, stress and traffic tolerant (Huang, 2014). Kentucky bluegrass is winter-hardy, mows well, recovers and reproduces well (Christians, 2011). An example of a good mixture for the Watertown soccer fields would be Tuff Turf Seed Mixture from Twin City Seed (**Table 3**), which is comprised of turf-type tall fescue, Kentucky bluegrass, creeping red fescue and perennial ryegrass. The mix includes creeping red fescue, which will provide another low-maintenance grass that is not only tolerant of stress, but also establishes quickly. Perennial ryegrass is also included to provide diversity, winter-hardiness and quick recuperative properties. This grass mixture will be superior to the existing stand. This improvement will increase the strength, durability and playability of the soccer fields. Once seeded, the fields should be lightly watered 2x per day for 1 week

to ensure successful germination. Resume normal watering schedule (deep and infrequent) and play after one week. Fertilization is also important to apply when seeding. This will give the seedlings the nutrition necessary for germination. As part of that nutrition, fertilizer containing phosphorus can be used at this time. Phosphorus is essential for plant growth, as it plays a part in the transfer of energy and maturity cannot occur without a sufficient supply (Christians, 2011). Fertilization will be covered in more depth in section 4 of this report.

Table 3. New Grass Seed Selection

Twin City Seed Tuff Turf Seed Mixture	
Turf-type tall fescue	50%
Creeping red fescue	20%
Kentucky bluegrass	15%
Turf-type perennial ryegrass	15%

Table 4. Importance of Grass Species Selection (Huang, 2014; Christians, 2011)

	Heat Tolerant	**Stress Tolerant**	**Traffic Tolerant**	**Low Maintenance**	**Quick Establishment**	**Quick Recovery/Repair**
Turf-type tall fescue	**x**	**x**	**x**	**x**		
Kentucky bluegrass						**x**
Creeping red fescue		**x**		**x**	**x**	
Perennial ryegrass					**x**	

Other Considerations

1. **Repair bare soil areas.** On September 14th, also apply ¼” topsoil and rake in tall fescue, Kentucky bluegrass and perennial ryegrass mix to better fill in bare areas from weedy-type tall fescue eradication (to be completed as necessary).

2. **Overseed throughout the year.** Overseeding can be considered in combination with aeration in spring and fall to keep turf thick. Seeding choices can be one or a mix of tall fescue, Kentucky bluegrass and perennial ryegrass.
3. **Dormant Seeding.** Dormant seeding can be considered as an option to establish new grass for spring play. This would be a practice of spreading seed in the late fall when temperatures are low (approximately mid-October). The seed will not germinate until the spring when the soil temperatures warm. This would be an option to seed during a time when it would not disrupt play. It also provides a good early spring soccer field, in which play could resume quickly (Minner, 2007).

Estimated Costs

Table 5. Estimated costs of removal and establishment

Application	**Cost (time and materials)**
Glyphosate (RoundUp) weedy-type tall fescue areas	$250 + applicable tax
Slit-seed entire soccer field area	$2500 + applicable tax
Apply topsoil and rake in new Tuff Turf Seed Mixture	$500 + applicable tax
Overseed with spreader at same time as aeration	$2500 + applicable tax

Fertilizer Application and Turf Health

Current System and Issues

Currently, two fertilizer applications are applied to the city's soccer fields using Lebanon's 19-0-6 (spring) and Lebanon's 18-0-5 (late fall) fertilizer. According the city administrator, a total of 100 lbs. of fertilizer was used for each application of an area of 245 x 85 yards. Application rate for each application is summarized in the Table 6. Soil test results are summarized in Table 6.

Table 6. Nitrate and Potassium Application Rate of Spring and Fall Fertilization Application. No phosphorus was applied.

Season of Application	Nitrate Application Rate (lbs/1000 ft^2)	Potassium Application Rate (lbs/1000 ft^2)
Spring Application	0.10	0.032
Fall Application	0.09	0.026
Total	0.19	0.058

Table 7. Soil test results of the four soccer fields. The school fields have more nutritious conditions compared to the city fields. In addition, school fields also have more organic matter and nitrogen, as well as adequate phosphorus and potassium. This explains why the school field turf has better color and density compared to the city fields.

Soccer Field	Organic Matter Level	Nitrate Level (ppm)*	Phosphorus Level	Potassium Level
School Field 1	Medium	20.9	Medium-High	Low-Medium
School Field 2	High	19.6	Medium-High	Medium
City Field 1	Low	6.6	Low-Medium	Low-Medium
City Field 2	Low	9.2	Low-Medium	Medium

*Generally, nitrate level greater than 25 ppm is considered as adequate.

Recommendations

1. **Nitrogen application is the key to maintain healthy sports turf:** To maintain healthy sports turf, the nitrogen application rate needs to be increased. The suggested spring

nitrogen application rate for sports turf is 1.5-2 lbs/1000 ft^2 (Sport Turf Management Association). The application should be applied after the temperatures are consistently in the 50's. It is best to split the amount into two applications - one in the early spring and one in late spring.

Late fall fertilization should be applied sometime between September and November. Most late fall fertilization programs provide sports turf moderate amounts of nitrogen, phosphorus, and potassium. A rate of 1 lb. of soluble nitrogen per 1000 ft^2 is suggested for heavily trafficked, cool season turf (Penn State Extension).

2. **Phosphorus and potassium in the soil:** Based on the soil test results, both school fields have medium to high levels of phosphorus in the soil. No special applications are needed at this time. However, the phosphorus in the city fields are at low to medium levels. Phosphorus is important to the turf's health so it is important to apply phosphorus within the same year as seeding occurs. Need to notice that the State of Minnesota has a phosphorus lawn law fertilizer law, so should be careful about phosphorus application. According to the law, phosphorous can't be used unless: 1) soil tests shows a need for phosphorus; 2) new lawn is being established by seeding or laying sod; 3) Phosphorus fertilizer is being applied on a golf course by trained staff or being applied on farms growing sod for sale (Minnesota Statutes 18C.60). Our suggestion would be choosing a type of fertilizer that includes phosphorus (5-10%) and apply it in the spring fertilizer application with new seeding. The percentage of potassium in city fields is also at the low to medium level. This could be improved by increasing application rate or change to other fertilizers that have a higher potassium content. Table 8 contains the choice of fertilizer for each soccer field based on the soil test results.

Table 8. Fertilizer suggestions for each of the four soccer fields.

Soccer field	Fertilizer ratio (Spring)	Fertilizer ratio (Fall)
School Field 1	15-5-10	15-0-10
School Field 2	15-5-10	15-0-10
City Field 1	20-10-10	20-0-10
City Field 2	20-10-10	20-0-10

Other Considerations

1. **Fast-release fertilizer could be used for spring applications**. It is less expensive, and gives a rapid green-up response. Frequent applications at low rates could reduce excessive growth and fertilizer burn. It is recommended to use the fast-release fertilizer for spring application.
2. **Slow-release fertilizer could be used in the fall applications**. Slow-release provides the longer duration of nitrogen release in the soil. In the winter, the turfgrass plants' metabolism is greatly reduced, where there will be less nutrient uptake. Fast-release fertilizers could be less useful for the fall applications. So we would suggest use slow-release fertilizer for the late fall application.
3. **Collect soil samples from all fields during March/early April and take them to Soil Testing Laboratory at University of Minnesota for analysis.** This can provide the applicant more information to optimize a spring fertilizer application program. The

phosphorus and potassium applications are subject to change based on the current year soil test results.

Estimated Costs

The estimated fertilizer costs for school and city fields are summarized in **Table 9**. Price is estimated based on 2.5 lbs. per 1000 ft^2 nitrogen application rate (1.5 lbs. for spring and 1 lb. for fall application).

Fertilizer	Unit Pricing (30 lbs. Pack)	Total Cost
15-5-10 (School Fields Spring)	$16.97	$1069.11 + applicable tax
20-10-10 (City Fields Spring)	$20.5	$963.5 + applicable tax
20-0-10 (City Fields Fall)	$39.75	$1272+ applicable tax
15-0-10 (School Fields Fall)	$54.75	$2299.5 +applicable tax

Final Thoughts

Our recommended management practices of the soccer fields at Watertown Mayer Elementary will hopefully enhance their function and quality. Practices such as increased aeration, reduction in irrigation, periodic overseeding, and a proper nutrient program should always be performed on each field. It has been discussed that field rotation be considered for complete field renovations that include intensive soil prep and grow-in procedures. Closing a field down to allow proper germination and establishment will allow for better future performance and overall quality of the turfgrass. Field renovations and closures should be considered for fields that are in the most critical shape. The order in which we would consider closing the fields year by year would be City Field 1, City Field 2, then either of the school fields following that. For both the city field renovations we suggest heavy aeration, sand topdressing, and overseeding procedures previously discussed in this document. A complete grow-in following the overseeding procedure on these fields is necessary to ensure dense establishment and species conversion to more desired turf-type grasses. We suggest heavy aeration and sand topdressing for the school fields in attempt to increase drainage, root depth, and overall soil quality. Overseeding can be performed on the school fields and is encouraged, however, a complete grow-in like the city fields is not necessary. Though our recommended management practices for the Watertown soccer fields will improve quality over time, temporary field closures for complete renovation will be most beneficial for quick and successful results.

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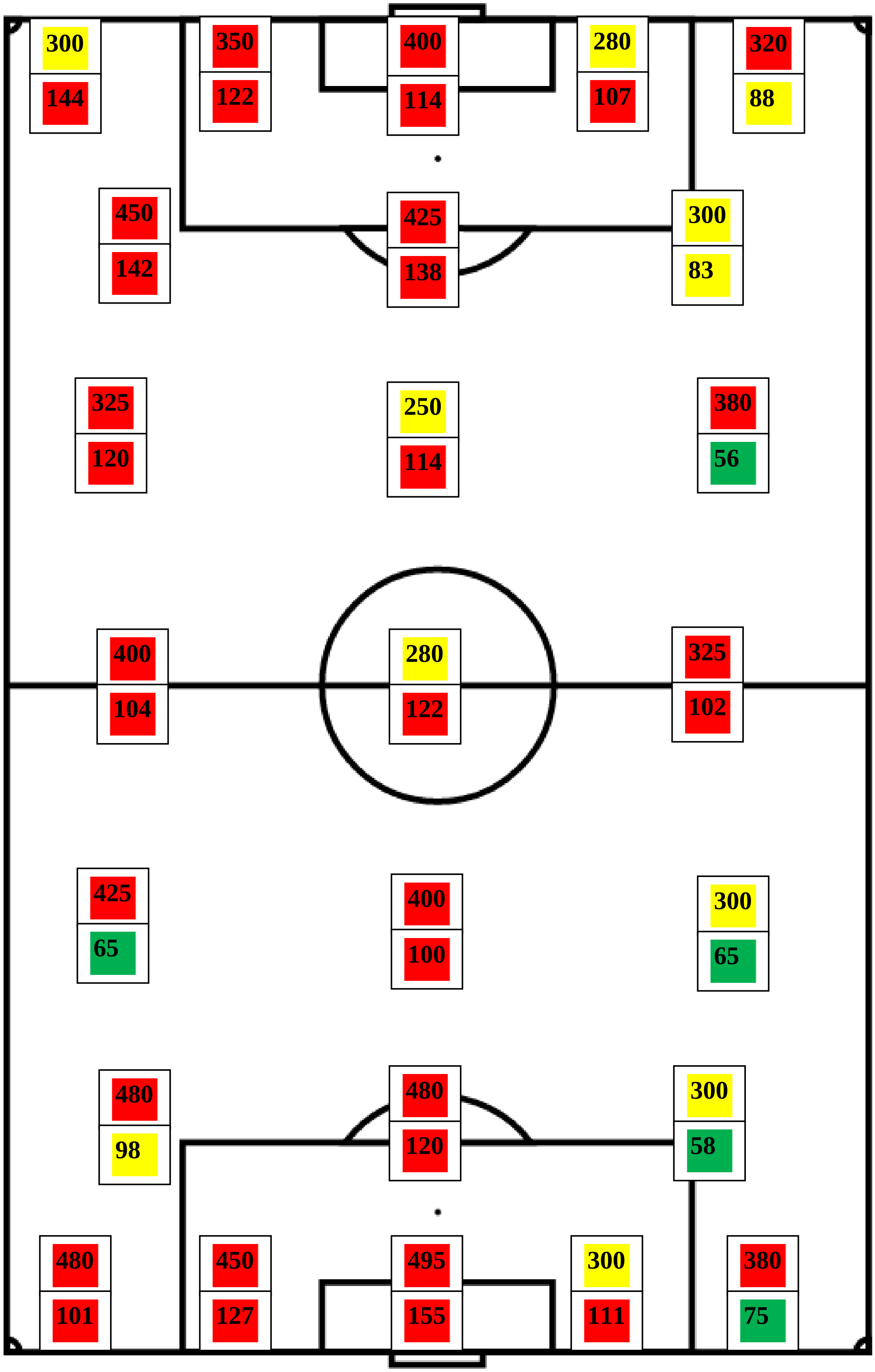
APPENDIX: Compaction Assessment Results

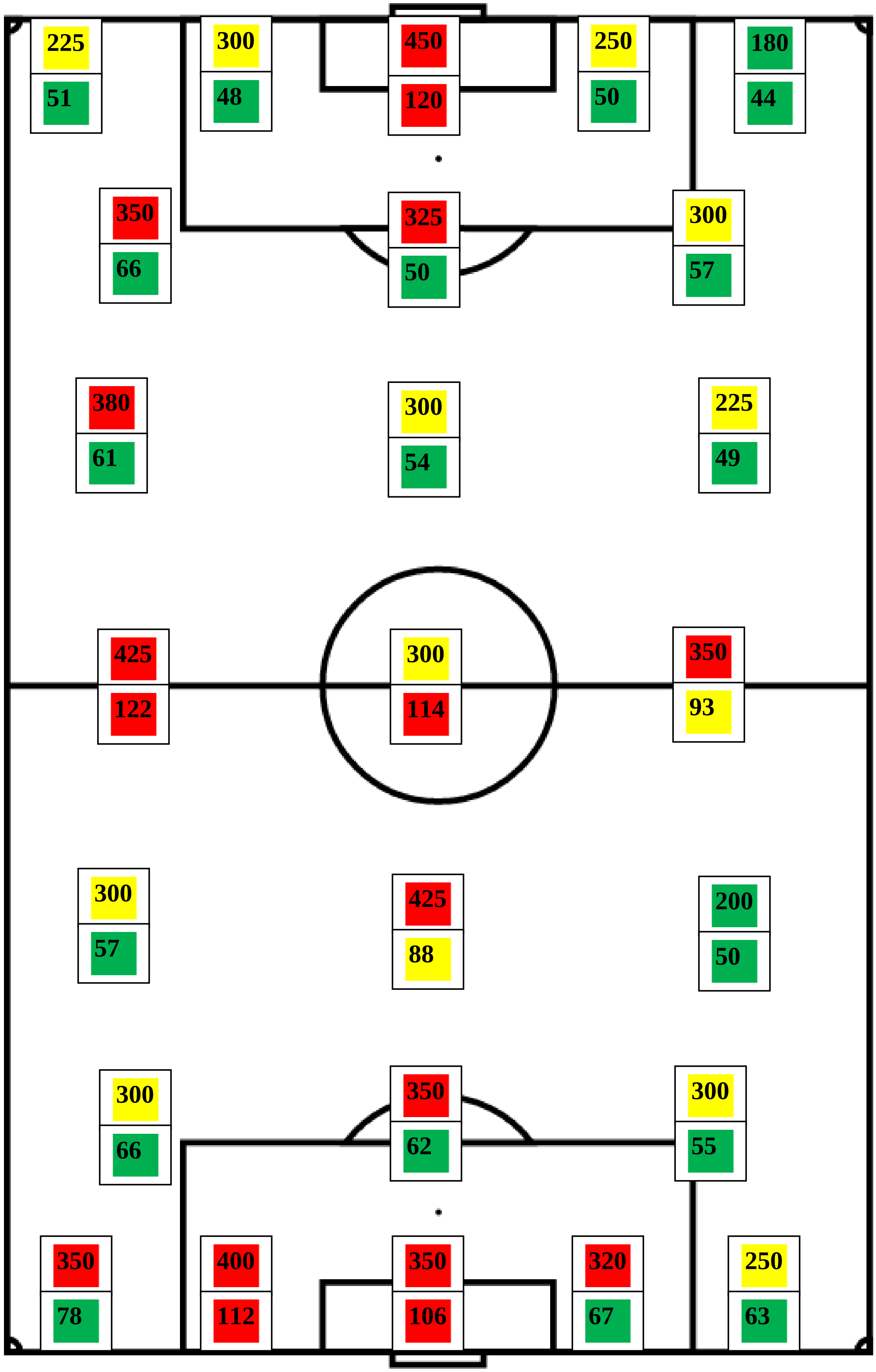
The following diagrams show compaction assessment results for each soccer field. The 25 rectangles displayed on each field layout show the recorded pressure to top 6 inches of soil (top value) and field hardness recordings (bottom value).

City Field 1

(green)	0-200 psi
(yellow)	201-300 psi
(red)	>300 psi
(green)	0-80 gmax
(yellow)	81-99 gmax
(red)	>100 gmax



City Field 2



(green)	0-200 psi
(yellow)	201-300 psi
(red)	>300 psi
(green)	0-80 gmax
(yellow)	81-99 gmax
(red)	>100 gmax

N

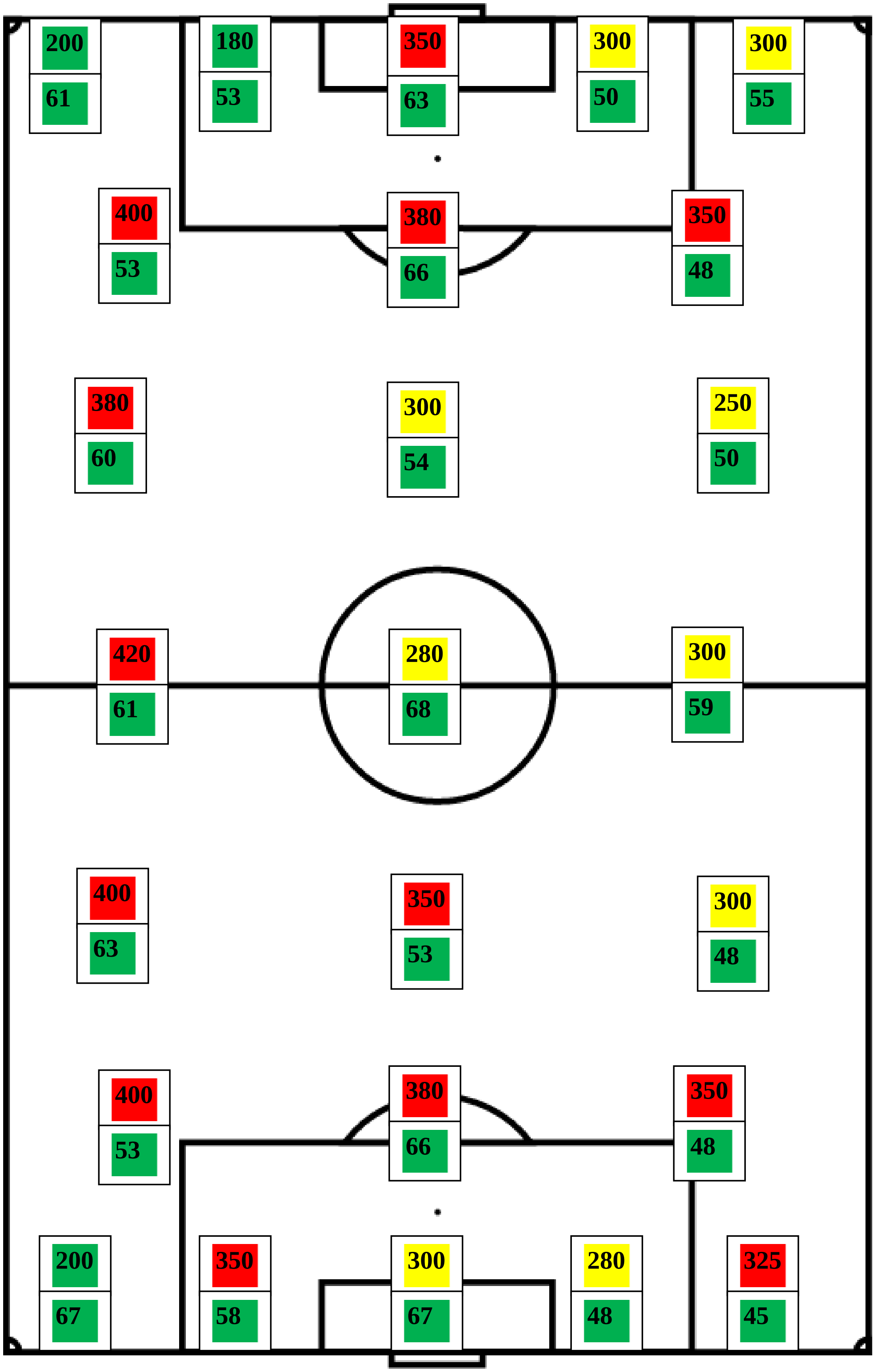
Example

225 Penetrometer (psi)

51 Clegg (gmax)

School Field 1

Green	0-200 psi
Yellow	201-300 psi
Red	>300 psi
Green	0-80 gmax
Yellow	81-99 gmax
Red	>100 gmax



School Field 2

- 0-200 psi
- 201-300 psi
- >300 psi
- 0-80 gmax
- 81-99 gmax
- >100 gmax