



Salem Municipal Golf Course Nutrient Management Plan

Prepared For:

City of Salem

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Certification Code: 654



Acreage – 35 Total Acres	
2 Soil Samples	
Fairway:	15
Rough	20

County:	City of Salem
Watershed:	RU09 – 35 - Sawmill Hallow, Mason Creek, Upper Roanoke

Plan Written: July 1, 2021

Plan Expires: July 1, 2026

Planner Signature

Contents

1.	Narrative	3
2.	Course Information.....	3
3.	Course Location	4
4.	Nutrient Management Principals	4
5.	Best Management Practices for Water Quality Protection	7
6.	Application Equipment Calibration.....	7
7.	Areas Managed.....	8
8.	Environmentally Sensitive Sites.....	9
9.	Season of Fertilization.....	10
10.	Site Maps All maps are to scale shown in lower right corner.	11
a.	Overview	11
b.	Management Areas	12
11.	Acreage Breakdown	13
12.	Soil Test Results	13
a.	Fairways/Rough.....	13
13.	Soil Test Summaries	13
14.	Nutrient Application Worksheets	14
15.	Fertilizer Application Records.....	16
16.	Reference Material	17
17.	Soil Test Results	33

Sources:

Maps – Maps are produced using Google Earth or provided by client.

Photos/Logos – Obtained from client, clients website, or taken by planner.

Site information – Obtained from client or clients website.

Technical Information –

Agronomy Handbook – A&L Labs – 2001

Best Golf Course Management Practices – McCarty – 2001

Environmental Best Management Practices for Golf Courses – Virginia GCSAA – January 2012

Golf Course Management and Construction, Environmental Issues – Balogh, Walker, USGA – 1992

Soil Fertility and Fertilizers 6th Ed. – Havlin, Beaton, Tisdale, Nelson – 1999

Spectrum Analytic Agronomic Library – www.spectrumanalytic.com

Sports Turf Management in the Transition Zone – Goatley, Askew, Ervin, McCall, VSTMA, Etc. – 2008

Turf Management for Golf Courses 2nd Ed. – Beard, USGA – 2002

Turfgrass Soil Fertility and Chemical Problems – Carrow, Waddington, Rieke – 2001

Urban Nutrient Management Handbook – VA DCR, Virginia Tech, Virginia State Uni. – May 2011

Virginia Nutrient Management Standards and Criteria – Commonwealth of Virginia – July 2014

Disclaimer: Statements and recommendations made within this document based on published research data and experience. Recommendations are based on the soil tests included in this document and not intended for use on any other facility. Products suggested are used in methods suggest by label guidelines when available, be sure to read label before using products as labels can change. Maximum rates are provided by Virginia Department of Conservation and Recreation Standards and Criteria and are not to be exceeded even when product label suggests otherwise. No guarantee or warranty is made, expressed or implied, concerning crop performance as a result of using the contents of this document.

1. Narrative

As a golf course required to have a plan by July 2017, Salem Municipal Golf Course, agrees to comply with all requirements set forth in the Nutrient Management Training and Certification Regulations, 4VAC50-85-10 et seq.; and to follow recommendations for turf fertilization and management as described in the Virginia Nutrient Management Standards and Criteria, Revised July 2014. This includes implementing the Department of Conservation and Recreation’s approved Nutrient Management Plan and maintaining fertilization records. All nutrient applications performed on Salem Municipal Golf Course shall comply with the provisions of this Nutrient Management Plan as of July 1, 2021. This plan is effective for five years (until July 1, 2026) or until major course renovation or major changes to maintenance practices occur. The planner should be alerted if this occurs or if new soil tests are taken with in the five-year period, a minor revision may be needed if tests show major differences. The process of updating this plan for a new five-year cycle should begin no later than 6 months prior to plan expiration.

2. Course Information

Salem Municipal Golf Course was built in 1919 on a 46-acre tract of land just a few blocks from the center of the city. The picturesque par 34, nine-hole, 2400-yard course is the perfect place for new golfers of any age to learn the game in a relaxing atmosphere.

From 2001 to 2008, the greens at the course consisted of artificial turf and over time they became increasingly slick and treacherous for even the most talented players. Workers from the city under the direction of Streets and Maintenance Director, Mike Tyler, ripped out the “worn out carpet” and replaced it with the sand greens that were the course’s trademark during its heyday.

The sand greens are made up of a combination of sand and clay and they have a consistency like the infield of a baseball diamond. The third and key ingredient in the mix is the bonding agent that holds the sand and dirt together. Durasoil is a synthetic, organic, environmentally friendly product that helps the greens remain packed and maintain a consistent roll.

These sand greens have no grass and are not fertilized. The tees on the course are all artificial pads. The 0.63-acre club house lawn. This area is planned separately in City of Salem’s Part 1 NMP.

Starting in the spring of 2021, defined fairways have returned to Salem Municipal Golf Course. 15 acres of fairways will be maintained and fertilized. All 20 acres of rough will also be fertilized at least once during the life of this plan, with yearly fertilization planned to help maintain turf density and discourage weeds. Naturalized areas will also occasionally be fertilized along with the mowed rough areas.

3. Course Location

From Main Street (RT 11) take Academy Street, Golf course will be on left.

Address: 601 Academy St.
Salem, VA 24153
GPS Coordinates: 37.297942, -80.063564

4. Nutrient Management Principals

Nutrient Management Plans focus on two primary objectives healthy plants and clean water. The *Standards and Criteria* are based upon years of scientific research and the rates suggested are optimal for plant health within the intended usage. Low input areas, like home lawns, require some fertilizer to maintain plant vigor thus maintaining turf cover and preventing erosion. High use areas, like sports fields, require frequent fertilizer input to help maintain plant health and to aid in recovery from stress. Clean water is maintained by applying fertilizer in a responsible manner that ensures minimum movement away from the intended site.

There are four different types of elements essential for plant health. Non-mineral, Primary and Secondary elements are all considered Macronutrients. The fourth is Micronutrients. Non-mineral elements consist of carbon, hydrogen, and oxygen; these elements are obtained from air and water. The Primary nutrients are nitrogen, phosphorus, and potassium. Secondary elements are calcium, magnesium, and sulfur. Micronutrients are iron, manganese, boron, zinc copper molybdenum, chlorine, cobalt, and nickel. All these elements are obtained from the soil and must be supplemented with fertilizer, lime or other soil amendments when a soil test shows a deficiency. In high maintenance situations, some elements are spray applied and absorbed through the leaf tissue.

Nitrogen and Phosphorus are the focus of a nutrient management plan, as these nutrients cause ecological problems. Lime is also important because having improper pH can make applied fertilizers unavailable to the plant and more likely to leach or runoff. While nitrogen and phosphorus are the focus, other nutrients are also discussed in the plan, these nutrients are beneficial to plant health, but do not cause water quality problems.

Nitrogen (N) – This element is responsible for green color, shoot growth and density, root growth, carbohydrate reserves, recuperative potential, heat, cold, drought hardiness, wear tolerance, and disease susceptibility. Nitrogen has a very complex cycle and only certain forms are available to the plant. It leaches through the soil rapidly and does not accumulate thus you cannot soil test for N. Due to these factors, nitrogen management is a large part of nutrient management. Nitrogen management includes but is not limited to using slow release materials, timing the applications in accordance with plant growth, and making multiple applications so that the element is available when it is needed by the plant.

Please refer to the chart below for the maximum allowable N rates for this golf course. In the second column, WSN stands for water-soluble nitrogen and WIN stands for water insoluble nitrogen. In order to use the WIN rate, the fertilizer material must be a slow release product.

According to DCR, the definition of “Slow or Controlled Release Fertilizer” means a fertilizer containing a minimum of 15% slowly available nitrogen. See page 19 for full definition. All granular applications in this plan utilize slow release products.

	30 days			Yearly Total Allowed by DCR	Amount Used in Plan
	WSN	WIN			
	Warm & Cool	Warm	Cool		
Greens	.7		.9	3-6 #/M	Sand
Tees	.7		.9	2-5 #/M	Artificial
Fairways	.5		.9	3-4 #/M – Cool	1.8 #/M
Rough	.7		.9	1-3 #/M	1.8 #/M

Phosphorus (P) – Phosphorus controls the establishment rate of newly seeded turf, plant maturation, root growth, and seed production. Like nitrogen, P also has a complex cycle. The major difference is that P readily attaches soil, it can be quantified by a soil test and only leaches when it completely saturates the soil. Phosphorus moves away from the application site when it is improperly applied to compacted soil or other impervious surfaces, when applied in excess, and since it attaches to the soil, with sediment rich runoff. Phosphorus management is also important to nutrient management. It should only be applied when called for by a soil test, to soils that are not compacted to prevent runoff and only applied to actively growing turf with sufficient turf cover/rooting to hold the soil in place.

Maximum P rates are outlined in application worksheets. Do not exceed this number. In extreme cases of turf loss or damage, an additional .5 #/M of P is available. Contact your planner to determine if you are eligible.

Potassium (K) - Potassium is responsible for root growth, heat, cold, and drought hardiness, wear tolerance, and disease susceptibility. While the *Standards and Criteria* do regulate the application of K, but in some cases, K input may exceed recommended levels, as it does not have the same detrimental effects on the health of Virginia’s waters as N and P. Potassium is considered the plant nutrient most responsible for turf quality. It helps plants respond to stresses like drought, extreme heat/cold, and insect/disease pressure. The plants increased ability to respond to stress in a positive manner can help reduce the need for increased N and P fertility and reseeding caused by stress. In addition to the benefits of K, it is difficult to limit the amount of K used as most modern slow release fertilizers contain both N and K while limiting or completely removing P. Nitrogen only products are not readily available in slow release form and custom blended fertilizers are expensive.

Potassium levels have been exceeded in most of the areas of this plan. As discussed above, K helps the plant deal with stress.

Lime - Liming is a critical management practice for maintaining soil pH at optimal levels for plant growth. Liming supplies the essential elements Calcium and/or Magnesium, reduces the solubility and potential toxicity of Aluminum and Manganese, and increases the availability of

essential nutrients. Many soil elements change form because of chemical reactions in the soil due to pHs that are either too acidic or too basic. Plants may not be able to use elements in some of these forms making some elements essential to plant health unavailable. Most plants grow well in the pH range 5.8 to 6.5. For this plan, 6.2 is the target pH.

Buffer pH is used to provide an indication of the soil's total (active + reserve) acidity and ability to resist a change in pH. This buffer measurement is the major factor in determining the amount of lime to apply. The Buffer pH starts at 7 (no lime needed) and goes lower as the soil's total acidity increases and more lime is needed to raise the soil pH. As an example, a clay soil with a pH of 6.1 could have a buffer pH of 6.8 and need 1 ton/A of lime in order to maintain/increase that pH around 6.2. A sandy soil could have a much lower pH but have the same buffer pH thus, needing the same amount of lime to change the pH to 6.2. This is because sandy soils have a lower cation exchange capacity thus, less storage for reserve acid.

Attempting to change the pH in the deep rooting zone of an established turf is difficult at best. One method of getting lime somewhat deeper in established turf areas is to apply lime in conjunction with aeration. Applying lime in the fall and winter months is recommended because the freeze/thaw cycle aids in mixing lime throughout the root zone.

Lime provides the essential nutrients Calcium and Magnesium. Calcium is the main component of plant cell walls while magnesium is the atom upon which chlorophyll is built. It is important that these elements be present in the soil not only to help regulate the soils acidity but to insure plant health. When a soils pH is acidic, these elements can be added with lime. Calcitic lime should be used when calcium is deficient and magnesium is high. Dolomitic lime, which is more common, is used when the both are deficient or balanced. If pH does not need to be adjusted, calcium levels can be raised with gypsum and magnesium is raised with Epsom salts. The *Standards and Criteria* provide guidance on adjusting soil pH levels but do not include any recommendations for Ca or Mg, as they do not affect water quality.

Not all liming materials are the same, if the liming material chosen does not equate to 100% Calcium Carbonate Equivalent (CCE % should be listed on bag) see chart on page 32 to adjust the required amount of lime.

In the reference area of this document there is a chart showing nutrient availability at different pHs (page 17).

Sulfur (S) - Sulfur is responsible for the plants green color, shoot growth and density, root growth, carbohydrate reserves, and disease susceptibility. Elemental sulfur applications should be avoided unless you are attempting to acidify (lower pH) the soil and should be applied at no more than 5#/M and watered in due to the turf burn potential. Unless called for by a soil test, the occasional use of sulfur containing fertilizers and micro nutrient packages should be the only S input needed to supplement the soil S content. This element is not included in the *Standards and Criteria*.

Iron (Fe) – Iron contributes to the plants green color, shoot growth and density, root growth, carbohydrate reserves, heat, cold and drought hardiness and wear tolerance. Iron is often

included in fertilizer and micronutrient blends because it produces a faster greening of turf than nitrogen. The *Standards and Criteria* recommends that Fe applications be occasionally substituted for N applications because it can produce the same greening results. This is a good strategy, but Fe apps cannot replace N. While Fe is used inside the plant, the greening created by Fe is superficial and caused the iron rusting on the plants surface. Fe should be used as an N replacement only when the plant is healthy and greening is desired without increased growth.

Micros – Other micronutrients are not mentioned by the *Standards and Criteria*. These elements are very important to plant growth, but regular input is not needed unless you are managing a sand based soil with low nutrient holding capacity. Most soils contain all the necessary micros and they will be available for the plant as long as the proper pH is maintained.

5. Best Management Practices for Water Quality Protection

The following list comes from the *Urban Nutrient Management Handbook* page 8-12 and details steps that can reduce the impact of nutrient management practices on water quality. A PDF of the complete handbook can be found online through ext.vt.edu or a printed copy can be obtained from DCR.

- Base fertilization practices on a soil test.
- Supplement the soil test with a plant tissue test when necessary.
- Aerate compacted soil to reduce runoff and aid phosphorus and lime in entering the soil.
- Minimize fertilizer rates on slopes and sandy soils. If using quickly available sources of nitrogen on deep, sandy soils or near shallow water tables, use no more than 0.25 to 0.50 pound of nitrogen per 1,000 square feet per application.
- Establish and maintain a buffer zone of reduced- to zero-input vegetation around bodies of water. In some cases, native vegetation might be appropriate, but whatever plant material is selected, it must persist indefinitely to serve as a functional buffer zone.
- Consider using iron as a supplement to nitrogen for greening response.
- Use at least 50 percent slowly available sources of nitrogen on soils subject to leaching.
- Time applications carefully. Do not apply fertilizer before a heavy rainfall.
- Irrigate lightly (0.10 to 0.25 inch) after each application of quick-release fertilizer so it is washed off the foliage and moved into the soil. (Wait to irrigate if foliar activity is desired)
- Avoid over irrigation.
- Return grass clippings to the turf to improve nutrient cycling and reduce the amount of fertilizer needed to produce healthy plants. Use a mulching mower whenever possible and consider that a mulching mower can even be used to manage fall leaves (Goatley 2006).
- When collected, compost grass clippings rather than disposing of them in landfills.
- Use a drop (gravity) spreader near bodies of water or impenetrable areas to lessen the chance of spreading material on these surfaces.
- Perhaps the most important best management practice toward improving water quality is to simply sweep or blow fertilizers and clippings off hardscape surfaces and back into the turf.

6. Application Equipment Calibration

An agronomically and environmentally sound fertilizer program can be negated by improperly calibrated equipment. It is important to calibrate your equipment prior to every application. Even moving from one location to another can knock your application equipment out of

adjustment so once you have your equipment calibrated for a particular product write down the setting. Use that setting to check the calibration for every site and adjust if necessary. The next time you use that product, use your records as a starting point and not a final calibration as equipment can wear over time thus changing the calibration point. For more information on how to calibrate your equipment see the *Urban Nutrient Management Handbook* Chapter 10 (ext.vt.edu) or visit your equipment manufactures website. Please remember that the number on the bag is not sufficient, every spreader and every application is different and that the bag number only serves as a calibration starting point.

7. Areas Managed

The Salem Municipal Golf Course is a 9 Hole course operated by the City of Salem.

Greens – Sand greens will not receive fertilizer.

Tees – Artificial tees will not receive fertilizer.

Fairways/Rough – There are 15 acres of fairways. These areas are mixed cool season turf and will be fertilized regularly.

Rough – There are 20 Acres of cool season rough. These areas will be fertilized annually as budget allows to maintain turf health, density and to discourage weeds.

Naturalized Areas – These areas are included in the rough acreage. They too will receiver fertilizer annually as budget allows to maintain turf health, density and to discourage weeds.

8. Environmentally Sensitive Sites

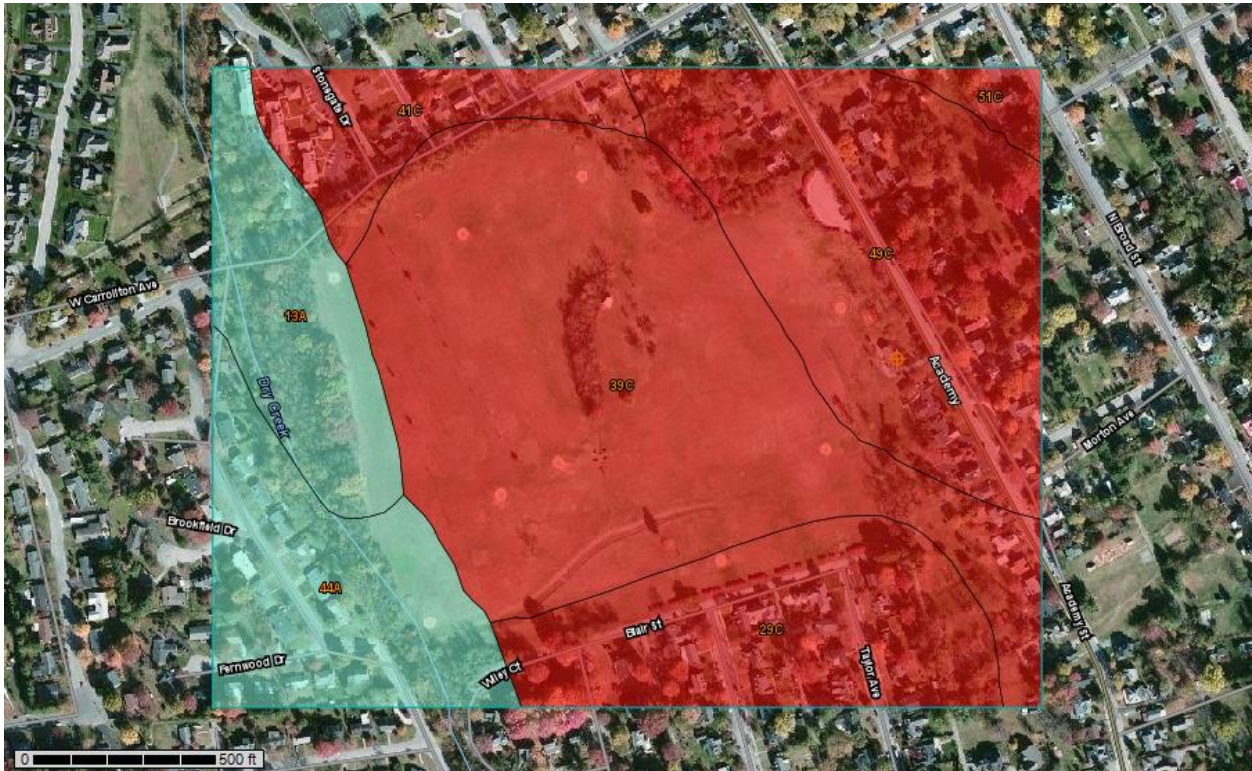
- Dry Creek runs to the west of the course along the 7th hole.
- A drainage ditch runs through the 6th hole to Dry Creek.
- The area of the 6th green and 7th hole lie in an occasional flood area.
- Applications of inorganic fertilizers will not occur on frozen or snow-covered ground.
- Any fertilizer that makes its way onto impervious surfaces (sidewalks, cart paths, etc.) should be swept or blown back into pervious turfgrass-covered areas.
- Do not use fertilizers as ice melt.

According to Web Soil Survey, flooding is concern, in the area of 6th green and entire 7th hole. Please refrain from making fertilizer applications prior to heavy storms.

Flooding Frequency Class Designations –Flooding is the temporary inundation of an area caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, and water standing in swamps and marshes is considered ponding rather than flooding.

Potential flooding frequency is expressed as none, very rare, rare, occasional, frequent, and very frequent.

	<i>"None" means that flooding is not probable. The chance of flooding is nearly 0 percent in any year. Flooding occurs less than once in 500 years.</i>
	<i>"Very rare" means that flooding is very unlikely but possible under extremely unusual weather conditions. The chance of flooding is less than 1 percent in any year.</i>
	<i>"Rare" means that flooding is unlikely but possible under unusual weather conditions. The chance of flooding is 1 to 5 percent in any year.</i>
	<i>"Occasional" means that flooding occurs infrequently under normal weather conditions. The chance of flooding is 5 to 50 percent in any year.</i>
	<i>"Frequent" means that flooding is likely to occur often under normal weather conditions. The chance of flooding is more than 50 percent in any year but is less than 50 percent in all months in any year.</i>
	<i>"Very frequent" means that flooding is likely to occur very often under normal weather conditions. The chance of flooding is more than 50 percent in all months of any year.</i>



9. Season of Fertilization

Per the Virginia Nutrient Management Standards and Criteria, Revised July 2014, fertilizers must be applied in between the following dates.

- These are guidelines and averages, in warmer years, fertilizer could be applied earlier and in cooler years, fertilizer should be applied later.
- Fertilizers should not be applied to frozen ground or to grass that is not actively growing. For warm season grasses please wait for green up to occur.
- For warm season grasses that are overseeded, follow the cool season application window. If overseeding is skipped, please revert to warm season window.

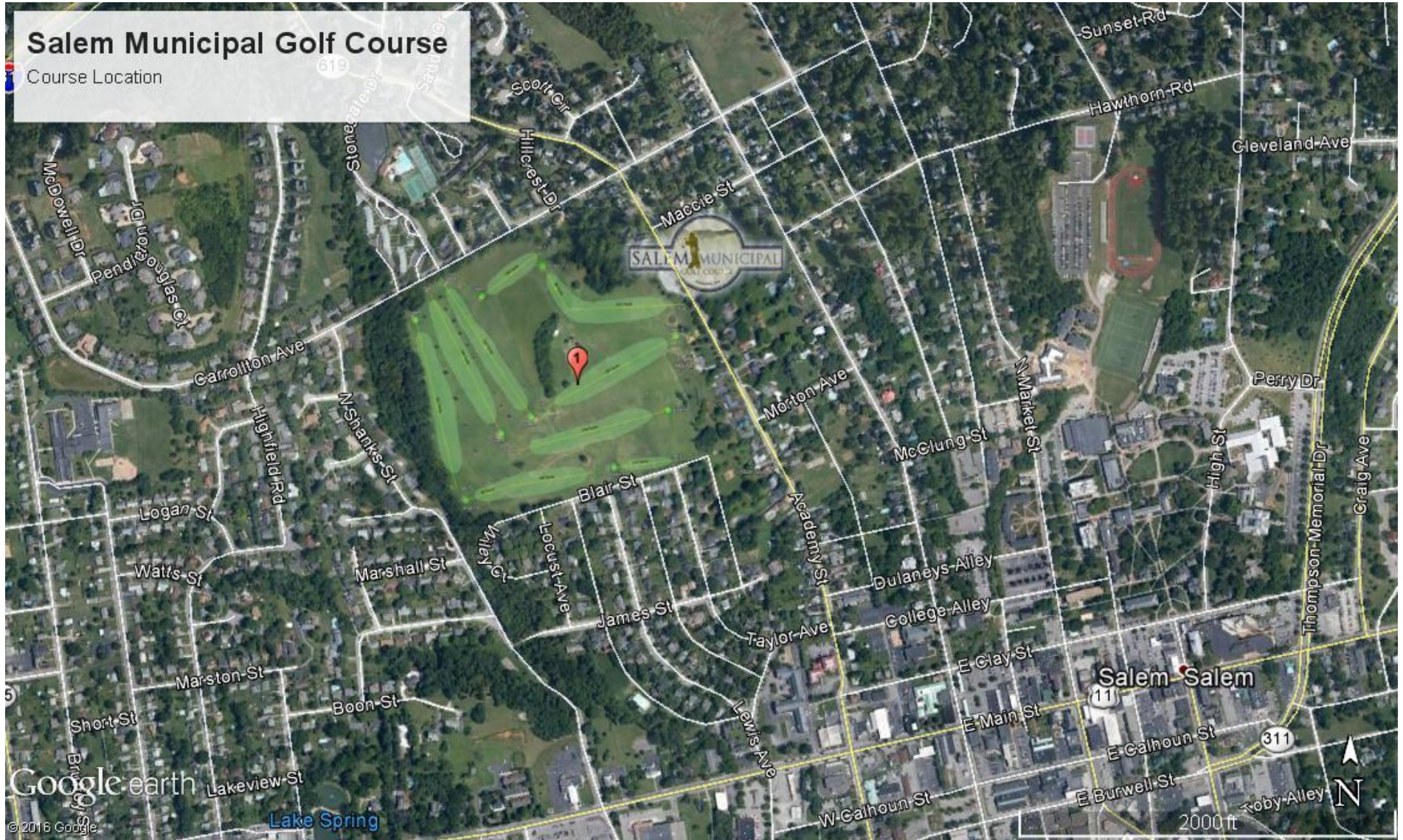
Data for frost date comes from the Southeast Regional Climate Center using 50% probability of frost at 32.5 degrees at the Roanoke WSO Airport Station.

<http://www.sercc.com/cgi-bin/sercc/cliMAIN.pl?va7285>

	Average Frost Dates	Cool Season Applications	Warm Season Applications
Spring	April 11	February 28	April 11
Fall	October 21	December 2	September 21

10. Site Maps All maps are to scale shown in lower right corner.

a. Overview



b. Management Areas



11. Acreage Breakdown

Acreage:	
Fairways	15
Rough	20

Acreages were estimated using Google Earth Pro using the previous map provided Salem Municipal Golf Course

12. Soil Test Results

Soil samples were taken by Robert Habel on 5/11/21. A minimum of 10 random sub samples were collected, at a depth of 3-4 inches, using a soil probe and placed in plastic bags. Thatch and other organics were removed prior to boxing. Testing was conducted by Waypoint Analytical.

Soil tests are rated in terms of Very Low to Very High. In order to comply with Virginia Nutrient Management Standards and Criteria, Revised July 2014, no phosphorus may be applied if a soil test rates that element Very High. In economic terms, nutrients are not necessarily needed if they test above a medium rating, plant response is not guaranteed if soils already test above medium. (See plant response chart page 18)

a. Fairways and Rough

Soil samples show medium (M-) levels of phosphorus and high (H) levels of potassium. 2 #/M phosphorus and .75 #/M of potassium is recommended.

Regulations allow for up to 3 #/M of nitrogen on fairways and rough.

Buffer pH is 6.75, 1 T/A or 46 #/M will be needed to adjust pH. Calcium is deficient, Calcitic lime is recommended. Attempt to apply lime at aeration.

13. Soil Test Summaries

Soil Test Summary									
Customer Name:		City of Salem							
Testing Lab:		Waypoint Analytical							
Sample Date:		5/11/2021							
Analysis Date:		5/14/2021							
Planner Name		Five Oaks Agronomy Consulting, LLC							
Certification Number		654							
Managed Area ID	Soil pH	Buffer pH	Lab P (ppm)	VT P (ppm)	VT (H/M/L)	Lab K (ppm)	VT K (ppm)	VT (H/M/L)	
Soil Test ID#									
SLM G1	Fwy 1-4	5.50	6.76	21	6.4	M-	141	100.1	H-
SLM G2	Fwy 5-9	5.60	6.75	29	10.0	M-	184	130.6	H
Allowed Inputs		Lime		P		K			
		1 T/M		2 #/M		0.75 #/M			

14. Nutrient Application Worksheets

The following worksheets detail the amount of total and monthly fertility allowed by DCR based on the previously discussed soil test information. All nutrient input level recommendations come from the Department of Conservation and Recreation's Nutrient Management Standards and Criteria, this document is part of the Code of Virginia and thus is law for those required to abide by their recommendations or those required to have a Nutrient Management Plan. While applications do not have to be followed specifically, it is important to note that per month nitrogen levels shall not be exceeded and per year phosphorus levels shall not be exceeded. Please be aware that the nitrogen rates in this plan are based on usage of slowly available forms of N. The rates change when using water-soluble sources. In some cases, potassium input may exceed recommended levels, as it does not have the same detrimental effects on the health of Virginia's waters as nitrogen and phosphorus. For more information on nutrients and rates see page 4.

- *Recommendations are made using a "limiting result" i.e. the worst soil test result of the group. If major differences are present, multiple applications plans will be recommended.*
- *Specific fertilizers have not been recommended. It is your responsibility to choose fertilizers and calculate appropriate rates that follow discussed regulations. The Urban Nutrient Management Handbook is a good source for fertilizers calculations. A digital copy is on provided on flash drive. Feel free to contact planner if you need assistance.*
- *Class B bio-solids and animal manures cannot be used without revising this plan to reflect the appropriate setbacks and environmental hazards. Class A bio-solids like Milorganite can be used without problem.*
- *All applications are represented in #/M (pounds per 1000 sqft).*

NUTRIENT APPLICATION WORK SHEET

NUTRIENT APPLICATION WORK SHEET													
Name:	City of Salem			Management Area:			Golf Course Fairway/Rough						
Prepared:	7/1/2021			Area:		35	Turf Type:		Cool Season				
Expires:	7/1/2025			Fertilizer Description		Rate/M	lbs/app	% Slow Release N	Total/M		Lime	Gypsum	lbs/app
Total Yearly Nutrient Needs	Application Month/Day	Analysis N - P - K	Interval (days)						N	P	K	lbs/M	lime/gyp
Nitrogen	No applications before February 28												
3	April 15 - May 15	16 - 3 - 8	30	16-3-8 50%XCU 20%Biosolids 2%Fe		3.75	5717	55	0.60	- 0.11	- 0.30		
Phosphorus													
2	August	16 - 3 - 8	30	16-3-8 50%XCU 20%Biosolids 2%Fe		3.75	5717	55	0.60	- 0.11	- 0.30		
Potassium													
0.75	September	12 - 3 - 12	30	12-3-12 20%XRT 35% NB 2.5%Ca 2.5%Fe		7.50	11435	31	0.90	- 0.23	- 0.90		
	October	12 - 3 - 12	30	12-3-12 20%XRT 35% NB 2.5%Ca 2.5%Fe		7.50	11435	31	0.90	- 0.23	- 0.90		
	No applications after December 2												
	Lime												
	September '21			Calcitic Limestone								50	76,230
	November '21			Calcitic Limestone								50	76,230
							Total used:		3.00	- 0.68	- 2.40		
							Do not exceed yearly maximum allowed by Regulation:		3	- 2	- 0.75	100	

- Greens tested M- in P and H in K.
- Foliar applications of nutrients, no matter how small, should be included in application records and totals.
- Applications of greater than 0.7 #/M N are at least 15% SAN. Per month (30 days) totals of N shall not exceed 0.7 #/M if using 100% WSN or 0.9 #/M if using at least 15% SAN.
- 1 T/A or 46 #/M should be applied to correct pH. Calcium is deficient so calcitic limestone should be used. Do not apply more than 50#/M every 30 days. These lime applications should only be made once during the 5-year plan. New soil samples should be taken before applying more lime.

15. Fertilizer Application Records

Fertilizer Application Records								
Location Information					Management Area information			
Name:	City of Salem				Management Area ID:	Fairways/Rough		
Address:	Laura Reilly, City Horticulturist				Management Area Size:	35		
	114 North Broad Street • PO Box 869				Plant Species:	Mixed Cool Season		
Phone#:	Salem, VA 24153				Notes:			
	Office: (540)375-3028							
Date	Applicator/Supervisor	Weather Info			Fertilizer Analysis	Rate	Amount Fertilizer Used	Equipment Used
		Temp	Wind	Precip				
When was the last time your fertilizer equipment was calibrated??? For information on calibration see Chapter 10 of the "Urban Nutrient Management Handbook". Available for download at http://pubs.ext.vt.edu/430/430-350/430-350.html								

16. Reference Material

Nutrient Availability According to pH

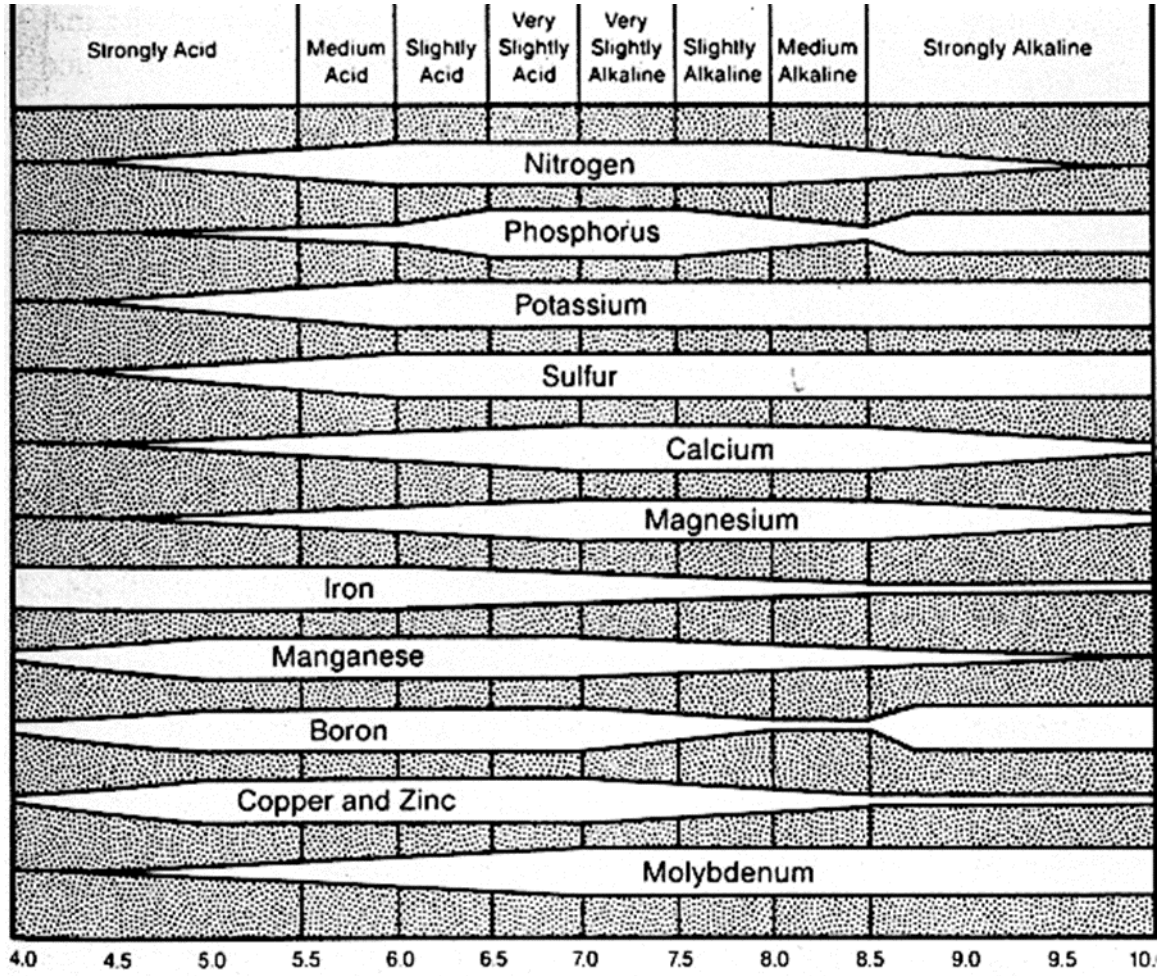


Figure 1: Nutrient Availability at pH

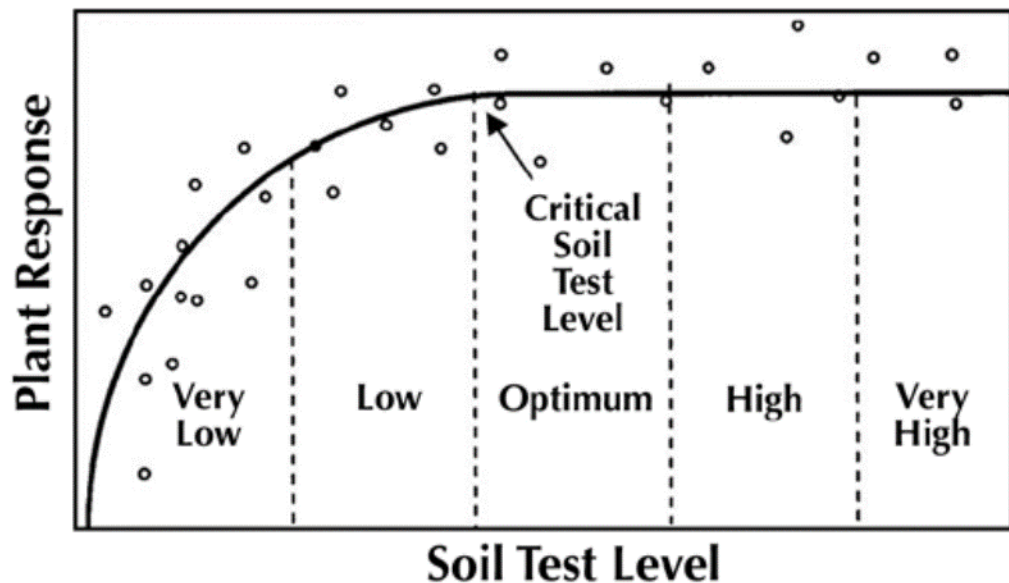


Figure 2: Plant Response Chart

Very low: A plant response is most likely if the indicated nutrient is applied. A large portion of the nutrient requirement must come from fertilization.

Low: A plant response is likely if the indicated nutrient is applied. A portion of the nutrient requirement must come from fertilization.

Medium: A plant response may or may not occur if the indicated nutrient is applied. A small portion of the nutrient requirement must come from fertilization.

High: Plant response is not expected. No additional fertilizer is needed.

Very high: Plant response is not expected. The soil can supply much more than the turf requires. Additional fertilizer should not be added to avoid nutritional problems and adverse environmental consequences.

Standards and Criteria

Section VI. Turfgrass Nutrient Recommendations for Home Lawns, Office Parks, Public Lands and Other Similar Residential/Commercial Grounds

Definitions

For the purposes of this section, the following definitions, as presented by the Association of American Plant Food Control Officials (AAPFCO), apply:

“Enhanced efficiency fertilizer” describes fertilizer products with characteristics that allow increased plant nutrient availability and reduce the potential of nutrient losses to the environment when compared to an appropriate reference product.

“Slow or controlled release fertilizer” means a fertilizer containing a plant nutrient in a form which delays its availability for plant uptake and use after application, or which extends its availability to the plant significantly longer than a reference “rapidly available nutrient fertilizer” such as ammonium nitrate, urea, ammonium phosphate or potassium chloride. A slow or controlled release fertilizer must contain a minimum of 15 percent slowly available forms of nitrogen.

“Water soluble nitrogen”, “WSN”, or “readily available nitrogen” means: Water soluble nitrogen in either ammonical, urea, or nitrate form that does not have a controlled release, or slow response.

Recommended Season of Application For Nitrogen Fertilizers - Applies to all Turf

A nitrogen fertilization schedule weighted toward fall application is recommended and preferred for agronomic quality and persistence of cool season turfgrass; however, the acceptable window of applications is much wider than this for nutrient management. The nutrient management recommended application season for nitrogen fertilizers to cool season turfgrasses begins six weeks prior to the last spring average killing frost date and ends six weeks past the first fall average killing frost date (see Figures 6-1 & 6-2). Applications of nitrogen during the intervening late fall and winter period should be avoided due to higher potential leaching or runoff risk, but where necessary, apply no more than 0.5 pounds per 1,000 ft² of water soluble nitrogen within a 30-day period. Higher application rates may be used during this late fall and winter period by using materials containing slowly available sources of nitrogen, if the water soluble nitrogen contained in the fertilizer does not exceed the recommended maximum of 0.5 pounds per 1,000 ft² rate. Do not apply nitrogen or phosphorus fertilizers when the ground is frozen.

The acceptable nitrogen fertilizer application season for non-overseeded warm season turfgrass begins no earlier than the last spring average killing frost date and ends no later than one month prior to the first fall average killing frost date (see Figures 6-1 & 6-2).

Figure 6-1

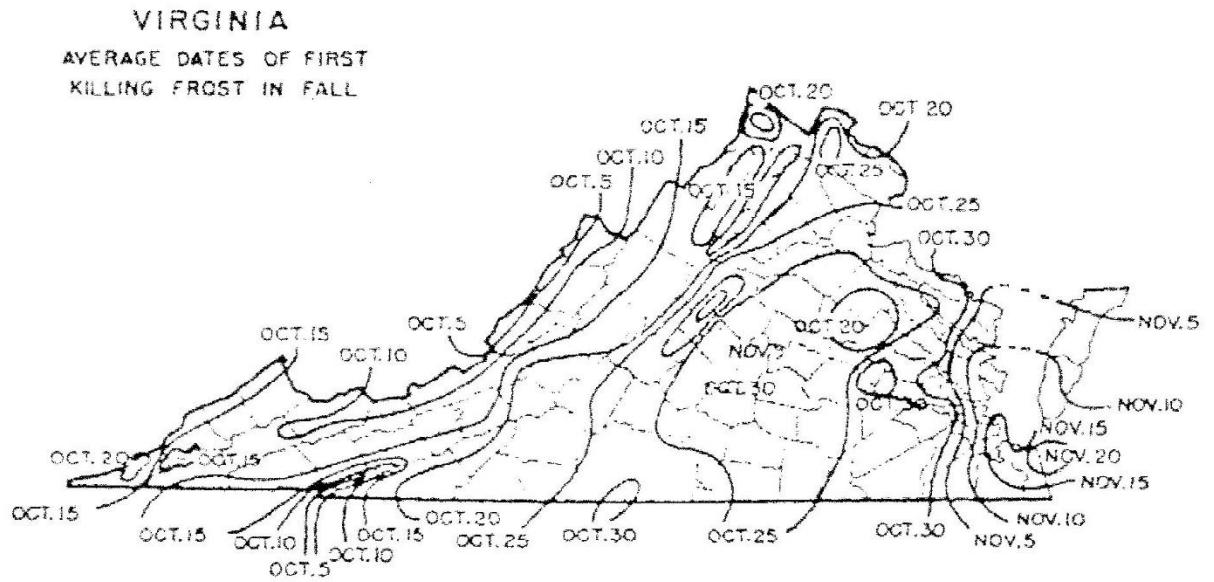
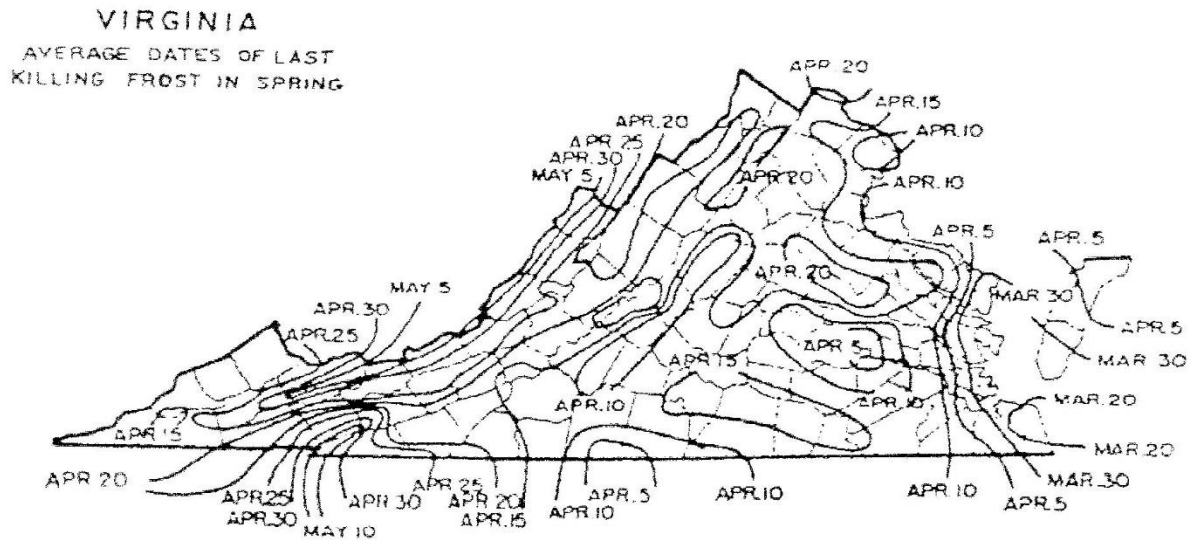


Figure 6-2



Per Application Rates

Do not apply more than 0.7 pounds of water soluble nitrogen per 1,000 ft² within a 30-day period. For cool season grasses, do not apply more than 0.9 pounds of total nitrogen per 1,000 ft² within a 30-day period. For warm season grasses, do not apply more than 1.0 pounds of total nitrogen per 1,000 ft² within a 30-day period. Lower per application rates of water soluble nitrogen sources or use of slowly available nitrogen sources should be utilized on very permeable sandy soils, shallow soils over fractured bedrock, or areas near water wells.

Annual Application Rates for Home Lawns and Commercial Turf

Up to 3.5 pounds per 1,000 ft² of nitrogen may be applied annually to cool season grass species or up to 4 pounds per 1,000 ft² may be applied annually to warm season grass species using 100 percent water soluble nitrogen sources. Lower rates of nitrogen application may be desirable on those mature stands of grasses that require less nitrogen for long-term quality. As a result, lower application rates will probably be more suited to the fine leaf fescues (hard fescue, chewings fescue, creeping red fescue, and sheep fescue) and non-overseeded zoysiagrass. Lower rates should also be used on less intensively managed areas.

Use of Slowly Available Forms of Nitrogen

For slow or controlled release fertilizer sources, or enhanced efficiency fertilizer sources, no more than 0.9 pounds of nitrogen per 1,000 ft² may be applied to cool season grasses within a 30-day period and no more than 1.0 pounds of nitrogen per 1,000 ft² may be applied to warm season grasses within a 30-day period.

Provided the fertilizer label guarantees that the product can be used in such a way that it will not release more than 0.7 pounds of nitrogen per 1,000 ft² in a 30-day period, no more than 2.5 pounds of nitrogen per 1,000 ft² may be applied in a single application. Additionally, total annual applications shall not exceed 80 percent of the annual nitrogen rates for cool or warm season grasses.

Phosphorus and Potassium Nutrient Needs (Established Turf)

Apply phosphorus (P₂O₅) and potassium (K₂O) fertilizers as indicated necessary by a soil test using the following guidelines:

<u>Soil Test Level</u>	<u>Nutrient Needs (pounds per</u>	
	<u>1,000 ft²)*</u>	
	<u>P₂O₅</u>	<u>K₂O</u>
L	2-3	2-3
M	1-2	1-2
H	0.5-1	0.5-1
VH	0	0

* For the lower soil test level within a rating, use the higher side of the range and for higher soil test level within a rating use the lower side of the recommendation range. (For example the recommendation for a P₂O₅ soil test level of L- would be 3 pounds per 1,000 ft².)

Do not use high phosphorus ratio fertilizers such as 10-10-10 or 5-10-10, unless soil tests indicate phosphorus availability below the M+ level.

Recommendations for Establishment of Turf

These recommendations are for timely planted turfgrass, that is, the seed or vegetative material (sod, plugs, and /or sprigs), are planted at a time of the year when temperatures and moisture are adequate to maximize turfgrass establishment. These recommended establishment periods would be late summer to early fall for cool-season turfgrasses and late spring through mid-summer for warm-season turfgrasses.

Nitrogen Applications

At the time of establishment, apply no more than 0.9 pounds per 1,000 ft² of total nitrogen for cool season grasses or 1.0 pounds per 1,000 ft² of total nitrogen for warm season grasses, using a material containing slowly available forms of nitrogen, followed by one or two applications beginning 30 days after planting, not to exceed a total of 1.8 pounds per 1,000 ft² total for cool season grasses and 2.0 pounds per 1,000 ft² for warm season grasses for the establishment period. Applications of WSN cannot exceed more than 0.7 pounds per 1,000 ft² within a 30-day period.

Phosphorus and Potassium Recommendations for Establishment

<u>Soil Test Level</u>	<u>Nutrient Needs (pounds per 1,000 ft²) *</u>	
	<u>P₂O₅</u>	<u>K₂O</u>
L	3-4	2-3
M	2-3	1-2
H	2-1	0.5-1
VH	0	0

* For the lower soil test level within a rating, use the higher side of the range and for higher soil test level within a rating use the lower side of the recommendation range.

Nutrient Recommendations for Golf Courses

Nitrogen Timing

The beginning and ending dates for application of nitrogen shall be determined using guidance and frost date maps contained in the Season of Application for Nitrogen section, Figures 6-1 and 6-2.

If the full rate or the highest rate of the recommendation range for a monthly application is applied in a single application, then the interval of application for nitrogen shall be at least 30 days to allow turf to utilize previous nitrogen applications. If several applications are to be made for the monthly nitrogen rate, then the timing of the applications shall be at approximately even intervals, with the rate per application to be evenly divided between each application with the total nitrogen applied not to exceed the maximum monthly rate. Use of Water Insoluble Nitrogen forms of Nitrogen is encouraged.

Nitrogen Rates

	Grass Type	Maximum WSN Rate Per Application - pounds per 1,000 ft ²	Total Annual Nitrogen Rate - pounds per 1,000 ft ² ^a
Greens		0.7 ^(b)	3-6
Tees		0.7 ^(b)	2-5
Fairways	Cool Season	0.7 ^(c)	2-3
	Warm Season	0.7 ^(c)	3-4
Fairways – Intensive Management	Cool Season	0.5 ^(d)	3-4
	Warm Season	0.5 ^(d)	3.5-4.5
	Overseeding Warm Season Fairways	.5	1.25
Roughs		0.7 ^(e)	1-3

Fairways-Overseeding Warm Season Fairways

- For warm season grasses, up to 0.7 pounds of nitrogen per 1,000 ft² in a 30-day period may be applied in the Fall after perennial ryegrass overseeding is well established. An additional nitrogen application of 0.7 pounds per 1,000 ft² may be made in February-March to overseeded perennial ryegrass if growth and color indicate need. Applications using WSN may not exceed 0.7 pounds per 1,000 ft² within a 30-day period.
- Soluble nitrogen rates of 0.25 pounds per 1,000 ft² or less which may be a component of a pesticide or minor element application, may be applied any time during the application windows described in Recommended Season of Application for Nitrogen Fertilizers of this section, but must be considered with the total annual nitrogen application rate.

(a) Use higher rates for intensively used turf where accelerated growth and/or rapid recovery are required, use lower rates for maintenance of lesser used areas; do not exceed total annual nitrogen levels as stated above.

- (b) Greens and Tees – Per application timing must be a minimum of 30 days between applications. A rate of 0.9 pounds per 1,000 ft² of total nitrogen may be applied for cool season grasses or 1.0 pounds per 1,000 ft² of total nitrogen may be applied for warm season grasses using a material containing slowly available forms of nitrogen.
- (c) Fairways-Normal Management (Non-Irrigated or Irrigated) - Per Application timing must be a minimum of 30 days between applications. Total nitrogen application rates of 0.9 pounds per 1,000 ft² of total nitrogen may be applied for cool season grasses or 1.0 pound per 1,000 ft² of total nitrogen may be applied for warm season grasses using a material containing slowly available forms of nitrogen.
- (d) Fairways-Intensive Management (Irrigated)- Per Application timing must be a minimum of 15 days between applications. This option requires optimized timing of more frequent applications of nitrogen with lesser rates per application. Alternatively, a maximum application rate of 0.9 pounds per 1,000 ft² of total nitrogen for cool season grasses or 1.0 pounds per 1,000 ft² of total nitrogen for warm season grasses using a material containing slowly available forms of nitrogen may be applied with a minimum of 30 days between applications.
- (e) Foliar fertilizer may be applied to warm season grasses within 30 days prior to the first killing frost in the fall, at a rate not to exceed 0.1 pounds per 1,000 ft² of nitrogen per application. This application must be accounted for in the total annual nitrogen rate.

Phosphorus and Potassium Recommendations for Established Golf Courses

Apply phosphorus (P₂O₅) and potassium (K₂O) fertilizers as indicated by a soil test using the following guidelines:

<u>Soil Test Level</u>	<u>Nutrient Needs (pounds per 1,000 ft²)*</u>	
	<u>P₂O₅</u>	<u>K₂O</u>
L	2-3	2-3
M	1-2	1-2
H	0.5-1	0.5-1
VH	0	0

- * For the lower soil test level within a rating, use the higher side of the range and for higher soil test level within a rating use the lower side of the recommendation range.
- For irrigated turf grown on Naturally Occurring and Modified Sand Based soils only, up to 0.5 pounds of P₂O₅ per 1,000 ft² may be applied, if needed, to aid in recovery of damaged turf during times of extreme use. No phosphorus applications shall be made when the soil phosphorus test level is above 65% saturation, based on the soil test phosphorus values and region as listed in Table 4-1 of Section IV.
- Avoid the general use of high phosphorus ratio fertilizers such as 10-10-10 or 5-10-10, unless soil tests indicate phosphorus availability below the M+ level.

Nitrogen Management on Athletic Fields - Cool Season Grasses

- This program is intended for those fields which are under heavy use.
- Nitrogen recommendations are based on the assumption that there is adequate soil moisture to promote good turf growth at the time of application. If no rainfall has occurred since the last application, further applications should be delayed until significant soil moisture is available.

Cool Season Grasses	Maintenance Program ^a	
	Normal	Intensive
When to Apply ^b	Pounds per 1,000 ft ² Nitrogen	
After August 15	-----	<u>0.5</u>
September	<u>0.7</u>	<u>0.7^c</u>
October	<u>0.7^c</u>	<u>0.7^c</u>
November	0.5	<u>0.7^c</u>
April 15 - May 15	0.5	0.5
June 1 - June 15	----	0.5

Notes:

- Soluble nitrogen rates of 0.25 pounds per 1,000 ft² or less which may be a component of a pesticide or minor element application may be applied any time the turf is actively growing, but must be considered with the total annual nitrogen application rate.
 - WSN = water soluble nitrogen; WIN = water insoluble nitrogen
- (a) Intensive managed areas must be irrigated.
- (b) The beginning and ending dates for application of nitrogen shall be determined using guidance and frost date maps contained in the preceding Season of Application for Nitrogen section, using Figures 6-1 and 6-2.
- (c) Rates up to 0.9 pounds per 1,000 ft² of total nitrogen can be applied using a material containing slowly available forms of nitrogen, with a minimum of 30 days between applications.
- (d) Make this application only if turf use warrants additional nitrogen for sustaining desirable growth and /or color.

Nitrogen Management on Athletic Fields - Warm Season Grasses

The following comments apply to both Naturally Occurring or Modified Sand based Fields and Predominantly Silt/Clay Soil Fields:

- Annual nitrogen rates for warm season grasses shall not exceed **4 pounds** in areas which have the average first killing frost on or before October 20, and shall not exceed **5 pounds** in areas which have the average first killing frost after October 20 as shown in Figure 6-1. Nitrogen rates and timings for overseeding warm season grasses are not included in these rates.
- April 15 - May 15 applications should not be made until after complete green-up of turf.
- Nitrogen applications June through August should be coordinated with anticipated rainfall if irrigation is not available.
- Use the lower end of the ranges for non-irrigated fields and the higher end of the ranges should be used on fields with irrigation.

- Nitrogen rates towards the higher end of the ranges may be applied on heavily used fields to accelerate recovery, however per application and annual rates cannot be exceeded.

Bermudagrass - Predominantly Silt/Clay Soil Fields ^a		
When to Apply^b	Pounds per 1,000 ft² Nitrogen^e	First Fall Killing Frost Date^b
April 15 - May 15	0.5- 0.7 ^(c)	Before Oct. 20
June	0.7	
July	0.5 – 0.7 ^(d)	
August	0.5 - 0.7 ^(d)	
Sept 1 - Sept 15	0.5 -0.7 ^(c)	After Oct. 20
If overseeded with perennial ryegrass		
Oct - Nov	0.5 ^(e)	
Feb-Mar	0.5 ^(e)	

Bermudagrass - Naturally Occurring or Modified Sand based Fields ^a		
When to Apply^b	Pounds per 1,000 ft² Nitrogen	First Fall Killing Frost Date^b
April 15 - May 15	0.5 -0.7 ^(c)	Before Oct. 20
June1	0.7 ^(c)	
July	0.7 ^(c)	
August	0.7 ^(c)	
Sept 1 - Sept 15	0.7 ^c	After Oct. 20
If overseeded with perennial ryegrass		
Oct - Nov	0.5 ^(e)	
Feb - Mar	0.5 ^(e)	

The following notes apply to both of the Bermudagrass tables above:

- (a) In the Piedmont and the Ridge and Valley areas of Virginia, the existing native soil will normally be comprised predominantly of clay and/or silt and these soils have inherently lower water infiltration and percolation rates and greater nutrient holding capacity. However, most areas of the Coastal Plain have existing native soils that are predominantly sandy textured soils and other facilities throughout the state may choose to install modified soil root zones that are predominantly sand (>50%) in order to maximize drainage and reduce compaction tendency. If subsurface drain tile surrounded by sand and/or gravel has been installed under the playing surface of any of these fields, their nitrogen programs should be managed as predominantly sand-based systems to minimize nutrient leaching.
- (b) The beginning and ending dates for application of nitrogen shall be determined using guidance and frost date maps contained in the Season of Application for Nitrogen section, Figures 6-1 and 6-2.
- (c) WSN must be applied as two applications not to exceed 0.35 pounds per 1,000 ft² each with a minimum of 15 days between applications. Alternatively, using a material that contains slowly available nitrogen sources, split applications of 0.5 pounds per 1,000 ft² may be applied with a minimum of 15 days between applications.

- (d) If a material containing slowly available forms of nitrogen is used, rates up to 1.0 pounds of nitrogen per 1,000 ft² may be applied in a single application with a minimum of 30 days between applications.
- (e) For overseeded warm season grasses, an additional 0.7 pounds per 1,000ft² of WSN may be applied in the Fall after the perennial ryegrass overseeding is well established. The WSN must be applied as two applications not to exceed 0.35 pounds per 1,000 ft² of nitrogen each, with a minimum of 15 days between applications. Additional WSN application of 0.5 pounds per 1,000 ft² may be made in February-March to overseeded perennial ryegrass if growth and color indicate need. Alternatively, split applications of 0.5 pounds of nitrogen per 1,000 ft² each with a minimum of 15 days between applications may be applied using a material containing slowly available nitrogen sources.

Phosphorus and Potassium Recommendations Athletic Fields

Apply phosphorus (P₂O₅) and potassium (K₂O) fertilizers as indicated by a soil test using the following guidelines:

<u>Soil Test Level</u>	<u>Nutrient Needs (pounds per 1,000 ft²)*</u>	
	<u>P₂O₅</u>	<u>K₂O</u>
L	2-3	2-3
M	1-2	1-2
H	0.5-1	0.5-1
VH	0	0

- * For the lower soil test level within a rating, use the higher side of the range and for higher soil test level within a rating use the lower side of the recommendation range.
- For irrigated turf grown on Naturally Occurring and Modified Sand Based soils only, up to 0.5 pounds of P₂O₅ per 1,000 ft² may be applied, if needed, to aid in recovery of damaged turf during times of extreme use. No phosphorus applications shall be made when the soil phosphorus test level is above 65% saturation, based on the soil test phosphorus values and region as listed in Table 4-1 of Section IV.
- Avoid the general use of high phosphorus ratio fertilizers such as 10-10-10 or 5-10-10, unless soil tests indicate phosphorus availability below the M+ level.

Establishment/Grow-In Recommendations for Golf Courses, Athletic Fields, and Sod Production

(These rates replace normal maintenance fertilizer applications that would have occurred during these time periods.)

Warm Season Grasses:

Predominantly Silt/Clay Soils

- ◆ Plant Date - late May -June for sprigs, plugs, sod, or seeding.
- ◆ Apply P_2O_5 and K_2O as needed based on soil test recommendations, incorporate into the top 2 inches if possible.
- ◆ At Planting - Up to 1.0 pounds of nitrogen per 1,000 ft² using a material containing slowly available forms of nitrogen may be applied as one application or lesser amounts applied at regular intervals, through the first 4 weeks, not to exceed a total of 1.0 pounds of nitrogen per 1,000ft².
- ◆ Four weeks after planting - 0.25 pounds.of WSN per 1,000 ft² per week for the next 4 weeks.

Naturally Occurring or Modified Sand Based Soils

- ◆ Plant Date - late May -June for sprigs, plugs, sod, or seeding.
- ◆ Apply P_2O_5 and K_2O as needed based on soil test recommendations, incorporate into the top 2 inches if possible.
- ◆ At Planting - Up to 1.0 pounds of nitrogen per 1,000 ft² using a material containing slowly available forms of nitrogen may be applied as one application or lesser amounts at regular intervals through the first 4 weeks, not to exceed a total of 1.0 pounds of nitrogen per 1,000 ft².
- ◆ Four weeks after planting - 0.25 pounds per1,000 ft² using a material containing slowly available forms of nitrogen per week for the next 4 weeks.

Cool Season Grasses:

Predominantly Silt/Clay Soils

- ◆ Plant Date - August - September (preferred)
- ◆ Apply P_2O_5 and K_2O as needed based on soil test recommendations, incorporate into the top 2 inches if possible.
- ◆ At Planting - up to 0.9 pounds of nitrogen per 1,000 ft² using a material containing slowly available forms of nitrogen may be applied; 30 days after planting, apply up to 0.5 pounds of nitrogen per 1,000 ft² every week for the next 4 weeks.

Naturally Occurring or Modified Sand Based Soils

- ◆ Plant Date - August -September (preferred)
- ◆ Apply P_2O_5 and K_2O as needed based on soil test recommendations, incorporate into the top 2 inches if possible.
- ◆ At Planting - up to 0.9 pounds of nitrogen per 1,000 ft² using a material containing slowly available forms of nitrogen may be applied.
- ◆ Apply up to 0.25 pounds of nitrogen per 1,000 ft² per week after germination is complete, for the next 8 weeks. If using a material that contains slowly available forms of nitrogen, up to 0.5 pounds of nitrogen per 1,000 ft² every two weeks may be applied after germination is complete for the next 8 weeks.

Sod Installations:

Site preparation should include a soil test, which can be done several months before the project begins in order to have time to get test results back. Phosphorus, potassium and lime applications should be based on soil test analysis to increase the likelihood of a successful installation. Shallow incorporation of material into the top 2 inches of the soil is preferred prior to sod installation, especially if lime is required.

No more than 0.7 pounds of nitrogen per 1,000 ft² of WSN may be applied before sod is installed. Alternatively, using a material with slowly available forms of nitrogen, 0.9 pounds of nitrogen per 1,000 ft² for cool season grasses or 1.0 pounds of nitrogen per 1,000 ft² for warm season grasses may be applied before sod is installed.

After installation apply adequate amounts of water to maintain sufficient soil moisture (i.e. to prevent visible wilt symptoms). Excessive water will limit initial root development. After roots begin to establish (as verified by lightly tugging on the sod pieces), shift irrigation strategy to a deep and infrequent program in order to encourage deep root growth. Apply approximately 1 inch of water per week (either by rainfall or irrigation), making sure that the water is being accepted by the soil profile without running off. This will insure thorough wetting of the soil profile.

After sod has completed rooting and is well established, initiate the normal nitrogen management program as described for the appropriate use shall be recommended.

Phosphorus and Potassium Recommendations for Establishment/Grow-In/Installation

<u>Soil Test Level</u>	<u>Nutrient Needs (pounds per</u>	
	<u>1,000 ft²)*</u>	
	<u>P₂O₅</u>	<u>K₂O</u>
L	3-4	2-3
M	2-3	1-2
H	2-1	0.5-1
VH	0	0

* For the lower soil test level within a rating, use the higher side of the range and for higher soil test level within a rating use the lower side of the recommendation range.

Other Turf Management Considerations for Golf Courses, Athletic fields, and Home Lawns

Lime Recommendations

Lime should be recommended based on a soil test to maintain soil pH within an agronomic range for turfgrass.

For new seedings where lime is recommended, incorporate the lime into the topsoil for best results.

Returning Grass Clippings

Recycling of clippings on turf should be encouraged as an effective means of recycling nitrogen, phosphorus, and potassium. Proper mowing practices that ensure no more than 1/3 of the leaf blade is removed in any cutting event will enhance turf appearance and performance when clippings are returned. Return all leaf clippings from mowing events to the turf rather than discharging them onto sidewalks or streets. Rotary mulching mowers can further enhance clipping recycling by reducing the size of clippings being returned to the turfgrass canopy.

Management of Collected Clippings

If clippings are collected they should be disposed of properly. They may be composted or spread uniformly as a thin layer over other turf areas or areas where the nutrient content of the clippings can be recycled through actively growing plants. They should not be blown onto impervious surfaces or surface waters, dumped down stormwater drains, or piled outside where rainwater will leach out the nutrients creating the potential for nutrient loss to the environment.

Use of Iron

Iron applications (particularly foliar applications) may periodically be used for enhanced greening as an alternative to nitrogen. These applications are most beneficial if applied in late spring through summer for cool season grasses and in late summer/fall applications for warm-season grasses.

Impervious Surfaces

Do not apply fertilizers containing nitrogen or phosphorus to impervious surfaces (sidewalks, streets, etc.). Remove any granular materials that land on impervious surfaces by sweeping and collecting, and either put the collected material back in the bag, or spread it onto the turf and /or using a leaf blower etc. to return the fertilizer back to the turfgrass canopy.

Table 3-1
Lime Recommendations for Virginia Crops (tons/acre)
 Lime Rates based on Va Tech Soil buffer pH

Buffer pH	Target Soil pH					Acidity meq/100g
	5.2	5.8	6.2	6.5	6.8	
6.60	0.00	0.00	0.00	0.00	0.00	0.00
6.50	0.00	0.00	0.00	0.00	0.00	0.03
6.40	0.00	0.00	0.00	0.00	0.50	0.06
6.38	0.00	0.00	0.25	0.25	0.50	0.12
6.36	0.00	0.00	0.25	0.25	0.75	0.24
6.34	0.00	0.00	0.25	0.50	0.75	0.36
6.32	0.00	0.00	0.50	0.50	0.75	0.48
6.30	0.00	0.00	0.50	0.75	1.00	0.59
6.28	0.00	0.25	0.75	0.75	1.00	0.71
6.26	0.00	0.25	0.75	1.00	1.25	0.83
6.24	0.00	0.25	0.75	1.00	1.25	0.95
6.22	0.00	0.50	1.00	1.00	1.50	1.07
6.20	0.00	0.50	1.00	1.25	1.50	1.19
6.18	0.00	0.75	1.25	1.25	1.75	1.30
6.16	0.00	0.75	1.25	1.50	1.75	1.42
6.14	0.25	0.75	1.50	1.50	2.00	1.54
6.12	0.25	1.00	1.50	1.75	2.00	1.66
6.10	0.50	1.00	1.50	1.75	2.25	1.78
6.08	0.50	1.25	1.75	2.00	2.25	1.90
6.06	0.50	1.25	1.75	2.00	2.25	2.02
6.04	0.75	1.25	2.00	2.00	2.50	2.13
6.02	0.75	1.50	2.00	2.25	2.50	2.25
6.00	1.00	1.50	2.00	2.25	2.75	2.37
5.95	1.00	1.75	2.25	2.50	3.00	2.67
5.90	1.25	2.00	2.50	3.00	3.25	2.96
5.85	1.50	2.25	2.75	3.25	3.50	3.26
5.80	1.75	2.50	3.25	3.50	3.75	3.56
5.75	2.00	2.75	3.50	3.75	4.25	3.85
5.70	2.25	3.00	3.75	4.00	4.50	4.15
5.65	2.50	3.25	4.00	4.25	4.75	4.45
5.60	2.75	3.50	4.25	4.50	5.00	4.74
5.55	3.00	3.75	4.50	4.75	5.25	5.04
5.50	3.25	4.00	4.75	5.25	5.50	5.34
5.40	3.75	4.50	5.25	5.75	6.25	5.93
5.30	4.25	5.00	5.75	6.25	6.75	6.52

Lime recommendations in the table above are based on the use of a liming material equivalent in neutralizing power to 100% CaCO₃. For application rates of liming material that is less than 100% neutralizing power of CaCO₃ (pure calcium carbonate) use the table in this section, Lime Rate Adjustment for CCE.

Lime Recommendations Using Other Testing Labs

For approved labs other than Virginia Tech, use the lime recommendations given by the lab. IF there are no recommendations with the soil analysis, use the table below for A&L Agricultural, Spectrum Analytical, and Brookside Laboratories.

Table 3-2
Lime Application Rate¹ (tons/acre) to achieve desired pH based on SMP Buffer Test

Soil-Buffer pH	Target Soil pH				
	5.2	5.8	6.2	6.5	6.8
6.9	0	0.25	0.50	0.50	0.75
6.8	0.50	0.75	1.00	1.00	1.25
6.7	1.00	1.50	1.50	1.75	2.00
6.6	1.50	1.75	2.00	2.25	2.50
6.5	2.00	2.25	2.50	3.00	3.25
6.4	2.75	3.00	3.25	3.75	4.00
6.3	3.25	3.50	4.00	4.50	5.00

¹ Ag-ground lime of 90% plus total neutralizing power (TNP) or CaCO₃ equivalent., and fineness of 40% < 100 mesh, 50% < 60 mesh, 70% < 20 mesh and 95% < 8 mesh. Adjustments in the application rate should be made for liming materials with different particle sizes, or neutralizing value.

Waters Agricultural Laboratories uses the Adams and Evans single buffer method which uses a different table for recommendations than the Mehlich or the SMP tables supplied here. In the event you would have lab reports from Waters Lab, which do not have lime recommendations, contact the lab for recommendations based on their analysis procedure.

Lime Rate Adjustment for CCE

Using the lime application rate to achieve the desired target pH based on the soil test buffer pH, use the table below to adjust that rate based on the % CCE of the liming material to be applied.

Table 3-3
Lime Application Rate Adjustment Based on % CCE of Material

T/ac*	% CCE of Your Liming Material										
	50	60	70	80	90	100	110	120	130	140	150
0.5	1.00	0.75	0.75	0.75	0.50	0.50	0.50	0.50	0.50	0.25	0.25
1.0	2.00	1.75	1.50	1.25	1.00	1.00	1.00	0.75	0.75	0.75	0.75
1.5	3.00	2.50	2.25	2.00	1.75	1.50	1.25	1.25	1.25	1.00	1.00
2.0	4.00	3.25	2.75	2.50	2.25	2.00	1.75	1.75	1.50	1.50	1.25
2.5	5.00	4.25	3.50	3.25	2.75	2.50	2.25	2.00	2.00	1.75	1.75
3.0	6.00	5.00	4.25	3.75	3.25	3.00	2.75	2.50	2.25	2.25	2.00
3.5	7.00	5.75	5.00	4.50	4.00	3.50	3.25	3.00	2.75	2.50	2.25
4.0	8.00	6.75	5.75	5.00	4.50	4.00	3.75	3.25	3.00	2.75	2.75

* Lime recommendation to adjust pH as determined from soil test analysis.

17. Fertilizer Labels

16-3-8 50%XCU 20%Biosolids 15%AS 2%Fe 0.2%B 0.5%Zn Mn Mg Cu

GUARANTEED ANALYSIS

Total Nitrogen (N) 16.00%
3.90% Urea Nitrogen*
3.2% Ammoniacal Nitrogen
0.80% Water Insoluble Nitrogen
8.10% Slowly Available Water Soluble Nitrogen

Available Phosphate (P₂O₅)3.00%

Soluble Potash (K₂O) 8.00%

Iron (Fe)..... 2.00%

Derived From: *8.00% slow release nitrogen derived from XCU

CONTAINS: EXCEPTIONAL QUALITY BIOSOLIDS

THIS FERTILIZER IS INTENDED ONLY FOR NONAGRICULTURAL

USE ON (A) TURF DURING IT'S FIRST GROWING SEASON (B) TURF BEING
RENOVATED OR REPAIRED (C) OR WHERE A SOIL TEST INDICATES A
PHOSPHOROUS DEFICIENCY

Net Weight 50 lbs (22.70 kg)

APPLY ONLY AS DIRECTED

MFG FOR LANDSCAPE SUPPLY, INC Roanoke, Va. 24016

By TIMAC USA, INC. Reading, Pa.

organicsPLUS

12-3-12 20% XRT 35% NB

Guaranteed Analysis

Total Nitrogen (N):	12%
Urea Nitrogen:	7.35%
XRT Controlled Nitrogen:	2.4%
Water Insoluble Nitrogen:	1.4%
Water Soluble Nitrogen:	0.35%
Ammoniacal Nitrogen:	0.5%
Available Phosphate (P205):	3%
Soluble Potash (K20):	12%

Manufactured for

18. Soil Test Results

See attached file