Drainage Solutions

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Prince George's County Department of Parks and Recreation

PALS - Partnership for Action Learning in Sustainability
An initiative of the National Center for Smart Growth

Table of Contents

Introduction

The purpose of this document is to provide a drainage plan for the Prince George's County Department of Parks and Recreation that establishes the purpose and reasoning for implementing new drainage technologies that use the most cost-effective treatment options.

This report is based on drainage analysis tests performed at two County golf courses—Paint Branch Golf Complex, a nine-hole, par 33 course and practice facility, and Enterprise Golf Course, an 18-hole facility, par 72 championship course.

This report and proposal contains:

- a site analysis of each golf course
- initial findings in our visits
- the analysis and results of two separate soil tests
- a list of the most effective and available drainage options
- the recommended drainage option.

Background and Objectives

By working with PALS and Prince George's County Parks, this project was designed to assess drainage issues on the greens at Paint Branch Golf Complex and Enterprise Golf Course. These recommendations are intended to yield improved infiltration rates, benefit root growth to improve playability, and be relatively budget-conscious.

The Paint Branch course at the Paint Branch Golf Complex in College Park features 2,035 yards of golf from the longest tees for a Par of 33. The course rating is 60.4 and it has a slope rating of 94. It was designed by Edmund B. Ault, ASGCA, and was opened in 1964.

The Enterprise Golf Course was built in 1976 by architects Robert Elder and Bill Love. It is located in Mitchellville, Maryland, on the grounds of the historic Newton White Mansion. Enterprise is an 18-hole course featuring 6,750 yards of rolling fairways. The course has a slope of 120 and a rating of 71.5.

Many golf courses experience issues with drainage throughout their lifetime. In many instances the native soils in Maryland can be particularly heavy in their clay content which impedes the water infiltration rate. It is not uncommon for "push-up" greens constructed decades ago to suffer from some form of drainage issue. The Paint Branch Golf Complex is also located on a flood plain, which gives it a propensity to episodes of water damage.

This project's major objective is to provide an understanding of the drainage problems associated with specific greens on the courses and apply that information to arrive at solutions specific to the needs of the Paint Branch and Enterprise courses. To meet this objective, site visits were made to Paint Branch and

Enterprise to conduct a variety of tests, including bulk density measurements, soil infiltrometer readings, and traditional soil nutrient tests.

To gain better insight into the Paint Branch course we met with Superintendent Ben Ellis to discuss drainage-related issues. One of his goals is to keep the water in the soil profile where it's needed, and at the same time allow it to drain in a timely fashion where it isn't needed. It's a task made more difficult given the course's location on a flood plain. Ellis shared photographs of various greens and fairway locations where water would sit; he also joined field visits to identify the most problematic greens.

Paint Branch Site Analysis

Conditions

Paint Branch Golf Complex is located in College Park, Maryland. Neighboring properties are wooded areas and the University of Maryland Paint Branch Turfgrass Research facility. These surrounding areas give the course a secluded feel.

According to the USDA's National Cooperative Soil Survey,[1] the Paint Branch Golf Complex sits on CF soil. The description of this soil identifies the key problem identified in site visits—the area is poorly drained. A golf course water management goal is to keep the water where it's needed, while draining it away from where it isn't needed. This it made more difficult when the soil is poorly drained, receives 44 inches of annual precipitation, and has a compacted soil profile beneath the root zone. In this case, the drainage goal would be to keep adequate water in the rootzone to maintain healthy turf stands, while actively moving unneeded water away from playing areas.

The first site visit reviewed the site and its problems, conveyed by management. There were signs of poor drainage in certain areas, annual bluegrass weevil damage, heavy compaction within the soil profile, lack of an organic matter layer on the greens, and maintenance practices that amounted to less than ideal greens conditions.

Ellis indicated that not all damage is drainage related, but the most is. Another issue are the impacts of severe drought in the latter half of the previous summer, made worse by the course's minimal irrigation system. The parts of the system that do work are inadequate to irrigate the course.

The site visit also revealed sand build-up in the rootzone from past aerifications. The top 2 ½ to 3 inches were primarily coarse sand, almost appearing to be sand-capped. Aeration with a light, fine sand topdressing is recommended as a short-term solution for wet conditions. The sand found in these greens is a granular size too large for a topdressing.

Findings

The water movement problems at Paint Branch result from the combination of coarse sand atop a compacted clay, which forms a perched water table. Water drains quickly through the top layer of sand, but once through the sand, it settles on the almost impermeable, compacted clay layer about an inch below the root zone. This water pools on the clay, creating the perched water table beneath the putting green. This is usually problematic and can contribute to Pythium root rot and wet wilt because of poor subsurface drainage. However, since the drought-like conditions in late summer 2019, the perched water table helped the greens by providing a water source to the roots by adhesion of water and sand. This can be a benefit in very dry situations, but under normal rainfall conditions and adequate irrigation, this poor subsurface drainage will encourage puddling on the surface, thus increasing disease pressure.

Currently, Paint Branch has little to no drainage on its putting greens. The course depends on the slope of the greens and the soil profile to carry water away from high traffic areas, with the hope that the soil dries out before play damages the grass. Slope and soil profile are two important drainage factors but adding drain lines to low areas would greatly improve the greens. Added drain lines would allow the course to accommodate more rounds per year, alleviate some of the stress on the greens, and provide better playability for golfers.

Enterprise Site Analysis

Conditions

Enterprise Golf Course in Mitchellville, MD, opened in 1976 on a historic property that was formerly the Newton White dairy farm. The drive into the property maintains the aura of the historic setting, and the approach to the clubhouse offers views of the short-game practice area and the course's rolling terrain. The tree-edged property hides surrounding roads and traffic.

As at Paint Branch, Enterprise rests on predominantly clay-based soil, which poses challenging obstacles for golf course operations and maintenance. For instance, heavy clay content will hold more water in films around the clay particles than a sandier soil, which usually leads to a more saturated profile. Clay soils also risk of heavy compaction over time. The combination of mechanical and foot traffic can compress the small clay particles and alter the soil structure. Compaction is detrimental to growing and playing conditions as the soil loses pore space for oxygen.

In conversations with Matt Burroughs, Enterprise's Superintendent, suggested evaluations on greens 2, 5, and 12—the ones with the most drainage problems. The bulk density test of the soil's dry weight was used to determine the amount of pore space, which relates to the soil's drainage ability. The double ring infiltrometer measures the rate at which water infiltrates through a given area, providing data on the time required for water to pass through the soil.

Findings

Testing indicated that the relative infiltration rates of the sampled greens are poor. The site survey showed a layer of coarse sand—about 5 inches deep on the tested greens. There is also a substantial amount of thatch buildup beneath the canopy of the greens. Most of the drainage issues on these greens could be connected to the incompatibility between the texture and shape of sand used in previous topdressing/aerification practices.

This could also be the case on green 12, where the slowest infiltrometer reading was taken. It was apparent that there was some sodding at the back of the green. Sodding was done to repair damage from heavily saturated soil, which encouraged wet wilt. As the soil becomes saturated due to ineffective drainage, the turfgrass roots are starved of oxygen. These anaerobic soil conditions, combined with high temperatures and high light conditions, can decimate a stand of turfgrass.

Materials and Methods

A series of tests were conducted to better characterize the infiltration characteristics of the greens. The first, a bulk density test, measures the volumetric weight of soil samples of a specific size plug from the testing area. After allowing adequate time for the samples to dry, scales recorded the soil weight. Measuring the weight determines how compact the soil is; a higher weight means more soil particles per area, which is not a good where pore space is critical to water infiltration. Using test cylinders with a cubic volume of 86.7 g/cm3, two samples were taken from each of three greens from Paint Branch and three greens from Enterprise. Table 1 details the findings of the bulk density test.

Table 1.

Bulk Density				
Paint Branch				
Green	Location	Dry Weight (Grams)	Bulk Density (g/cm3)	Average Bulk Density (g/cm3)
Hole Six	Back	127.29	1.47	1.42
	Front	118.18	1.36	
Hole Three	Back Center	119.42	1.38	1.37
	Back Left	118.18	1.36	
Hole Eight	Back	125.14	1.44	1.47
	Front	129.43	1.49	
Enterprise				
Hole Two	Back	106.62	1.23	1.22
	Front	104.73	1.21	
Hole Five	Back	121.34	1.40	1.33
	Front	109.09	1.26	
Hole Twelve	Back	118.96	1.37	1.29
	Front	103.87	1.20	
Comments				
Bulk density (g/cm3) = Dry soil weight (g) / Soil volume (cm3)				
Cumbic Volume of Soil Samples:				86.7
Number of Plugs:				12
Comments: Plugs air dried; mechanical drying process showed little difference in readings on the scale				

The second test was a water infiltration test. The methodology uses a double ring infiltrometer, which measures the soil's drainage capabilities by timing the water's infiltration into the soil in real time. In ten-minute intervals, the inner ring, then the outer ring was filled with water, measuring how deep the water was able to infiltrate, a calculation of infiltration per hour (see Table 2).

Table 2.

Infiltration Rate				
Paint Branch				
Green	Infiltration (Inches)	Iniltration/Hour	Mean Infiltration	Comments
Hole 3	2.357	14.14	13.71	Infiltration measured in increments of ten minutes per green using double ring infiltrometer.
Hole 6	1.25	7.50		
Hole 8	3.25	19.50		
Enterprise				
Hole 2	0.5	3.00	1.25	Infiltration on #12 did not move appriciateively. Significant drainage issues.
Hole 5	0.125	0.75		
Hole 12	0.00	0.00		

Discussion of Options

Installations to improve putting green drainage include Existing Greens Drainage (XGD), Sand Channel Drainage, and Passive Capillary Drainage (PC).

XGD involves the installation of piping (typically two-inch) in an existing green at a set spacing. It requires removing sod from the green, digging the trenches at a given spacing (typically three feet on center), backfilling the trench, and replacing the sod. When backfilling, a typical putting green mix of 6-1-2 (six parts sand, one part peat, two parts soil) is used. Water on greens drains through the sand to the pipes and then out to a main drainage pipe. Mixing soil and peat into sand protects against the mix draining "too well" and being too droughty, posing management problems during the summer.

This method of drainage is considered the most effective way to improve drainage on an existing green short of a full renovation. When done professionally, it can be completed in a few days with the course open for play almost immediately after completion. While this is the most effective method, it is also the most expensive.

Sand channel drainage involves cutting slits out of greens and backfilling them with the 6-1-2 putting green mix. The slits are at most, 9-inches deep. The backfilled slits allow water to drain more easily through the soil and eventually to existing drain lines. These lines are typically spaced 10-inches apart. The result reduces surface water between existing drainage. This renovation can be undertaken by the grounds crew during the offseason or done professionally. Using a professional it will be more expensive but can help ensure the work is done correctly and quickly.

Passive capillary action is a relatively untried method that hasn't been widely used. Rope is installed in trenches set into the greens creating a path for the water. The process uses capillary action; water will flow through a medium (the rope) against the flow of gravity using intermolecular forces. This is often illustrated in chemistry by connecting two beakers next to with a paper towel. One beaker is full and over time, the water travels through the paper towel, against gravity, into the other beaker. The same concept is used in this drainage system. The water comes through the sand, to the rope, and then flows to a catch basin where it meets the main drainage lines. The trenches are set in a tight 3-foot spacing.

Based on budget and practicality, sand channel drainage appears to be the best option for Paint Branch's problematic greens. This installation would provide the necessary drainage but also not be too expensive or tedious for the small, in-house crew. The work could also be completed as needed; it wouldn't have to be installed on all the greens and can be undertaken year-to-year when problems arise. Based on the tested three greens, this is a viable solution for the major drainage issues.

Conclusion

Though XGD drainage would be the ideal option, Sand Channel Drainage is a more cost-efficient option and will support better greens by reducing the negative effects of poor drainage, such as scalding. Undertaking this type of project during the growing season is not ideal, but as a long-term investment, it's the best available option. This study's goal was to review the best options available, and so the others are included for comparison and consideration.

Improper or ineffective drainage will lead to a significant loss in turfgrass over the growing season or wet season. Those negative effects can be reduced and ultimately negated with the proposed drainage solution. Implementing Sand Channel Drainage will stabilize the greens' soil hydrology and meet expectations for summer time operations.

Appendix

Paint Branch Greens Area	
Green	Area (sqft)
Hole 1	4448.72
Hole 2	3792.07
Hole 3	4214.58
Hole 4	3799.12
Hole 5	3586.88
Hole 6	3246.99
Hole 7	3315.18
Hole 8	2996.70
Hole 9	3690.02
Putting Green	6787.98
Total in sqft	39878.24
Total in Acres	0.92

Paint Branch Golf Course

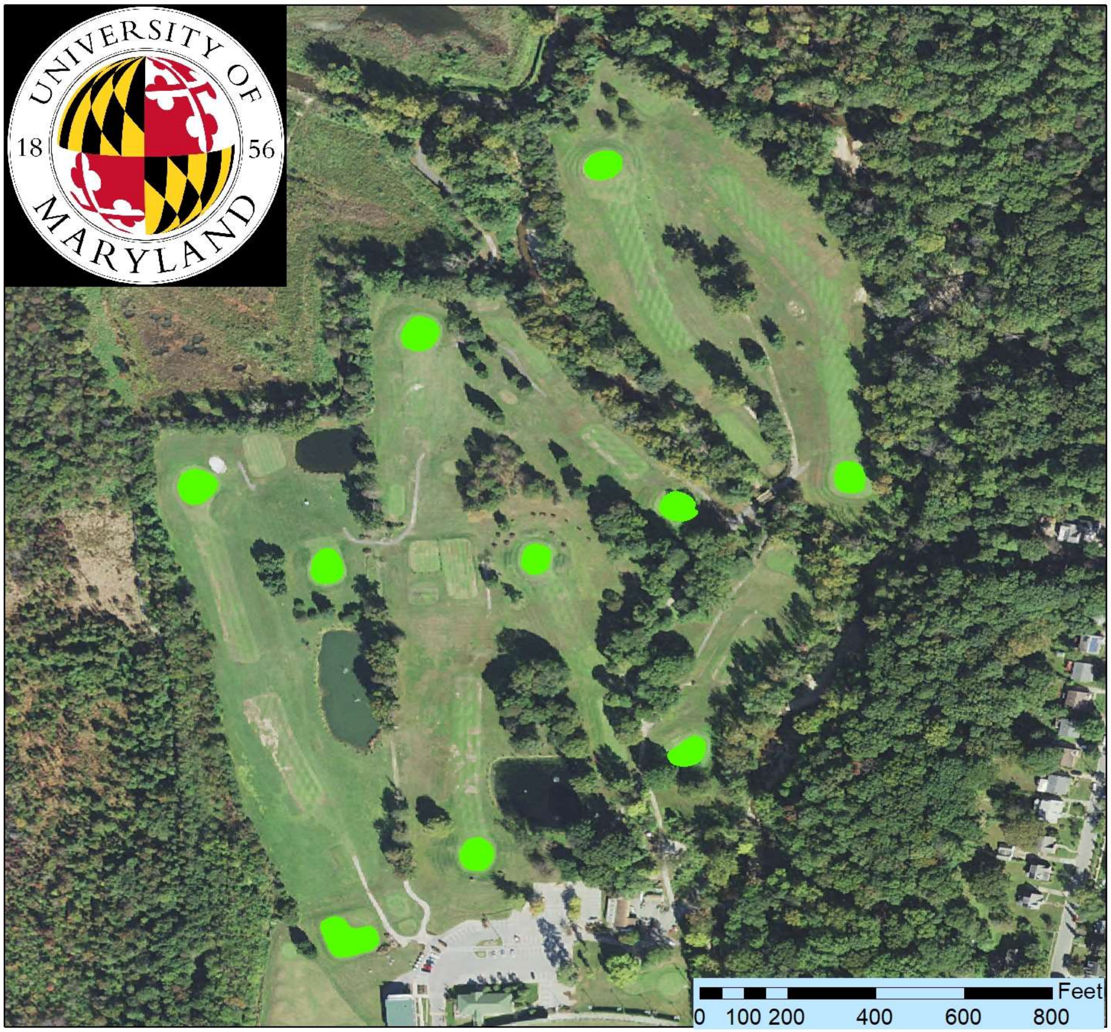

Image courtesy of:
GeoSpatial Data Gateway
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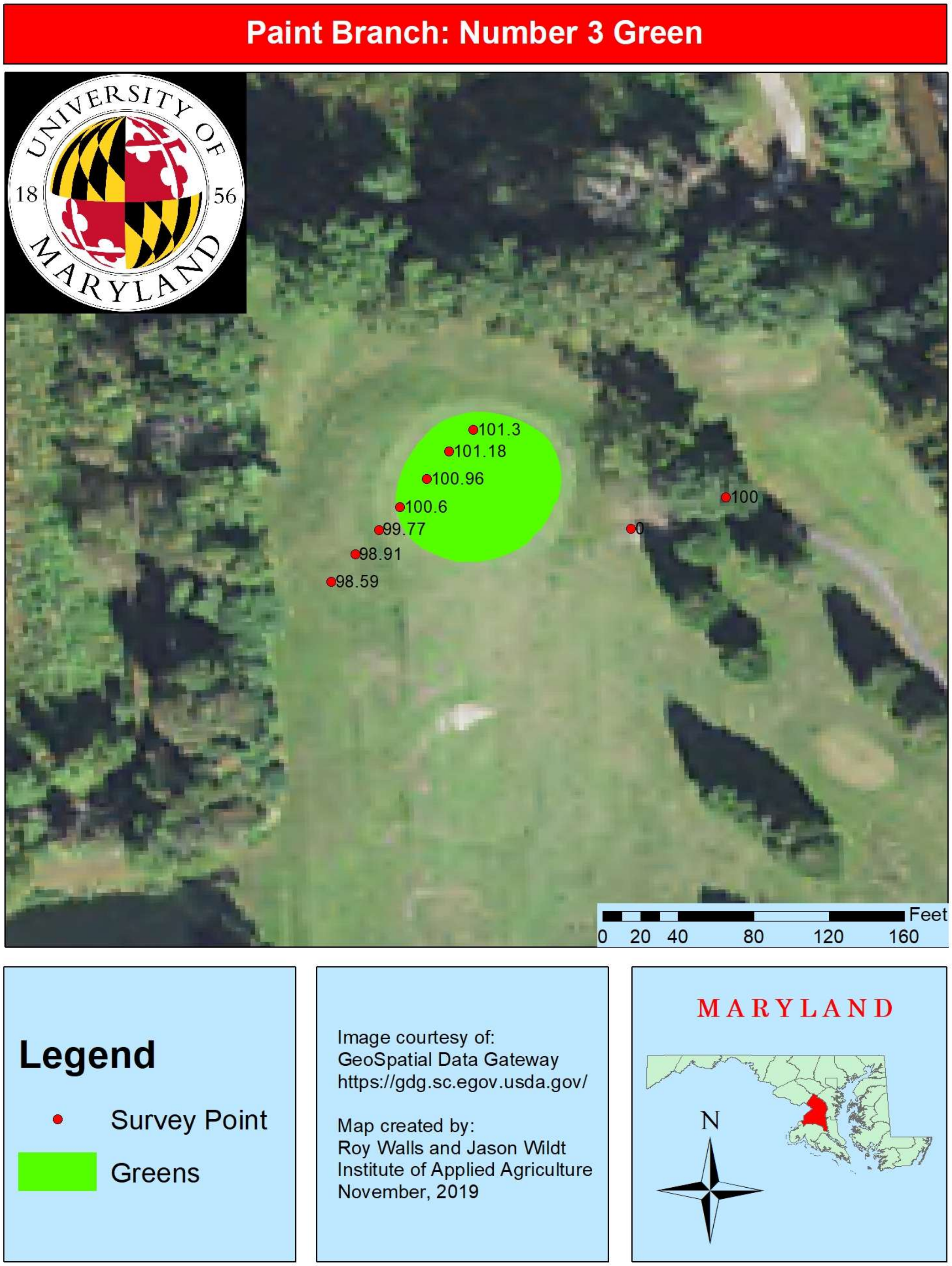
Map created by:
Roy Walls and Jason Wildt
Institute of Applied Agriculture
November, 2019


Paint Branch: Number 3 Green
UNIVERSITY OF MARYLAND
18 56
101.3
101.18
100.96
100.6
99.77
98.91
98.59
0
100
Feet
0 20 40 80 120 160
Legend
Survey Point
Greens
Image courtesy of:
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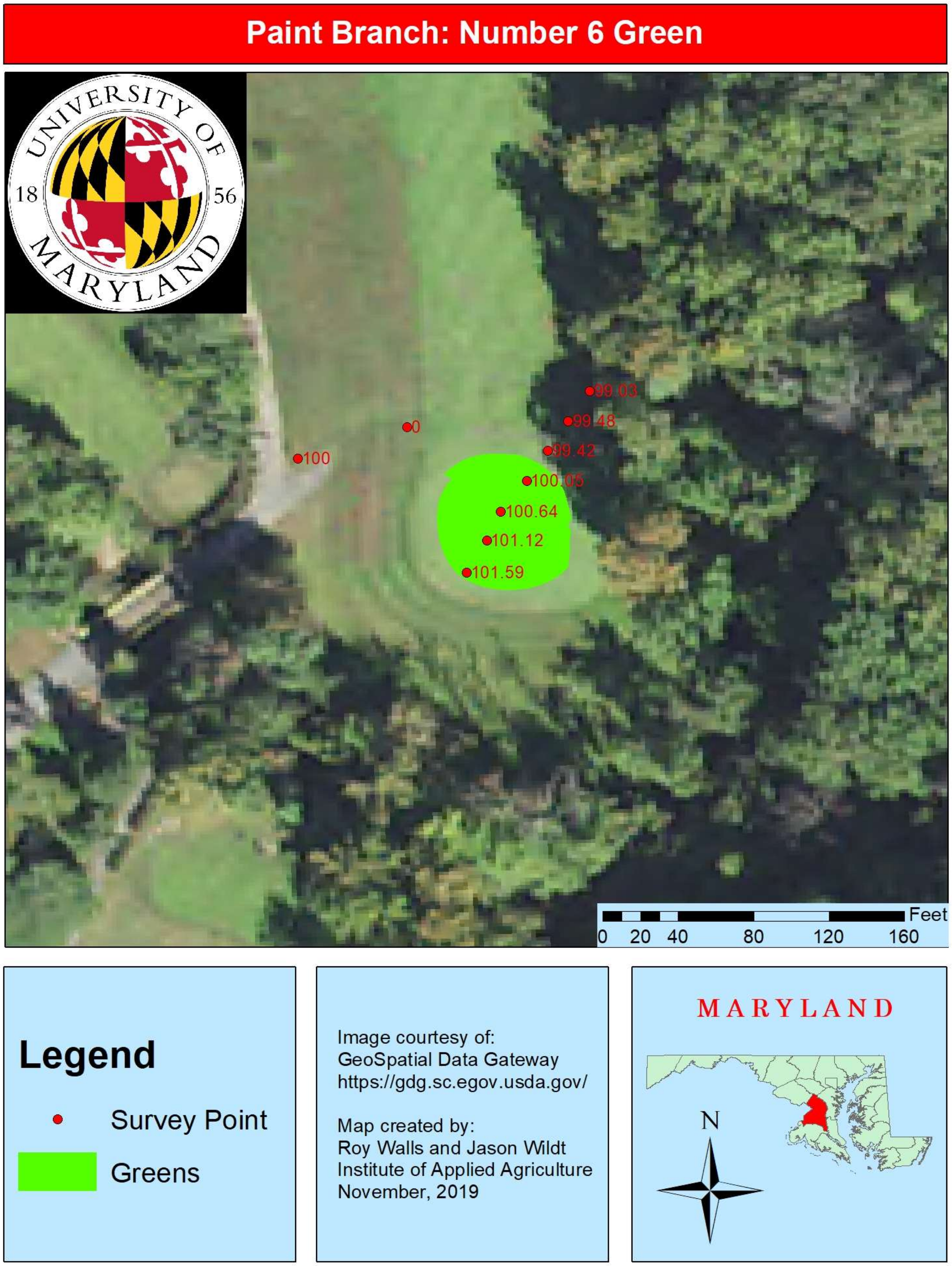
N

Paint Branch Hole 3 Elevation and Slope				
1	2	3	4	5
				Elev
STA	BS	HI	FS	Profile
BM	3.28			100.00
		103.28		
0+00			1.98	101.30
0+18			2.10	101.18
0+36			2.32	100.96
0+54			2.68	100.60
0+72			3.51	99.77
0+90			4.37	98.91
1+08			4.69	98.59
BM			3.28	
Existing Slope		0.0251	3%	


Paint Branch: Number 6 Green
UNIVERSITY OF MARYLAND
18
56
0
100
99.03
99.48
99.42
100.05
100.64
101.12
101.59
Feet
0 20 40 80 120 160
Legend
Survey Point
Greens
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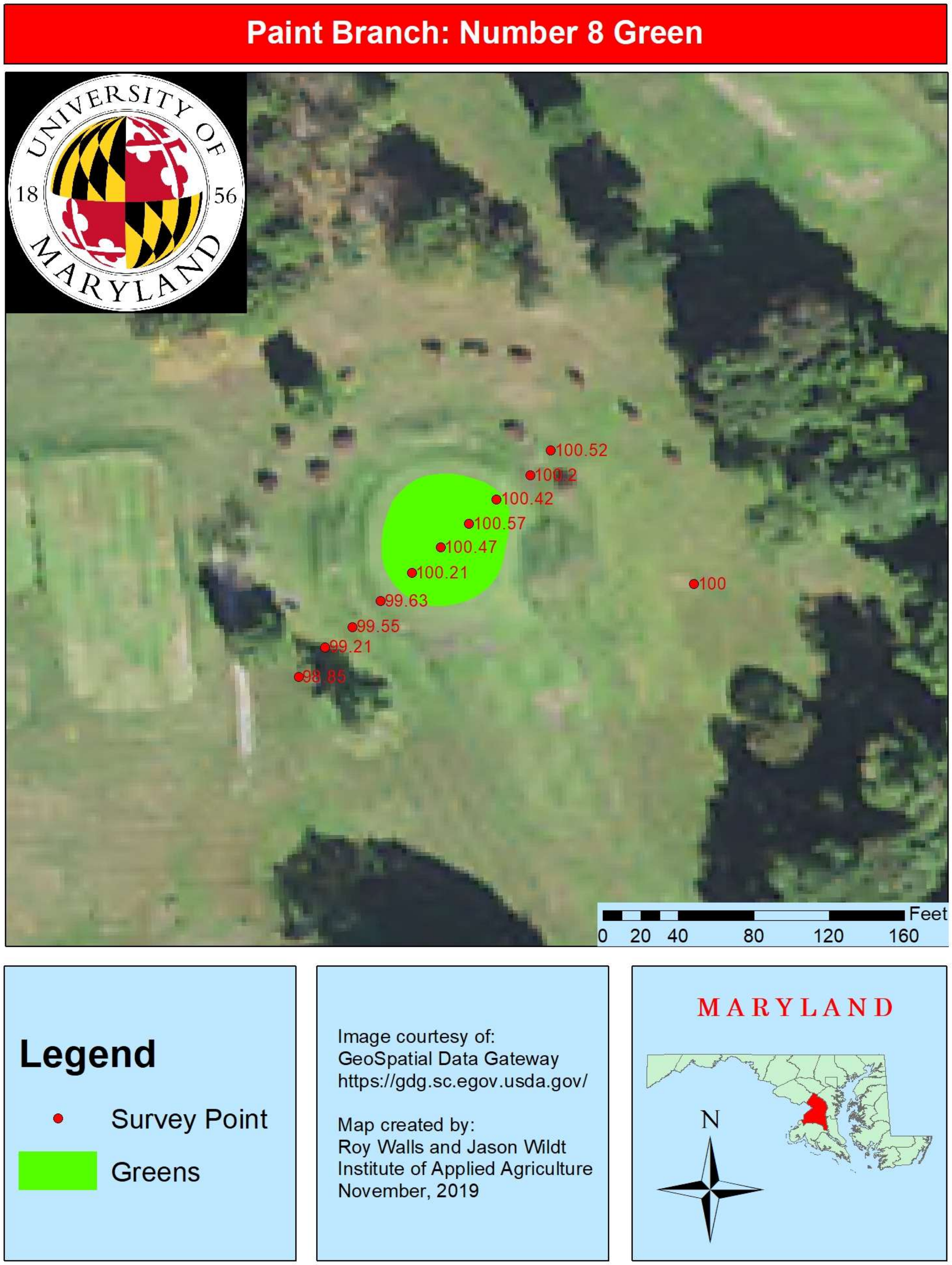
Paint Branch Hole 6 Elevation and Slope				
1	2	3	4	5
				Elev
STA	BS	HI	FS	Profile
BM	4.43			100.00
		104.43		
0+00			2.84	101.59
0+18			3.31	101.12
0+36			3.79	100.64
0+54			4.38	100.05
0+72			5.01	99.42
0+90			4.95	99.48
1+08			5.40	99.03
BM			4.43	
Existing Slope		0.023704	2%	


Paint Branch: Number 8 Green
UNIVERSITY OF MARYLAND
18 56
100.52
100.2
100.42
100.57
100.47
100.21
100
99.63
99.55
99.21
98.85
Feet
0 20 40 80 120 160
Legend
Survey Point
Greens
Image courtesy of:
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Paint Branch Hole 8 Elevation and Slope				
1	2	3	4	5
				Elev
STA	BS	HI	FS	Profile
BM	4.32			100.00
		104.32		
0+00			3.80	100.52
0+18			4.12	100.20
0+36			3.90	100.42
0+54			3.75	100.57
0+72			3.85	100.47
0+90			4.11	100.21
1+08			4.69	99.63
1+26			4.77	99.55
1+44			5.11	99.21
1+62			5.47	98.85
BM			4.32	
Existing Slope		0.01031	1%	

Page 1 of 3
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Grower: Geoffrey Rinehart

SOIL ANALYSIS REPORT

Analytical Method(s): SMP Buffer pH Mehlich 3 Loss On Ignition Water pH

Date Received: 11/20/2019 **Date Of Analysis:** 11/21/2019 **Date Of Report:** 11/21/2019

Sample ID Field ID	Lab Number	OM % Rate	W/V Soil Class	ENR lbs/A	Phosphorus M3 ppm Rate	Phosphorus ppm Rate	Phosphorus ppm Rate	Potassium K ppm Rate	Magnesium Mg ppm Rate	Calcium Ca ppm Rate	Sodium Na ppm Rate	pH Soil pH	pH Buffer Index	Acidity H meq/100g	C.E.C meq/100g
ENGrn2	14518	3.2 M		107	130 VH MD = 144			107 H MD = 68	74 M MD = 59	561 M MD = 44		5.8	6.84	0.9	4.6
ENGrn5	14519	3.0 M		100	120 VH MD = 133			88 L MD = 55	118 M MD = 92	1018 H MD = 102		6.6		0.4	6.7
ENGrn12	14521	2.4 L		91	136 VH MD = 150			146 H MD = 93	77 M MD = 61	536 M MD = 41		5.4	6.78	1.5	5.2
PBGrn3	14522	1.8 L		78	39 M MD = 45			102 M MD = 64	105 H MD = 83	758 H MD = 69		6.4		0.5	5.4
PBGrn8	14523	1.8 L		79	32 M MD = 37			96 M MD = 60	104 H MD = 82	773 H MD = 71		6.7		0.2	5.2

Sample ID Field ID	Percent Base Saturation K %	Mg %	Ca %	Na %	H %	Nitrate NO_3N ppm Rate	Sulfur S ppm Rate	Zinc Zn ppm Rate	Manganese Mn ppm Rate	Iron Fe ppm Rate	Copper Cu ppm Rate	Boron B ppm Rate	Soluble Salts SS ms/cm Rate		
ENGrn2	6.0	13.4	61.0		19.6										
ENGrn5	3.4	14.7	76.0		6.0										
ENGrn12	7.2	12.3	51.5		28.8										
PBGrn3	4.8	16.2	70.2		9.3										
PBGrn8	4.7	16.7	74.3		3.8										

Values on this report represent the plant available nutrients in the soil. Rating after each value: VL (Very Low), L (Low), M (Medium), H (High), VH (Very High). ENR - Estimated Nitrogen Release. C.E.C. - Cation Exchange Capacity.

Explanation of symbols: % (percent), ppm (parts per million), lbs/A (pounds per acre), ms/cm (milli-mhos per centimeter), meq/100g (milli-equivalent per 100 grams). Conversions: ppm x 2 = lbs/A, Soluble Salts ms/cm x 640 = ppm.

This report applies to sample(s) tested. Samples are retained a maximum of thirty days after testing.

Analysis prepared by: Waypoint Analytical Virginia, Inc.

by: Pauric McGroary

Pauric McGroary

Page 3 of 3
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PBGrn6	14524	2.0 L		83	30 L MD = 35			108 H MD = 68	110 H MD = 86	709 H MD = 63		6.9		0.1	4.8

Sample ID Field ID	Percent Base Saturation K %	Mg %	Ca %	Na %	H %	Nitrate NO_3N ppm Rate	Sulfur S ppm Rate	Zinc Zn ppm Rate	Manganese Mn ppm Rate	Iron Fe ppm Rate	Copper Cu ppm Rate	Boron B ppm Rate	Soluble Salts SS ms/cm Rate		
PBGrn6	5.8	19.1	73.9		2.1										

Values on this report represent the plant available nutrients in the soil. Rating after each value: VL (Very Low), L (Low), M (Medium), H (High), VH (Very High). ENR - Estimated Nitrogen Release. C.E.C. - Cation Exchange Capacity.

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Analysis prepared by: Waypoint Analytical Virginia, Inc.

by: Pauric McGroary

Pauric McGroary

Date Received: 11/20/2019
Date Of Report: 11/21/2019

SOIL FERTILITY RECOMMENDATIONS

Sample ID Field ID	Intended Crop	Yield Goal	Lime Tons/A	Nitrogen N lb/A	Phosphate P_2O_5 lb/A	Potash K_2O lb/A	Magnesium Mg lb/A	Sulfur S lb/A	Zinc Zn lb/A	Manganese Mn lb/A	Iron Fe lb/A	Copper Cu lb/A	Boron B lb/A
PBGrn6	Putting Green	0	0.0	12.0	1.0	4.0	0						

Comments:
"The recommendations are based on research data and experience, but NO GUARANTEE or WARRANTY expressed or implied, concerning crop performance is made."

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ENGrn2	Putting Green	0	0.0	12.0	0	4.0	0						
ENGrn5	Putting Green	0	0.0	12.0	0	5.0	0						
ENGrn12	Putting Green	0	0.0	12.0	0	3.0	0						
PBGrn3	Putting Green	0	0.0	12.0	0.5	4.0	0						
PBGrn8	Putting Green	0	0.0	12.0	0.5	5.0	0						

Comments:
"The recommendations are based on research data and experience, but NO GUARANTEE or WARRANTY expressed or implied, concerning crop performance is made."

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