Brent Mecham

Irrigation Codes & Standards

OUR STAMP ON THE FUTURE

Through Technology, Best Practices and Awareness

Brent Mecham, CID, CLWM, CAIS, CIC, CLIA

Irrigation Association

Market Transformation

Voluntary

- BMPs
- Standards
- Green Initiatives
- Consumer Expectations

Mandatory

- Ordinances
- Codes
- Executive Orders

Executive Orders

- **Executive Order 13514** – Federal Leadership in Environmental, Energy, and Economic Performance (10/5/2009)
  - 26% improvement in water efficiency by 2020
- **Executive Order 13693** – Planning for Federal Sustainability in the Next Decade (3/19/2015)
  - Reduce water intensity by 2 percent per year through 2025.

- **Executive Order 13514**
  - Guidance for Federal Agencies on Sustainable Practices for Designed Landscapes October 31, 2011
- **Executive Order 13693**
  - Guiding Principles for Sustainable Federal Buildings and Associated Instructions February 2016 (Council on Environmental Quality)
- **Note:**
  - E.O. 13693 supersedes E.O. 13514
  - However, the guidelines for 13693 reference the guidelines for 13514

Guiding Principles (from CEQ)

(f) improve agency water use efficiency and management, including stormwater management by:

- (i) **reducing** agency **potable water** consumption intensity by **36 percent** relative to a baseline of the agency's water use in 2007
- (ii) installing water meters to improve water conservation and management
- (iii) reducing agency industrial, landscaping, and agricultural (ILA) water consumption by two percent annually through fiscal year 2025 relative to a baseline of fiscal year 2010
- (iv) installing appropriate green infrastructure features on federally owned property to help with stormwater and wastewater management

- **Outdoor Water Use:**
  water efficient landscape and irrigation strategies to reduce outdoor potable water consumption.
  - The installation of water meters is required for irrigation systems serving more than 25,000 square feet of landscaping.
- **Alternative Water:**
  Implement cost effective methods to utilize alternative sources of water such as harvested rainwater, treated wastewater, air handler condensate capture, grey water, and reclaimed water, to the extent permitted under local laws and regulations.

- **California Gov. Brown Executive Order 5-9-2016**
- Use Water More Wisely
  - Mandatory reduction of potable water use
  - New water use targets building on the 20% reduction by 2020
  - Outdoor irrigation (water budget)
- Eliminate Water Waste
  - Prohibit water waste
    - No runoff from lawn watering
    - No irrigation within 48 hours of precipitation
    - No irrigating ornamental turf on public medians
  - Minimize system leaks
  - **CEC** shall certify innovative technologies that also increase energy efficiency

Tests—Sprinklers & Bubblers

- Flow Rate
- Distance of Throw
- Distribution Uniformity
- Burst Pressure
- Check Valve
- Pressure Regulation

Tests—Emitters and Microsprays

- Uniformity of flow rate
- Flow rate as a function of pressure
- Emitter exponent for PC devices
- Check valve function


ASPE
American Society of Plumbing Engineers
ARCSA
PLUMBING ENGINEERING & DESIGN STANDARD
ARCSA/ASPE/ANSI 78-2015:
Stormwater Harvesting System Design for Direct End-Use Applications
ANSI


ASPE
ARCSA
ARCSA/ASPE/ANSI 63-2013:
Rainwater Catchment Systems
NSF
IAPMO


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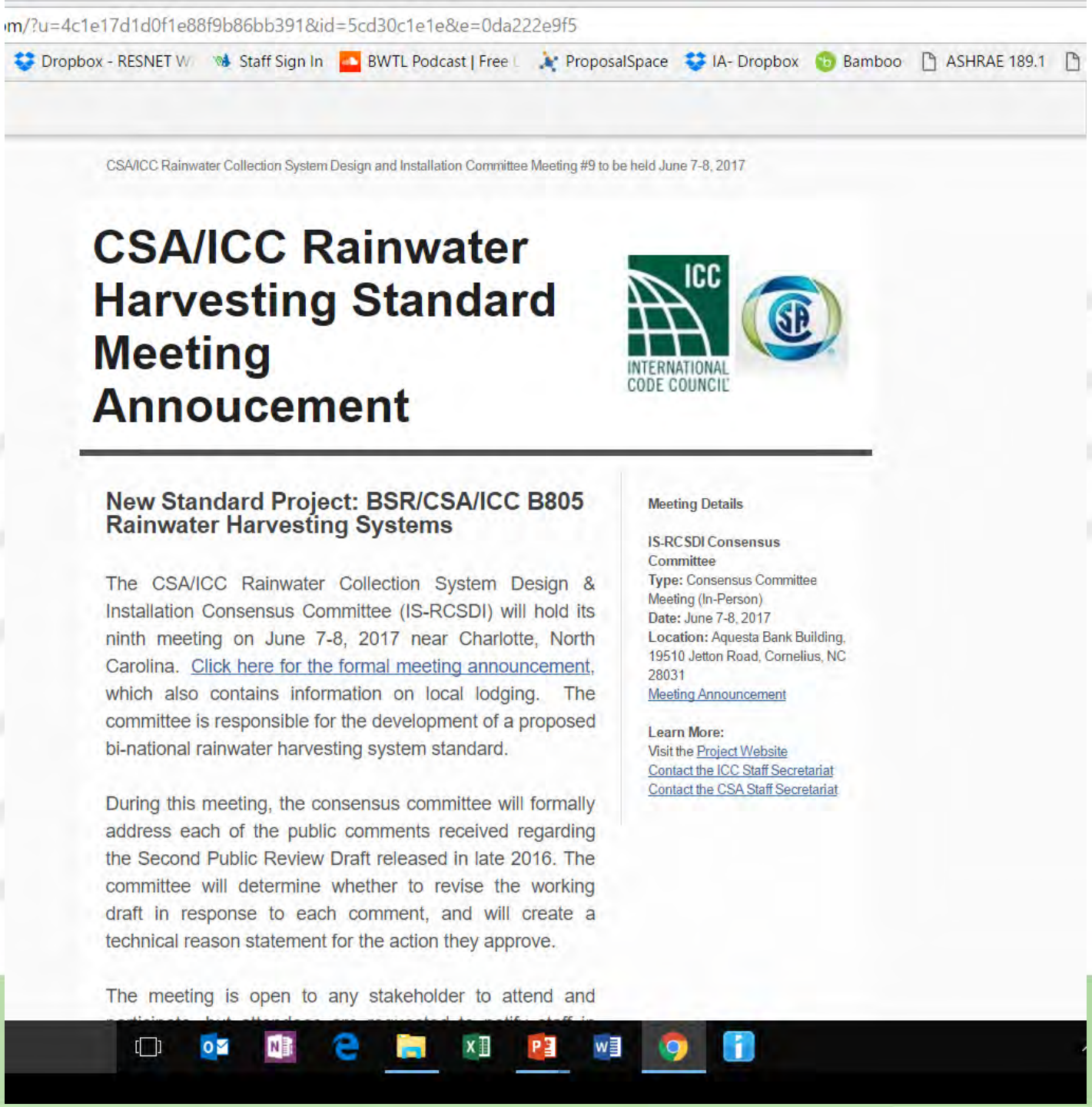
ASIC
SEATTLE, WASHINGTON
NATIONAL CONFERENCE 2017
47th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Staff Sign In
BWTL Podcast | Free
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IA- Dropbox
Bamboo
ASHRAE 189.1
CSA/ICC Rainwater Collection System Design and Installation Committee Meeting #9 to be held June 7-8, 2017
CSA/ICC Rainwater Harvesting Standard Meeting Annoucement
ICC
INTERNATIONAL CODE COUNCIL
New Standard Project: BSR/CSA/ICC B805 Rainwater Harvesting Systems
The CSA/ICC Rainwater Collection System Design & Installation Consensus Committee (IS-RCSDI) will hold its ninth meeting on June 7-8, 2017 near Charlotte, North Carolina. Click here for the formal meeting announcement, which also contains information on local lodging. The committee is responsible for the development of a proposed bi-national rainwater harvesting system standard.
During this meeting, the consensus committee will formally address each of the public comments received regarding the Second Public Review Draft released in late 2016. The committee will determine whether to revise the working draft in response to each comment, and will create a technical reason statement for the action they approve.
The meeting is open to any stakeholder to attend and
Meeting Details
IS-RCSDI Consensus Committee
Type: Consensus Committee Meeting (In-Person)
Date: June 7-8, 2017
Location: Aquesta Bank Building, 19510 Jetton Road, Cornelius, NC 28031
Meeting Announcement
Learn More:
Visit the Project Website
Contact the ICC Staff Secretariat
Contact the CSA Staff Secretariat


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47th

ASIC

ANSI/ASABE S626 SEP2016
Landscape Irrigation System Uniformity and Application Rate Testing

American Society of Agricultural and Biological Engineers

ASHRAE 189.1

- Standard for High-Performance Green Buildings
  - ✓Includes the landscape and irrigation
    - ✓***influencing the market significantly***
    - ✓***referenced by Federal Government***

ASHRAE 189.1

- Water Use Efficiency (2017 version)
  - 40% turf limit* (exclude areas for sports/golf at schools, residential common areas or public recreational facilities)
  - Excluded areas can't use potable water
  - Other landscape areas maximum 1/3 potable water the rest is alternate water
- Irrigation Systems
  - Hydrozoning
  - Master valve & flow sensor
  - Prevent piping from draining between irrigation events
  - ASABE/ICC sprinkler standard compliance
  - No sprinklers in areas less than 4 feet in any dimension
  - Max. PR of 0.75 in/hr on slopes greater than 25%
  - Sprinklers permitted on vegetation less than 8 inches, minimum 4" pop-up
  - Drip irrigation with indicator to confirm operation by visual inspection
  - Smart controllers (WBIC or SMS) with posted programming parameters

ASHRAE 189.1

- Rainfall-ETc Compatible Plants (replace turf limitations)
  - Plants with documented ETc rates
    - Not native nor invasive
    - After establishment does not require supplemental annual irrigation based on 10-year average annual rainfall of local climate based on 80% of plant's ETc
  - Exceptions:
    - Landscapes irrigated solely with alternate on-site water
    - Where average annual rainfall is less than 12 inches, plants other than turfgrass with annual ETc of 15" shall be deemed equivalent to Rainfall-ETc Compatible plants
  - Irrigation of Rainfall-ETc Compatible Plants:
    - can't use potable or reclaimed water after establishment.
    - In-ground systems using potable or off-site reclaimed water are prohibited.
  - Exception to the irrigation requirement
    - Plants deemed equivalent to rainfall-ETc compatible plants are exempt from irrigation ban.

ASHRAE 189.1

- Commissioning and Inspection
  - Irrigation is a system that has to be inspected and if the project is large enough to be commissioned.
  - Independent third-party.

- ASHRAE 189.1, International Construction Council, USGBC
  - IgCC 2018 will use ASHRAE 189.1-2017 as technical requirements
  - LEED projects following ASHRAE 189.1-2017 meet minimum requirements
  - ICC is used in 35 states
  - IgCC can be adopted as-is or amended (i.e. Washington DC, Seattle, Tucson)

IAPMO

- UPC, UMC (Used by State of California)
- 2015 IAPMO Green Technical Supplement

- **WE-Stand 2017**
- Provisions for efficient irrigation systems based on IA/ASIC BMP document
  - Qualified designer
  - Measuring water
  - Master valve & flow sensor
  - Pressure regulation
  - Hydrozoning
  - Matched precipitation rates
  - Responsive controllers
  - Inspections
- Provisions on use of alternate water sources

- CalGreen
  - California Building Standards Commission
  - Uses UPC
  - Sections out for public comment until5/1/2017
  - Qualified design professional
  - Alternate water sources
  - Commissioning & Functional performance testing
  - Complies with MWELO

Other standards (points-based programs)

- Green Building Initiative
- National Green Building Standard (ICC 700)
  - Single family residences
  - Developments
- LEED v4
- SITES v2

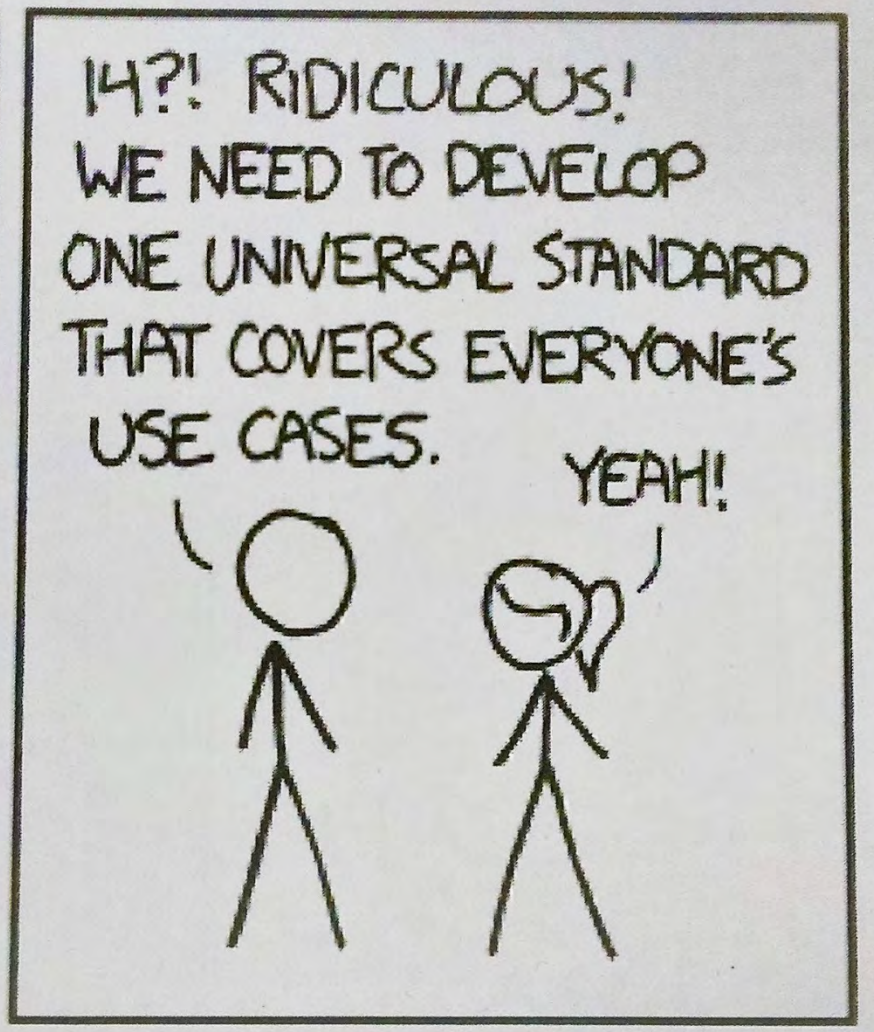
HOW STANDARDS PROLIFERATE:

(SEE: A/C CHARGERS, CHARACTER ENCODINGS, INSTANT MESSAGING, ETC.)

HOW STANDARDS PROLIFERATE:

(SEE: A/C CHARGERS, CHARACTER ENCODINGS, INSTANT MESSAGING, ETC)

SITUATION: THERE ARE 14 COMPETING STANDARDS.

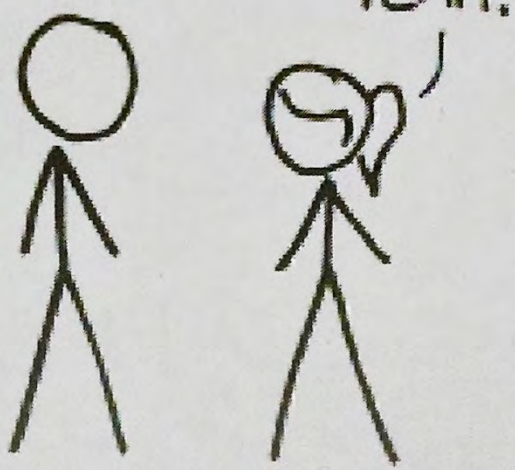


HOW STANDARDS PROLIFERATE:

(SEE: A/C CHARGERS, CHARACTER ENCODINGS, INSTANT MESSAGING, ETC)

SITUATION:
THERE ARE
14 COMPETING
STANDARDS.

14?! RIDICULOUS!
WE NEED TO DEVELOP
ONE UNIVERSAL STANDARD
THAT COVERS EVERYONE'S
USE CASES.



SOON:

SITUATION:
THERE ARE
15 COMPETING
STANDARDS.

John Wallace

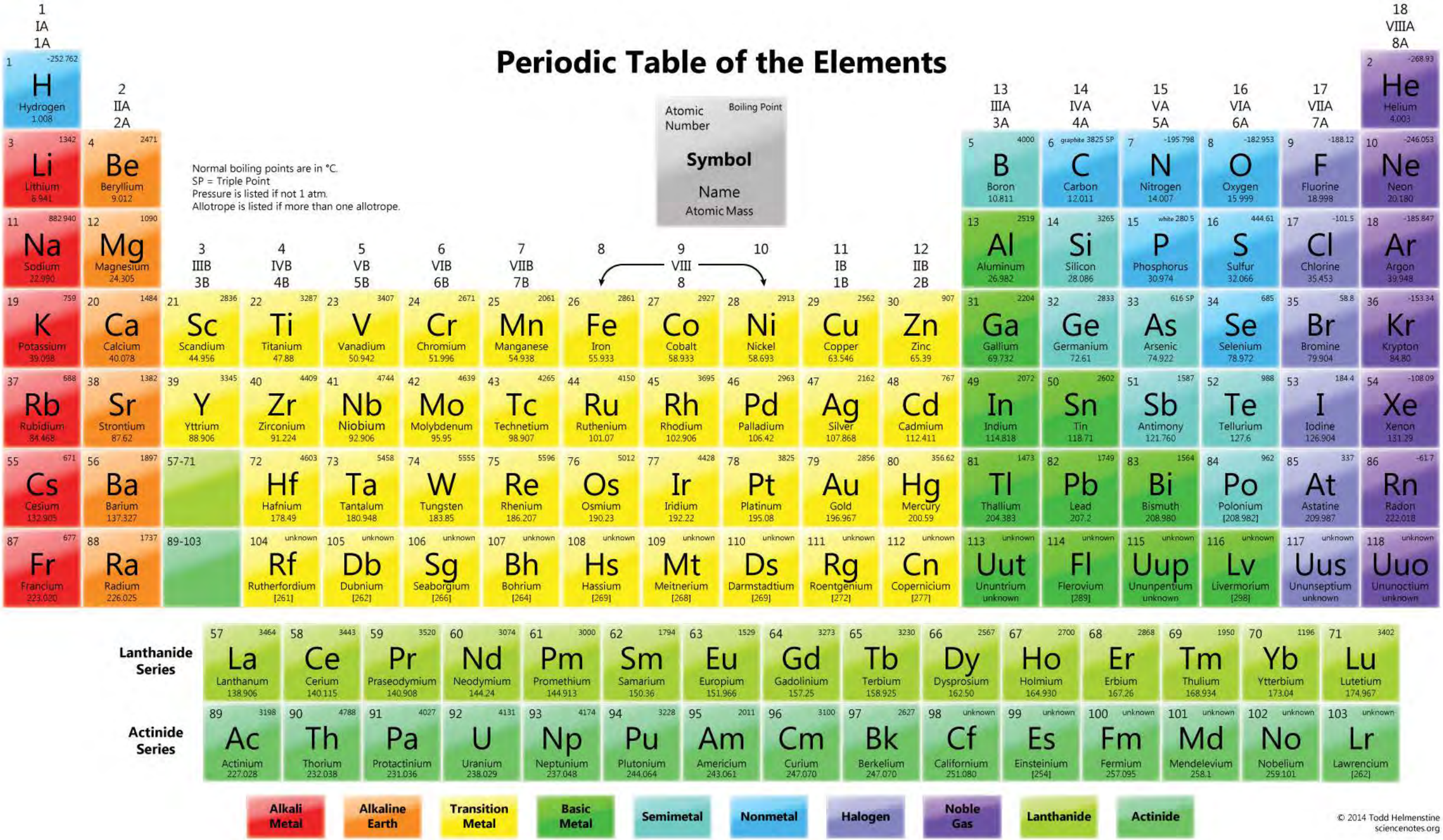
EARTH: The Stuff of Life

BY FIRMAN E. BEAR

Second Edition, Revised

BY H. WAYNE PRITCHARD AND WALLACE E. AKIN

Periodic Table of the Elements

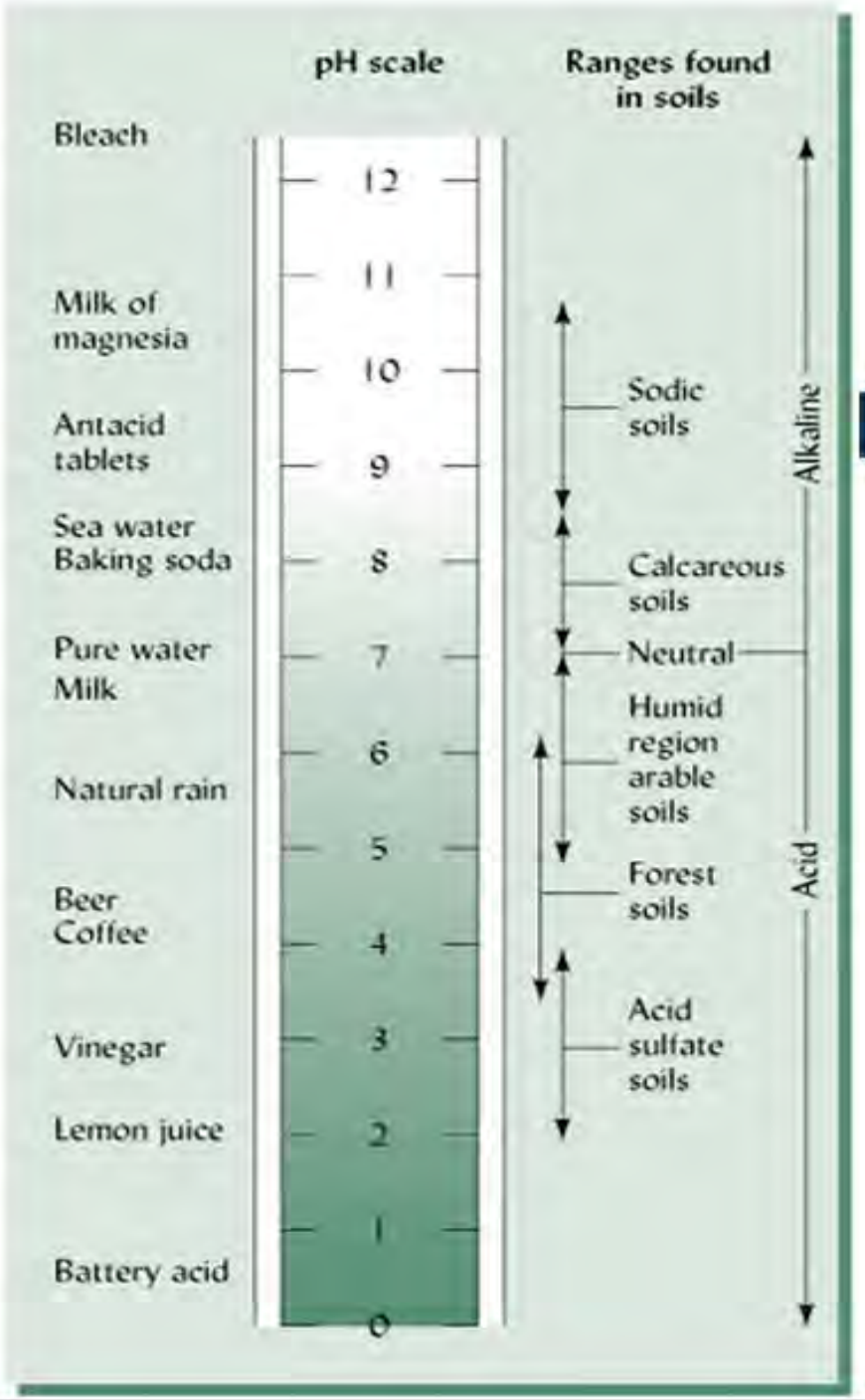


Essentials for a Water Test

- pH
- Salinity
- Macro Nutrients
- Sodium/SAR
- Bicarbonates/Carbonates
- Calcium
- Chloride
- Boron

pH

- What produces acidity?
- Effect of pH extremes on plants
- How to correct pH imbalances
- Optimal pH is not a rigid number


pH scale
Ranges found in soils
Bleach
Milk of magnesia
Antacid tablets
Sea water
Baking soda
Pure water
Milk
Natural rain
Beer
Coffee
Vinegar
Lemon juice
Battery acid
12
11
10
9
8
7
6
5
4
3
2
1
0
Sodic soils
Calcareous soils
Neutral
Humid region arable soils
Forest soils
Acid sulfate soils
Alkaline
Acid

Waypoint ANALYTICAL

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Anaheim, CA 92807
Main 714-282-8777 ° Fax 714-282-8575
www.waypointanalytical.com

IRRIGATION WATER

Send to :
[redacted]

[redacted]

Report No :	16-139-0101
Cust No :	00188
Date Printed :	05/20/2016
Date Received :	05/18/2016
Page :	1 of 4
Lab Number :	50181

Sample Id : **Well Head**

CATIONS		mg/L	meq/L
Sodium	Na	72	3.13
Calcium	Ca	73	3.64
Magnesium	Mg	48	3.95
Potassium	K	4	0.10
Ammonium	NH_4	0	0.00
	NH_4 - N	0	
SUM OF CATIONS			**10.82**

ANIONS		mg/L	meq/L
Chloride	Cl	155	4.37
Sulfate	SO_4	46	0.96
	S	15	
Bicarbonate	HCO_3	298	4.89
Carbonate	CO_3	0	0.00
Nitrate	NO_3	4	0.06
	NO_3 - N	1	
Phosphate	PO_4	2	0.06
	P	1	
SUM OF ANIONS			**10.34**

Hydrogen Ion Activity	pH	7.4	
Equilibrium Reaction	pHc	6.56	
Electrical Conductivity	ECw	0.99	dS/m
Total Dissolved Solids	TDS	634	mg/L
Adj Na Adsorption Ratio	SARadj	1.86	
Sodium Adsorption Ratio	SAR	1.61	
Hardness		381	ppm

Copper	Cu	0.02	mg/L
Zinc	Zn	0.07	mg/L
Manganese	Mn	0.59	mg/L
Iron	Fe	5.32	mg/L
Boron	B	0.20	mg/L
Fluoride	F	0.20	mg/L
Aluminum	Al	6.99	mg/L
Molybdenum	Mo	0.01	mg/L

mg/L = parts per million parts water meq/L - milliequivalents per liter
Hardness is determined from calculations using the calcium and magnesium concentrations in the water.
TDS calculated by ECw * 640

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Page :	2 of 4
Lab Number :	50181

Sample Id : **Well Head**

WATER ANALYSIS INTERPRETATION, AGRICULTURAL

Potential Problem	Units	Test Result	Degree of Restriction on Use: Criteria None	Slight to Moderate	Severe	Graphical Results None	Slight to Moderate	Severe
Salinity								
ECw[1]	dS/m	0.99	< 0.7	0.7 - 3	> 3			
Specific Ion Toxicity								
Sodium (Na)[1]								
Surface irrigation	SARadj	1.86	< 3	3 - 9	> 9			
Sprinkler irrigation[2]	meq/L	3.13	< 3	3 - 6	> 6			
Chloride (Cl)[1]								
Surface irrigation	meq/L	4.37	< 4	4 - 10	> 10			
Sprinkler irrigation[2]	meq/L	4.37	< 3	3 - 5	> 5			
Boron (B)[1]	mg/L	0.20	< 0.7	0.7 - 3	> 3			
Fluoride (F)[1]	mg/L	0.20	< 1	1 - 5	> 5			
Clogging of Drip Systems or Unsightly Residues								
Iron (Fe)[3]	mg/L	5.32	< 0.3	0.3 - 1.5	> 1.5			
Manganese (Mn)[3]	mg/L	0.59	< 0.2	0.2 - 1.5	> 1.5			
pH - pHc[4]		0.84	<= 0	> 0				
Reduced Water Infiltration[5] (Ratio based on adjSAR / ECw)		1.88	< 4	4 - 10	> 10			
Alkalinity								
Bicarbonate (HCO_3) + Carbonate (CO_3)[6]	meq/L	4.89	< 2	2 - 8.5	> 8.5			
Potential Low Nutrient Issues (Soilless media)[7]								
Sulfate	mg/L	46	> 48	48 - 20	< 20			
Magnesium	mg/L	48	> 10	10 - 4	< 4			
Boron	mg/L	0.20	> 0.3	0.3 - 0.05	< 0.05			

1. Crop tolerance to salinity, sodium, chloride, boron and fluoride varies widely. Most tree crops are sensitive to sodium and chloride while many annual crops are not. Soil conditions, irrigation method and climate must be considered.
2. Leaf burn from foliar and root absorption will be enhanced under conditions of : low humidity, high temperature and high air movement .
3. Elevated iron in combination with sulfides or tannins can result in bacterial slimes that can clog drip systems. Removal of iron and manganese often involves oxidation (aeration or chlorination) followed by filtering.
4. Positive pH - pHc (saturation index) values indicate the potential for calcium and magnesium carbonate precipitates that might impair efficiency of irrigation systems with small orificed parts and/or may leave unsightly lime deposits on leaves. Problems can be reduced by mineral acid addition.
5. Infiltration problems are most likely when water with low ECw and/or high SAR adj. is used on mineral soils containing some silt and clay. Evaluation of infiltration problems should include analysis of both irrigation water and soil-water extracts. Treatment may involve injecting gypsum into the water or applying gypsum to the soil surface.
6. Bicarbonate when excessive may result in difficulty in controlling soil pH and may impair root assimilation of minor elements.
7. Sulfur, magnesium and /or boron may become limiting if not supplied by soil or fertilizer. Use soil and leaf analysis to confirm need.

Comments :

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Report No :	16-139-0101
Cust No :	00188
Date Printed :	05/20/2016
Date Received :	05/18/2016
Page :	3 of 4
Lab Number :	50182

Sample Id : **Holding Tank**

CATIONS		mg/L	meq/L
Sodium	Na	60	2.61
Calcium	Ca	53	2.64
Magnesium	Mg	59	4.85
Potassium	K	1	0.03
Ammonium	NH_4	0	0.00
	NH_4 - N	0	
SUM OF CATIONS			**10.13**

ANIONS		mg/L	meq/L
Chloride	Cl	161	4.54
Sulfate	SO_4	46	0.96
	S	15	
Bicarbonate	HCO_3	261	4.28
Carbonate	CO_3	0	0.00
Nitrate	NO_3	4	0.06
	NO_3 - N	1	
Phosphate	PO_4	2	0.06
	P	1	
SUM OF ANIONS			**9.90**

Hydrogen Ion Activity	pH	7.6	
Equilibrium Reaction	pHc	6.70	
Electrical Conductivity	ECw	0.96	dS/m
Total Dissolved Solids	TDS	614	mg/L
Adj Na Adsorption Ratio	SARadj	1.46	
Sodium Adsorption Ratio	SAR	1.35	
Hardness		374	ppm

Copper	Cu	0.10	mg/L
Zinc	Zn	0.14	mg/L
Manganese	Mn	0.06	mg/L
Iron	Fe	0.05	mg/L
Boron	B	0.10	mg/L
Fluoride	F	0.21	mg/L
Aluminum	Al	0.32	mg/L
Molybdenum	Mo	0.01	mg/L

mg/L = parts per million parts water meq/L - milliequivalents per liter
Hardness is determined from calculations using the calcium and magnesium concentrations in the water.
TDS calculated by ECw * 640

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WATER ANALYSIS INTERPRETATION, AGRICULTURAL

Potential Problem	Units	Test Result	Degree of Restriction on Use – Criteria: None	Slight to Moderate	Severe	Graphical Results: None	Slight to Moderate	Severe
Salinity								
ECw[1]	dS/m	0.96	< 0.7	0.7 - 3	> 3			
Specific Ion Toxicity								
Sodium (Na)[1]								
Surface irrigation	SARadj	1.46	< 3	3 - 9	> 9			
Sprinkler irrigation[2]	meq/L	2.61	< 3	3 - 6	> 6			
Chloride (Cl)[1]								
Surface irrigation	meq/L	4.54	< 4	4 - 10	> 10			
Sprinkler irrigation[2]	meq/L	4.54	< 3	3 - 5	> 5			
Boron (B)[1]	mg/L	0.10	< 0.7	0.7 - 3	> 3			
Fluoride (F)[1]	mg/L	0.21	< 1	1 - 5	> 5			
Clogging of Drip Systems or Unsightly Residues								
Iron (Fe)[3]	mg/L	0.05	< 0.3	0.3 - 1.5	> 1.5			
Manganese (Mn)[3]	mg/L	0.06	< 0.2	0.2 - 1.5	> 1.5			
pH - pHc[4]		0.90	<= 0	> 0				
Reduced Water Infiltration[5] (Ratio based on adjSAR / ECw)		1.52	< 4	4 - 10	> 10			
Alkalinity								
Bicarbonate (HCO_3) + Carbonate (CO_3)[6]	meq/L	4.28	< 2	2 - 8.5	> 8.5			
Potential Low Nutrient Issues (Soilless media)[7]								
Sulfate	mg/L	46	> 48	48 - 20	< 20			
Magnesium	mg/L	59	> 10	10 - 4	< 4			
Boron	mg/L	0.10	> 0.3	0.3 - 0.05	< 0.05			

1. Crop tolerance to salinity, sodium, chloride, boron and fluoride varies widely. Most tree crops are sensitive to sodium and chloride while many annual crops are not. Soil conditions, irrigation method and climate must be considered.
2. Leaf burn from foliar and root absorption will be enhanced under conditions of : low humidity, high temperature and high air movement .
3. Elevated iron in combination with sulfides or tannins can result in bacterial slimes that can clog drip systems. Removal of iron and manganese often involves oxidation (aeration or chlorination) followed by filtering.
4. Positive pH - pHc (saturation index) values indicate the potential for calcium and magnesium carbonate precipitates that might impair efficiency of irrigation systems with small orificed parts and/or may leave unsightly lime deposits on leaves. Problems can be reduced by mineral acid addition

Waypoint ANALYTICAL

San Jose Office
May 27, 2016
Report 16-139-0101

[redacted]

[redacted]

[redacted]

Background

Two samples were received on May 18, 2016 identified as raw well water from a well head and ozone treated well water from a holding tank. The samples were analyzed for irrigation suitability. Results of the analyses are attached.

Analytical Results

Well Head
The bicarbonate level is slightly higher than preferred and will tend push the soil towards an alkaline reaction. The slightly alkaline reaction of the water is higher than the calculated equilibrium pH of the sample indicating that upon evaporation, the irrigation water may form carbonate precipitates on irrigation equipment that could result in obstructions. Additionally, water spots could develop on wetted plant foliage and hardscape.

Salinity (ECw) and sodium are slightly elevated and salt sensitive plant material could be injured by overhead spray. Chloride is moderately elevated to a level that burning on tips and margins of foliage could occur, if irrigated by either surface or overhead spray. Aluminum is also elevated. Boron and fluoride are safely low and are not problematic.

Iron is extremely elevated and manganese is moderately elevated indicating the potential for issues with staining on hardscape and bacterial slime accumulation on irrigation emitters. No other potentially problematic elements are present at this time.

Nutritionally, calcium and magnesium are adequately present. The water will be a moderate source of boron and sulfate.

Holding Tank
The bicarbonate level is slightly higher than preferred and will tend push the soil towards an alkaline reaction. The slightly alkaline reaction of the water is higher than the calculated equilibrium pH of the sample indicating that upon evaporation, the irrigation water may form carbonate precipitates on irrigation equipment that could result in obstructions. Additionally, water spots could develop on wetted plant foliage and hardscape.

Salinity (ECw) is very slightly elevated and salt sensitive plant material could be injured by overhead spray. Chloride is moderately elevated to a level that burning on tips and margins of foliage could occur, if irrigated by either surface or overhead spray. Sodium, aluminum, boron and fluoride are safely low and are not problematic.

[redacted]
Report 16-139-0101

Iron and manganese are both safely low indicating no potential for issues with staining on hardscape and bacterial slime accumulation on irrigation emitters. No other potentially problematic elements are present at this time.

Nutritionally, magnesium is adequately present. The water will be a moderate source of calcium and sulfate. This water will not be a significant source of boron.

Comments

Since the Holding Tank sample water has slightly elevated carbonates, the pH of the soil where the irrigation water is applied will likely become slightly alkaline, if not already. Plants that are not tolerant of alkaline conditions may develop alkalinity induced chlorosis (yellowing of foliage). The use of acidifying fertilizers can help to decrease the soil pH value somewhat.

Blending the well water with another water source that has low carbonates is an option, particularly if acid-loving plants such as azaleas or rhododendrons are being installed. For example, if the Holding Tank water was blended with a source that has very low carbonates (1.0 meq/L) at a ratio of 50:50 (holding tank water:other source), the blend would result in approximately 2.6 meq/L of bicarbonates. This level would be acceptable and have less of an impact on the soil pH value. The salinity and chloride content would also be decreased and not problematic.

If blending does not occur, increasing the leaching fraction (time of watering) is recommended to help flush the salts past the root zone. Avoiding overhead spray is recommended.

If we can be of any further assistance, please feel free to contact us.

Annmarie Lucchesi
alucchesi@waypointanalytical.com

Emailed 6 Pages: jcacciato@jensencorp.com

WALLACE LABS
365 Coral Circle
El Segundo, CA 90245
(310) 615-0116

WATER ANALYSIS January 22, 2015
Location
Requester

	15-22W-01	milliequivalent/liter		maximum concentrations
		cation	anion	for agronomic uses
elements	mg/liter			FAO & UC
phosphorus	< 0.0244		0.00	
potassium	2.866	0.07		
iron	0.007	0.00		1
manganese	0.101	0.00		0.2
zinc	0.001	0.00		2
copper	0.003	0.00		0.2
boron	0.207		0.02	0.5 to 10
calcium	147.884	7.39		
magnesium	33.976	2.81		
sodium	90.993	3.96		70 foliar
sulfur	112.022		7.00	
molybdenum	< 0.0017			0.01
aluminum	< 0.0067			5
arsenic	< 0.0066			0.1
barium	0.050			
cadmium	0.003			0.01
chromium	< 0.0021			0.1
cobalt	< 0.0026			0.01
lead	< 0.0155			5
lithium	0.198	0.03		2.5
mercury	< 0.0015			
nickel	< 0.0032	0.00		0.2
selenium	< 0.0246			0.02
silicon	6.139			
silver	< 0.0008			
strontium	0.773	0.02		
tin	< 0.0140			
titanium	0.006			
vanadium	0.006			0.1
pH	7.20			
ECw (dS/m)	1.46			3
bicarbonate	241		3.95	100 foliar
carbonate	nd		0.00	
nitrate as N	10.4		0.74	
ammonium as N	0.4	0.03		
chloride	160		4.51	105 foliar, 150
SAR	1.7			3
Adjusted SAR	4.0			
ion sum		14.31	16.23	

Gypsum requirement in pounds per acre foot of water (234 pounds equals 1 me/l)

for sodium control	none
for total bicarbonate and sodium control	none
for magnesium control	none

Units are milligrams per liter (parts per million) except as noted.

WALLACE LABS
365 Coral Circle
El Segundo, CA 90245
(310) 615-0116

WATER ANALYSIS April 5, 2017
Location
Requester

elements	17-95W-02 Well Water mg/liter	milliequivalent/liter cation	anion	maximum concentrations for agronomic uses FAO & UC
phosphorus	0.152		0.00	
potassium	56.238	1.44		
iron	< 0.0014	0.00		1
manganese	0.005	0.00		0.2
zinc	< 0.0004	0.00		2
copper	< 0.0006	0.00		0.2
boron	6.590		0.61	0.7
calcium	187.703	9.39		
magnesium	166.204	13.74		
sodium	570.797	24.82		70 foliar
sulfur	828.869		51.80	
molybdenum	< 0.0017			0.01
aluminum	0.020			5
arsenic	< 0.0066			0.1
barium	0.016			
cadmium	0.005			0.01
chromium	< 0.0021			0.1
cobalt	0.006			0.01
lead	< 0.0155			5
lithium	0.890	0.13		2.5
mercury	< 0.0015			
nickel	< 0.0032	0.00		0.2
selenium	< 0.0246			0.02
silicon	2.593			
silver	< 0.0008			
strontium	10.047	0.23		
tin	< 0.0140			
titanium	< 0.0003			
vanadium	< 0.0011			0.1
pH	7.66			
ECw (dS/m)	6.00			1.00
bicarbonate	427		7.00	100 foliar
carbonate	nd		0.00	
nitrate as N	10.4		0.74	
ammonium as N	3.1	0.22		
chloride	405		11.41	105 foliar, 150
SAR	7.3			3
Adjusted SAR	18.0			
ion sum		49.96	71.58	

Gypsum requirement in pounds per acre foot of water (234 pounds equals 1 me/l)

for sodium control	none
for total bicarbonate and sodium control	2035
for magnesium control	4214

Units are milligrams per liter (parts per million) except as noted.

WALLACE LABS
365 Coral Circle
El Segundo, CA 90245
(310) 615-0116

WATER ANALYSIS April 7, 2017
Location
Requester

elements	17-97W-03 Filter mg/liter	milliequivalent/liter cation	milliequivalent/liter anion	17-97W-04 R.O. mg/liter	milliequivalent/liter cation	milliequivalent/liter anion	maximum concentrations for agronomic uses FAO & UC
phosphorus	0.045		0.00	0.034		0.00	
potassium	3.323	0.08		0.443	0.01		
iron	< 0.0014			< 0.0014			1
manganese	0.003			< 0.0003			0.2
zinc	0.290	0.01		0.051	0.00		2
copper	0.009	0.00		0.002	0.00		0.2
boron	0.118		0.01	0.074		0.01	0.7
calcium	24.150	1.21		1.216	0.06		
magnesium	11.530	0.95		0.368	0.03		
sodium	67.192	2.92		4.272	0.19		70 foliar
sulfur	23.837		1.49	0.545		0.03	
molybdenum	< 0.0017			< 0.0017			0.01
aluminum	0.016			0.075			5
arsenic	< 0.0066			< 0.0066			0.1
barium	0.043			0.006			
cadmium	< 0.0015			< 0.0015			0.01
chromium	< 0.0021			< 0.0021			0.1
cobalt	< 0.0026			< 0.0026			0.01
lead	< 0.0155			< 0.0155			5
lithium	0.018	0.00		0.004	0.00		2.5
mercury	< 0.0015			< 0.0015			
nickel	< 0.0032	0.00		< 0.0032	0.00		0.2
selenium	< 0.0246			< 0.0246			0.02
silicon	2.731			0.332			
silver	0.002			< 0.0008			
strontium	0.249	0.01		0.011	0.00		
tin	< 0.0140			< 0.0140			
titanium	< 0.0003			< 0.0003			
vanadium	0.002			< 0.0011			0.1
pH	6.59			5.16			
ECw (dS/m)	0.57			0.03			1.00
bicarbonate	73		1.20	15		0.25	100 foliar
carbonate	nd		0.00	nd		0.00	
nitrate as N	2.4		0.17	1.4		0.10	
ammonium as N	0.7	0.05		0.9	0.06		
chloride	72		2.02	5		0.14	105 foliar, 150
SAR	2.8			0.9			3
Adjusted SAR	2.9						
ion sum		5.23	4.90		0.35	0.53	

Gypsum requirement in pounds per acre foot of water (234 pounds equals 1 me/l)

for sodium control	none	38
for total bicarbonate and sodium control	459	81
for magnesium control	163	0

Units are milligrams per liter (parts per million) except as noted.

WALLACE LABS
365 Coral Circle
El Segundo, CA 90245
(310) 615-0116

WATER ANALYSIS
Location
Requester

February 17, 2017

elements	17-47W-03 Hydropnic Water mg/liter	milliequivalent/liter cation	milliequivalent/liter anion	full-strength hydroponic concentrations
phosphorus	71.422		2.30	60
potassium	399.641	10.22		200
iron	3.915			2.5
manganese	0.041			0.25
zinc	0.016	0.00		0.05
copper	0.221	0.01		0.02
boron	0.003		0.00	0.25
calcium	90.447	4.52		100
magnesium	35.111	2.90		25
sodium	10.581	0.46		
sulfur	262.287		16.39	35
molybdenum	0.017			0.05
aluminum	< 0.0067			
arsenic	< 0.0066			
barium	0.013			
cadmium	< 0.0015			
chromium	0.003			
cobalt	0.005			
lead	< 0.0155			
lithium	0.051	0.01		
mercury	< 0.0015			
nickel	0.009	0.00		
selenium	< 0.0246			
silicon	0.250			
silver	< 0.0008			
strontium	0.673	0.02		
tin	< 0.0140			
titanium	< 0.0003			
vanadium	0.004			
pH	5.79			
ECw (dS/m)	1.85			1.00
bicarbonate	7		0.12	
carbonate	nd		0.00	
nitrate as N	27.0		1.93	150
ammonium as N	2.4	0.17		25
chloride	2		0.06	<150
SAR	0.2			
Adjusted SAR	0.1			
ion sum		18.31	20.81	

Gypsum requirement in pounds per acre foot of water (234 pounds equals 1 me/l)

for sodium control	none
for total bicarbonate and sodium control	none
for magnesium control	299

Units are milligrams per liter (parts per million) except as noted.

WALLACE LABORATORIES, LLC
365 Coral Circle
El Segundo, CA 90245
phone (310) 615-0116 fax (310) 640-6863

January 23, 2015

Steve Hohl, shohl@waterconcern.com
Water Concern Ltd.
29829 Santa Margarita Parkway, Suite 200
Rancho Santa Margarita

RE: Rancho Mission Viejo, PA2.1, Our ID No. 15-22W-01

Dear Steve,

The pH is slightly alkaline at 7.20. Salinity is modestly high for irrigation water at 1.46 millimho/cm. Most of the salinity is due to calcium and sulfate.

Sodium is modestly high at 91 parts per million. For foliar contact, sodium should be less than about 70 parts per million. Adjusted SAR (sodium adsorption ratio) is 4.0.

Chloride is 160 parts per million. For foliar contact, chloride should be less than about 105 parts per million. For root contact, chloride should be less than about 150 parts per million.

Bicarbonate is high at 241 parts per million. For foliar contact, bicarbonate should be less than about 100 parts per million.

Boron is safe at 0.21 part per million.

A modest level of manganese is present at 0.10 part per million.

Recommendations

Monitor the soil and leaf tissues. Irrigate deeply but not frequently to avoid accumulating sodium, chloride and sulfates in the soil.

Sincerely,

Garn A. Wallace, Ph. D.
GAW:n


ICP
Auftrag: 544610
ARCOS II
SOP
Projekt:
141555
SPECTRO ARCOS
AMETEK
www.spectro.com

- Ways to adjust undesirable water conditions
  - Purify with Filters & R.O.
  - Aerification
  - Blend with Potable Water
  - Fertigation Systems

Wallace Laboratories

John Wallace, Lab Director

OUR STAMP ON THE FUTURE

Through Technology, Best Practices and Awareness

Justin McClellan

GREENSIGHT
AGRONOMICS

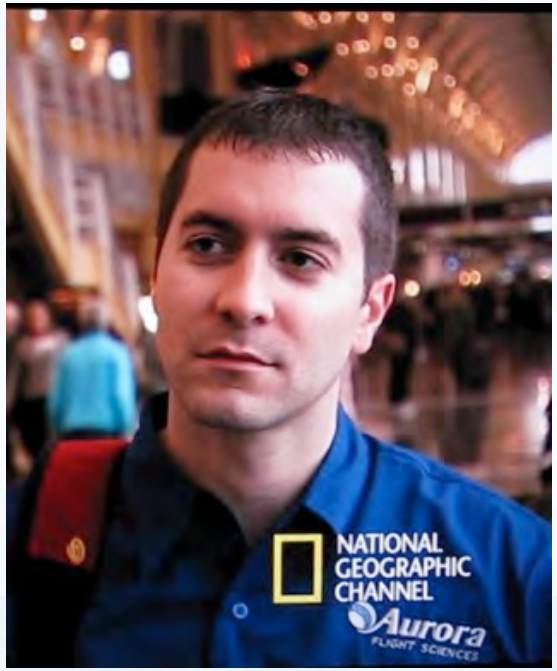
Making Golf Courses Greener

Aerial water and chemical management

Feb 3rd, 2017

Intro

Justin McClellan



10-years developing military drone technology

Founder GreenSight Agronomics

Topics:

- Overview Of Drones, Sensors
- Legality and the FAA
- Full-Service Providers
- GreenSight's Offering
- Sample Imagery

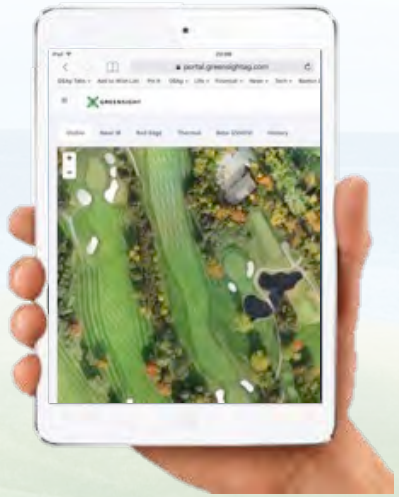
Drones Make Sense For Golf Courses

(and parks, campuses, etc)

GREENSIGHT AGRONOMICS

- Large Coverage Area

- Unique Point of View



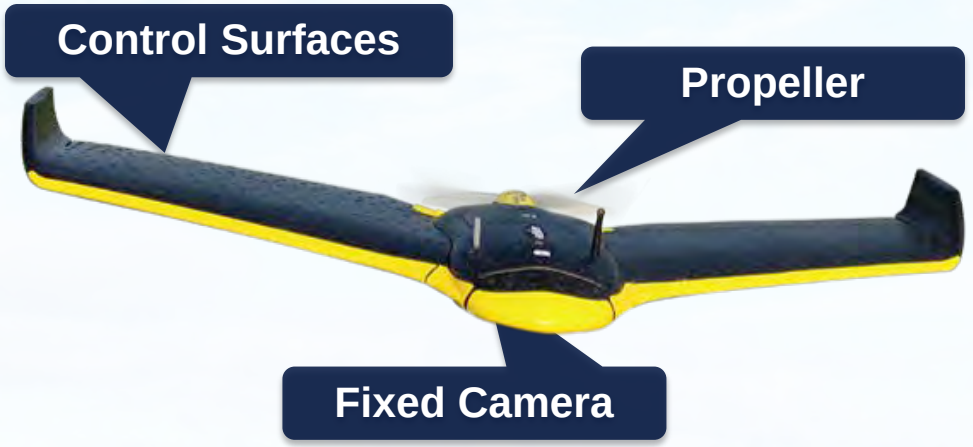
- Fast

Unmanned Aerial System (UAS) 101

GREENSIGHT AGRONOMICS

MULTIROTOR (QUADCOPTER)

FIXED WING

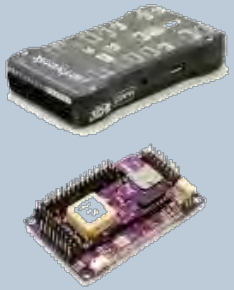


OTHER COMPONENTS

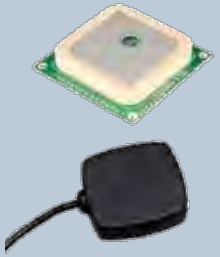
Camera/Sensor

Controller

Autopilot



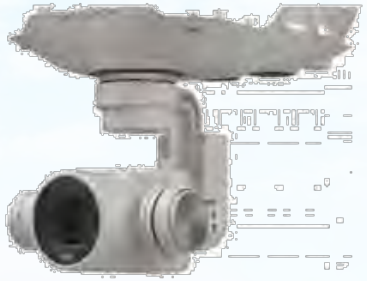
GPS



$ensors

GREENSIGHT AGRONOMICS

- Video (and Gimbal)
  - HD video
  - 4K video



$300-$400

- Agronomic Sensors
  - Near-Infrared (NDVI)
  - Red-edge

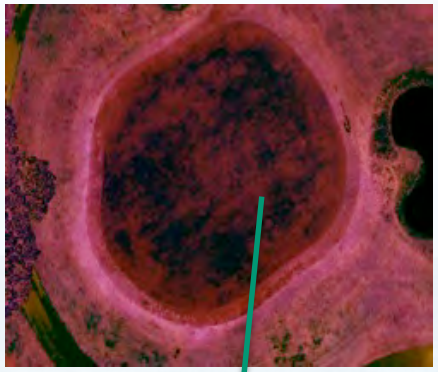
$3,000-$12,000

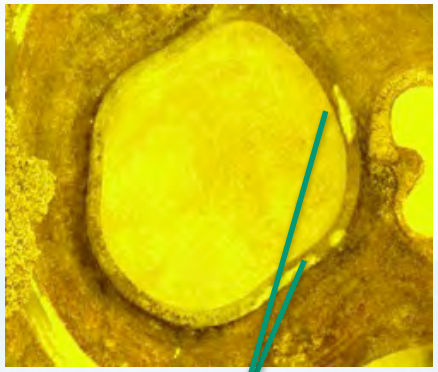
- Thermal Cameras
  - Night vision
  - Calibrated Temperature

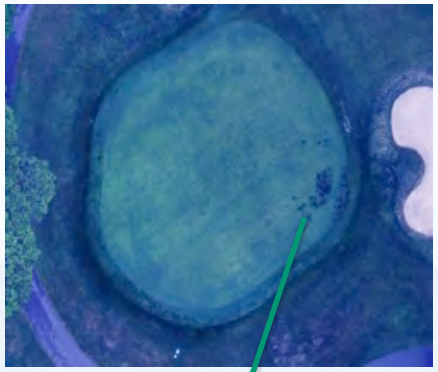
$1,000-$50,000

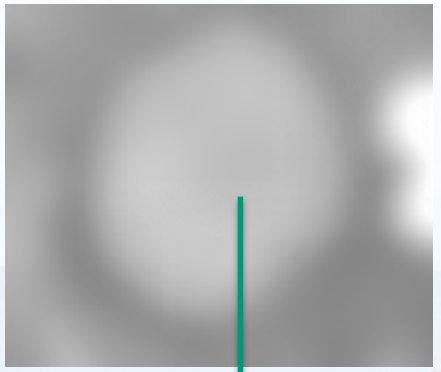
Multi-spectral Imaging

- Gather data in multiple wavelengths
  - Narrow “color” bands not visible to the naked eye
  - Common issues impact reflectance in narrow color bands









Red
Nitrogen Deficiency

Yellow
Grubs, root damage

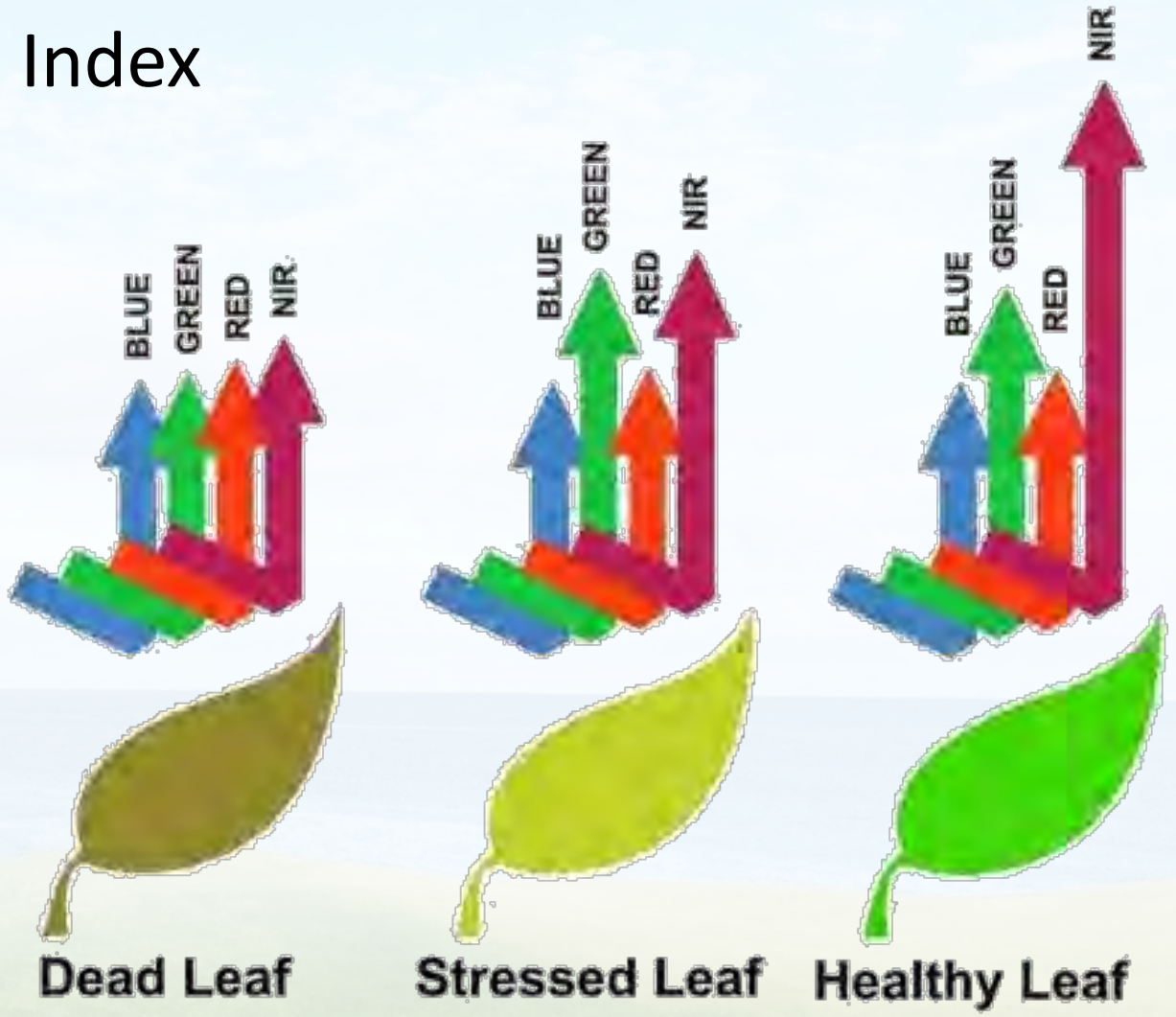
Blue
Fungal Infection

Thermal
Temp., Moisture

Relative Turf Health Index (NDVI)

Normalized Difference Vegetative Index

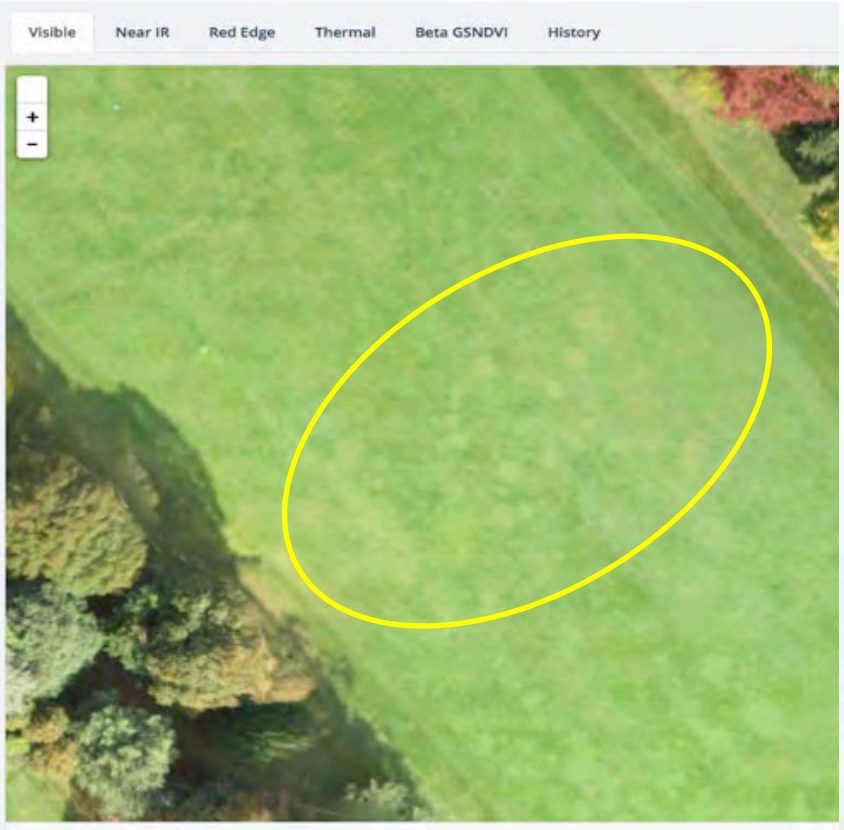
- Near-infrared and visual camera – focused on key plant reflectance
- NDVI false color images – exaggerate areas with reduced health/vigor
- Reveals issues before they are visible to the naked eye



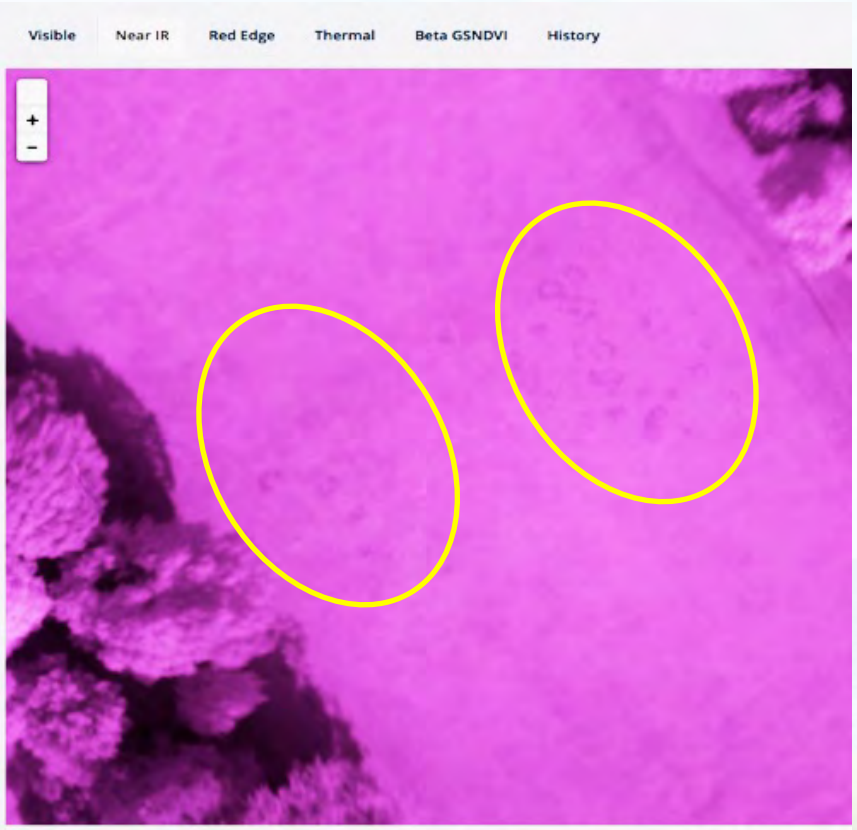
Relative Turf Health Index (Fungal Infection)

GREENSIGHT AGRONOMICS

Visible

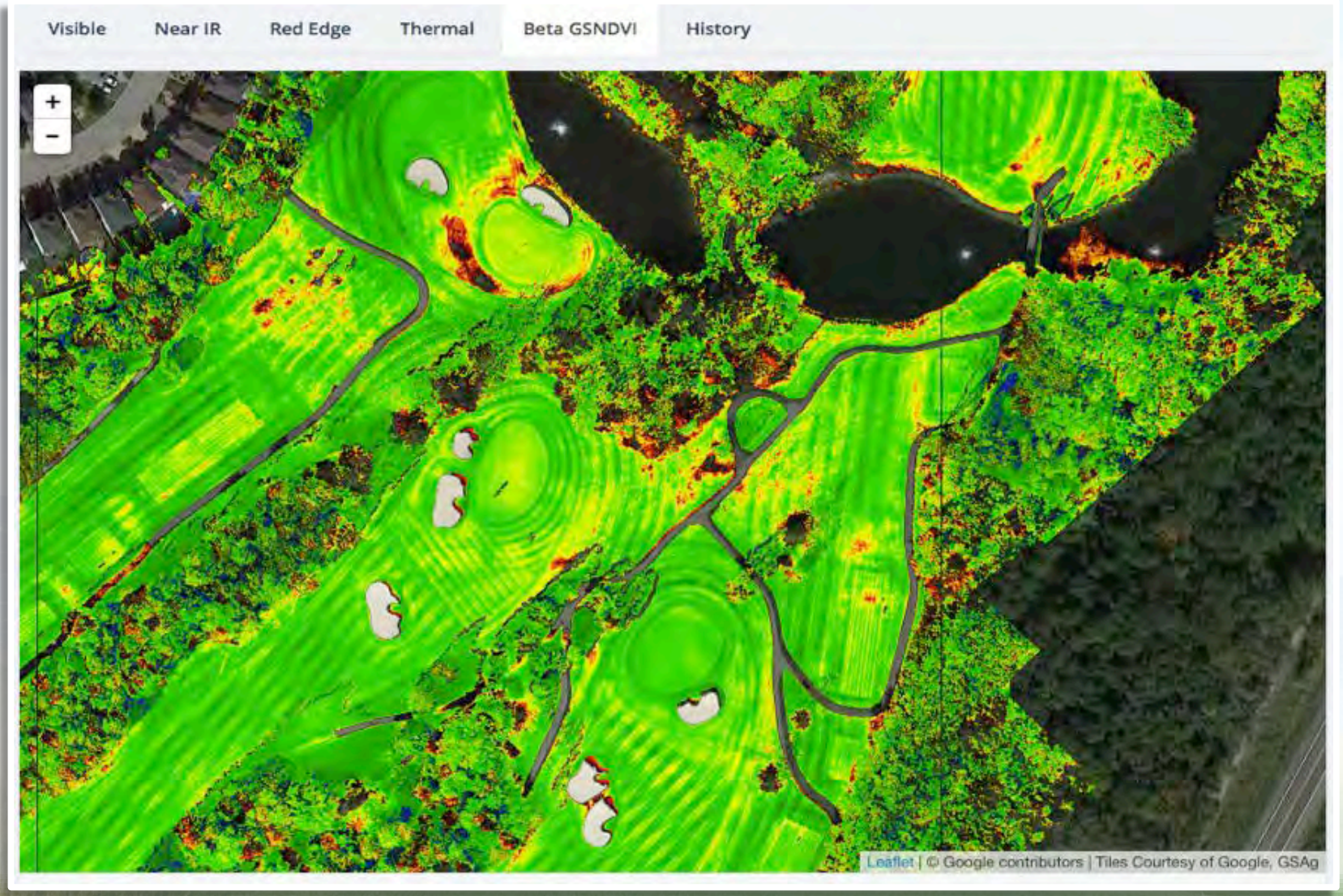


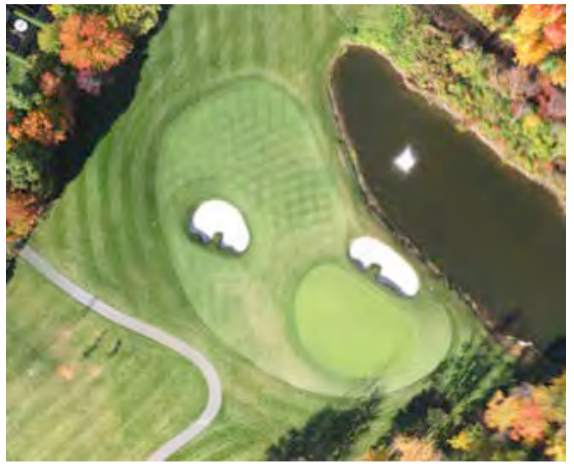
Near-Infrared

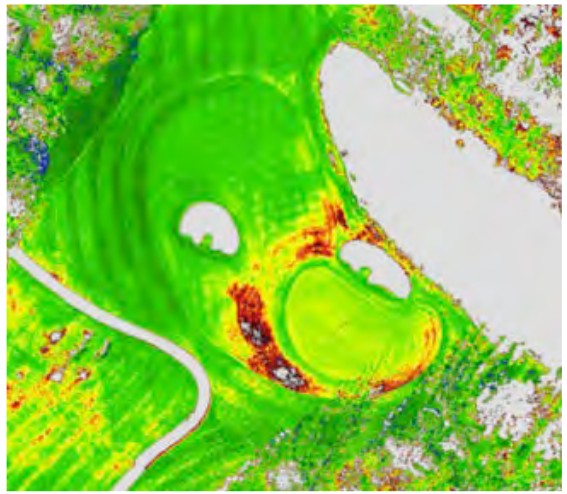


NDVI

Relative Turf Health Index (NDVI)







The FAA and Legality

GREENSIGHT AGRONOMICS

- Hobby Use:
  - Register your drone – registermyuas.faa.gov
  - Check airspace (apps like Drone Buddy), notify airport/ATC if within 5 mi
  - Fly under 400ft, within line of sight, don't cross property lines
- Commercial Use (this is you!) – Operate under FAA Part 107:
  - Pass an FAA Part 107 exam and earn Airman Certificate
  - Obtain Insurance (your liability policy likely doesn't cover drones)
  - Check airspace – potentially file an Airspace Waiver

GreenSight's Offering

&

Other Full Service Providers

Full Service Providers

- GREENSIGHT AGRONOMICS
  - Daily automated flights, constantly expanding features, subscription/lease
- TurfSolutions
  - As needed flights, agricultural-based software, pilots provided
- PrecisionTurf™ TECHNOLOGIES
  - Occasional flights, consultant-based feedback

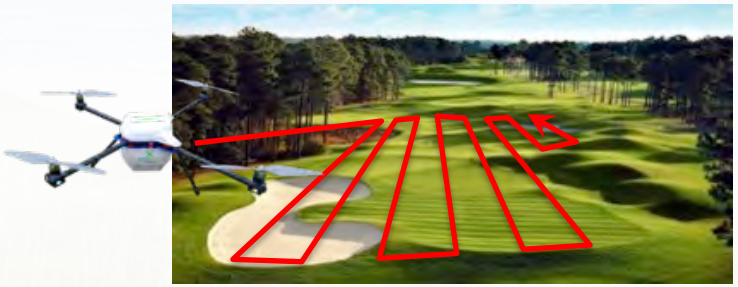
GREENSIGHT AGRONOMICS DAILY TURF MONITORING SERVICE

GREENSIGHT AGRONOMICS

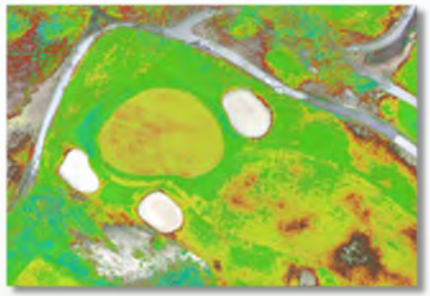
1. Leased Drones

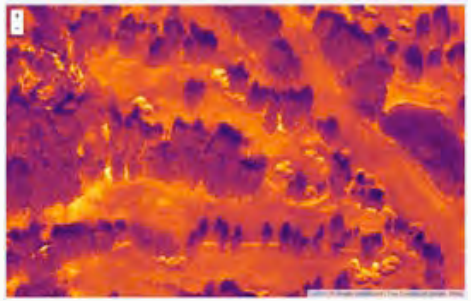
4. Actionable Maps and Analysis

2. Daily Automated Flights



3. Multi-spectral and Thermal Imaging





Seamlessly Integrated System

GREENSIGHT AGRONOMICS

Drone

Onsite, Legal, Insured Unattended(2018)

Everything Included With subscription

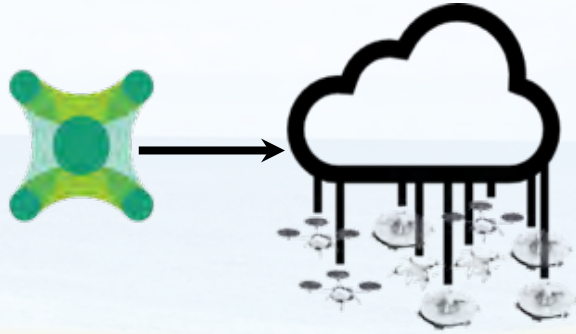
Cameras

1° Accuracy Thermal Camera Aerial Moisture Measurement

1” Image Resolution Multispectral Cameras

Processing

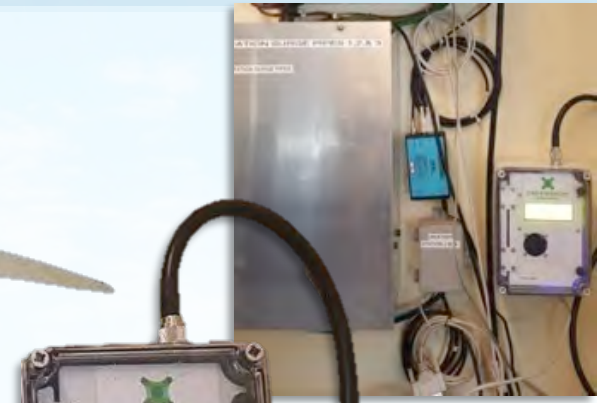
Cloud Processing, Analysis, and Alerts



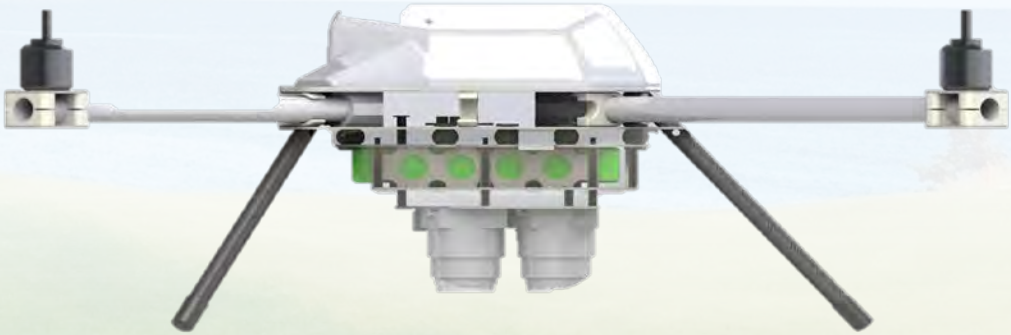
Remotely Administered by GreenSight

GreenSight Custom Drone System

- 4-rotor Quadcopter
  - 4lb “Microdrone”
  - Optimized for 35 min flight
  - ~100 acres per flight



- Unique Remote Admin and Command
  - Flight commanded by GreenSight
  - Simply plug in to recharge
  - Automatic data download and processing



Automated Right to Your Screen

GREENSIGHT AGRONOMICS

1. Automated Drones

2. Daily Automated Flights

3. Automated Upload, Process

VPN

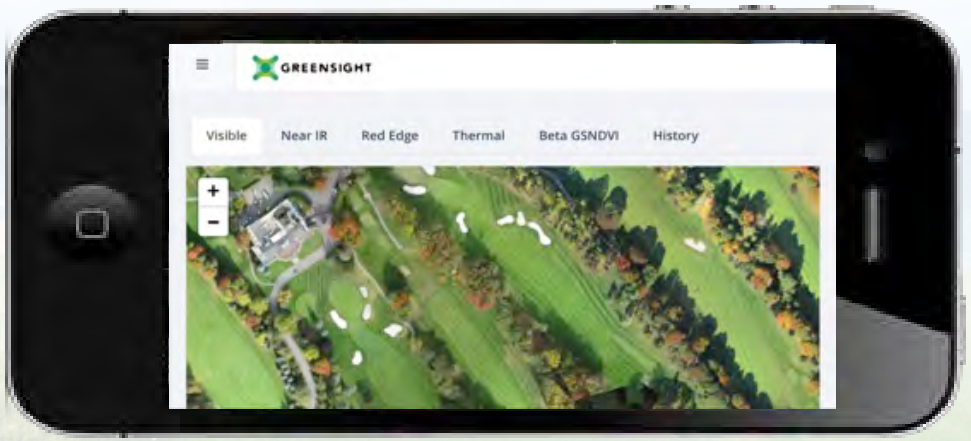
4. Cloud Storage *Encrypted, redundant storage of all data*

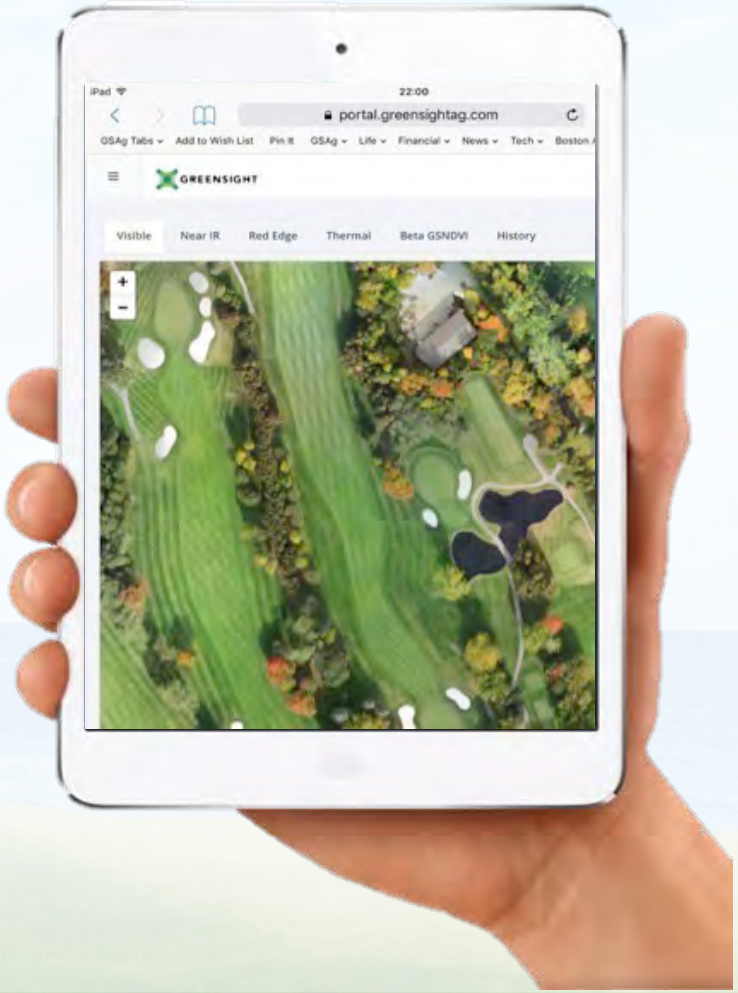
5. Image Preprocessing, maps

6. Web Portal

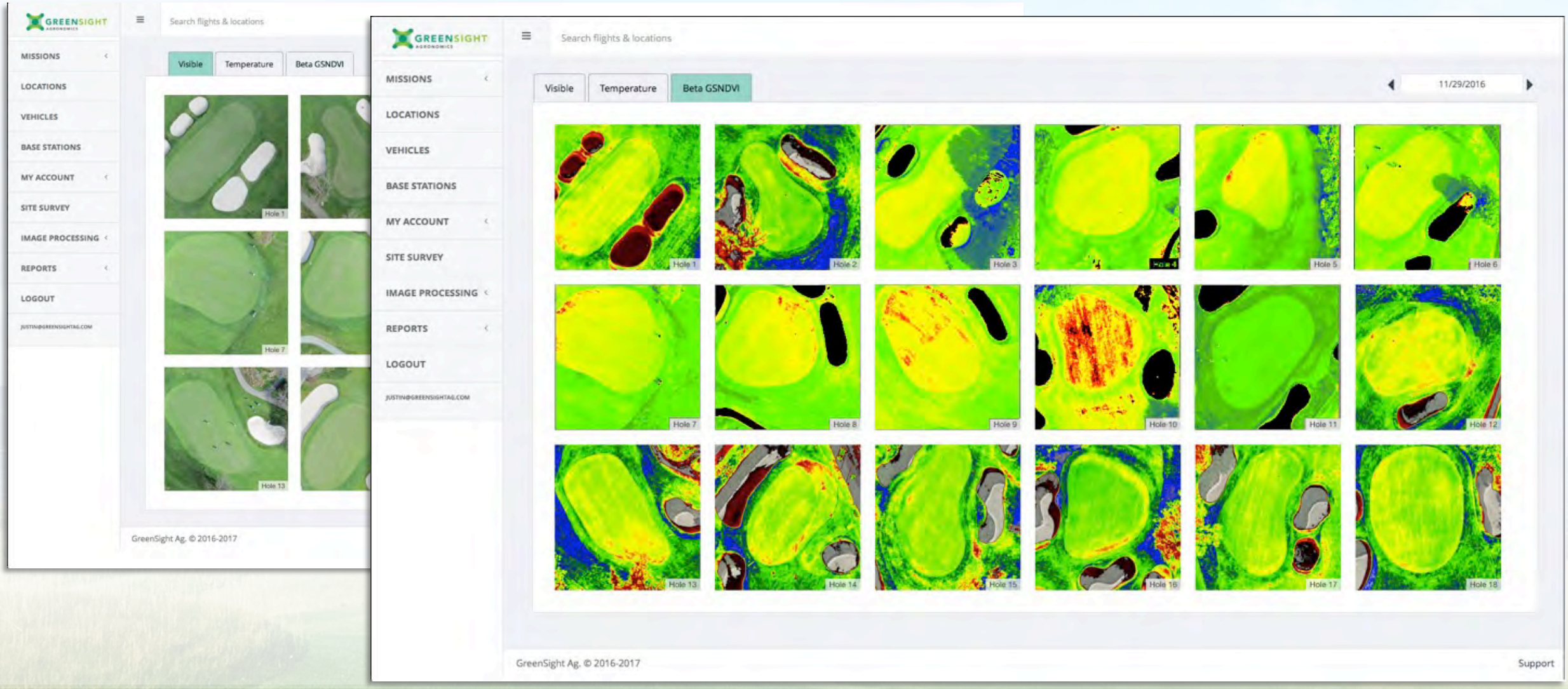
Imagery And Analysis Accessible Anywhere

GREENSIGHT AGRONOMICS





Summary Views



View the Big Picture, or Zoom In

GREENSIGHT AGRONOMICS

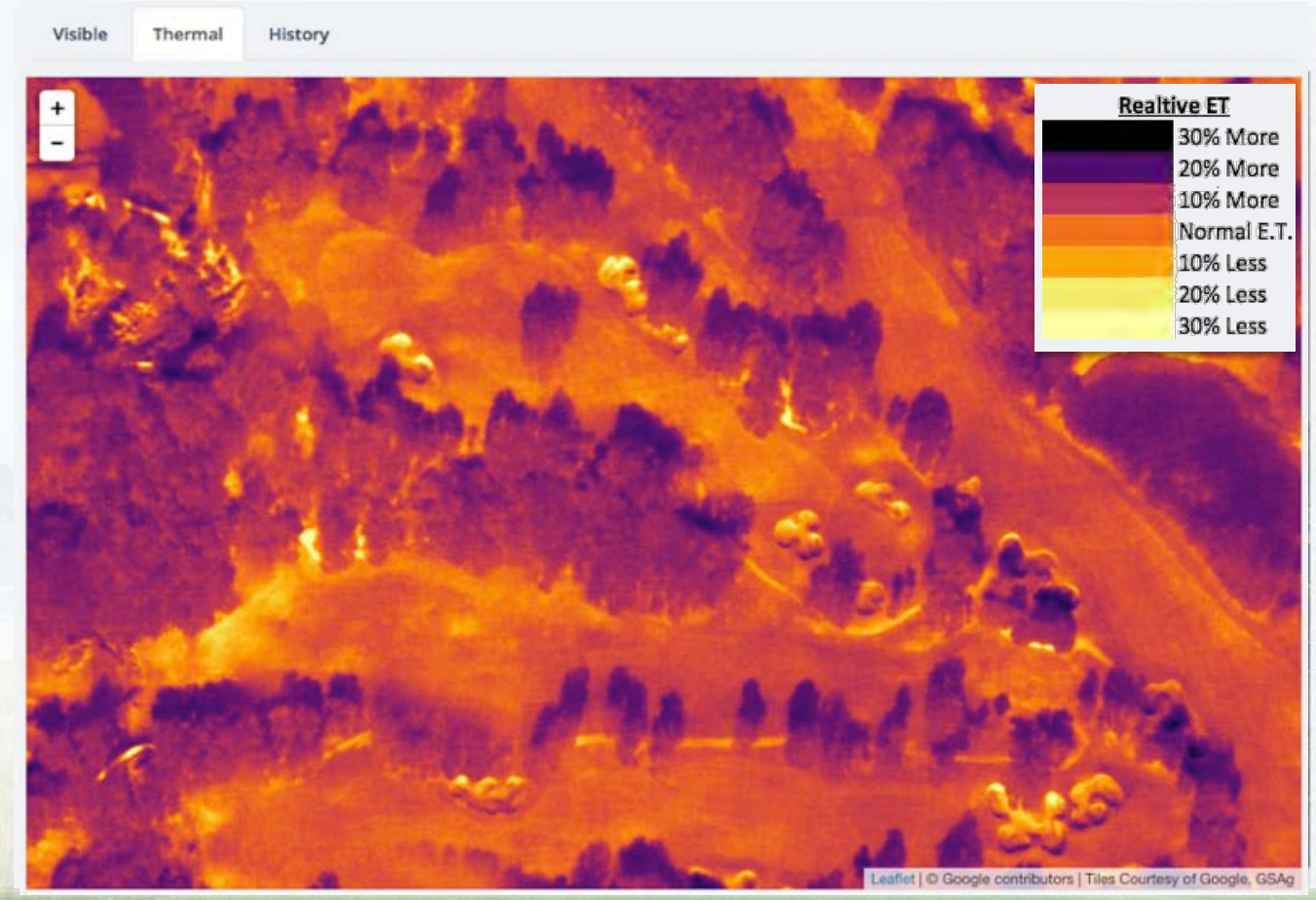
See the Big Picture

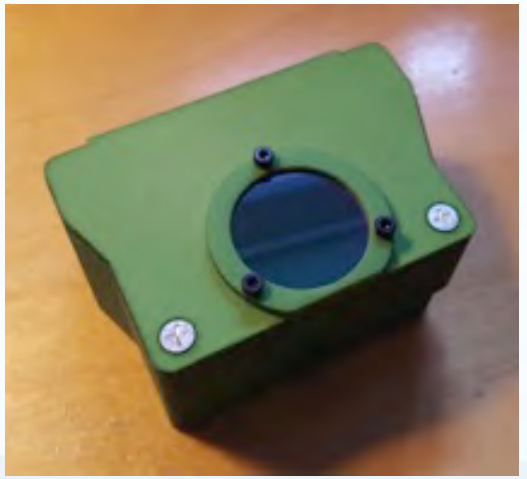
Or zoom in to examine the details

Irrigation Uniformity Issues

Thermal Temperature Measurements

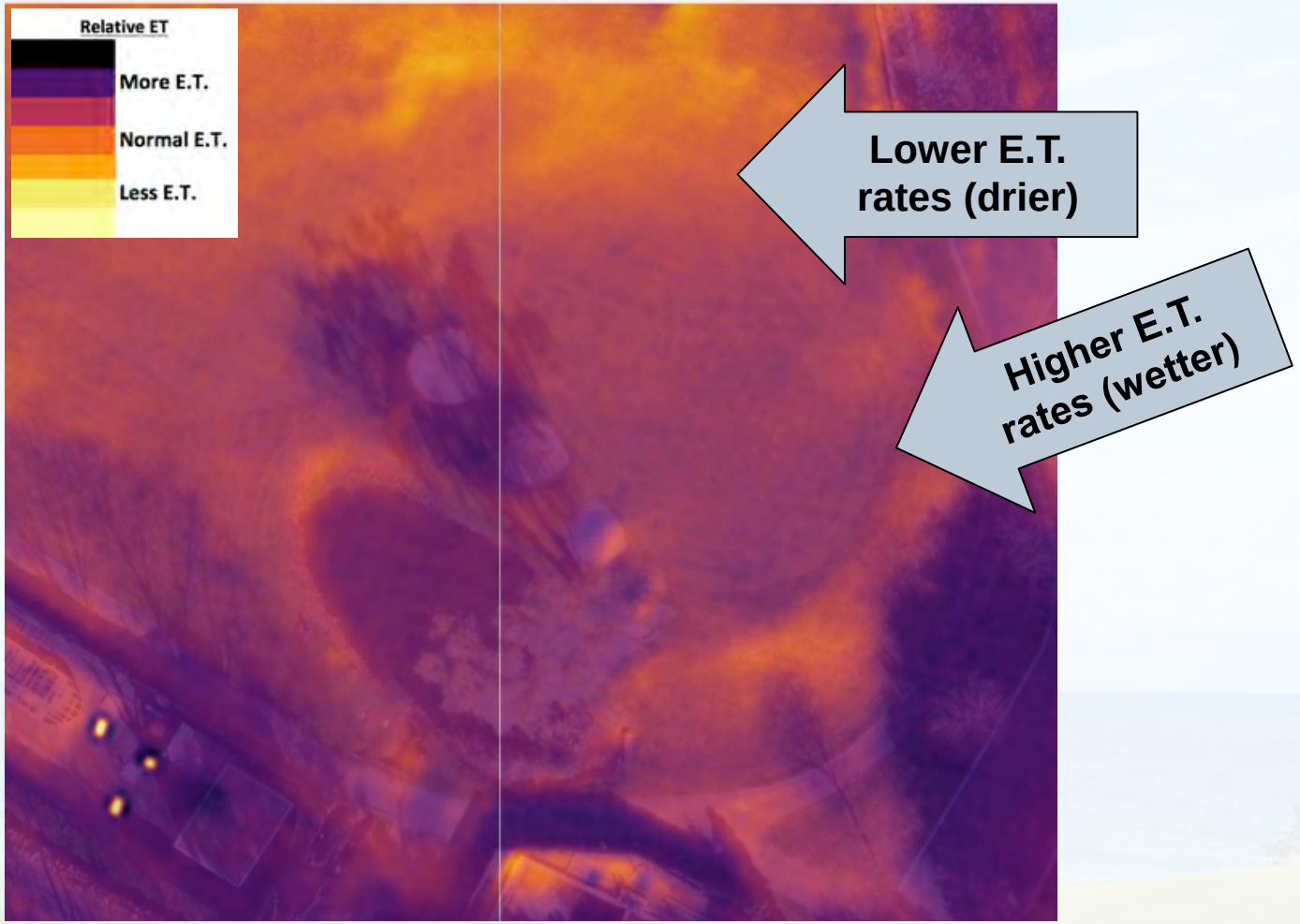
- Precise measurement of grass temperature
- Integrated with weather - hyper-local estimated evapotranspiration



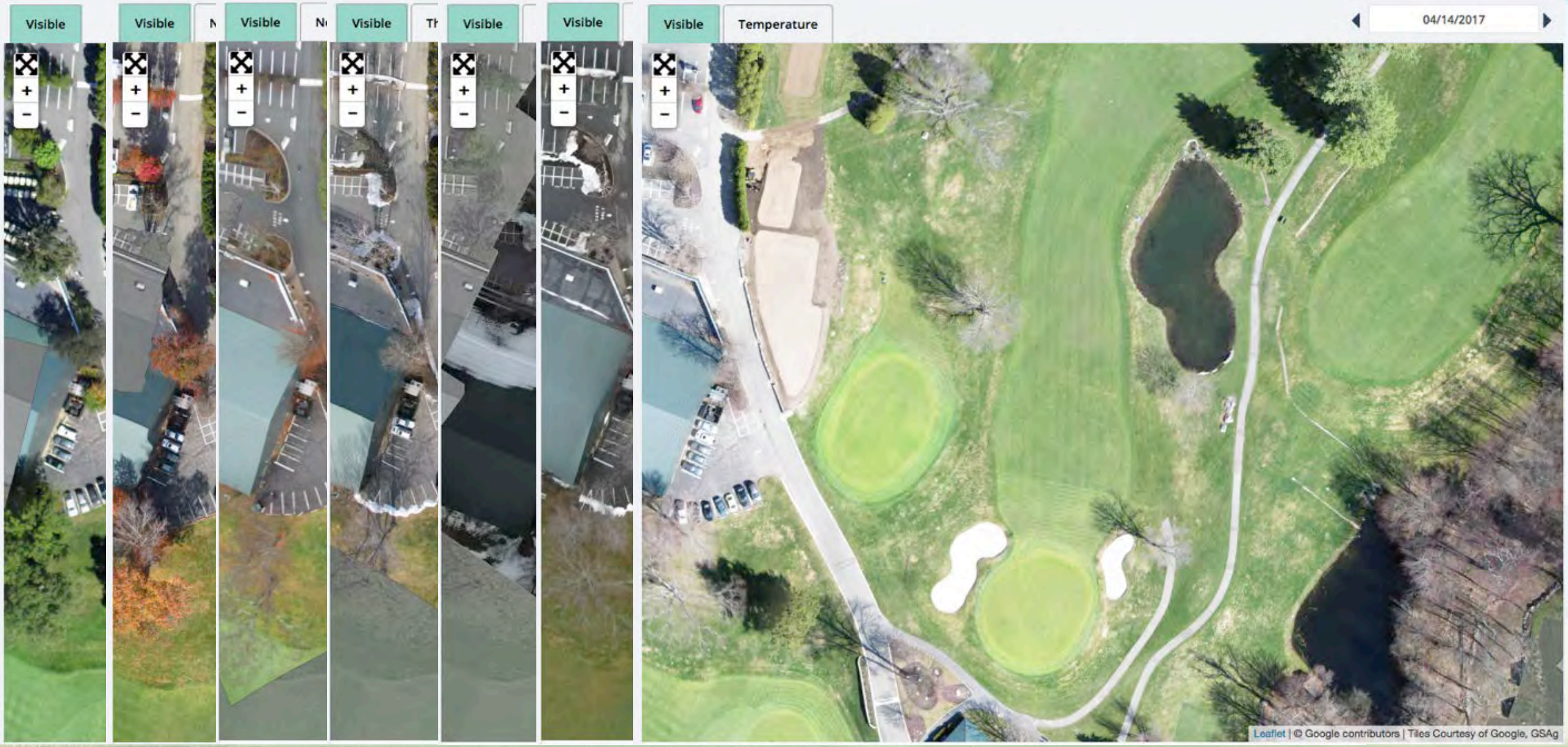


Generated with custom thermal camera – patent-pending calibration method

Moisture differences



Step through course history



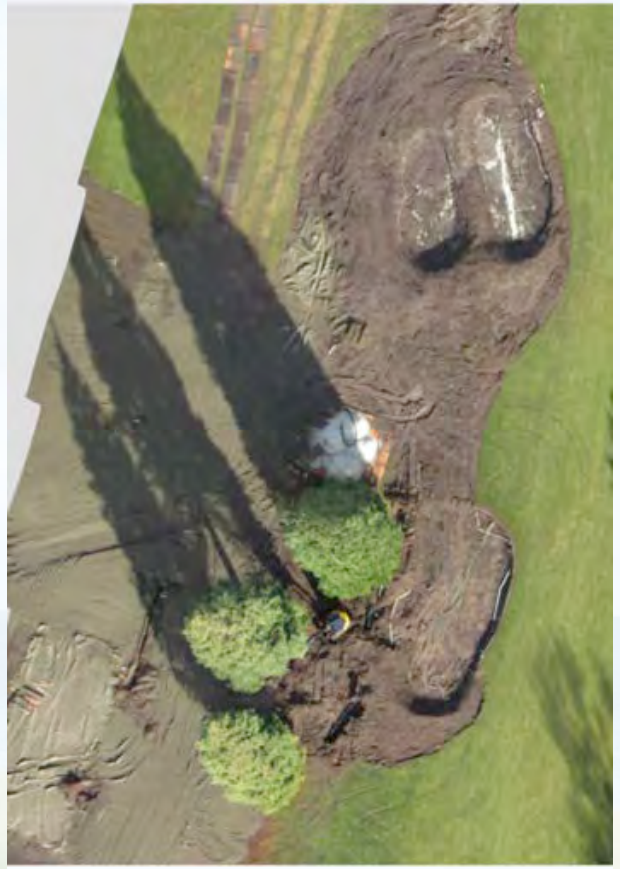
Renovation Progress

GREENSIGHT AGRONOMICS

Jan 9th, 2017

Jan 23rd, 2017

Feb 11th, 2017



April 10th, 2017

Shade and Shade Movement

GREENSIGHT AGRONOMICS

Nov 10th, 8am

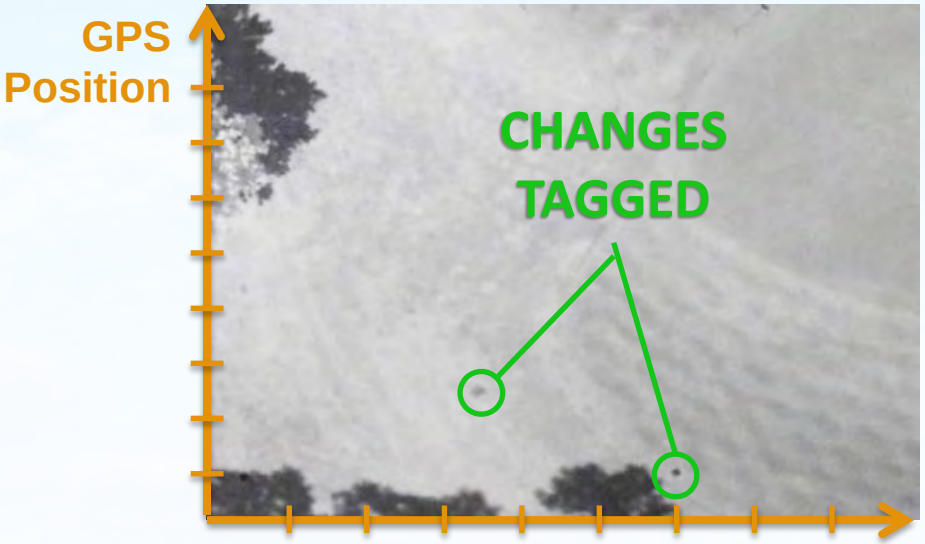
Nov 10th, 9am

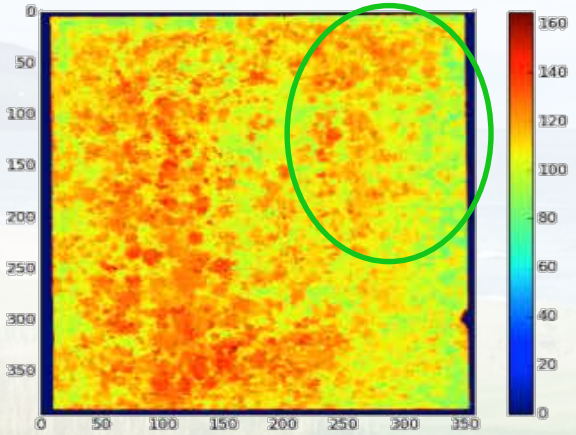
Drainage

The Future?

Change Detection Analytics

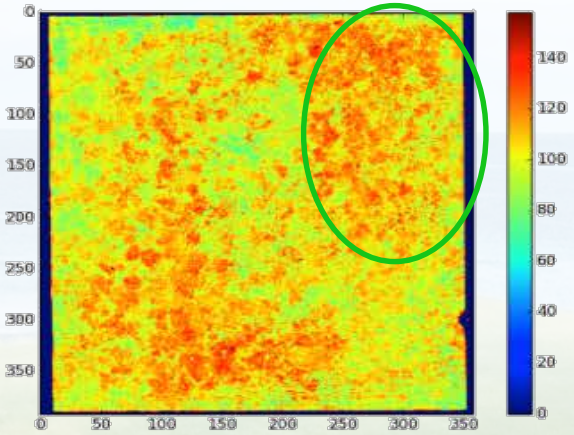
- Consistent, daily flights enable robust change detection
- Algorithm monitors changes in plant reflectance to gauge issue severity



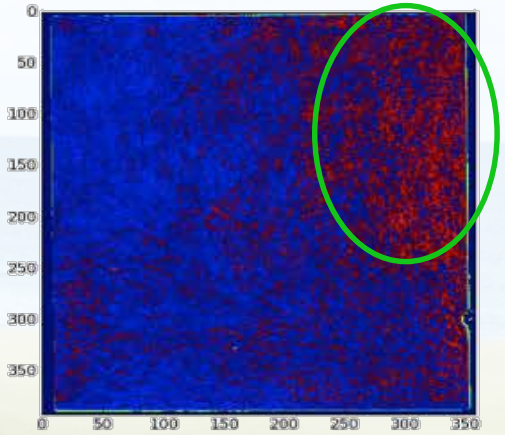


Sept. 20th

1 Day



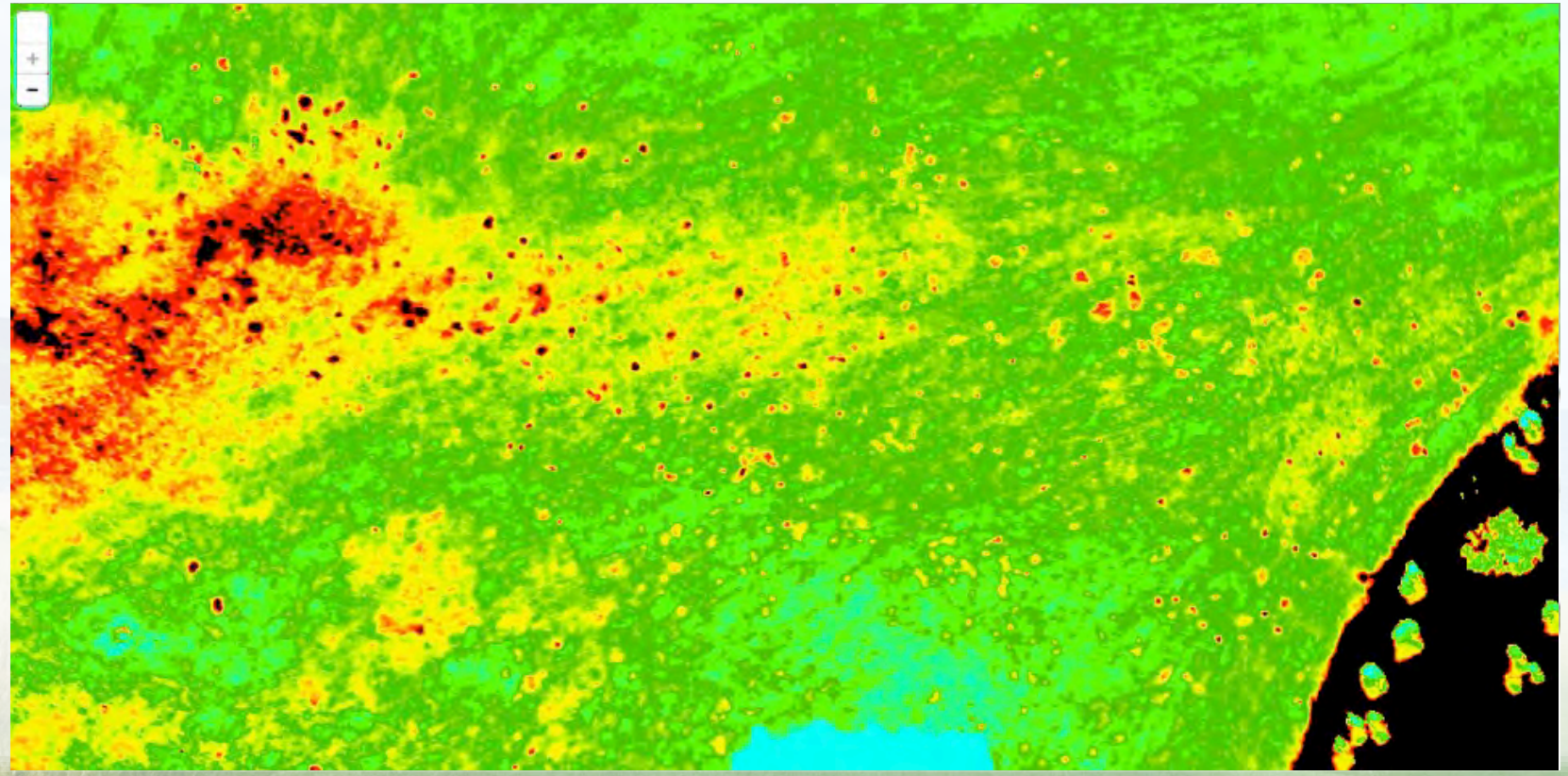
Sept. 21th

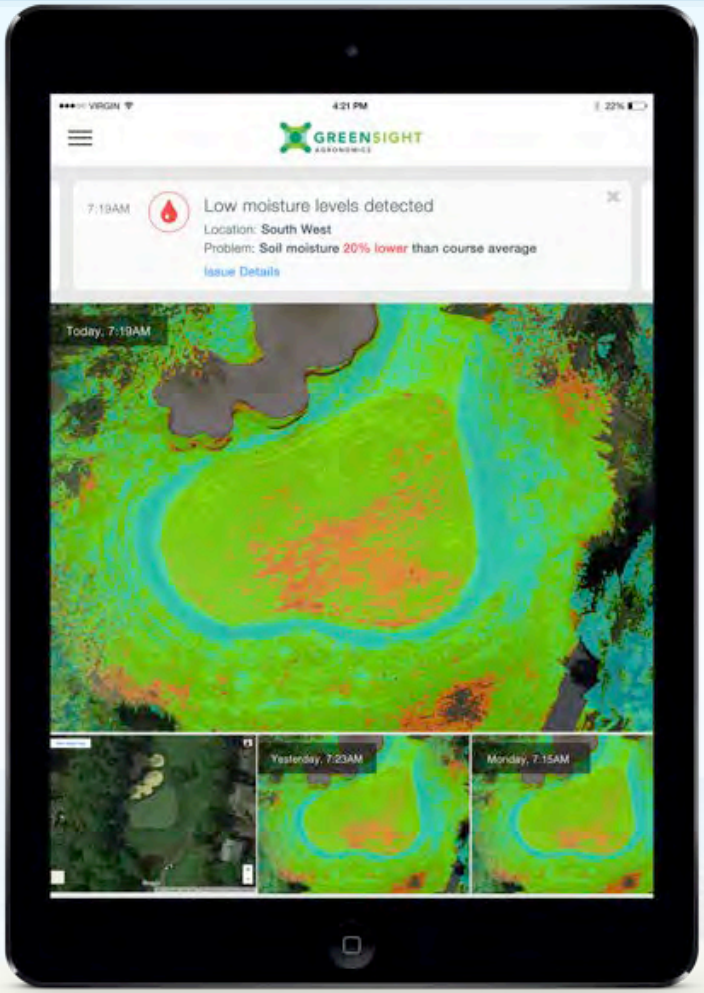


Change Map

GreenSight Predictive Alerts

- Highlight areas needing more irrigation
- Highlight where irrigation can be reduced
- Spot leaks
- ID pests and pathogens before they spread





GREENSIGHT

AGRONOMICS

Questions?

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