ASIC 2016
NORTHEAST REGIONAL CONFERENCE
APRIL 21 – 22, 2016
Westchester, NY
Theresa Backhus
USGBC Update
LEED v4: Impact on the Irrigation Industry

Theresa Backhus, USGBC

Presentation Provided by: USGBC
The Evolution of LEED: Where has it been?

LEED 2009 (v3)
CREATIVE TENSION

MARKET

URGENCY
Must comply with environmental laws

Must be a complete, permanent building or space

Must use a reasonable site boundary

Must comply with minimum floor area requirements

Must comply with minimum occupancy rates

Must commit to sharing whole-building energy and water usage data

Must comply with a minimum building area to site area ratio
<table>
<thead>
<tr>
<th>Rating system</th>
<th>Registration Close</th>
<th>Certification Sunset</th>
</tr>
</thead>
<tbody>
<tr>
<td>V2008</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Homes</td>
<td>10/31/16</td>
<td>6/30/21</td>
</tr>
<tr>
<td>V2009</td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Construction (and Italia NC)</td>
<td>10/31/16</td>
<td>6/30/21</td>
</tr>
<tr>
<td>Core and Shell</td>
<td>10/31/16</td>
<td>6/30/21</td>
</tr>
</tbody>
</table>
The Evolution of LEED: Where is it now?

v4 FOCUS ON PERFORMANCE
Global Adaptations

LEED v4:
ONE GLOBAL LEED
LEED v4 System Goals

- Climate Change: 35%
- Human Health: 20%
- Water Resources: 15%
- Biodiversity: 10%
- Green Economy: 10%
- Community: 5%
- Natural Resources: 5%
# Rating System Families

<table>
<thead>
<tr>
<th>Rating Systems</th>
<th>LEED® for Building Design and Construction</th>
<th>LEED® for Interior Design and Construction</th>
<th>LEED® for Building Operations and Maintenance</th>
<th>LEED® for Neighborhood Development™</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference Guides</td>
<td><img src="image1" alt="LEED Certification" /></td>
<td><img src="image2" alt="LEED Certification" /></td>
<td><img src="image3" alt="LEED Certification" /></td>
<td><img src="image4" alt="LEED Certification" /></td>
</tr>
<tr>
<td>Market Sector Adaptations</td>
<td>New Construction Core and Shell Schools Retail Healthcare Data Centers Hospitality Warehouses and Distribution Centers Homes Multifamily Midrise</td>
<td>Commercial Interiors Retail</td>
<td>Existing Buildings Data Centers Warehouses and Distribution Centers Hospitality Schools</td>
<td>Plan Project</td>
</tr>
</tbody>
</table>

![Image](image5)
LEED v4

- **Must be in a permanent location on existing land**
- **Must use reasonable LEED boundaries**
- **Must comply with project size requirements**
LEED Credit Library
LEED Documentation

Fewer Forms.
Reduced forms by 80% compared to LEED 2009 to improve system performance and consistency.

Alignment across rating systems
Includes campus, multiple building, recertification

Fewer fields to document.
Removed low-value documentation requirements.

Removed required signatories
Removed duplication of content
Credit Substitutions

Use v4 credits on your v2009 project

Published on 10 Jan 2014  Written by Batya Metalitz  Posted in LEED

Excited to start using LEED v4, but not sure you're ready to make the switch on your existing projects?
LEED v4 Technical Improvements: WE

Addresses **more water uses** including fixtures & fittings, processes, appliances, cooling towers, and landscape water use.

Focuses on **measuring water use** through a new water metering prerequisite and credit.

Outdoor Water Use is now a **prerequisite** (in addition to the credit).
LEED v4 Technical Improvements: WE

Prerequisite: Water Use Reduction

Prerequisite: Outdoor Water Use Reduction
Prerequisite: Indoor Water Use Reduction
Prerequisite: Building-Level Water Metering

Credit: Water Efficient Landscaping

Credit: Outdoor Water Use Reduction

Credit: Innovative Wastewater Techniques

Credit: Indoor Water Use Reduction

Credit: Water Use Reduction

Credit: Cooling Tower Water

Credit: Process Water Use Reduction (Schools)

Credit: Water Metering

KEY: Green = No or non-substantive change
      Yellow = Minor change
      Red = New credit or substantial modification
Show that the landscape does not require a permanent irrigation system beyond a maximum two-year establishment period.

Option 1: No Irrigation Required

Reduce the landscape water requirement (LWR) by at least 50% (30% prereq) from calculated baseline (first by plant selection and irrigation system efficiency via EPA WaterSense Water Budget Tool)

>30% reduction: use any combination of efficiency, alternative water sources, and smart scheduling technologies

Option 2: Reduced Irrigation
Reduce irrigation water use by 50% through plant species, density, irrigation efficiency, captured or recycled water, etc.

**Option 1:** Reduce by 50%

**Option 2:** No potable water use or irrigation

Meet Option 1 and:

Path 1. Use only alternative water sources.

Or

Path 2. No permanent irrigation

2009 WEc1 Water Efficient Landscaping (BD+C)
Show that the landscape does not require a permanent irrigation system beyond a maximum two-year establishment period.

Use the existing landscape to calculate the LWR using the EPA WaterSense Water Budget Tool. Install an irrigation meter and demonstrate a reduction in water use.

Establish a baseline using the annual average of at least 3 years of consecutive data out of the last 5 years and demonstrate a reduction in water use over the most recent 12 months.
Option 1: Baseline vs. Actual Use

Calculate baseline and compare to metered irrigation water use.

Option 2: Baseline vs. Estimated Use

Calculate baseline and compare to estimated irrigation water use. Determine ET0, species/density/microclimate factors. Calculate landscape coefficient and estimated water use.

Option 3: Independent Tools

Use local, regional, provincial, state, territorial or national performance or ranking tools to demonstrate reductions in water use.
LEED v4 Technical Improvements: SS

**Prerequisite:** Construction Activity Pollution Prevention

**Credit:** Brownfield Redevelopment

**Credit:** Site Development – Protect or Restore Habitat

**Credit:** Site Development – Maximize Open Space

**Credit:** Stormwater Design – Quantity Control

**Credit:** Stormwater Design – Quality Control

**Credit:** Heat Island Effect – Nonroof

**Credit:** Heat Island Effect – Roof

**Credit:** Light Pollution Reduction

**Prerequisite:** Construction Activity Pollution Prevention

**Credit:** Site Assessment

**Credit:** Site Development – Protect or Restore Habitat

**Credit:** Site Development – Open Space

**Credit:** Rainwater Management

**Credit:** Heat Island Reduction

**Credit:** Light Pollution Reduction

**KEY:**
- Green = No or non-substantive change
- Yellow = Minor change
- Red = New credit or substantial modification
SSc Rainwater Management

Intent: To reduce runoff volume and improve water quality by replicating the natural hydrology and water balance of the site, based on historical conditions and undeveloped ecosystems in the region.
SSc Rainwater Management (BD+C)

Option 1: Percentile of Rainfall Events

Path 1: 95th Percentile
- Replicate natural site hydrology
- Manage runoff for 95th percentile
- Use LID and GI

Path 2: 98th Percentile
- Replicate natural site hydrology
- Manage runoff for 98th percentile
- Use LID and GI

Path 3: 85th Percentile
- Replicate natural site hydrology
- Manage runoff for 85th percentile
- Use LID and GI

Option 2: Natural Land Cover Conditions

- Manage increase in runoff from natural land cover conditions

Only for zero lot line projects
Synergies with Other Credits

**WEp/c: Water Metering:** submeter irrigation water systems serving at least 80% of the irrigated landscaped area. Calculate the percentage of irrigated landscape area as the total metered irrigated landscape area divided by the total irrigated landscape area. Landscape areas fully covered with xeriscaping or native vegetation that requires no routine irrigation may be excluded from the calculation.

**SSc Open Space:** irrigation of qualifying vegetated open spaces
Synergies with Other Credits

WEc Total Water Use (Homes, Multifamily): use the EPA WaterSense Water Budget Tool to calculate the baseline landscape water consumption and the design landscape water consumption. Implement measures to further reduce landscape water consumption. Add the savings associated with the following measures to the reduction from the LWR: Install smart scheduling technology; captured rainwater; reclaimed water; water treated on site or conveyed by a public agency specifically for nonpotable uses.
Synergies with Other Credits

SSp Site Management Policy (O+M): monitor irrigation systems manually or with automated systems at least every two weeks during the operating season for appropriate water usage, system times, leaks, or breaks)

SSc Heat Island Reduction: vegetated roof irrigation

SSc Site Improvement Plan (O+M): rainwater reuse opportunities, potable water-use reduction
## LEED Outdoor Water Use Calculator

### Landscape Water Requirement

**Average monthly rainfall for the site’s peak watering month (in/month)**: 2.88

### Table: Landscape water requirement

<table>
<thead>
<tr>
<th>Zone ID</th>
<th>Hydrozone or Landscape Feature Area (sq ft)</th>
<th>Plant Type or Landscape Feature</th>
<th>Water Requirement</th>
<th>Landscape Coefficient ($K_L$)</th>
<th>Irrigation Type</th>
<th>Distribution Uniformity (DU)</th>
<th>$LWH_{H1}$ (gal/month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7,800 Turfgrass</td>
<td>High</td>
<td>0.8</td>
<td>Micro spray</td>
<td>70%</td>
<td>N/A</td>
<td>50,698</td>
</tr>
<tr>
<td>2</td>
<td>1,600 Groundcover</td>
<td>Low</td>
<td>0.2</td>
<td>No irrigation</td>
<td>N/A</td>
<td>N/A</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>1,600 Shrubs</td>
<td>Medium</td>
<td>0.5</td>
<td>Drip (press comp)</td>
<td>90%</td>
<td>N/A</td>
<td>4,233</td>
</tr>
<tr>
<td>4</td>
<td>1,000 Trees</td>
<td>Low</td>
<td>0.2</td>
<td>No irrigation</td>
<td>N/A</td>
<td>N/A</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>395 Trees</td>
<td>Medium</td>
<td>0.5</td>
<td>No irrigation</td>
<td>N/A</td>
<td>N/A</td>
<td>0</td>
</tr>
</tbody>
</table>

**Total hydrozone or landscape feature area (sq ft)**: 12,196

**Landscape water requirement based on the site’s peak watering month (gal/month)**: 54,332
**Summary**

Note: All information on this tab is READ-ONLY. To edit, see previous tabs.

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landscape water allowance (LWA) (gal/month)</td>
<td>34,694</td>
</tr>
<tr>
<td>Landscape water requirement (LWR) (gal/month)</td>
<td>54,332</td>
</tr>
<tr>
<td>Percentage reduction from baseline (%)</td>
<td>-57%</td>
</tr>
</tbody>
</table>
EPA WaterSense Water Budget Tool

Interactive Water Budget Tool

**STEP 1** Location and Area

**STEP 2** Plants and Irrigation

**STEP 3** The Results

Fill out the chart below with all the appropriate information to calculate your landscape’s water needs.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Area (sq. ft.)</th>
<th>Plant Type / Landscape Feature</th>
<th>Water Demand</th>
<th>Irrigation Type</th>
<th>Impact on Water Use</th>
<th>Required Water (gal/month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15,000</td>
<td>42,802</td>
<td>0</td>
<td>42,802</td>
<td>0</td>
<td>Remaining Area (sq. ft.)</td>
</tr>
</tbody>
</table>

*Total: 0*

*Add zone*

NEXT STEP >
LEED Outdoor Water Use Form

WE Prerequisite Outdoor Water Use Reduction
WE Credit Outdoor Water Use Reduction

Select one of the following:
- Option 1. No irrigation required (0-2 points)
- Option 2. Reduced irrigation (0-2 points)

Option 2. Reduced Irrigation

Upload: EPA WaterSense Tool or Outdoor Water Use Reduction Calculator
Provide the completed EPA WaterSense Water Budget Tool (accessible at epa.gov/watersense/water_budget) OR Outdoor Water Use Reduction Calculator (found under the prerequisite's "Resources" tab in the Credit Library).

Upload: Site plan
The Evolution of LEED: Where is it going?

PROVEN PERFORMANCE
Upcoming Changes and Additions

**Whole Project Water Use Reduction Pilot Alternative Compliance Path:** measure the baseline water use of the entire project (including irrigation) and demonstrate a reduction. Replaces most credits in the WE category.

**Green Walls:** inclusion of exterior green walls in calculations.

**Water Quality Pilot Credit:** especially important outside of the U.S. India and Mexico have proposed requirements for consideration.
The Sustainable Sites Initiative (SITES®) offers a systematic, comprehensive rating system designed to define sustainable sites, measure their performance, and ultimately elevate the value of landscapes. Administered by GBCI, the SITES rating system can apply to development projects located on sites with or without buildings, including open spaces, streetscapes and plazas, commercial, residential, educational/institutional, infrastructure, government, military and industrial.
The LEED® Dynamic Plaque™ is a building performance monitoring and scoring platform for LEED-certified projects, providing annual LEED recertification and global benchmarking. The plaque displays a LEED performance score, which reflects the measured performance of the building across five categories: energy, water, waste, transportation and human experience. The LEED Dynamic Plaque makes the invisible actionable and offers a means for interaction with the building on multiple levels.
Resources

www.usgbc.org/credits
www.usgbc.org/leed/v4
www.usgbc.org/leedonline
www.usgbc.org/sampleforms
www.usgbc.org/leed-interpretations

www.usgbc.org/pilotcredits
www.gbig.org/
www.sustainablesites.org
www.leedon.io
www.leeduser.com
Thank you!

Theresa Backhus
USGBC
tbackhus@usgbc.org
Regulating Irrigation

The centuries old battle over water has just begun…
Let’s talk politics…
Democratic Delegate Count

- Allocated Delegates: 2,383
- Needs: 635 delegates
- Remaining: 1,959 delegates

Republican Delegate Count

- Allocated Delegates: 1,237
- Needs: 494 delegates
- Remaining: 720 delegates

*Delegate count as of April 8, 2016*
Hillary Clinton’s Favorability Has Declined Since 2011

Jan 2009 – Apr 2016 Hillary Clinton Favorability Ratings

Analysis
• Hillary Clinton’s favorability has steadily declined over the past few years
• She has been more unfavored than favored since mid-2015
Bernie Sanders’ Favorability Has Consistently Risen Since March 2015

Analysis
- Sanders’ favorability has steadily increased since March 2015
- The percentage of people undecided about Sanders has dropped significantly as he became more well known over the course of his campaign
- The percentage of people who see Sanders unfavorably has also risen, but Sanders has generally been seen more favorably than unfavorably since July 2015
Donald Trump’s Favorability Has Decreased in Recent Months

May 2015 – Apr 2016 Donald Trump Favorability Ratings

Analysis
- Donald Trump has consistently been more unfavored than favored since May 2015
- Over the past few months, his favorability rating has decreased and his unfavorability rating has increased
Ted Cruz Has Been More Unfavored than Favored Throughout His Tenure as Senator

Analysis
- Ted Cruz has always been more unfavored than favored, since June 2013
- While his favorability has slightly increased over the past few months, his unfavorability rating has also increased
John Kasich’s Favorability Has Risen Since January 2016

Analysis

- John Kasich has had a higher favorable rating than unfavorable rating since the end of January.
- His favorability rating has risen, while his unfavorable rating has mostly stayed the same.
## 2016 Election Calendar

<table>
<thead>
<tr>
<th>Election Date</th>
<th>Debate</th>
<th>FEC Deadline</th>
<th>Convention</th>
</tr>
</thead>
</table>

### March
- **7**: April 5, 2016 | Katharine Conlon, Justin Brown and Christine Yan
- **11**: Primaries (AL, AR, GA, MA, OK, TN, TX, VT, VA)
- **21**: Republican Nat’l Convention (Cleveland, OH)
- **28**: Democratic Nat’l Convention (Philadelphia, PA)

### April

### May
- **9**: FEC Filing Deadline
- **10**: WA GOP Primary
- **17**: May 3: IN Primary

### June
- **9**: FEC Filing Deadline
- **11**: June 7: Primaries (CA, MT, NI, NM, SD), ND Dem. Caucus
- **14**: DC Dem. Primary
- **28**: UT Primary

### July
- **15**: FEC Filing Deadline
- **18-21**: Republican Nat’l Convention (Cleveland, OH)
- **25-28**: Democratic Nat’l Convention (Philadelphia, PA)

### September
- **8**: Sept. 26: First Presidential Debate
- **12**: Oct. 4; Vice Presidential Debate
- **9**: Oct. 9; Second Presidential Debate
- **15**: Oct. 15; FEC Filing Deadline
- **19**: Oct. 19; Third Presidential Debate

### October
- **8**: Nov. 8: Election day
Consistently Democratic or Republican States

Based on Past Presidential Elections, Democrats May Hold a Slight Advantage Heading into 2016 General Election

States That Voted Consistently in the Past Six Presidential Elections

- Voted Republican every election since 1992
- Voted Democratic every election since 1992

Analysis

- Democrats won 18 states plus the District of Columbia six times in a row, which in 2016 would earn 242 electoral votes, about 90 percent of the 270 electoral votes needed to win.
- In contrast, Republicans consistently carried 13 states over the last six elections, which in 2016 would earn the party 102 electoral votes, 38 percent of the 270 needed to win.

For more information on the political climate of the presidential primary, read Charlie Cook’s analysis.


December 7, 2015 | Christine Yan
April 4, 2016

**RAINFALL**
108% of normal

**SNOWPACK**
91% of normal
1997-1998 El Nino

RAINFALL

164% of normal

SNOWPACK

166% of normal
Fuse lit: April 1, 2015 – Executive Order on Drought from Governor Jerry Brown

2015: Updates to Model Water Efficient Landscape Ordinance Completed

2016: California Water Plan Updated
Who is driving the future?
Market Trends

- Native-type landscapes that won’t require irrigation.
- Minimal turf grass areas.
- No potable water for irrigation.
Voluntary

BMPs
Standards
Green Initiatives
Consumer Expectations

Mandatory

Ordinances
Codes
Regulations
Irrigation BMPs

BMP & Practice Guidelines
Design
Installation
Management
Appendices

Inspection & Commissioning
Water Budgeting
Scheduling
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 emission devices
  Check valve function
Standards in Progress

- ASABE S626 20__ Landscape Irrigation System Uniformity and Application Rate Testing
- ASABE S627 20__ Weather-based Landscape Irrigation Control Systems
- Both are out for public comment to ASABE
- ASABE S633 draft Soil Moisture Sensor for Landscape Irrigation in beta testing
Codes

- Shift to write standards in mandatory language.
- Adopted by code setting bodies or rating systems
- ICC, IAPMO, CalGreen
Observation

- Efficiency = reduction or elimination
- Assumes no benefit comes from plants
- Natives are superior
- No points for superior irrigation systems
- No follow up to the water budget
Strategy

• Use of BMP document
• IA has written a model landscape irrigation ordinance
  – Works with existing landscape ordinances
  – Modify for local circumstances
• Separate landscape issues from irrigation issues
Water resources are increasingly targets of legislation and regulation. IA provides a powerful ally to represent and protect your interests, nationally and locally.

Public Policy Issues

Model Irrigation Ordinance

Version 1.0 of the model irrigation ordinance, released on October 5, 2018, provides design parameters for new landscape irrigation systems and guidelines for existing irrigation systems. The ordinance works in conjunction with established landscape codes/ordinances and can be modified to meet local needs. In addition to the model irrigation ordinance, sample reports and checklists are available below.

- Model Irrigation Ordinance
- Irrigation Inspection Affidavit
- Example Irrigation Plan Checklist
- Certifier Report

If you have questions, please contact IA Government and Public Affairs Director John Farmer at johnfarmer@irrigation.org or IA Senior Policy and Advocacy Manager Elizabeth McCartney at elizabethmccartney@irrigation.org
§ 4.0 Irrigation Design Plan.

(a) This section applies to landscaped areas requiring permanent irrigation. For the efficient use of water, an irrigation system shall be planned and designed according to the most current version of the Landscape Irrigation Best Management Practices, by the Irrigation Association and the American Society of Irrigation Consultants.

(b) An irrigation design plan meeting the following design criteria shall be submitted for review and approval by the jurisdiction having authority and a permit issued if required.

1. Plan requirements:

2. The irrigation design plan, at a minimum, shall contain:

   (1) a scaled plan showing property lines, easements, existing or proposed structures, impervious surfaces, and existing natural features and if a new landscape project then consistent with the approved landscape plan;

   (2) location and size of the point of connection to the water supply and meter locations along with static water pressure at the point of connection to the water supply and dynamic water pressure for proper system operation;

   (3) reclaimed/recycled water or alternative water sources such as grey water shall comply with local plumbing codes including marking of pipes and system components;

   (4) location, type and size of all components of the irrigation system, including, backflow preventer, smart irrigation controllers, main and lateral lines, manual valves, remote control valves, sprinkler heads, moisture sensing devices, rain switches, quick couplers, pressure regulators;

   (5) an irrigation legend showing the identification of irrigation components;

   (6) flow rate (gallons per minute), application rate (inches per hour), and design operating pressure (pressure per square inch) for each irrigation zone;

   (7) installation details for each of the irrigation components.

3. Design statements and signature:

   (1) the following statement: "I have complied with the criteria of the ordinance and applied them accordingly for the efficient use of water in the irrigation design plan"; and

   (2) the signature of a qualified irrigation professional such as licensed landscape architect with irrigation credentials, certified irrigation designer, licensed/certified landscape contractor, or any other person authorized to design an irrigation system within the jurisdiction.

4. Irrigation system requirements:

   (a) Backflow prevention devices shall be required to protect the potable water supply from contamination by the irrigation system and comply with local plumbing codes.

   (b) Manual shut-off valves (such as a gate valve, ball valve, or butterfly valve) shall be required, as close as possible to the point of connection of the water supply and to
Concern

• Lack of understanding that plants provide and create ecosystem services that gets more valuable with time.
• Benefits are enhanced with actively growing plants—they need water.
Support of the initiative…
Authorization – Congressional (in)Action
Products
   Sprinklers
   Soil moisture- based irrigation controllers
Incentives
   State incentives and federal tax exemption
## Interpretations of Clean Water Rule by the EPA and Opposing Groups

<table>
<thead>
<tr>
<th>Role</th>
<th>EPA Interpretation</th>
<th>Opposing Groups Interpretation</th>
<th>Takeaway</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose of Rule</td>
<td>Clarifies which waters fall under Clean Water Act (CWA) jurisdiction by adding site-specific information to definitions; for example, seasonal streams are defined as sites that have water beds, banks, and high water marks</td>
<td>Expands CWA jurisdiction over waters by adding site-specific information to definitions; for example, seasonal streams are defined as all sites with seasonal water flow</td>
<td>The EPA characterizes the CWA Rule as clarifying the CWA’s jurisdiction, but many opposing groups characterize it as expanding the CWA’s jurisdiction</td>
</tr>
<tr>
<td>Scope of Rule</td>
<td>Scope unchanged; rule merely clarifies definitions of waterways already under CWA jurisdiction</td>
<td>Scope increases; rule would subject 3% more of U.S. waters to CWA jurisdiction</td>
<td>Many groups are debating the CWA’s scope under the rule; the EPA maintains the rule will not expand CWA jurisdiction, but opposing groups fear the rule will bring more waters under CWA authority</td>
</tr>
<tr>
<td>Rule’s Impact on Private Sector</td>
<td>Minimal impact; for example, rule identifies 50 agriculture conservation practices that will not be subject to clean water dredge and fill permitting requirements</td>
<td>Major impact; for example, rule expands CWA jurisdiction to ephemeral waters often found on agricultural and industrial sites</td>
<td>Most private sector groups expect increased compliance costs under the rule</td>
</tr>
</tbody>
</table>
“Waters of the U.S.”
in New York Farmland

Maps by Geosyntec
Analysis by American Farm Bureau Federation
Area of focus is near Hurley, New York in Ulster County.
Perennial, intermittent and **ephemeral** tributaries and adjacent wetlands all deemed jurisdictional without further analysis. (Under prior rules, only perennial and intermittent tributaries were jurisdictional without case-by-case analysis.) Ditches also regulated if “excavated in” or “relocated” a tributary. This map does not show smaller ditches that may be jurisdictional. (Note: light blue shapes designate freshwater ponds, dark blue shapes designate lakes, aqua blue shapes designate riverine, green shapes designate wetlands.)
Automatically Regulated Adjacent Waters

Includes all “waters”—including wetlands—that lie even partially within a 100-foot buffer (pink shading) around all perennial, intermittent and ephemeral tributaries.
Automatically Regulated Adjacent Waters

Includes all “waters”—including wetlands—where any part is within the 100-year floodplain and not more than 1,500 feet from a tributary. Light green shading shows the 1,500-feet zone and hash marks show the known FEMA 100-year flood zone (which may be out-of-date or may not be relied upon by the Corps). Absent definitive flood zone information from the Corps, any water partially within the light green shading is a possible “adjacent water.”
Water/wetlands even partially within 4,000 feet (about \(\frac{3}{4}\) mile) of a tributary can be regulated on a “significant nexus” finding. Orange shading shows land outside the possible adjacency zone but within the 4,000 feet zone. Even without mapping smaller jurisdictional ditches, the area of possible regulation covers the entire map.
Area of focus is near Scipio, New York in Cayuga County.
Automatically Regulated “Tributaries”

Perennial, intermittent and ephemeral tributaries and adjacent wetlands all deemed jurisdictional without further analysis. (Under prior rules, only perennial and intermittent tributaries were jurisdictional without case-by-case analysis.) Ditches also regulated if “excavated in” or “relocated” a tributary. This map does not show smaller ditches that may be jurisdictional. (Note: light blue shapes designate freshwater ponds, green shapes designate wetlands.)
Automatically Regulated Adjacent Waters

Includes all “waters”—including wetlands—that lie even partially within a 100-foot buffer (pink shading) around all perennial, intermittent and ephemeral tributaries.
Automatically Regulated Adjacent Waters

Includes all “waters”—including wetlands—where any part is within the 100-year floodplain and not more than 1,500 feet from a tributary. Light green shading shows the 1,500-feet zone and hash marks show the known FEMA 100-year flood zone (which may be out-of-date or may not be relied upon by the Corps). **Absent definitive flood zone information from the Corps, any water partially within the light green shading is a possible “adjacent water.”**
Maybe Regulated “Significant Nexus” Waters

Water/wetlands even partially within 4,000 feet (about ¾ mile) of a tributary can be regulated on a “significant nexus” finding. Orange shading shows land outside the possible adjacency zone but within the 4,000 feet zone.

Even without mapping of all jurisdictional ditches, the area of possible regulation covers the entire map.
Area of focus is near Mapleton, New York in Niagara County.
New WOTUS Rule – More Automatically Regulated “Tributaries”

Perennial, intermittent and ephemeral tributaries and adjacent wetlands all deemed jurisdictional without further analysis. (Under prior rules, only perennial and intermittent tributaries were jurisdictional without case-by-case analysis.) Ditches also regulated if “excavated in” or “relocated” a tributary. This map does not show smaller ditches that may be jurisdictional. (Note: light blue shapes designate freshwater ponds, green shapes designate wetlands.)
Automatically Regulated Adjacent Waters

Includes all “waters”—including wetlands—that lie even partially within a 100-foot buffer (pink shading) around all perennial, intermittent and ephemeral streams.
Includes all “waters”—including wetlands—where any part is within the 100-year floodplain and not more than 1,500 feet from a tributary. Light green shading shows the 1,500-feet zone and hash marks show the known FEMA 100-year flood zone (which may be out-of-date or may not be relied upon by the Corps). Absent definitive flood zone information from the Corps, any water partially within the light green shading is a possible “adjacent water.”
Maybe Regulated “Significant Nexus” Waters

Water/wetlands even partially within 4,000 feet (about ¾ mile) of a tributary can be regulated on a “significant nexus” finding. Orange shading shows land outside the possible adjacency zone but within the 4,000 feet zone.

Even without mapping around all jurisdictional ditches, the area of possible regulation covers the entire map.
The scope of the final rule’s impact in the focus area is similar to the rest of the state.
What Activities May Trigger CWA Liability and Permit Requirements?

• The application from a mechanical applicator (sprayer/spreader/nozzle) of any “pollutant” in any amount into a WOTUS requires a section 402 NPDES permit issued by state regulatory agencies or directly from EPA. A permit is required even if the WOTUS is dry at the time of application. Pollutants include, among other things:
  – chemical or biological pesticides (herbicides, insecticides, fungicides and coated seeds)
  – fertilizers (nitrogen, phosphorus, potassium and micro nutrient)
  – manure and manure products (including compost)

• A discharge of “dredged or fill material” can occur as a result of farming or ranching activities that involve moving dirt in a WOTUS. These discharges require a section 404 “dredge and fill” permit issued by the Corps of Engineers (again, even if the feature is dry at the time)—unless the activity qualifies for an exemption explained below. Possibly regulated activities include:
  – manipulating the soil on a field, such as grading, laser leveling, terracing, plowing, deep ripping, etc.;
  – construction and maintenance of roads, fences, ditches, ponds and culverts.

• Congress established several exemptions from the section 404 “dredge and fill” permit requirement. Under these exemptions, farmers and ranchers may not need a permit for plowing, seeding, cultivating, and harvesting (defined as “normal” farming practices), or for certain other activities like minor drainage, upland soil and water conservation practices, drainage ditch maintenance, construction and maintenance of irrigation ditches, farm/stock ponds, farm/forest roads and maintenance of levees/dams.

It is very important to understand that the Corps of Engineers has interpreted these exemptions very narrowly and its interpretations will generally be controlling in any enforcement action. As a result, many common farming practices that involve moving dirt in a WOTUS will NOT qualify for an exemption and will trigger a need for a 404 permit.
## “Waters of the U.S.” Zones in New York

<table>
<thead>
<tr>
<th>New York</th>
<th>Acres</th>
<th>Share of Total Acres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Acres in State</td>
<td>31,079,144</td>
<td></td>
</tr>
<tr>
<td>Total Acres w/i 4,000-foot buffer</td>
<td>30,458,484</td>
<td>98%</td>
</tr>
<tr>
<td>Total Acres w/i 1,500-foot buffer</td>
<td>24,225,363</td>
<td>78%</td>
</tr>
<tr>
<td>Total Acres w/i 100-foot buffer</td>
<td>2,317,069</td>
<td>7%</td>
</tr>
</tbody>
</table>
President Obama Vetoes Congress’ Attempt to Kill the Clean Water Rule

Steps for “Waters of the United States” Rule Submitted by the Environmental Protection Agency and the Corps of Engineers

- Rule was Finalized/Published In Federal Register
- Congress Had 60 Days to Review the Rule
- Rule was Enacted
- Introduced in the Senate
- The Senate passed a Congressional Review Act resolution to block the Clean Water Rule in November
- Passed the Senate, 53-44
- Passed the House, 253-166
- White House Vetoes the Bill

Realities

1) Policymakers’ involvement in the landscape irrigation industry will increase, not decrease
2) Landscape water use will be reduced (mandated)
3) Potable water will not be the main source for irrigation water
4) Landscapes will not look the same 10 years from know as they do today
5) Our industry needs to partner with governments and other stakeholders to form sustainable solutions
Oxygen.  
Food.  
Life.  

Just add water.

John Farner  
Irrigation Association  
Government and Public Affairs Director  
johnfarner@irrigation.org
What’s Happening in Turfgrass Research?

Stacy A. Bonos, Ph.D.

Dept of Plant Biology and Pathology
New Jersey Agricultural Experiment Station

2016 ASIC Northeast Regional Conference, April 21, 2016
The Changing Climate

- Variable weather patterns
  - Higher temperatures and drought stress
  - Polar vortex during winters
- Results in additional stresses on turfgrasses including additional and more intense disease/insect outbreaks
- Need to develop turfgrasses that can tolerate these temperature extremes and related stresses
We’re not raising grass - We’re raising families!

A large tractor sprays toxic chemical pesticides on the grass in the suburbs of Montgomery County, Maryland. Visit us at SafeGrowMontgomery.org

NO PESTICIDES
I LOVE MY FAMILY
AND THE ENVIRONMENT
MORE THAN MY LAWN.

BeeSafe.® Play safe.
Organic lawncare.
Turfgrass Breeding Objectives

- Drought
- Heat
- Diseases
- Salinity
- Low Maintenance
Breeding for Salt Tolerance
Greenhouse Screening Technique

(Koch and Bonos, Crop Sci. 2010)
Results

(10 weeks)

Treatment 1 (Control)
EC = 1

Treatment 4
EC = 15 dS/m
Hydroponic Greenhouse Method
Field Method

- Salt solution is made from NaCl and CaCl
- Solution: EC = 10 dS/m
- 0.125 gallons / plant
  - Flowmeter is used
  - 3 times / week
- Weekly soil tests
- % Green ratings (1-10 scale)
Salt Stress Injury
Soil EC of Kentucky Bluegrass Treated with Salt Solution
Field Screening of Kentucky Bluegrass for
Kentucky Bluegrass Cultivar Rankings
Perennial Ryegrass Cultivar Rankings

% Green Rating

Cultivars

- RKS
- Gator 3
- MSH Comp
- Apple GL
- Applaud
- Phenom
- ISPR314
- Palmer III
- Top Hat 2
- Paragon GLR
- Soprano
- Manhattan 5 GLR
- Mach 1
- Palmer IV
- Harrier
- AMS Comp
- Monterey II
- Zoom
- Linn
- Exacta
- Brightstar SLT
- Amazing
- Fiesta III

Legend:
- 2008
- 2010
Salt Tolerance of Bentgrasses
Germination Salinity Tolerance
Germination Tolerance to Salinity

- Cultivars with quick germination also those that germinate quickly under salinity
- No cultivar by treatment interaction
Potential Grasses for Low Maintenance

- Kentucky bluegrass
- Colonial bentgrass
- Fine fescues
- Tall fescue
Turfgrasses for Low Maintenance

- Kentucky bluegrass requires more fertility than other species - 1.5/2.0 lbs N/1000 each year
- Other species – fine fescues/tall fescues - 1.0 lb N/1000
- No fungicides
- No supplemental irrigation
- Mowed weekly with Toro Groundsmaster 2.5 inches
No Mow Hard Fescue

Hudson National golftripper.com
Hard Fescue – Drought Tolerant
Summer Patch of Hard Fescue
Germplasm Improvement of Low-Input Fine Fescues in Response to Consumer Attitudes and Behaviors

USDA-NIFA, Specialty Crop Research Initiative award number 2012-51181-19932.

Eric Watkins, Chengyan Yue, Kristen Nelson, Brian Horgan
University of Minnesota
Paul Koch, University of Wisconsin
Stacy Bonos, William Meyer, James Murphy, Bruce Clarke, Bingru Huang
Rutgers University
Germplasm Improvement of Low-Input Fine Fescues in Response to Consumer Attitudes and Behaviors.

- Collaborative Project - Univ. of Minn, Rutgers, Univ. of Wisc.
- Breeding and evaluation of fine fescues for improved quality, disease resistance, heat and drought tolerance, wear tolerance
- Marketing, Social and Extension Components
Fine Fescue Turf Quality in Presence of Summer Patch Disease

1-9 scale, 9 = least disease
Tiller Plots
Spaced-plant nurseries inoculated with summer patch disease
Diallel Crossing

\[ \begin{align*}
\text{RR} \times \text{RR} &= \text{RR} \\
\text{RR} \times \text{SS} &= \text{SS} \\
\text{SS} \times \text{SS} &= \text{SS} \\
\text{RS} \times \text{RR} &= \text{RS} \\
\end{align*} \]
Seedlings
Wear Tolerance of Fine Fescues
<table>
<thead>
<tr>
<th>Rank</th>
<th>Entry</th>
<th>Turf Qty</th>
<th>Rank</th>
<th>Entry</th>
<th>Turf Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>A00-2882</td>
<td>6.4</td>
<td>14.</td>
<td>Merit</td>
<td>4.3</td>
</tr>
<tr>
<td>2.</td>
<td>Mercury</td>
<td>6.3</td>
<td>15.</td>
<td>Armada</td>
<td>4.3</td>
</tr>
<tr>
<td>4.</td>
<td>LTP-A-03-38</td>
<td>6.0</td>
<td>17.</td>
<td>SR 2284</td>
<td>4.1</td>
</tr>
<tr>
<td>5.</td>
<td>Volt</td>
<td>6.0</td>
<td>18.</td>
<td>Baron</td>
<td>4.1</td>
</tr>
<tr>
<td>6.</td>
<td>Kenblue</td>
<td>5.7</td>
<td>19.</td>
<td>Raven</td>
<td>3.9</td>
</tr>
<tr>
<td>7.</td>
<td>Cabernet</td>
<td>5.4</td>
<td>20.</td>
<td>Zinfadel</td>
<td>3.9</td>
</tr>
<tr>
<td>8.</td>
<td>Langara</td>
<td>5.4</td>
<td>21.</td>
<td>Midnight</td>
<td>3.9</td>
</tr>
<tr>
<td>10.</td>
<td>Fielder</td>
<td>4.9</td>
<td>22.</td>
<td>Arrowhead</td>
<td>3.9</td>
</tr>
<tr>
<td>11.</td>
<td>Legend</td>
<td>4.9</td>
<td>23.</td>
<td>Fahrenheit 90</td>
<td>3.9</td>
</tr>
<tr>
<td>12.</td>
<td>Shiraz</td>
<td>4.8</td>
<td>24.</td>
<td>Bordeaux</td>
<td>3.8</td>
</tr>
<tr>
<td>13.</td>
<td>Bluenote</td>
<td>4.4</td>
<td>25.</td>
<td>LTP-A-08-6</td>
<td>3.4</td>
</tr>
</tbody>
</table>

Turf Quality rated on 1-9 scale, where 9 = best overall turf quality. Data average of the 2014 and 2015 growing seasons. Lsd at 5% = 0.9
# 2013 Low Maintenance Kentucky Bluegrass
## 2014-15 Turf Quality Ratings – Top Performers

<table>
<thead>
<tr>
<th>Rank</th>
<th>Entry</th>
<th>Turf Qty</th>
<th>Rank</th>
<th>Entry</th>
<th>Turf Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>PST-T10-18</td>
<td>6.7</td>
<td>11.</td>
<td>Pick 033</td>
<td>6.2</td>
</tr>
<tr>
<td>4.</td>
<td>KB11-22</td>
<td>6.5</td>
<td>14.</td>
<td>A00-1400</td>
<td>6.0</td>
</tr>
<tr>
<td>5.</td>
<td>Avalanche</td>
<td>6.5</td>
<td>15.</td>
<td>PST-K8-88</td>
<td>6.0</td>
</tr>
<tr>
<td>6.</td>
<td>A04TB-7</td>
<td>6.5</td>
<td>16.</td>
<td>RAD-1409</td>
<td>5.9</td>
</tr>
<tr>
<td>7.</td>
<td>Touche</td>
<td>6.4</td>
<td>17.</td>
<td>Keeneland</td>
<td>5.9</td>
</tr>
<tr>
<td>8.</td>
<td>A07-782</td>
<td>6.3</td>
<td>18.</td>
<td>PST-K11-123</td>
<td>5.9</td>
</tr>
<tr>
<td>9.</td>
<td>Washington II</td>
<td>6.3</td>
<td>19.</td>
<td>4724-8</td>
<td>5.9</td>
</tr>
<tr>
<td>10.</td>
<td>Bolt</td>
<td>6.2</td>
<td>20.</td>
<td>A03-38</td>
<td>5.9</td>
</tr>
</tbody>
</table>

Turf Quality rated on 1-9 scale, where 9 = best overall turf quality. Data average of the 2014 and 2015 growing seasons. Lsd at 5% = 0.9
### 2013 Low Maintenance Kentucky Bluegrass
#### 2014-15 Drought Quality Ratings – Top Performers

<table>
<thead>
<tr>
<th>Rank</th>
<th>Entry</th>
<th>Turf Qty</th>
<th>Rank</th>
<th>Entry</th>
<th>Turf Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>98-10 Purple</td>
<td>6.7</td>
<td>11.</td>
<td>KB11-47</td>
<td>5.7</td>
</tr>
<tr>
<td>3.</td>
<td>A07-783</td>
<td>6.2</td>
<td>13.</td>
<td>Legend</td>
<td>5.7</td>
</tr>
<tr>
<td>5.</td>
<td>A05-347</td>
<td>6.0</td>
<td>15.</td>
<td>103-585</td>
<td>5.5</td>
</tr>
<tr>
<td>6.</td>
<td>Fullback</td>
<td>6.0</td>
<td>16.</td>
<td>A08-2</td>
<td>5.3</td>
</tr>
<tr>
<td>7.</td>
<td>A07-782</td>
<td>6.0</td>
<td>17.</td>
<td>PST-K8-88</td>
<td>5.3</td>
</tr>
<tr>
<td>8.</td>
<td>Pick 033</td>
<td>5.8</td>
<td>18.</td>
<td>Keeneland</td>
<td>5.3</td>
</tr>
<tr>
<td>9.</td>
<td>KB11-28</td>
<td>5.8</td>
<td>19.</td>
<td>A98-233</td>
<td>5.3</td>
</tr>
<tr>
<td>10.</td>
<td>RAD-1409</td>
<td>5.8</td>
<td>20.</td>
<td>A13-1</td>
<td>5.3</td>
</tr>
</tbody>
</table>

Drought Quality rated on 1-9 scale, where 9 = best overall turf quality under drought conditions.
Data average of the 2014 and 2015 growing seasons. Lsd at 5% = 1.5
Selection of Kentucky Bluegrass for Deep Root Production
Mid-Atlantic types have deeper root production under high temperature stress
Mid-Atlantic Type - Cultivars

Aura
Bandera
Cabernet
Eagleton*
Fahrenheit 90

Longhorn
Spitfire
Starburst*

* Limited quantities available
Comparison of Tall Fescue and Kentucky Bluegrass

KB  TF  TF  KB
Tall Fescue Drought/Heat Stress Injury - 2010
Tall Fescue Tiller Plots: Evaluation of Drought Tolerance of Progeny
Drought Tolerance Screening in Tall Fescue

Water withheld 75 days (June-August)
Water withheld 75 days (June-August) Tall Fescue spaced plants
Improvements through breeding

‘Kentucky-31’    Improved Turf-Type
Low Maintenance Mixture Trial – North Brunswick, NJ

- Mixtures bought from local stores
- Costume mixtures put together
- Tall fescue, Kentucky bluegrass (light or dark), hard fescue, strong creeping red fescue, Chewings, perennial ryegrass
2011 Turfgrass Mixture Trial

- Components of species blends were created using equivalent quantities by weight based on seed counts performed for each species
  - Tall fescue
    - Bullseye + Faith + Mustang 4 (33.3:33.3:33.3 %)
  - Hard fescue
    - Beacon + Firefly (50:50 %)
  - Kentucky bluegrass “Dark”
    - Midnight II + Bewitched (50:50 %)
  - Kentucky bluegrass “Light”
    - Bluenote + A05-361 (50:50 %)
  - Chewings fescue
    - Fairmont + Intrigue II (50:50 %)
  - Strong Creeping Red fescue
    - Celestial + Wendy Jean (50:50 %)
  - Perennial Ryegrass
    - Fiesta 4 + Paragon GLR + Grand Slam GLD (33.3:33.3:33.3 %)
2014 vs 2015

September 10, 2015
Acceptable turf quality?
First irrigation event since 2013: September 22, 2015
Hard Fescue (36.5%) + Kentucky Bluegrass - Dark (12.5%) + Chewings Fescue (51%)

October 31, 2014
November 2, 2015

Bullseye' Tall Fescue

Hard Fescue (74.4%) + Kentucky Bluegrass (Dark) (25.6%)

Hard Fescue (36.5%) + Kentucky Bluegrass-Dark (12.5%) + Chewings Fescue (51%)
Hard Fescue (27.1%) + Tall Fescue (72.9%)

Hard Fescue (74.4%) + Kentucky Bluegrass-Dark (25.6%)

Hard Fescue (73.6%) + Kentucky Bluegrass-Light (26.6%)

Hard Fescue (41.7%) + Chewings Fescue (58.3%)

October 31, 2014
Hard Fescue (27.1%) + Tall Fescue (72.9%)

Hard Fescue (74.4%) + Kentucky Bluegrass-Dark (25.6%)

Hard Fescue (73.6%) + Kentucky Bluegrass-Light (26.6%)

November 2, 2015
October 31, 2014

Kentucky Bluegrass (Light) (14.7%) + Perennial Ryegrass (85.3%)

Kentucky Bluegrass (Dark) (14.1%) + Perennial Ryegrass (85.9%)
Kentucky Bluegrass (Light) (14.7%) + Perennial Ryegrass (85.3%)

Kentucky Bluegrass (Dark) (14.1%) + Perennial Ryegrass (85.9%)

November 2, 2015
November 2, 2015

Tall Fescue (88.7%) + Kentucky Bluegrass (Dark) (11.3%)

Kentucky Bluegrass (Light) (14.7%) + Perennial Ryegrass (85.3%)
Retail Mixture
‘Dakota’ Tall Fescue (19.8%)
‘Frontier’ Perennial Ryegrass (19.8%)
‘Deepblue’ Kentucky bluegrass (19.7%)
‘Harpoon’ Hard Fescue (19.7%)
‘Carmen’ chewings Fescue (19.7%)

“Thrives without chemicals”
“Creates a lush beautiful organic lawn”
Retail Mixture
‘Dakota’ Tall Fescue (19.8%)
‘Frontier’ Perennial Ryegrass (19.8%)
‘Deepblue’ Kentucky bluegrass (19.7%)
‘Harpoon’ Hard Fescue (19.7%)
‘Carmen’ chewings Fescue (19.7%)

“Thrives without chemicals”
“Creates a lush beautiful organic lawn”
## Turfgrass Mixture Trial
### 2012-15 Turf Quality Ratings – Top Performing Tall Fescue Mixtures (% by weight)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Tall Fescue</th>
<th>Hard Fescue</th>
<th>Ky Blue Dark</th>
<th>Ky Blue Light</th>
<th>Chewings</th>
<th>Strong Crp Red</th>
<th>Per. Rye</th>
<th>Turf Qty 2012-15</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>88.3</td>
<td></td>
<td></td>
<td>11.7</td>
<td></td>
<td></td>
<td></td>
<td>5.3</td>
</tr>
<tr>
<td>2.</td>
<td>88.7</td>
<td></td>
<td>11.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5.3</td>
</tr>
<tr>
<td>3.</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5.1</td>
</tr>
<tr>
<td>4.</td>
<td>41.3</td>
<td>5.2</td>
<td></td>
<td>21.5</td>
<td></td>
<td>32</td>
<td></td>
<td>5.1</td>
</tr>
<tr>
<td>5.</td>
<td>52.6</td>
<td>6.7</td>
<td></td>
<td></td>
<td></td>
<td>40.7</td>
<td></td>
<td>4.9</td>
</tr>
<tr>
<td>6.</td>
<td>72.9</td>
<td>27.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.8</td>
</tr>
<tr>
<td>7.</td>
<td>56.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>43.6</td>
<td></td>
<td>4.8</td>
</tr>
<tr>
<td>8.</td>
<td>Pennington Tall Fescue (“Rebel + Rebel Advance + Brockton”; 39.1:39.1:19.5)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.8</td>
</tr>
<tr>
<td>9.</td>
<td>66.7</td>
<td>24.8</td>
<td>8.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.7</td>
</tr>
<tr>
<td>10.</td>
<td>42.1</td>
<td></td>
<td>5.6</td>
<td></td>
<td>19.8</td>
<td>32.5</td>
<td></td>
<td>4.7</td>
</tr>
<tr>
<td>11.</td>
<td>41.2</td>
<td>5.5</td>
<td>21.4</td>
<td></td>
<td></td>
<td>31.9</td>
<td></td>
<td>4.7</td>
</tr>
<tr>
<td>12.</td>
<td>34.6</td>
<td>4.4</td>
<td>18</td>
<td></td>
<td>16.3</td>
<td>26.7</td>
<td></td>
<td>4.7</td>
</tr>
<tr>
<td>13.</td>
<td>36.5</td>
<td>13.5</td>
<td>4.6</td>
<td></td>
<td>17.2</td>
<td>28.2</td>
<td></td>
<td>4.7</td>
</tr>
</tbody>
</table>

Turf Quality rated on 1-9 scale, where 9 = best overall turf quality.
Data average of the 2012 through 2015 growing seasons. Lsd at 5% = 0.8
Low Maintenance Turfgrass Selections

- Tall fescue first choice
- Can be mixed with Kentucky bluegrass for a high quality low maintenance lawn
- Needs to be the right Kentucky bluegrass
- Fine fescues are improving
What about Bentgrasses?
Dollar Spot Disease Following Natural Infection
Dollar Spot Resistance in Creeping Bentgrass

Dramatically reduce fungicide use
Bentgrass Breeding

- Brown Patch Resistance
- Anthracnose Resistance
- Copper Spot Resistance
- Traffic Tolerance
- Low Mowing Tolerance
- Salt Tolerance
- Drought Tolerance
### NTEP Bentgrass Fairway Trial – Drought Tolerance

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Qty</th>
<th>Cultivar</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>A08-EBM</td>
<td>9.0</td>
<td>007</td>
<td>6.0</td>
</tr>
<tr>
<td>A08-FT12</td>
<td>9.0</td>
<td>Authority</td>
<td>6.0</td>
</tr>
<tr>
<td>BCD</td>
<td>8.7</td>
<td>Penncross</td>
<td>5.7</td>
</tr>
<tr>
<td>Greentime</td>
<td>8.7</td>
<td>Princeville</td>
<td>5.3</td>
</tr>
<tr>
<td>Tiger II</td>
<td>8.7</td>
<td>Pure Select</td>
<td>5.3</td>
</tr>
<tr>
<td>L-93</td>
<td>7.3</td>
<td>Barracuda</td>
<td>5.0</td>
</tr>
<tr>
<td>PST R9D7</td>
<td>7.3</td>
<td>Declaration</td>
<td>4.3</td>
</tr>
<tr>
<td>Crystal Blue Links</td>
<td>7.0</td>
<td>Luminary</td>
<td>4.3</td>
</tr>
<tr>
<td>CY-2</td>
<td>7.0</td>
<td>Memorial</td>
<td>4.3</td>
</tr>
<tr>
<td>Proclamation</td>
<td>7.0</td>
<td>Pin-Up</td>
<td>4.3</td>
</tr>
<tr>
<td>T-1</td>
<td>7.0</td>
<td>Benchmark DSR</td>
<td>1.7</td>
</tr>
<tr>
<td>SRP-1WM</td>
<td>6.3</td>
<td>LSD</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Drought ratings based on a 1-9 scale, 9=best
# Creeping Bentgrass Cultivars

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>007</td>
<td>Focus</td>
<td>Penn G-6</td>
<td>Seaside II</td>
<td>777</td>
</tr>
<tr>
<td>13M</td>
<td>Independence</td>
<td>Penncross</td>
<td>Shark</td>
<td>Nightlife</td>
</tr>
<tr>
<td>96-2</td>
<td>Kingpin</td>
<td>Penneagle II</td>
<td>Southshore</td>
<td>Armor</td>
</tr>
<tr>
<td>Alpha</td>
<td>L93</td>
<td>Pennlinks II</td>
<td>SR 1119</td>
<td>Kingdom</td>
</tr>
<tr>
<td>Authority</td>
<td>Luminary</td>
<td>Pin Up</td>
<td>SR 1150</td>
<td>Piranha</td>
</tr>
<tr>
<td>Barracuda</td>
<td>Mackenzie</td>
<td>Proclamation</td>
<td>T-1</td>
<td>L93XD</td>
</tr>
<tr>
<td>Cobra 2</td>
<td>Mariner</td>
<td>Pure Distinction</td>
<td>Tyee</td>
<td></td>
</tr>
<tr>
<td>Crystal Bluelinks</td>
<td>Memorial</td>
<td>Pure Select</td>
<td>V8</td>
<td></td>
</tr>
<tr>
<td>CY-2</td>
<td>Penn A-1</td>
<td>Putter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Declaration</td>
<td>Penn A-4</td>
<td>Runner</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flagstick</td>
<td>Penn G-2</td>
<td>Sandhill</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
New Cultivars to Look For

- L93XD, 777, Piranha
- Excellent wear, heat, drought, disease resistance (multiple diseases)
- Very high shoot density
Brown Patch in Colonial Bentgrass
Brown Patch in Colonial Bentgrass
New Improved Colonial Bentgrasses

- Capri
- Puritan
- Musket
- Heritage
Low Maintenance Fairway Trial

- Creeping, Colonial, Fine fescues, mixtures with colonial and Chewings, colonial and hard, etc.
- Mowed at ½ inch
- Curative fungicide and weed control treatments
- Limited irrigation
- Wear applied with a golf cart
Conclusions

- Mixtures had the best turf quality, wear tolerance
- They were better than both the individual cultivars by themselves
- Chewings, Hard and Slender creeping red fescue had the best disease resistance while creeping and colonial bentgrasses had the poorest
- Colonial/Chewings and Colonial/Hard fescue proved to be promising mixtures for low maintenance fairways

- Overall, our goal is to improve cool-season grasses for low maintenance and other stresses such as drought, heat and diseases
Bret Ramsey
Testing Ground Resistance

Bret Ramsey, Golf Field Service Manager

ASIC – April 21, 2016

The Intelligent Use of Water.™
Today’s Agenda

Grounding & Surge Protection

1. What is Surge?
2. Why is Grounding Important?
3. Typical Grounding & Surge Protection Equipment
4. What Influences Soil Resistance?
5. Testing Grounds
6. Case Studies
7. How can Bad Grounding be Improved?
8. Shielding Wire
Power surges, or spikes are fast, short duration electrical transients in voltage (voltage spikes), current (current spikes), or transferred energy (energy spikes) in an electrical circuit.

Typical causes for voltage spikes:

- Lightning strikes
- Power outages
- Tripped circuit breakers
- Short circuits
- Power transitions in other large equipment on the same power line
- Malfunctions caused by the power company
- Electromagnetic pulses (EMP) with electromagnetic energy distributed typically up to the 100 kHz and 1 MHz frequency range.
- Inductive spikes
Why is Grounding Important?

For Your System’s Protection…

The theory behind most surge protection is to provide a path of least resistance for electrical surges so they dissipate harmlessly in the ground. Such surge protection involves both surge arrestors and proper grounding.

No Ground = No Surge Protection
Grounding Equipment
Surge Protection Equipment

Examples of Surge Protection Components:

- ICSD = Integrated Control Surge Device
- MSP-1 = Protection for ICI

![ICSD](image1)

![Polyphaser](image2)

![MSP-1](image3)

![LSP-1](image4)
Grounding & Surge Protection

WITHOUT Surge Protection:
Grounding & Surge Protection

Purpose of **ICSD** is to **CONTAIN** Surge:
Improving Grounding Conditions

Ground Resistance is Affected by:

1. Soil Type
   - Sandy/Rocky Soils = High Resistance (Typ.)
   - Clay/Silt/Loam Soils = Low Resistance (Typ.)

<table>
<thead>
<tr>
<th>Soil</th>
<th>Resistivity (approx), Ω-cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ashes, cinders, brine, waste</td>
<td>Min.</td>
</tr>
<tr>
<td></td>
<td>590</td>
</tr>
<tr>
<td>Clay, shale, gumbo, loam</td>
<td>340</td>
</tr>
<tr>
<td>Same, with varying proportions of sand and gravel</td>
<td>1,020</td>
</tr>
<tr>
<td>Gravel, sand, stones with little clay or loam</td>
<td>59,000</td>
</tr>
</tbody>
</table>
Improving Grounding Conditions

Ground Resistance is Affected by:

2. Soil Moisture
   - As Soil Moisture Increases, Ground Resistance Decreases
   - Resistance increases dramatically when soil moisture falls below 20%
   - Where Possible, Locate Ground Rods/Plates in IRRIGATED Areas

<table>
<thead>
<tr>
<th>Moisture content % by weight</th>
<th>Resistivity Ω-cm Top soil</th>
<th>Resistivity Ω-cm Sandy loam</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>&gt;10°</td>
<td>&gt;10°</td>
</tr>
<tr>
<td>2.5</td>
<td>250,000</td>
<td>150,000</td>
</tr>
<tr>
<td>5</td>
<td>165,000</td>
<td>43,000</td>
</tr>
<tr>
<td>10</td>
<td>53,000</td>
<td>18,500</td>
</tr>
<tr>
<td>15</td>
<td>19,000</td>
<td>10,500</td>
</tr>
<tr>
<td>20</td>
<td>12,000</td>
<td>6,300</td>
</tr>
<tr>
<td>30</td>
<td>6,400</td>
<td>4,200</td>
</tr>
</tbody>
</table>
Improving Grounding Conditions

Ground Resistance is Affected by:

3. Temperature
   - Cooler temperatures increase soil resistance
   - Not easily influenced

4. Mineral Content
   - + Salt = <Resistance
   - Typical Enhancement Ingredient

<table>
<thead>
<tr>
<th>Added Salt (% by weight of moisture)</th>
<th>Resistivity (Ohm-centimeters)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10,700</td>
</tr>
<tr>
<td>0.1</td>
<td>1,800</td>
</tr>
<tr>
<td>1.0</td>
<td>460</td>
</tr>
<tr>
<td>5</td>
<td>190</td>
</tr>
<tr>
<td>10</td>
<td>130</td>
</tr>
<tr>
<td>20</td>
<td>100</td>
</tr>
</tbody>
</table>
Grounding Test Equipment

- **Fall of Potential Tester**
  - Requires disconnect from utility power.

- **Clamp on Tester**
  - Requires connection to utility power.
Grounding Test Equipment

- **Fall of Potential Tester**
  - Many Earth Ground Test Instruments offer multiple test capabilities.
  - 2, 3 & 4 Probe Tests are Common
  - Use **ONLY the 3 Probe**, Fall of Potential test when testing ground electrodes.

Disconnect Jumper for 3 Probe Tests!!!
Testing a Grounding Electrode

By Ohm’s Law: 
\( R = \frac{E}{I} \) you can determine the earth resistance at any point measured. For example, if the measured voltage \( E \) between rods 1 and 3 is 30 V and the measured current \( I \) is 2 A, the resistance of the earth \( R \) at that point would be 15 \( \Omega \).

(Megger- Getting Down to Earth)
“The electrode can be thought of as being surrounded by concentric shells of earth or soil, all of the same thickness. The closer the shell of the electrode, the smaller its surface; hence the greater the resistance. The farther away the shells are from the electrode, the greater the surface of the shell; hence the lower the resistance.” (AEMC-3640-4610-Manual)
## Testing Resistance of the Grounding Grid

**Distance to Auxiliary Electrodes using the 62% Method**

<table>
<thead>
<tr>
<th>Depth Driven</th>
<th>Distance to Y</th>
<th>Distance to Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 Feet</td>
<td>45 Feet</td>
<td>72 Feet</td>
</tr>
<tr>
<td>8 Feet</td>
<td>50 Feet</td>
<td>80 Feet</td>
</tr>
<tr>
<td>10 Feet</td>
<td>55 Feet</td>
<td>88 Feet</td>
</tr>
<tr>
<td>12 Feet</td>
<td>60 Feet</td>
<td>96 Feet</td>
</tr>
<tr>
<td>18 Feet</td>
<td>71 Feet</td>
<td>115 Feet</td>
</tr>
<tr>
<td>20 Feet</td>
<td>74 Feet</td>
<td>120 Feet</td>
</tr>
</tbody>
</table>
Testing Resistance of the Grounding Grid

Proper Spacing of Test Probes:
• Z Probe – far enough from X for **no overlap** of Effective Resistance areas
• Resistance should not vary if Y probe is moved 10% towards X or Z
Testing Resistance of the Grounding Grid

IMPROPER Spacing of Test Probes – Z TOO CLOSE to X:
• Z Probe – too close to X, Effective Resistance spheres overlapping
• Resistance will vary significantly if Y probe is moved 10% towards X or Z
Grounding & Surge Protection

- **Testing Earth Ground Resistance**
  - Resistance readings must be taken **WITHOUT** the bonding/shielding wire connected (grounding electrode only).
  - Each ICSD must have a local earth ground resistance of less than 50 ohms (without bonding/shielding wire).
  - Combination of grounding electrodes may be necessary to obtain proper resistance.
### Case Study – Tampa, FL

<table>
<thead>
<tr>
<th>WPT</th>
<th>Course</th>
<th>Phase</th>
<th>Hole</th>
<th>Description</th>
<th>Grid</th>
<th>Rod</th>
<th>Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>336</td>
<td>Hills</td>
<td>2</td>
<td>3F</td>
<td>Strike Location</td>
<td>N/A</td>
<td>N/A</td>
<td>62</td>
</tr>
<tr>
<td>337</td>
<td>Hills</td>
<td>2</td>
<td>3F</td>
<td>ICSD</td>
<td>8.0</td>
<td>609</td>
<td>73</td>
</tr>
<tr>
<td>338</td>
<td>Hills</td>
<td>2</td>
<td>3T</td>
<td>ICSD</td>
<td>5.6</td>
<td>589</td>
<td>70</td>
</tr>
<tr>
<td>339</td>
<td>Hills</td>
<td>2</td>
<td>2T</td>
<td>ICSD</td>
<td>5.5</td>
<td>229</td>
<td></td>
</tr>
<tr>
<td>341</td>
<td>Pines</td>
<td>3</td>
<td>8F</td>
<td>Strike Location / ICSD</td>
<td>5.0</td>
<td>366</td>
<td>72</td>
</tr>
<tr>
<td>342</td>
<td>Pines</td>
<td>3</td>
<td>8F</td>
<td>ICSD</td>
<td>5.2</td>
<td>58</td>
<td>52</td>
</tr>
<tr>
<td>343</td>
<td>Lakes</td>
<td>1</td>
<td>17F</td>
<td>ICSD</td>
<td>2.9</td>
<td>484</td>
<td>61</td>
</tr>
<tr>
<td>344</td>
<td>Lakes</td>
<td>1</td>
<td>18F</td>
<td>ICSD</td>
<td>2.8</td>
<td>333</td>
<td>44</td>
</tr>
<tr>
<td>345</td>
<td>Lakes</td>
<td>1</td>
<td>18F</td>
<td>ICSD</td>
<td>N/A</td>
<td>124</td>
<td>51</td>
</tr>
<tr>
<td>346</td>
<td>Lakes</td>
<td>1</td>
<td>18F</td>
<td>ICSD</td>
<td>2.2</td>
<td>370</td>
<td>45</td>
</tr>
<tr>
<td>347</td>
<td>Lakes</td>
<td>1</td>
<td>18F</td>
<td>ICSD</td>
<td>N/A</td>
<td>33</td>
<td>38</td>
</tr>
<tr>
<td>348</td>
<td>Lakes</td>
<td>1</td>
<td>18F</td>
<td>ICSD</td>
<td>2.9</td>
<td>1,133</td>
<td>50</td>
</tr>
<tr>
<td>349</td>
<td>Lakes</td>
<td>1</td>
<td>8G</td>
<td>ICSD</td>
<td>2.4</td>
<td>289</td>
<td>51</td>
</tr>
<tr>
<td>350</td>
<td>Lakes</td>
<td>1</td>
<td>15/16</td>
<td>ICSD</td>
<td>2.6</td>
<td>89</td>
<td>30</td>
</tr>
<tr>
<td>351</td>
<td>Lakes</td>
<td>1</td>
<td>12/13</td>
<td>ICSD</td>
<td>2.7</td>
<td>655</td>
<td>75</td>
</tr>
<tr>
<td>352</td>
<td>Hills</td>
<td>2</td>
<td>10F</td>
<td>ICSD</td>
<td>3.5</td>
<td>195</td>
<td>63</td>
</tr>
<tr>
<td>353</td>
<td>Hills</td>
<td>2</td>
<td>13G</td>
<td>ICSD</td>
<td>3.1</td>
<td>397</td>
<td>56</td>
</tr>
<tr>
<td>354</td>
<td>Hills</td>
<td>2</td>
<td>15F</td>
<td>ICSD</td>
<td>1.8</td>
<td>436</td>
<td>59</td>
</tr>
<tr>
<td>355</td>
<td>Hills</td>
<td>2</td>
<td>17G</td>
<td>ICSD</td>
<td>2.1</td>
<td>936</td>
<td>37</td>
</tr>
<tr>
<td>356</td>
<td>Pines</td>
<td>3</td>
<td>10T</td>
<td>Strike Location / ICSD</td>
<td>4.2</td>
<td>789</td>
<td>43</td>
</tr>
<tr>
<td>357</td>
<td>Pines</td>
<td>3</td>
<td>10F</td>
<td>Strike Location / ICSD</td>
<td>2.1</td>
<td>419</td>
<td>38</td>
</tr>
<tr>
<td>359</td>
<td>Pines</td>
<td>3</td>
<td>10F</td>
<td>Strike Location / ICSD</td>
<td>3.0</td>
<td>335</td>
<td>59</td>
</tr>
<tr>
<td>360</td>
<td>Pines</td>
<td>3</td>
<td>13F</td>
<td>ICSD</td>
<td>3.7</td>
<td>239</td>
<td>49</td>
</tr>
<tr>
<td>361</td>
<td>Pines</td>
<td>3</td>
<td>16F</td>
<td>ICSD</td>
<td>1.3</td>
<td>251</td>
<td>32</td>
</tr>
<tr>
<td>362</td>
<td>Pines</td>
<td>3</td>
<td>17F</td>
<td>ICSD</td>
<td>2.0</td>
<td>256</td>
<td>37</td>
</tr>
</tbody>
</table>

**Bonding Wire Connected**

**Rod Only, Bonding Wire Disconnected**
Case Study – Tampa, FL
Improving Grounding Conditions

Ground Resistance may be reduced by:

- Adding Rods
- Adding Plates
- Adding Grounding Enhancement Material such as POWER SET or GEM
- Improving Moisture

Scatterplot of Grid Resistance vs Elevation
Case Study – Armonk, NY

“Direct Strike”
- Properly Grounded (tested to 50 Ohms or less)
- Proper ICSD locations
- Result = Damage contained to 14 ICM’s
Improving Grounding Conditions

Ground Resistance may be Reduced by:

- Adding Rods
- Adding Plates
- Adding Grounding Enhancement Material such as POWER SET or GEM
Improving Grounding Conditions

Ground Resistance may be Reduced by:

- Adding Rods

Figure 2: Stacking grounding rods with threaded couplers can help decrease ground resistance.
Improving Grounding Conditions

Ground Resistance may be Reduced by:

- Adding Rods
- Adding Plates
  4”x96”x.0625” Min.
Conducting a Grounding Survey

1. Install a 5/8” x 10’ copper clad ground rod and test for resistance
   • If resistance is 50 Ohms or less, a single rod will suffice at this location
   • If resistance is > 50 Ohms, an enhancement strategy is required
2. Install a grounding plate 15’ away from the ground rod at a 3’ depth and measure its resistance
   • If the grounding rod is not at or below the resistance of the plate (measured independently), couple a second rod and drive the total length to a depth of 20’
   • If the resistance of the 20’ rod is 50% or less of that of the 10’ rod, coupling rods is a good strategy
   • If the resistance of the 20’ rod is not 50% or less than that of the 10’ rod, adding a second 10’ rod that is 20’ away (preferably in an irrigated area) is a better strategy.
Optional Bonding/Shielding Wire

Purpose of Bonding/Shielding Wire:

1. To protect wires and cables from lightning surges - When lightning strikes the ground, its electro-magnetic energy is dissipated into the soil in an area as far as 15-20 miles from the point of impact. This electro-magnetic energy is then induced on the underground wires and causes thousands of amperes to flow in the copper conductors. At times, this high flow of current is sufficient to melt the copper conductor, which in turn melts the insulation of the wire.
Optional Shielding Wire
Revolutionizing the way we manage water

Install Confidence.
Install Rain Bird.
Jerry Riley
Grounding / Clamp Tester
Earth ground should be attained for proper ground protection at the Gateway Unit.

**0 - 10 Ohms - Optimum**

Toro recommends a 5/8” clamp or “Cad Weld” fastener for the wire to rod connection.

Ground wire to additional rod(s) (Optional)

8AWG (8mm) Solid Bare Copper Wire

Valve Box w/Lid

8" Minimum Radius

8" Maximum Distance

8 – 12 Feet Max
“The sphere of influence”
(For ground rods)

8 ft. Ground Rod

16 ft.
Ground rod spacing

(Top view)

CORRECT
(2 times the ground rod length)

INCORRECT
“The sphere of influence”
(For ground plates)
Ground plate spacing
(Top view)

CORRECT
(2 times the ground plate width)
Ground rod/plate spacing

INCORRECT

Cable
Ground rod/plate spacing

CORRECT
When checking a resistance reading, make sure no other devices are connected to the same ground rod / plate.

Good ohm readings is less than 10 ohms
When checking a resistance reading, make sure no other devices are connected to the same ground rod / plate.

Good ohm readings is less than 10 ohms
When a reading shows “Loop” above the ohm reading, that means other devices are connected to the same ground rod / plate.

Disconnect ground wire
Incorrect

Correct
Questions
Tow Behind Sensor Technology

Larry Spain, LI 575, C.L.I.A.
The Toro Company
Precision Turf Management
Measuring & understanding variability in site conditions is the challenge.
Precision Turf Management

Precision Irrigation Management
Site-specific Irrigation Management

**Efficiency** requires
- Water use
- Operating budgets
- Labor
- Chemicals
- Fertilizers
- Equipment

**Precision** requires
- Precise application & management of all inputs

**Information** requires
- Critical agronomic site conditions
- Equipment performance

**Sensors & GIS**
- Soil Properties
  - Moisture
  - Compaction
  - Fertility
  - Salinity
- Turf Performance/Quality
- Topography/Relief
- Weather
- GPS
Precision Turf Management: Turf Quality vs. Inputs

Zone of normal operation today
- Best we can do with info we have
- Safe – predictable outcome

Zone of maximum efficiency through Precision
- Highest turf quality for the least inputs
- Small margin of error

Turf quality
Playability
Uniformity

Resource use
Management costs
Labor
Environmental impact

High return on investment
<table>
<thead>
<tr>
<th>Efficient Water Distribution</th>
<th>Site Variability</th>
<th>Real-Time Soil Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Precise Nozzles</td>
<td>• Soil Type</td>
<td>• Soil Moisture</td>
</tr>
<tr>
<td>• Precise Spacing</td>
<td>• Plant Type</td>
<td>• Salinity</td>
</tr>
<tr>
<td>• Precise Patterns</td>
<td>• Root Depth</td>
<td>• Temperature</td>
</tr>
<tr>
<td>• Precise Pressure</td>
<td>• Precipitation Rate</td>
<td>• Measurement</td>
</tr>
<tr>
<td>• Precise Trajectory</td>
<td>• Infiltration Rate</td>
<td>• Durations</td>
</tr>
<tr>
<td>• Precise Scheduling</td>
<td>• Elevation/Slope</td>
<td></td>
</tr>
<tr>
<td>• Precise Frequency</td>
<td>• Exposure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Outside Factors</td>
<td></td>
</tr>
</tbody>
</table>
Efficient Water Distribution

- Infinity Sprinkler
- LYNX Software
- P.A.C.E. Software
- Audit Kits

Site & System Variability

- Soil Type
- Plant Type
- Root Depth
- Precipitation Rate
- Infiltration Rate
- Compaction
- Elevation/Slope
- Exposure
- Outside Factors

Real-Time Soil Monitoring

- Turf Guard Soil Sensors
- Hand-Held Sensor
Site Assessment

Efficient Water Distribution

Soil Condition Monitoring
Decagon Soil Moisture Sensors
Two important observations:
1) Soil moisture distribution is consistent over time
2) Soil moisture patterns reflect soil texture.
Precise placement of Wireless Soil Sensors based on site evaluations will provide constant verification of soil conditions in like areas with minimal sensors.
PrecisionSense™ Data Collection Vehicle

- GPS provides latitude & longitude referencing and elevation data
- Soil sensors measure moisture & salinity content plus compaction
- Spectrometers measure turf vigor

- Foamer provides navigation
- • Soil moisture
  • Soil salinity
  • Soil compaction
  • Turf quality
  • Topographic relief
PrecisionSense™ maps give you the information to help with Precision Turf Maintenance practices
PrecisionSense™ Site Assessment

600-900 data points

Sampling pattern
PrecisionSense™ Data Collection Vehicle

Three Components:
1) Data collection tools “PS 6000”
2) Data processing & analysis using GIS
3) Data interpretation & consulting

• Decision-support system
• Data collection & analysis
• The product is Information
Soil compaction
Turf vigor
Soil moisture
Topography
Data collection & analysis process

Data collection & analysis process

1. Data collection
   On-site – Distributor technician

2. GIS ArcView processing & analysis
   Toro

3. Primary Data Products (Google Earth format)
   Toro

4. GIS application analysis
   Toro

5. Application Data Products & Implementation
   On-site – Distributor consultant
   • Irrigation management zones defined
   • Turf Guard sensor placement
   • SitePro/Lynx customization

Analysis products delivered to consultant & customer electronically

Data transmitted electronically to Toro

Application Data Products & Implementation
On-site – Distributor consultant
• Irrigation management zones defined
• Turf Guard sensor placement
• SitePro/Lynx customization

Primary Data Products (Google Earth format)
Toro

GIS ArcView processing & analysis
Toro

Soil moisture
Soil salinity
Turf vigor
Topography

Data transmitted electronically to Toro

Analysis products delivered to consultant & customer electronically
Base Maps
Soil Moisture
(VWC)
Turf Vigor
(NDVI)
NDVI

Normalized Difference Vegetation Index
Soil Compaction (P.S.I.)
Salinity
deci-Siemens (dS/m)
Salinity
deci-Siemens (dS/m)
Elevation

Contour Lines

Slope

Aspect
Topography

Contour Lines
Slope
Aspect
Precision Management Zones
Soil Moisture Classification

- **Saturation**
  (all pore space occupied by water)

- **Free or gravitational water**
  - Water lost through gravitational drainage

- **Capillary water**
  - Water available for plant uptake
  - Permanent Wilting point

- **Hydroscopic water**
  - Water unavailable to plants
  - Dry soil

- **Field capacity**
Water holding capacity depends on soil type (texture)

- Plant available water (field capacity)
- Unavailable water (permanent wilting point)

% pore space occupied by plant available water

- Sand
- Loamy sand
- Sandy loam
- Loam
- Sandy clay
- Clay loam
- Silty loam
- Silty clay
- Silty clay loam
- Silt
- Clay

9% 12% 14% 20% 22% 23% 26% 28% 31% 32% 33% 35%

Derived from: http://weather.nmsu.edu/models/irrsch/soiltype.htm
Measurement of soil moisture (VWC) at field capacity reveals soil texture variability.
Using that variability, Irrigation Management Zones are identified down to the sprinkler level for scheduling of irrigation by soil type and for Turf Guard sensor placement.
Map layers can be added to Toro’s LYNX central software for use in reprogramming to use the management zones.
Irrigation Management by Zones with In-ground Soil Sensors

Implementation:
• Turf Guard sensor placement & installation in individual zones
• SitePro/Lynx customization – program by irrigation zone
• Turf Guard sensors provide continuous feedback
• Readjusting with experience
• Resampling & remapping???
Precise placement of Soil Sensors based on site evaluations will provide constant verification of soil conditions in like areas with minimal sensors.
Software provides constant verification of soil conditions
Leaching events flush salts out of the root zone-verified by Turf Guard sensors.
Compare soil temperatures across holes and sensors on each hole
Thresholds can be set to display indicators for moisture, salinity, & temperature levels.
Turf Guard Sensor feedback can be linked to Toro’s Lynx Irrigation Control Software for decision making.
Turf Guard Sensors can be viewed in the Lynx Map for integrated decision-making.
Here, the Turf Guard Sensors are indicating moisture needs for specific stations based on user-defined thresholds.
Precision
Irrigation Audit
Irrigation Auditing

Distribution uniformity test using the catch-can method
Uniform soil moisture
Non-uniform soil moisture
Irrigation audit maps display Low Quarter Soil Moisture Uniformity (SMU) for identification of dry zones.
Irrigation audit maps display High Quarter Soil Moisture Uniformity (SMU) for identification of wet zones.
Compaction High Quarter maps help you see where treatment is needed to aid in water absorption and nutrient uptake.
Irrigation Auditing
Evaluating soil moisture distribution around individual sprinkler heads

Frwy #16
Head 1-162-4
MU 64.6%
Directional variation 21.5%
Pattern scale 43.6%
## Individual Irrigation Head Level - Metrics

<table>
<thead>
<tr>
<th>Head ID</th>
<th>Min</th>
<th>Mean</th>
<th>Max</th>
<th>Range</th>
<th>Std. Dev.</th>
<th>CV</th>
<th>Moisture Uniformity</th>
<th>Pattern</th>
<th>Pattern Scale</th>
<th>Directional Variation</th>
<th>Turf Vigor Correlation</th>
<th>Compaction Correlation</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>162-10</td>
<td>20.63</td>
<td>47.38</td>
<td>87.2</td>
<td>66.57</td>
<td>12.78</td>
<td>27%</td>
<td>67%</td>
<td>1</td>
<td>22.89</td>
<td>18.2</td>
<td>0.40</td>
<td>-0.63</td>
<td>5</td>
</tr>
<tr>
<td>162-11</td>
<td>23.78</td>
<td>56.4</td>
<td>89.07</td>
<td>65.29</td>
<td>12.29</td>
<td>21.8%</td>
<td>70%</td>
<td>9</td>
<td>38.78</td>
<td>14.7</td>
<td>0.68</td>
<td>-0.67</td>
<td>4</td>
</tr>
<tr>
<td>162-12</td>
<td>23.37</td>
<td>51.52</td>
<td>80.22</td>
<td>56.85</td>
<td>12.81</td>
<td>24.9%</td>
<td>67%</td>
<td>1</td>
<td>62.78</td>
<td>9.7</td>
<td>0.42</td>
<td>-0.82</td>
<td>5</td>
</tr>
<tr>
<td>162-13</td>
<td>14.8</td>
<td>39.25</td>
<td>60.53</td>
<td>45.73</td>
<td>9.48</td>
<td>24.2%</td>
<td>67%</td>
<td>3</td>
<td>26.11</td>
<td>17.9</td>
<td>0.54</td>
<td>-0.79</td>
<td>4</td>
</tr>
<tr>
<td>162-14</td>
<td>15.77</td>
<td>46.53</td>
<td>97.92</td>
<td>82.15</td>
<td>17.19</td>
<td>36.9%</td>
<td>59%</td>
<td>1</td>
<td>72.30</td>
<td>21.2</td>
<td>0.41</td>
<td>-0.54</td>
<td>5</td>
</tr>
<tr>
<td>162-31</td>
<td>23.01</td>
<td>38.52</td>
<td>57.95</td>
<td>34.94</td>
<td>7.79</td>
<td>20.2%</td>
<td>77%</td>
<td>5</td>
<td>12.84</td>
<td>13.6</td>
<td>0.79</td>
<td>0.13</td>
<td>8</td>
</tr>
<tr>
<td>162-32</td>
<td>16.2</td>
<td>43.79</td>
<td>104.6</td>
<td>88.4</td>
<td>21.29</td>
<td>48.6%</td>
<td>53%</td>
<td>1</td>
<td>66.96</td>
<td>25.2</td>
<td>0.06</td>
<td>-0.53</td>
<td>5</td>
</tr>
<tr>
<td>162-33</td>
<td>23.26</td>
<td>45.99</td>
<td>99.83</td>
<td>76.57</td>
<td>17.81</td>
<td>38.7%</td>
<td>61%</td>
<td>13</td>
<td>29.00</td>
<td>31.4</td>
<td>0.67</td>
<td>-0.60</td>
<td>4</td>
</tr>
<tr>
<td>162-34</td>
<td>16.76</td>
<td>50.03</td>
<td>92.82</td>
<td>76.06</td>
<td>14.24</td>
<td>28.5%</td>
<td>61%</td>
<td>1</td>
<td>46.51</td>
<td>19.9</td>
<td>0.20</td>
<td>-0.51</td>
<td>5</td>
</tr>
<tr>
<td>162-35</td>
<td>25.9</td>
<td>40.88</td>
<td>59.03</td>
<td>33.13</td>
<td>8.6</td>
<td>21%</td>
<td>73%</td>
<td>7</td>
<td>23.19</td>
<td>19.4</td>
<td>0.81</td>
<td>0.19</td>
<td>4</td>
</tr>
<tr>
<td>162-36</td>
<td>15.37</td>
<td>30.59</td>
<td>56.71</td>
<td>41.34</td>
<td>9</td>
<td>29.4%</td>
<td>69%</td>
<td>3</td>
<td>48.56</td>
<td>16.9</td>
<td>0.39</td>
<td>-0.29</td>
<td>5</td>
</tr>
<tr>
<td>162-37</td>
<td>24.79</td>
<td>37.08</td>
<td>48.63</td>
<td>23.84</td>
<td>4.24</td>
<td>11.4%</td>
<td>86%</td>
<td>3</td>
<td>15.06</td>
<td>10.1</td>
<td>0.02</td>
<td>0.00</td>
<td>10</td>
</tr>
<tr>
<td>162-38</td>
<td>18</td>
<td>41.33</td>
<td>63.16</td>
<td>45.16</td>
<td>9.36</td>
<td>22.6%</td>
<td>72%</td>
<td>1</td>
<td>50.49</td>
<td>11.1</td>
<td>0.04</td>
<td>-0.09</td>
<td>6</td>
</tr>
<tr>
<td>162-39</td>
<td>36.79</td>
<td>44.86</td>
<td>49.88</td>
<td>13.09</td>
<td>2.48</td>
<td>5.5%</td>
<td>93%</td>
<td>NA</td>
<td>3.85</td>
<td>3.1</td>
<td>-0.16</td>
<td>0.14</td>
<td>10</td>
</tr>
<tr>
<td>162-40</td>
<td>16.25</td>
<td>48.78</td>
<td>162.94</td>
<td>146.69</td>
<td>24.93</td>
<td>51.1%</td>
<td>49%</td>
<td>3</td>
<td>87.41</td>
<td>28.4</td>
<td>0.54</td>
<td>-0.70</td>
<td>4</td>
</tr>
</tbody>
</table>

### Head 162-10

#### Soil Moisture

- **Soil Moisture Turf Vigor Soil Compaction**

#### Turf Vigor

- **Soil Compaction**
Irrigation audit maps display Low Quarter Soil Moisture Uniformity (SMU) for identification of dry zones.
Soil moisture uniformity, quality of turf, and compaction are combined to create a chart of trouble spots ranked by number.
Sprinkler arc overlap maps display how many sprinklers impact the same areas helping to understand why areas might be drier or wetter.
Head spacing and sprinklers in non-uniform areas are identified on the maps in red for location of high priority work orders.
Hand Watering

Primary Observations:

1a) Inaccurate sprinkler head location data: The irrigation consultant for Bear's Best was unable to specify the map projection for the sprinkler head location data. As a result, locations used in this analysis for some heads appear to be off by up to 15 ft. when compared visually to Google aerial images with running sprinklers visible (6/21/11 aerial image, fwy. 2, tee end), or to small areas of high turf vigor caused by weeping or drainage at heads (visible in same image above).

1b) Inaccurate head data in the Lynx database: Three different heads and six different nozzle set combinations are listed as the primary heads – 760-62, 64 & 65; 730-34 & 35; 720-9. Many instances of head specs compared to locations/applications appear to be in error. For example, several heads in the middle of Fwy 3 are shown as 720 and 760 half circle heads rather than 730s. As a result, the head coverage analysis and map layer is generalized based on an average throw radius of 59.6’ for all heads rather than using specific radii for specific heads which would have made the analysis of coverage more accurate and useful.

Partial list of apparent head discrepancies found in the Fairway Heads layer created from the Lynx DB:

- 720-9 heads with 180° arcs found in the middle of fairways: Fwy 3 – 2 heads, Fwy 8 – 1 head, Fwy 9 – 2 heads, Fwy 10 – 5 heads, Fwy 11 – 2 heads, Fwy 12 – 9 heads
- 760-64 heads with 180° arcs found in the middle of fairways: Fwy 8 – 7 heads, Fwy 12 – 12 or more heads, Fwy 10 – 15 or more heads
A. Soil Moisture

A4. Sprinkler head overlap vs. high soil moisture

A sprinkler head coverage map created from head spacing data combined with radius-of-throw and water pressure data taken from the Lynx data base shows consistent overlap at nearly every fairway sprinkler head. The head layout at xxxxxxx results in a 10-20' diameter area around the majority of fairway heads that is overlapped by seven heads while the midpoint between heads is overlapped by 3 or 4 heads on average. The average head spacing on fairways is 59.2 ft. The specified throw radius for heads and nozzles at xxxxxxx is 63-67 ft. depending on water pressure. (This analysis assumes that the actual radius-of-throw matches the throw specified by the head data in the data base.)

The disparity in overlap around heads vs. overlap midway between heads could be a primary cause of repetitive patterns of wet to dry soil moisture around and between heads.

Catch can tests have revealed that the actual extent of head overlap is

---

[Images: Head Coverage, Soil Moisture, Turf Vigor maps]
After this information is provided, start checking sprinkler performance with catch can audits in trouble spots. Also check database information and confirm it matches the field hardware.
Justin McClellan
Making Golf Courses Greener

Reducing water and chemical costs while enhancing turf quality
The Challenges

Golf courses face rising irrigation expenses
- National Average: >$75K/year
- $500k+ is not uncommon in Southwest

Chemical use must be efficiently managed
- Chemicals and fertilizer <$40,000 annually (per 18-holes)
- Regulation and limitation of treatments

Public Pressure to reduce water, chemical use
- New water regulations
- New pesticides/fungicide bans and regulations

Drone Data enables precise application, saving courses 25%
Solution: GreenSight Zero-Labor Turf Monitoring Service

One time setup: unpack, plug in

Minimizes User Effort

System operates automatically every day

User receives DAILY ACTIONABLE information
Proprietary System

- Machine-to-machine interface
  Admin via web
- Custom Sensor
  5x more data
- Completely Automated
  Flies daily
  Sends email/text alerts
- Turfgrass-Specific Analytics
  Unique add-ons
- Machine-to-machine interface
- Admin via web
- Custom Sensor
  5x more data
- Completely Automated
  Flies daily
  Sends email/text alerts
- Turfgrass-Specific Analytics
  Unique add-ons
Multi-spectral Imager

• Custom camera gathers data in multiple wavelengths to detect a variety of conditions
  - Tuned to narrow “color” bands, camera gathers data on reflectance of leaf that is not visible to the naked eye
  - Common issues impact this reflectance in narrow color bands

- Grubs (root damage)
- Dollar Spot (fungal infection)
- Nitrogen Deficiency, Red Thread
Thermal Imager & Moisture

• True thermal imager measuring temperature
  ▪ Proprietary calibration provides +/- 1 degree accuracy
  ▪ Onboard sensors provide ambient temp, pressure, humidity, & luminosity

• We compute high accuracy temperature differentials
  ▪ Calculate soil moisture based on canopy temperature
  ▪ Greater accuracy than evapotranspiration models

• Compliment to in-ground sensors
  ▪ We add 100% areal coverage
  ▪ ~10cm resolution
Change Detection Analytics

- **Pixel Counting Algorithm**
  - GPS-referenced-images evaluated
  - Issues show up as high/low intensity
  - Pixels counted, position and “color” of issue logged in our database.

- **Change Detection**
  - Our consistent, daily flights enable robust change detection
  - Algorithm monitors changes in plant reflectance to gauge issue severity
Drone System

• 4-rotor “Quadcopter”
  ▪ 4 lbs, 24” across
  ▪ Optimized for 45-60 min flight
  ▪ 100-120 acres per flight

• Fully Automated
  ▪ Pre-programmed waypoints
  ▪ Vision-guided landing in base station
  ▪ Automatic recharge, data download
  ▪ Remotely administered via Wi-Fi, 3G, Ethernet
Potential Benefits With Our System

System provides

1. Soil moisture maps covering entire course
2. Soil moisture alerts
3. Early ID and alerts for common pests (Dollar Spot, Pythium, Grubs)

Efficient chemical application >$15k/yr

Irrigation optimization saves $15k-$100k/yr

Prevention of damage $1M+ lost revenue or repair

Optimizing labor maximizes turf quality within existing budget

Utilize limited resources more effectively!
Subscription Service

- Subscription pricing starting at $900/mo
- Hardware is included, warrantied, and upgraded
- Web-based analytics and processing, easy!
- Additional add-on services rolled out regularly

Simple to use, no software or maintenance headaches
2016 Pilot Key Features

• Moisture Monitoring
  ▪ Thermal camera measures temp differentials across entire course
  ▪ Custom analytics calculate moisture at root ball

• Fungal Detection
  • 4 cameras tuned to specific light reflectance of fungus before visible

• Intelligent Processing in the Cloud
  ▪ We tag and tracks Issues over subsequent flights
    • Ie: Ball mark or expanding dollar spot infection
  ▪ Send alerts to regions that are too wet/dry
  ▪ Store historic maps of relative moisture

New pest alerts and features rolled out regularly
Current Research

Working With 3 Turfgrass/Ag Research Sites

- Drought Stress Research – validate moisture analysis on test plots
  - Current technology prototype getting well tested
    - Knitted maps for each part of the spectrum
    - “Change maps” built to highlight daily changes
    - Quantitative metrics for each test plot recorded
  - We track specific changes
    - Grass temperature differentials
    - Soil Moisture at rootball
    - Precise areal percentage of:
      - Discoloration, wilt
Analysis Add-Ons in Our Pipeline

- Pythium blight
- White grubs
- Poa/Bluegrass detection/severity
- Tree shade mapping
- Turf Traffic
- Divots Maps
- 3D Terrain Maps, as-built mapping

As we gather turf data we can expand offering
Key Feature: Automatic Operation

We have 30+ years developing drones for US Military

- Container opens, drone automatically takes off
- Drone flies over and images entire course based
- Auto-lands in container after flight
- Container closes
- Drone downloads images to cloud server and recharges batteries
- Email and Text Alerts about trouble spots

Flight, processing is automatic - you can focus on the Turf
Key Feature: Inconspicuous

- Flies at 200-300 feet
- 2’ x 2’ drone is virtually invisible at that altitude
- Uses 4 electric motors, inaudible once it reaches 150 feet
- Base station container is 3’ x 3’ x 2’ and only requires a power cord

Designed to not disturb players
Key Feature: Mobile Accessible Data and Analytics

• Online setup, image processing, analytics, and storage
  ▪ User receives email notifications
  ▪ Details on turf condition along with GPS location of issues and images

• Cloud allows better experience
  ▪ Constant analytics improvements based on data
  ▪ No user software to update
  ▪ No hard drive crashes
  ▪ Simplifies data management
GreenSight is operating 100% within the legal framework for drone operations

- We have a “333” authorization from the FAA to operate our drones over golf courses

GreenSight is fully insured

- Drone system are insured for injury, death, or damage to property caused by the equipment under proper usage

GreenSight Respects Privacy

- GreenSight will ensuring the privacy of neighbors and players. We don’t image adjacent properties
- GreenSight will does not disclose any data or imagery that could identify the course
The GreenSight Team

James Peverill – CEO
Led $2M white board-to-Afghanistan drone development for US Air Force
World class expertise in rapid development of drone products

Justin McClellan – CMO
Led $3M Reconnaissance Satellite R&D Program for DARPA
Former Lead for R&D Spinouts and Technology Commercialization
MBA and BS Aerospace Eng. Boston Univ.

Joel Pedlikin – COO
VP Engineering | GM of R&D leading 50+ Aerospace Engineers
Developed PacAstro Rocket Engine | Services Startup Founder
MBA Babson, MS Aeronautics CalTech, BSME Brown

John Kaminski, PhD – CAO
Director Golf Course Turfgrass Management Program @ Penn State
MS Agronomy, PhD Natural Resource Science Univ. Maryland,
BS Turfgrass Science Penn. State
Questions?

Info@GreenSightAg.com
GreenSightAg.com
@GreenSightAg
Unique Solutions to Challenging Pumping Problems
Mike Bartley
Unique Solutions to Challenging Pumping Problem

VFD introduced into turf market

Benefits:

• Energy saving
• Reduce water hammer
• Auto restarts
Unique Solutions to Challenging Pumping Problem

VFD introduced into turf market

Issues:

- Environment
- Shut trip circuit breakers / contactors
- Boost / isolation transformers
- Surge protection / grounding
- New construction / power surges
Unique Solutions to Challenging Pumping Problem

VFD trends in today’s market

Challenge:
• Irrigation programs using cycle / soak
• Understanding the customers irrigation practices
• Multiple irrigation controllers on one pumping system
• Multiple sources on one pumping system
Unique Solutions to Challenging Pumping Problem

VFD trends in today’s market

Solution:

• Individual drives / load sharing
• Large pressure maintenance pumps
Unique Solutions to Challenging Pumping Problem

VFD trends in today’s market

Points for discussion:
• Added cost of individual drive
• Additional cooling requirements
• Additional efficiency loses – 2% drive efficiency
• When do use XL/VFD bypass contactors
• When to go from a “PM” pump to a Jockey pump
Rex Hansen
Pump Station Solutions

Rex Hansen P.E.
Rain Bird Corporation
Rotor Placement
Pressure Tanks
Critter Infestation
Pump Station Vs. Car
Excessive Flow Shut Down
Pump House Aesthetics
Test Flow at Commissioning
High Voltage Concerns
Air Conditioning
Bankruptcy
Installation Surprise
Sports Fan
Pump Stations in the Future
Rick Reinders, President
rick.reinders@watertronics.com
Nail Bay – Project Profile

- Private Residence in British Virgin Islands
- 5 golf holes – golf tees can play it like a 27 hole course
- Architect – Chris Gray; Consultant – AS Altum & Associates
- Contractor – Customer supplied with Watertronics supervision
Nail Bay: What was the problem?

- No fresh water source available for irrigation
- Ambitious owner in need of 300 gallons per minute for irrigation
- Short time line
- Very remote location
Nail Bay: What was the solution?

Complete integrated solution using:

- Reverse Osmosis
- Source Blending
- Media Filters
- Fertigation Injection
- Irrigation pump station
- One Integrated Solution
Nail Bay: How does it work?

Step 1
- Ocean Supply Station
- Intake Screen W/ Foot Valve
- Media Filter Flush to Ocean

Step 2
- RO Supply Station
- RO Water Cistern

Step 3
- CIP Back Flush & RO Concentrate Flow to Ocean
- RO System

Step 4
- Portable RO CIP System
- Blended Discharge

Step 5
- Blending Supply Station
- IRGigation Pump Station
- Fertilizer Tank
- RO Filtered Discharge

Step 6
FACTORY PRE-TESTED

- Dynamically tested in our facility
- Confirmation of Integrated processes
Nail Bay: What were the results?
Remote Monitoring and Control of all systems
One Integrated Management System
MANAGE MULTIPLE PROJECTS
THANK YOU!
Dick Young
Dick Young
Sales Manager
Unusual Pumping Situations
You Have Encountered and
How You Solved Them
Project Companies

- Architect: Robert McNeil
- Irrigation Consultant: Joe Sarkisian
- General Contractor: NMP Golf Const.
Irrigation system requirements
• 1800 GPM
• 145 PSI
## Challenge 1

<table>
<thead>
<tr>
<th>Well ID</th>
<th>Pump Set Depth</th>
<th>Transducer Set Depth</th>
<th>Low Water Shut Off</th>
<th>Seasonal Yield</th>
<th>Stable Well Yield at End of Fall 2007 Test</th>
<th>Typical Maximum Documented Pumping Rate</th>
<th>Daily Pump On Cycle</th>
<th>Pump Control Limits if Basins are Full on April 15th (and in any case after May 30th)</th>
<th>Pump Control Limits if Basins are Not Full on April 15th (from April 15 to May 30th)</th>
<th>Seasonal Maximum Withdrawal (180-day basis)</th>
<th>Pump Control Limits (from November 1st to April 14th)</th>
<th>Maximum Off Season Withdrawal (166-day basis)</th>
<th>Gallons per Season (April 15 to Oct. 31)</th>
<th>Gallons per Off Season (Nov. 1 to April 14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pond V</td>
<td>862</td>
<td>852</td>
<td>842</td>
<td>16.0</td>
<td>23,040</td>
<td>46,080</td>
<td>21.3</td>
<td>23,040</td>
<td>32.0</td>
<td>46,080</td>
<td>29.9</td>
<td>32.256</td>
<td>4,147,200</td>
<td>13.3</td>
</tr>
<tr>
<td>Well 2</td>
<td>315</td>
<td>305</td>
<td>295</td>
<td>13.7</td>
<td>19,728</td>
<td>26,352</td>
<td>18</td>
<td>18</td>
<td>18</td>
<td>19,728</td>
<td>18.3</td>
<td>19,728</td>
<td>2,683,523</td>
<td>13.3</td>
</tr>
<tr>
<td>Well 3</td>
<td>295</td>
<td>285</td>
<td>275</td>
<td>10.2</td>
<td>14,688</td>
<td>19,584</td>
<td>13.6</td>
<td>14,688</td>
<td>13.6</td>
<td>14,688</td>
<td>24.0</td>
<td>25,920</td>
<td>2,643,840</td>
<td>0.0</td>
</tr>
<tr>
<td>Well 5</td>
<td>525</td>
<td>515</td>
<td>505</td>
<td>14.7</td>
<td>21,168</td>
<td>28,224</td>
<td>19.6</td>
<td>21,168</td>
<td>19.6</td>
<td>21,168</td>
<td>24.0</td>
<td>25,920</td>
<td>3,810,240</td>
<td>0.0</td>
</tr>
<tr>
<td>Well 6</td>
<td>580</td>
<td>570</td>
<td>560</td>
<td>23.3</td>
<td>33,552</td>
<td>44,784</td>
<td>31.1</td>
<td>33,552</td>
<td>31.1</td>
<td>33,552</td>
<td>24.0</td>
<td>25,920</td>
<td>6,039,360</td>
<td>19.4</td>
</tr>
<tr>
<td>Well 10</td>
<td>609</td>
<td>599</td>
<td>589</td>
<td>16.4</td>
<td>23,616</td>
<td>31,392</td>
<td>21.8</td>
<td>23,616</td>
<td>21.9</td>
<td>23,616</td>
<td>24.0</td>
<td>25,920</td>
<td>4,250,880</td>
<td>13.6</td>
</tr>
<tr>
<td>Well 12</td>
<td>525</td>
<td>515</td>
<td>505</td>
<td>15.4</td>
<td>22,176</td>
<td>44,352</td>
<td>10.7</td>
<td>3,919,680</td>
<td>5.12</td>
<td>3,919,680</td>
<td>0.0</td>
<td>0</td>
<td>3,919,680</td>
<td>0.0</td>
</tr>
<tr>
<td>Club House Well</td>
<td>220</td>
<td>210</td>
<td>200</td>
<td>2.1</td>
<td>3,024</td>
<td>4,032</td>
<td>24</td>
<td>2.1</td>
<td>3,024</td>
<td>0</td>
<td>544,320</td>
<td>0.0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
**Challenge 1 – Transducer Depth**

<table>
<thead>
<tr>
<th>Transducer Set Depth</th>
<th>Low Water Shut Off</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ft.</td>
<td>Ft.</td>
</tr>
<tr>
<td>852</td>
<td>842</td>
</tr>
<tr>
<td>305</td>
<td>295</td>
</tr>
<tr>
<td>285</td>
<td>275</td>
</tr>
<tr>
<td>515</td>
<td>505</td>
</tr>
<tr>
<td>570</td>
<td>560</td>
</tr>
<tr>
<td>599</td>
<td>589</td>
</tr>
<tr>
<td>515</td>
<td>505</td>
</tr>
<tr>
<td>210</td>
<td>200</td>
</tr>
</tbody>
</table>
## Variable Flow Rates

<table>
<thead>
<tr>
<th>Daily Pump On Cycle</th>
<th>Pump Control Limits if Basins are Full on April 15th (and in any case after May 30th)</th>
<th>Pump Control Limits if Basins are Not Full on April 15th (from April 15 to May 30th)</th>
<th>Seasonal Maximum Withdrawal (180-day basis)</th>
<th>Pump Control Limits (from November 1st to April 14th)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hrs.  GPM  GPD</td>
<td>GPM  GPD</td>
<td>Gallons per Season (April 15 to Oct. 31)</td>
<td>GPM  GPD</td>
</tr>
<tr>
<td><strong>Pond V Well</strong></td>
<td>18</td>
<td>21.3  23,040</td>
<td>29.9  32,256</td>
<td>4,147,200</td>
</tr>
<tr>
<td><strong>Well 2</strong></td>
<td>18</td>
<td>18.3  19,728</td>
<td>24.0  25,920</td>
<td>3,551,040</td>
</tr>
<tr>
<td><strong>Well 3</strong></td>
<td>18</td>
<td>13.6  14,688</td>
<td>24.0  25,920</td>
<td>2,643,840</td>
</tr>
<tr>
<td><strong>Well 5</strong></td>
<td>18</td>
<td>19.6  21,168</td>
<td>24.0  25,920</td>
<td>3,810,240</td>
</tr>
<tr>
<td><strong>Well 6</strong></td>
<td>18</td>
<td>31.1  33,552</td>
<td>24.0  25,920</td>
<td>6,039,360</td>
</tr>
<tr>
<td><strong>Well 10</strong></td>
<td>18</td>
<td>21.9  23,616</td>
<td>24.0  25,920</td>
<td>4,250,880</td>
</tr>
<tr>
<td><strong>Well 12</strong></td>
<td>8</td>
<td>46.2  22,176</td>
<td>10.7  5,120</td>
<td>3,991,680</td>
</tr>
</tbody>
</table>
Solution

- All well pumps to run on a VFD
- Instead of pressure, change process variable to flow
- Change flow rates based upon date
Use Restrictions

- Shut off wells when
  - Daily hour limits reached
  - Daily flow total reached
  - Annual flow total reached
Well Set up Screen
Well Monitoring Screen
Well Trending Screen
Well Vault Internals
Well Vault Installed
Pond A Level Setup
Pond B/C Level Setup
Several of the wells and the transfer equipment need to run year round. To facilitate that the flow sensors, isolation valves, and flow sensor test ports were installed in concrete vaults below the frost line.
Transfer Vault
Challenge 2

The geography, wells and ponds separated by thousands of feet. Radio communication was a challenge.
Thank You