Use of Spatial Analysis for Turfgrass

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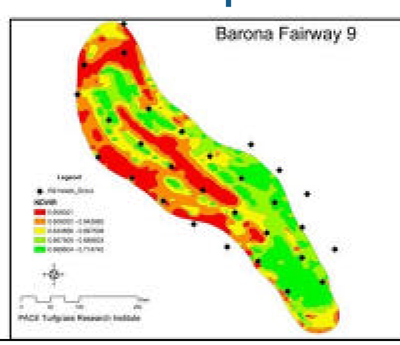
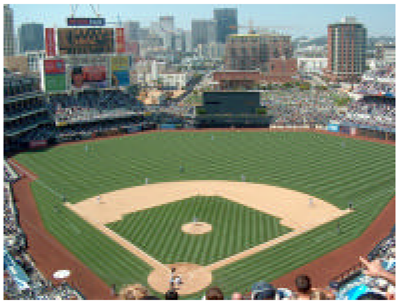
Outline

- Turf overview
  - Unique features that impact approach to spatial analysis
  - Needs that spatial analysis can address
- Case studies that illustrate uses of spatial analysis in turf
- Issues in adoption
- What the future holds



Turf overview

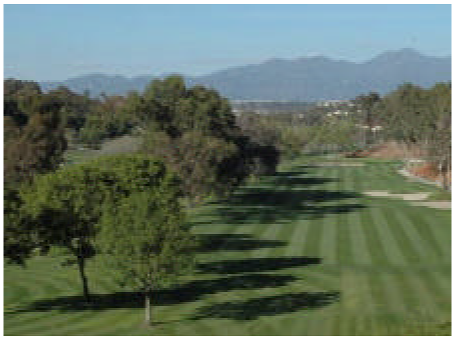
- 50 million acres managed turf (3rd in total U.S. acreage nationwide)
- Generates $40 billion annually
- #1 or 2 ag commodity in MD, PA, FL, NJ, NC
- 1.5 million acres golf course turf (3%); ~16,000 courses
- 700,000 athletic fields
- Parks
- Home lawns
  - Homeowners
  - Lawn care companies



Turf overview

A different mindset

- Success not measured by yield, but instead by more subjective factors: color, uniformity, surface firmness
- Tolerance for damage very low
- Water use restrictions and/or mandated use of recycled water
- Constant public contact and involvement
- Intensive management of 100 acres or less



Turf overview

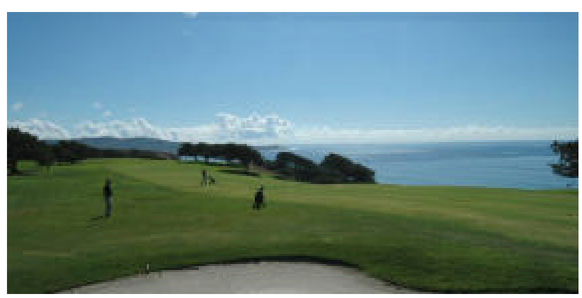
Intensively managed turf already subjected to intensive mapping, labeling

Tees & Greens:	6 – 7 A
Fairways:	30 A
Roughs:	50 – 70 A
Non-turf	50 A

Turf overview

Needs that spatial analysis can address

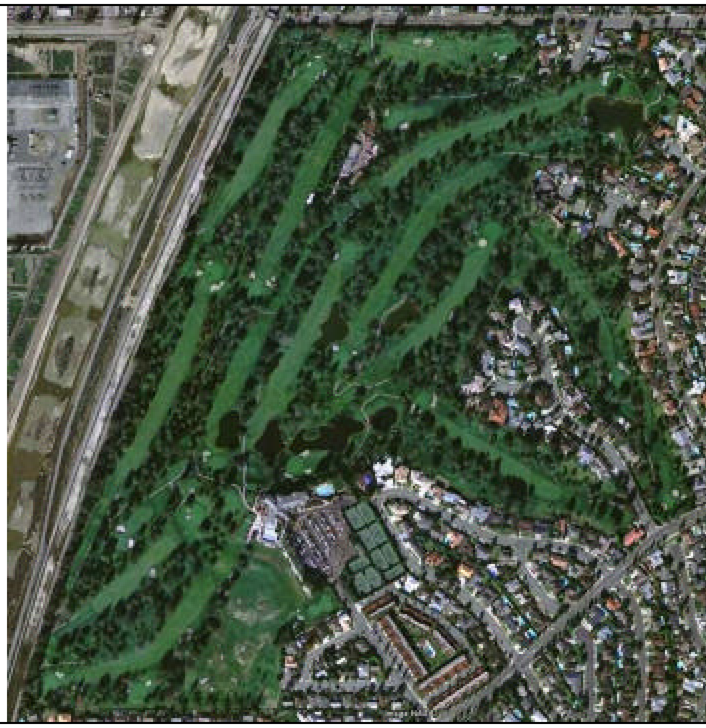
- Map, characterize, measure, monitor and document
  - Reduce pesticide, fertilizer, water inputs
  - Monitor soil moisture, salinity, turf performance
  - Address surface firmness issues
  - Enhance communication with users and community



Case Studies

- Golf course soil structure failure predicted by NRCS Web Soil Survey
- Virtual irrigation audit
- Turfgrass disease evaluation
- Thoroughbred horse track safety and irrigation
- Professional ball field multi-use event impact

Soil Rutting on Rough 17



GARFIELD AVE
GISLER AVE
CAPE VERDE PL
BAHAMA PL
PANAY CIR
MADEIRA AVE
BALI CIR
JAMAICA RD
Santa Ana River
191
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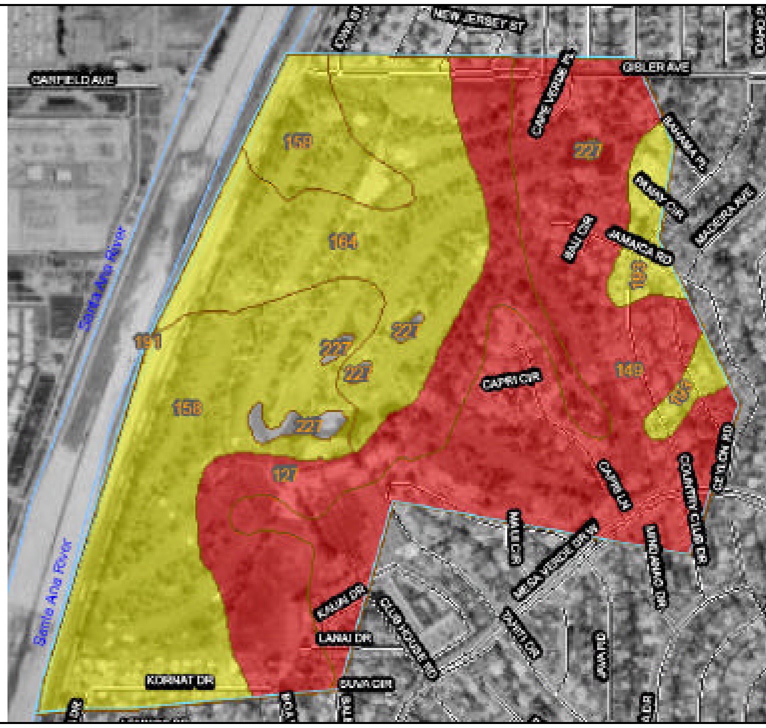
CAPRI CIR
127
CAPRI LN
CEYLON RD
COUNTRY CLUB DR
MAUI CIR
MESA VERDE DR W
MINDANAO DR
KAUAI DR
CLUB HOUSE RD
LANAI DR
TAHITI DR
KORNAT DR
SUVA CIR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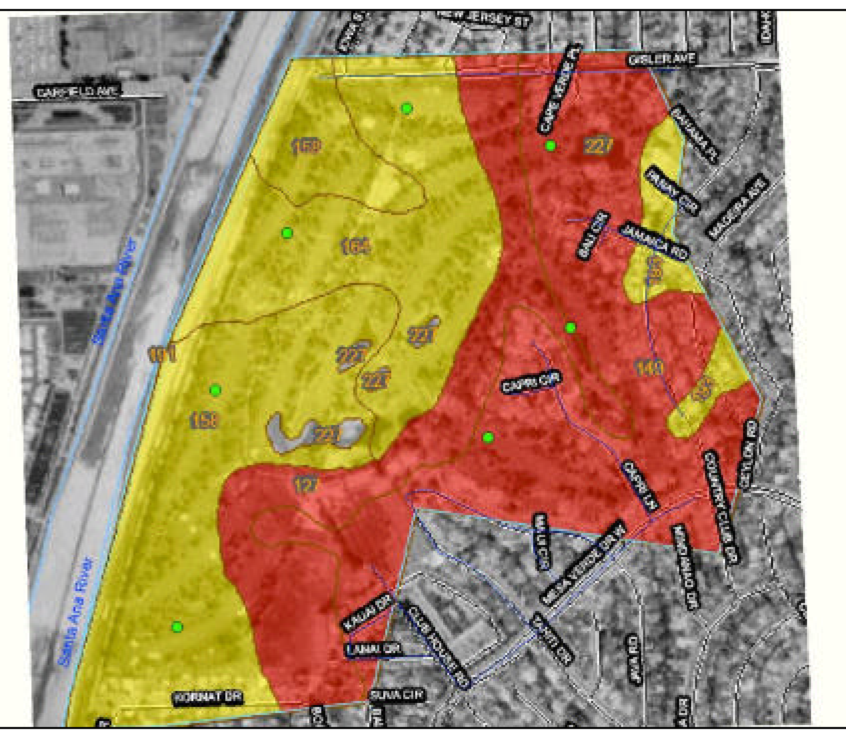
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CEYLON RD
KAUAI DR
LANAI DR
CLUB HOUSE RD
KORNAT DR
SUVA CIR
Santa Ana River
159
164
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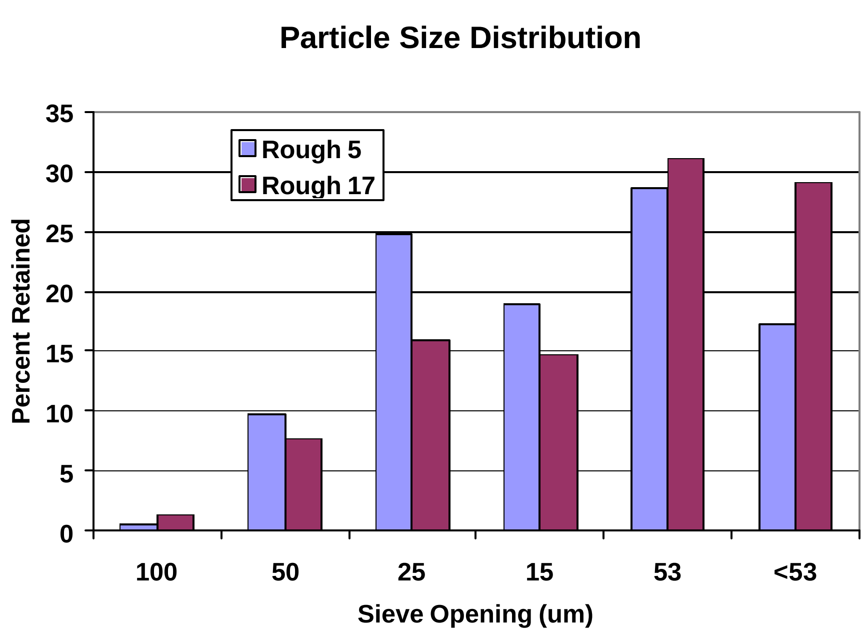
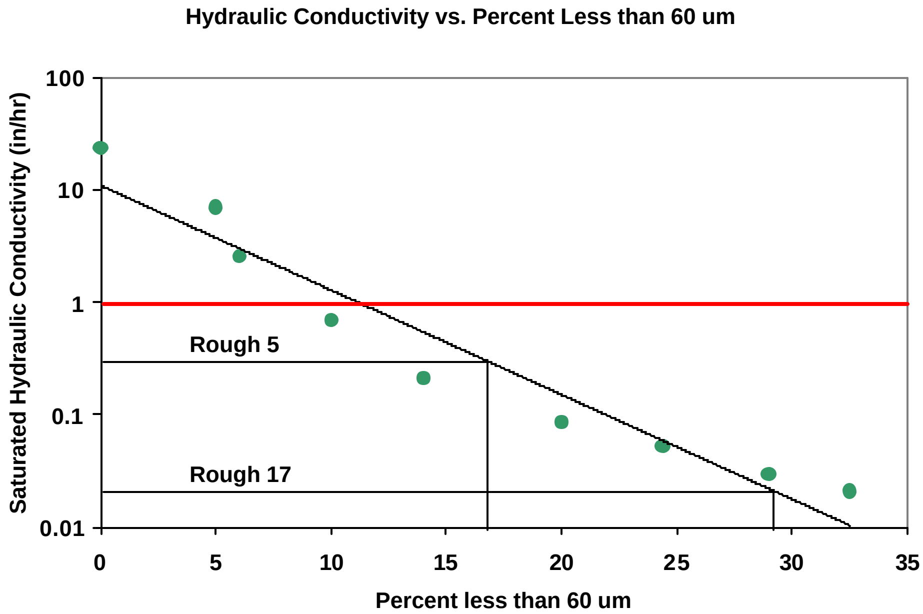
227
127
149

Soil type	Hydraulic Conductivity Ksat (in/hr)	Location
Metz Loamy Sand	6.0 – 20.0	Rough 5
Hueneme Fine Sandy Loam	2.0 – 6.0	Rough 5
Bosanko Clay	0.02 – 0.20	Rough 17
Cropley Clay	0.06 – 0.20	Rough 17





Adams and Gibbs, 1994. “Natural turf for sport and amenity: science and practice”. CAB International, Wallingford, U.K., 404 pp.

Outcome

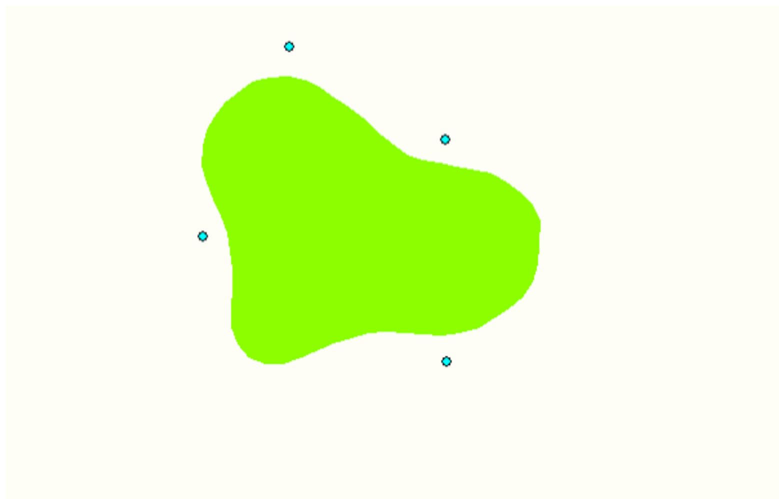
- NRCS soil maps aided in selection of soil sample locations
- GPS used to navigate and record soil sample locations
- Soil physical conditions adequately matched NRCS soil maps
- Communication with golfers supported by sound data
- Solution: extend sand topdressing into the roughs where rutting is a problem

Virtual Irrigation Audit

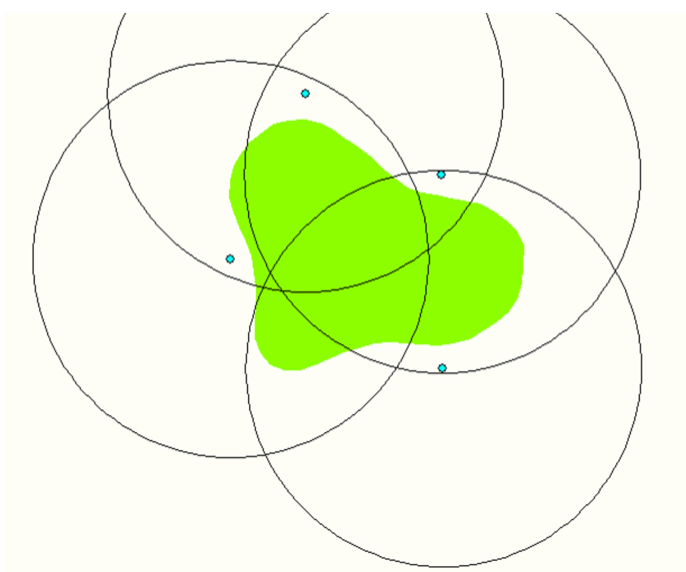
- Simple method to identify irrigation design flaws
- Aids in identifying associations between irrigation design and turf performance
- Can be conducted in real-time (no need for catch cans)

1. Map perimeter

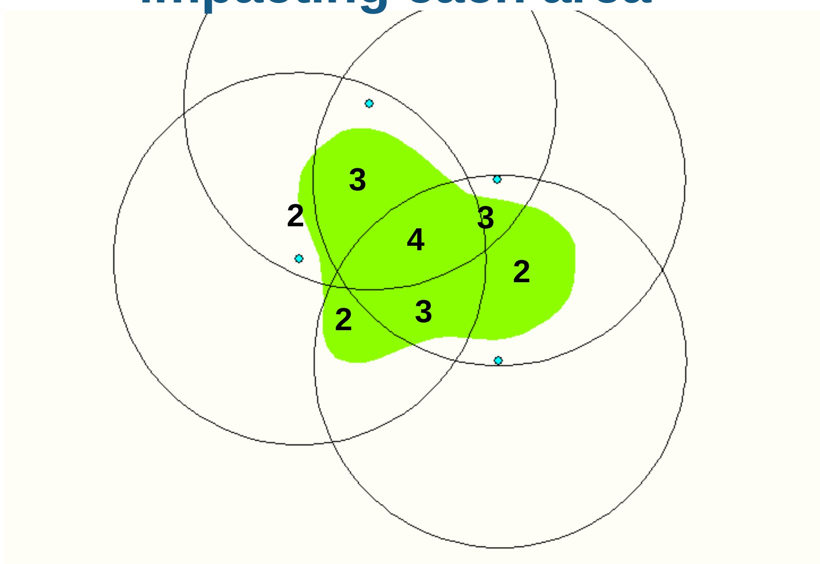
2. Map head locations



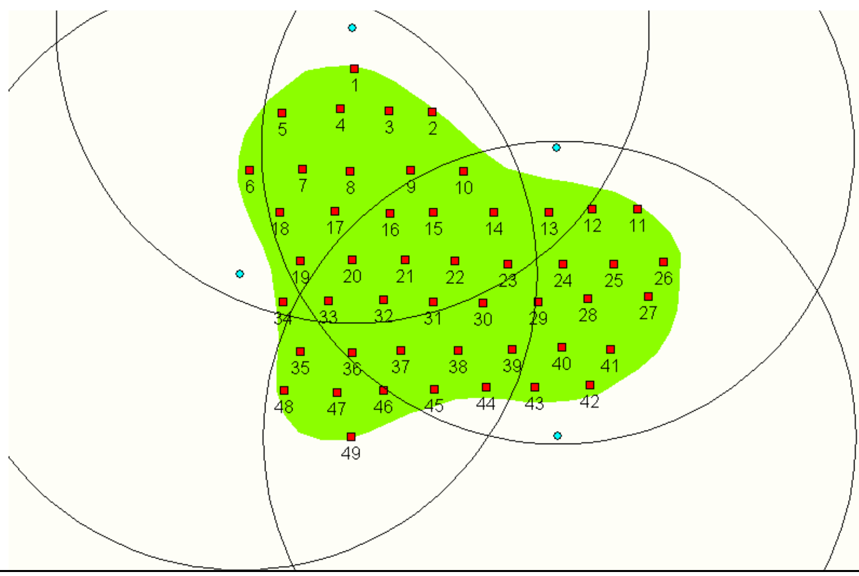
3. Project theoretical throw



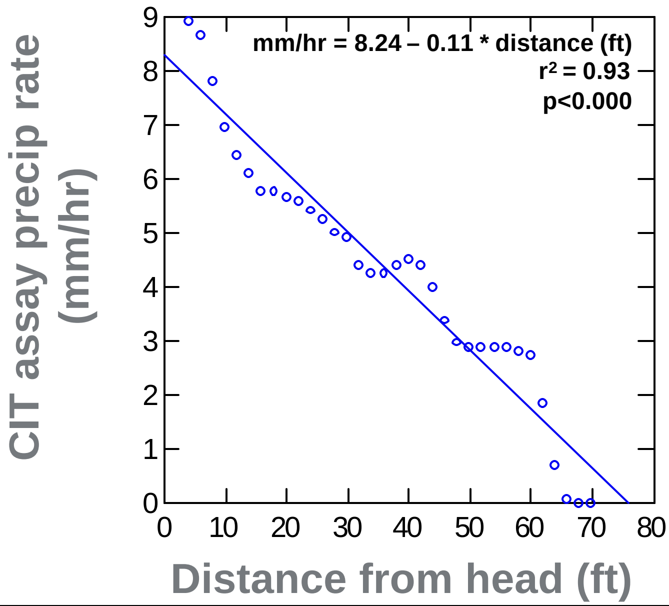
Determine number of heads impacting each area



Place Catch Cans on Grid for Validation



Toro 830 Head Performance

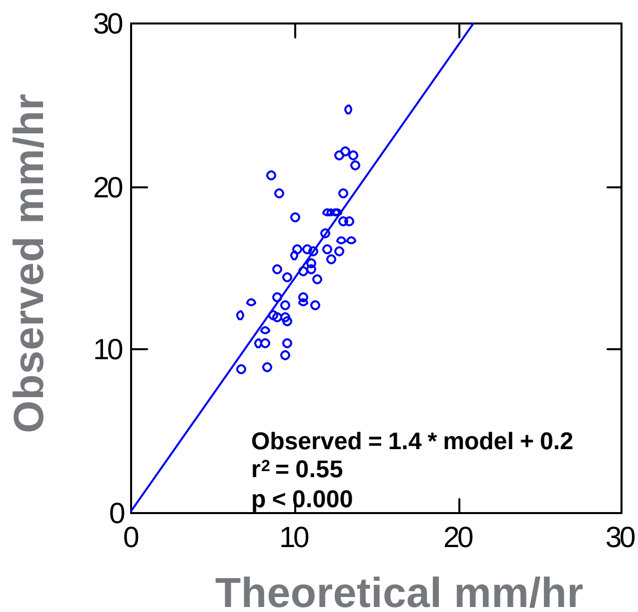


Theoretical Precipitation

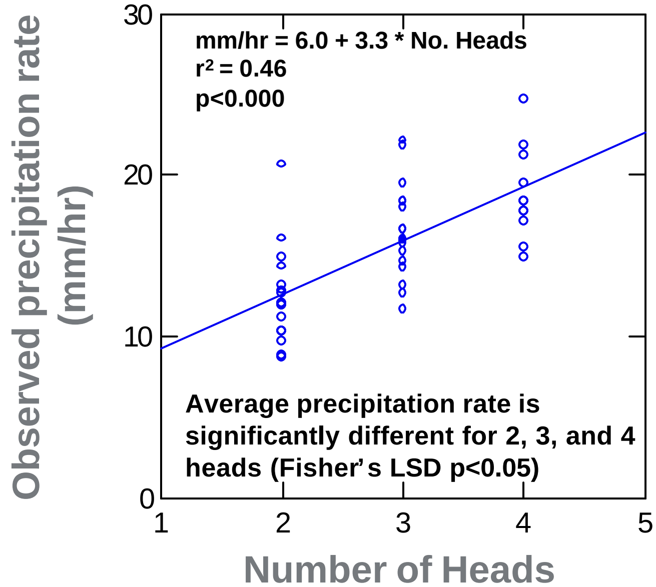
- Georeference heads and catch cans and then compute distances between heads and catch cans.
- Theoretical precipitation rate determined based upon head performance (Center for Irrigation Technology assay) and distance from head to catch can.

$$\text{Distance (ft)} = 5280 \times \sqrt{\left(\left(69.1 * (lat1 - lat2)\right)\right)^2 + \left(\left(69.1 * (lon1 - lon2)\right) * \cos\left(\frac{lat1}{57.3}\right)\right)^2}$$

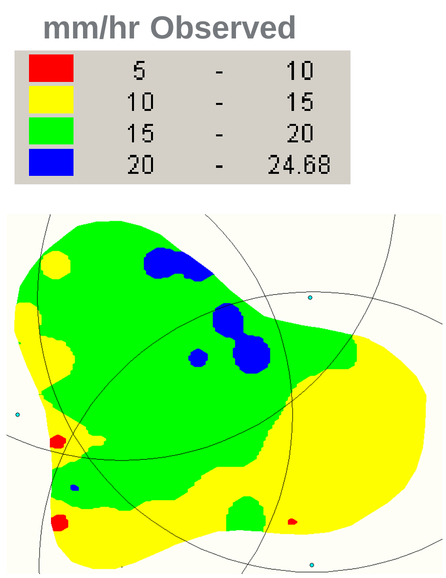
Observed vs. Theoretical Precipitation



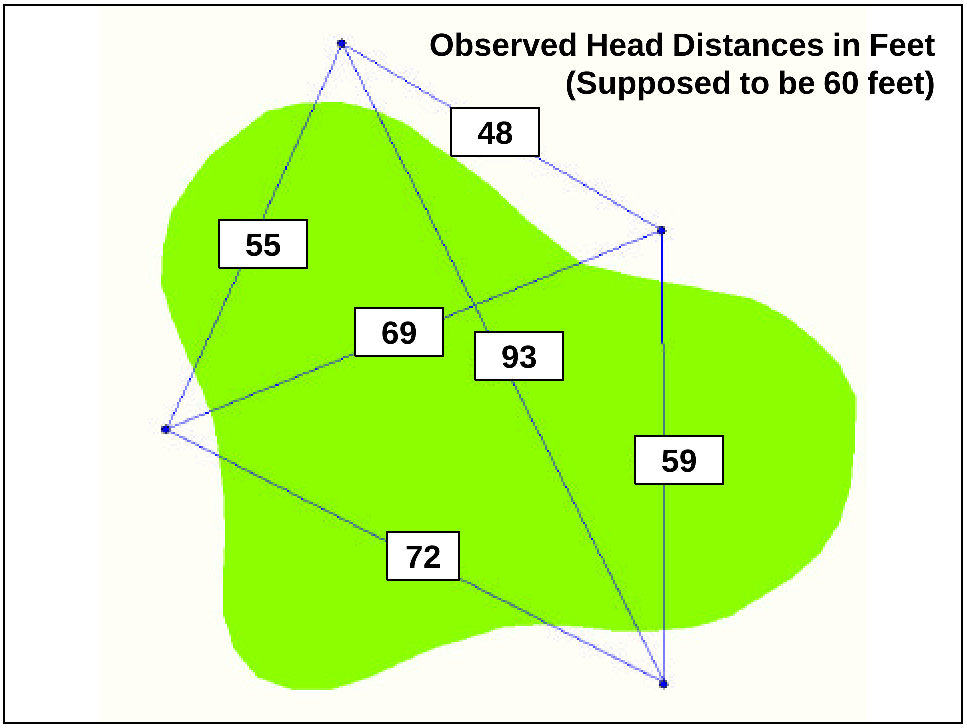
Observed Precipitation vs. Number of Heads



Observed Distribution



DU = 69

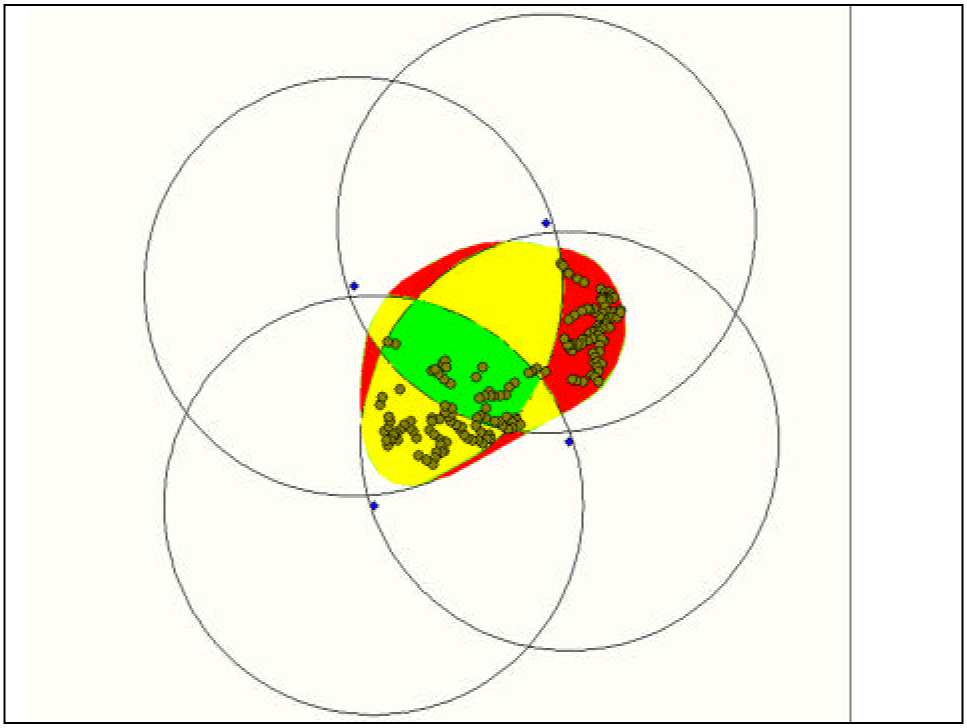


Outcome

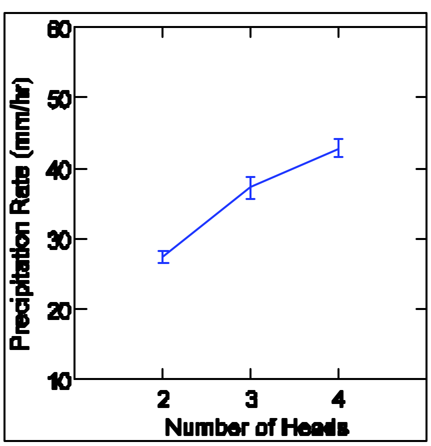
- Irrigation design flaws were identified
- Solution: Management was altered – additional hand watering was recommended to increase soil moisture in areas of deficit irrigation

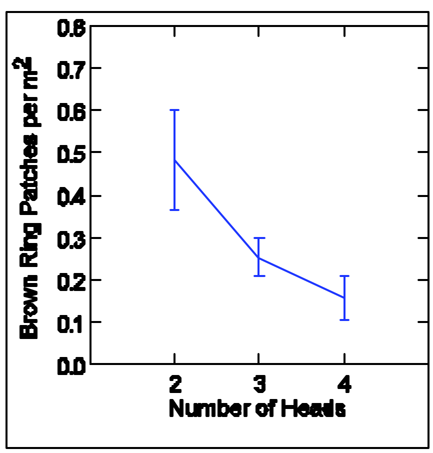
Turf disease evaluation

- **An extension of the virtual irrigation audit**
- **Brown ring patch (BRP) caused by *Rhizoctonia circinata* is an emerging disease**
- **Unlike other *Rhizoctonia* diseases, BRP is more severe at lower soil moistures**
- **Virtual irrigation audits identified low moisture impact on severity of BRP**

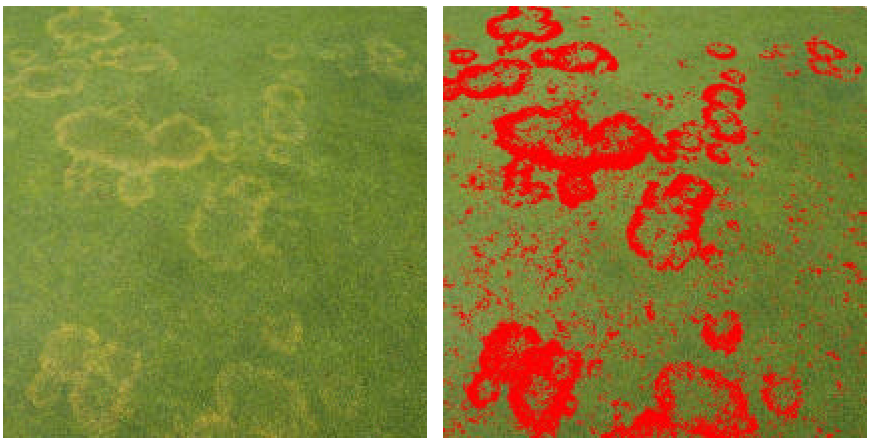


Brown Ring Patch Incidence

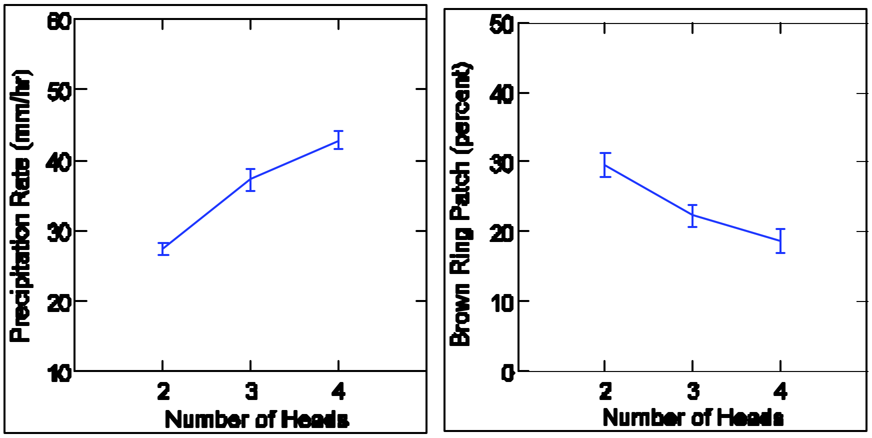




Digital Image Analysis



Brown Ring Patch Severity



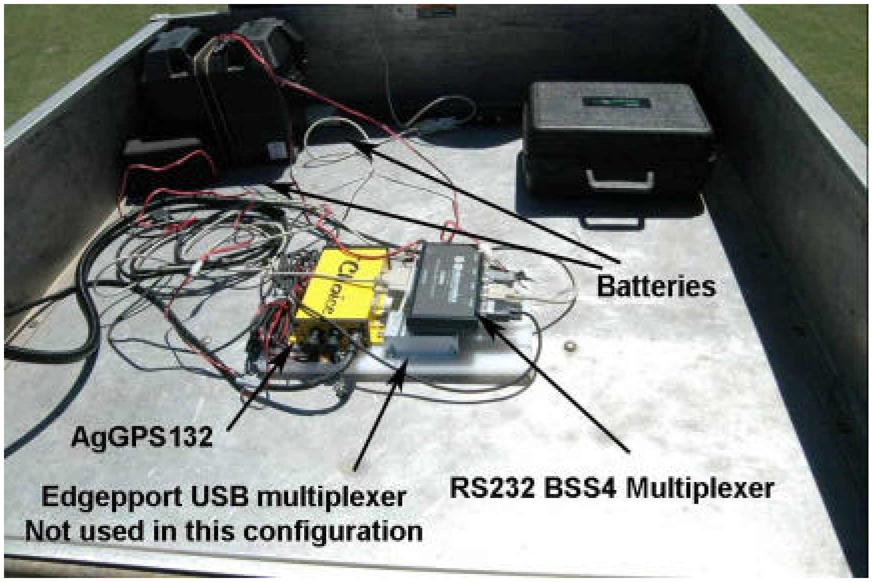
Outcome

- Adequate soil moisture may reduce severity of brown ring patch
- Additional investigations are targeting soil moisture conditions that are conducive to disease
- Fungicide applications might be avoided or applied less frequently
- Solution: Monitoring and maintenance of adequate soil moisture can reduce turf damage and fungicide inputs

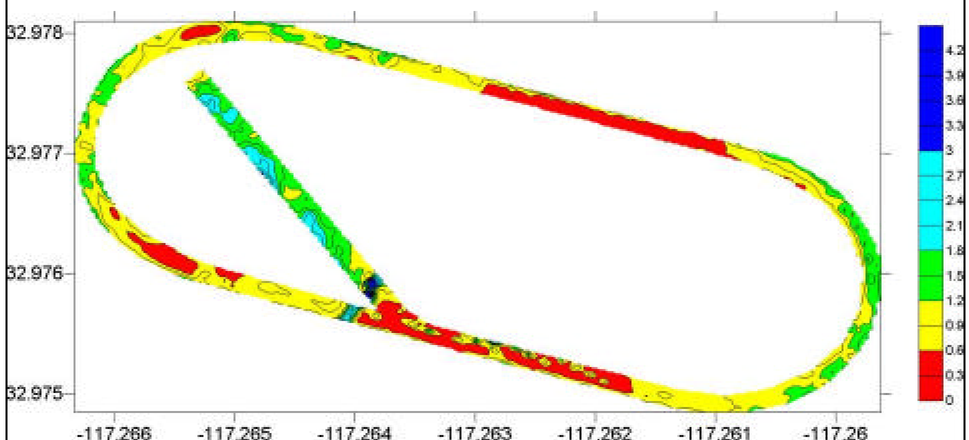
Del Mar Thoroughbred Club

EM38 & NTech GreenSeeker Normalized Difference Vegetative Index (NDVI)

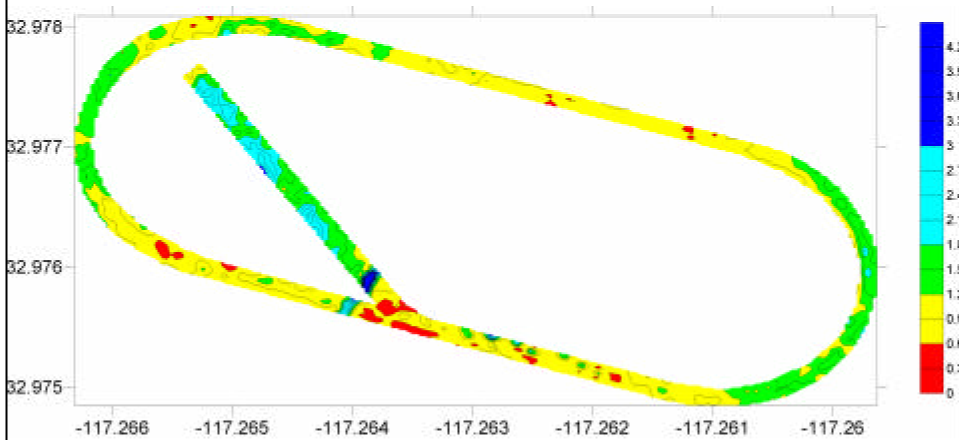
Trimble AgGPS132 GPS, BB Electronics RS232 Multiplexer



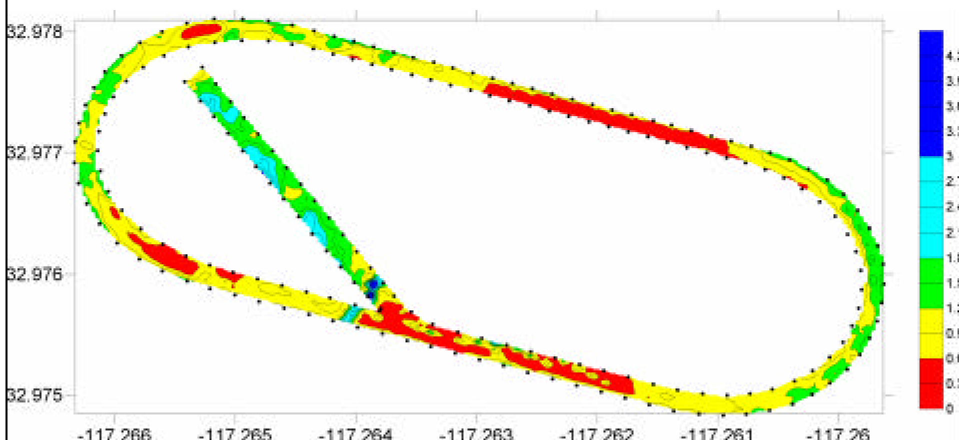
Before 2 inch irrigation



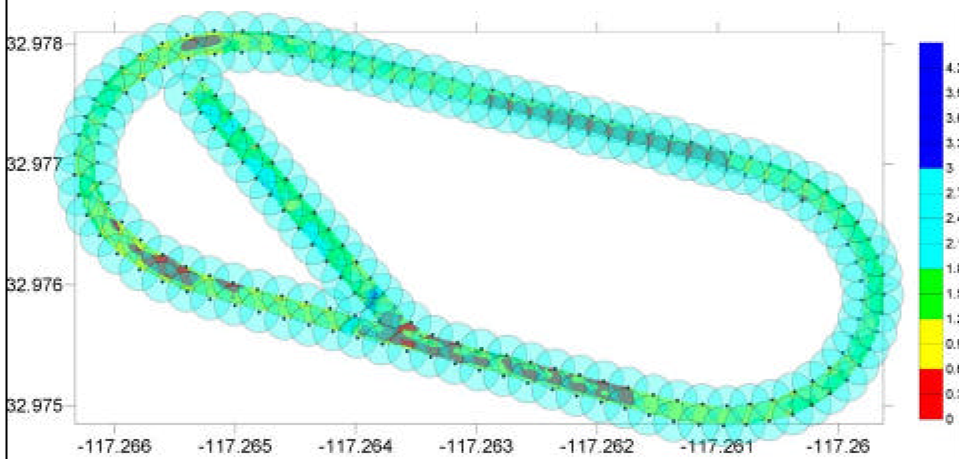
After 2 inch irrigation



Irrigation Head Location



Spacing and Soil Moisture



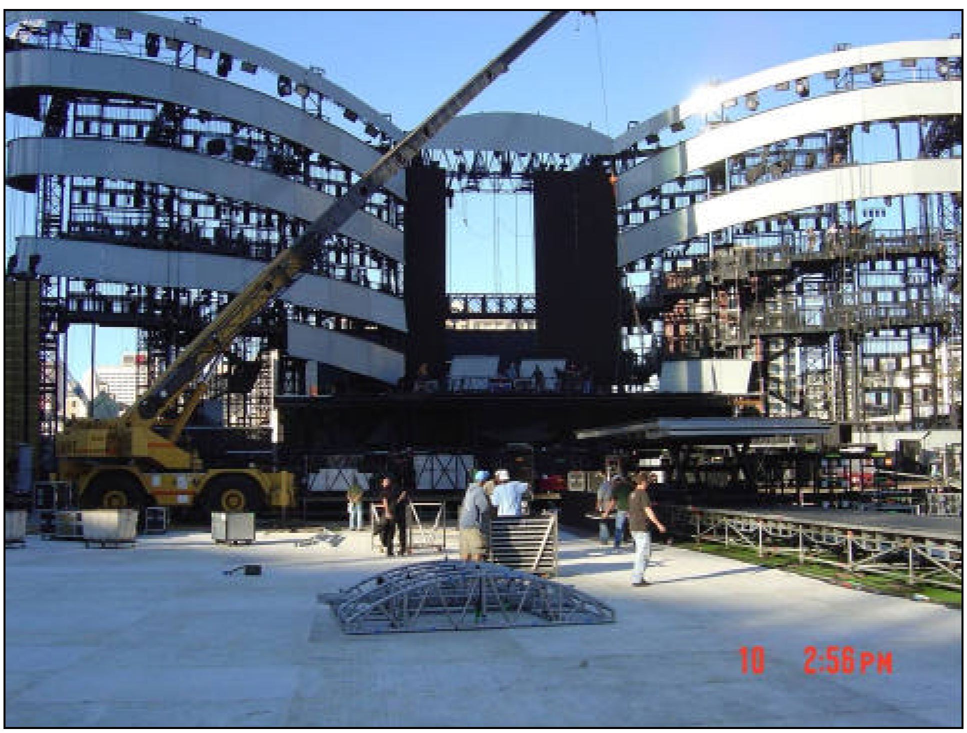
Outcome

- EM38 identified soil moisture inconsistencies
- Head mapping identified spacing problems
- Solution: The track width was adjusted and head spacing modified. As a result, track consistency has improved

Compaction Evaluation

- New sports venues actively seek events that are compatible with the site in the off-season to maintain an income stream
- Concerts, X-games, Motocross, Monster trucks all are options
- What is the agronomic impact of off-season events (compaction)?


8 11:36 AM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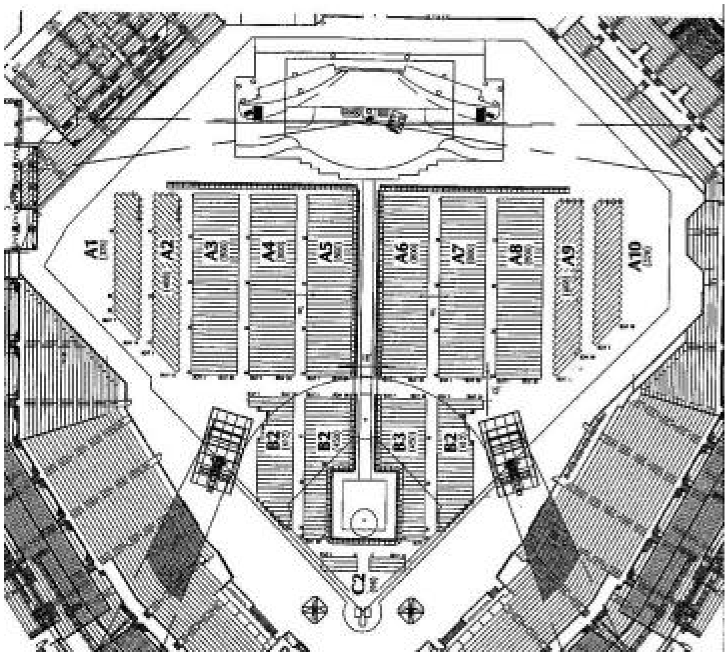
A1
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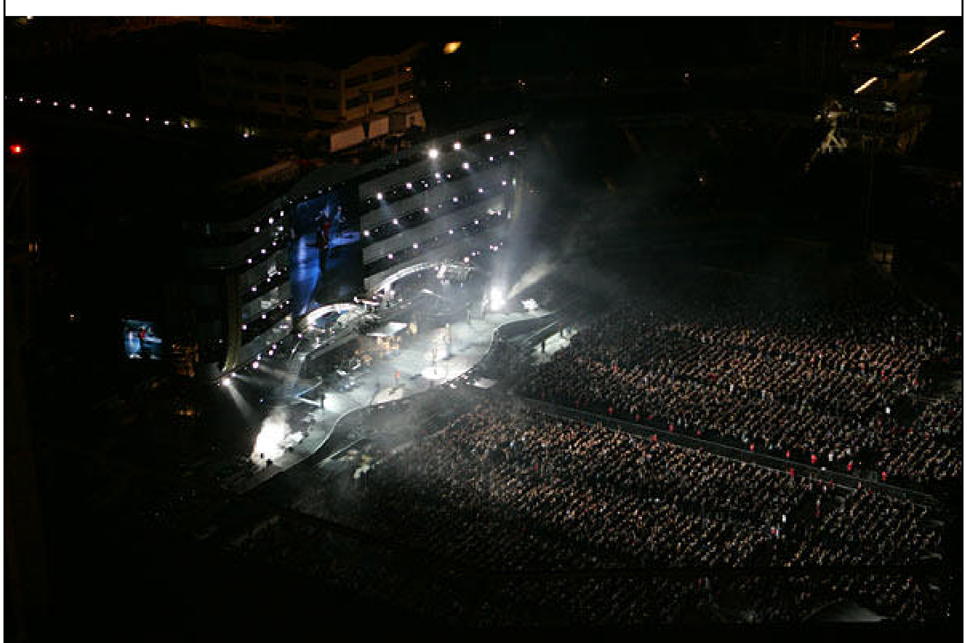
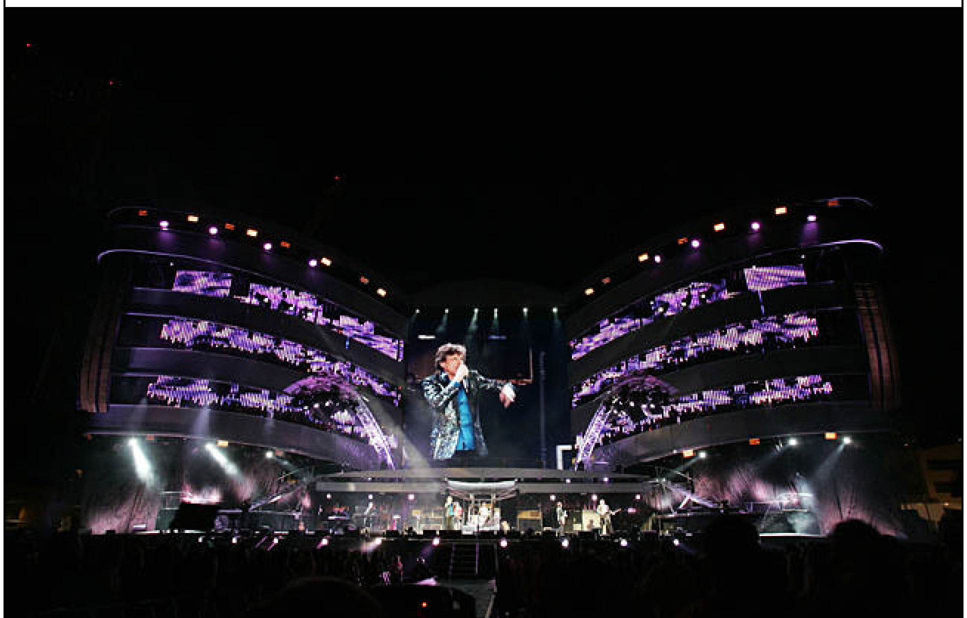
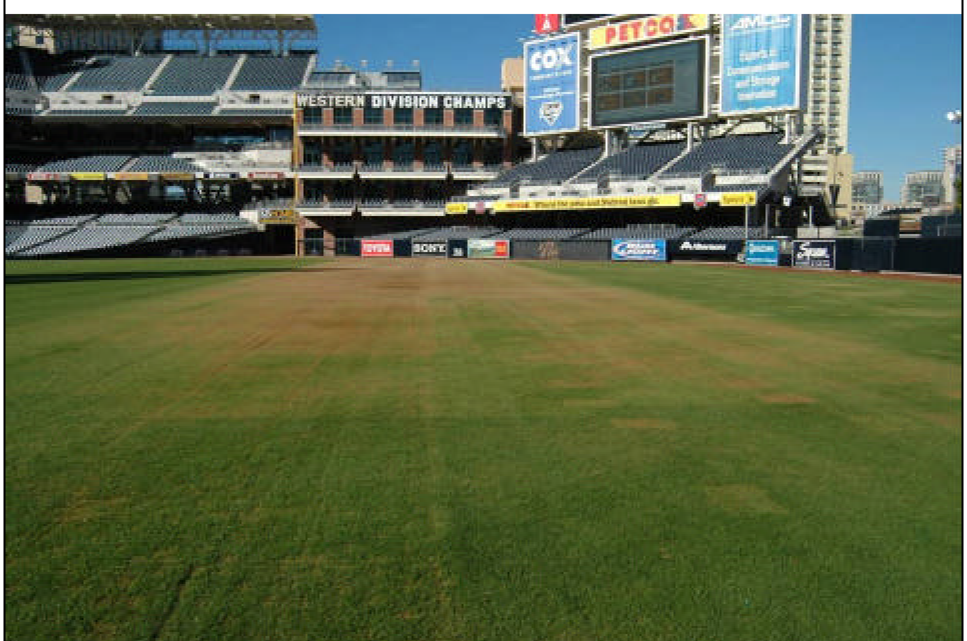
C2





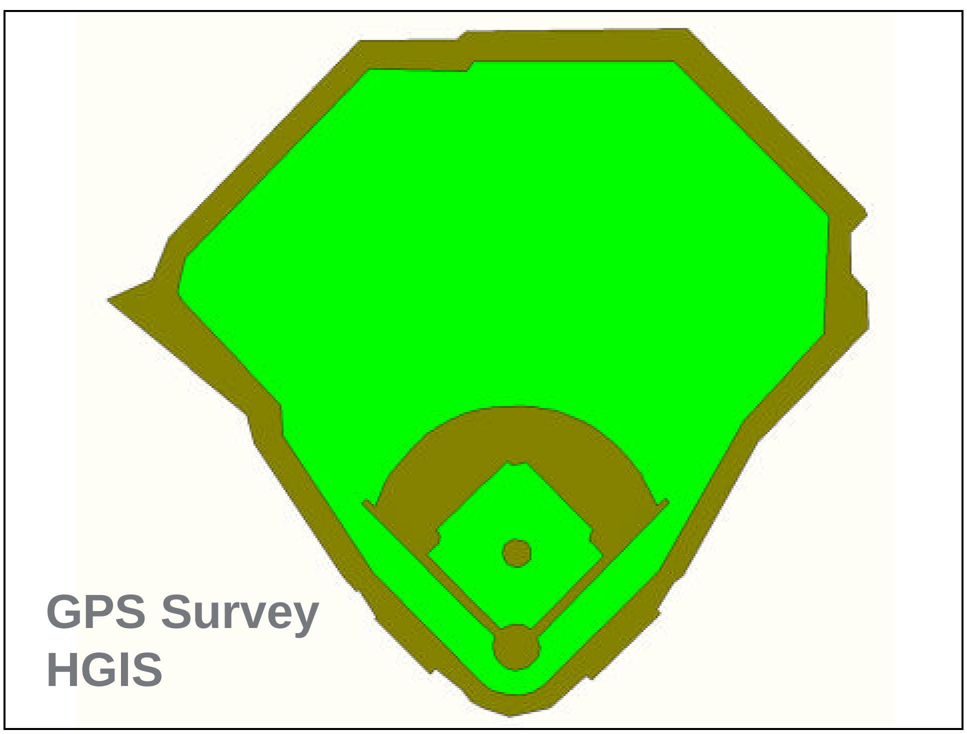

Enkamat under plywood roadway

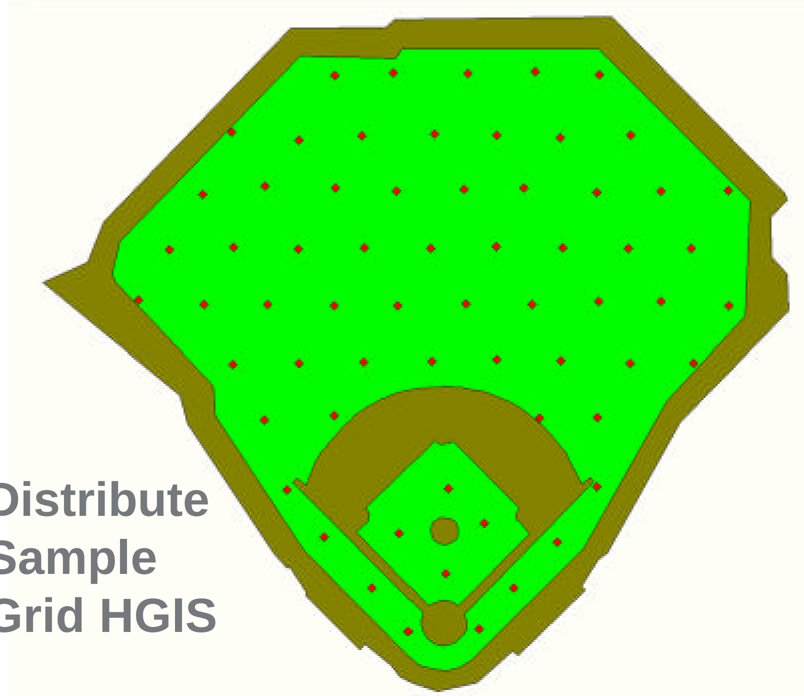

WESTERN DIVISION CHAMPS
COX
PETCO
SONY

Concrete Stage Footings

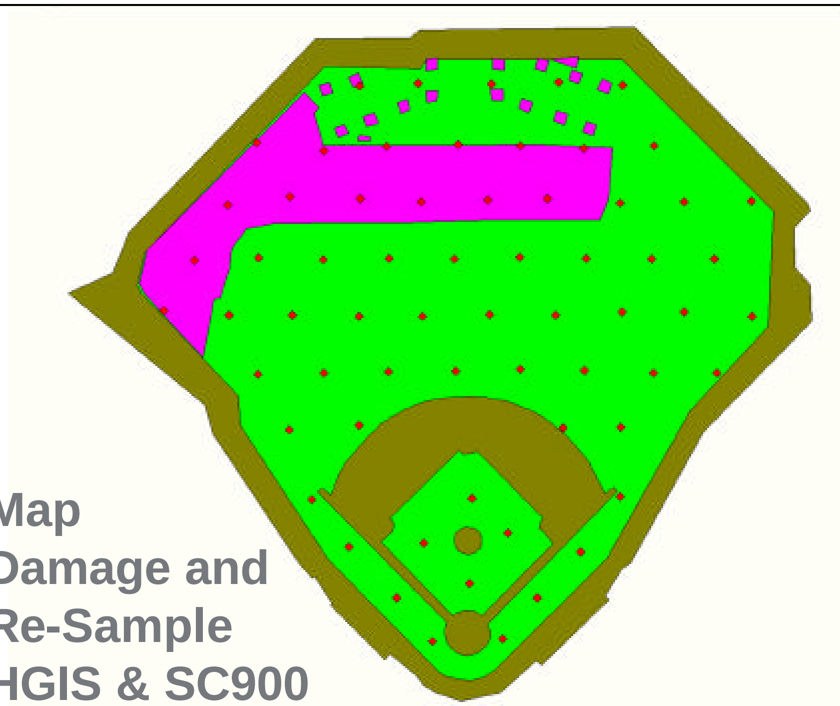
Terrafloor for seating on field


COX
Trimble AgGPS 132
TDS400 Handheld PC
HGIS Software
SC900 Compaction Meter


GPS Survey
HGIS



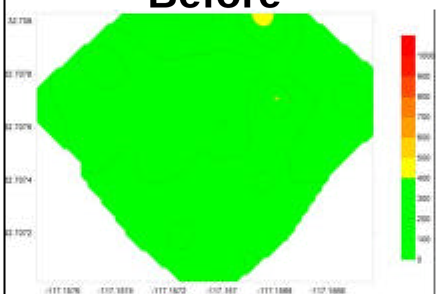
Distribute
Sample
Grid HGIS



Map
Damage and
Re-Sample
HGIS & SC900

Compaction Map
Surfer

Before



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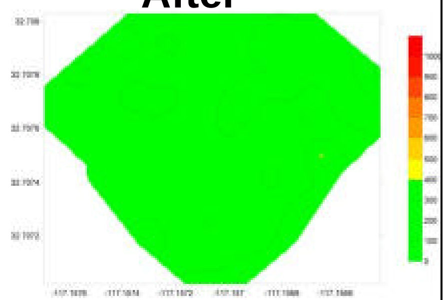
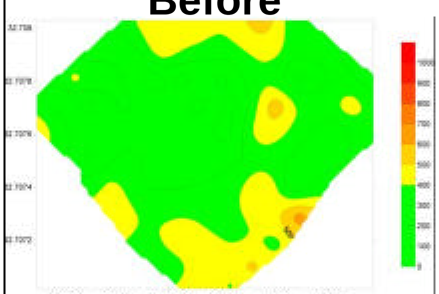


8 cm (3 in)

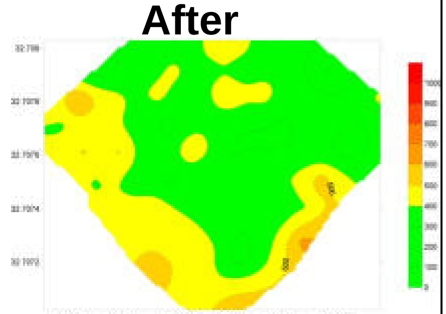
300 psi = 2.1 Mpa

Compaction Map
Surfer

Before



After

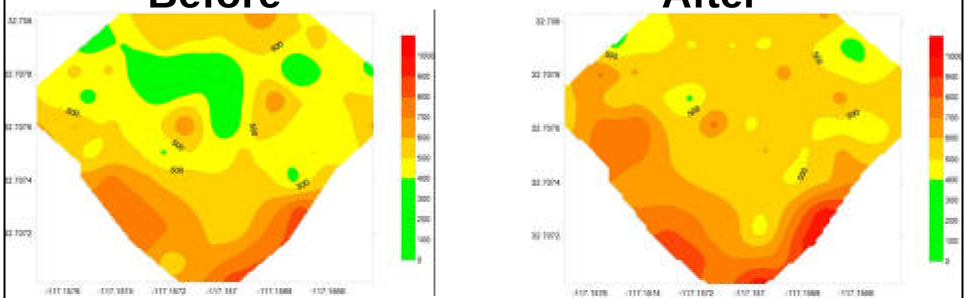


10 cm (4 in)

300 psi = 2.1 Mpa

Compaction Map
Surfer

Before **After**

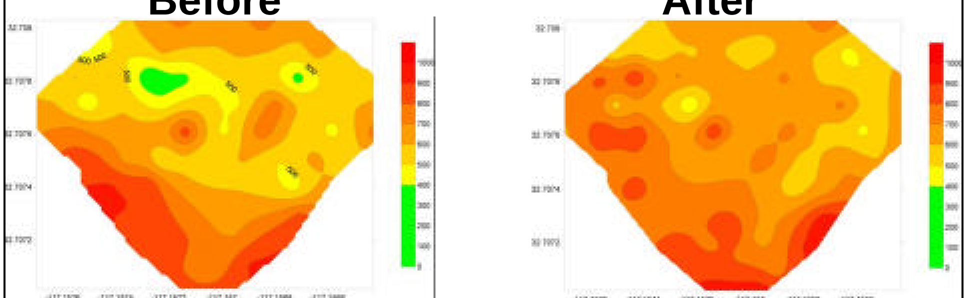


13 cm (5 in)

300 psi = 2.1 Mpa

Compaction Map
Surfer

Before **After**

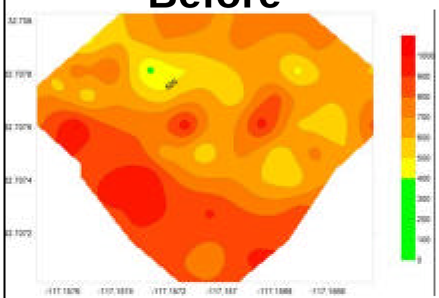


15 cm (6 in)

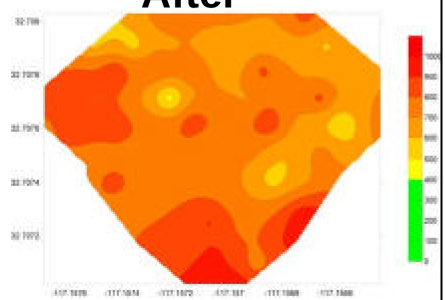
300 psi = 2.1 Mpa

Compaction Map
Surfer

Before



After

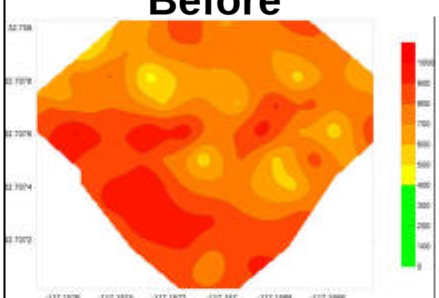


18 cm (7 in)

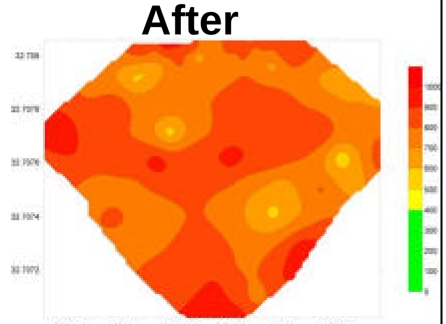
300 psi = 2.1 Mpa

Compaction Map
Surfer

Before



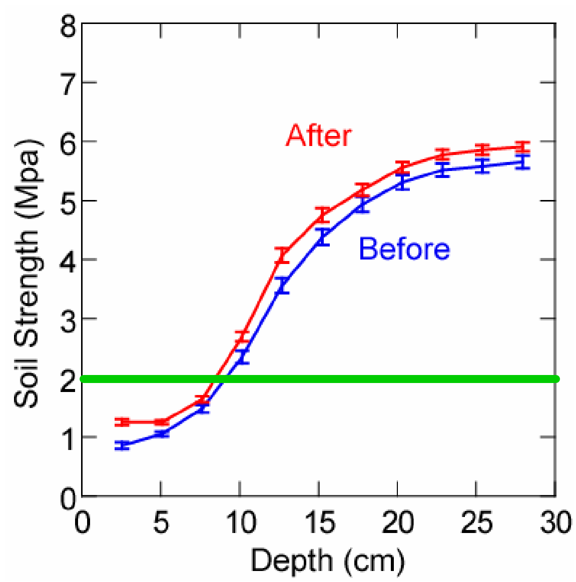
After

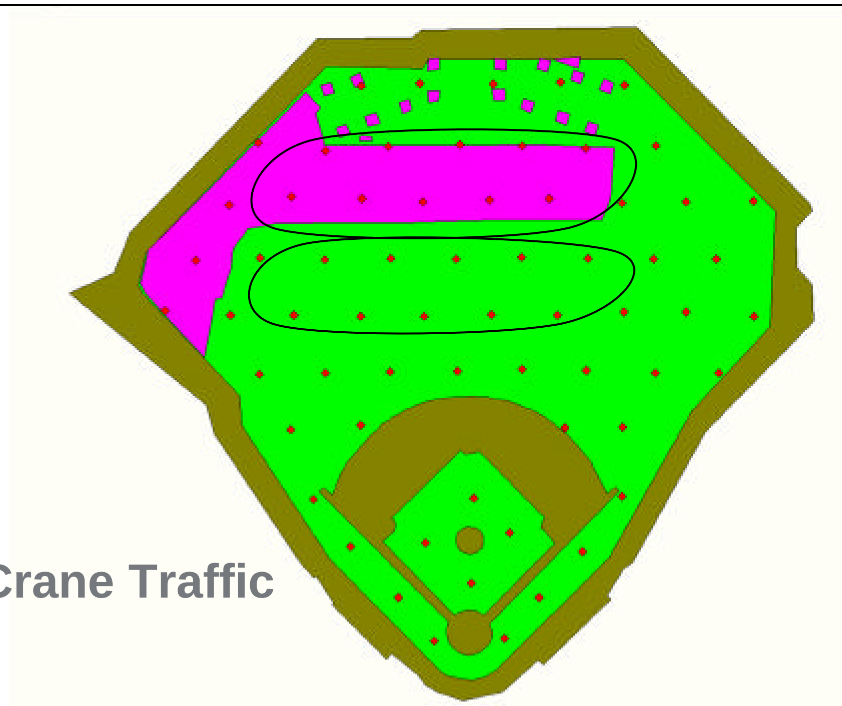


20 cm (8 in)

300 psi = 2.1 Mpa

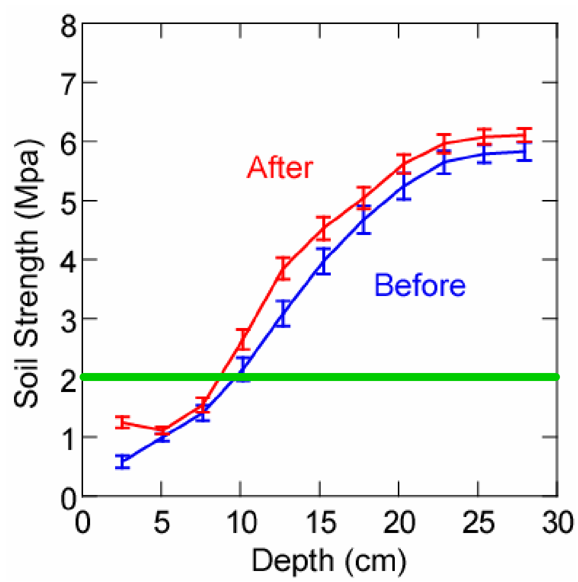
Full Survey Data Set

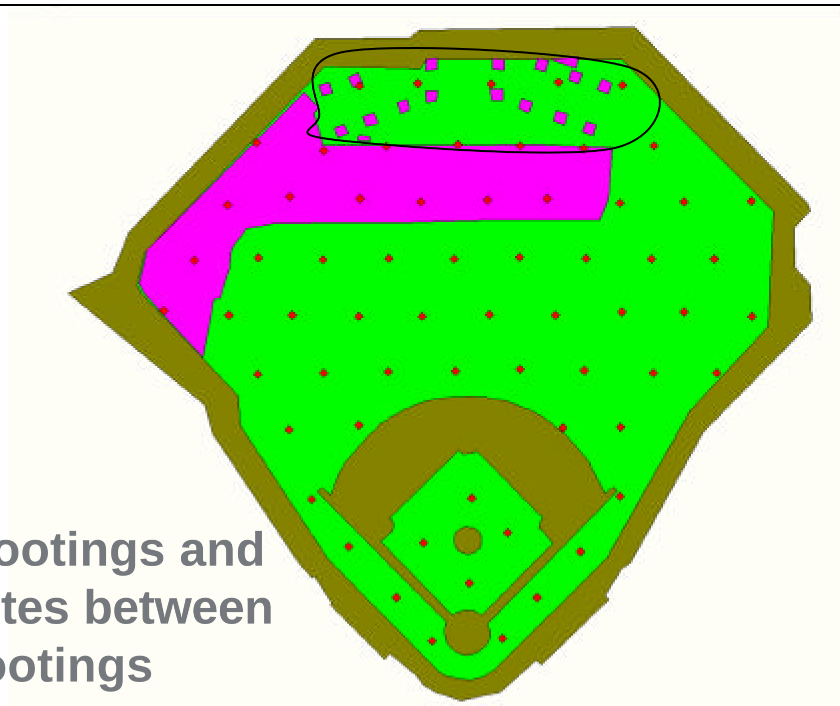




Crane Traffic

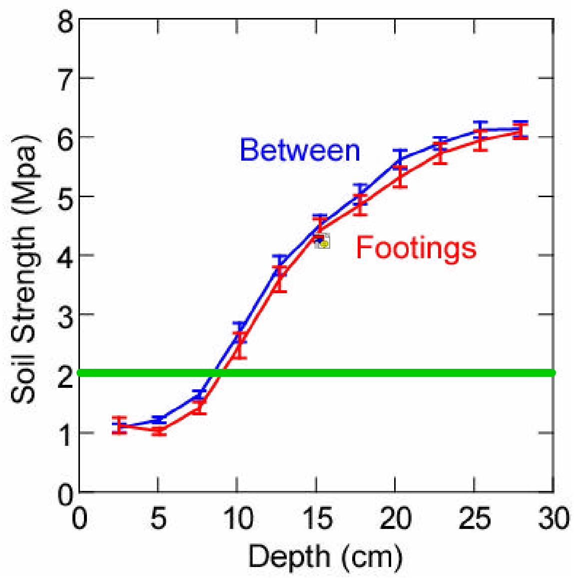
Crane Traffic Area





Footings and sites between footings

Footings and Between



Outcome

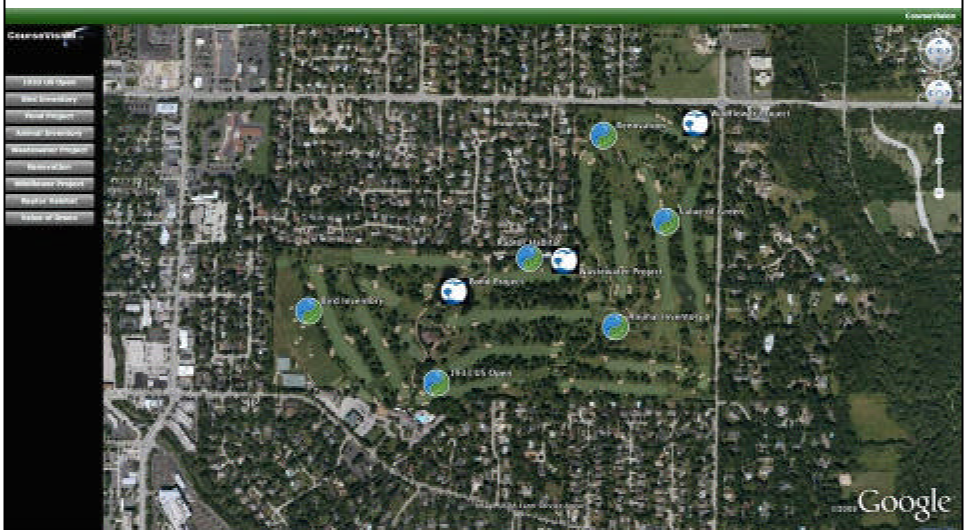
- Crane traffic resulted in significant compaction in surface 5 cm
- Compaction deeper in the profile was observed but compaction was already severe prior to the event
- Solution: Removing compaction in the top 10 cm by rototilling was used to return the surface soil strength to pre-event compaction levels

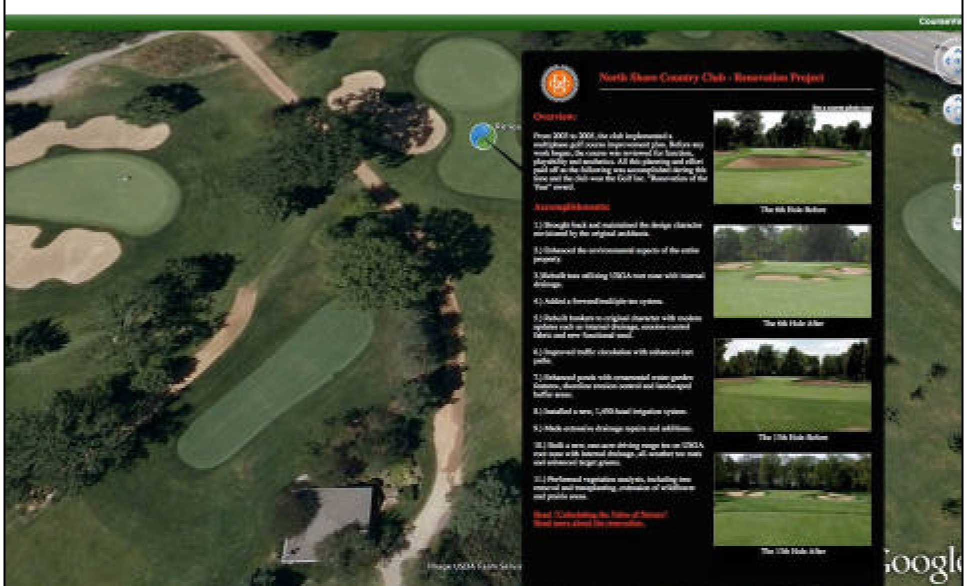
Issues in Adoption

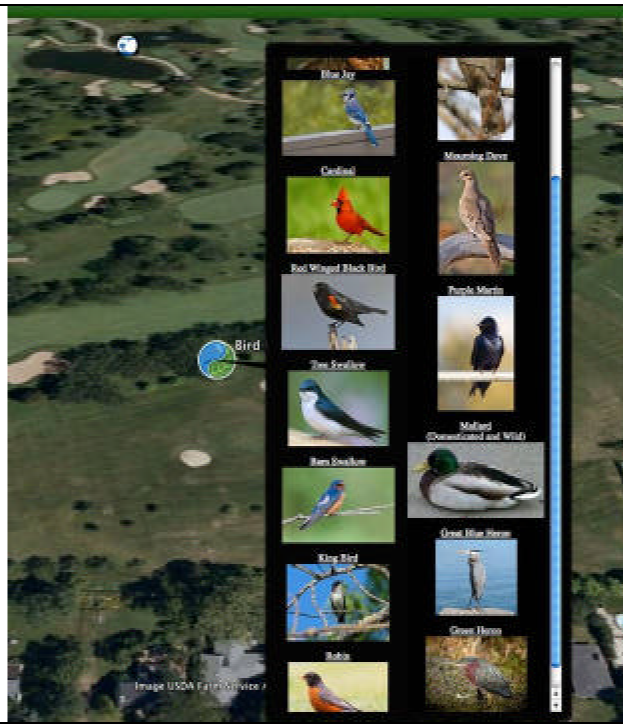
- Sensor technology is complex – what does the reading really mean?
- Data acquisition software and post-processing data is cumbersome
- Interpretation can be confusing
- End users are not equipped to go it alone – much like precision Ag

What the Future Holds

- Equipment mounted sensors
  - Easy to operate
  - Easy to maintain
  - Reliable
  - Telemetry
- Remote data management
- Web-based data delivery
- Google Earth interface


CourseVision
1933 US Open
Bird Inventory
Pond Project
Renovation
Wastewater Project
Google


North Shore Country Club - Renovation Project
Overview:
Accomplishments:
1.) Brought back and maintained the design character envisioned by the original architects.
2.) Enhanced the environmental aspects of the entire property.
4.) Added a forward/multiple-tee system.
8.) Installed a new, 1,450-head irrigation system.
9.) Made extensive drainage repairs and additions.
The 6th Hole Before
The 6th Hole After
The 13th Hole Before
The 13th Hole After



Hardware

- Trimble AgGPS123 Receiver
- TDS400 hand held computer
- B&B Electronics BSS4 RS232-4 smart switch multiplexer
- Geonics EM38 EM meter
- NTech Industries GreenSeeker (red and green) NDVI
- Spectrum Technologies CM1000 chlorophyll meter
- Spectrum Technologies TDR300 moisture meter
- Spectrum Technologies SC900 recording soil compaction meter

Software

- HGIS from Starpal (www.starpal.com) – data acquisition, some data management GPS/GIS handheld, portable, desktop
- ArcView ESRI (www.esri.com) – GIS
- Surfer Golden Software (www.goldensoftware.com) contour mapping
- SigmaScan (www.sigmaplot.com)– image analysis
- NRCS Web Soil Survey: websoilsurvey.nrcs.usda.gov/app/HomePage.htm

http://www.paceturf.org/PTRI/Documents/isspa2009.pdf

http://www.paceturf.org/journal

Search for isspa

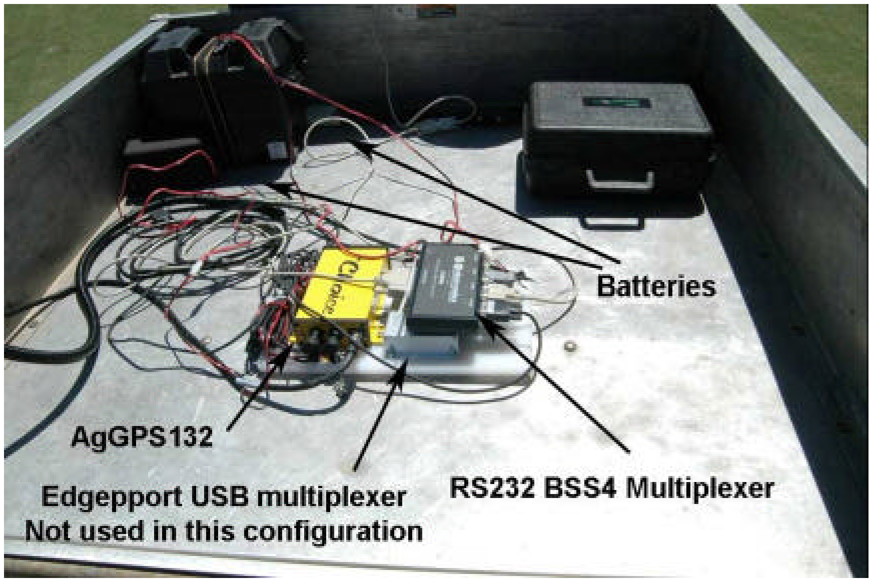
PACE TURF

Irrigation Management

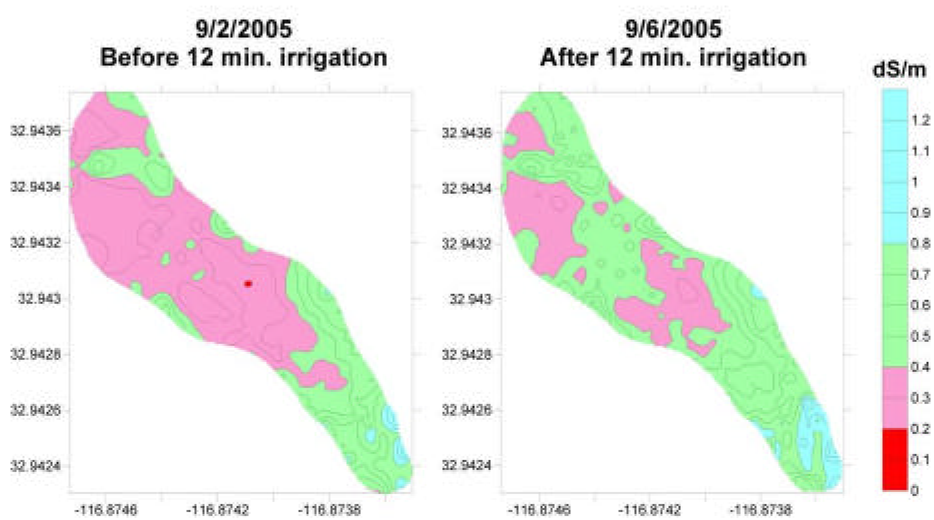
- Can EM sensors provide useful soil moisture information?
- Can a sensor array be built from currently available equipment?

EM38 & NTech GreenSeeker Normalized Difference Vegetative Index (NDVI)

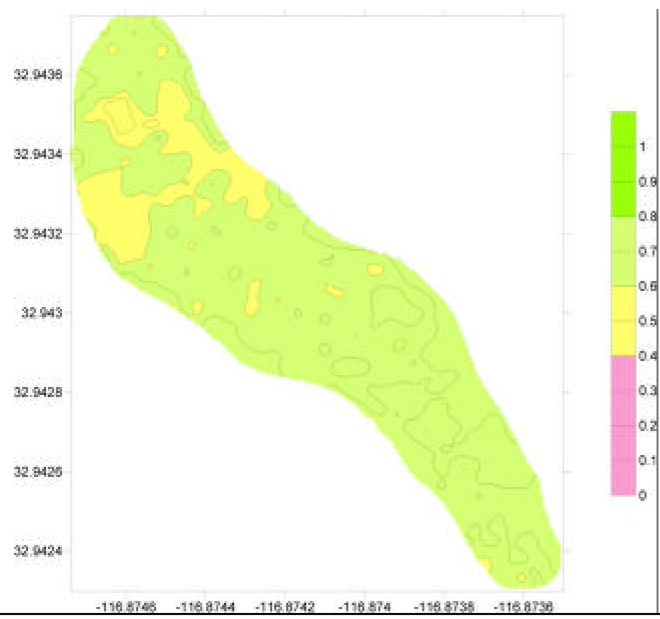
Trimble AgGPS132 GPS, BB Electronics RS232 Multiplexer



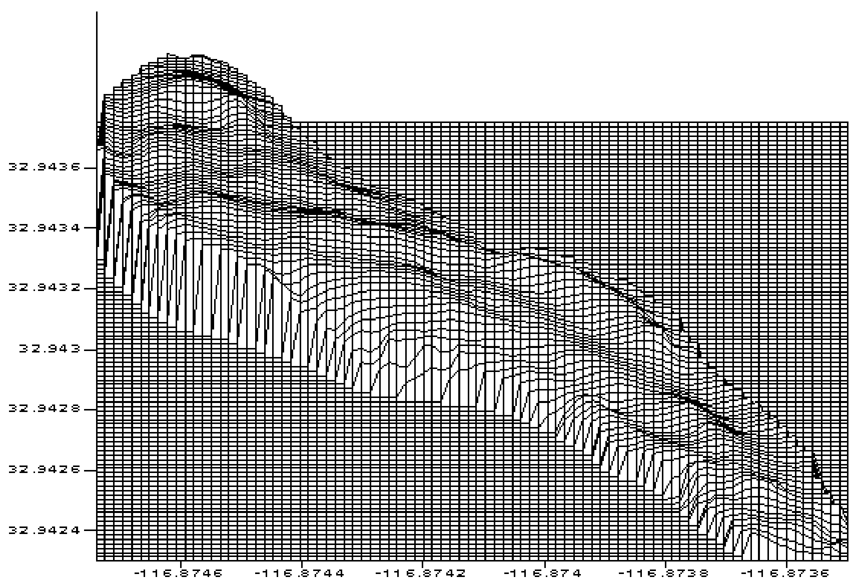
Barona Creek Golf Club Fairway 9
120% normal irrigation (70% ETo)

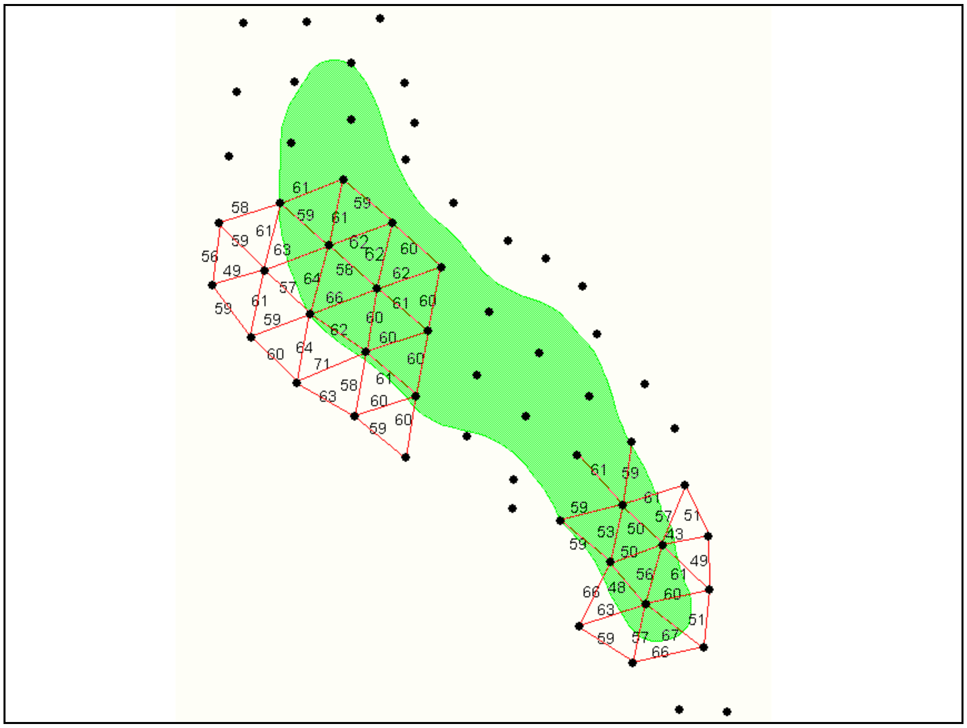


12 min irrigation fairway 9 – NDVI red

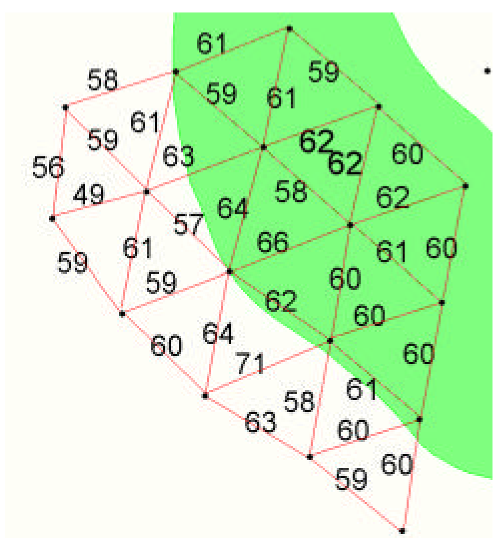


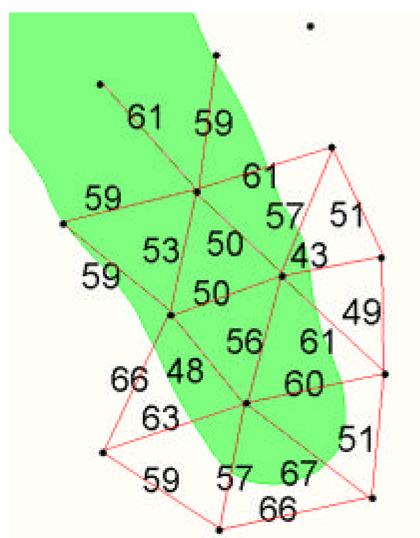
Altitude variations, Fairway 9



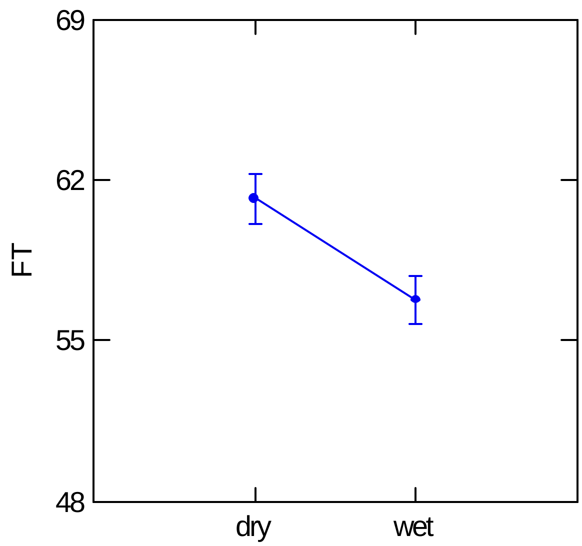


Dry area 61.2 ft **Wet area 56.8 ft**





Head Spacing



Outcome

- EM-38 provided useful soil moisture information
- Head spacing was identified as the likely cause of water application inconsistency
- Solution: Irrigation run times were increased in the dry area – not the entire fairway – seems obvious but sometimes data is needed