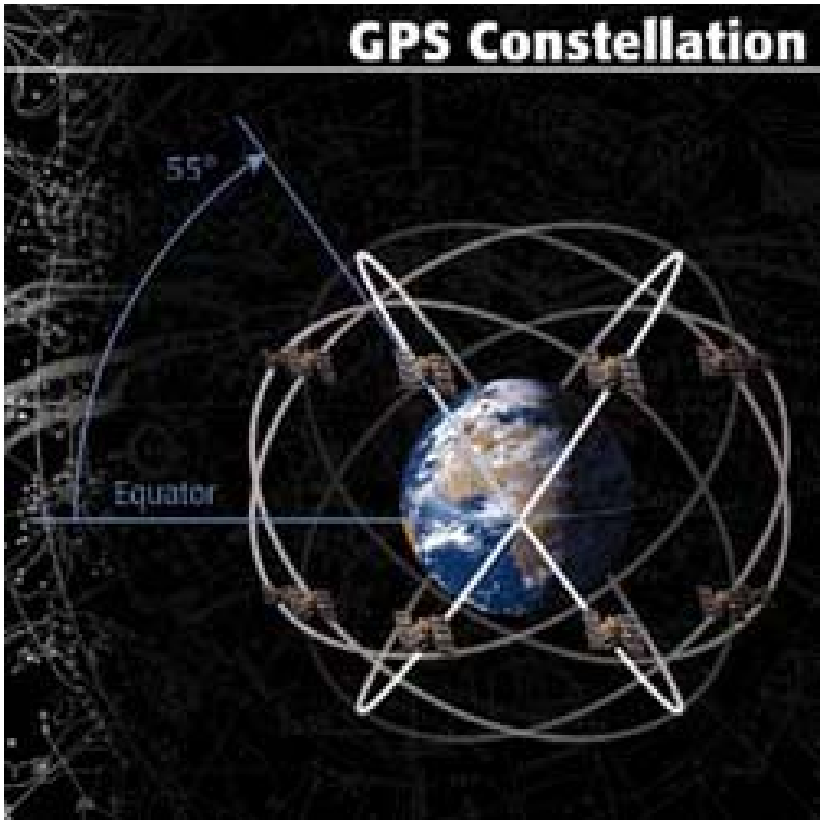
Research Farm Mapping Options

An Overview of :

- GPS
- GIS
- Remote Sensing
- Web based information

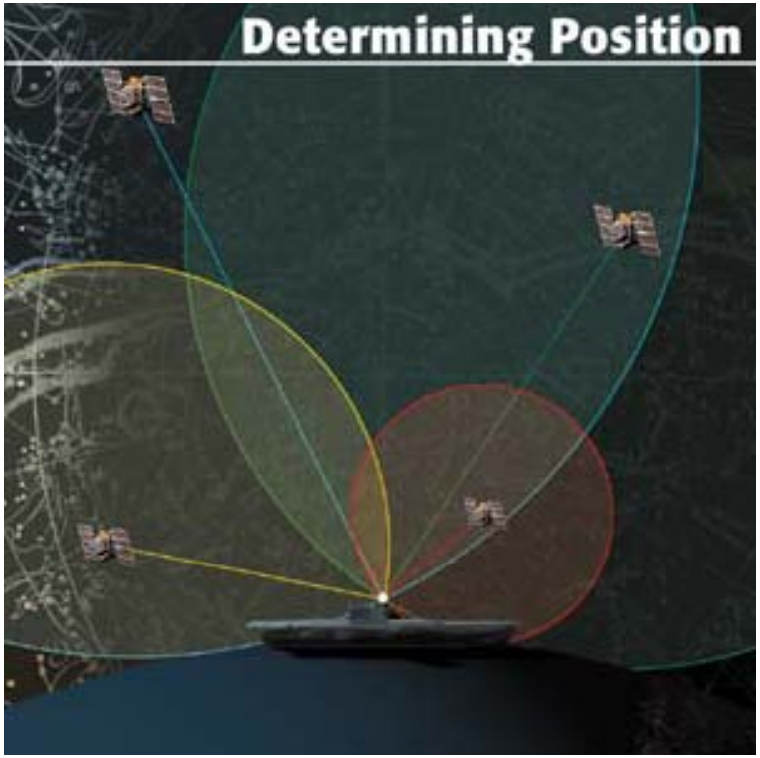
What is GPS?

- GPS: The Global Positioning System is a satellite based navigation system consisting of a network of 26 satellites that are orbiting in space eleven thousand miles above Earth's Equator. The satellites are constantly moving, making two complete orbits around the Earth every 24 hours.



Levels of GPS Accuracy

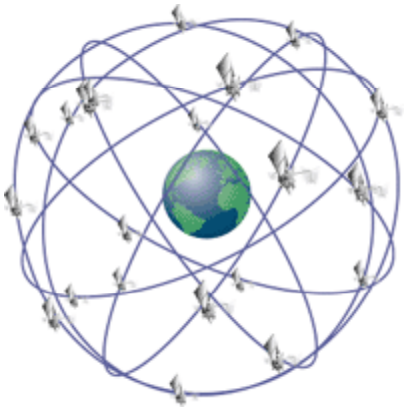
- Horizontal vs. Vertical
  Accuracy estimations by manufacturers are based on the horizontal “X/Y” axis.
- Vertical accuracy, “Z”, is usually 3 times worse than horizontal.



Levels of GPS Accuracy

- Absolute GPS: 50 – 150 feet

Absolute GPS is based solely on the satellites' triangulation with no ground based reference. Used mainly in low end cost items such as On-Star and cheap handheld units

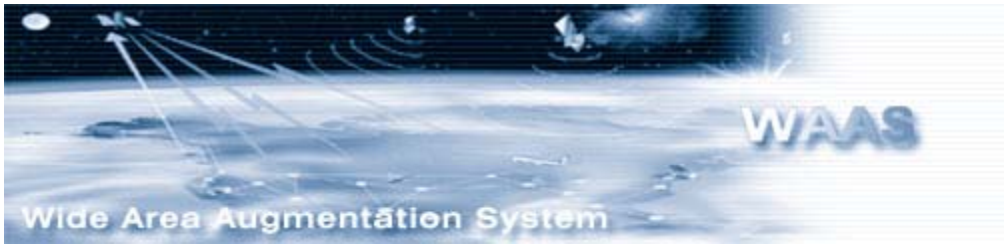


Levels of GPS Accuracy

- WAAS: 2 – 10 feet (DGPS < 2 feet)

Wide Area Augmentation System, WAAS, is based on a network of approximately 25 precisely surveyed ground reference stations throughout North America. These stations receive the satellite GPS signals and correct them and uplink to a geosynchronous satellite which is then rebroadcast for WAAS enabled receivers.

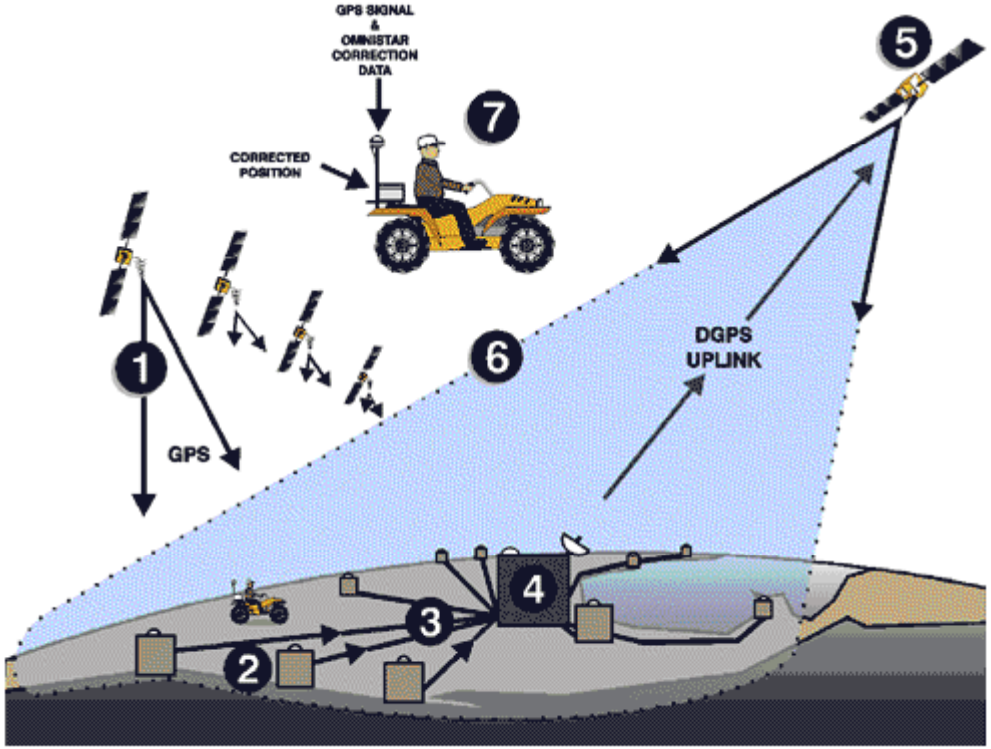
Differentially Corrected GPS, DGPS, requires a second receiver to triangulate the satellite data with a ground based transmitter. In many areas, WAAS (because of proximity to its tower network) has reached DGPS accuracy.



Levels of GPS Accuracy

- OmniSTAR: < 3 feet; usually < 1 foot
  - OmniSTAR is a wide-area differential GPS service, using satellite broadcast techniques. Data from many widely-spaced Reference Stations is used in a proprietary multi-site solution to achieve sub-meter positioning over most land areas worldwide.

Yearly subscription fee required on top of high initial cost.



Levels of GPS Accuracy

- RTK: 1 cm (fixed) 5 cm (floating)

  » 2.54 cm = 1 inch

Real Time Kinetics, RTK, requires a transmitting base station within a 10 mile radius of the receivers. This allows accuracy not only in the horizontal axis, but also in the vertical axis, thus allowing excellent elevation data to be accessed.

Pictures on left and right represent two types of portable base stations

Levels of GPS Accuracy

- Absolute GPS: 50 – 150 feet
- WAAS: 2 – 10 feet
- DGPS: 1 – 3 feet (including differentially corrected WAAS)
- OmniSTAR: < 3 feet; usually< 1 foot
- RTK: 1 cm (fixed) 5 cm (floating)
  - » 2.54 cm = 1 inch

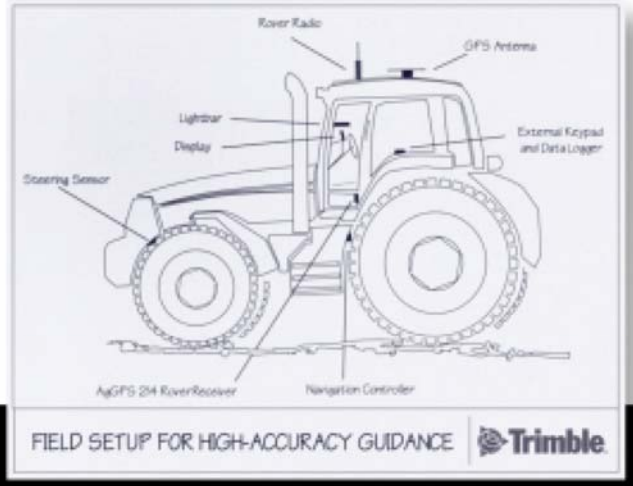
Guidance use by GPS

- Guidance with WAAS (DGPS)

Works well with Spraying and Fertilizing
Accuracy 1-3 feet

Guidance use by GPS

- Guidance by RTK

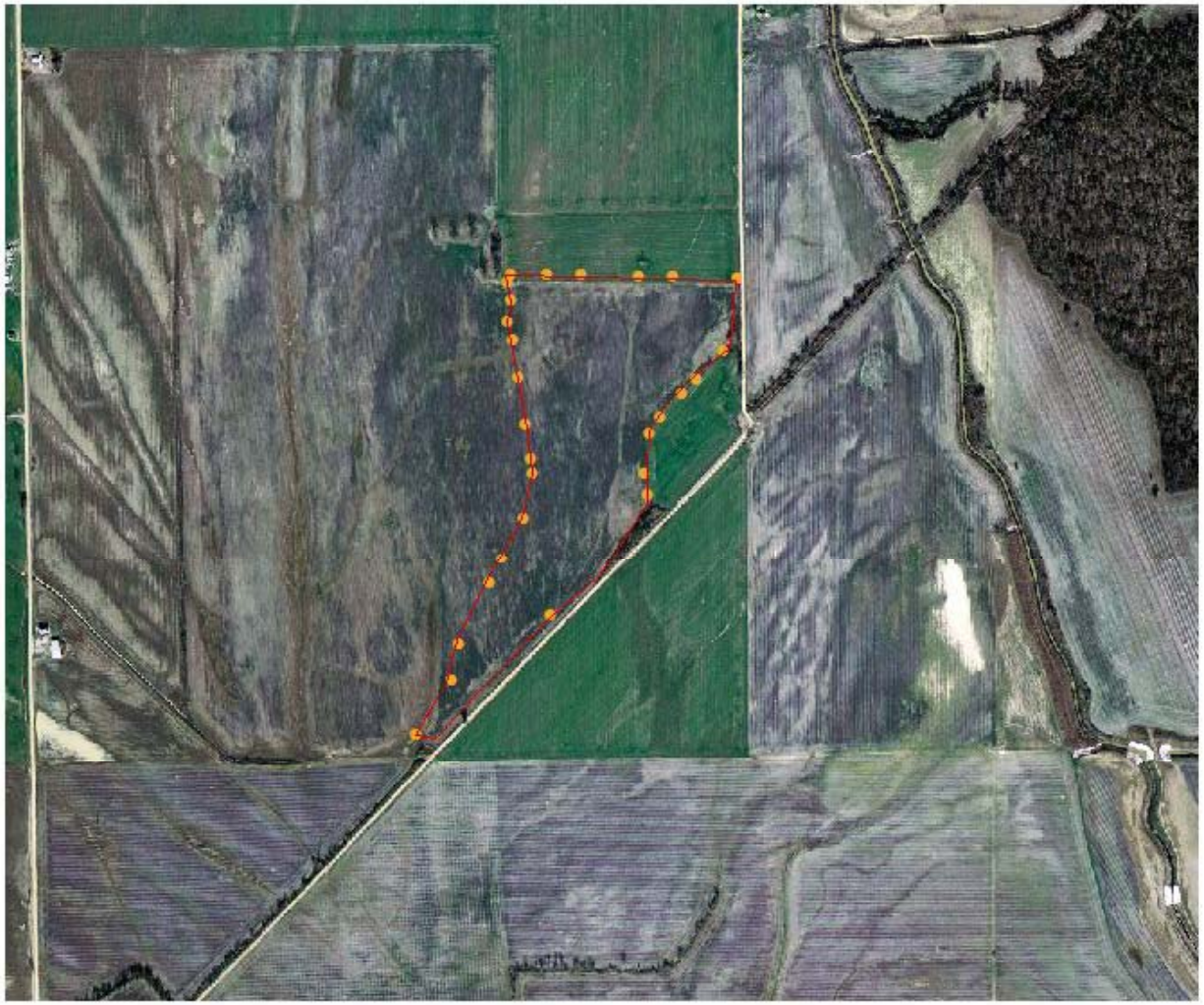


HOW IT WORKS

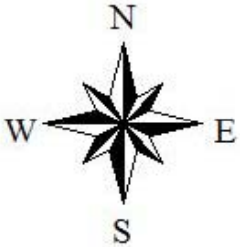
Autopilot is powered by Trimble's high performance GPS-based navigation controller connected to your tractor's power steering mechanism. An in-cab display lets you select field patterns and view operating parameters. Once Autopilot lines up your tractor at the beginning of a row, the automated steering guides the tractor smoothly down the row. A lightbar provides feedback on your course. It's that simple.

Accuracy within 1 cm – Excellent Precision control

Bob Pollard's damaged wheat

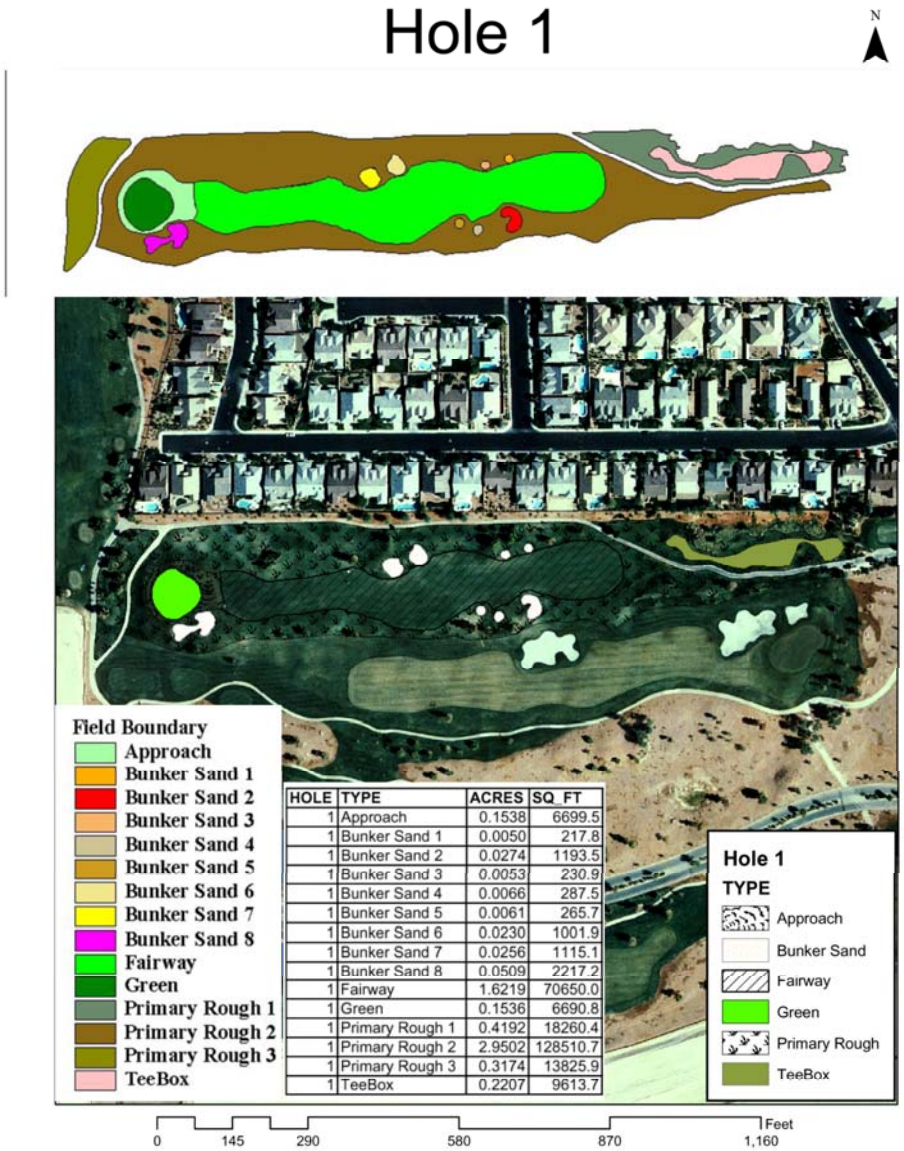


(39.6ac.)Pollard Damaged Wheat
Points1



GIS: Geographical Information System

- Designs the data to be understandable and visual
- Resource management tool

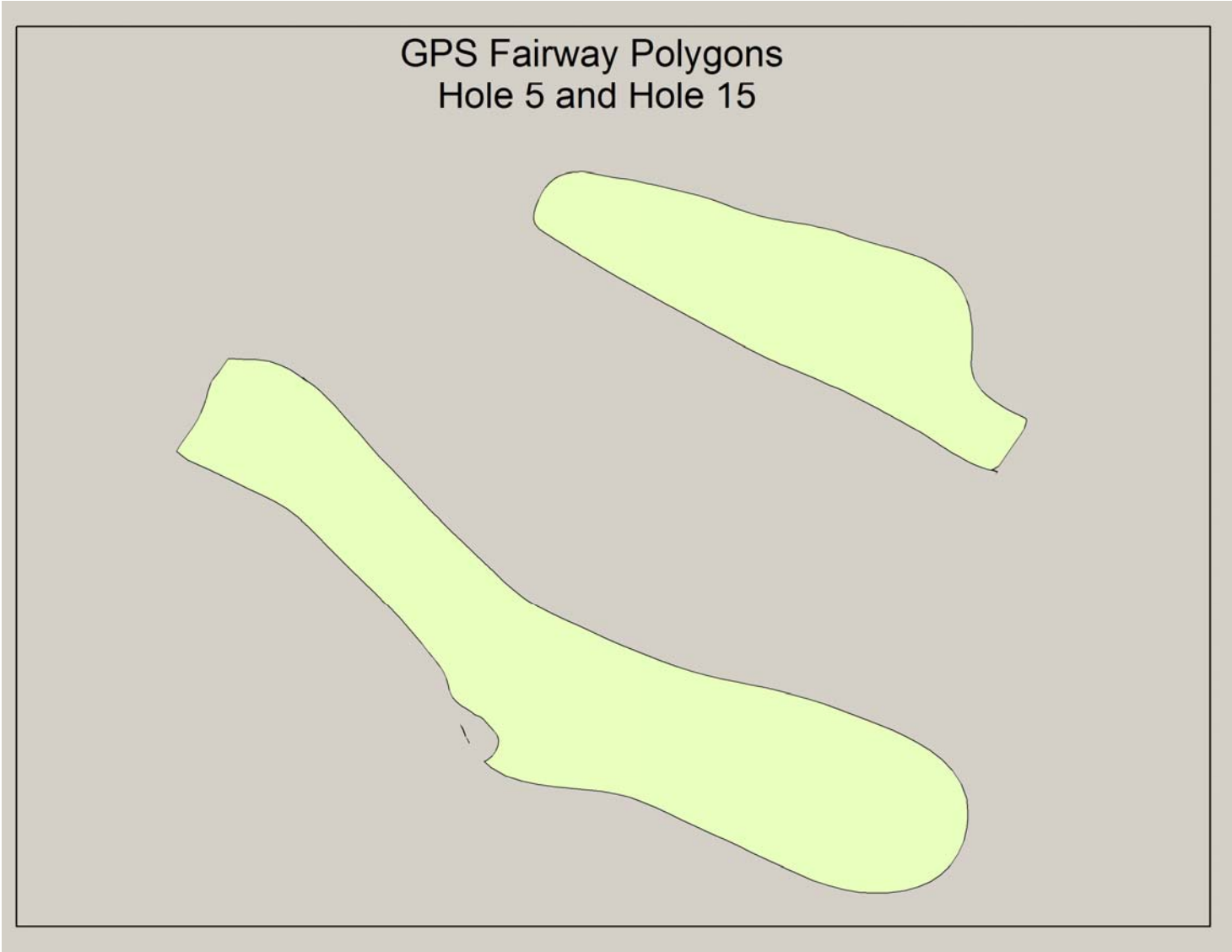


HOLE	TYPE	ACRES	SQ_FT
1	Approach	0.1538	6699.5
1	Bunker Sand 1	0.0050	217.8
1	Bunker Sand 2	0.0274	1193.5
1	Bunker Sand 3	0.0053	230.9
1	Bunker Sand 4	0.0066	287.5
1	Bunker Sand 5	0.0061	265.7
1	Bunker Sand 6	0.0230	1001.9
1	Bunker Sand 7	0.0256	1115.1
1	Bunker Sand 8	0.0509	2217.2
1	Fairway	1.6219	70650.0
1	Green	0.1536	6690.8
1	Primary Rough 1	0.4192	18260.4
1	Primary Rough 2	2.9502	128510.7
1	Primary Rough 3	0.3174	13825.9
1	TeeBox	0.2207	9613.7

GIS: Geographical Information System

It allows for the incorporation of Imagery

- GPS WITHOUT IMAGERY



GIS: Geographical Information System

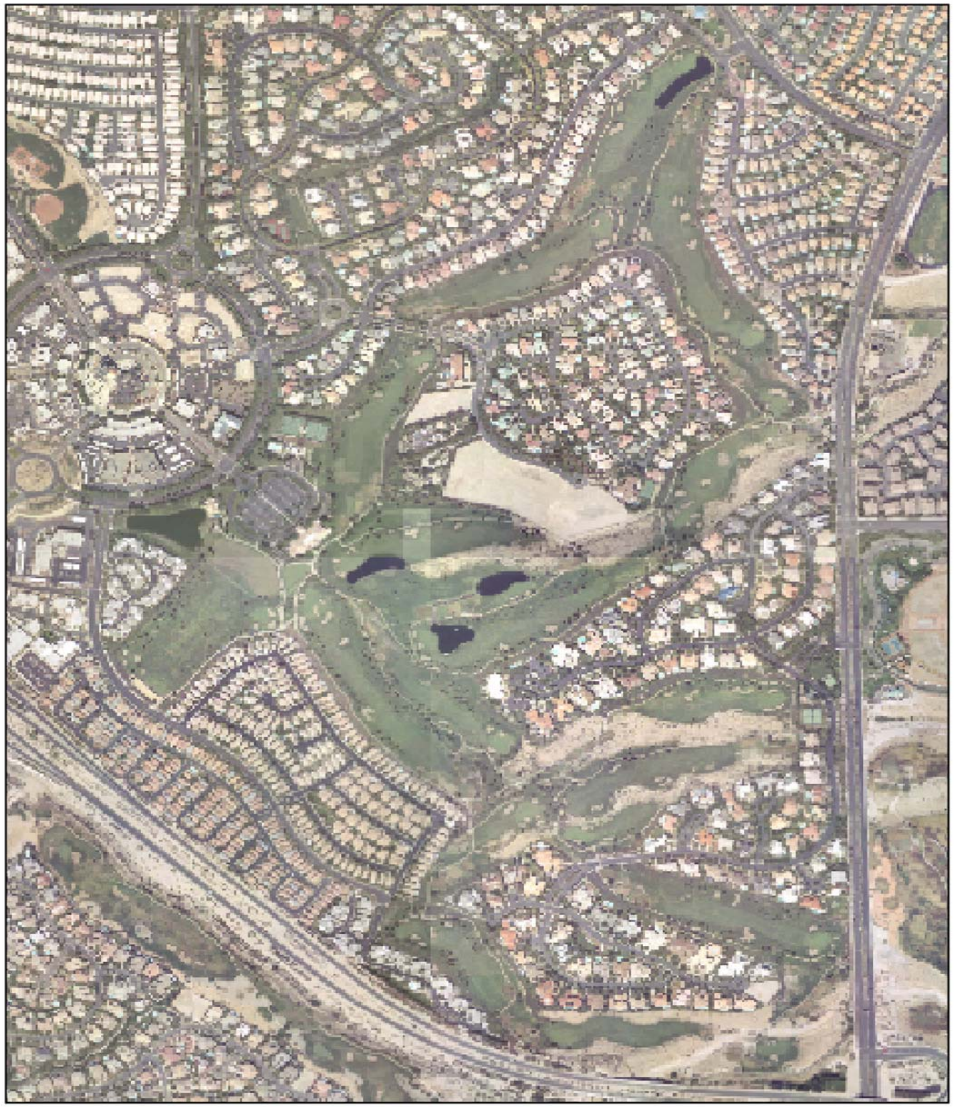
- GIS takes GPS data and correlates it to imagery
- Look at the bottom fairway, the GPS signal drifted and mistakes were made

Clark County, Nevada provides excellent aerial images

1 foot resolution

Updated every 6 months
Geo-Referenced

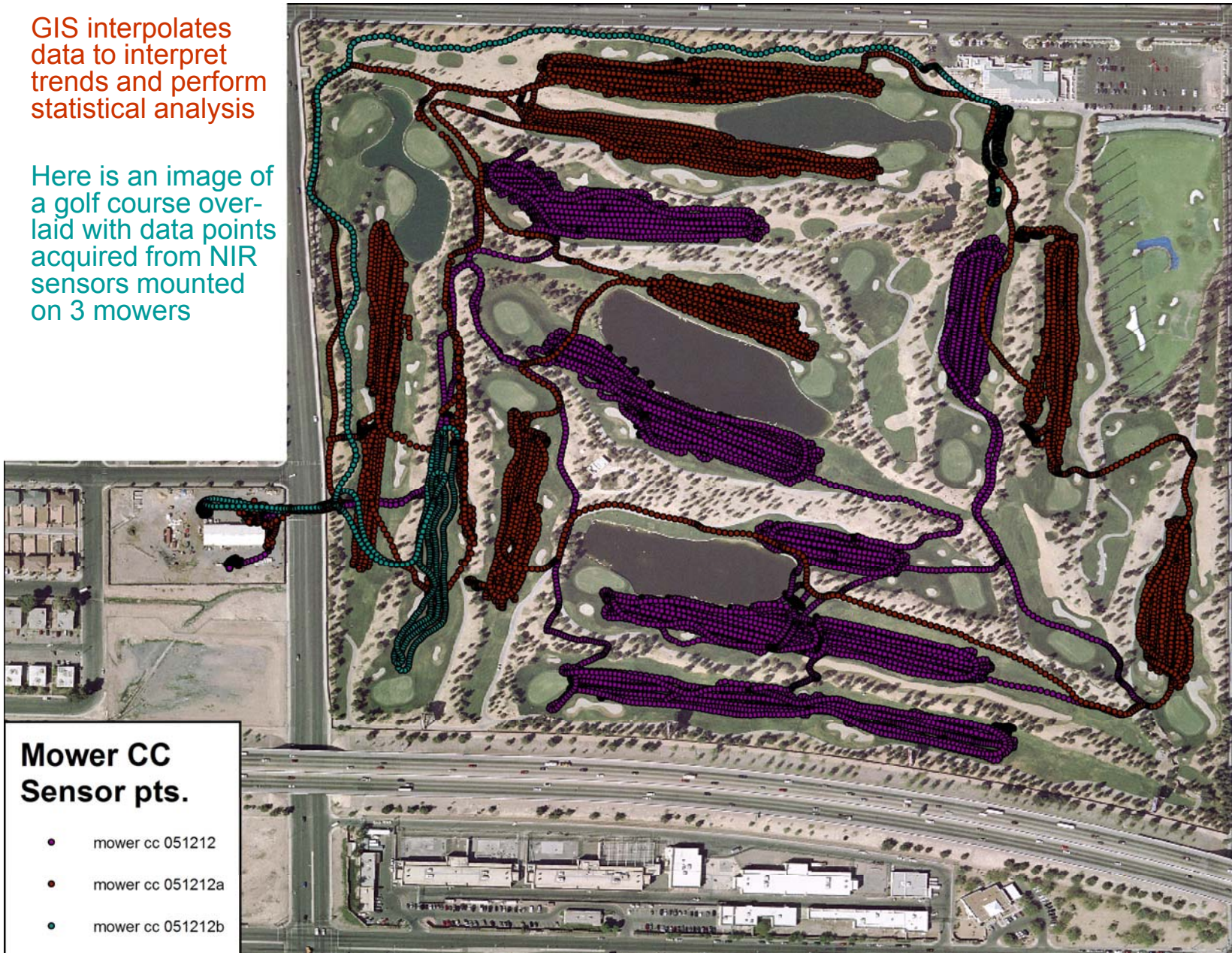
Extremely Affordable



Imagery file size exceeds 150 MB of data

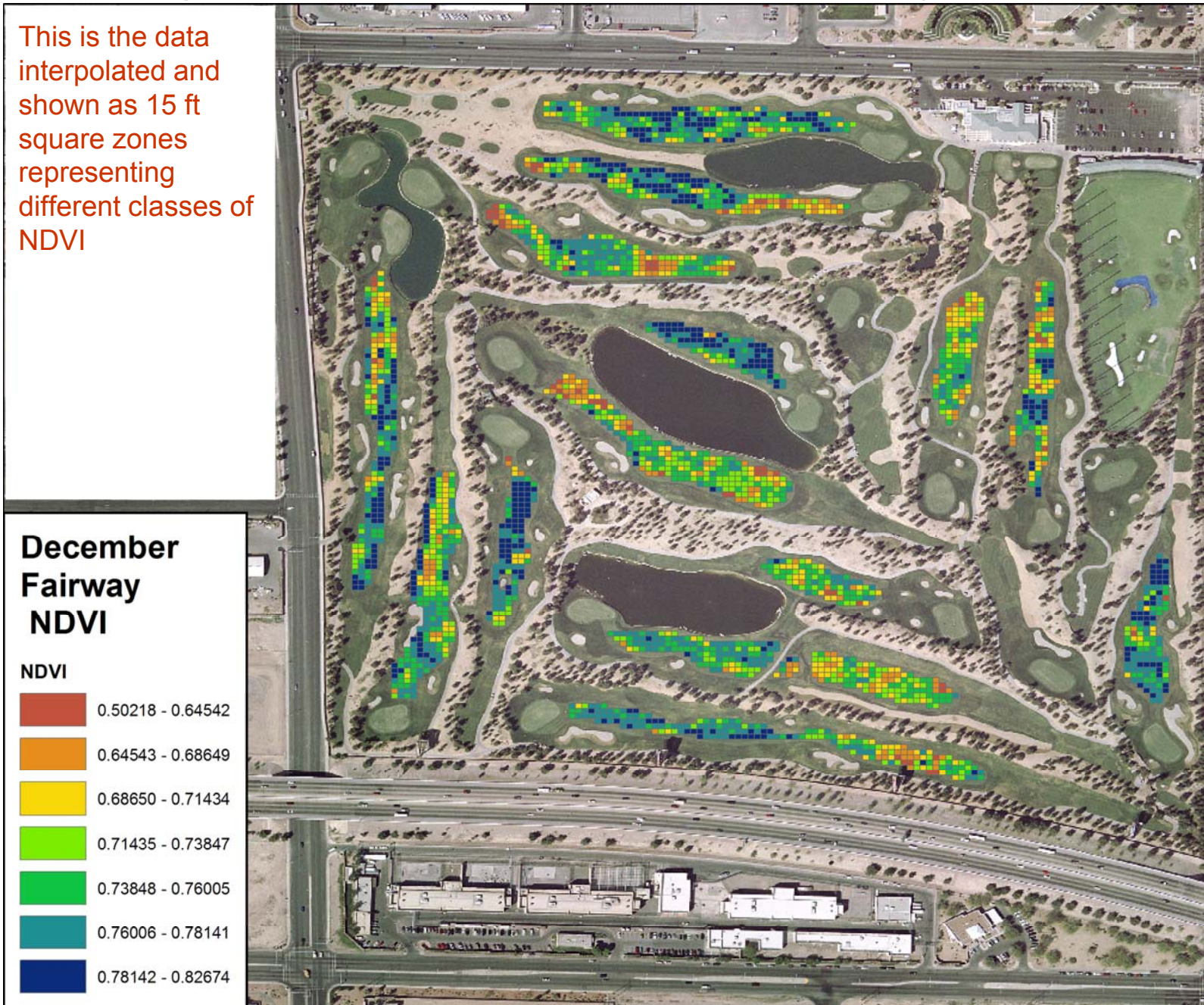
GIS: Geographical Information System

- GIS interpolates data to interpret trends and perform statistical analysis
- Here is an image of a golf course over-laid with data points acquired from NIR sensors mounted on 3 mowers



GIS: Geographical Information System

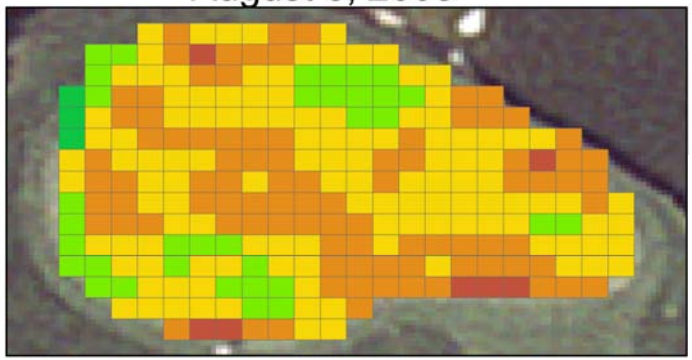
- This is the data interpolated and shown as 15 ft square zones representing different classes of NDVI



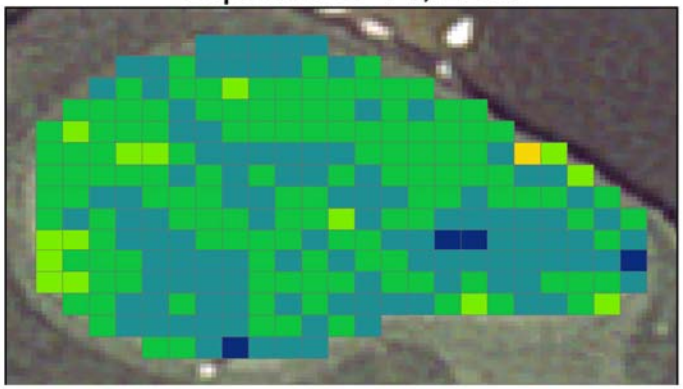
GIS: Geographical Information System

- Establishes an historical spatial database

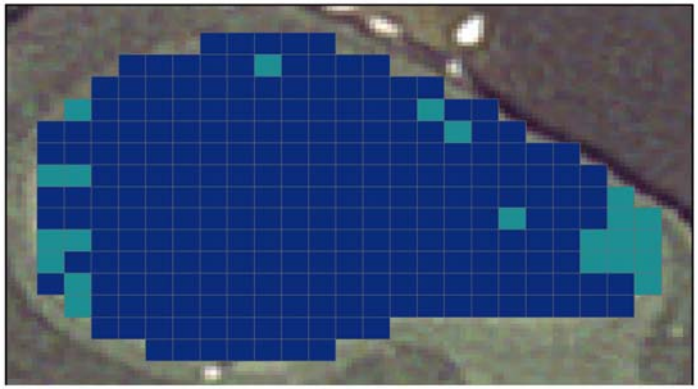
August 6, 2005

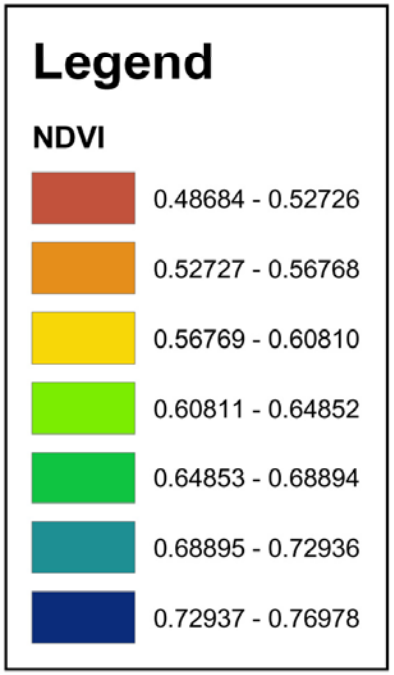


September 14, 2005



October 28, 2005





Industry Standards

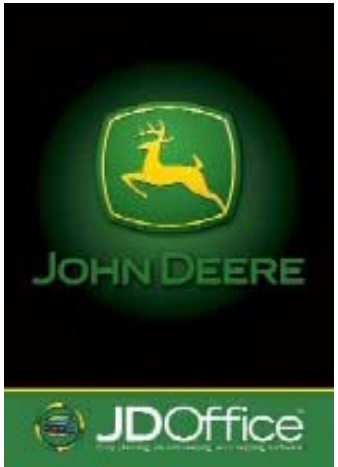
- All GPS is received as decimal degrees of Lattitude/Longitude known as WGS84 or World Geographical Survey of 1984
- ESRI has established itself as the leading GIS software provider
- The SHAPE (.shp) file format of ESRI has become the Industry Standard
- Trimble, Garmin, and other major GPS receivers save their points in the .shp file format

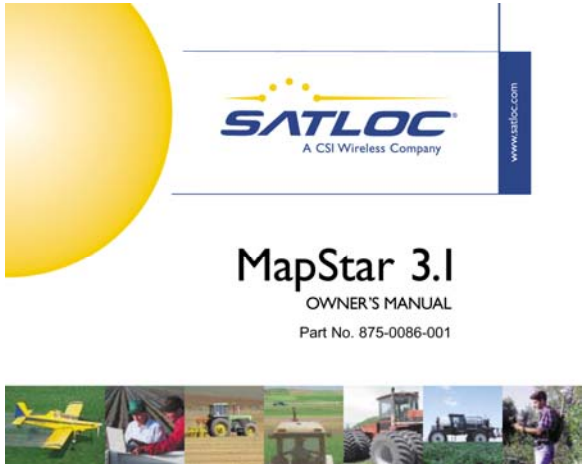
Pros and Cons of Proprietary GIS Software

Proprietary GIS uses its own encryption of data to limit its use to a specific software program.

- Benefits
  - One stop shopping for hardware and software
  - Hands-on learning of software
  - Easily accessible database

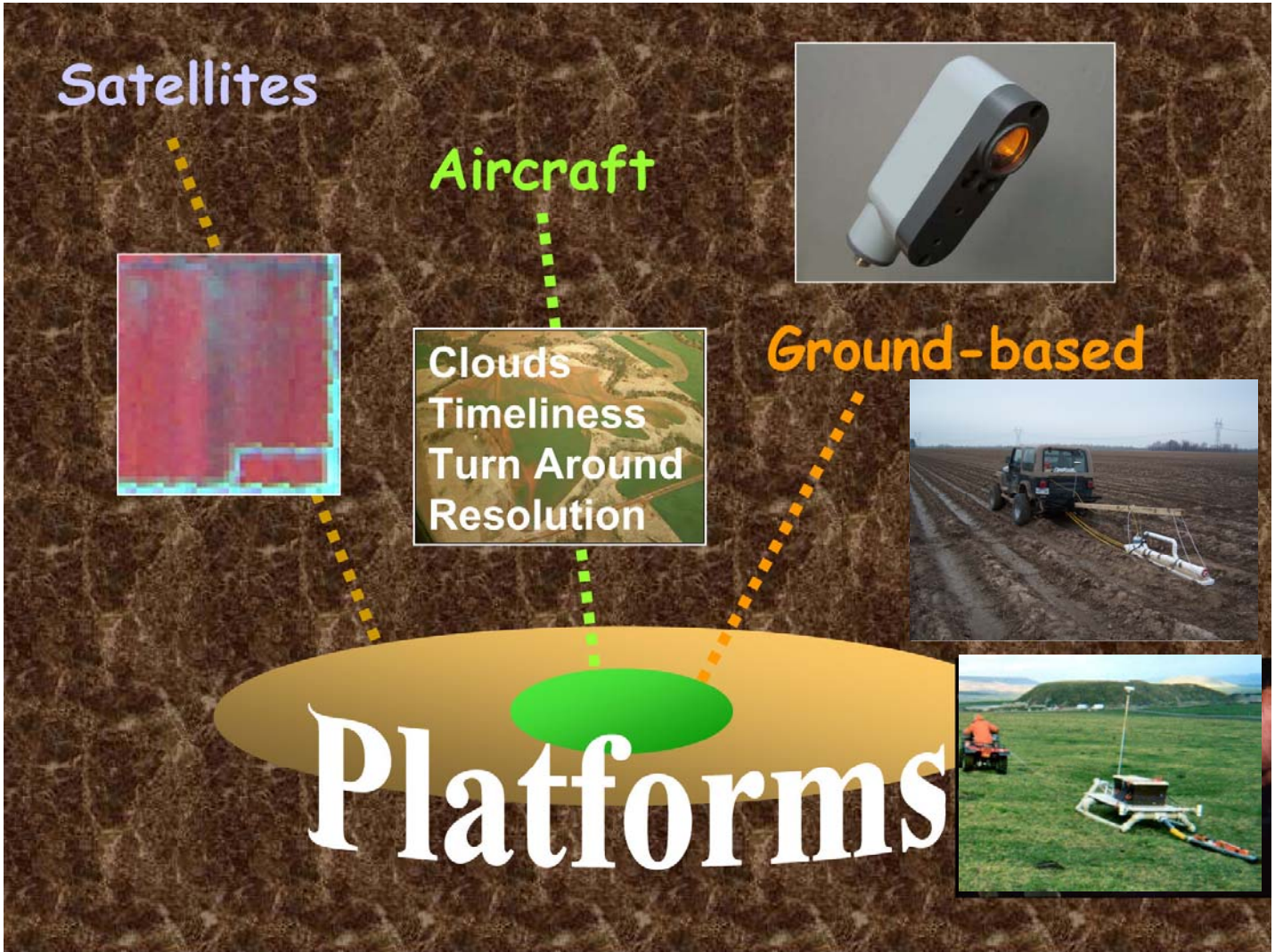
- Pitfalls
  - Survivor ability of software company
  - Software Antiquity
  - Yearly subscription fee
  - Compatibility of Proprietary software with GIS industry standard (.shp)
  - Ownership issues surrounding your course's data





What is Remote Sensing?

- Remote Sensing is the acquisition of information of an object by a recording device that is not in physical contact with the object.



Ways of Sensing your Turf

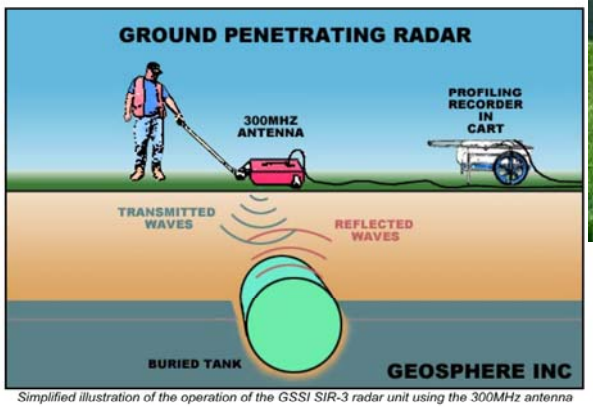
Ground Penetrating Radar

NDVI Sensor

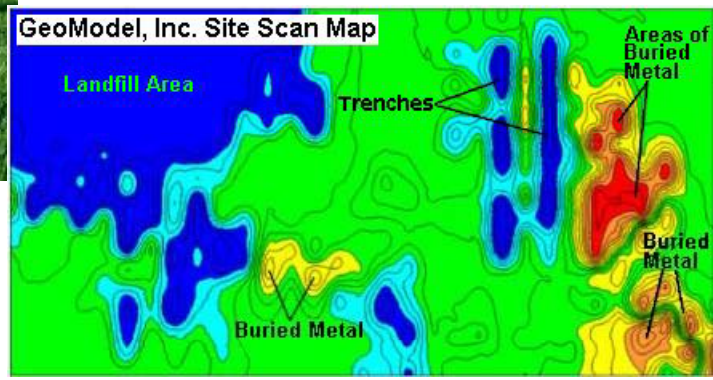
Geonics Conductivity Probe

DualEM Conductivity Sensor

Ground Penetrating Radar



Simplified illustration of the operation of the GSSI SIR-3 radar unit using the 300MHz antenna



The radar method determines subsurface conditions by sending pulses of **high frequency electromagnetic waves** into the ground from a **transmitter antenna** located on the surface. Subsurface structures cause some of the wave energy to be reflected back to the surface, while the rest of the energy continues to penetrate deeper. The reflected wave energy is picked up by a **receiver antenna** on the surface. These signals are then processed and plotted in a distance-versus-time display. Thus, as the radar antenna is slowly towed across the surface, a continuous cross-sectional "picture" of subsurface conditions is generated. The radar reflections are caused by wave responses at interfaces of materials having different electrical properties. These interfaces include many natural conditions such as bedding, cementation, changes in moisture and clay content, voids, fractures, and intrusions as well as man-made objects.

GPR

Depth of penetration is dependent on conditions found at each site. Radar waves are attenuated (absorbed or scattered) by certain properties of the site's soil, the most important of which is the electrical conductivity of the material. Generally, better overall penetration is achieved in dry sandy soils; reduced penetration is achieved in moist, clayey or conductive soils. Considerable depth may be attained in saturated sands or through lake water if the specific conductance of the water is low. Radar penetration is excellent in massive dry materials such as granite, limestone and concrete.

Resolution of radar reflections can be increased by increasing the frequency of the radar waves transmitted into the ground. This is done by using one of several different antennas available for the radar system. However, there is a trade-off between increased resolution and depth of penetration. In good conditions, the higher frequency (**900** and **500 megahertz (MHz)) antennas** are capable of penetrating 5 to 15 feet of soil with resolution on the order of 0.5-2 inches, whereas the lower frequency (**300** and **80 MHz) antennas** may attain 30 to 80 feet depths with resolution on the order of 0.5-3 feet.

Depths to buried layers or objects is proportional to the time it takes the radar pulse to travel from the surface antenna to the target and back again to the receiver antenna. This time is called **two-way travel time** and is dependent on the **dielectric** properties of the media through which the radar pulse travels. These dielectric properties are in turn a complex function of the **composition** and **moisture content** of the soil and rock. In almost all cases, the moisture content has the greatest influence because water has a very high dielectric value compared to common soils and rock. The greater the amount of water saturation, the lower the radar velocity and the lower the object will appear in the radar profile.

Equipment that measure Soil EC

- DualEm
  - The DualEm utilizes the Electromagnetic Induction Method which measures the soil's response to a magnetic field between transmitter and receiver coils located 1 meter apart on a unit riding along the soil's surface.

- Veris
  - Veris enlists the Galvanic Contact Resistivity Method. This method measures the soil resistance to the flow of an electric current emitted and collected by electrodes mounted on coulters. This resistance is then converted to conductivity and displayed in millisiemens per meter

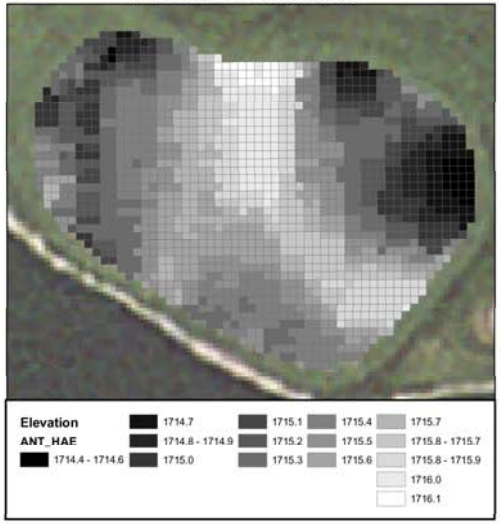
EC Data on Green

Green 9 Images

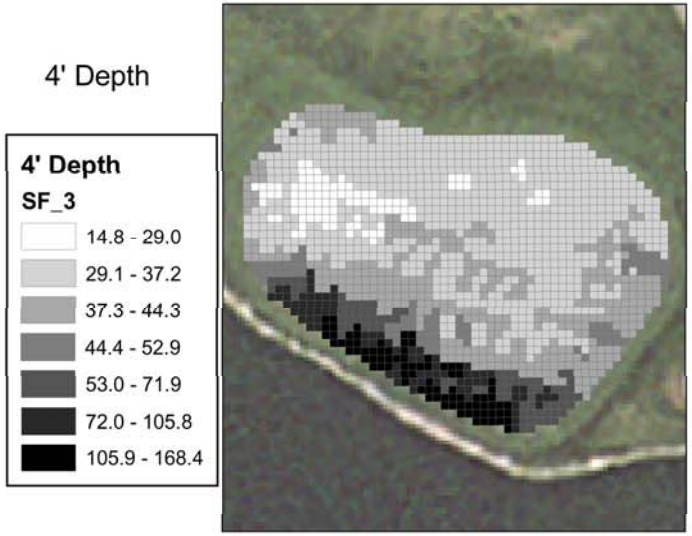
Aerial Image Spring 2004

N

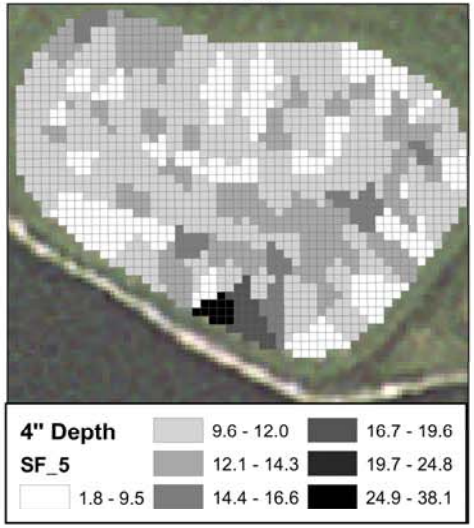
Elevation Contour



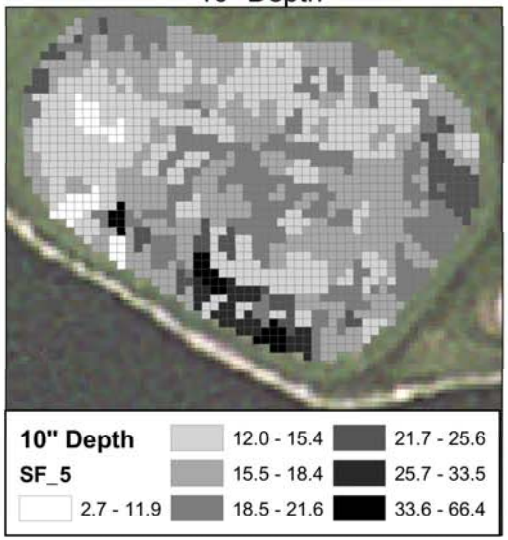
4' Depth



4" Depth

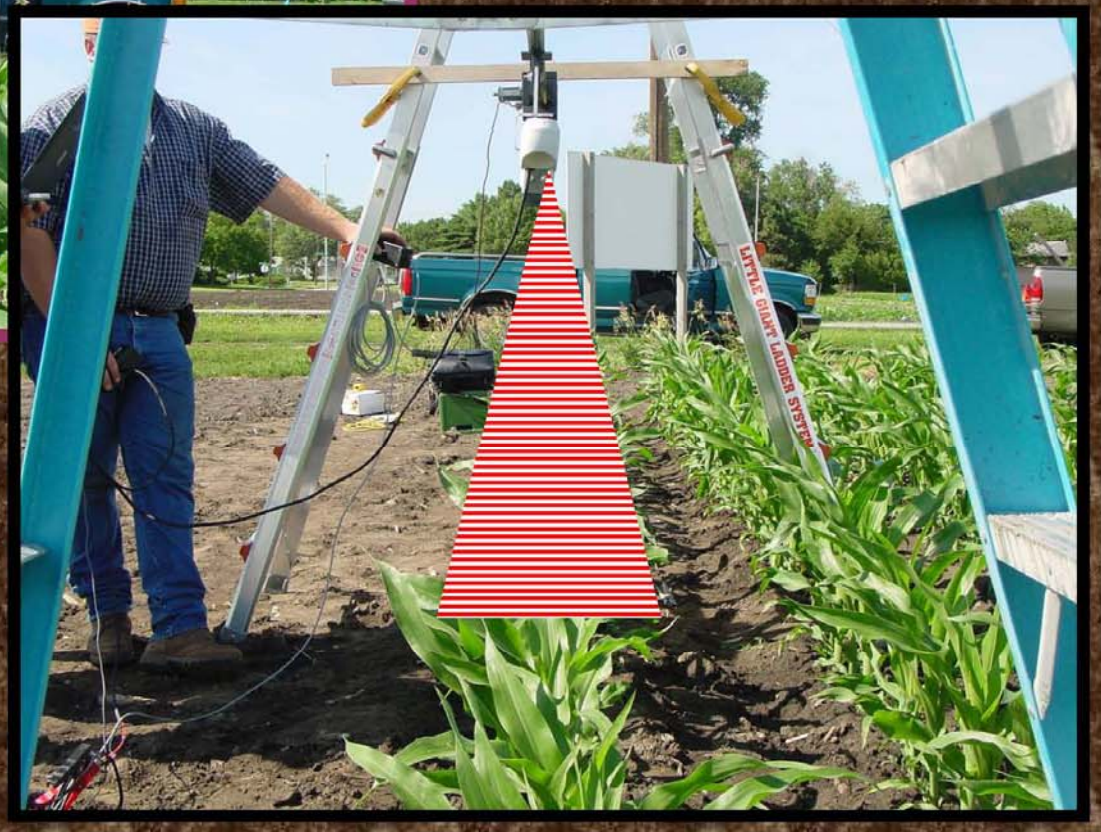


10" Depth



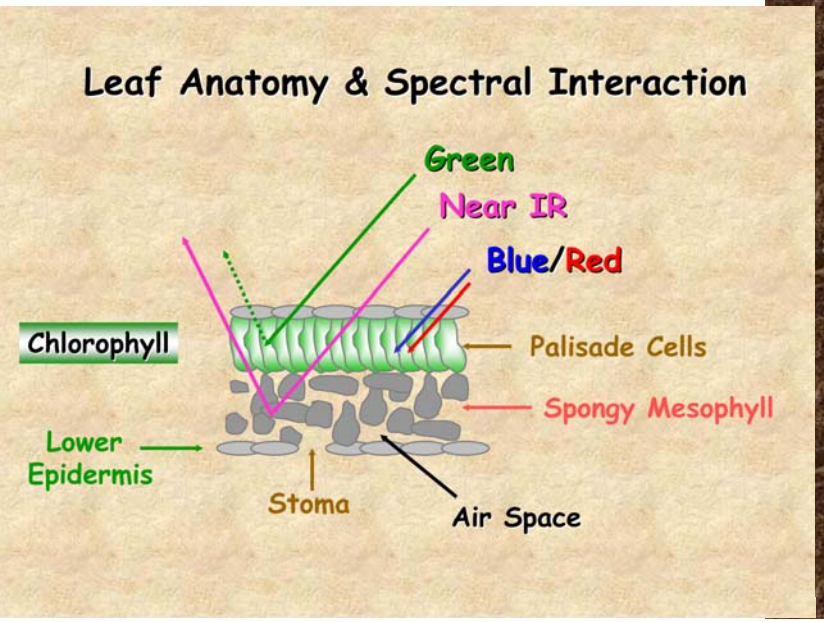
Crop Circle sensor on garage-door opener

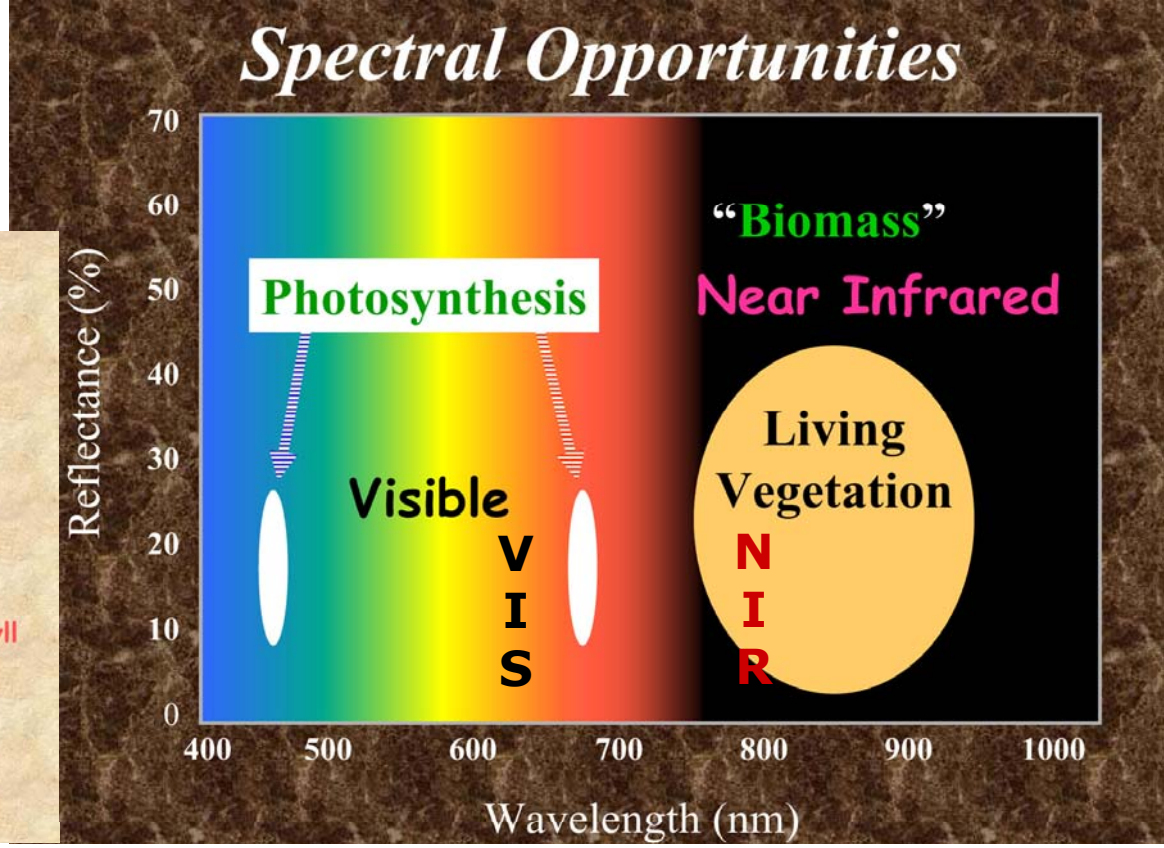
GreenSeeker



Ground Based NIR Sensors measures
biomass reflectance levels in visible and near Infrared wavelengths

What is NDVI?





There are many Vegetation Indexes, but the industry standard for turf is NDVI or Normalized Difference Vegetative Index. NDVI is simply a mathematical method of representing the two wavelengths' reflectance intensities in a way that can best show differences between healthy turf and poor growth.

Specifically it is: (NIR-VIS)/(NIR+VIS). The number range is usually between .25000 and .85000. The lower range represents a low BioMass/Chlorophyll level and the higher Range represents a high BioMass/Chlorophyll level (a healthy turf).

Taking the image to the Course

This is the next step in the Remote Sensing Process.

Uploading the imagery into an Ipaq with GPS
And navigating to the areas of concern.

To know what the problem is you must Ground Truth the area

Imagery and Other Web based GIS Information

- The Internet can provide remotely acquired data from various sources:
- Raster
  - Georeferenced imagery
- Vector
  - Line, Point, and Polygon GIS database

Raster Data

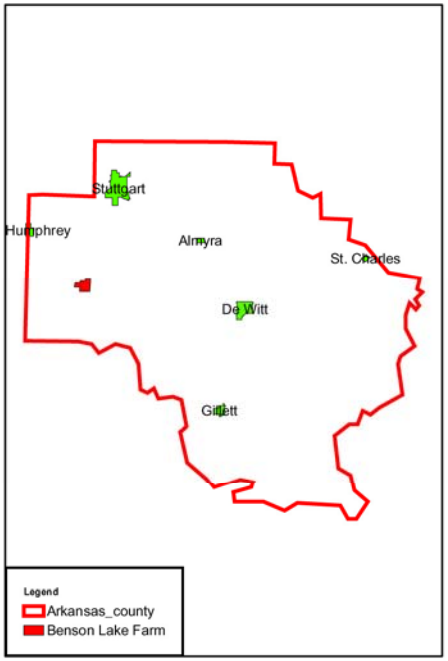
- GeoTiff & Sid
  - These files are geo referenced images that can be downloaded and used as a back drop for other data (point, line, and polygons)

2006 False Color Imagery

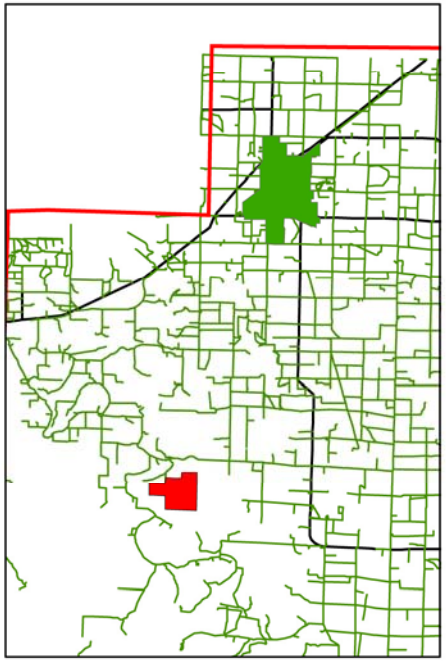
2001 NIR Imagery

Vector Data

- Vector data are files that are line or point or polygon files (usually in a shp file format). These files represent roads, rivers, cities(pts.), and city boundaries



1 inch equals 14.9 miles



1 inch equals 4.82 miles

State GIS Web Sites and NRCS Data Gateway

MARIS
Mississippi Automated Resource Information System

3825 Ridgewood Road, Jackson, MS 39211-6453 ▪ (601) 432-6128 ▪ (601) 432-6893 (FAX)
Index

Home | Download Data | Mapping | Training | News/Events | Links | Other | FAQ

Overview ▪ Technical Center ▪ Location ▪ Staff Listing

- search and retrieval of data descriptions (metadata)
- retrieval of Mississippi data sets
- posting of news related to GIS developments
- announcements of upcoming meetings and events
- mapping of data sets
- access and retrieval to aerial photography covering Mississippi

MARIS MISSION

- Serve as the legislative mechanism within Mississippi state government to provide for the systematic arrangement, availability, and use of digital natural and cultural resource information
- Encourage compatibility of Geographic Information Systems (GIS) and data distribution within state government.

Serving Mississippi's GIS needs by providing Mapping, Geo-data, Education, and Service since 1982.

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GISource

Click here to visit the TNMap

Welcome to the GISource website, GIS Services gateway to the Internet. This site will be a dynamic source for information about geospatial technologies in Tennessee state government.

Mission

The mission of the GIS Services Division is to provide the highest possible quality geospatial services to users within the State of Tennessee in a timely fashion as economically as possible. The Division will facilitate the efficient and effective management of the human, cultural, and financial, and natural resources of the State of Tennessee, and its local communities. Geospatial services is defined as technical, management, and administrative consulting, data provision, application development and implementation services of spatial information.

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Data Gateway

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