GK Technology
For Agriculture

RTK

LiDAR

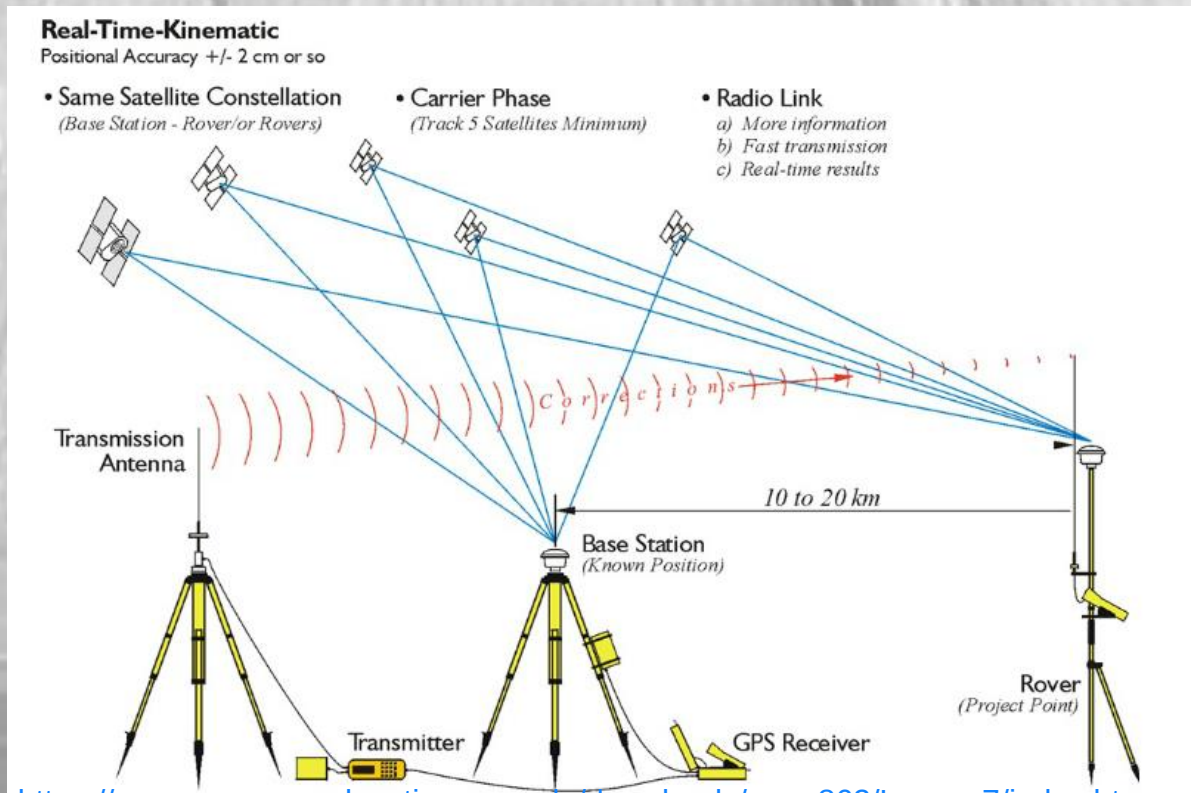
AGVISE
LABORATORIES

Overview

- Data Collection
  - What is RTK
  - RTK Accuracy
  - CORS
  - What is LiDAR
  - LiDAR Accuracy
- Data Uses
  - Zone Management
  - Background Images

RTK – What is it?

- RTK = Real Time Kinematics
  - Requires 2 RTK - GPS receivers (base & rover)
  - Base & Rover need 5 satellites in common
  - RF communications
    - 900 MHz signal
    - 450 MHz signal
  - Limited distance
    - 10 km or 6 miles
    - Data Collection



Graphics from - https://courseware.e-education.psu.edu/downloads/geog862/Lesson7/index.htm

RTK Accuracy
Time & Repeatability

- RTK Accuracy
  - Due to a multitude of variables in GPS & RTK calculations, % of time is another measurement.
- A quote from Trimble on Year to Year Acc.
  - *“So, a +/- 1 inch year-to-year accuracy means you can drive the same rows next year within 1 inch of this year’s rows, 95% of the time.”*

NOTE: This is referring to steering accuracy XY.

--- Accuracy = Time & Repeatability ---

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RTK – Accuracy

- **Horizontal Accuracy** – X & Y- Lat & Lon
  - Many systems are claiming < 1 cm or 0.4”
  - This is likely true within 4-6 miles of the base
  - I believe that you can hold < 2 cm or 0.8” acc.8-10 miles
- **Vertical Accuracy** – Z – Elevation
  - Claims of < 2 cm or 0.8” acc. within 4-6 miles of base
  - My comments
    - @ 1 mile expect <2 cm or 0.8”
    - @ 2 miles expect < 4 cm or 1.6”
    - @ 4 miles expect < 7.5 cm or 3.0”
    - @ 8 miles expect < 15 cm or 6.0”

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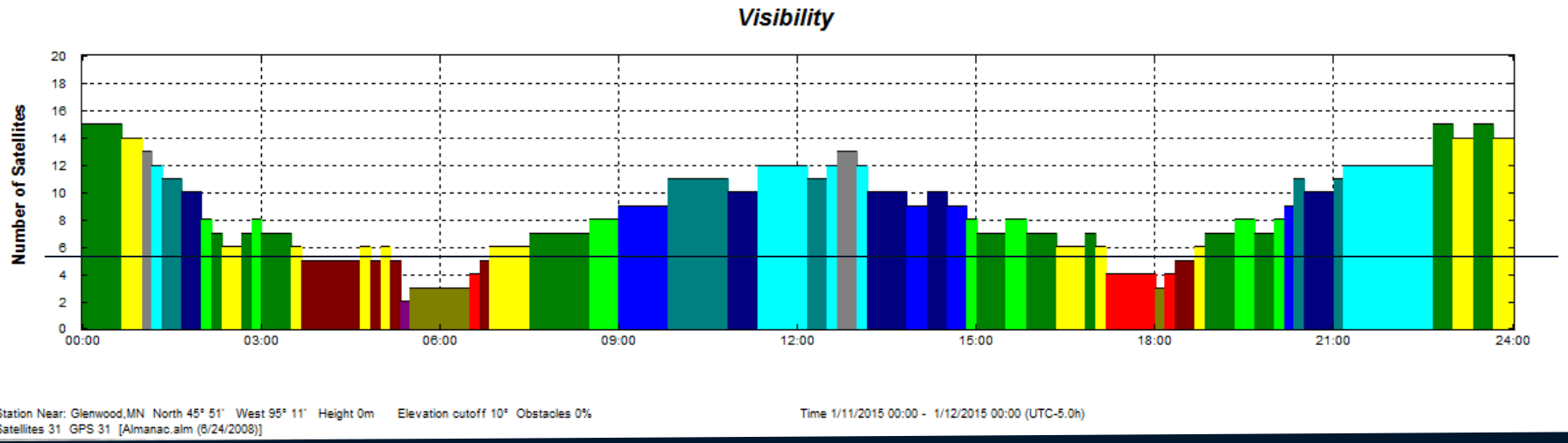
Planning - Near: Glenwood,MN, 1/11/2015 - [Almanac.alm]

File Almanac Satellites Graphs Lists Options Windows Help

Satellite Systems: ☑ GPS ☐ Glonass ☐ Galileo ☐ Compass ☐ WAAS

GPS = Global Positioning System

Number of Satellites



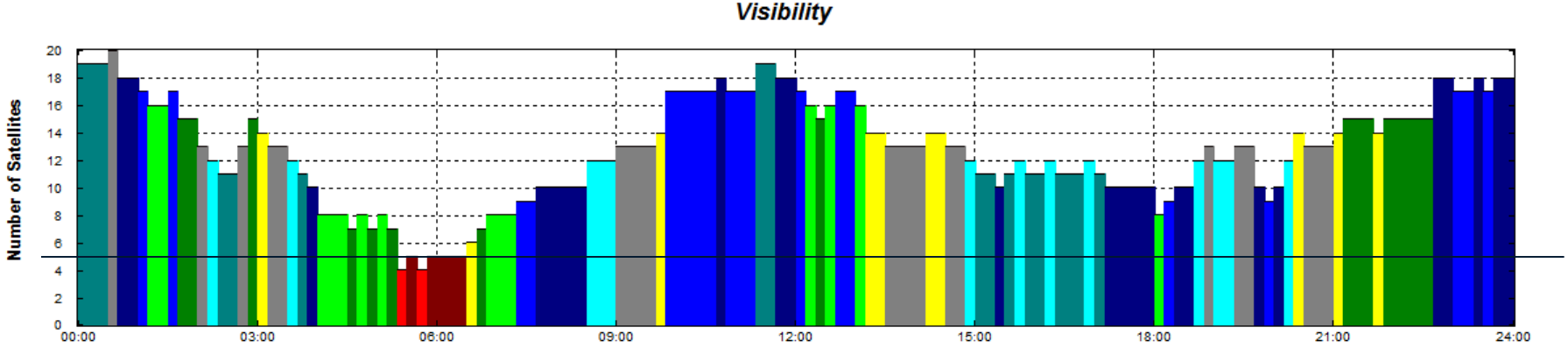
Station Near: Glenwood,MN North 45° 51' West 95° 11' Height 0m Elevation cutoff 10° Obstacles 0%
Satellites 31 GPS 31 [Almanac.alm (6/24/2008)]

Time 1/11/2015 00:00 - 1/12/2015 00:00 (UTC-5.0h)

Satellite Systems: ☑ GPS ☑ Glonass ☐ Galileo ☐ Compass ☐ WAAS

"*Globalnaya navigatsionnaya sputnikovaya sistema*" or GLONASS = Global Navigation Satellite System

Number of Satellites



Station Near: Glenwood,MN North 45° 51' West 95° 11' Height 0m Elevation cutoff 10° Obstacles 0%
Satellites 45 GPS 31 Glonass 14 [Almanac.alm (6/24/2008)]

Software shown – Trimble "Planning v2.80"
http://ww2.trimble.com/planningsoftware_ts.asp

CORS Towers

"Network"

CORS Towers

- **CORS -** Continuously Operating Reference Station
- Base reference stations
- Typically accessed via cell modem (expect delays)
  - *Machine Control 5x & 10x / sec*
- Claims 10cm or 3.8” Vert. Acc.
- Services & Maintained by
  - NOAA (National Oceanic and Atmospheric Administration)
  - State DOT (Department of Transportation)

CORS Towers

- CORS Map – Towers - Update Times

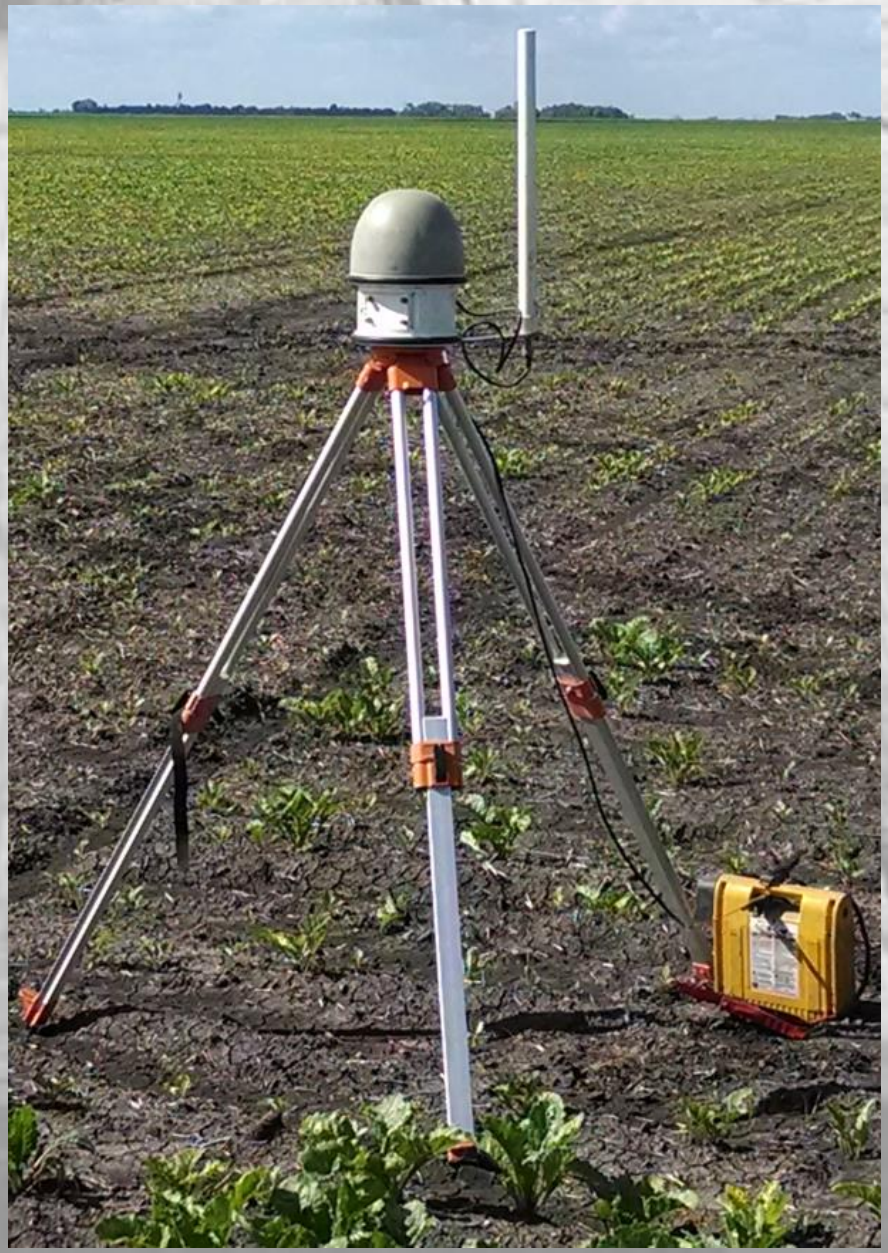
Only GPS	GPS+GLONASS GNSS	All
		1 sec rate
		5 sec rate
		15 sec rate
		30 sec rate
		All Active
		All Non-Oper
		Decommissio

MN = 5 hz data rates

Image Thanks to:
http://www.ngs.noaa.gov/CORS_Map/

RTK is the ANSWER

- Data collection
- Machine controls
- No replacement
  - At this time
- Other Systems
  - CORS Distance & Delay
  - VRS Delay
  - OPUS not an option



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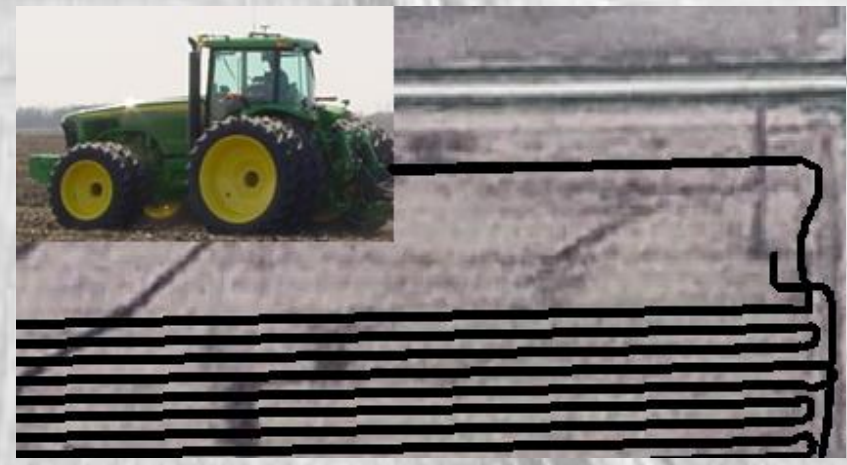
RTK Data Collection

- Within 4-6 miles of RTK Base
  - Mobile Base or Tower Network
- 40’-60’ passes
- Collect –
  - Ditch bottoms
  - Hill tops / ridges
  - Potential inlet & outlets
  - Benchmarks
- Data can be merged



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RTK Summary - Usage

- Base within 2 miles
  - Machine Controls
- Base within 4-6 miles
  - Data Collection
- RTK best most economical answer for sub-inch accuracy

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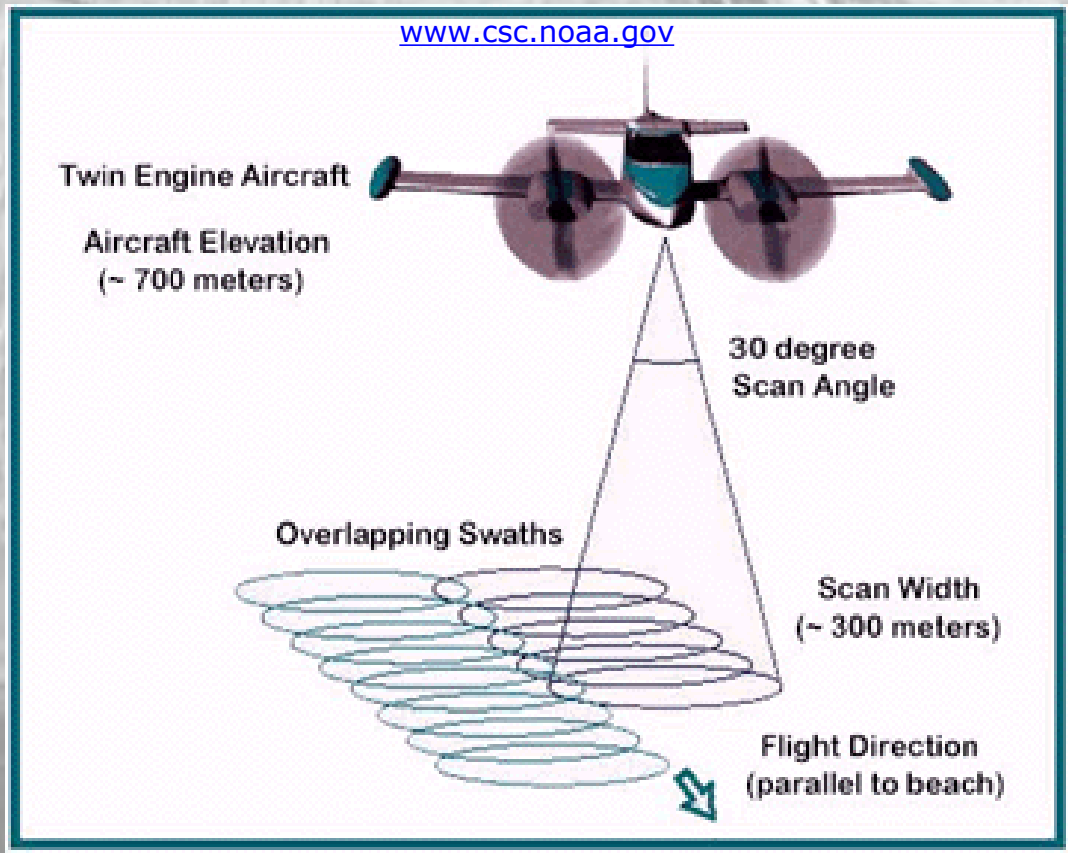
LIDAR – What is it?

- LiDAR = Light Detection And Ranging
- Elevation collected by planes equipped with GPS & LIDAR sensing unit
- Vertical Accuracy
  - 6” RRV Basin
  - 8” MN ND SD Data



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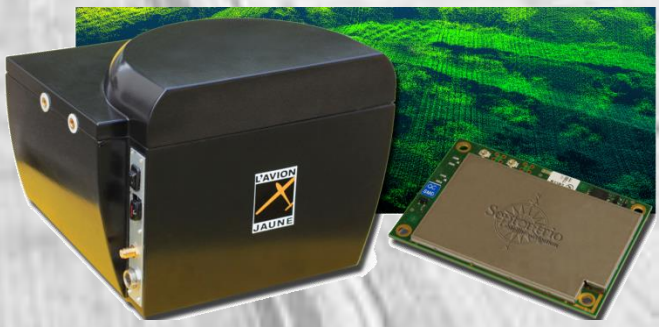
LiDAR Collection Tools

- LiDAR records surface elevation using “NIR” laser pulses
  - Up to 250,000 per second*
- Pulses are returned to an onboard computer
- High Acc. GPS



Thanks to:
-MN Department of Natural Resources
-http://gpsworld.com
for images in this slide

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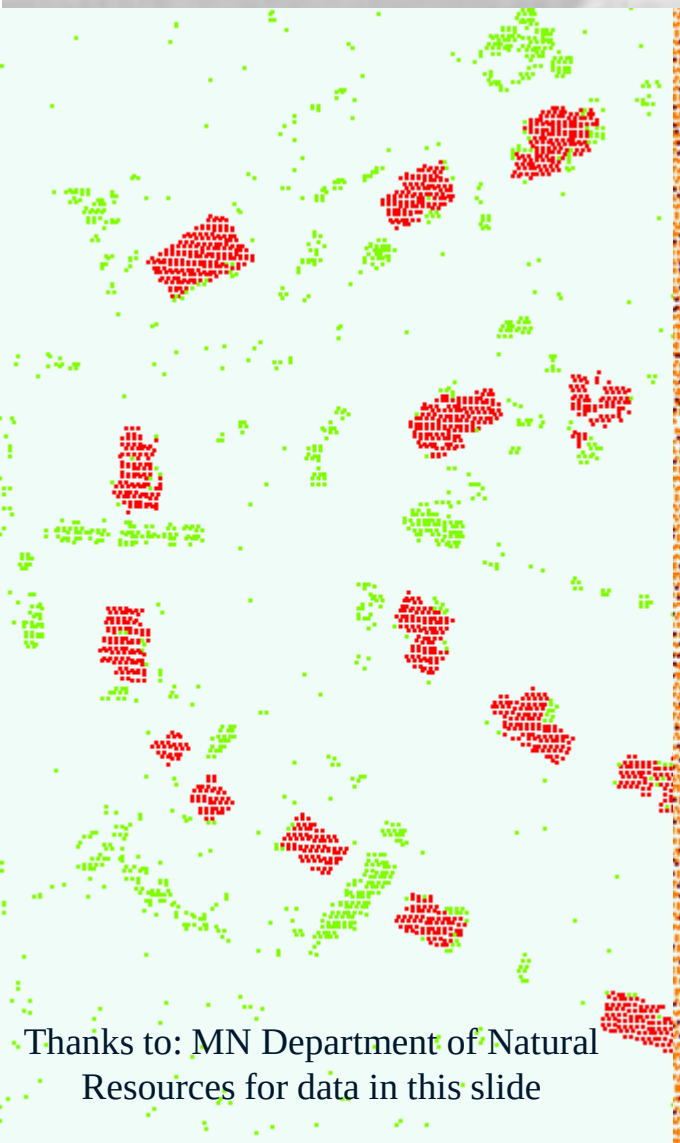
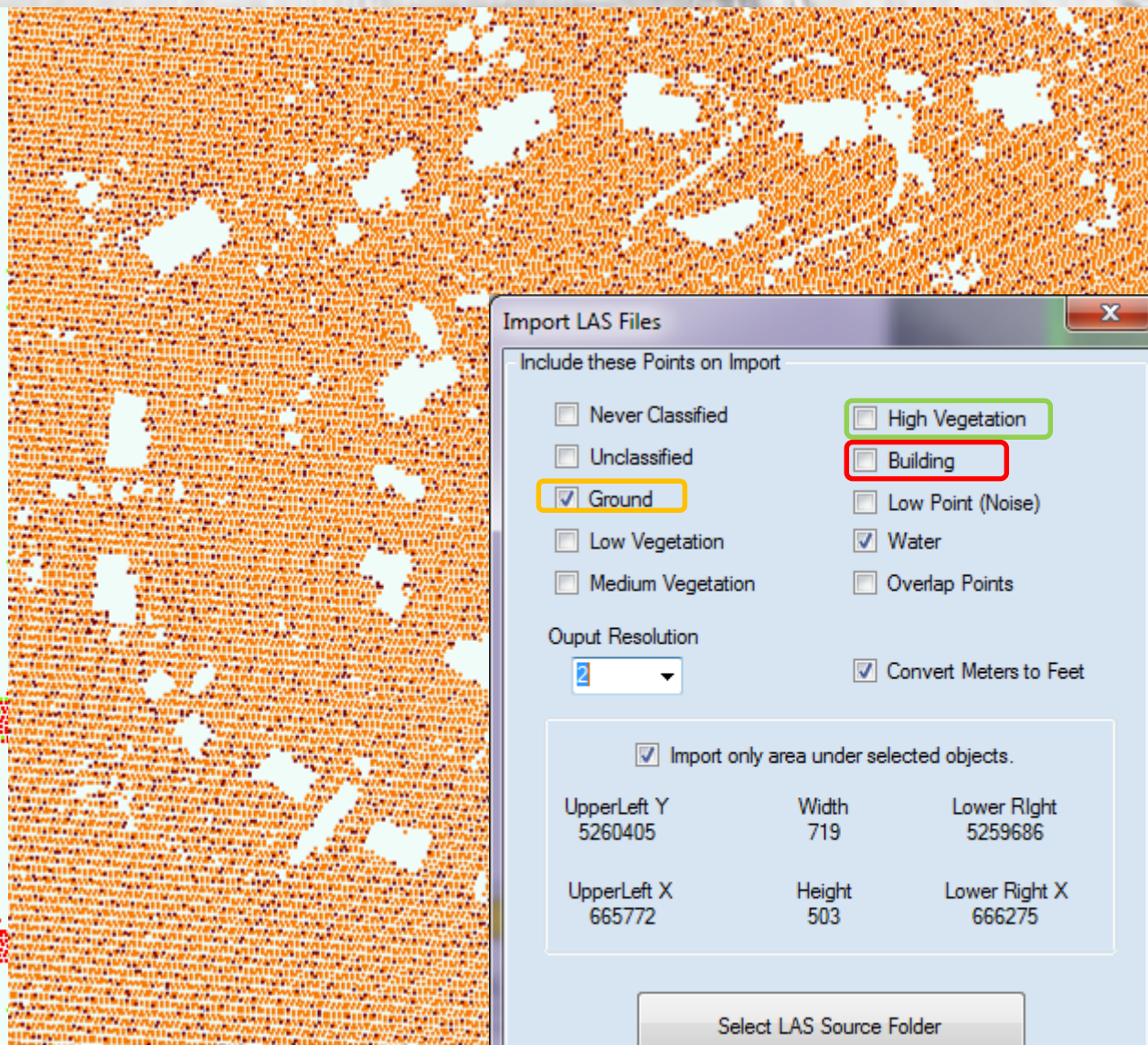
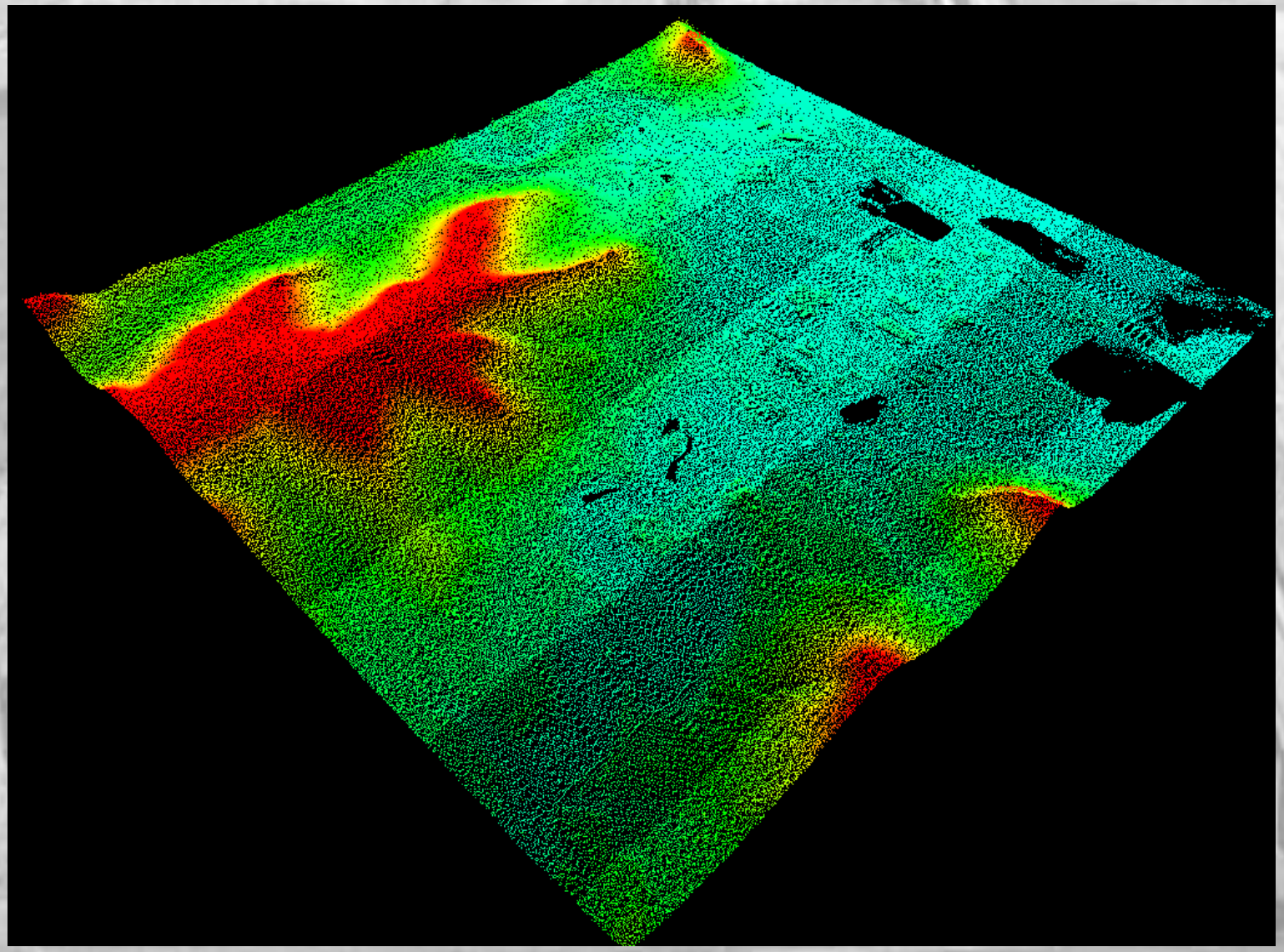
LiDAR Classifications





Thanks to: MN Department of Natural Resources for data in this slide



Thanks to: MN Department of Natural Resources for data in this slide

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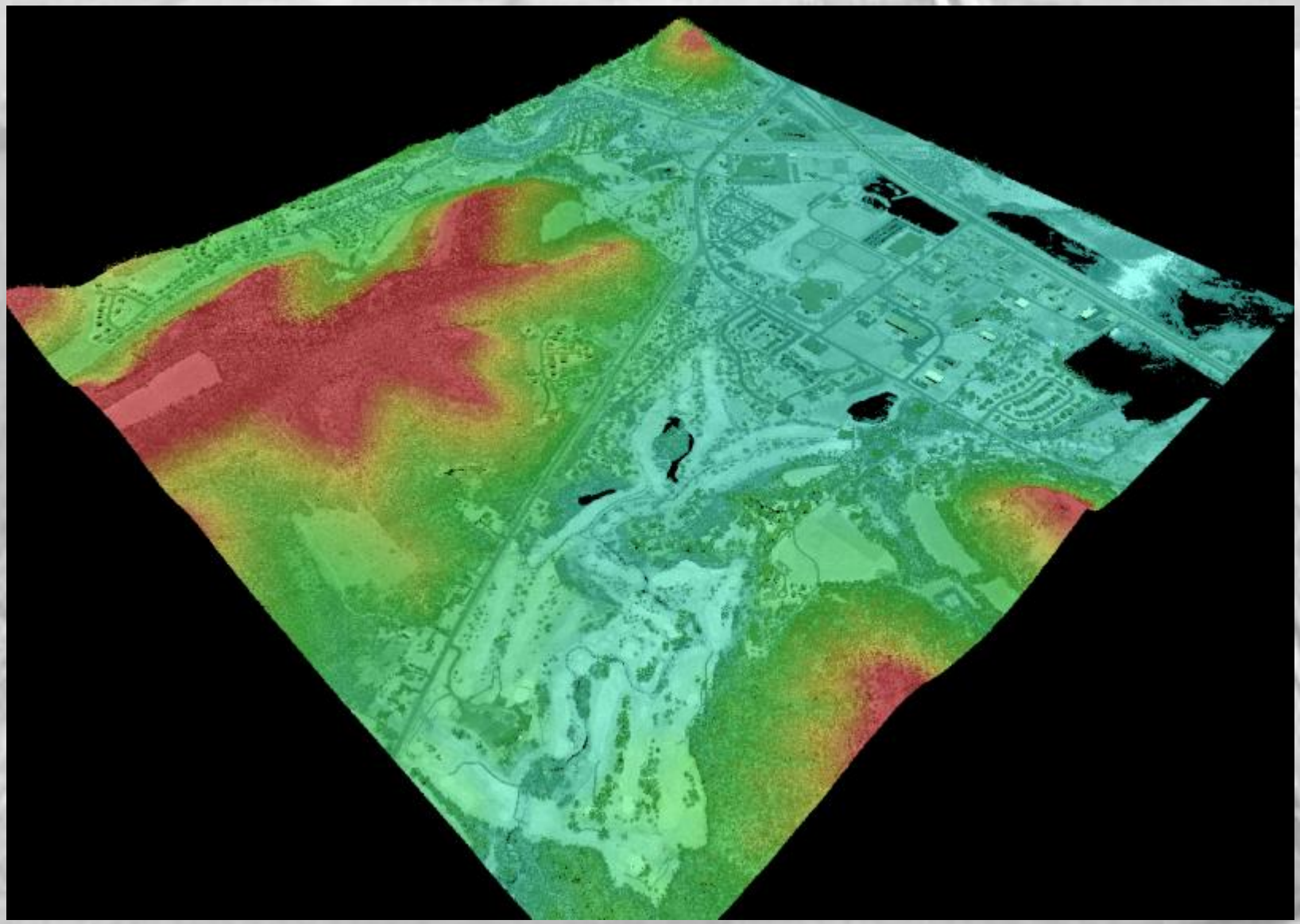
GK Technology For Agriculture



Thanks to: MN Department of Natural Resources for data in this slide

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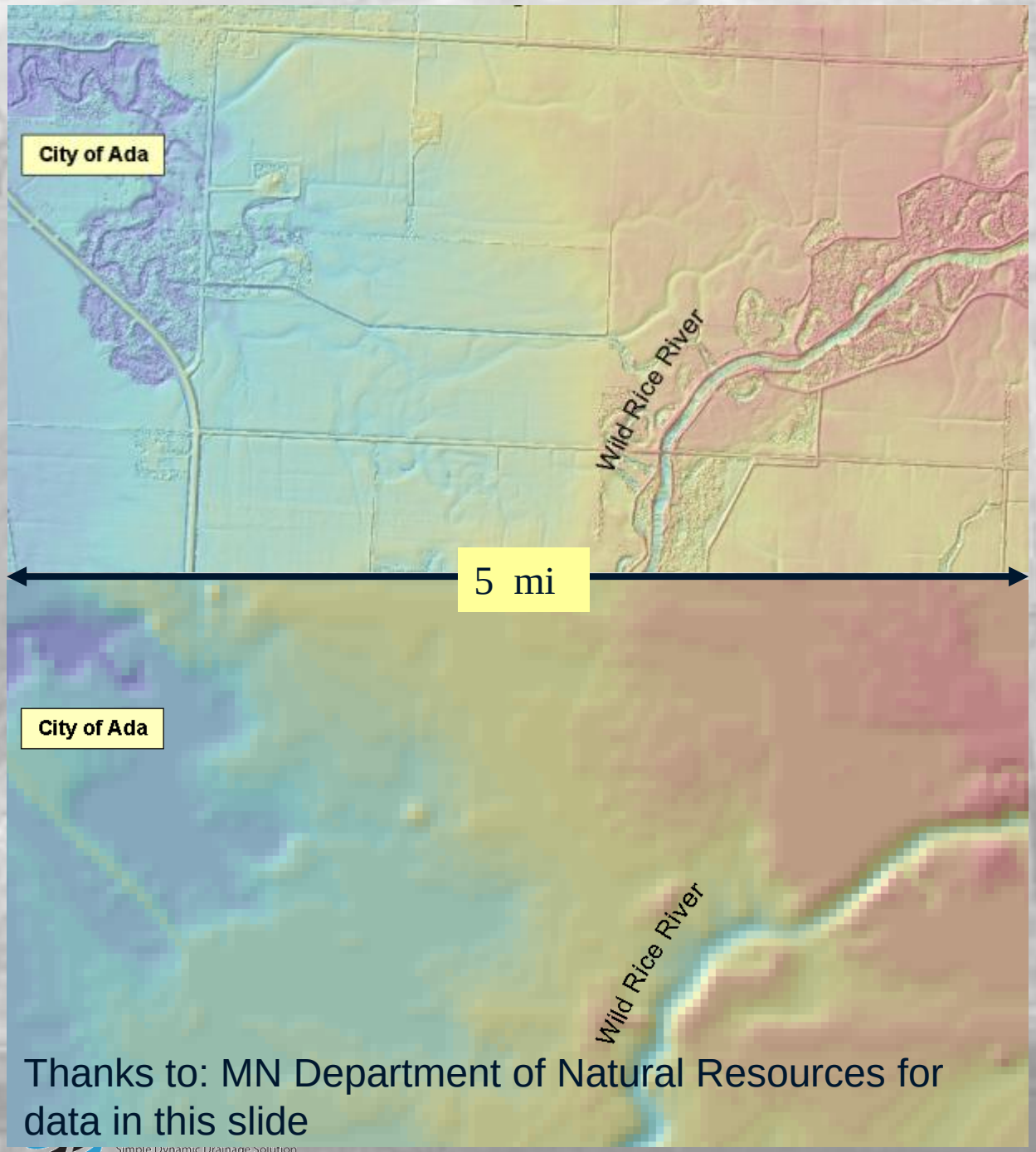
LiDAR Limitations

- Cannot penetrate
  - Water (near-infrared Lasers)
  - Heavy canopy cover
  - Rain, Snow, Clouds
- Limited window of opportunity to collect
  - Vegetation and snow free periods in the spring and fall
  - Flooding
  - High winds hinder collection

Thanks to: MN Department of Natural Resources for data in this slide



LiDAR Derived DEM

Cell Size: 1 meter sq

1.5 million points / sq mile

USGS Standard DEM

Cell Size: 30 meter sq

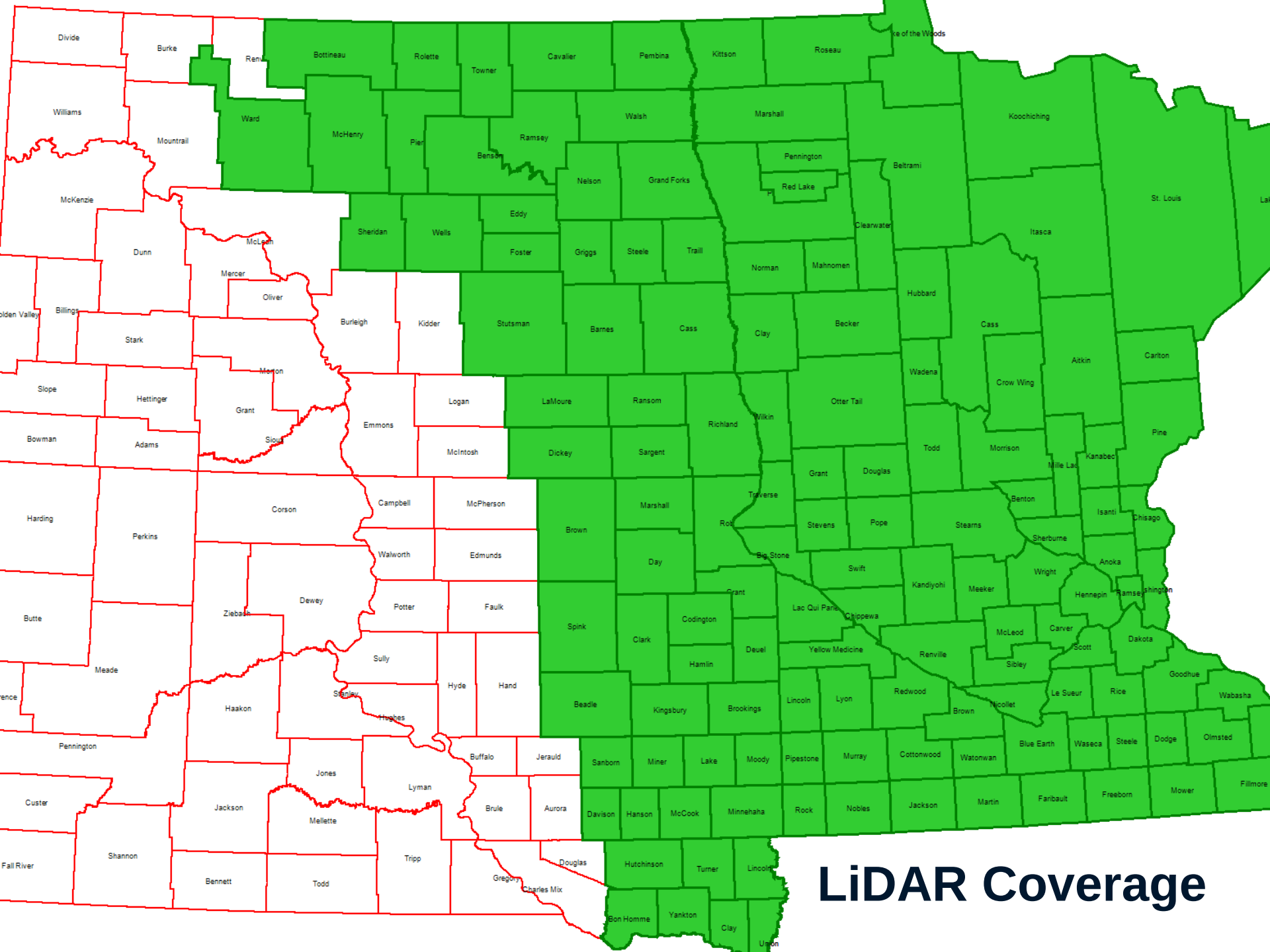
SRTM – Shuttle Radar Topography Mission

1600 points / sq mile

Thanks to: MN Department of Natural Resources for data in this slide

Simple Dynamic Drainage Solution

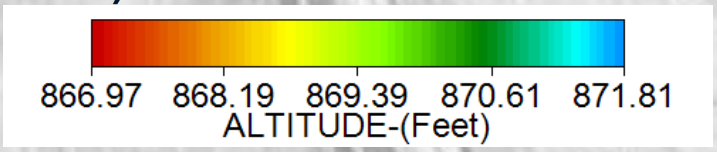
GK Technology For Agriculture



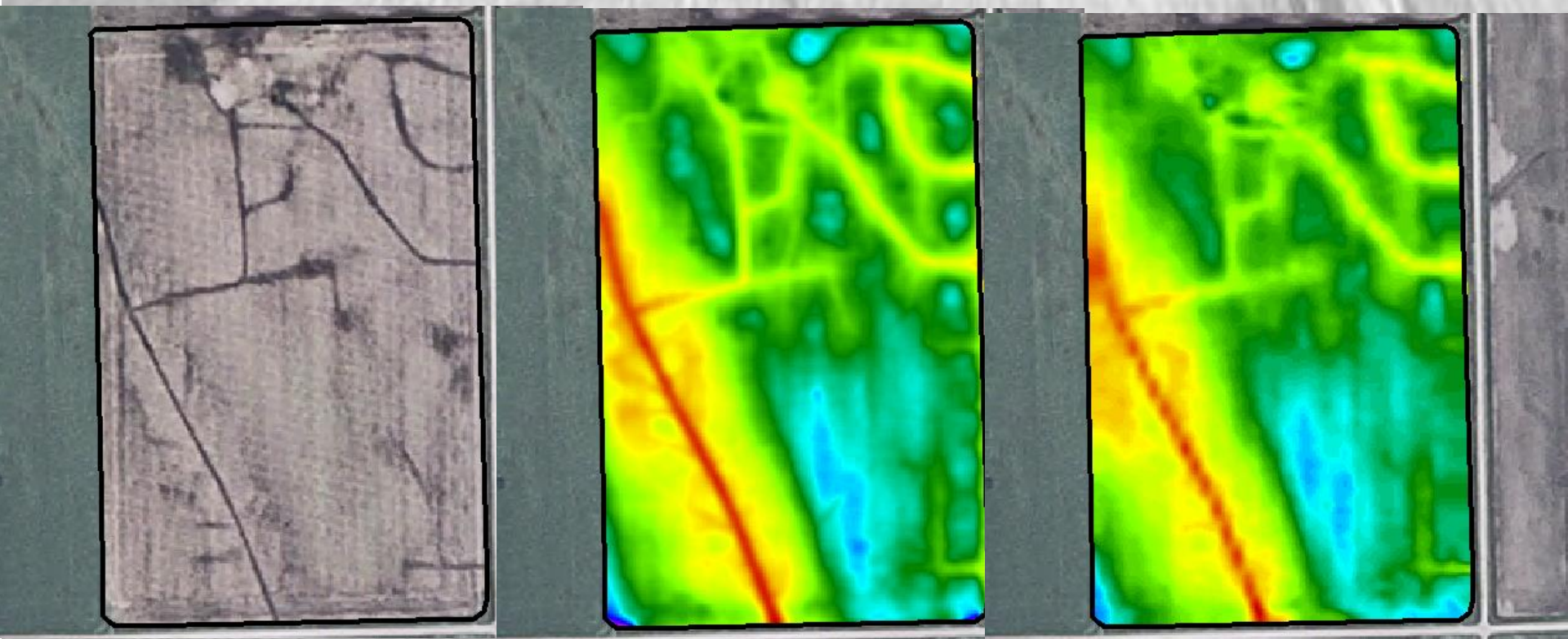
LiDAR Coverage

LiDAR – RTK Vertical Accuracy

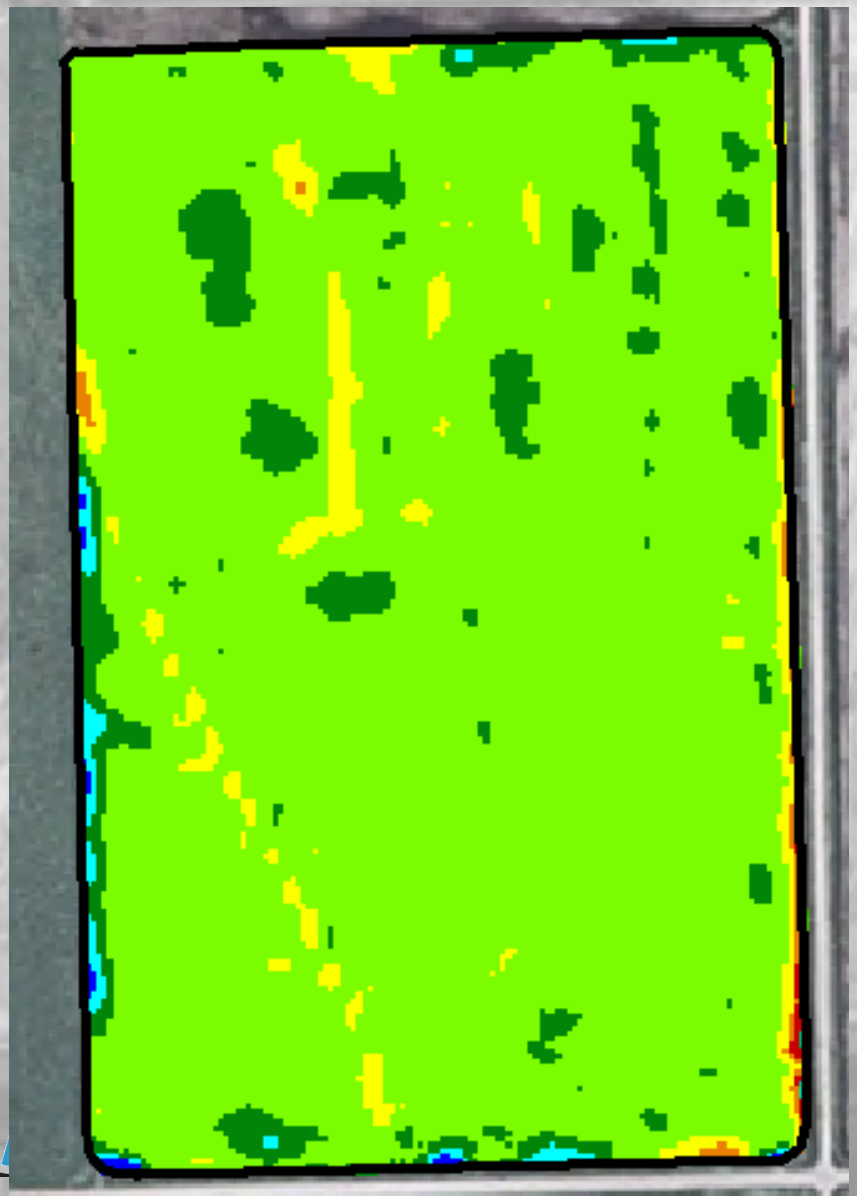
- LiDAR RRV Basin 6 inches (0.5’)
- RTK 2.4 inches (0.2’)



FSA 2005 LiDAR 2008 RTK 2006



Elevation Difference (LiDAR-RTK)

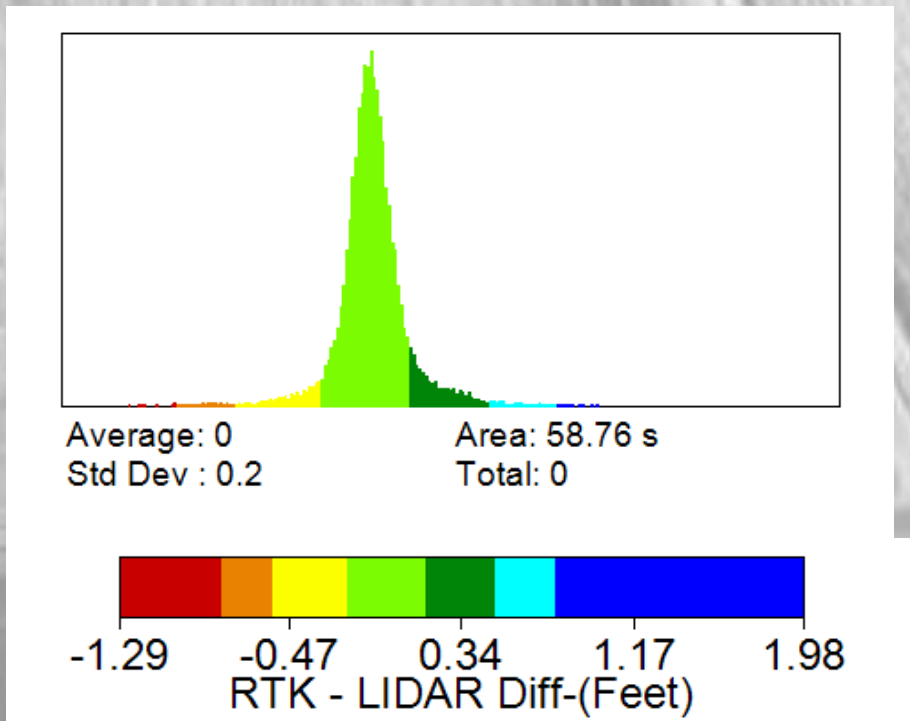


LimeGreen = acc +/- 0.2’

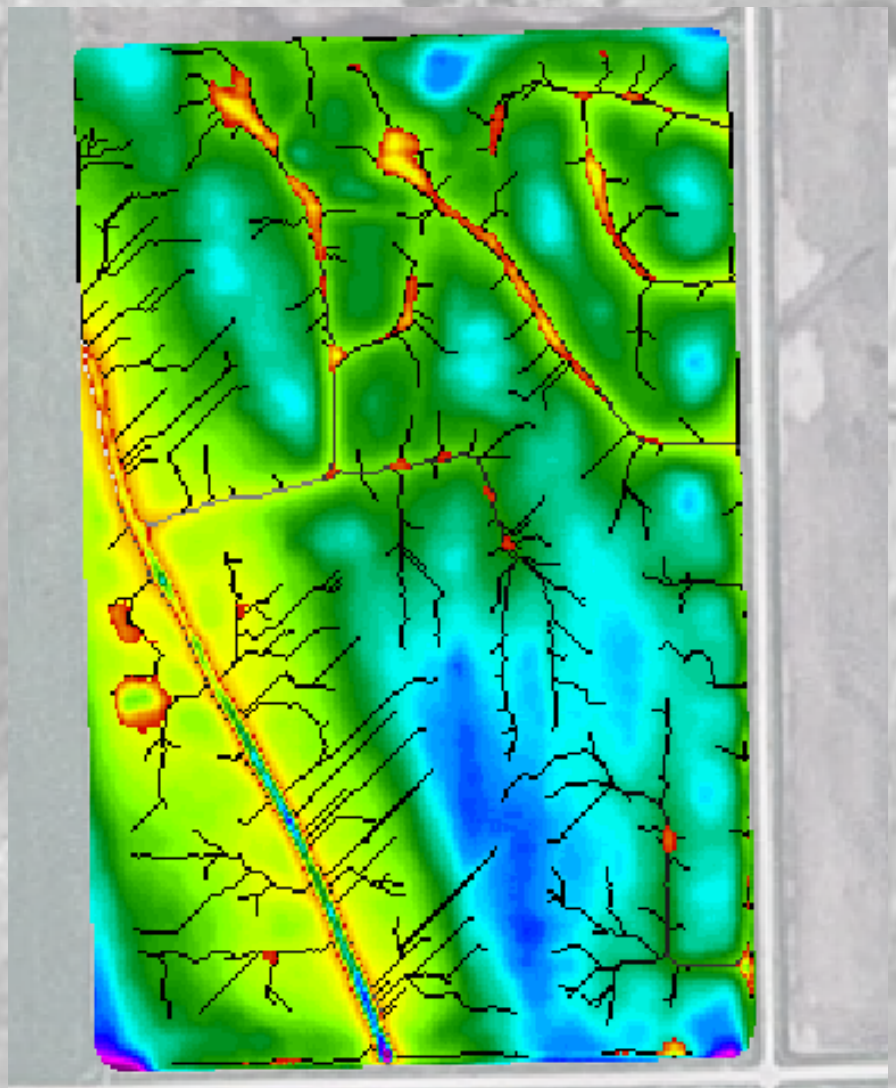
DarkGreen = acc + 0.2’ to 0.5’

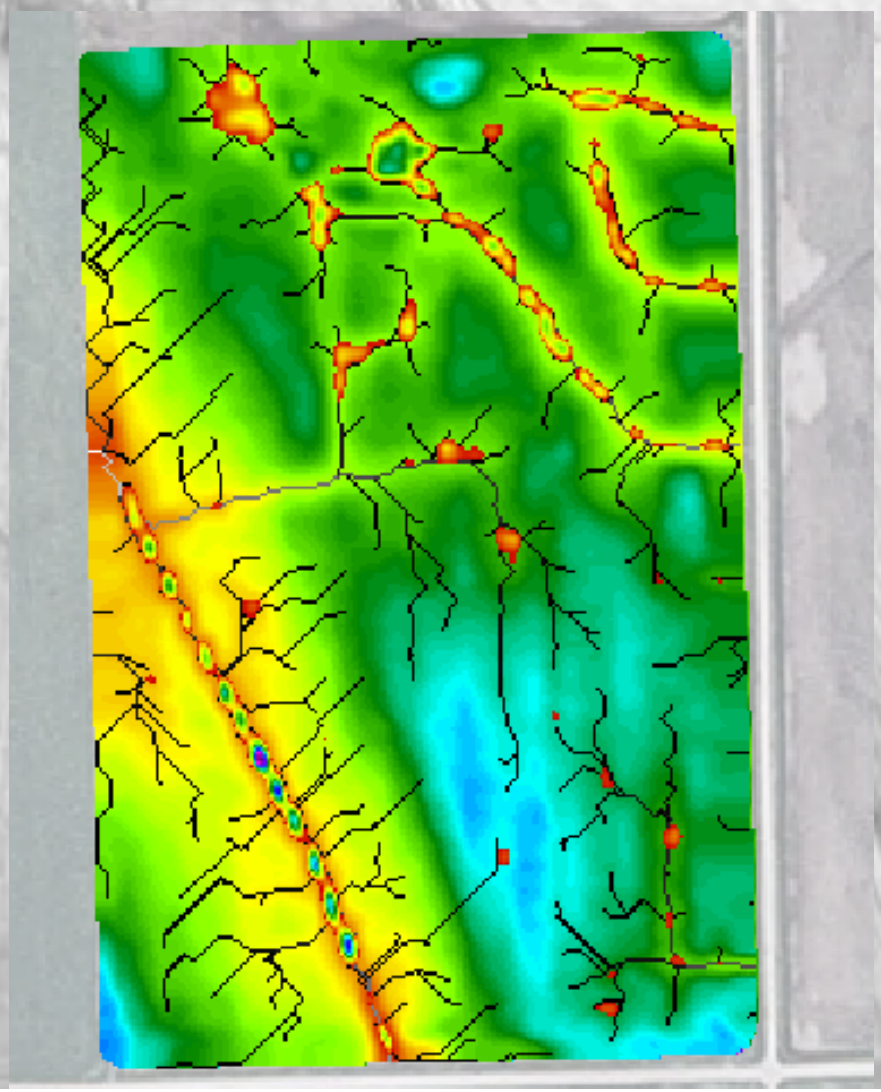
Yellow = acc – 0.2’ to 0.5’

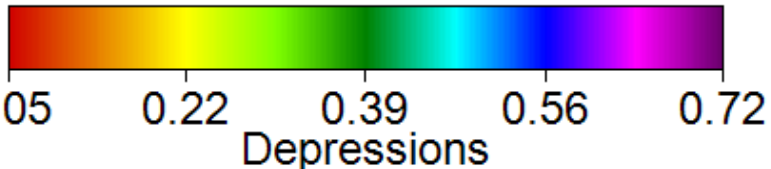
Note: “reds & blues” outside combined area.

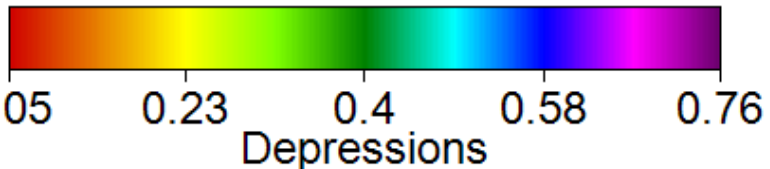


LIDAR vs RTK






0.05
0.22
0.39
0.56
0.72
Depressions


0.05
0.23
0.4
0.58
0.76
Depressions

Topography Maps & GPS

- LIDAR & RTK
- Produce
  - Flow
  - Watersheds
  - Depressions
- Map from 2008 LIDAR

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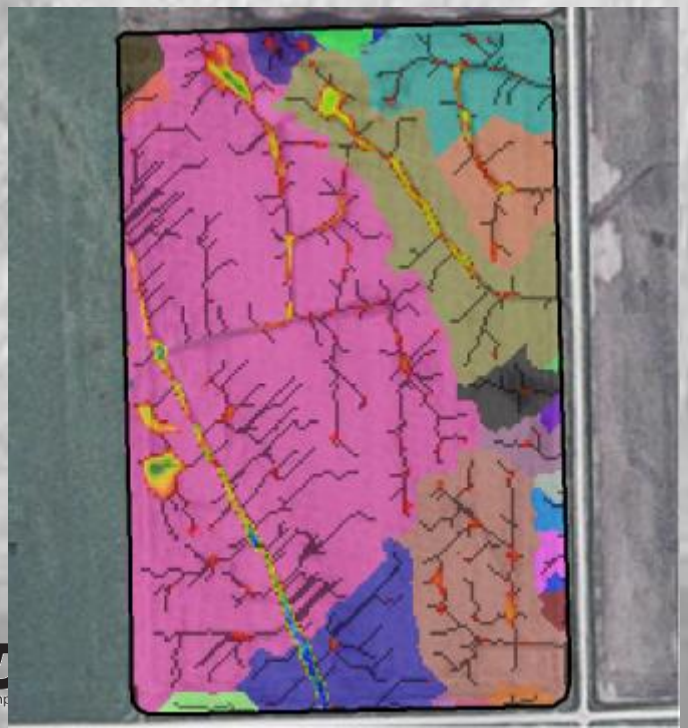
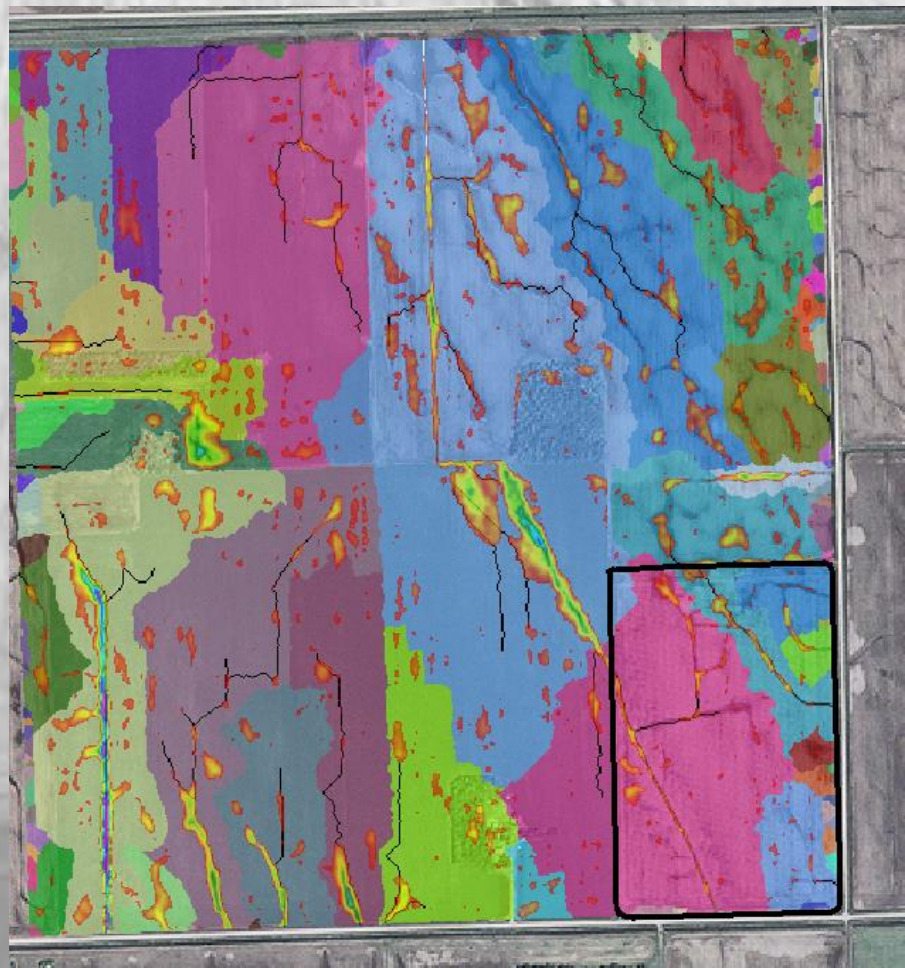
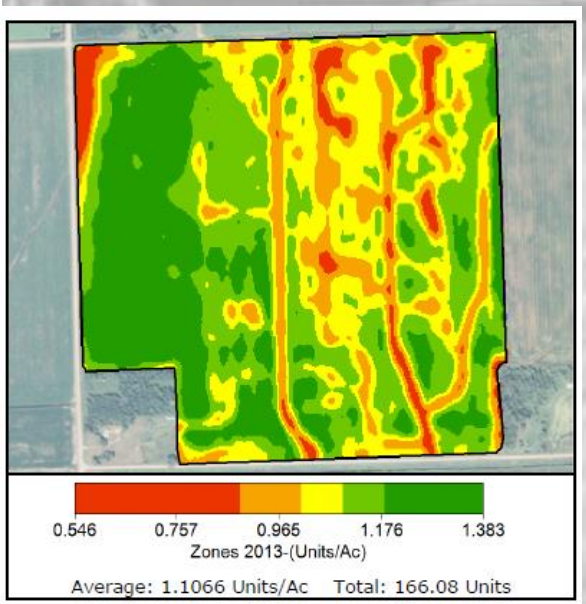
LIDAR – Benefits

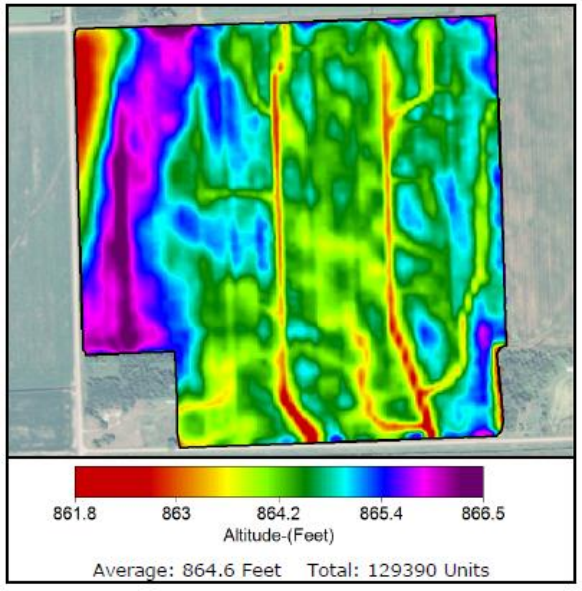
- Great for drainage planning
  - Surface or Tile
- See the “PROJECT” not just “FIELD”





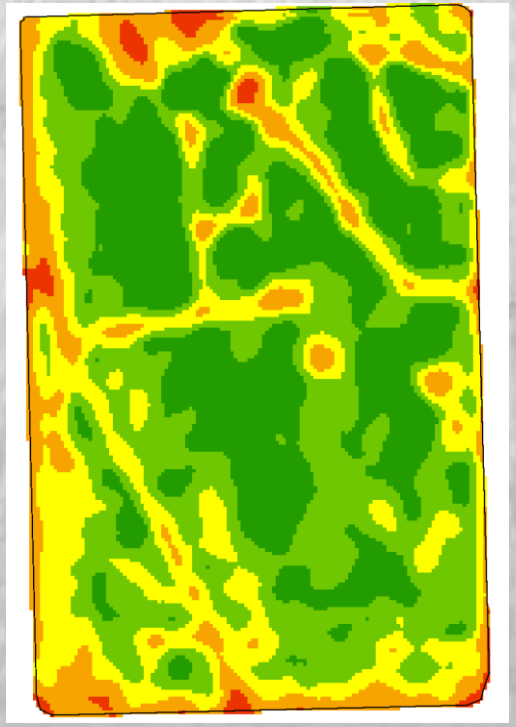
Topo for Zone Management



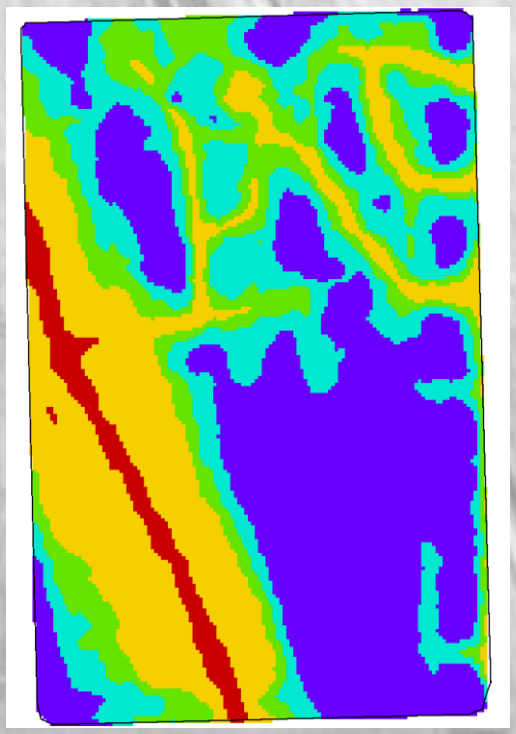


- Zones from Multiple years of data

2014 Zones



LiDAR



Strong Correlation - use with other data

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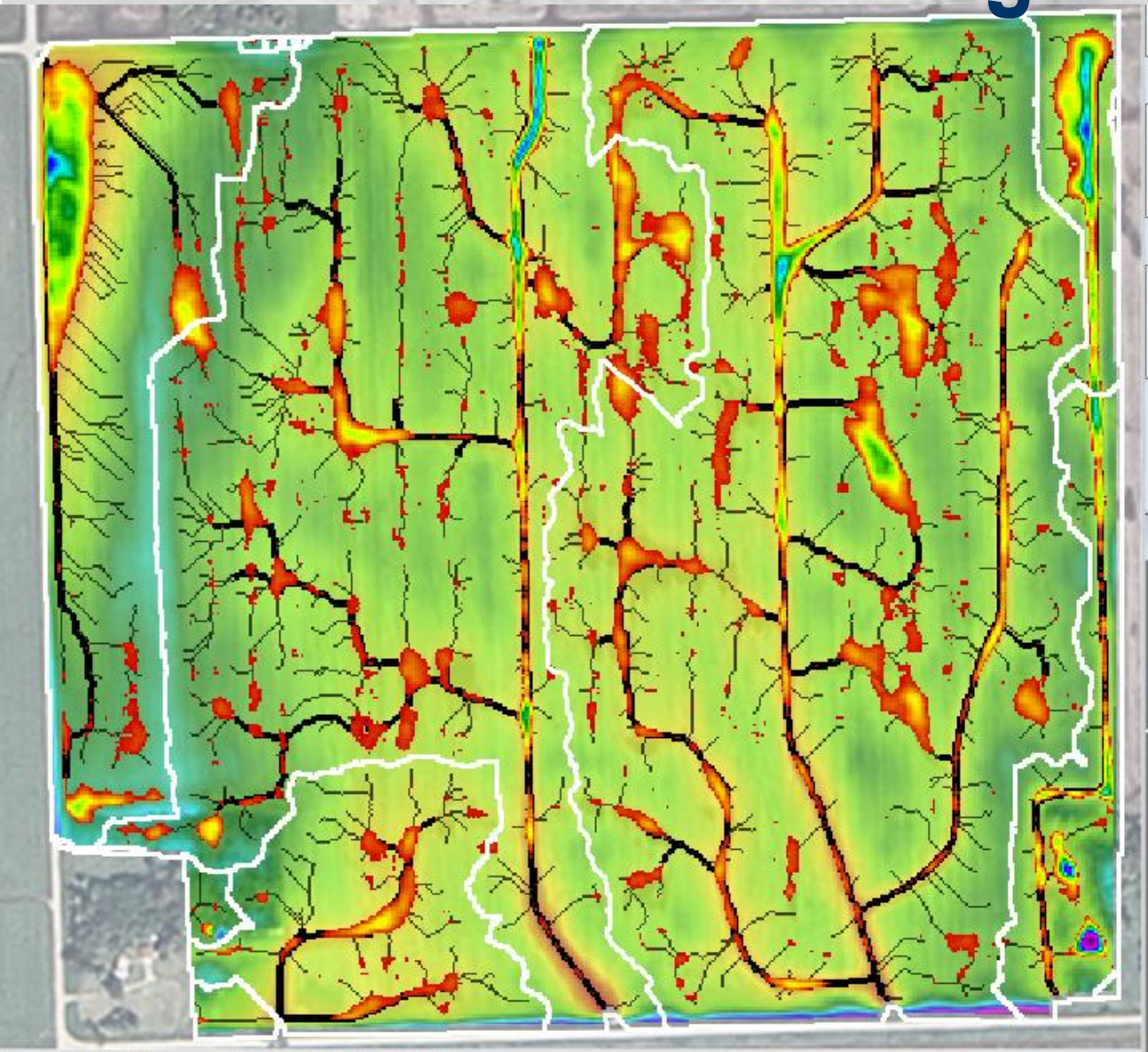
Surface Drainage Maps



Lat: 47.448927 Lon: -96.78998 130-127-129

Field: Shelly_21_SW Layer: Watersheds.shp

Surfaces In Map

Lidar Topo
FlowAccumulation
Watersheds
FlowAccumulation-Main

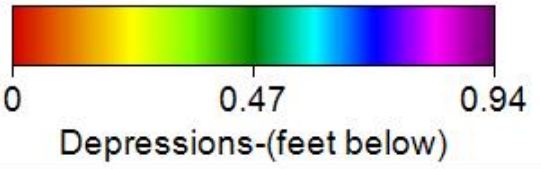
Images In Map

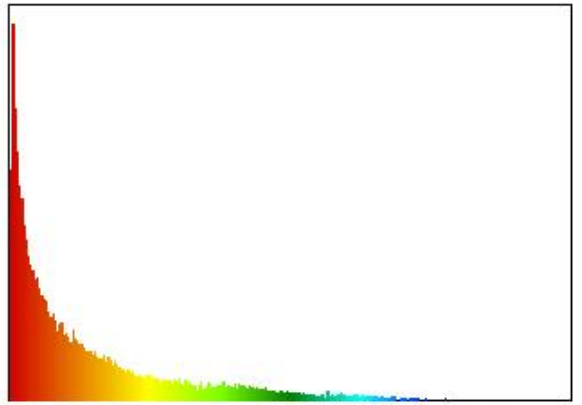
Norman NAIP 2005

Current Layer

Norman\Norman NAIP 2005.sid

Statistics

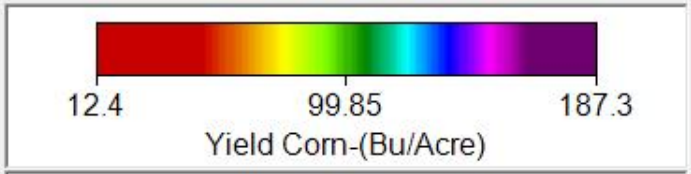


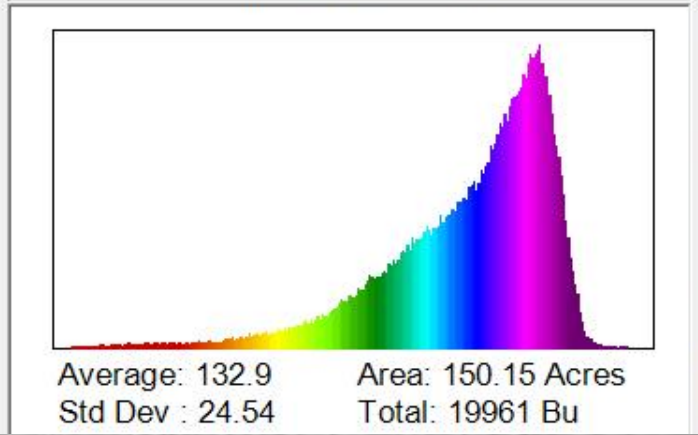


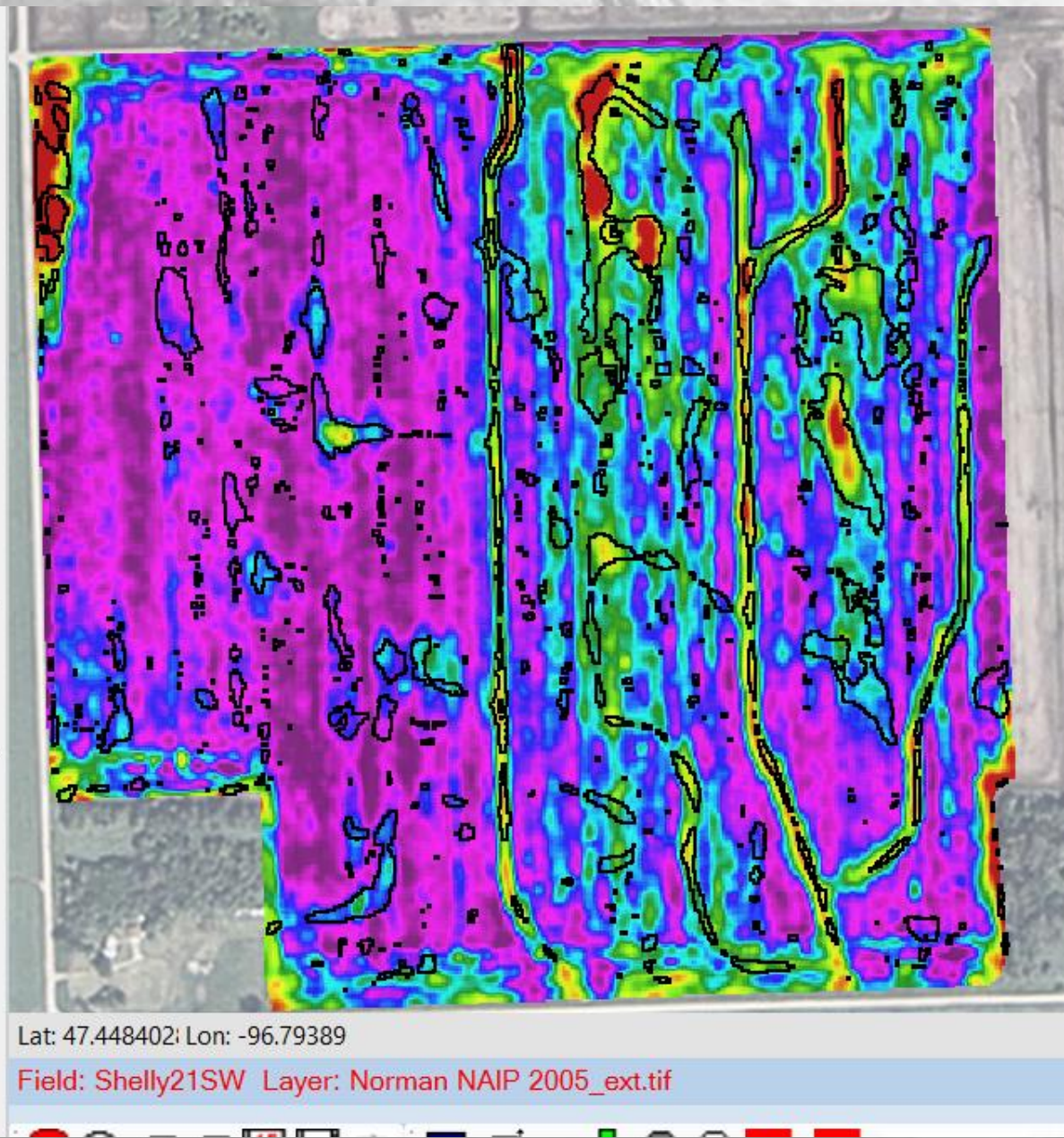
Average: 0.1 Area: 20.9 Acres

Drainage Losses - Corn Yield

- Black areas = 20.9 acres of Depressions
- 132.9 bu Corn Yield





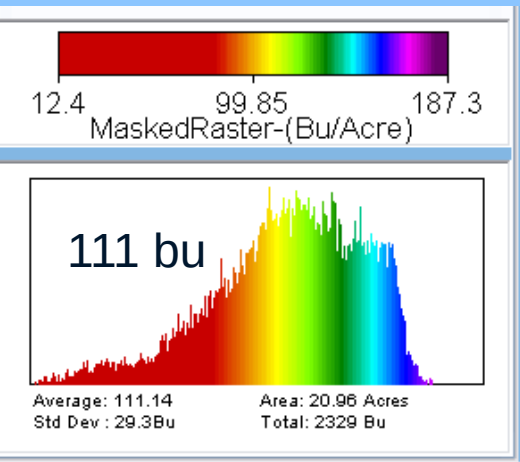


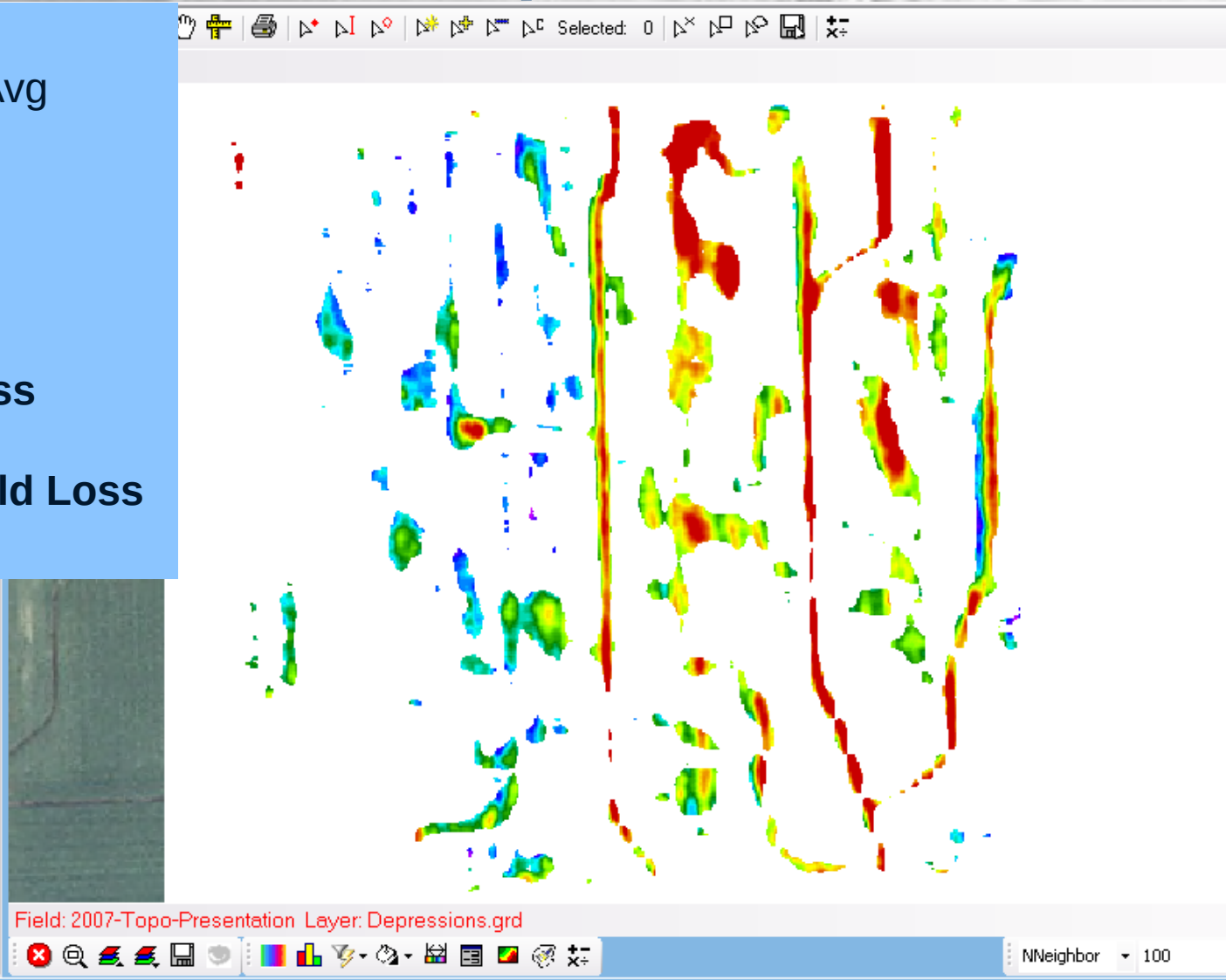
Drainage Losses
Corn Yields - Depressions

132 bu/ac Field Avg
111 bu/ac Depression Avg
-21 bu/ac Loss
@ $3.50 bu
$73.50 / ac
on 20.9 ac

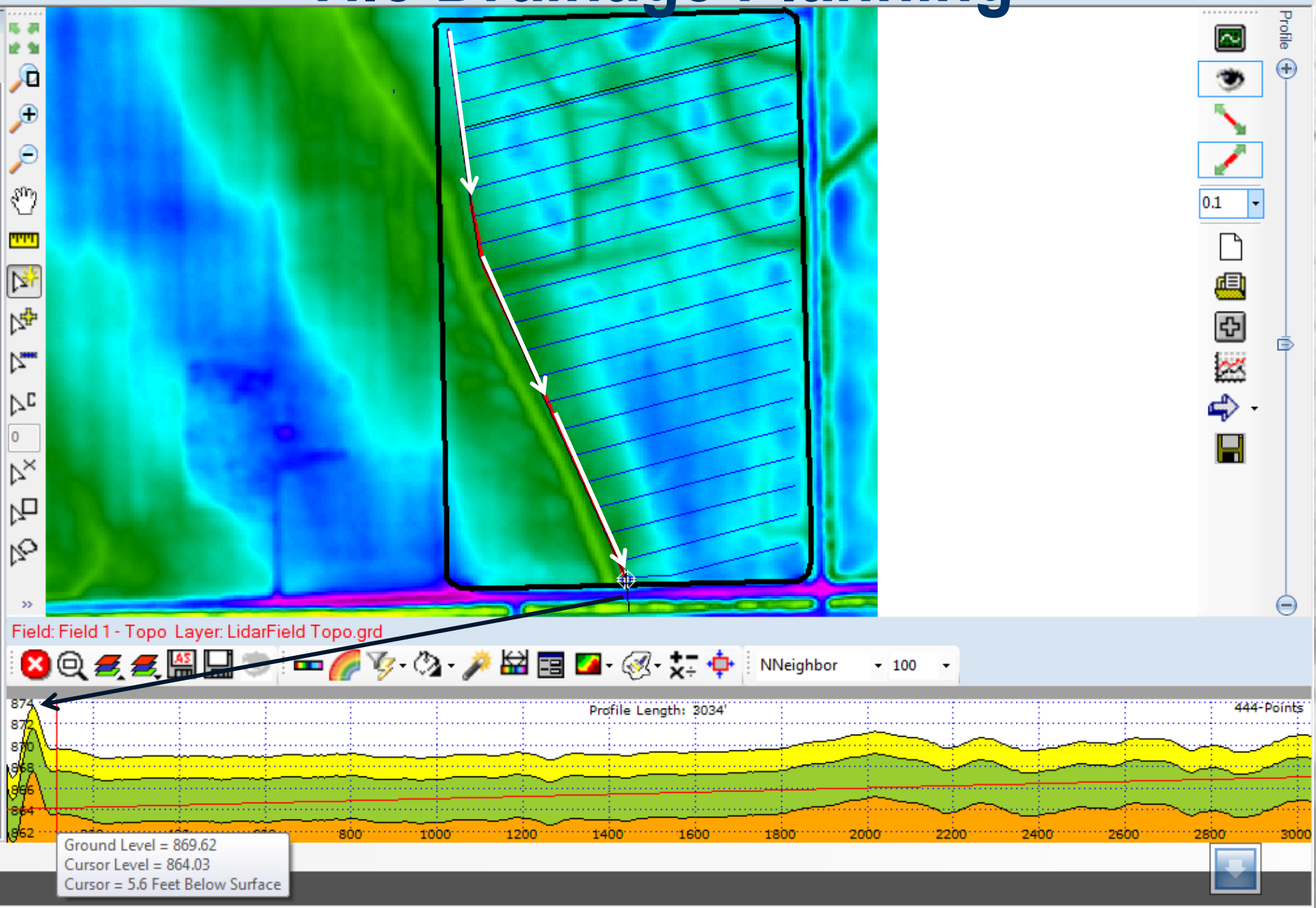
-$1540 Total Field Loss

- $10 / Acre - Avg. Field Loss





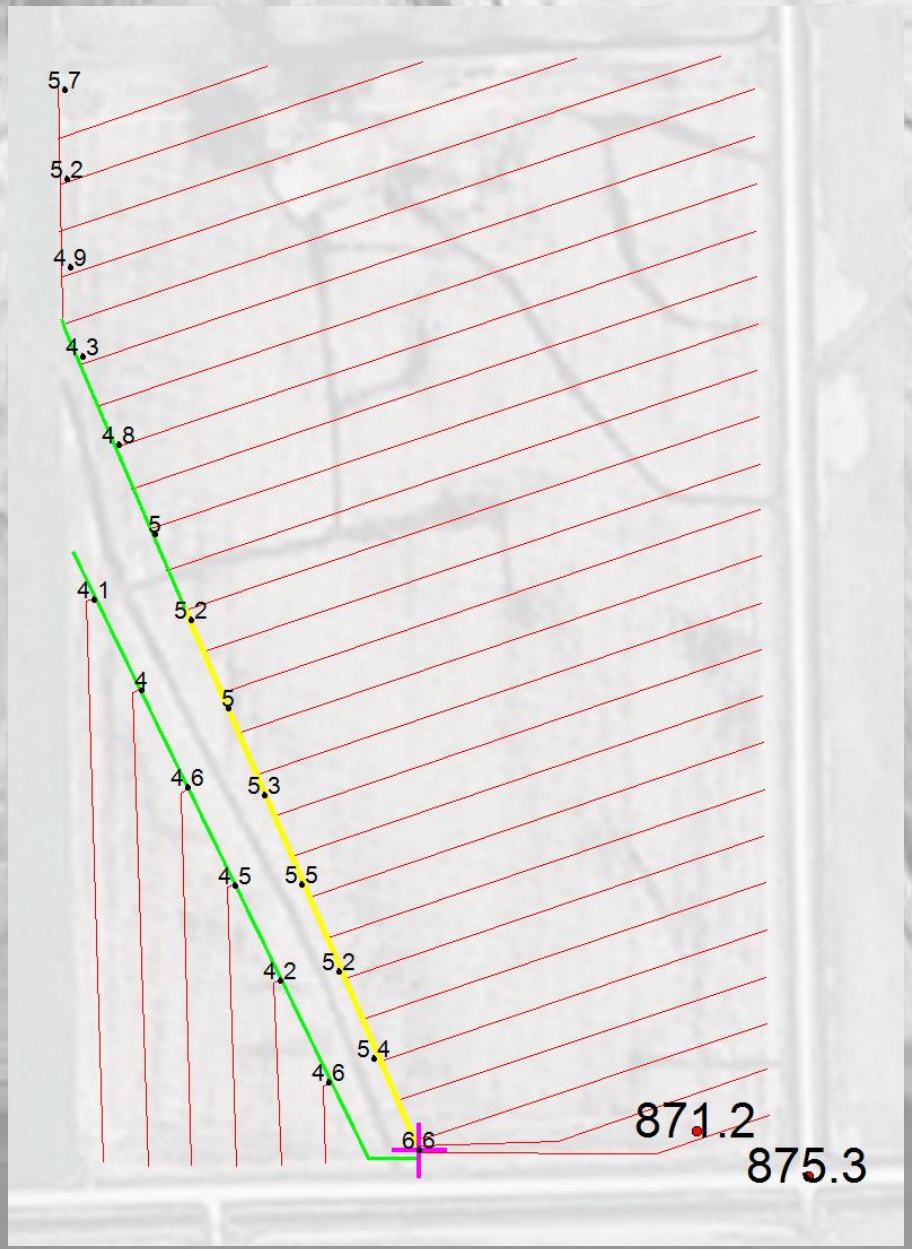
Tile Drainage Planning



Background Maps

Tile Drainage

- PC's running ADMS (w/GPS)
- SD Drain
- AGPS
- John Deere 2600 & 2630 (through APEX)
- Outback Max
- Google Earth .kmz /.kml



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Summation of LiDAR & RTK

- Accurate Sources for Topography
  - Surface drainage
  - Tile Drainage design
- RTK Excellent for Machine Control
  - Within 2 miles of Base
- Background images !!

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Thanks for your time!

Questions
&
Comments

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LABORATORIES