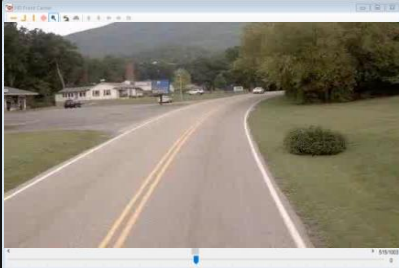


# Cloud Intelligence

# ARRB Systems History



# Network Survey Vehicle



+ Digital imaging system

+ GNSS DGPS geospatial location



+ 3D Surface Defects  
Full Lane

+ 3D Rutting  
Full Lane

+ 3D Cracking  
Full Lane



Roughness  
Left and Right wheel paths

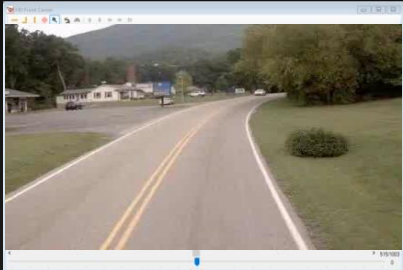
+ Texture  
Centre and Both wheel paths

+ DMI linear location

+ IMU Geometry  
Cross fall, Grade, Horizontal and Vertical curvature

# intelligent Safety Assessment Vehicle

+ Digital imaging system



+ GNSS DGPS geospatial location



+ Geometry

Cross fall, Grade, Horizontal and Vertical curvature



Continuous Friction Response  
Sideways Force Coefficient  
Vertical Loading Force  
Surface, Air, Tyre & Water Temperature

+ Rutting  
Full Lane Width

+ Texture  
Centre and Both wheel paths



Simultaneous collection of Friction + Geometry + Rutting + Texture + Imaging = high risk/low risk

# intelligent Pavement Assessment Vehicle



+ GNSS DGPS geospatial location

+ Geometry

Cross fall, Grade, Horizontal and Vertical curvature

+ 3D Roughness  
Full Lane

+ 3D Rutting  
Full Lane

+ 3D Cracking  
Full Lane

+ 3D Surface Defects  
Full Lane

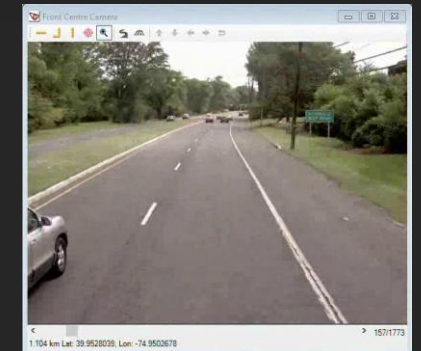


Continuous Deflection Measurement  
Pavement velocity  
Full Deflection Bowl  
Applied Load  
Surface & Air Temperature

Roughness  
Left and Right wheel paths

+ Texture  
Centre and Both wheel paths

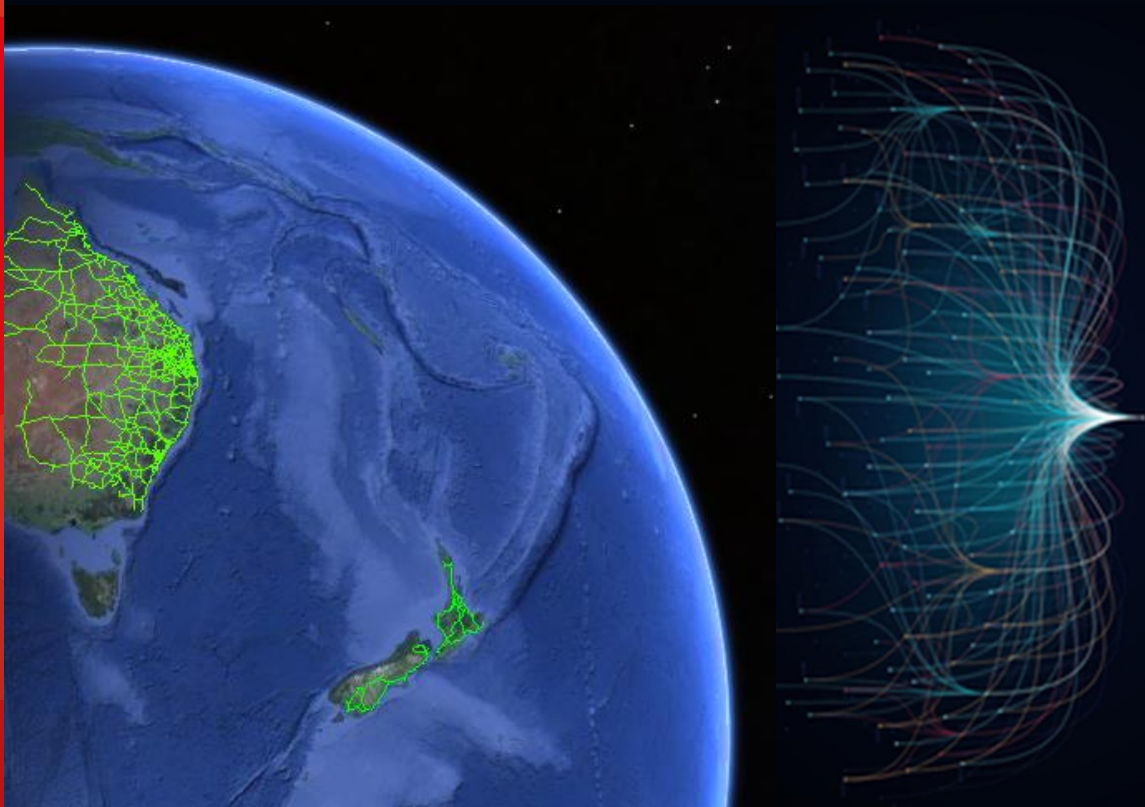
+ Digital imaging system



Simultaneous collection of Functional + Structural data = Comprehensive Pavement Assessment

# Data, Data, Data.....

- With hundreds of thousands of kilometres collected annually
- results in millions of deflections, friction readings
- plus cracking, profile, texture, and imagery....



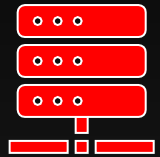
= Billions of data records..

# Cloud Storage

- Unlimited storage
- Backed up
- Secure
- Accessible from anywhere
- Agile and Flexible
- Creative opportunities



# Flexible - Compatible - Functional



## Data

Roughness, Texture, Rutting Deflection, Friction, Visual Defects and Asset Inventory



## Filter

Filter map data by different attribute values for custom displays



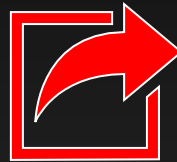
## Multi Channel Video

Up to 9 video channels in thumbnail and high resolution at high speeds



## Layers

Adjust Opacity, ordering and visibility of custom layers



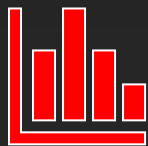
## Sharing

Share your point of interest, imagery, charts, URLs and desktop view via emailable links



## Comparing

View multiple years and timeline of data side by side both graphically and visually



## Charts

Data Visualisation through interactive graphs



## High Speed Video

High speed full frame adjustable speed video up to 30 fps and 1000 km/h

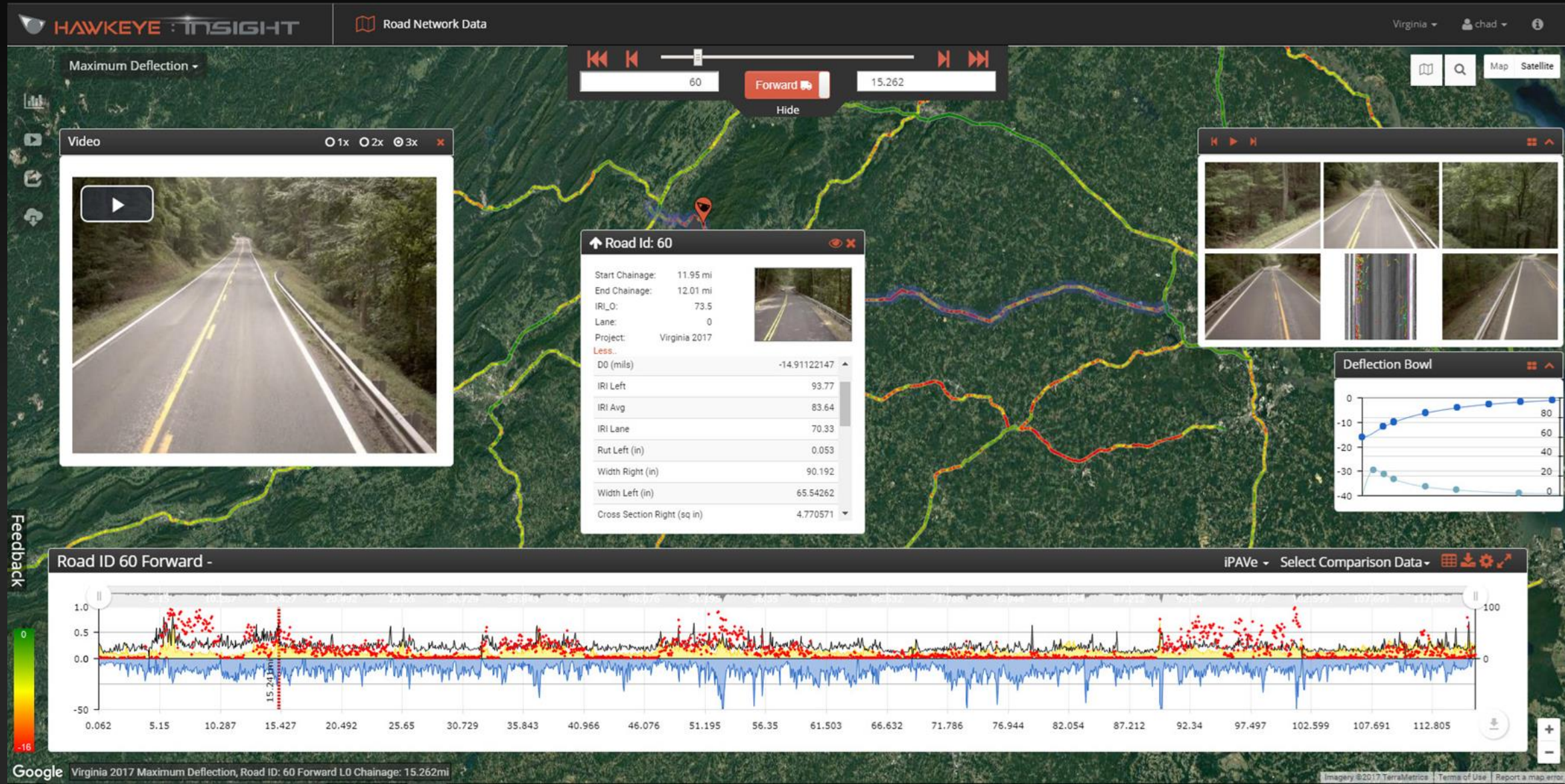


## Navigation

Navigate via Clickable map or Route number or Chainage or Road name or Road number or Direction.



# Network level data, project level detail



# Time Series Data – Decades of change

DPTI 2009 - Road ID: 1503 Olympic Dam - Pimba Left 34.500km L1 [Front Center]

Lat/Lon: -30.76672, 136.90787



Collected: 18 Jun 2009

hawkeye:::3564841899970:34.524373365698025



Collected: 28 Mar 2014

hawkeye:::182521057834636:34.5

10 years ago in 2009

5 years ago in 2014

# Time Series Data – Seasonal Changes

Summer 2017 - Road ID: Loop\_01 Eagle Bay Loop Forward 4.672mi L0 [Rear Right]  
Lat/Lon: 40.10584, -75.66867



Collected: 22 Jun. 2017

hawkeye:::306763863188352:4.665976791212947



Collected: 13 Feb. 2018

hawkeye:::479387400929840:4.671902123635498

Summer

Winter

# Time Series Data – Observing Failures

Winter 2018 - Road ID: Loop\_01 Eagle Loop Forward 2.038mi L0 [Front Center]  
Lat/Lon: 40.07965, -75.63649



Collected: 13 Feb. 2018

hawkeye:::479387400929840:2.042712293782691



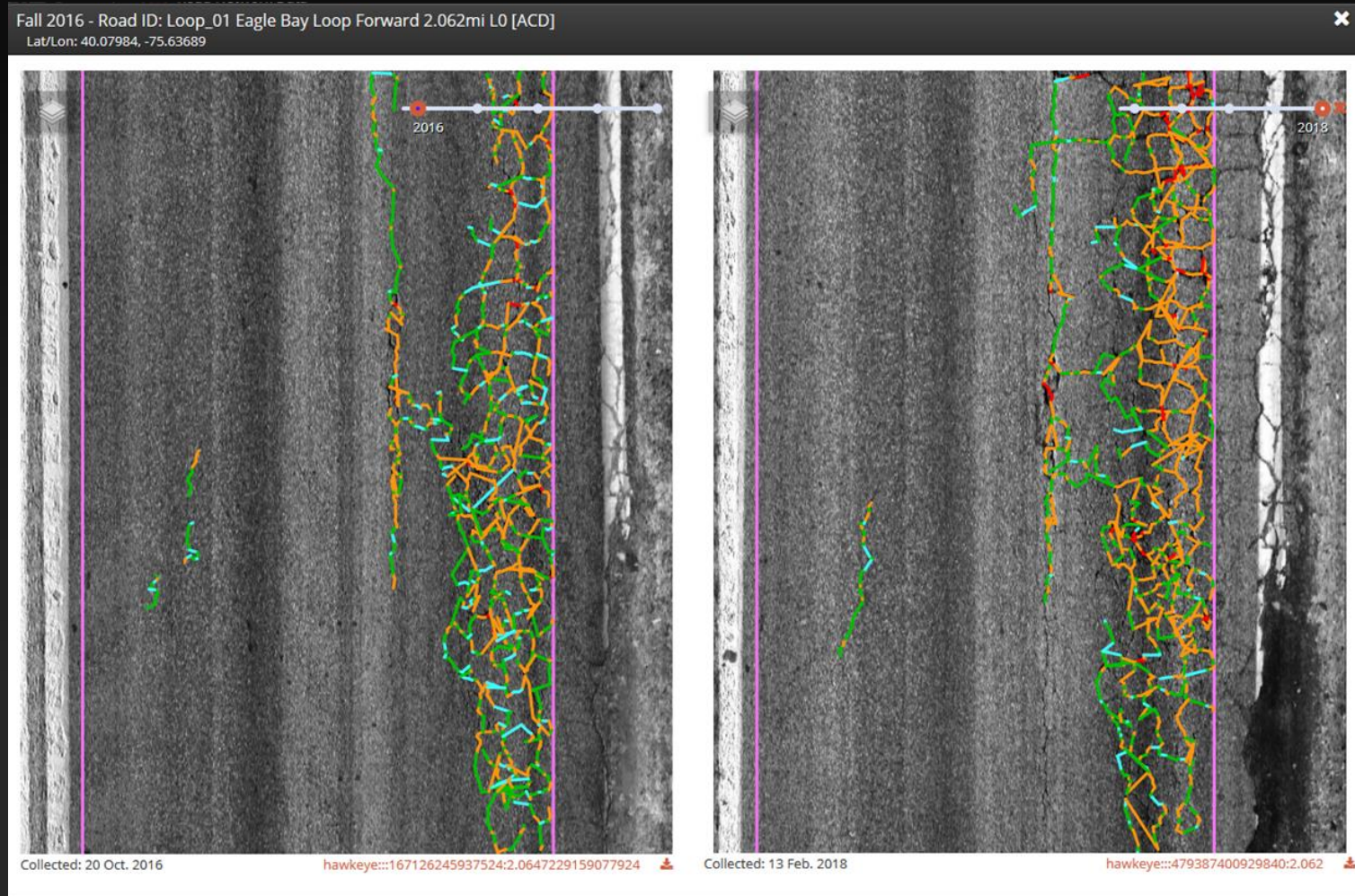
Collected: 10 May 2018

hawkeye:::545357853260957:2.0365996076462127

○ Feb 2018 16

16 May 2018 ter

# Time Series Data - Observing deterioration



October 2016

16 months later

# Time Series Data – Observing Recovery

2019 - Road ID: 10006 COUNTRY CLUB DR Forward 0.579mi L0 [Rear Left]  
Lat/Lon: 39.73799, -121.56767



Collected: 23 Jan. 2019

hawkeye:::733375372560349:0.579



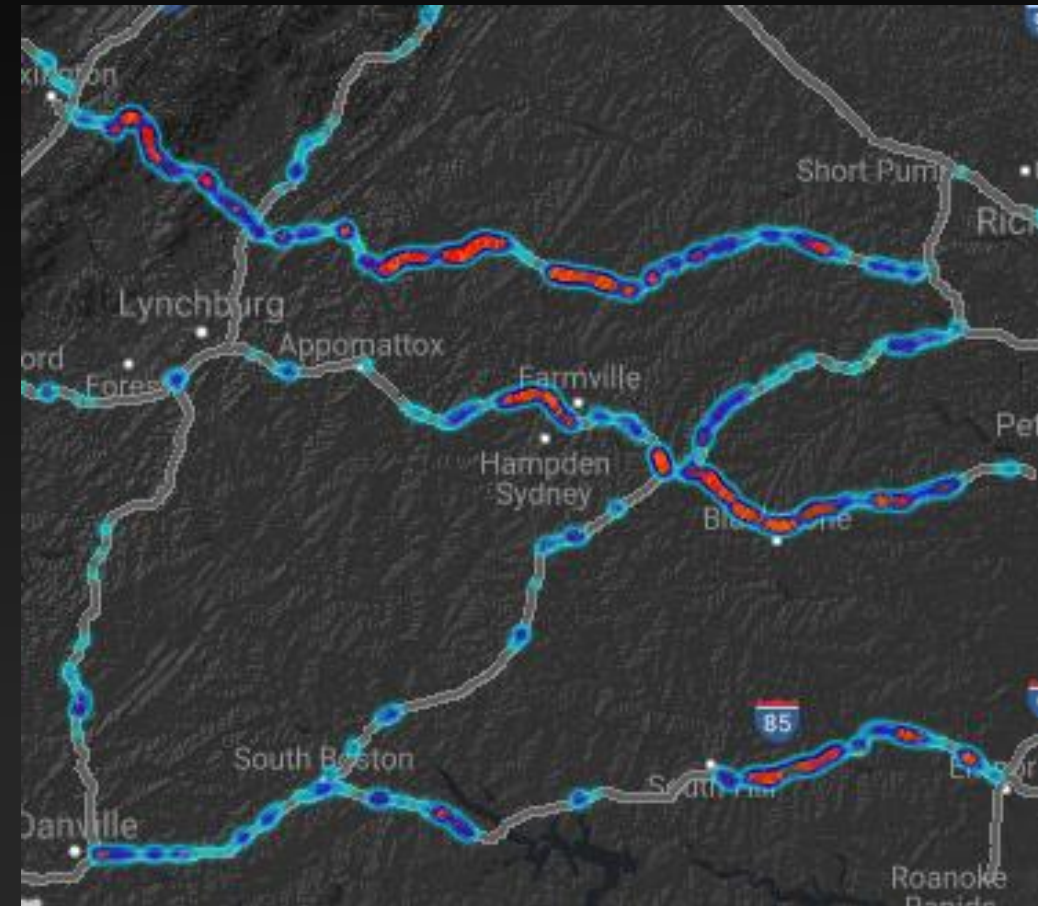
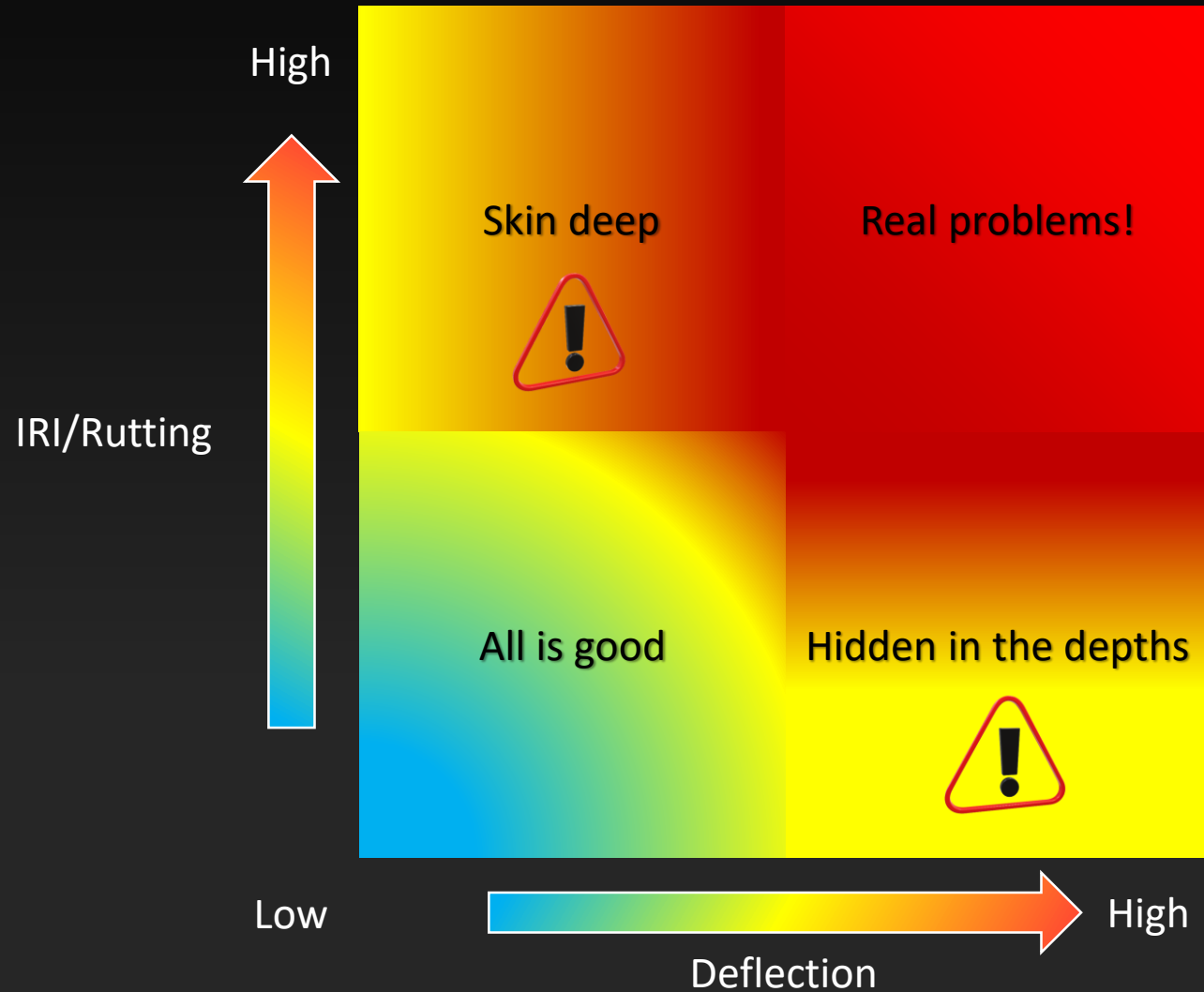
Collected: 4 Sep. 2019

hawkeye:::1000557343533097:0.5898111145829934

January 2019

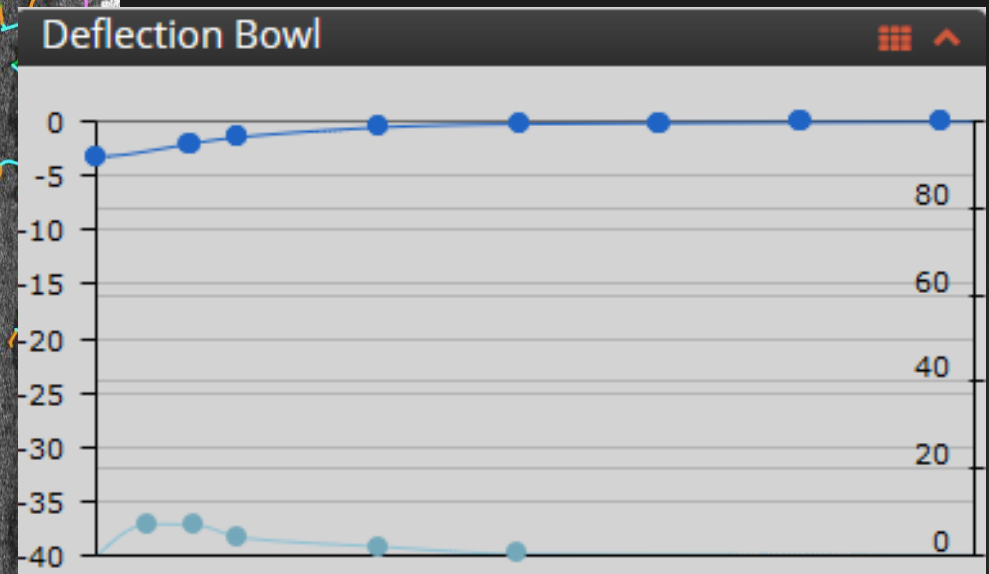
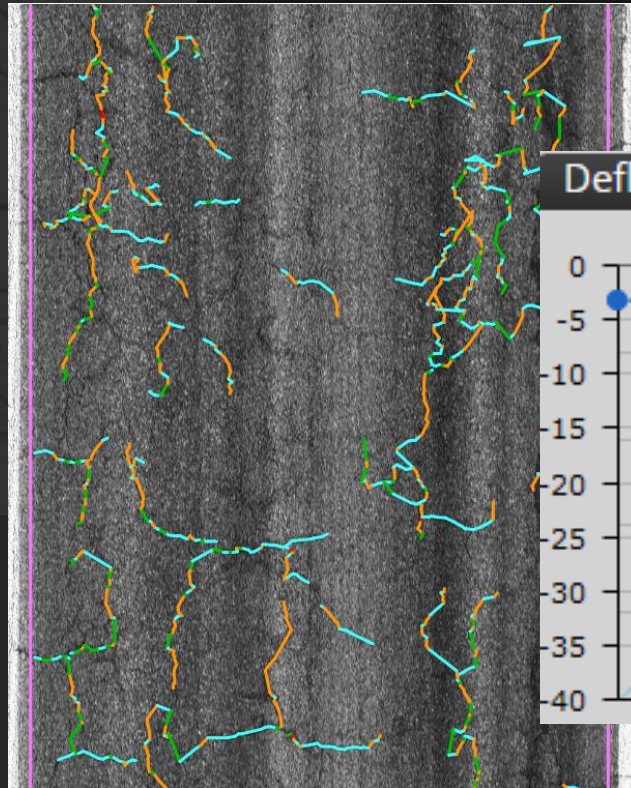
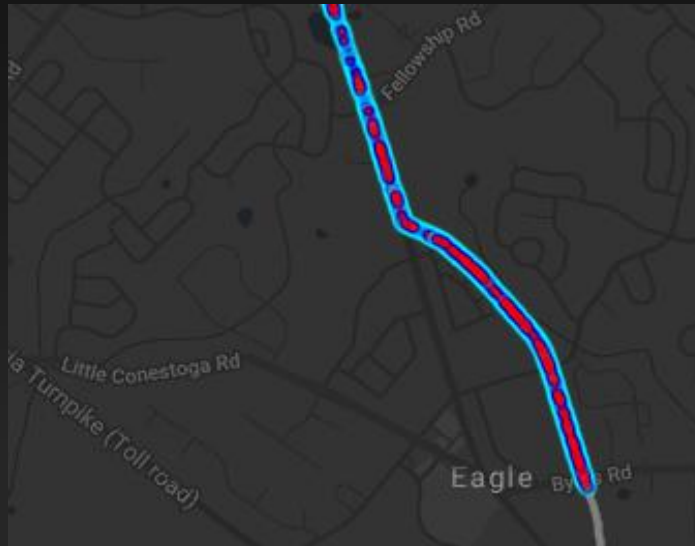
September 2019

# Heat Mapping Hot Spots



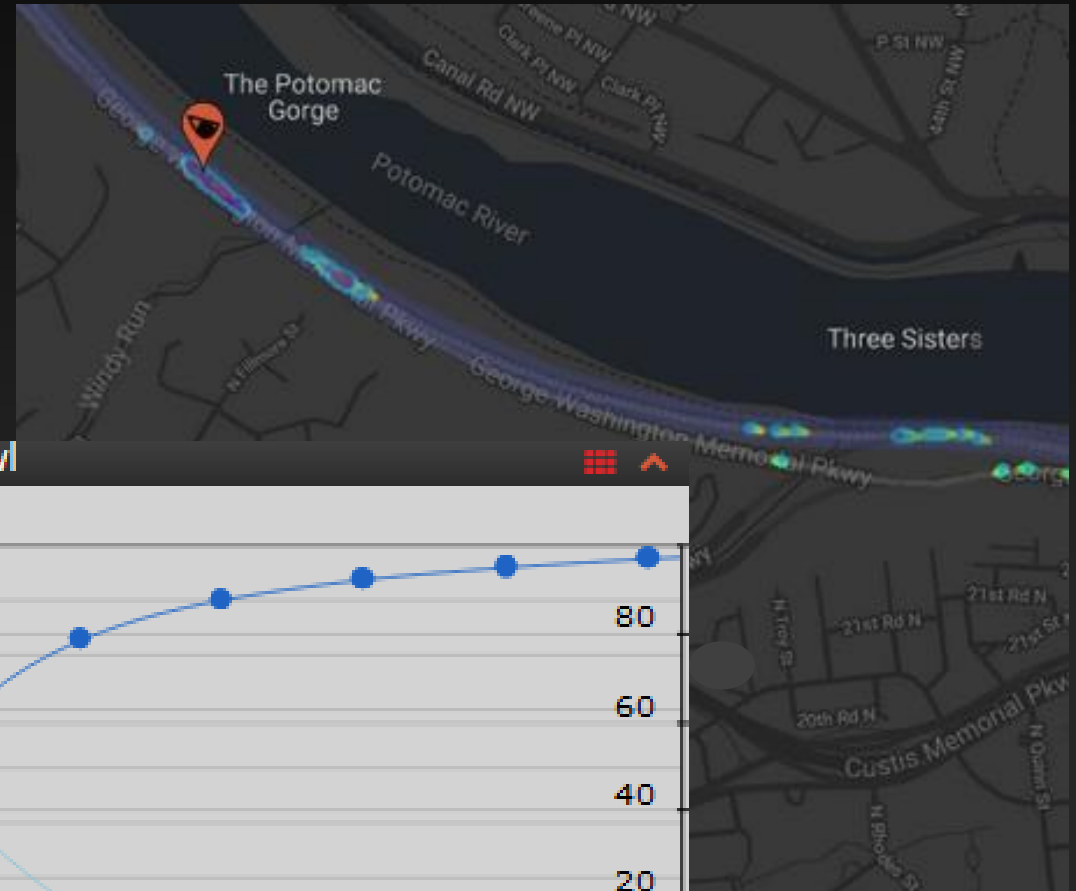
# Skin Deep

High cracking seem to indicates weak structure...  
...in fact, structure is very strong

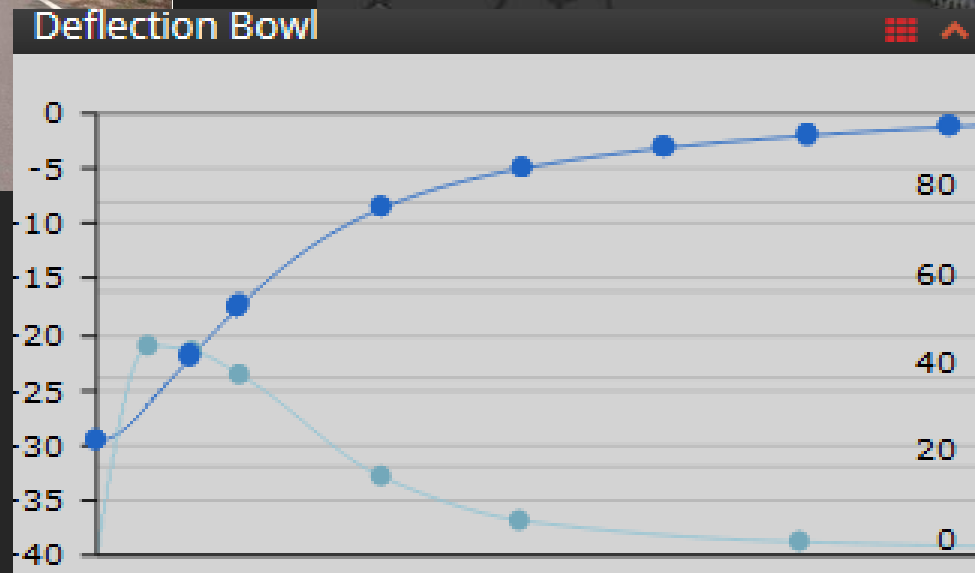


# Hidden in the depths

Smooth surface with no cracking, however, has a very weak structure

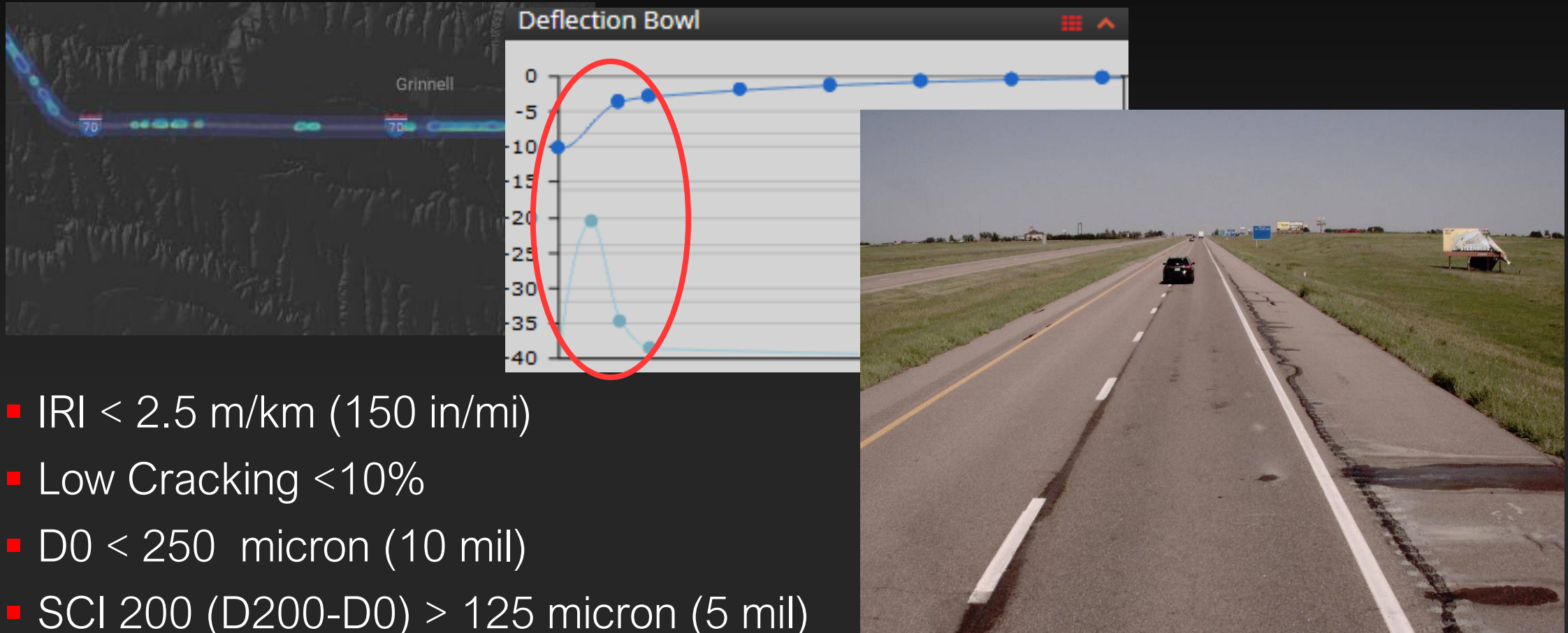


- $IRI < 2$  m/km (125 in/mi)
- No Cracking
- $D0 < 750$  micron (30 mil)



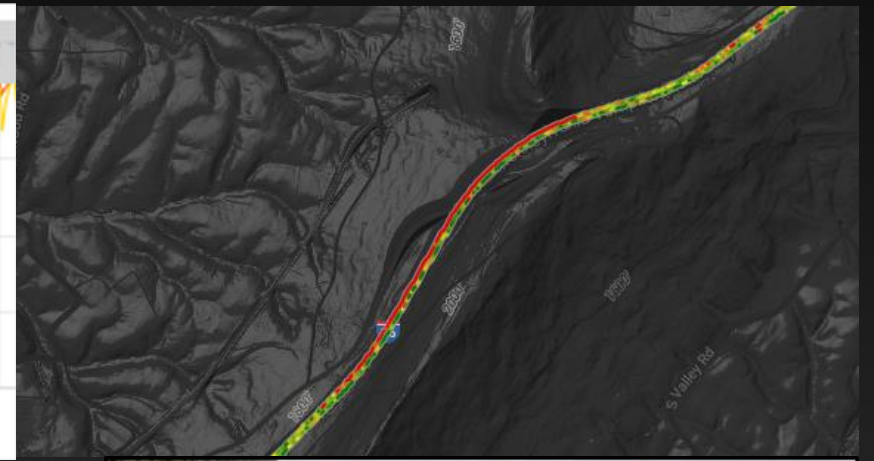
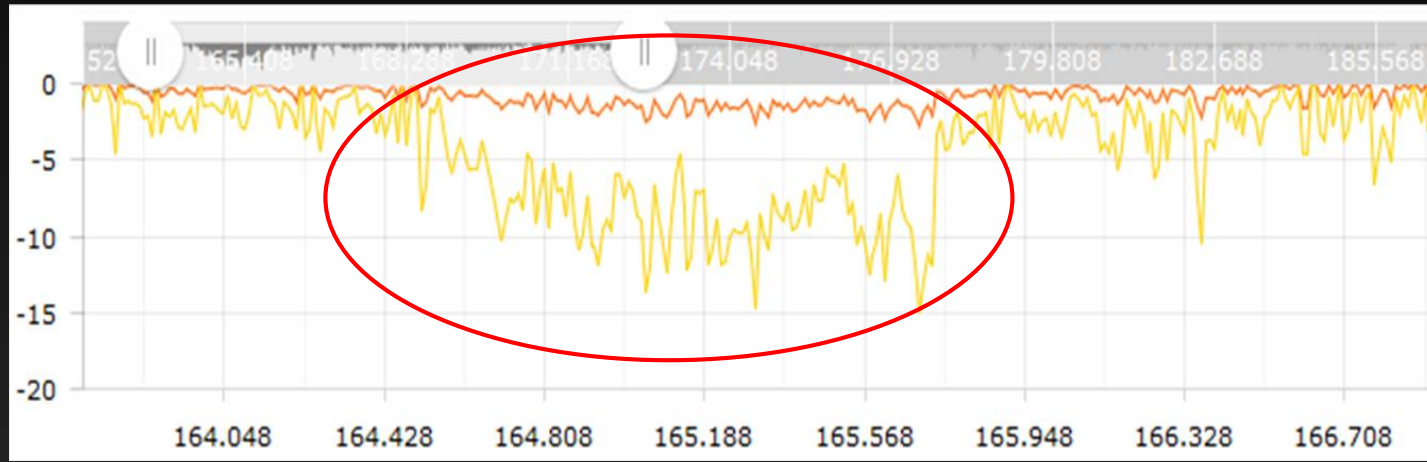
# Hidden in the depths

Smooth Surface however SCI shape indicates weak upper layers



# Hidden in the depths

SCI-Sub indicates weak substructure despite Smooth & Strong Surface



- No Cracking
- IRI < 0.8 m/km (50 in/mi)
- D0 < 125 micron (5 mil)
- SCI Subgrade (D60-D36) > 300 micron (12 mil)



# Hidden in the depths

2018 - Road ID: I-395 Interstate 395 Forward 3.148mi L0 [Front Center]  
Lat/Lon: 41.42793, -72.12401



1.745mi L0 [Front Center]



Collected: 21 Sep. 2018

hawkeye:::694893098489969:3.148

hawkeye:::694893098489969:1.745

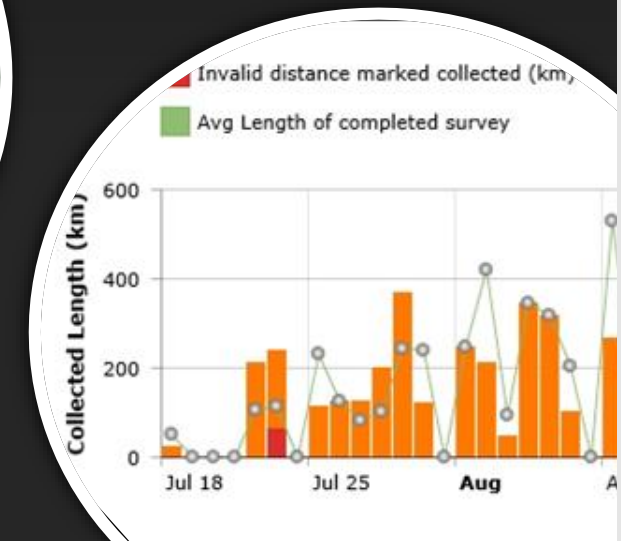
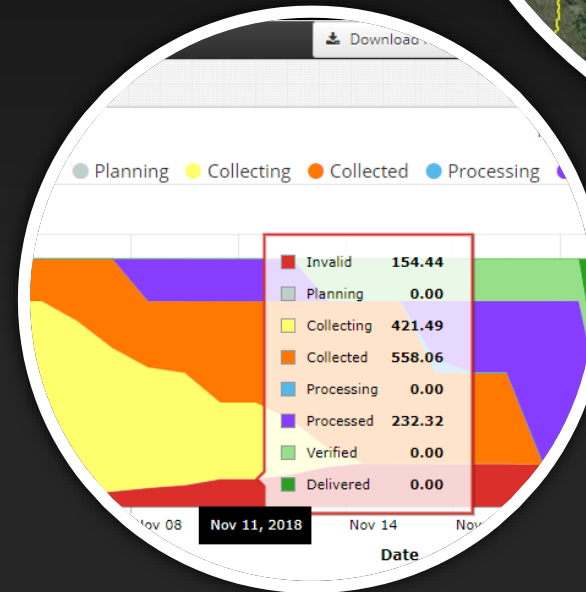
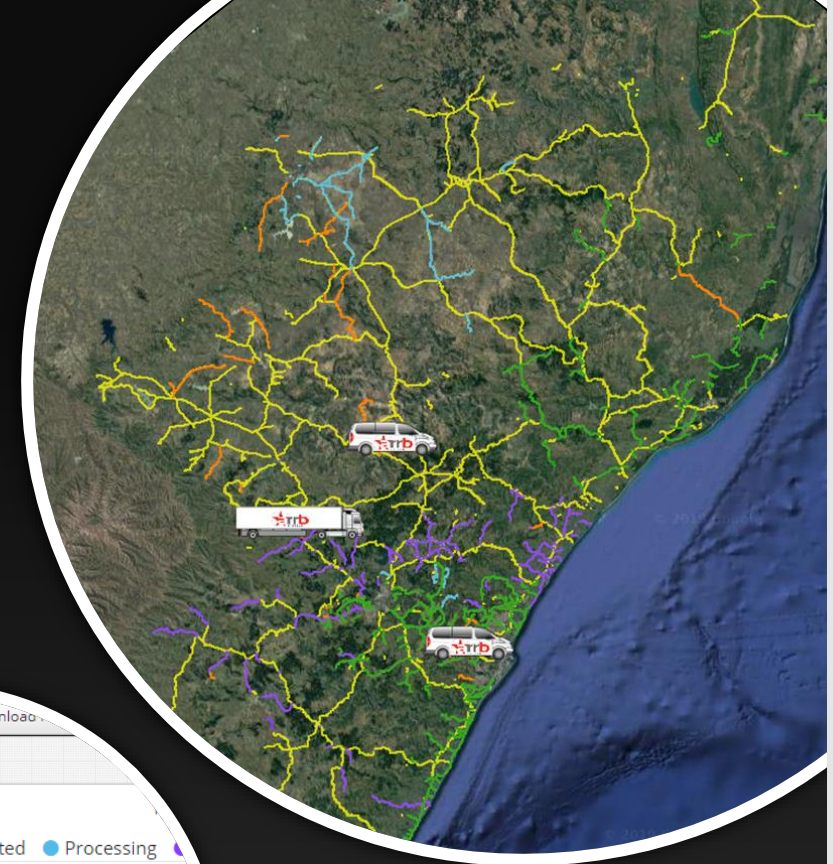
# Intelligent Survey Management

- Connected Project Planning
  - Connected Vehicle Management
- Connected Project Management
  - Connected Quality Management
  - Connected Data Backup



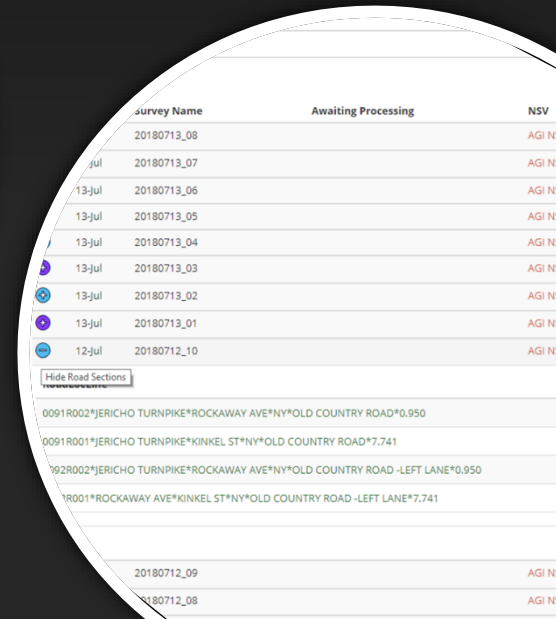
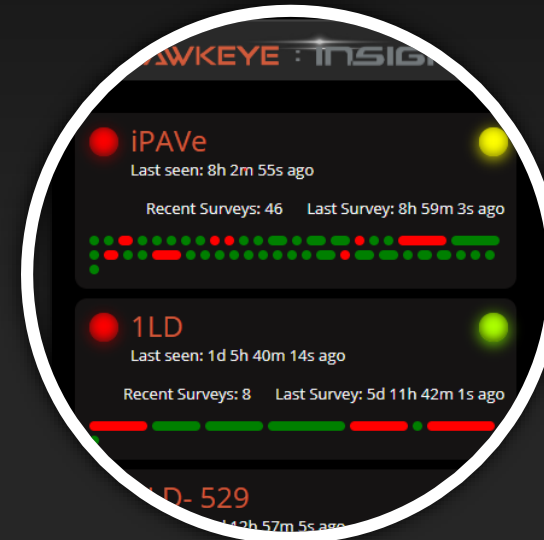
# Intelligent Project Management

- Connected Project planning
- Live Weather at vehicle location
- Survey progress and status
  - collected
  - processing
  - processed
  - verified
  - delivered
- Any project in the world
- At any time
- All in real time



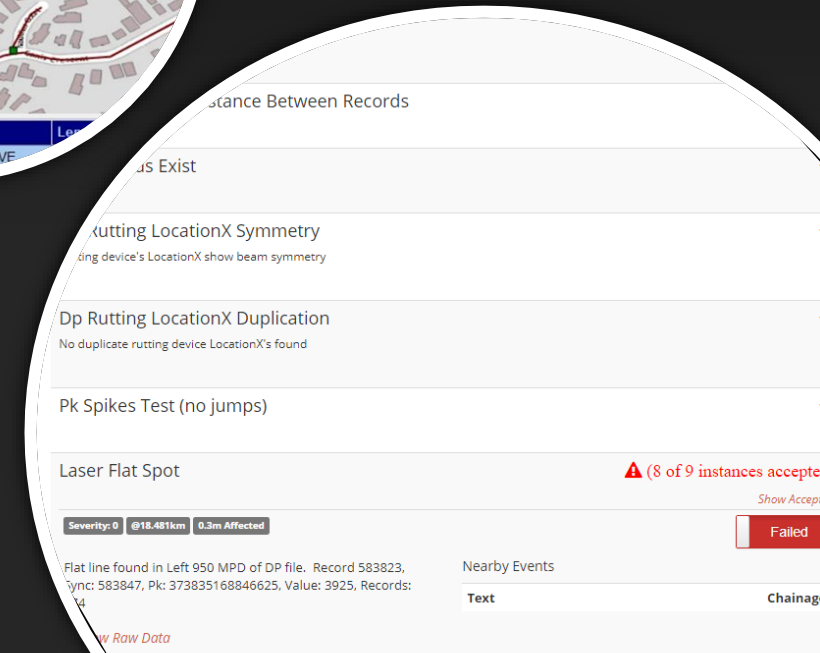
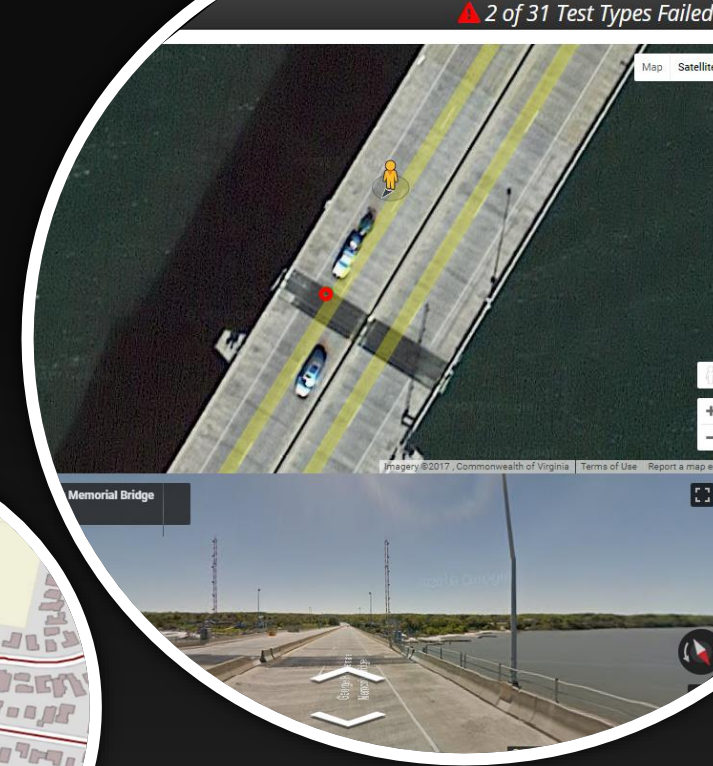
# Intelligent Fleet Management

- Real-time location status
- Real-time monitoring
- Real-time technician access
- Remote diagnostics





# Intelligent Quality Control

- Automated routing
- Automated referencing
- QC reporting routines
- Automated data verification
- Realtime remote notifications
- Auto Cloud upload
- Automated data backup
- Automated Calibration



# All Information at hand

- 
- 
- 
- 
- Comprehensive multiple data streams from multiple years
    - Project level evaluation with network data collection
  - Data mining for forensics and treatment selection
    - Exception reporting of network 'hot spots'
  - Monitoring of survey progress and data quality.
    - Automation of routing, calibration and verifications

# Emerging from the Cloud

## Machine learning

- Find hidden dependencies
- Classification of street signs, cracks etc.
- Association linked defects and causations

## Artificial Intelligence

- Assign, monitor and analyze treatment performance
- Self plan, self conduct, self verify data collection



# BACK TO THE FUTURE

Near Future ...

Automated operator surveys?

Not too distance Future...?

100% automated survey vehicle?

Future....?

AI survey, analysis and repair of networks?





Thank You

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PAVEMENT MANAGEMENT INTELLIGENCE