Multi-Year Cracking Analysis: A Spatial Approach

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RPUG Road Profile Users' Group

"Pavement maintenance involves doing the right treatment, in the right place, at the right time. To achieve this, good management and an understanding of the choices are required."

-Foundation for Pavement Preservation

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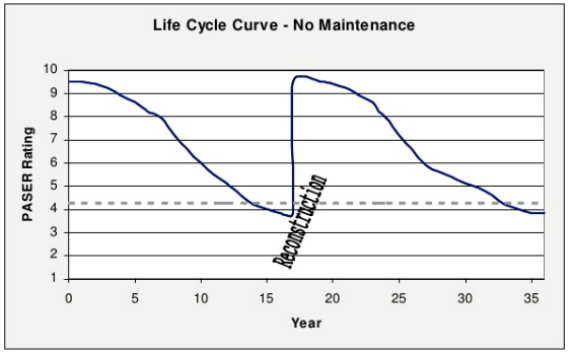
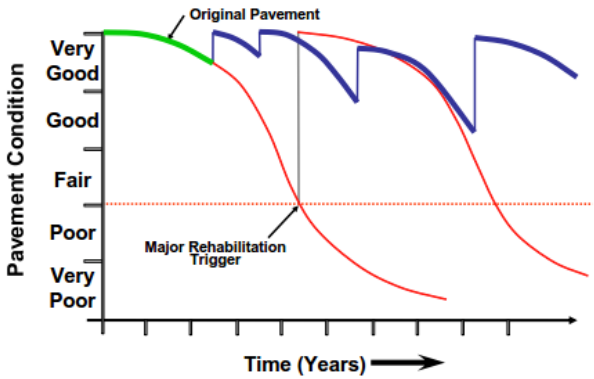
Why do we need Condition Data Anyway?

- Life Cycle Analysis
- Return of Investment
- Maintenance/Preservation Decisions





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Technology's Role in Condition Data

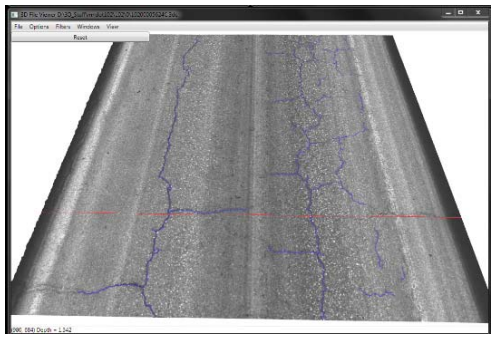
Collect Numerous Data Types in a Single Pass

- **High Resolution Right-of-Way**
- **High Resolution Surface Imaging**
- **Roughness Data**
- **Rutting Data & Transverse Profile**
- **Road Geometrics**
- **Faulting Data**
- **Vertical Clearance**
- **Shoulder and Edge Dropoff**
- **Asset Inventory & Mgmt**
- **GIS**
- **GPS**
- **GPR**
- **Macro Texture**
- **Pavement Condition Rating**
- **3D Pavement Surface Depths**
- **LiDAR**

Technology's Role in Condition Data

- Huge Advances in recent years of Precision/Data Density (LiDAR, 3D Road Surfaces Systems, etc.)
- Better integration of IMU and GPS subsystems

Automated Crack Detection



Advanced GPS/IMU Data

Pavement Management Toolkit

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3D Road Surface Data Can Do A Lot!

- Automated Crack Detection (or vastly-improved semi-automated distress rating)
- Continuous Transverse Profiles / Rutting
- Longitudinal Profile
- Highly Accurate Faulting Data
- Macrotexture

3D Data Can Do Even More with Excellent IMU/GPS

- Massively Improved Cross Slope Data in curves/ Supers
- Terrestrial Mapping, Ponding Depths, Volumes
- Spatial-based Data Collection for Maximum repeatability, independent of LRS limitations
- Data Comparisons and Reporting independent of LRS inaccuracies & limitations

LRS Limitations in Collection & Reporting

- 2 years ago, a certain (un-named) state DOT was struggling internally to match data collected at different times or by different people
- Multiple LRS were used by different departments
- Some LRS are referential and not distance-based
- LRS were constantly being updated and data had to be reconciled annually

LRS Limitations in Data Collection

- Historically, data collection was based on roadway markers
  A. Roads can change names/ownership
  B. MP Signs are moving targets

LRS Limitations in Data Collection

- Historically, data collection was based on roadway markers

A. Roads can change names/ownership
B. MP Signs are moving targets
C. Roads Get Realigned (Offsets/Equations complicate things)
D. New Roads don't always fit into our existing systems

LRS Limitations in Data Collection

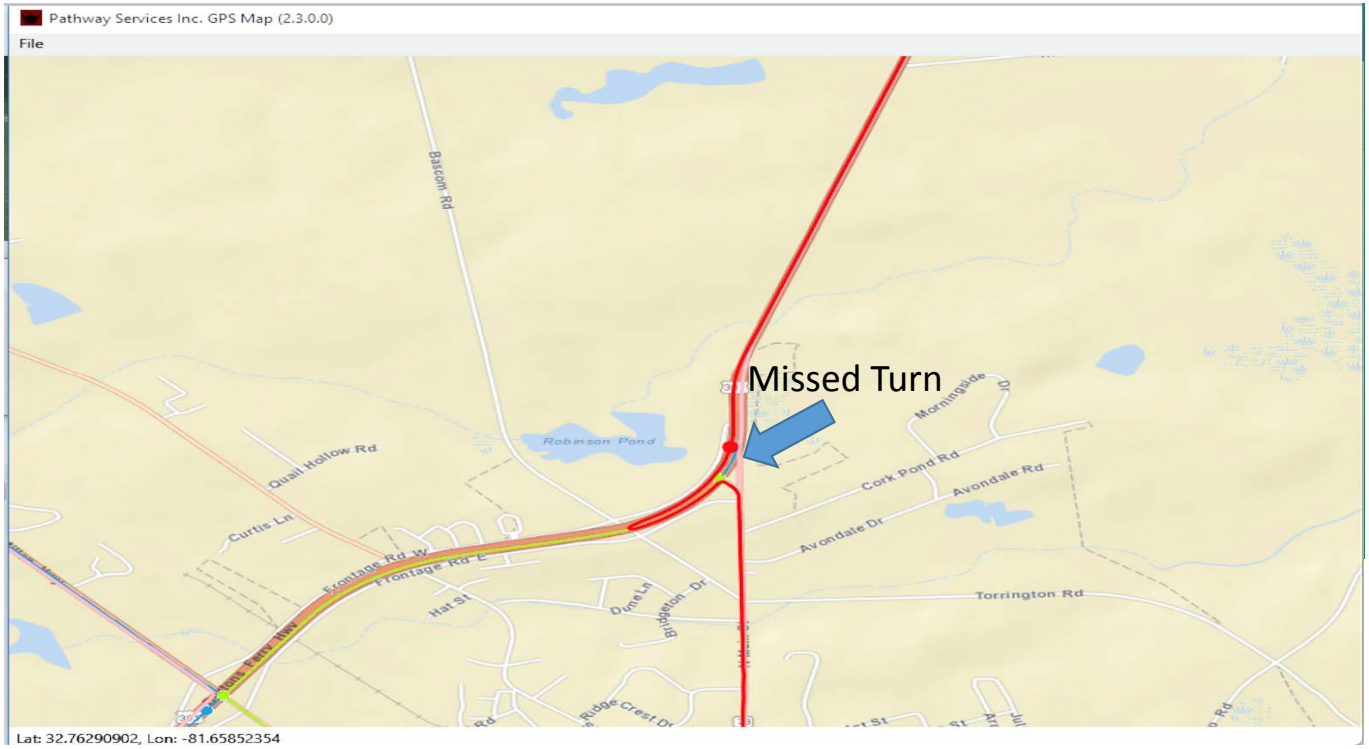
- Nodal-Based Collection (intersections don't move but…)

A. Humans interpret the point of intersection differently
B. Interchanges are far more complex than a single "X" or "T"
C. County lines are often marked incorrectly
D. Even GPS-based collection can be limited by dated/poor line work or disagreement with one of more LRS in use

Limitations in Data Reporting based solely on LRS

- Not always comparing “Apples to Apples” in tabular (flat) data sets. Different Roads/locations, etc.
- Construction complicates multi-year comparisons
- Different LRS may get different results
- Concurrent routes can complicate integration
- GPS checks were typically only done at the beginning and at the end of a route—no shape checks in between
- QC process is quite lengthy to verify all discovered differences & anomalies

Examples: Data Reporting based solely on LRS



- YOY comparisons show an unexpected difference
- Go to the imaging to see why
- ”self healing roads”
- Wrong Road / segment / wrong turns!!

This project created a “Paradigm Shift”:

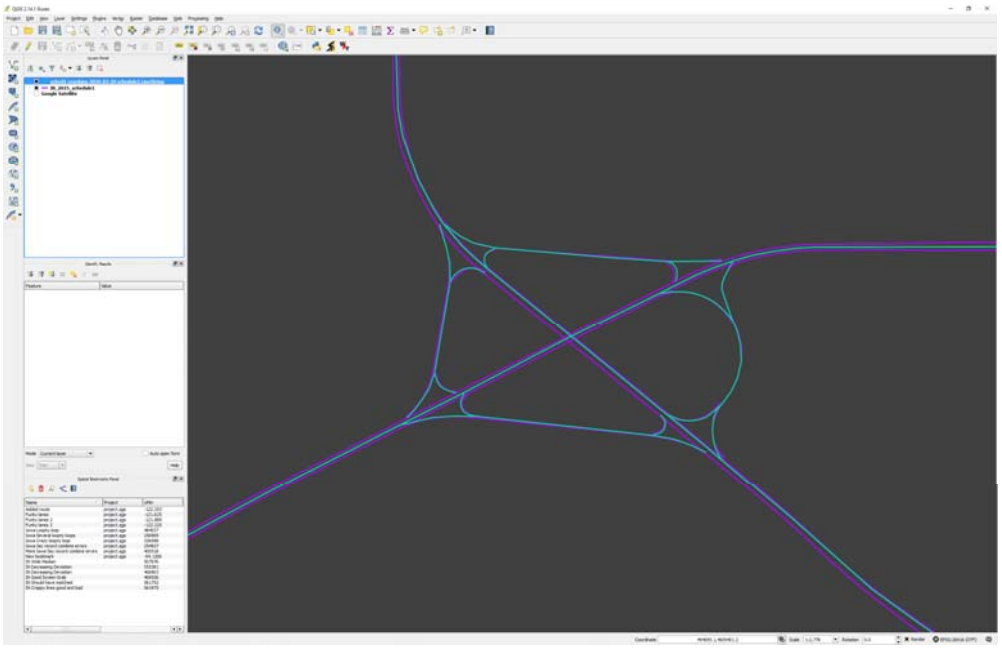
- Change our way of thinking away from Road attributes (Road name, direction, milepoint---anything in a table) and
- Simply focus on getting 100% network coverage with no gaps or overlaps

- Only way to do that is dive into spatial-based data collection and reporting

Advantages of Spatial-Based Data Reporting

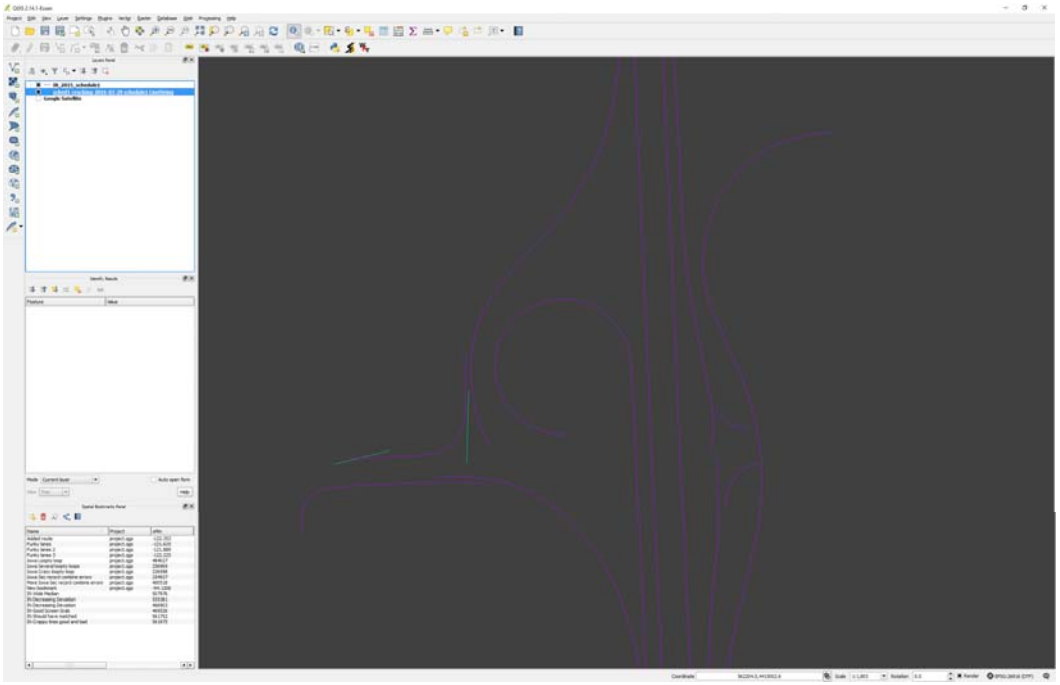
- Data is not only tabular, but graphical
- Reporting is independent of Road name, mile points
- Location checks/joins at more than just the beginning and ending points (we use the whole polyline!)
- Drastically reduced QC effort
- Data joins / Accuracy down to 3-5 feet in many cases

Examples: Data Reporting Based On Spatial Location



- 28 Different Road Names (not 28!!)
- Ramps on 3 different LRS (one non-distance-based)
- Route names and milepoints applied after the spatial join and heading analysis
- Historically only had GPS on end points of spiral routes
- GPS Matched throughout each polyline to match full route
- Begin/End Descriptions were wrong in the provided database
- Incorrect route automatically detected and reported to DOT

Examples: Data Reporting Based On Spatial Location



- New Interchange
- LRS and Line work not provided before data collection
- After collection, data joined to DOT line work
- Anything Missing shown in Green (assigned for recollection)

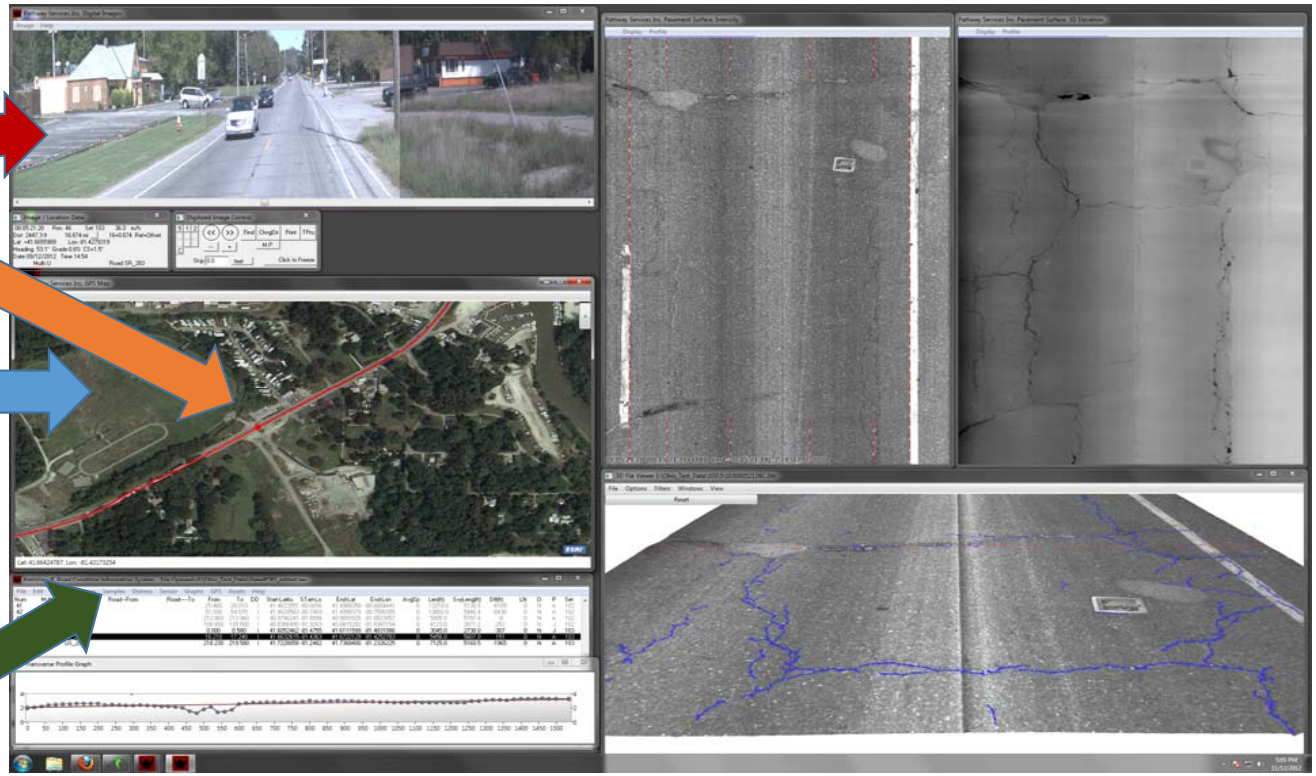
Advantages of Spatial-Based Data Reporting

Spatially-plotted data can be used as navigation to view imaging and extracted roadway assets such as signs, guardrails, ramps, etc.

Data Falls on your network where it should, not dependent on matching route name/LRS

Line work can be color coded by index. Multiple years plotted simultaneously. Multiple LRS can be viewed as layers too!

Every Asset is stored in a spatial database for plotting and navigation. Including cracking!



28 Years – Pavement Performance into The Future

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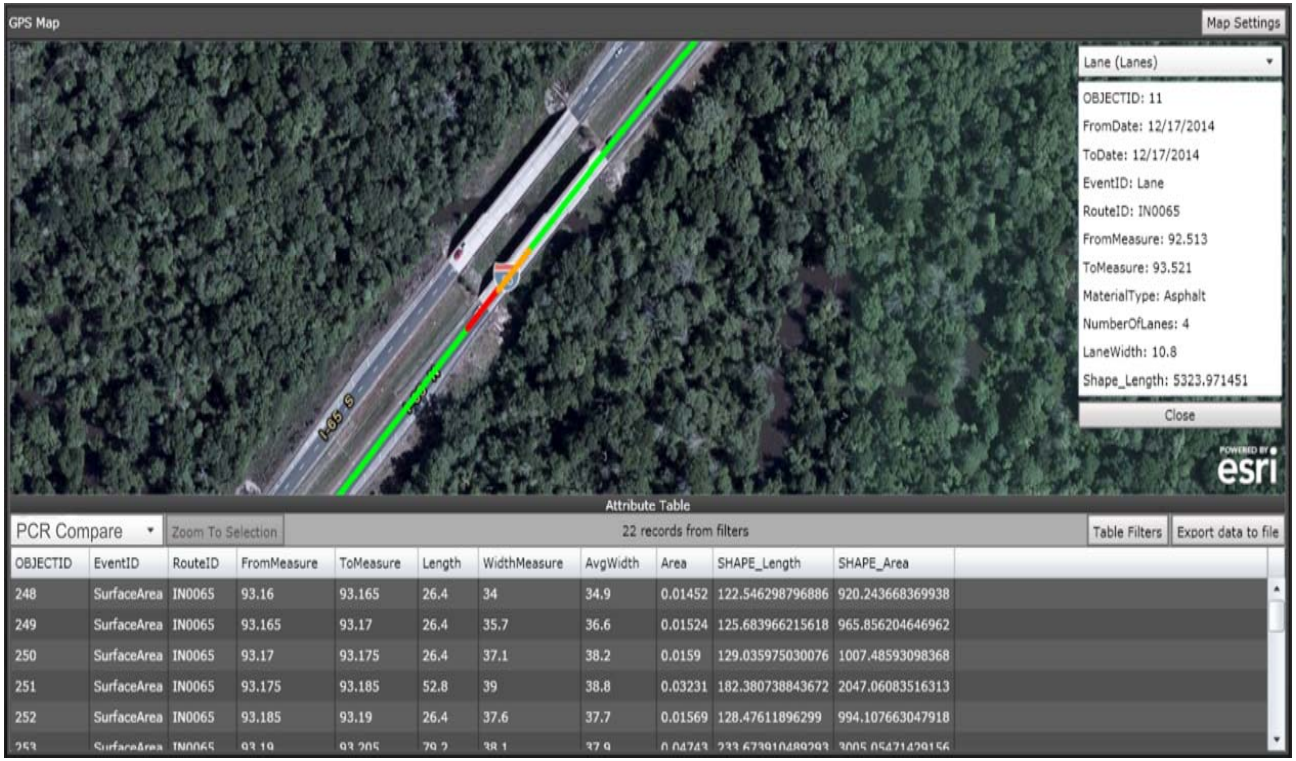
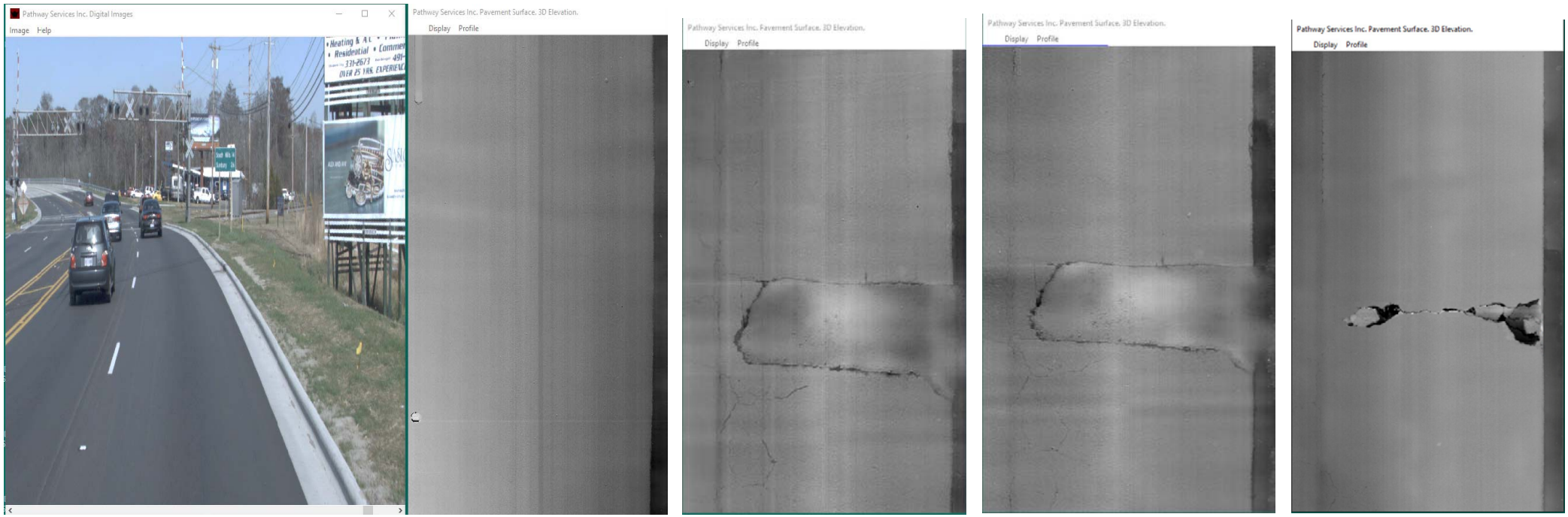
Cracking Year-Over-Year



OBJECTID	EventID	RouteID	FromMeasure	ToMeasure	Length	WidthMeasure	AvgWidth	Area	SHAPE_Length	SHAPE_Area
248	SurfaceArea	IN0065	93.16	93.165	26.4	34	34.9	0.01452	122.546298796886	920.243668369938
249	SurfaceArea	IN0065	93.165	93.17	26.4	35.7	36.6	0.01524	125.683966215618	965.856204646962
250	SurfaceArea	IN0065	93.17	93.175	26.4	37.1	38.2	0.0159	129.035975030076	1007.48593098368
251	SurfaceArea	IN0065	93.175	93.185	52.8	39	38.8	0.03231	182.380738843672	2047.06083516313
252	SurfaceArea	IN0065	93.185	93.19	26.4	37.6	37.7	0.01569	128.47611896299	994.107663047918
253	SurfaceArea	IN0065	93.19	93.205	79.2	38.1	37.9	0.04743	233.673910489293	3005.05471429156

- We are comparing Apples to Apples—only what can be joined is compared.
- Data Layers are Graphical (YOY PCR shown)
- Differences can be color-coded

Cracking Year-Over-Year



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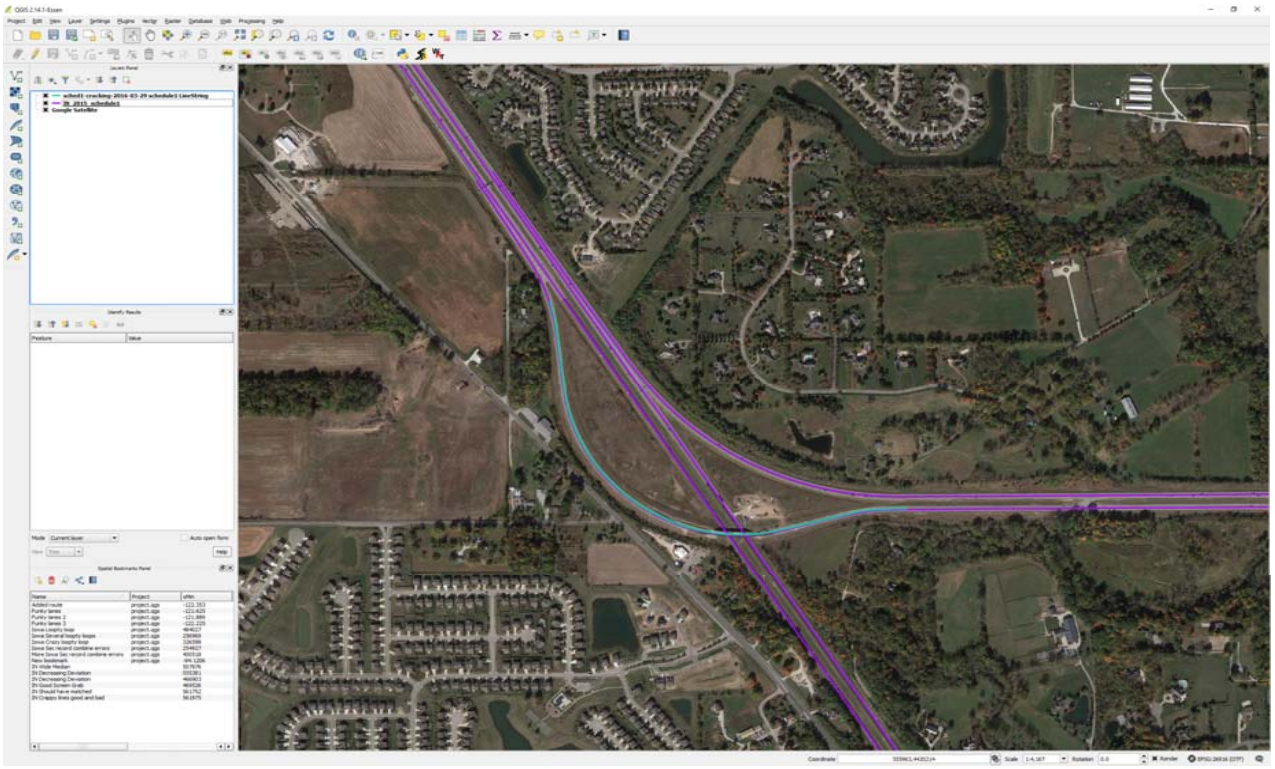
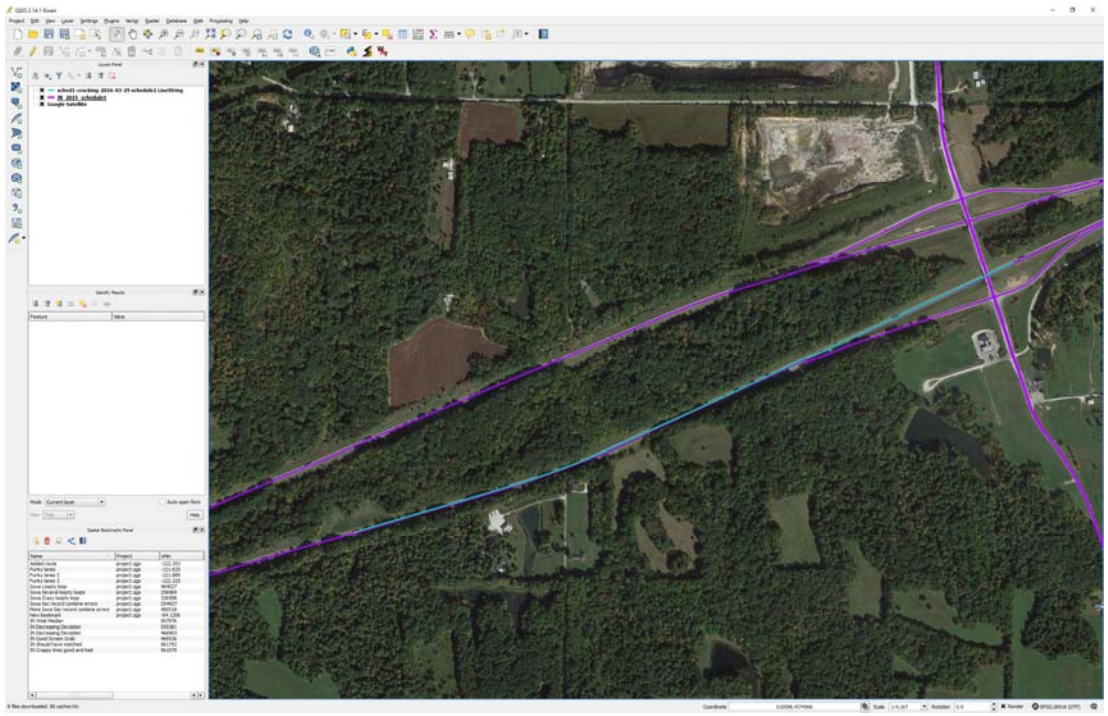
Challenges: Data Reporting Based On Spatial Location



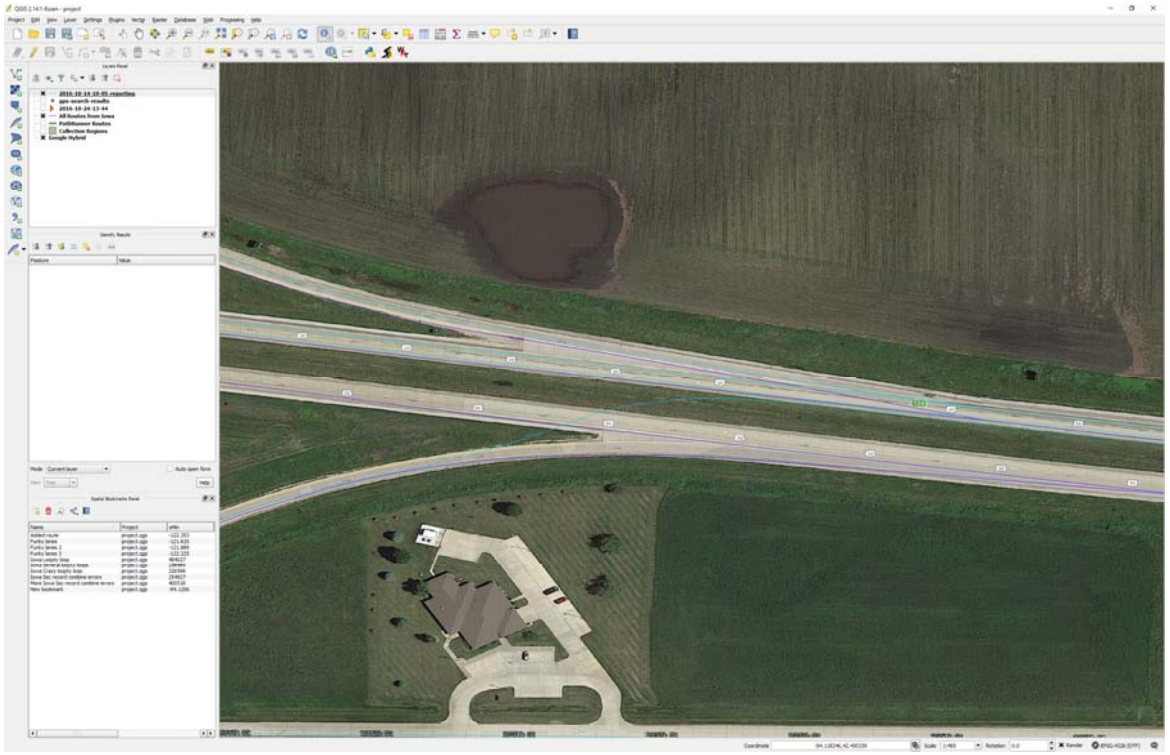
- Line work provided may not always be bidirectional
- Many states may only provide line work in “inventory direction” and joins for decreasing routes need tolerance adjustments

Challenges: Data Reporting Based On Spatial Location



- Line work provided may be based on centerlines
- Large medians and multi-lane segments take some complicated logic to join effectively

Challenges: Data Reporting Based On Spatial Location



- Line work provided may not include new roads
- Large medians and multi-lane segments take some complicated logic to join effectively

General Summary After Completing Several Spatial-Only Projects

- With Good line work, most of your network can be joined and reported within a few feet, independent of road name or LRS values
- LRS values can be assigned during import or later in a spatial join
- ”Self-Healing” roads have reduced by 70% on our first 3 statewide projects using fully spatial reporting
- Roads not joined are logged and reported separately--typically the original DOT line work needs to be updated. Average about 100-200 Miles for large networks annually

Limitations / Future Desired Improvements

- Your reporting is only as good as your line work
- Line work changes throughout the year as network improvements are conducted, but collection based on a "snap shot" from project kickoff.
- "Subscription" to edited line work?
- Access to maintenance schedules? Field crews also often know about construction before the PME—we could provide feedback immediately

Questions?

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