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GPR Detection of Asphalt Pavement Stripping

FHWA NDT Peer Exchange
November 28, 2022

Overview

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- Asphalt Pavement Stripping
- 3D GPR Basics
- GPR to Detect Anomalies (Stripping)
  - Collecting GPR Field Data
  - Examining GPR Data
  - Reporting Results
- Suggestions for multi-State Field Surveys
- Suggestions for multi-Team Data Analysis

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What is Asphalt Mixture Stripping?

- Separation of the asphalt binder from the aggregate due to moisture.
- Minor stripping: separation with NO (little) change in the mixture density.
- Severe stripping:
  - reduction in mixture strength
  - displacement of aggregate within the mixture
  - movement of the mixture layer
- Stripping is caused by:
  - asphalt binder and aggregate chemistry
  - presence of moisture
  - hydro-dynamic pressure of vehicle passes

Types of Stripping

- Layer / lift [poor mix material design]
- Transverse crack bottom-up [moisture in the crack]
- Longitudinal joint [low mixture density]
- Hydro-dynamic pressure in mixture due to traffic

- **Debonding between layers <u>is not stripping</u>**

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Types of Ground Penetrating Radar

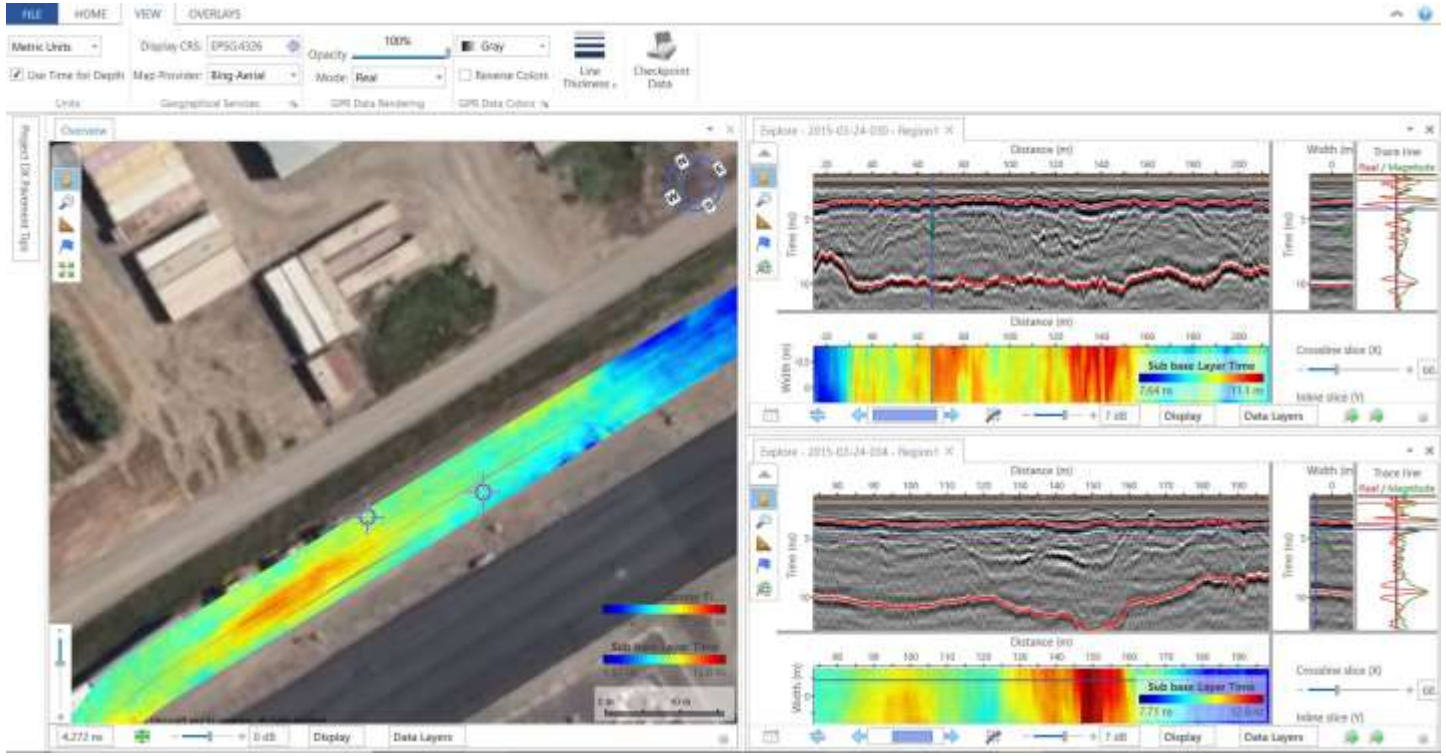
Various types of GPR:

- Impulse based (most common)
- Noise Modulated
- Frequency Modulated
- **Step Frequency (Kontur 3D-Radar)**

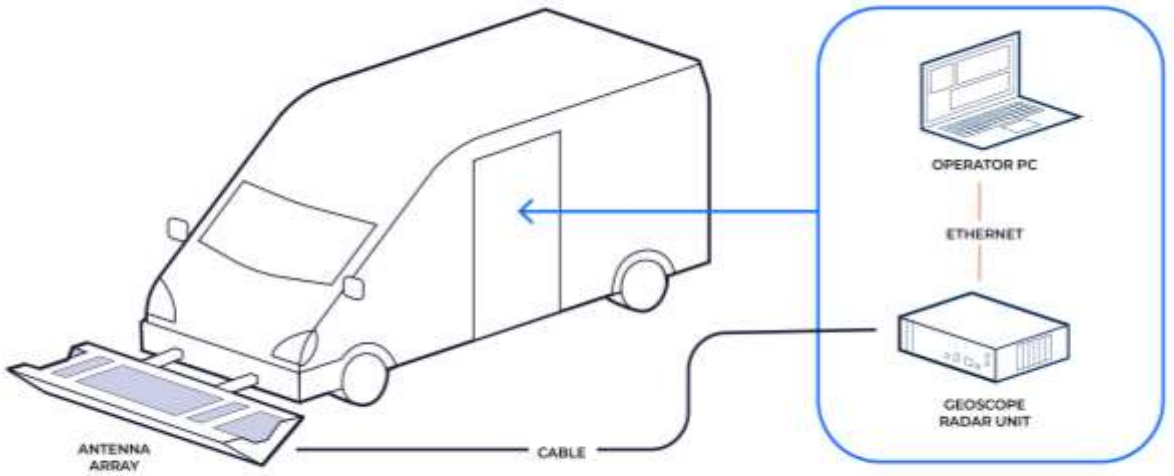
Typical GPR trade-off: High frequencies bring high resolution, but do not travel as far as low frequencies (subsurface acts as a low-pass)

Kontur 3D GPR System

- GPR **ARRAY** technology
- **STEP-FREQUENCY**
- **OPTIMUM RESOLUTION** and **PENETRATION**
- Collect best possible GPR data
- **ACCURATELY POSITIONED** information
- **EXAMINER** software package

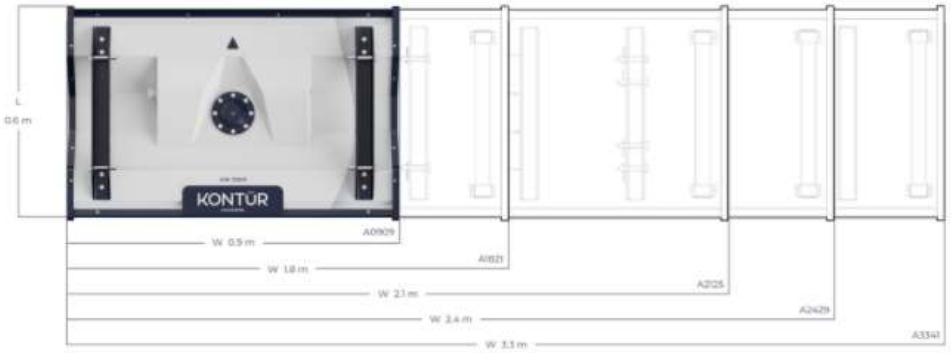


Kontur System



Air-launched Antenna Arrays

- Ultra-wideband antenna elements
- Multi-channel (7.5cm spacing)
- Air-coupled (high-speed surveys)
- Single Transmitter / Dual Receiver
- Independent Tx / Rx element selection
  - Common Offset
  - Common Middle Point (CMP)
- Embedded PPS receiver



	A0909	A1821	A2125	A2429	A3341
WIDTH	0.9 m	1.8 m	2.1 m	2.4 m	3.3 m
NO. OF CHANNELS	9	21	25	29	41
SCAN WIDTH	0.7 m	1.6 m	1.9 m	2.2 m	3.1 m
SIZE	1.8 x 0.6 x 0.2 m	1.8 x 0.6 x 0.2 m	2.1 x 0.6 x 0.2 m	2.4 x 0.6 x 0.2 m	3.3 x 0.6 x 0.2 m
WEIGHT	18 kg	28 kg	33 kg	38 kg	50 kg
TRANSPORT CONTAINER SIZE	1.0 x 0.7 x 0.3 m	1.9 x 0.7 x 0.3 m	2.2 x 0.7 x 0.3 m	2.5 x 0.7 x 0.3 m	3.5 x 0.7 x 0.3 m
TRANSPORT CONTAINER WEIGHT	18 kg	27 kg	30 kg	33 kg	55 kg
TRANSPORT TOTAL WEIGHT	36 kg	55 kg	63 kg	71 kg	105 kg

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Air-Coupled Antenna Mounting Options

SFCW GPR Optimizes Resolution and Penetration

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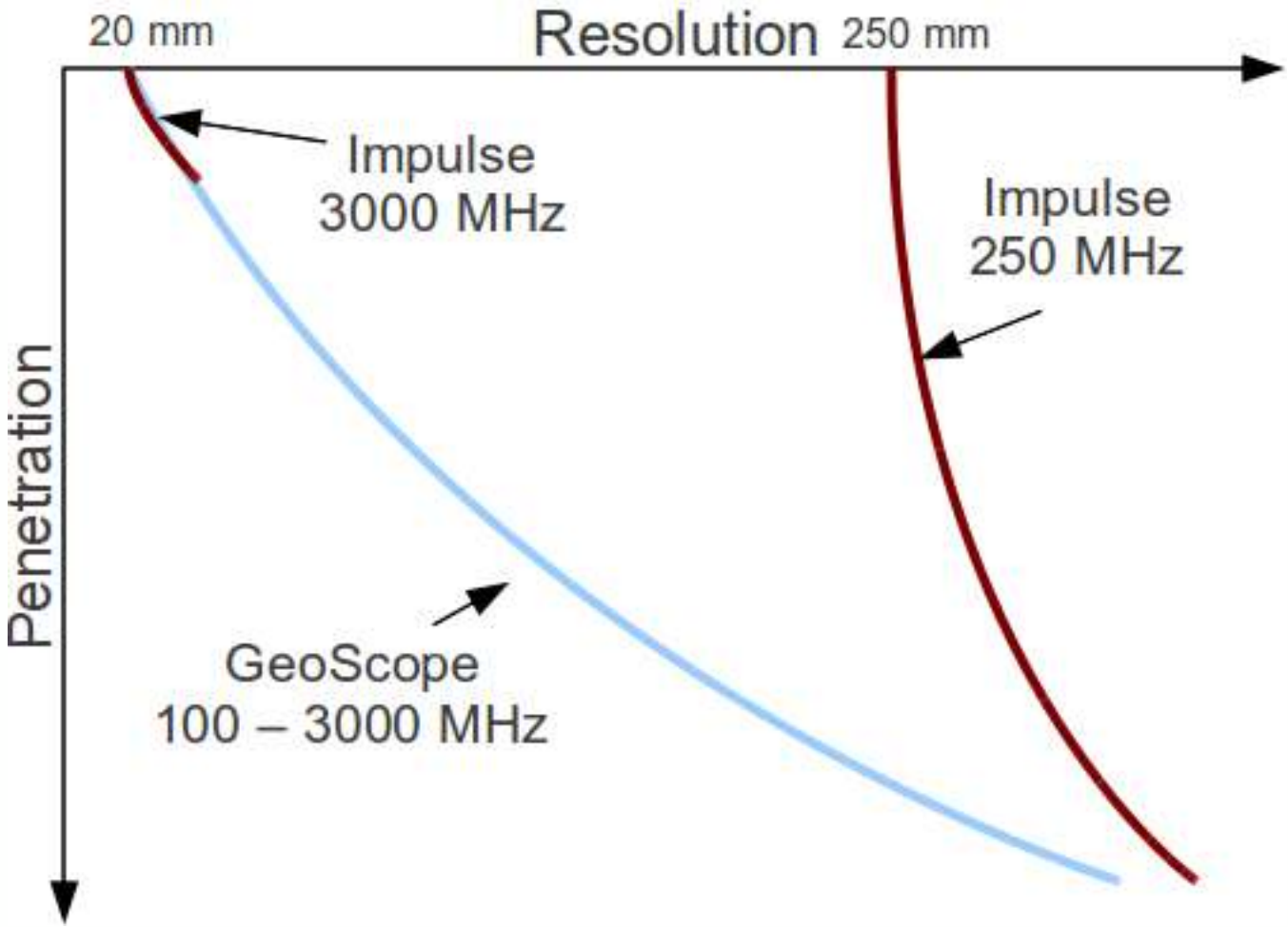
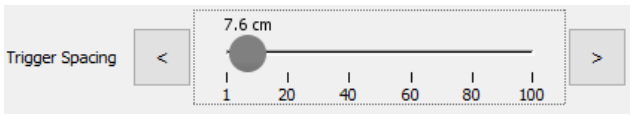
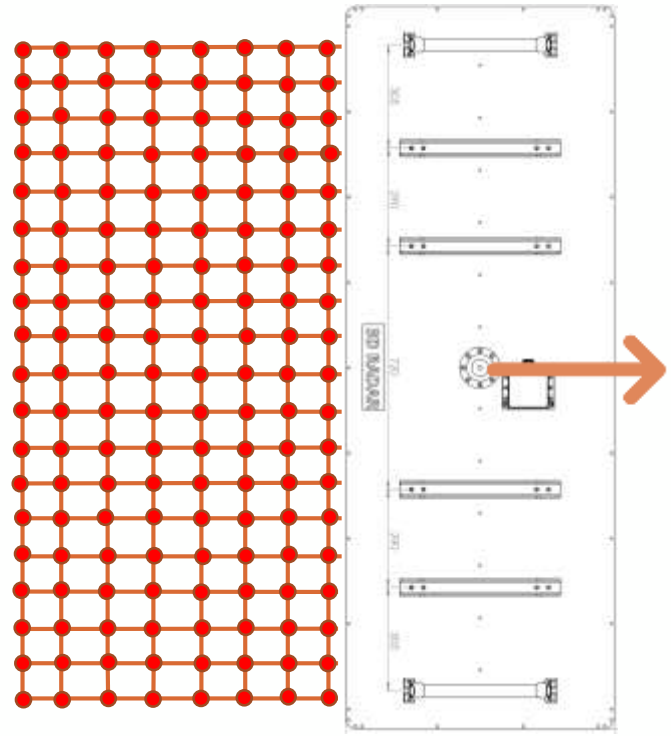
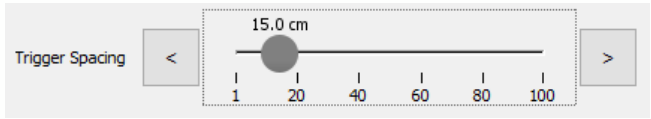


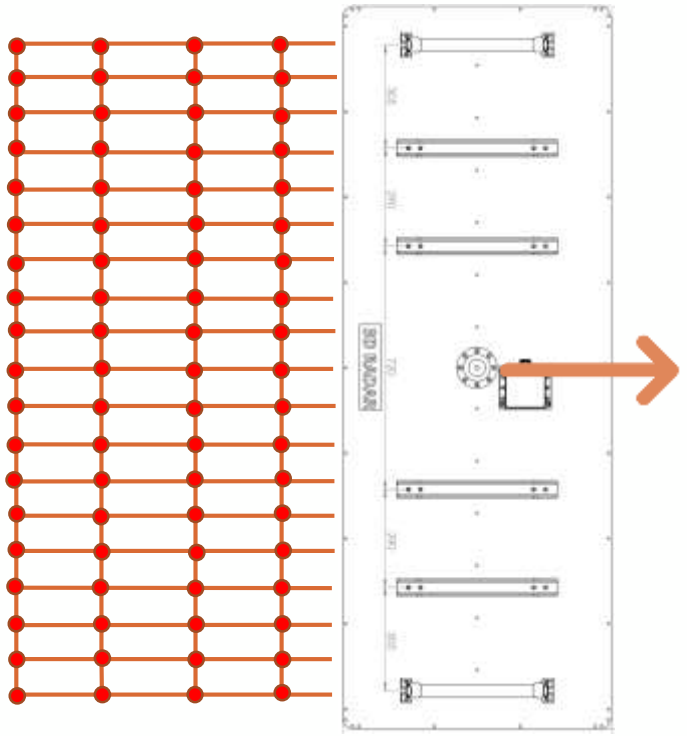
Survey Settings – Trigger Spacing



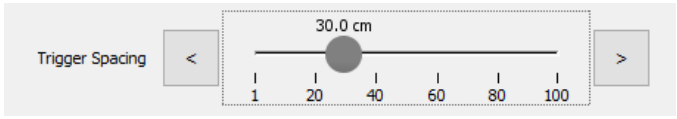


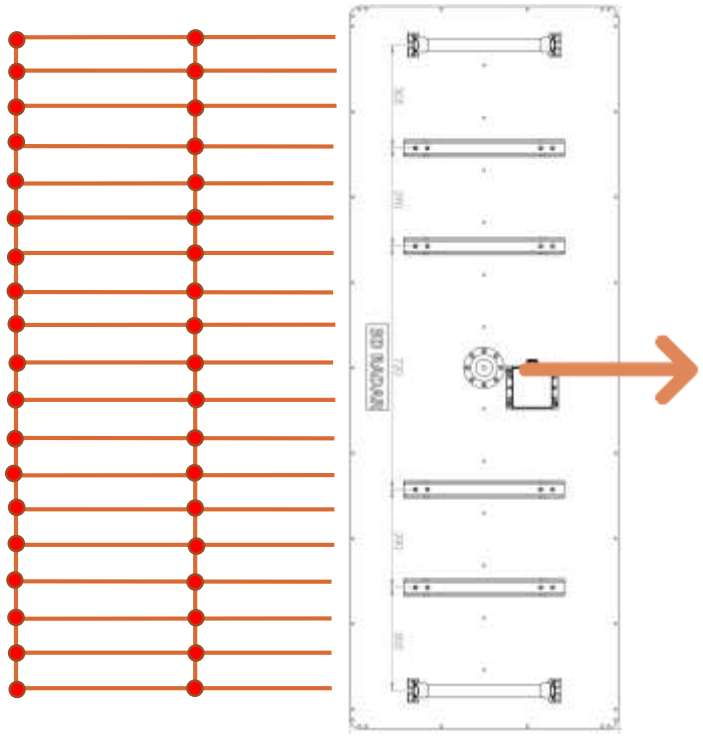
7.6cm x 7.6cm grid





7.6cm x 15.0cm grid

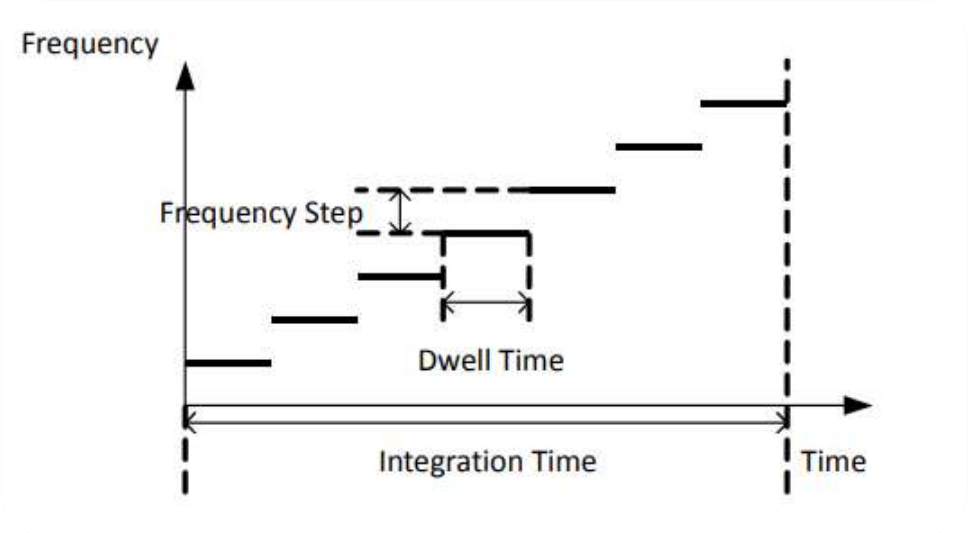


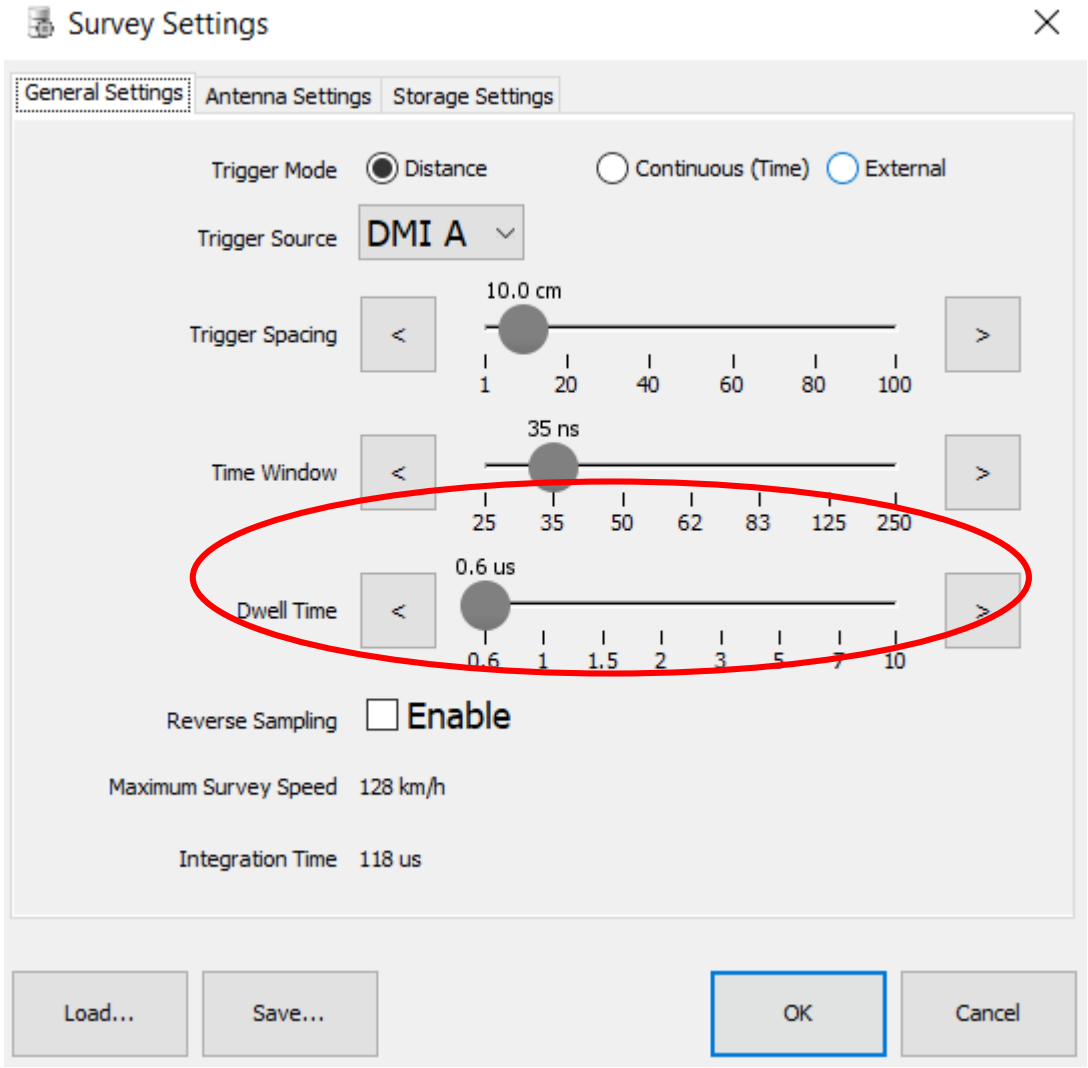


7.6cm x 30.0cm grid

Survey Settings – Dwell Time

- Shown in microseconds
- Can be considered as a quality slider
- The amount of time the antenna will stay on each frequency as it cycles through 150MHz to 3GHz





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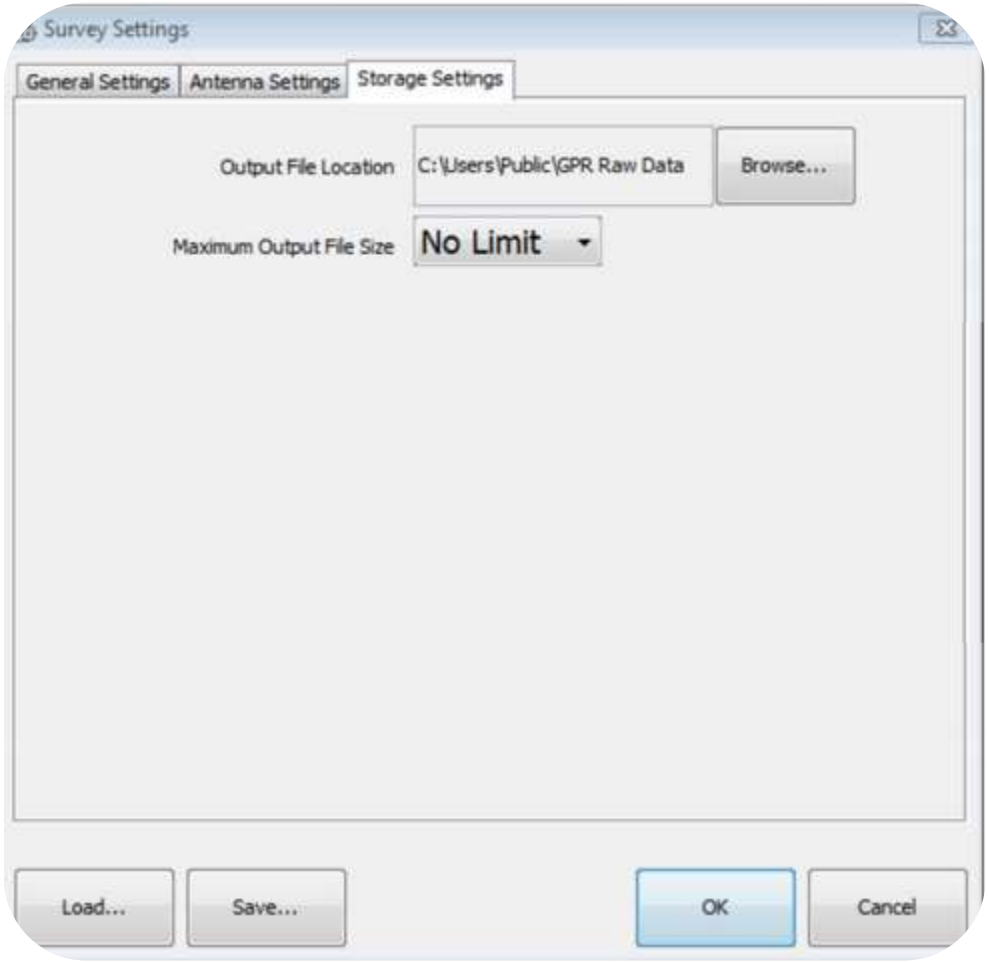
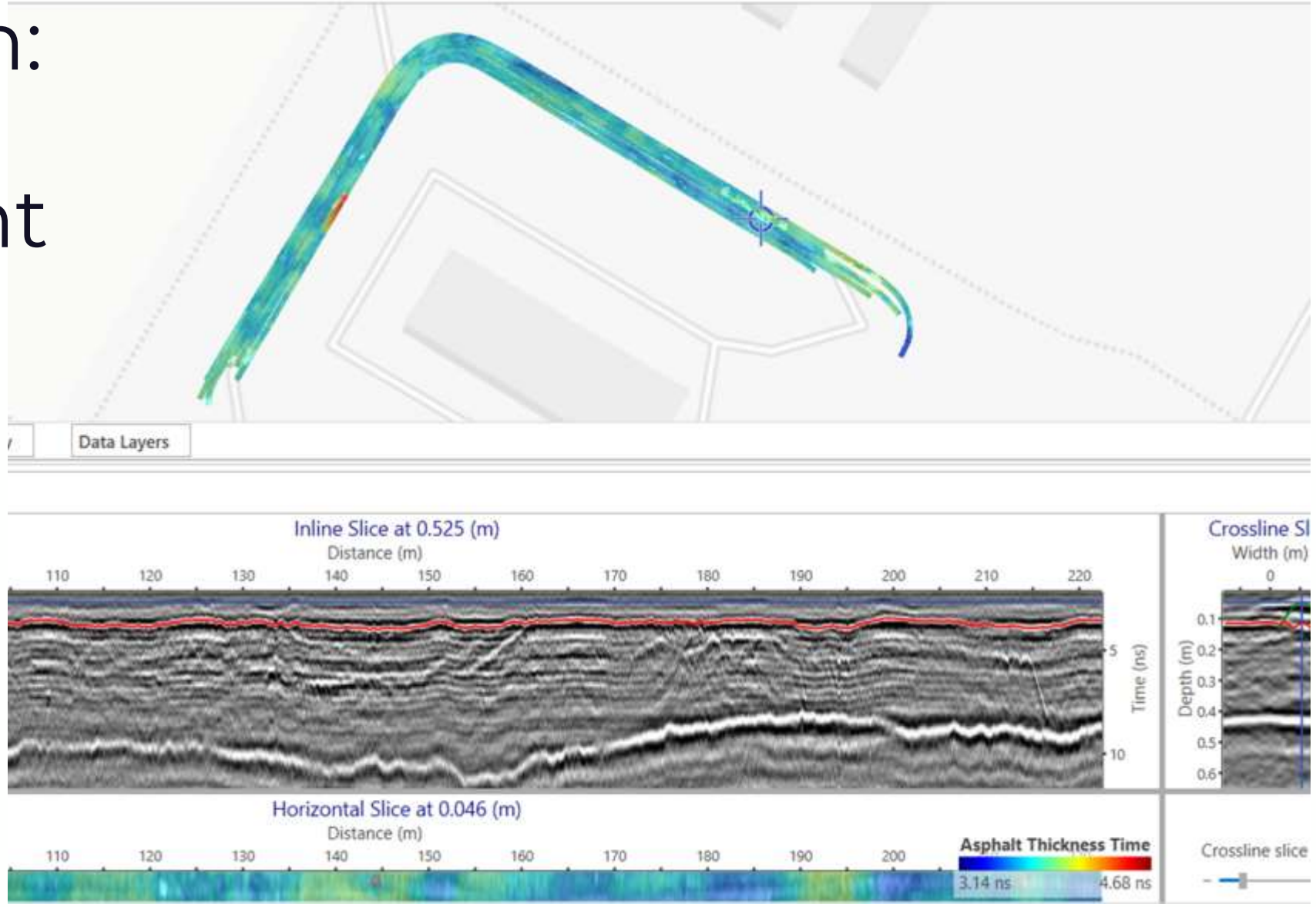
Survey Settings – Storage Settings

- Where to store the survey data
  - Local internal hard drive of the laptop
- Maximum Output File Size
  - When the file size is reached, a new file will be created. Dividing the survey into increments.
    - No Limit - for unlimited file size.
    - 100MB
    - 250MB
    - 500MB - recommended
    - 1000MB
- **General rule: 1.0 mile, 1 pass = 1.0 GB data**

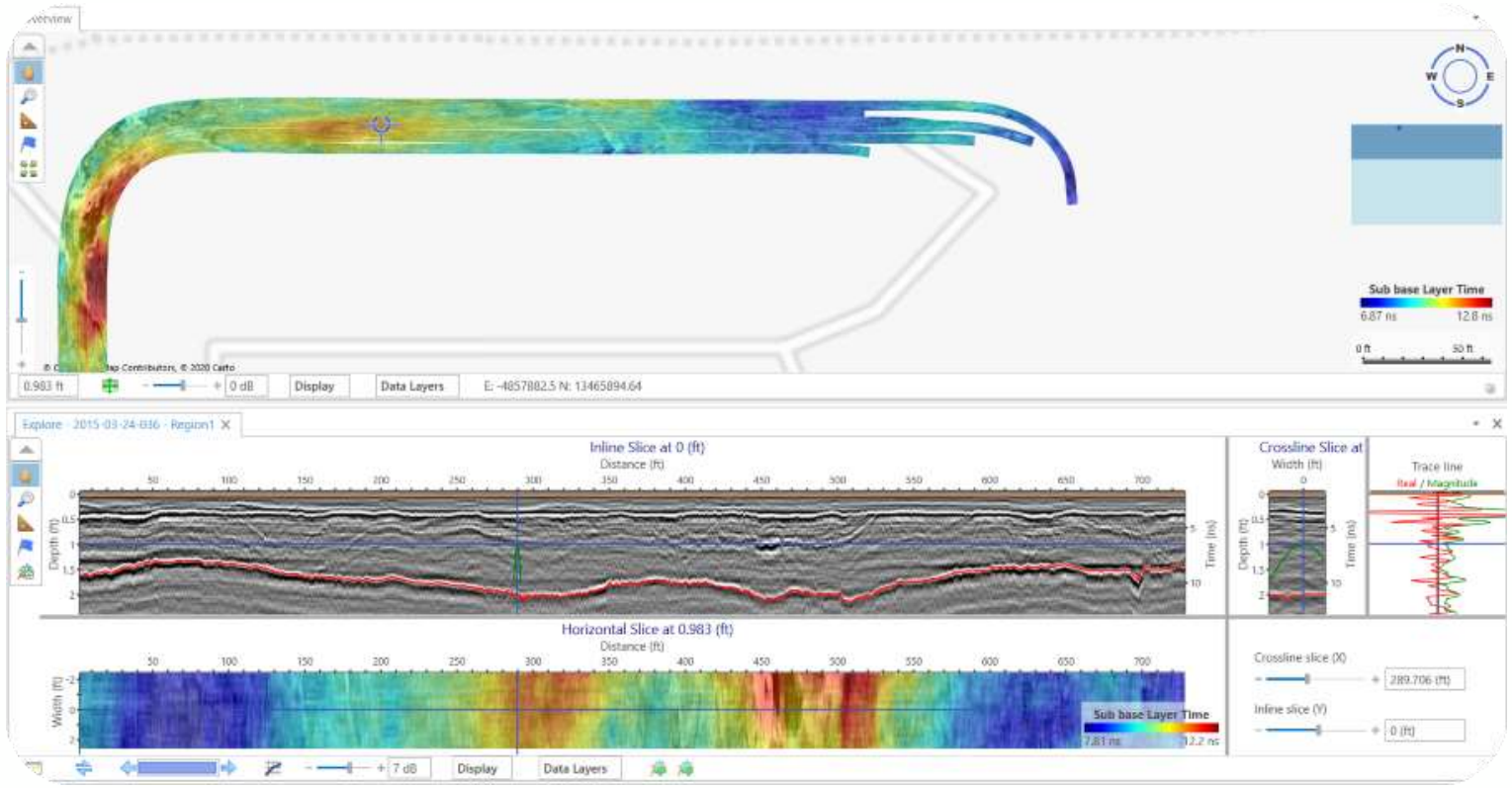


Application: Pavement Assessment



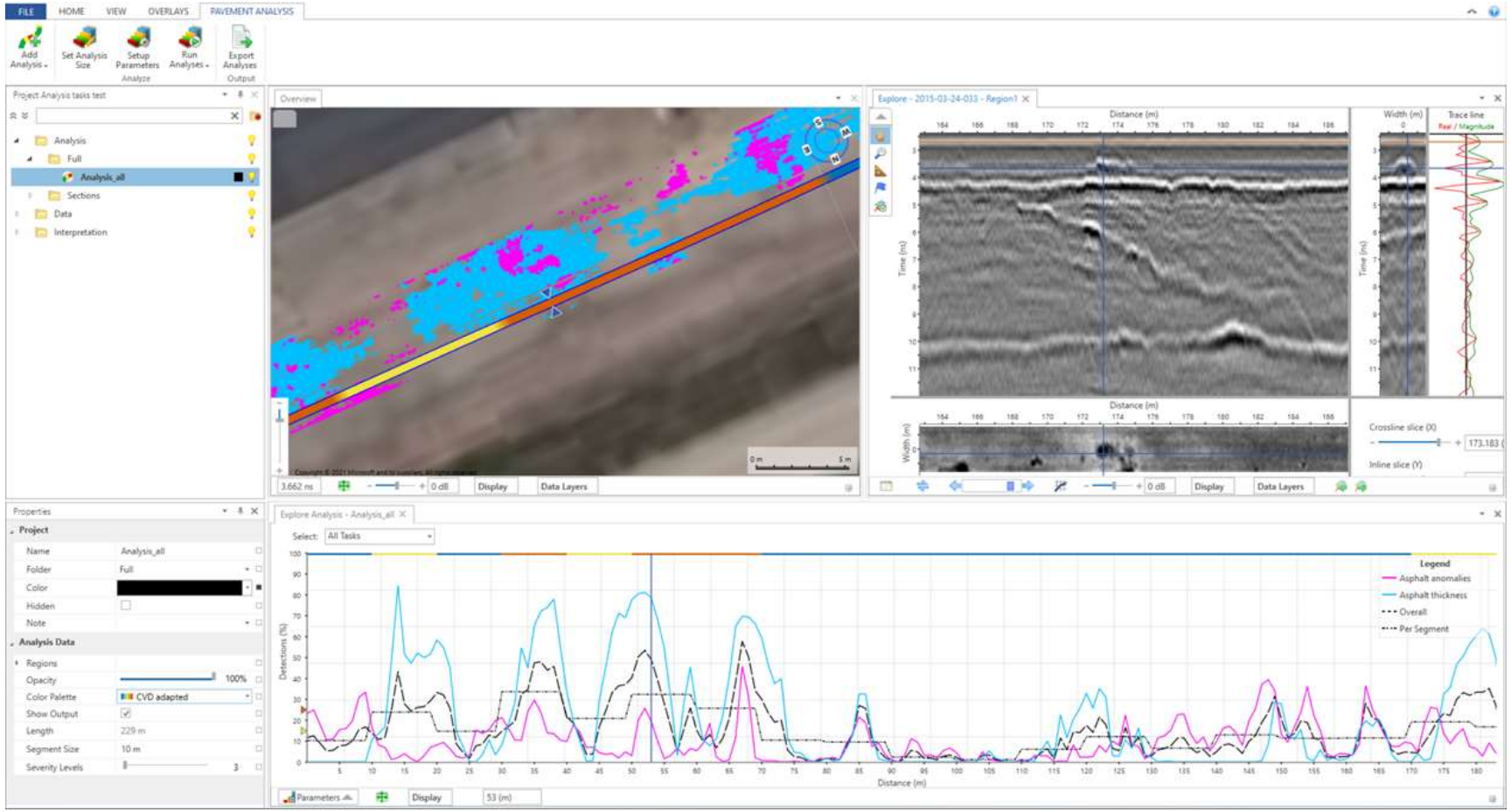
EXAMINER 3

- Examiner 3 is software owned and developed by Kontur
- The platform is purpose built to handle data generated by Kontur array products
- Examiner is unique in the way it handles high volume, detailed, ground penetrating radar data collected by a modern-day array
- The platform caters for engineers of all levels
- 3-Dimensional approach and software speed allows engineers to identify areas of interest in the data and extract information they need



EXAMINER 3 – Pavement Analysis

- Anomaly detection task designed to find and highlight stripping-like reflections in layers
- Define segment size and severity levels
- Synchronized visualization
- Possibility to store and open projects without GPR data



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Guidelines for GPR Field Surveys
(to successfully identify anomalies)

- Moisture improves the ability to identify the locations
  - Survey the pavement 3-10 days after a rain event (when possible)
- Capture the condition of the longitudinal pavement edge (right and left).
  - Survey the entire lane width
- Survey at normal vehicle speed
  - Use a 8-10 mm test spacing
- Confirm the system (GRP and GPS) is working correctly before surveying the entire to project.
  - Survey a short test section (with known pavement features) and examine the data

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Examine the GPR Data for Anomalies

1. Stitch the field data together
2. Identify the pavement layers and suppress locations of external noise.
3. Find a pavement length where the GPR data represents a sound (normal) pavement.
4. Will analysis focus on a single layer/interface or examine the entire asphalt pavement material?
5. Perform the anomaly scan to identify suspect locations.
6. Manually examine the GPR data where anomalies are identified.
   - If scan parameters were too sensitive, adjust parameters, and re-run the automated analysis.
7. Report the anomalies.

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Reporting Pavement Anomalies

- Route location (X) (milepost).
- Lane location (Y) (left/right/wheel path).
- Layer location (Z) (depth from surface).
- Anomaly area and severity (based on scan value compared to “normal” value).
- Summary log: pavement lane area per route length increment (EX: sq.yds./0.1 mile).

NOTE: Lane area is not sufficient for making pavement rehab decisions. Depth and severity of the stripping are also key factors.

Quality GPR Data for the Pooled Fund Project

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- Responsive to GPR field equipment schedule.
- All field surveys with the same equipment.
- Select projects to reduce travel time.
- Suggest 10 miles maximum project lengths.
- Coordinate “required” traffic control (GPR field survey will operate at traffic speed).
  - Cost not transferred to the GPR survey operation.
- In-State GPR system parallel data would be collected at the same time.
- Field cores should be obtained quickly after the GPR field survey.

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Teams Developing Software to Detect ”Stripping” with Kontur 3D Data

- Access to VERY LARGE project GPR field data files.
- Standard file naming convention for data files.
- All use the same version of EXAMINER.
- Do not export GPR raw data for independent software approach.
- Create software that is compatible within EXAMINER.


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