
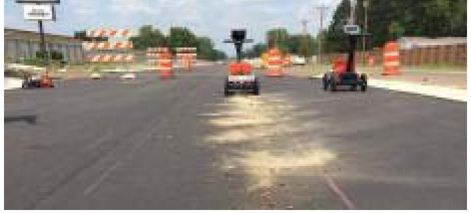


SHRP2 SOLUTIONS
TOOLS FOR THE ROAD AHEAD

Peer Exchange PaveScan RDM Meeting

GSSI Process – From the Beginning, to Now, and Future

Rob Sommerfeldt – Application Specialist
Roger Roberts – SW Engineer

October 24-25, 2017

U.S. Department of Transportation
Federal Highway Administration

American Association of State Highway and Transportation Officials
AASHTO

Presentation Overview

- Background
- Building the Technology
- Where We are Now
- Future

PaveScan RDM – Background

What is the PaveScan RDM?

- **A Ground Penetrating Radar system that provides compaction information of newly laid and compacted asphalt**
- **Provides continuous full coverage (CFC, thank you Richard Giessel, Alaska DOT) information, not just random spot checks**
- **Provides core locations**
- **Collect data using GPS coordinates, Station numbers and Distance**
- **KML map and contour maps of the area**

PaveScan RDM – Background

- Road evaluation with ground penetrating radar

1993?

Road evaluation with ground penetrating radar

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Abstract

This paper provides a status report of the Ground Penetrating Radar (GPR) highway applications based on studies conducted in both Scandinavia and the USA. After several years of research local transportation agencies are now beginning to implement GPR technology for both network and project level surveys. This paper summarizes the principles of operation of both ground-coupled and air-launched GPR systems together with a discussion of both signal processing and data interpretation techniques. In the area of subgrade soil evaluation GPR techniques have been used to nondestructively identify soil type, to estimate the thickness of overburden and to evaluate the compressibility and frost susceptibility of subgrade soil. In road structure surveys, GPR has been used to measure layer thickness, to detect subsurface defects and to evaluate base course quality. In quality control surveys, GPR techniques have been used for thickness measurements, to estimate air void content of asphalt surfaces and to detect mix segregation. Future developments are described where the technique has great potential in assisting pavement engineers with their new pavement designs and in determining the optimal repair strategies for deteriorated roadways.

Keywords: Ground penetrating radar; Road structure; Subgrade; Dielectric value

1. Introduction

In Scandinavia, the first Ground Penetrating Radar (GPR) tests with ground-coupled antennae were performed in early 1980s in Denmark (Berg, 1984) and in Sweden (Johansson, 1987), but the method did not gain general acceptance at that time. In Finland the first tests were made in 1986 (Saarenketo, 1992) and after the Road District of Lapland of the Finnish National Road Administration (Finnra) purchased its own unit in 1988, the method has been used as routine survey tool in various road design and rehabilitation projects in Finland (Saarenketo, 1992; Saarenketo and Maijala, 1994; Saarenketo and Scullion, 1994). Most of the research and development works in highway applications in Finland has been performed with low frequency (100–500 MHz) ground-coupled antenna in order to evaluate subgrade soils and their interlayers, probe the depth of overburden and survey road structural layers. GPR technique was also applied in aggregate prospecting (Saarenketo and Maijala, 1994). In early- and mid-1990s

Fig. 2. Texas Transportation Institute (TTI) GPR survey van with Pulse Radar 1.0 GHz horn antenna.

PaveScan RDM – Background

- Road evaluation with ground penetrating radar
- Using Ground Penetrating Radar and Dielectric…

Using Ground-Penetrating Radar and Dielectric Probe Measurements in Pavement Density Quality Control

TIMO SAARENKETO

Ground-penetrating radar and capacitance-based dielectric surface probe measurements are used to measure fluctuations in voids, bitumen content, or both, in newly asphalted pavements without causing structural damage. Both methods rely on the compaction of asphalt to reduce the proportion of low-dielectricity air in the material, which increases the volumetric proportions of high-dielectricity bitumen and rock and thus results in higher asphalt dielectricity values. Ground-penetrating radar enables pavement thicknesses to be measured rapidly from a moving vehicle and information on variations in pavement voids content to be collected simultaneously on the basis of dielectricity fluctuations. The results can be calibrated against real void content by material sampling or by comparison of dielectric value with voids content values determined beforehand for the same material under laboratory conditions. This means that the subcontractor can be informed quickly of any values that exceed or fall below the norms and can take immediate steps to rectify such defects. Other advantages offered by the technique are the rapidity of the measurements and the immediate availability of the results. In addition, the one measurement provides simultaneous information on pavement and base thicknesses and the quality of the latter. The dielectric probe based on capacitance measurements lends itself to use in asphalt mass proportioning examinations performed at the laboratory stage, which enables the values to be used directly for monitoring in situ pavement compaction. The advantages of the dielectricity probe are rapidity of measurement, low costs, and the avoidance of radiation. Thus far, the probe has been excessively sensitive to variations in the roughness of pavement surfaces. The theory behind these research methods is discussed, the methods are described, and the results of

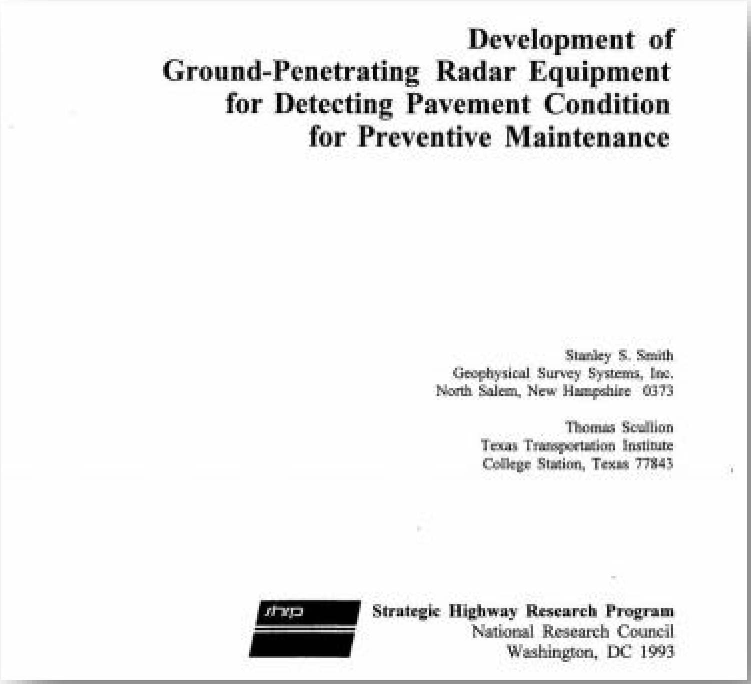
Ground-penetrating radar has traditionally been used to measure the thickness of pavements, initially by means of ground-coupled antennae, the use of which was hampered by the low measurement speed and changes in the properties of the antennae with fluctuations in properties of the pavement. The trend around 1990 was thus toward the use of a horn antenna, which allows repeated measurements and higher measurement speeds. Measurement and calculation methods that enable pavement surface dielectric values to be calculated have been developed in recent years for use with these antennae (*1*), although the technique has been used in the United States only for evaluating the transmission speed of the radar signal in pavement thickness measurements. The principle of the horn antenna technique is described in Figure 2.

The method was tried in Finland for the first time in the summer of 1993, in a project financed by the Finnish Technology Development Centre. Multichannel, ground-penetrating radar equipment manufactured by Road Radar, Inc., of Canada was tested on experimentally surfaced pedestrian paths beside Highway 4 between Rovaniemi and Saarenkylä, which contained void spaces of different types depending on the number of times the pavements had been rolled. The results were not encouraging, however, mainly due to technical problems and the inability of the interpretation software to identify the correct reflections from the measurement data.

Measurements were continued at the Texas Transportation Insti-

PaveScan RDM – Background

- Road evaluation with ground penetrating radar
- Using Ground Penetrating Radar and Dielectric…
- Development of Ground Penetrating Radar Equipment for Detecting….


Development of
Ground-Penetrating Radar Equipment
for Detecting Pavement Condition
for Preventive Maintenance

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National Research Council
Washington, DC 1993

Leo Galinovsky
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http://onlinepubs.trb.org/onlinepubs/shrp/SHRP-H-672.pdf

PaveScan RDM – Background

SHRP2 Solution

Rapid Technologies to Enhance Quality Control on Asphalt Pavements (R06C)

GPR, one of two ways to evaluate asphalt pavements during construction

- Measures uniformity and potential defect areas in asphalt pavements during construction.
- Offers real-time testing of potentially 100 percent of the pavement area.

PaveScan RDM – Background

SHRP2 Solution

Rapid Technologies to Enhance Quality Control on Asphalt Pavements (R06C)

- University of Minnesota/Minnesota DOT
- Maine DOT
- Nebraska DOT
- Alaska DOT
- Washington DOT
- Florida DOT

PaveScan RDM – Building the Technology

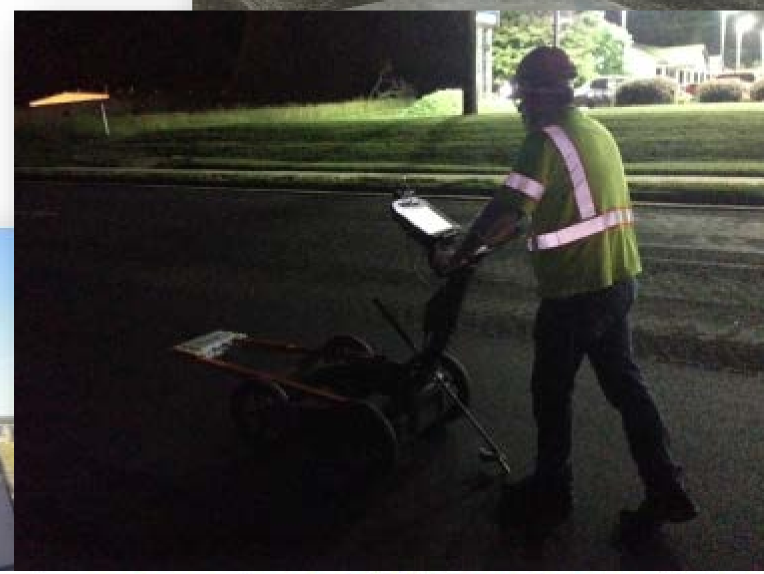
Testing the Concept With Small Antennas

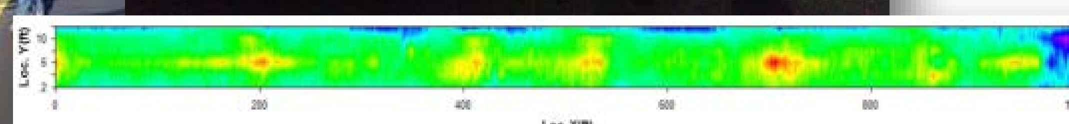
- TTI – 2012

PaveScan RDM – Building the Technology

Concept to Prototype

- TTI – 2012
- Virginia with TTI – 2013
  - Charlottesville
  - Fredericksburg





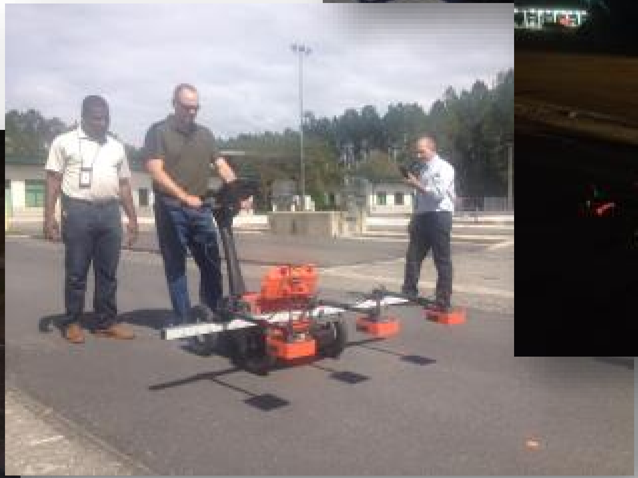
PaveScan RDM – Building the Technology

Concept to Prototype

- TTI – 2012
- Virginia with TTI – 2013
  - Charlottesville
  - Fredericksburg
- University of Minnesota - 2015

PaveScan RDM – Building the Technology

- Places I've Been
  - Maine DOT
  - Nebraska DOT
  - Alaska DOT
  - Washington DOT
  - Florida DOT
  - University of Waterloo, Ontario
  - Port Dover, Ontario
  - Kentucky



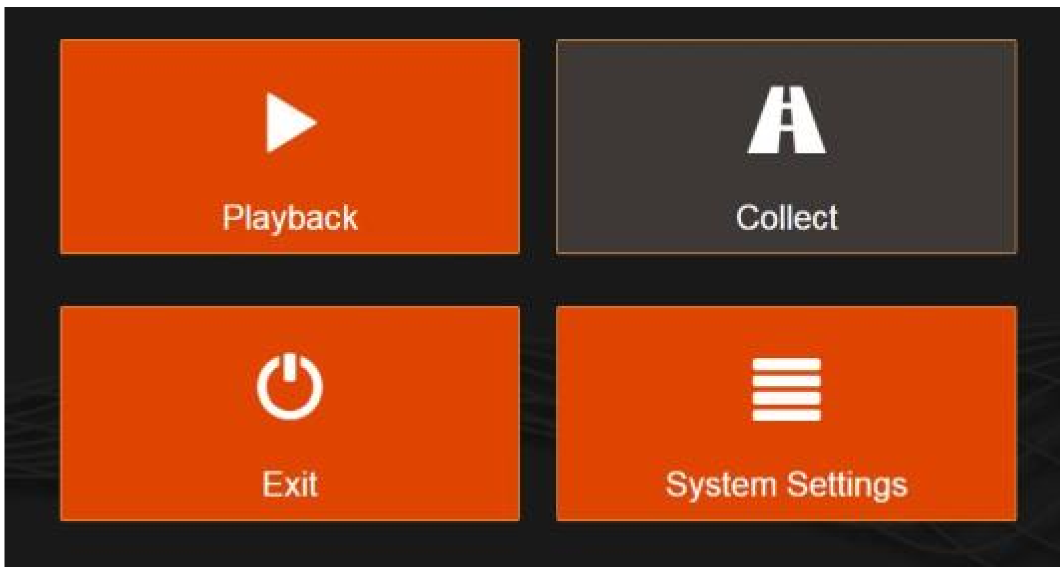
PaveScan RDM – Where We are Now

- Factory calibration to compensate for temperature affects
- Noise issue from cell towers, scan rate was changed, modified software
  - Minimize impact of RF interference
  - Calculate when interference is present (signal Quality)

Output Interval (ft): 0.50													
GPS Time Lag (sec): 0.00													
Distance (ft	Station	Longitude	Latitude (°	Elevation (	Lateral Off:	Dielectric	Signal Qual	Longitude (	Latitude (°	Elevation (	Lateral Off:	D
68400	684+0.00	61.33128	-149.583	77.5	1	5.11	99.97	61.33128	-149.583	77.5	3	
68400.5	684+0.50	61.33128	-149.583	77.5	1	4.99	99.97	61.33128	-149.583	77.5	3	
68401	684+1.00	61.33128	-149.583	77.5	1	5.05	99.9	61.33128	-149.583	77.5	3	
68401.5	684+1.50	61.33128	-149.583	77.5	1	4.99	99.98	61.33128	-149.583	77.5	3	
68402	684+2.00	61.33128	-149.583	77.5	1	4.89	99.91	61.33128	-149.583	77.5	3	
68402.5	684+2.50	61.33128	-149.583	77.5	1	4.9	99.81	61.33128	-149.583	77.5	3	
68403	684+3.00	61.33128	-149.583	78.1	1	5.04	99.74	61.33128	-149.583	78.1	3	
68403.5	684+3.50	61.33128	-149.583	78.1	1	4.97	99.68	61.33128	-149.583	78.1	3	
68404	684+4.00	61.33128	-149.583	78.1	1	4.97	99.61	61.33128	-149.583	78.1	3	
68404.5	684+4.50	61.33128	-149.583	78.1	1	4.96	99.62	61.33128	-149.583	78.1	3	

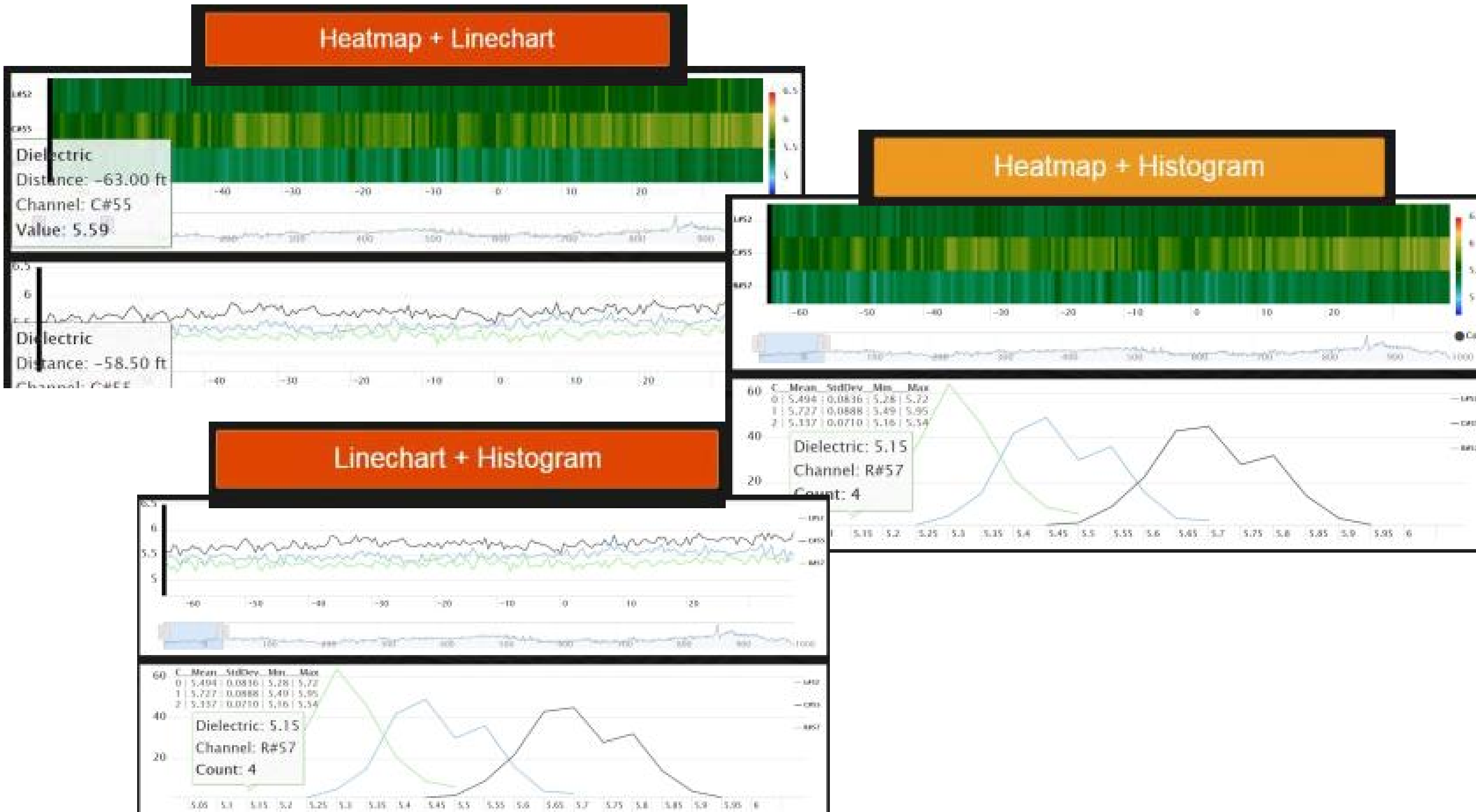
Improved UI and New Features

Main Menu



PaveScan RDM – Where We are Now

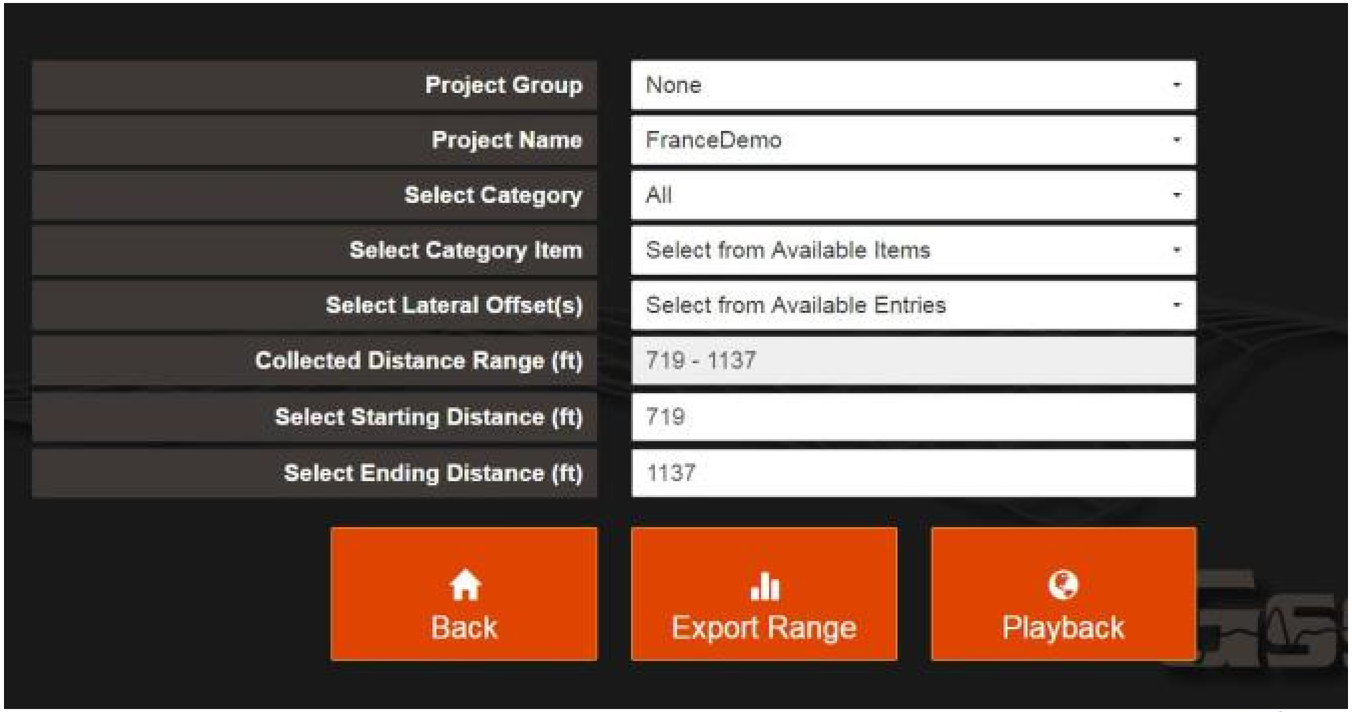
Improved UI and New Features



PaveScan RDM – Where We are Now

Improved UI and New Features

Range Options and more Levels (Project Group)



PaveScan RDM – Where We are Now

Output

RDM Export File
Project Name: GHHE-HMA-L1-NB-SH-12R
Project Location: 647.18
Operator: rich and dan
Project Coı 2017
Lateral Offset Reference: Left Shoulder
Lateral Offset Reference Side: Left
Lateral Offset from Reference (ft): 3
Sensor Lateral Offsets (ft): Serial#60=1;Serial#61=3;Serial#63=5;
Lot:
Sublot:
File Name: GHHE-HMA-L1-SH-12R__002
File Type: Distance
Creation Date and Time: 2017-06-03.07:52:14
File Comments:
Moving Average Window Size (ft): 0.50
Output Interval (ft): 0.50
GPS Time Lag (sec): 0.00

Distance (ft	Station	Longitude	Latitude (°	Elevation (	Lateral Off	Dielectric	Signal Qual	Longitude (	Latitude (°	Elevation (	Lateral Off	D
68400	684+0.00	61.33128	-149.583	77.5	1	5.11	99.97	61.33128	-149.583	77.5	3	
68400.5	684+0.50	61.33128	-149.583	77.5	1	4.99	99.97	61.33128	-149.583	77.5	3	
68401	684+1.00	61.33128	-149.583	77.5	1	5.05	99.9	61.33128	-149.583	77.5	3	
68401.5	684+1.50	61.33128	-149.583	77.5	1	4.99	99.98	61.33128	-149.583	77.5	3	
68402	684+2.00	61.33128	-149.583	77.5	1	4.89	99.91	61.33128	-149.583	77.5	3	
68402.5	684+2.50	61.33128	-149.583	77.5	1	4.9	99.81	61.33128	-149.583	77.5	3	
68403	684+3.00	61.33128	-149.583	78.1	1	5.04	99.74	61.33128	-149.583	78.1	3	
68403.5	684+3.50	61.33128	-149.583	78.1	1	4.97	99.68	61.33128	-149.583	78.1	3	
68404	684+4.00	61.33128	-149.583	78.1	1	4.97	99.61	61.33128	-149.583	78.1	3	
68404.5	684+4.50	61.33128	-149.583	78.1	1	4.96	99.62	61.33128	-149.583	78.1	3	

PaveScan RDM – Where We are Now

Output

PaveScan RDM – Future

- Research using Bulks (Briquettes if you live in Canada)
- Vehicle Mounted Systems
- System can be accepted and trusted so coring can be eliminated.
- Continue to incorporate valuable feedback from users.

PaveScan RDM – Conclusion

Questions?

Thank You