



SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

Advanced Methods to Identify Asphalt Pavement Delamination (R06D) Spectral Analysis of Surface Waves (SASW) and Impact Echo (IE)

Texas Department of Transportation

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Webinar
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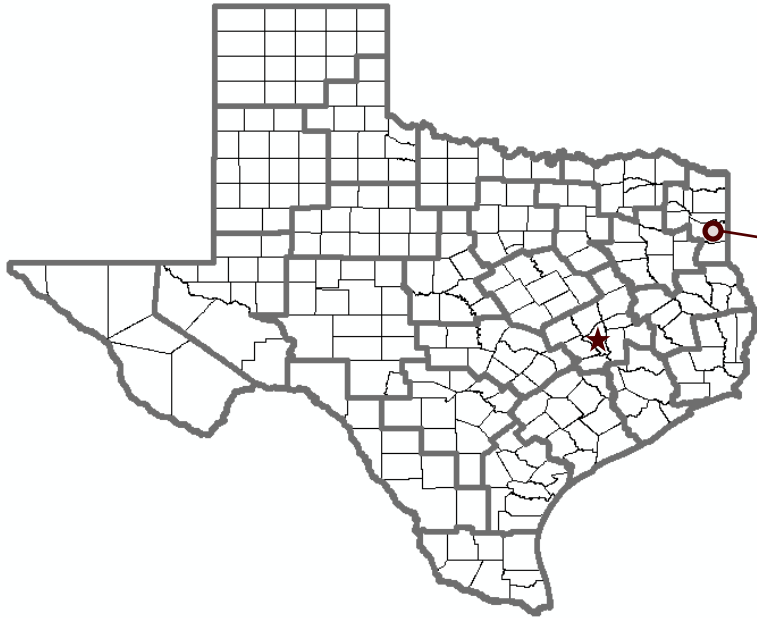


U.S. Department of Transportation
Federal Highway Administration

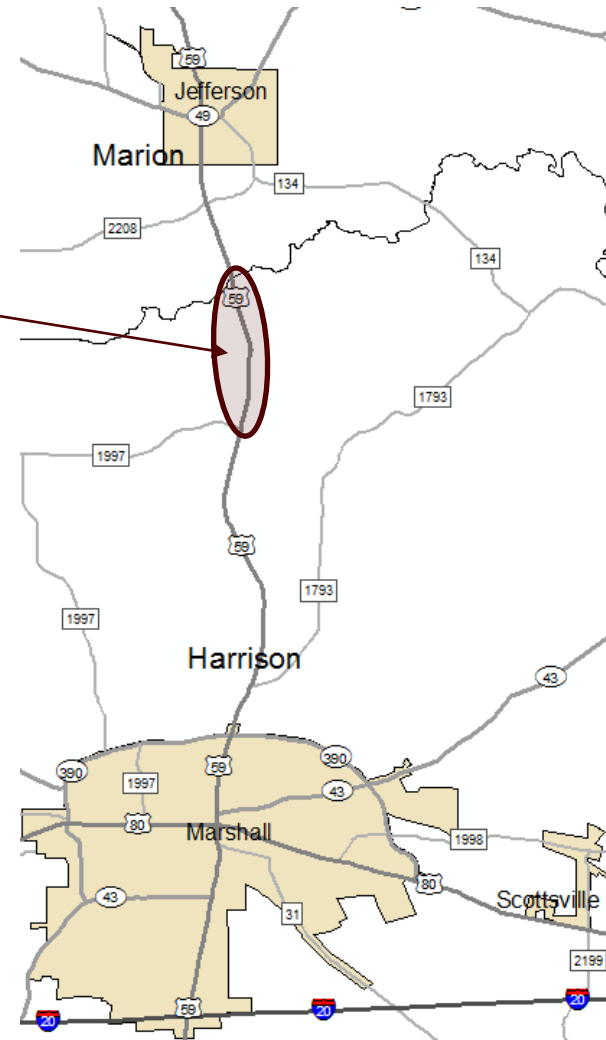
AMERICAN ASSOCIATION
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AASHTO

SASW/IE Test Location



US 59
From Marion/Harrison County line
to FM 1997



SASW/IE – US 59

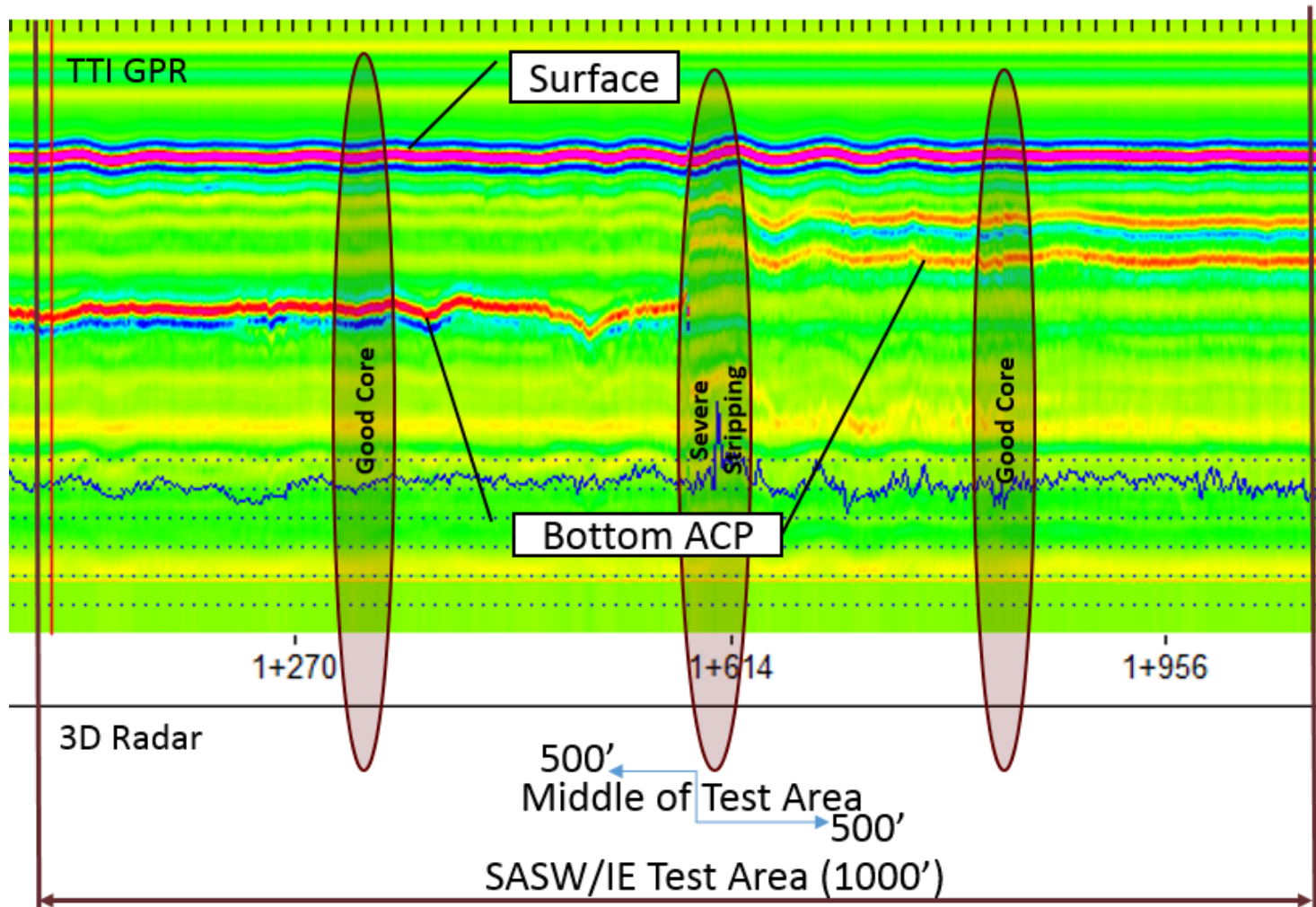
SBOL Looking North
~middle of test section



SBOL Looking South
Beginning of test section



SASW/IE – US 59 Test Area



SASW/IE Testing US 59

- 1000' test Section
- 6 Scan Lines
 - At 1', 3', 5', 7' 9' and 10' measured from white edge line.
- Testing Time was ~2 hours.
 - 20 min/1000 ft scan line
- Pavement Surface temperature ~50°F



Impact Echo (IE) Test Results

US 59

- Impact Echo (IE) Test Results
 - Test every 6 inches resulting in ~12,000 tests for the 6000 LF tested (1000' test section with 6 locations)
 - IE velocity of 8,000 ft/sec used for thickness values
 - Yellow and Red areas are potential deteriorated areas

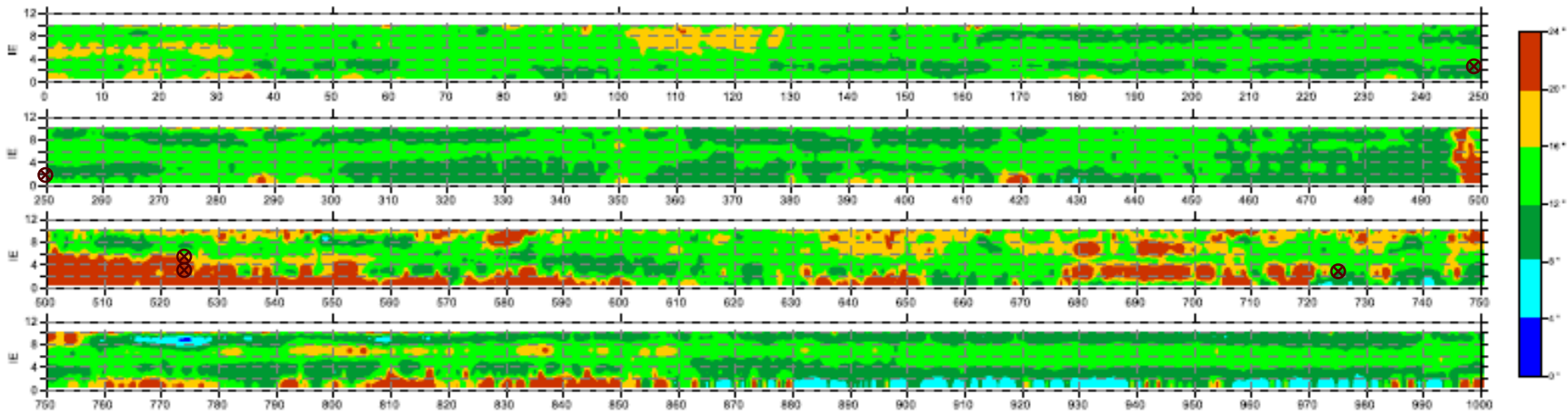


Figure A1: IE Results, Highway 59 SB Right Lane. X = 0 @ start of section, Y = 0 at right shoulder.

⊗ Core Locations

IE Test Results – 250'

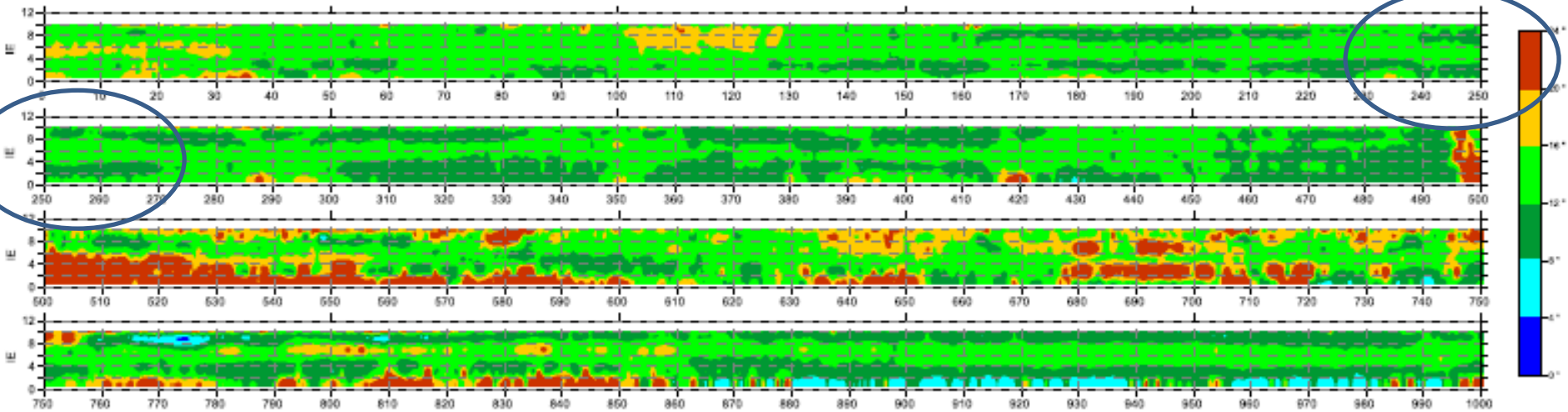


Figure A1: IE Results, Highway 59 SB Right Lane. X = 0 @ start of section, Y = 0 at right shoulder.



IE Test Results – 525'

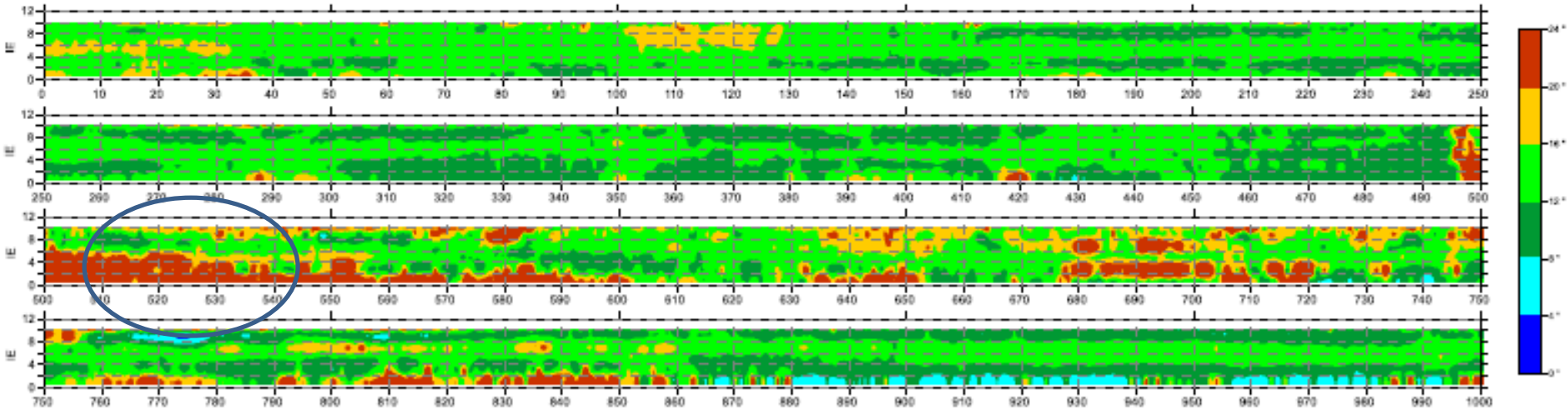


Figure A1: IE Results, Highway 59 SB Right Lane. X =



Between Wheel Paths



Right Wheel Path

IE Test Results – 750'

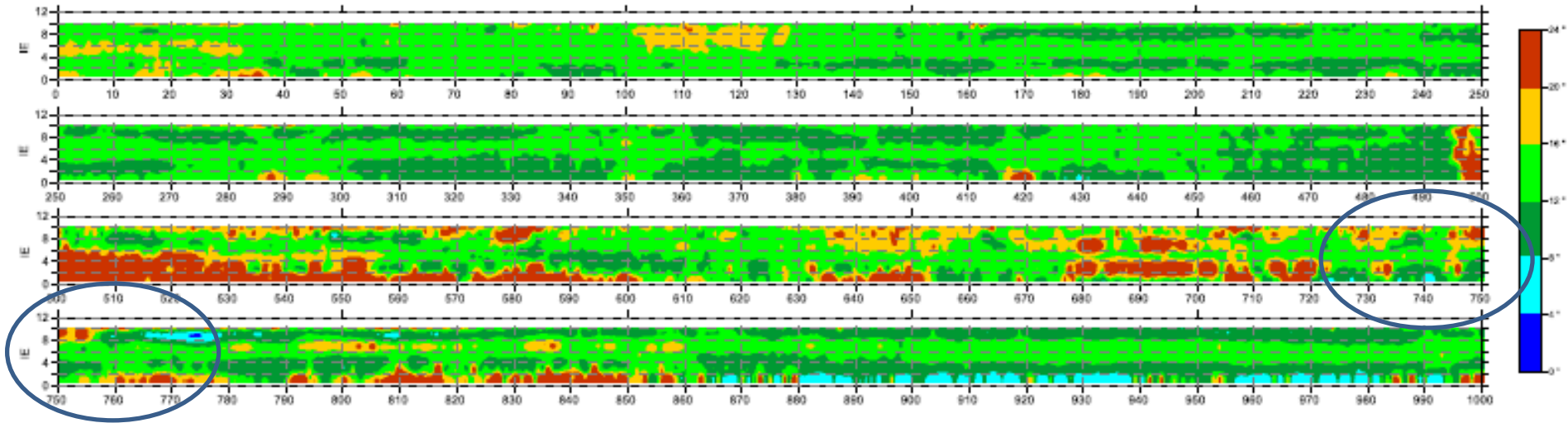


Figure A1: IE Results, Highway 59 SB Right Lane. X = 0 @ start of section, Y = 0 at right shoulder.



Spectral Analysis of Surface Waves (SASW)

Test Results - US 59

- Test every 6 inches
 - ~12,000 tests for the 6000 LF tested
- Based on velocity profile with depth at each location.
 - Drop in velocity at depth of the degradation. Larger velocity drop indicates worse conditions.
 - Velocity scale
- The SASW test results are presented 3 separate ways:
 - 1st as absolute velocity,
 - 2nd as normalized velocity (percentage)
 - 3rd as changes in normalized velocity between depths.

SASW Test Results – Absolute Velocity

US 59

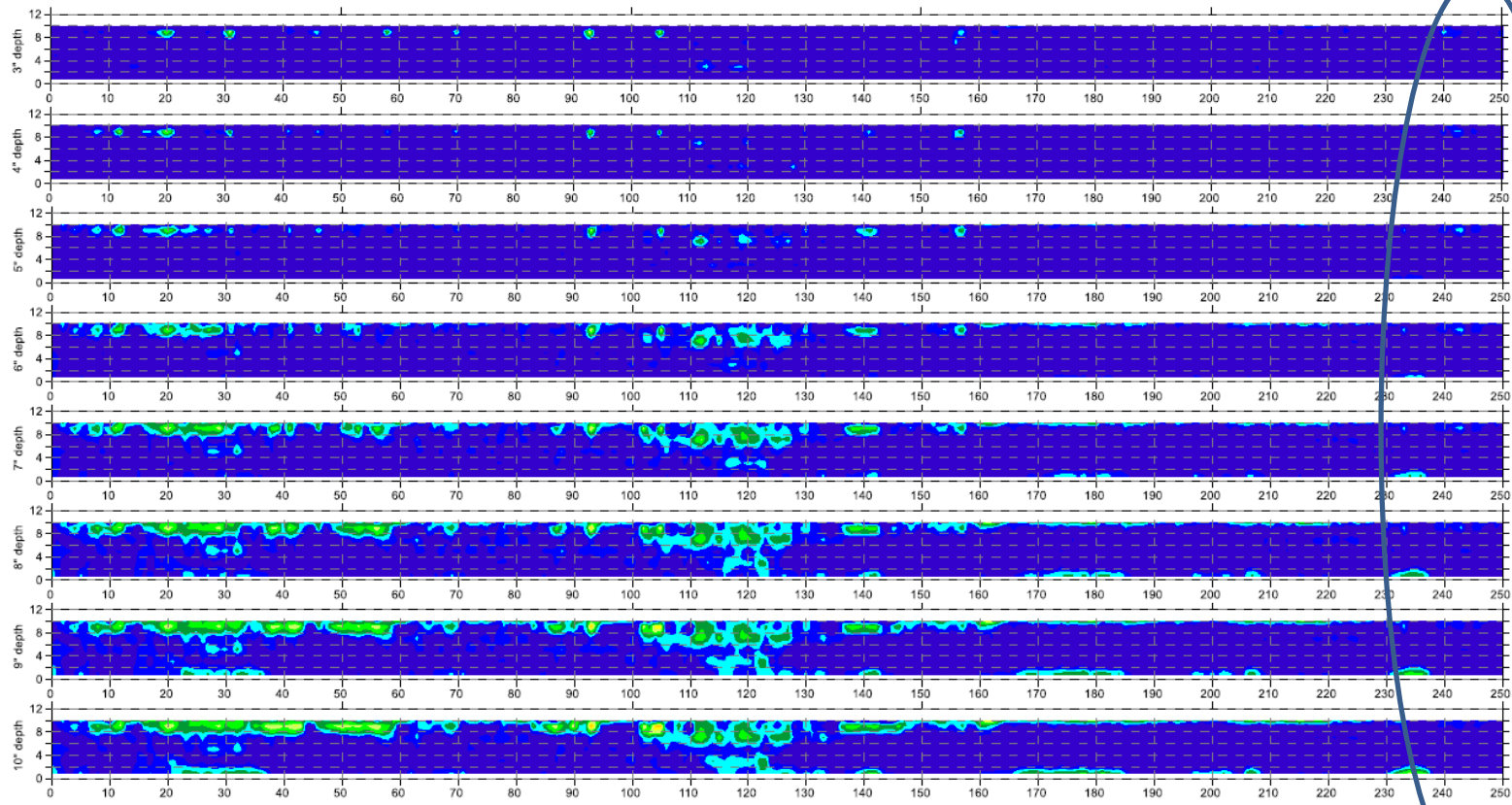


Figure B1: SASW Results, Absolute Velocity, Highway 59 SB, Right Lane. X = 0 @ start of section, Y = 0 at right shoulder. Distance 0 – 250 feet.



Core – RWP @ 250'

SASW Test Results – Absolute Velocity

US 59

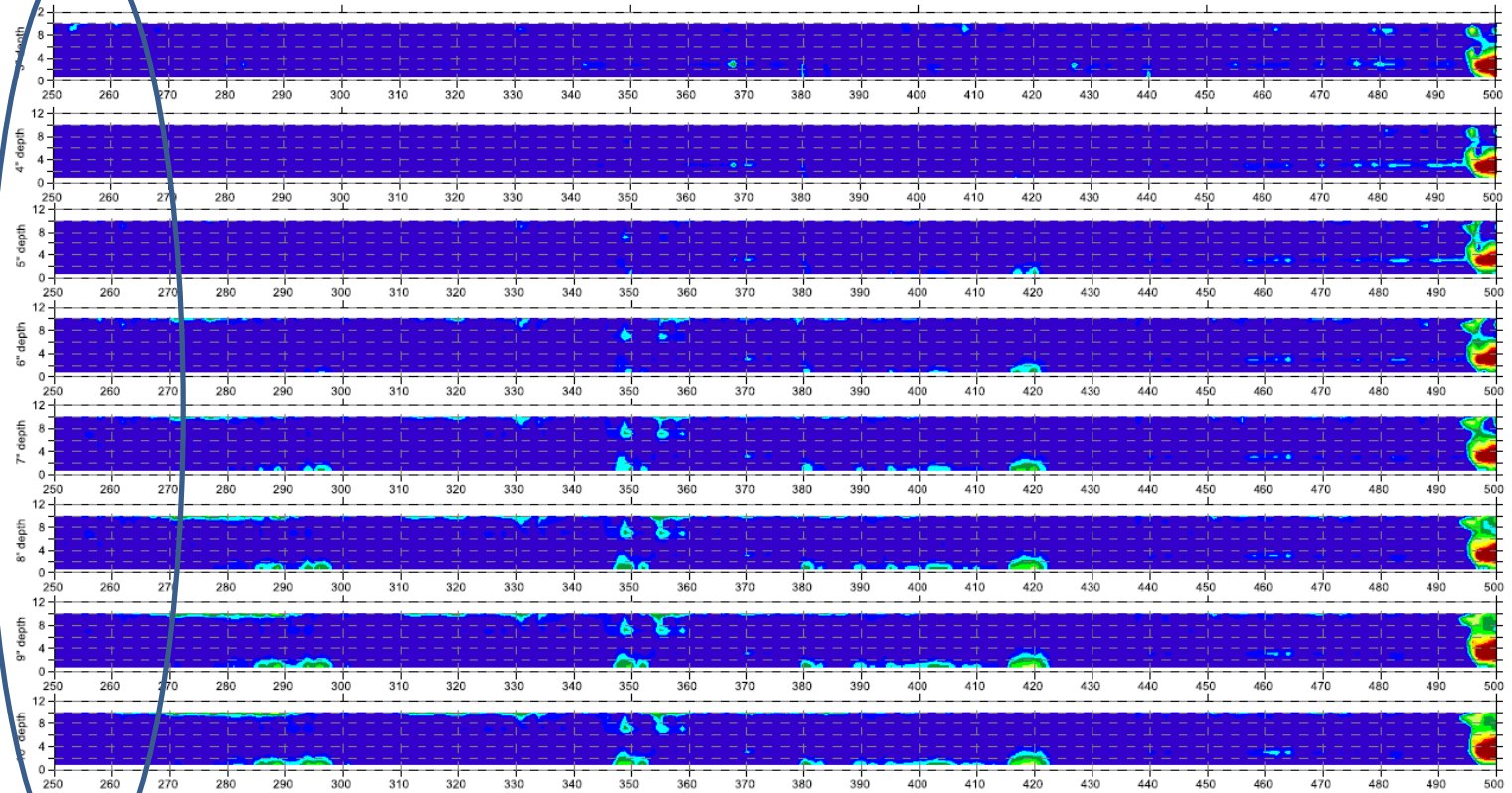


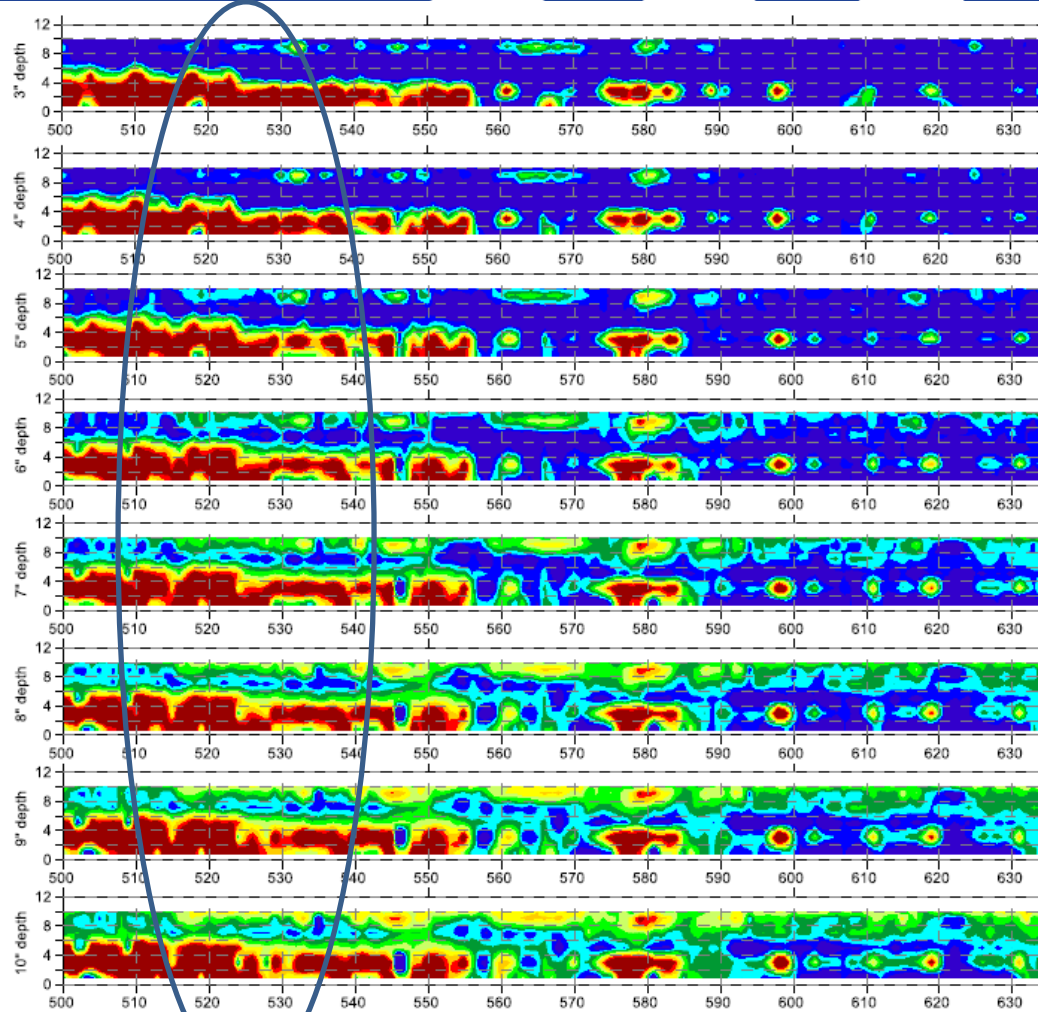
Figure B2: SASW Results, Absolute Velocity, Highway 59 SB, Right Lane. X = 0 @ start of section, Y = 0 at right shoulder. Distance 250 – 500 feet.

Core RWP @ 250'

SASW Test Results – Absolute Velocity

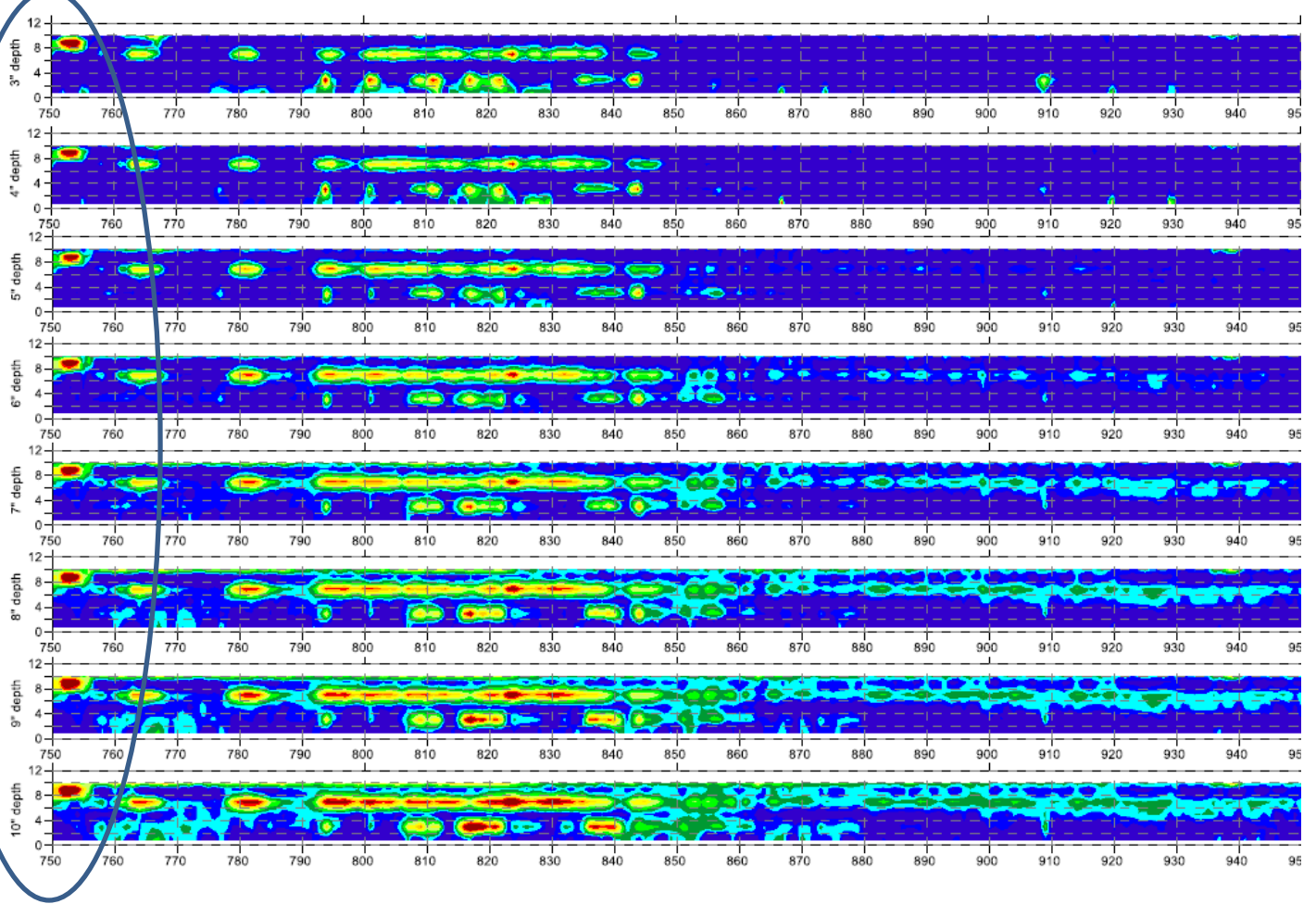
US 59

Cores RWP
&
Between WP
at 525'



SASW Test Results – Absolute Velocity

US 59

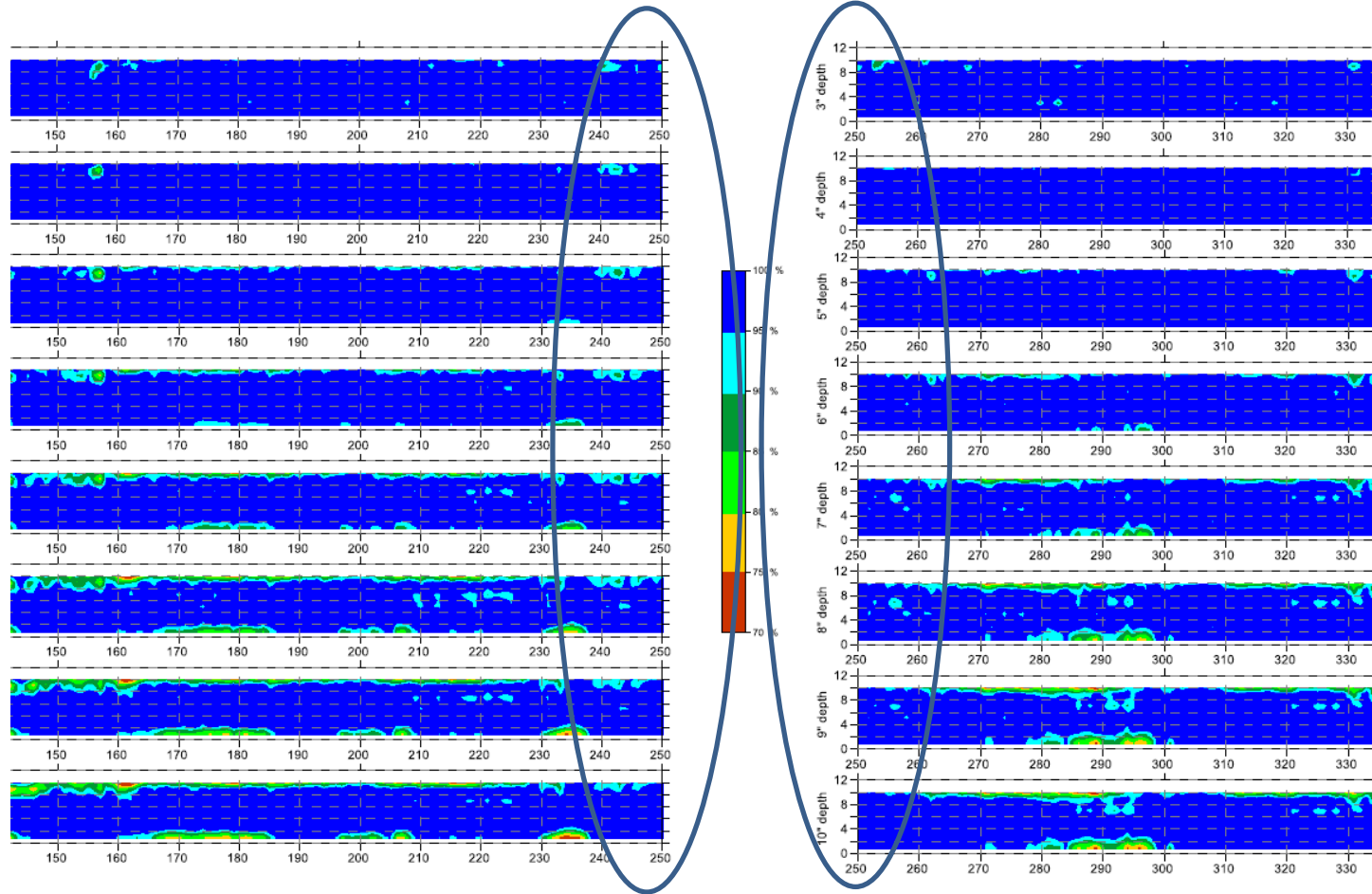


Core RWP @ 750'

SASW Test Results

Normalized Velocity

US 59



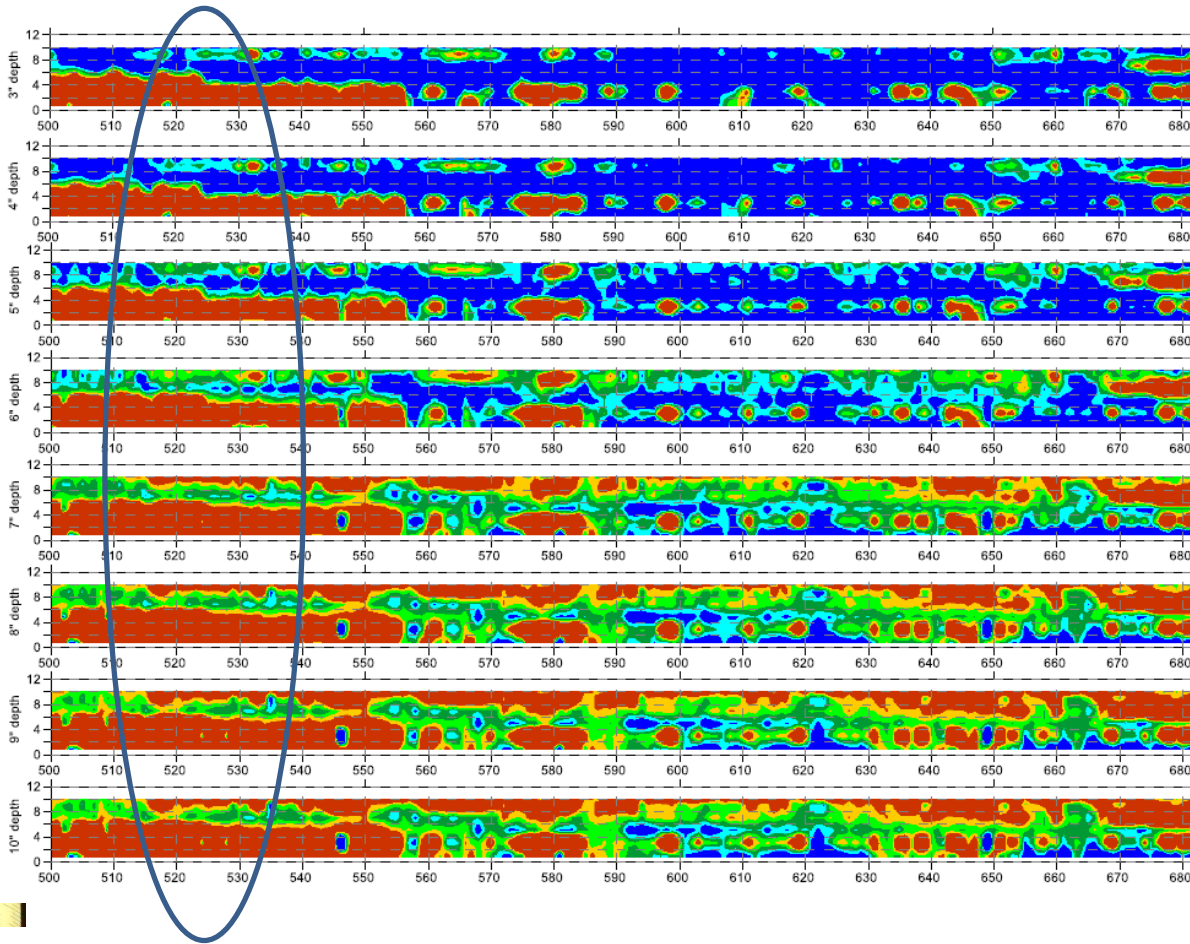
Core RWP @ 250'

SASW Test Results

Normalized Velocity

US 59

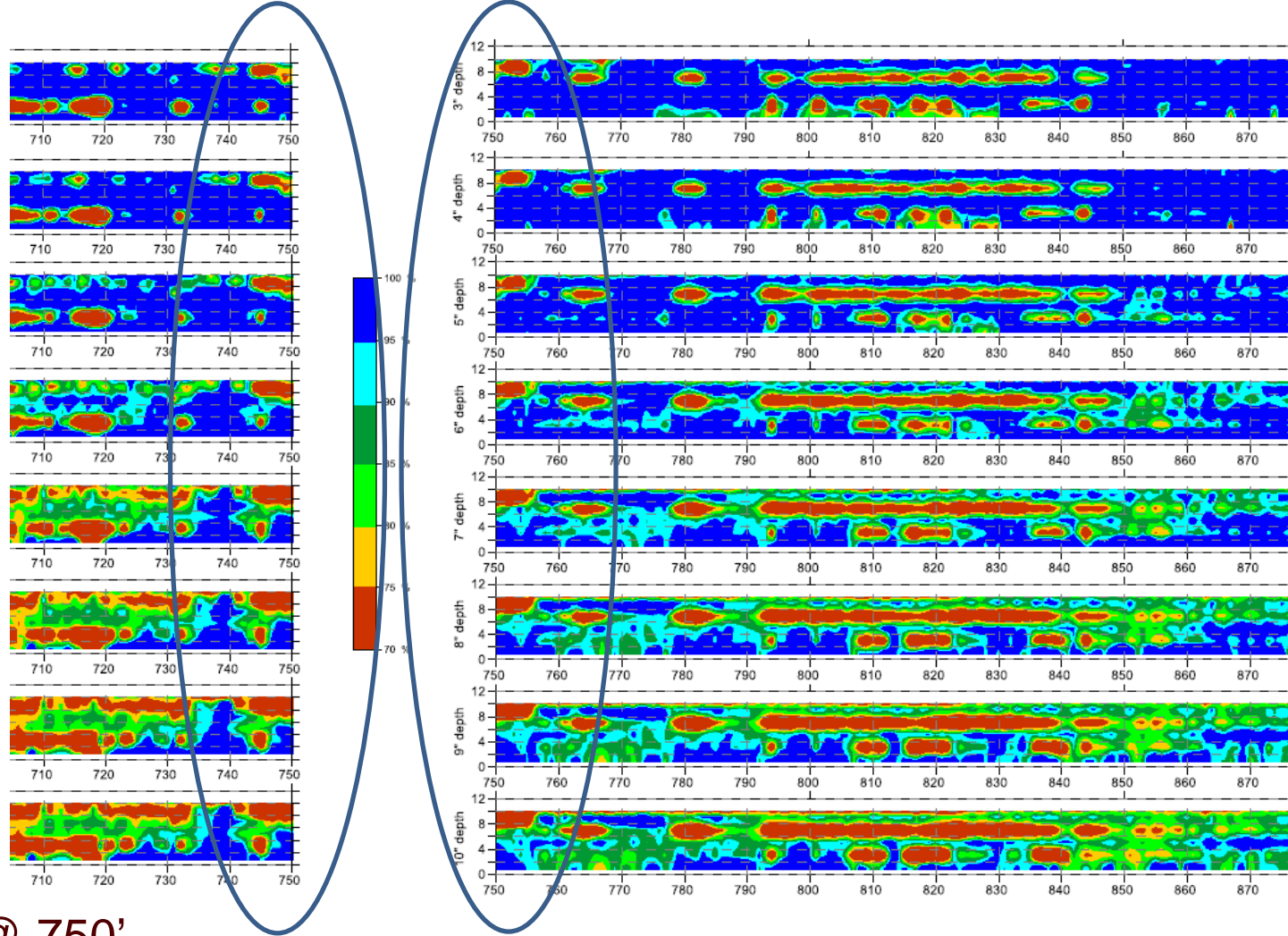
Cores RWP & Between WP at 525'



SASW Test Results

Normalized Velocity

US 59

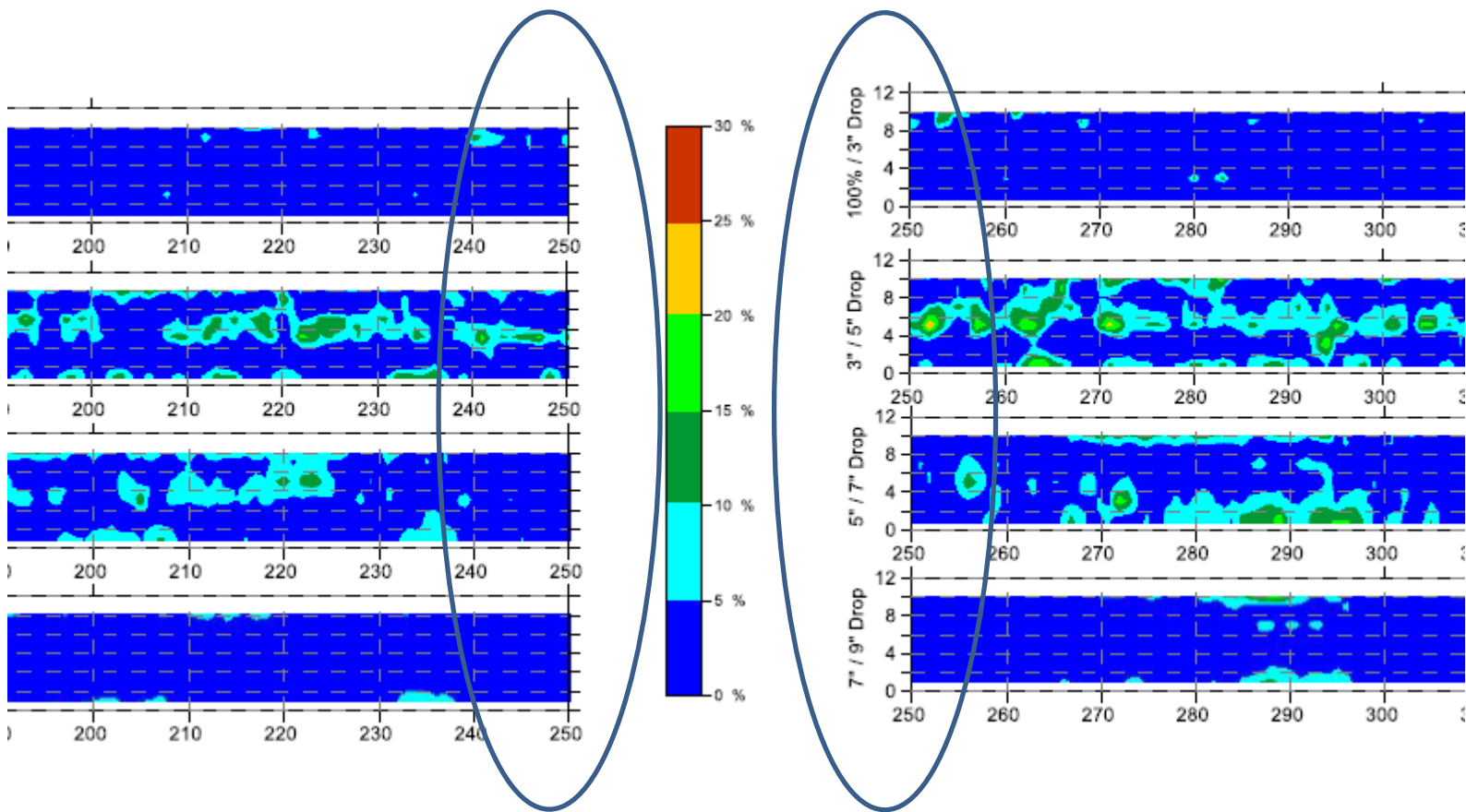


Core RWP @ 750'

SASW Test Results

Normalized Depth Difference

US 59



Core RWP @ 250'

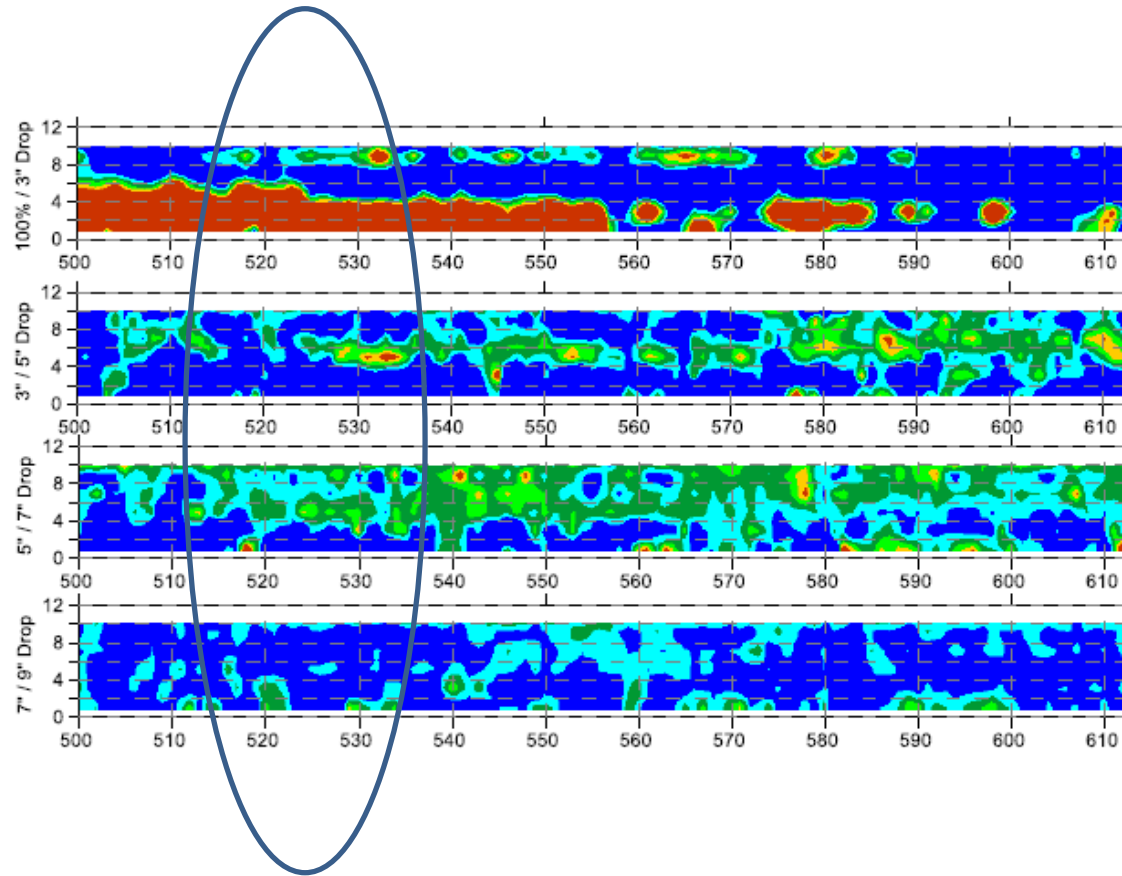
SASW Test Results

Normalized Depth Difference

US 59



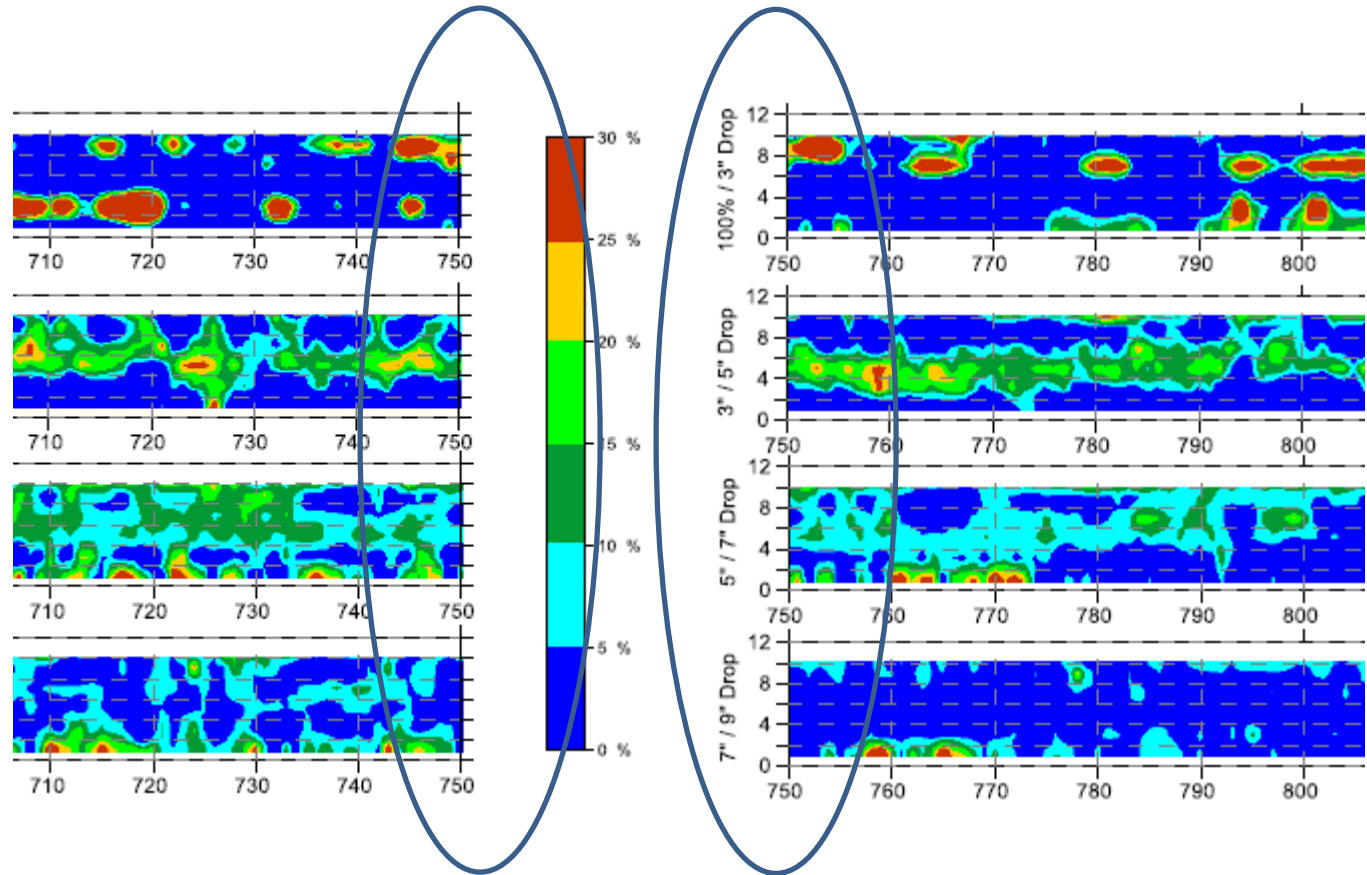
Cores RWP & Between WP at 525'



SASW Test Results

Normalized Depth Difference

US 59



Core RWP @ 750'

Spectral Analysis of Surface Waves (SASW) Test Results - US 59

Core #	Distance from Start (ft)	Expected Condition	Depth of Deterioration (inches)	Notes
1	250	Good Condition, Full Depth	NA	
2	525	Poor Condition	<3 to 7"	Core on borderline regarding depth to degradation, possibly near surface, possibly 6-7" deep
3	750	Fair Condition	7"	Core on borderline of Poor Condition near surface and Fair condition at 7" deep

SASW/IE – US 59 Test Area Cores

1st Core – GOOD CONDITION

Core #	250'r	MP + offset:	272 +	mi	Direction of Travel:	SB	Lane:	Outside
3D Radar File	4"	Latitude, Longitude:	32.699546		94.342567			

Existing Roadway Condition

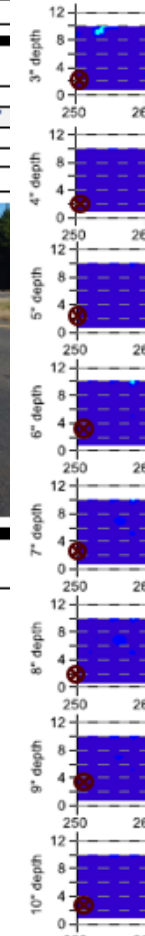
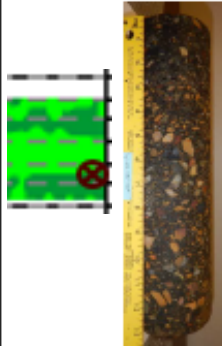
Looking In direction of Travel

	1'	2'	3'	4'	5'	6'	7'	8'	9'	10'	11'
	owp		WheelPath			between wp		WheelPath			
Core Loc (x)											
Rutting (in)				3/8						3/8	

check if apply	
Transverse Crk	
Long Crk	
Alligator Crk	
Pothole	
Bleeding	
Raveling	
Polished Aggr	
Patch	
Pumping	

Core Description

Description of Layers & Notes:	Depth Below Surface (inches)		Layer thickness
	From	To	
Dense Graded HMA	0	2 1/4	2 1/4
Dense Graded HMA; gravel	2 1/4	3	3/4
Dense Graded HMA; gravel	3	4	1
Dense Graded HMA; gravel	4	4 7/8	7/8
Dense Graded HMA; gravel	4 7/8	5 7/8	1
Dense Graded HMA; gravel	5 7/8	7 1/4	1 3/8
Dense Graded HMA; gravel	7 1/4	9 3/4	2 1/2
Dense Graded HMA; gravel	9 3/4	13 1/4	3 1/2



2nd Core – POOR CONDITION

Core #	525'r	MP + offset:	272 + 0.25	mi	Direction of Travel:	SB	Lane:	Outside
3D Radar File	4"	Latitude, Longitude:	32.698883		94.34235			

Existing Roadway Condition

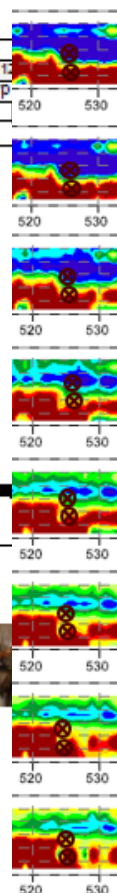
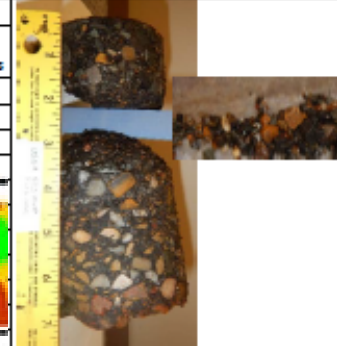
Looking In direction of Travel

	1'	2'	3'	4'	5'	6'	7'	8'	9'	10'	11'	12'
	owp		WheelPath			between wp		WheelPath			owp	
Core Loc (x)												
Rutting (in)				1/5						3/8		

check if apply	
Transverse Crk	
Long Crk	
Alligator Crk	
Pothole	
Bleeding	
Raveling	
Polished Aggr	
Patch	
Pumping	

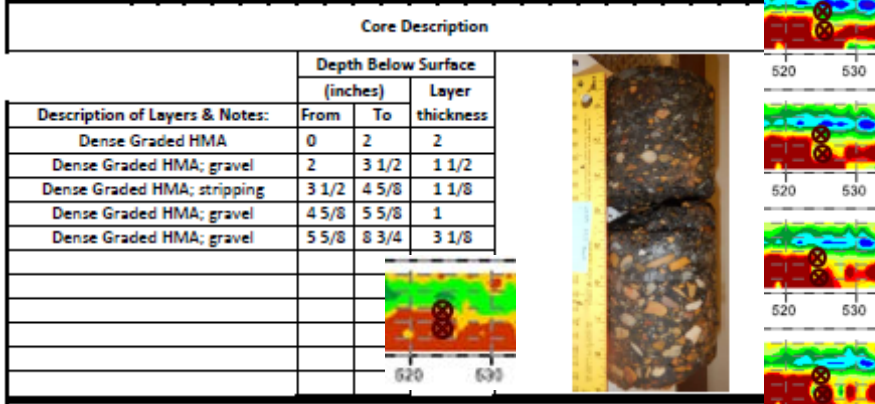
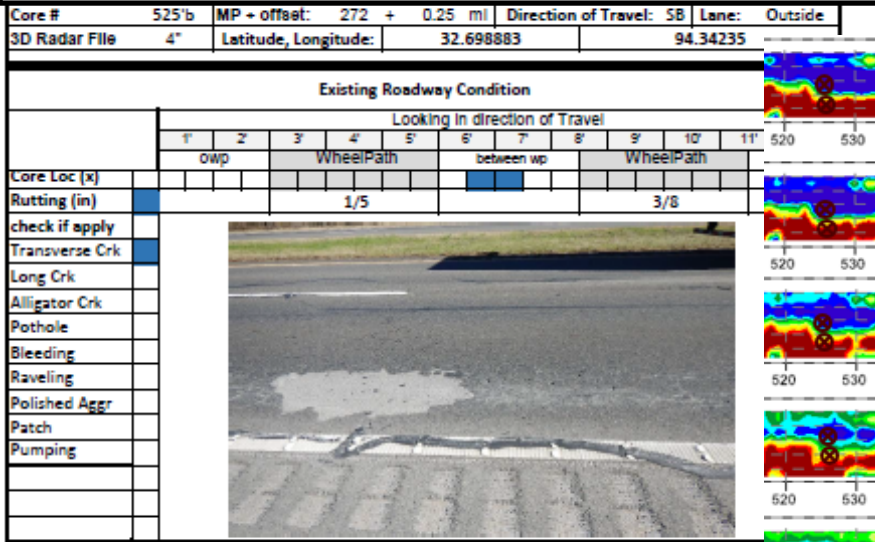
Core Description

Description of Layers & Notes:	Depth Below Surface (inches)		Layer thickness
	From	To	
Dense Graded HMA; cracked	0	2	2
Dense Graded HMA; stripping	2	3 1/2	1 1/2
Dense graded HMA; gravel	3 1/2	7	3 1/2

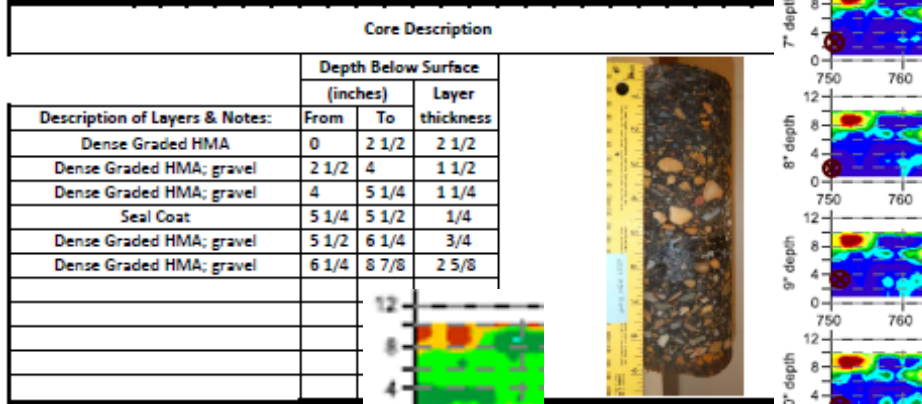
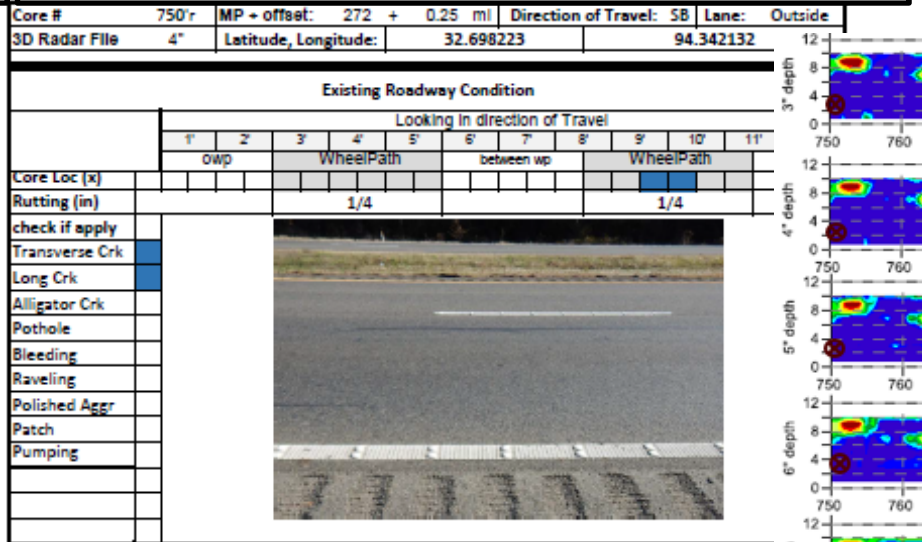


SASW/IE – US 59 Test Area Cores

2nd Core – POOR CONDITION



2nd Core – FAIR CONDITION



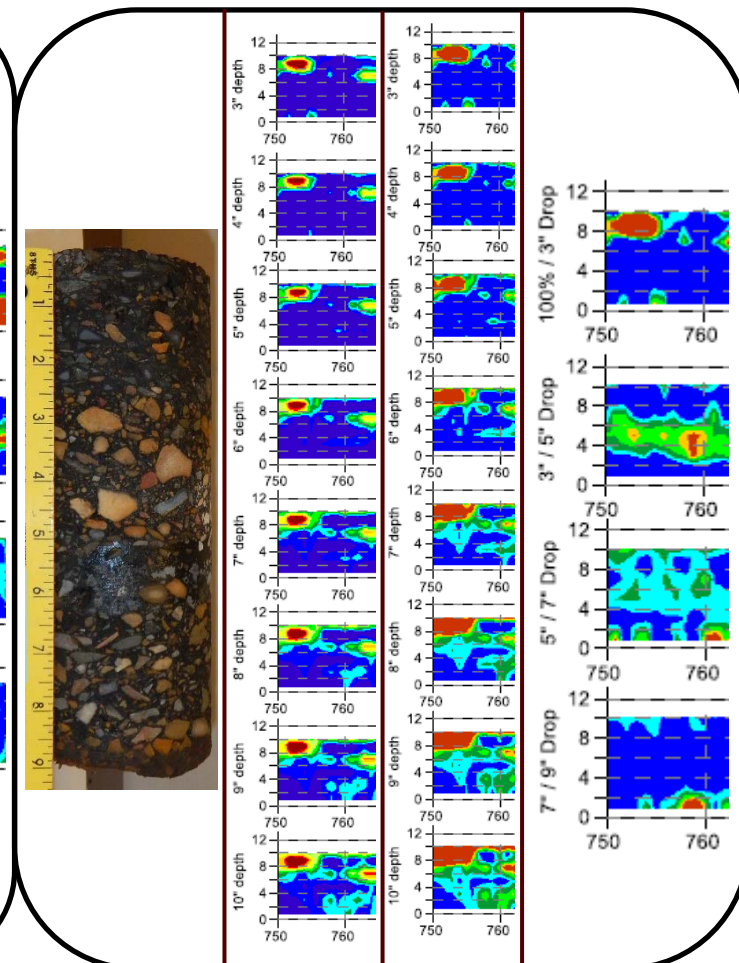
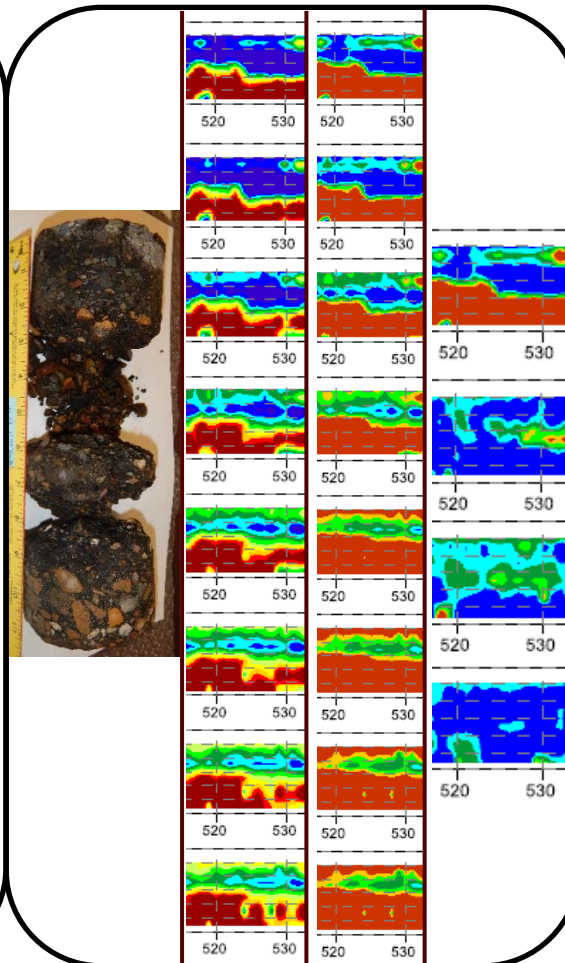
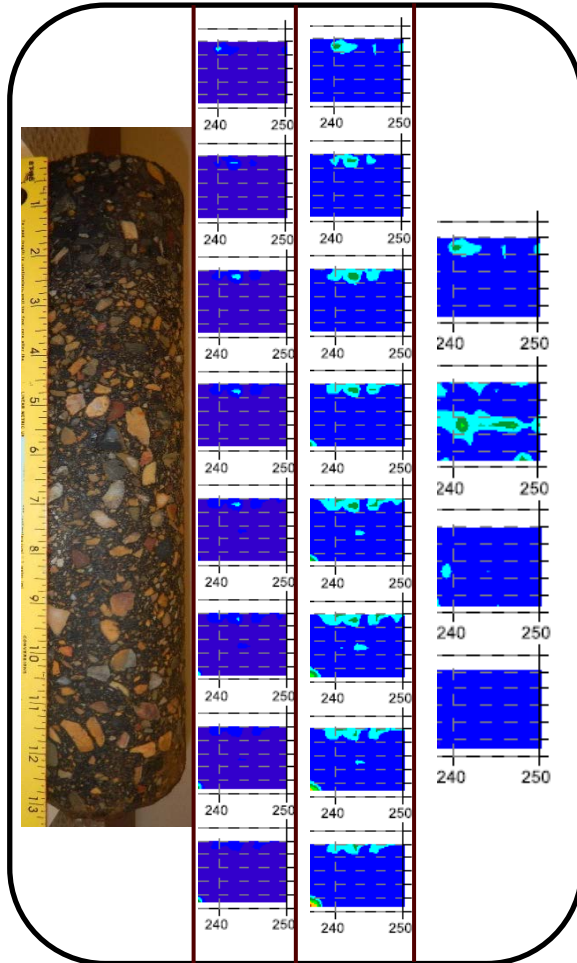
SASW Analysis at Cores

US 59

Absolute Velocity,

Normalized Velocity

Normalized Depth-Difference



SASW/IE Olson Engineering Report

- Information from Olson Engineering Report (IE)
 - “The IE test method does not provide a measure of the level of degradation, only an indication if degradation is present or not in the form of a resonance echo outside the expected range.”
 - “The IE method is considered sub-optimal on asphalt surfaces due to the difficulty exciting the necessary frequency range.”
 - “There appears to be good correlation between the IE and SASW test results.’

SASW/IE Olson Engineering Report

- Information from Olson Engineering Report (SASW)
 - “There is extensive degradation of the tested area particularly between distances 495 – 850 feet.”
 - “All three presentation methods show the same general results.”
 - “It is likely that the normalized velocity method will allow users to become more comfortable with interpretation by removing the variable of temperature effects from the interpretation and allowing users to observe velocity changes on a percentage basis.”
 - “The difference maps help determine the depth range of deterioration.”
 - “Beyond the first significant poor layer (velocity drop) the SASW data becomes less definitive as the poor layer will affect the “appearance” of everything below it.”