

**MICHIGAN DEPARTMENT OF TRANSPORTATION
MDOT**

THREE YEAR EVALUATION OF WHITETOPPING PROJECT ON M-46

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Testing and Research Section
Construction and Technology Support Area
Research Project 98 G-0322
Research Report R-1417

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Lansing, Michigan
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EXECUTIVE SUMMARY

This report summarizes the condition of thin and ultra-thin concrete overlays (also known as whitetopping) on M-46 between Carsonville and Port Sanilac. This is the first whitetopping project constructed in Michigan by the Michigan Department of Transportation (MDOT). This report also summarizes the condition of several standard bituminous rehabilitation methods from a project just to the west of the whitetopping project. The purpose of this trial project is to study whitetopping as an alternative to MDOT's standard bituminous fixes for rehabilitating deteriorated bituminous pavements.

The test sections are as follows:

Bituminous Fixes

1. Mill and resurface with 3.5 inches of bituminous.
2. Minor surface repair with 3 inches of bituminous overlay.
3. Crush and shape and overlay with 3.5 inches of bituminous.

Concrete Whitetopping Fixes

4. 6 inches whitetopping without fibers.
5. 6 inches whitetopping with fibers.
6. 5 inches whitetopping with fibers.
7. Mill and overlay (inlay) with 3 inches whitetopping with fibers.

Section 1 is the control for section 7, section 2 is the control for section 6, and section 3 is the control for sections 4 and 5.

All three bituminous test sections are performing very well with about a dozen cracks totaling less than 25 feet for all three sections. No rutting has been observed yet.

Sections 4, 5, and 6 have experienced some longitudinal cracking. A total of 148 (3.4 percent) of the ten foot long (three meter) panels have longitudinal cracking down the center of the lane. There is also one transverse crack and eight spalls greater than six inches. An investigation of the longitudinal cracking using the Falling Weight Deflectometer (FWD) and Ground Penetrating Radar concluded that the cause was most likely less support under the right edge of the lane, which is causing it to bend about the center.

Section 7 (ultra-thin) has also experienced a significant amount of distress; 456 (4.8 percent) of the 3.3 foot by 3.3 foot (1 meter by 1 meter) panels have some form of distress. Approximately 80 percent of the distressed panels are over the edge of the old pavement (bituminous over concrete). The milling operation left a very ragged edge in the bituminous surface that is a support problem, resulting in cracked and shattered panels.

INTRODUCTION

In 1998 Michigan decided to join the growing number of states who use whitetopping as an alternative for bituminous pavements in need of rehabilitation. A site on M-46 from east of Carsonville to Port Sanilac was chosen to try the whitetopping because a project on M-46 from the Village of Carsonville to the east was already being designed using a standard method of rehabilitation. This site was chosen because it would provide similar pavement cross sections, pavement conditions, and traffic conditions for both jobs. A location and test section map are shown in Figure 1.

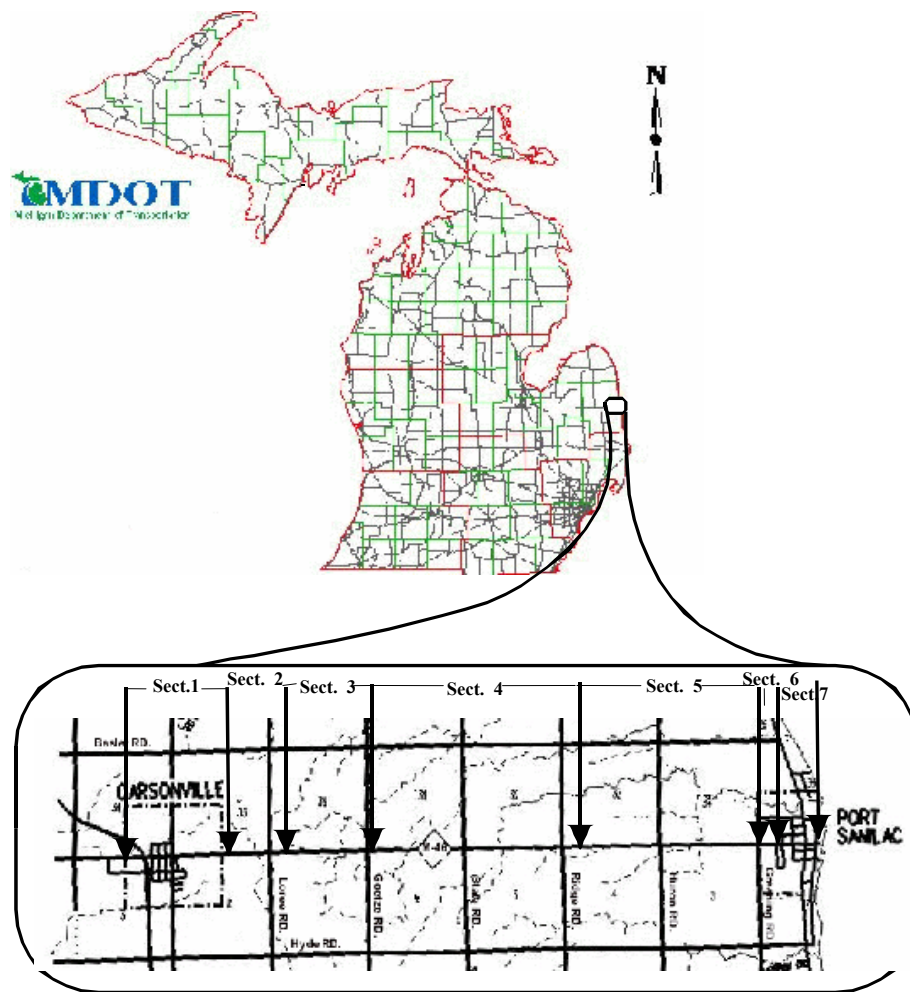


Figure 1. Project and Test Section Locations.

Average Annual Daily Traffic is 2800, with about 12 percent being commercial. The standard method job (herein referred to as the bituminous job) was changed to three test sections using bituminous fixes. This job starts at the west village limits and continues east out of Carsonville for approximately 2.5 miles to just west of Goetze Road. The whitetopping job begins where the bituminous job ends and continues west for approximately 4.5 miles to the junction of M-46 and

M-25 in the Village of Port Sanilac. Both projects were designed and built using metric units.

The test sections are as follows:

Bituminous Fixes

1. Village of Carsonville - mill and resurface with bituminous - existing pavement is composite (1.00 miles long).
2. East village limits to Loree Road - minor surface repair with 3 inches bituminous overlay - existing pavement is flexible (0.54 miles long).
3. Loree Road to Goetze Road - crush and shape with new 3.5 inches bituminous pavement - existing pavement is flexible (0.975 miles long).

Concrete Whitetopping Fixes

4. Goetze Road to Ridge Road – 6 inches whitetopping without fibers - existing pavement is flexible.
5. Ridge Road to 1,000 feet west of west village limits of Port Sanilac – 6 inches whitetopping with fibers - existing pavement is flexible.
6. 1,000 feet west of west village limits of Port Sanilac to the west village limits – 5 inches whitetopping with fibers - existing pavement is flexible.
7. West village limits to M-25 - mill and overlay (inlay) with 3 inches whitetopping with fibers - existing inner lanes are composite and outer lanes are flexible.

In test section 1, the existing pavement was 4 inches of bituminous over 8 inches non-reinforced concrete. The base consisted of anywhere from 12 inches to 27.6 inches of sand or in some spots the pavement was built directly on clay. In test sections 2 through 6, the existing pavement was 4 inches of bituminous over 8 inches of gravel and about 12 inches of sand. In test section 7, the existing pavement was 4.8 inches of bituminous over 8 inches of concrete. The subbase averaged 6.7 inches and varied between a sand or gravel.

Table 1 - Expected Fix Lives			
Concrete Fix	Design Life, Years	Bituminous Fix (Control)	Design Life, Years
Section 7, inner lanes	10	Section 1	10
Section 7, outer lanes	10	Section 2	15
Section 6	10		
Section 4	15	Section 3	15
Section 5	15		

Expected lives of the various fixes can be found in Table 1. Section 1 is the control for section 7, section 2 is the control for section 6, and section 3 is the control for sections 4 and 5.

Typical cross-sections can be found in the Appendix. Details on design, preconstruction evaluation, and construction of these two projects can be found in MDOT’s report *Whitetopping Project On M-46 Between Carsonville and Port Sanilac*.

EVALUATION

Both the bituminous and whitetopping projects were visually evaluated every six months. Any distresses found were recorded. FWD and ride quality testing were conducted annually in the fall.

Bituminous Sections

Test sections 1, 2, and 3 are near as-constructed condition. No observable cracks were found until the fall of 2002 when 13 cracks were noted. Five of these are longitudinal, with the longest being 4 feet. The other eight are transverse cracks, most of which are only about a foot long. In total, there are less than 25 feet of observable cracks on all three sections.

Ride quality was measured prior to construction, eight months after construction, and again at three and a half years. Michigan uses its own Ride Quality Index (RQI). Table 2 has the average RQI numbers. An RQI of 0 to 30 is considered excellent, 31 to 53 is considered good, 54 to 69 is considered fair, and greater than 70 is considered poor.

Table 2. Ride Quality Numbers For Asphalt Sections						
Section	Pre-Construction		April 2000		February 2003	
	EB	WB	EB	WB	EB	WB
1	114	95	53	48	53	55
2	70	62	39	35	43	34
3	56	68	38	41	33	32

EB = Eastbound; WB = Westbound

As can be seen in the table, the sections fall in to the “good” category, with the exception of Section 1, which slipped into the *fair* category.

Normal Whitetopping Sections

Test sections 4, 5, and 6 have exhibited a few distresses; the primary one being longitudinal cracking. The first sign of longitudinal cracking came during the summer of 2000; about one year after project completion. A long longitudinal crack down the center of the eastbound lane near the west end of the project was reported. It was a hairline crack and 21 panels long.

Figure 2 shows what it looked like initially. Inspection of the remainder of the project turned up several cracks in the westbound lane totaling 18 panels. These were also right down the center of the lane, and in all cases the crack began and ended at a transverse joint.



Figure 2. Initial Condition of Longitudinal Crack.

In the Spring of 2001, the total number of panels with a longitudinal crack increased to 59. By the fall of that year the total had increased to 135, with only minor increases during each inspection since then. Figures 3 and 4 show the number and percentage, respectively, of

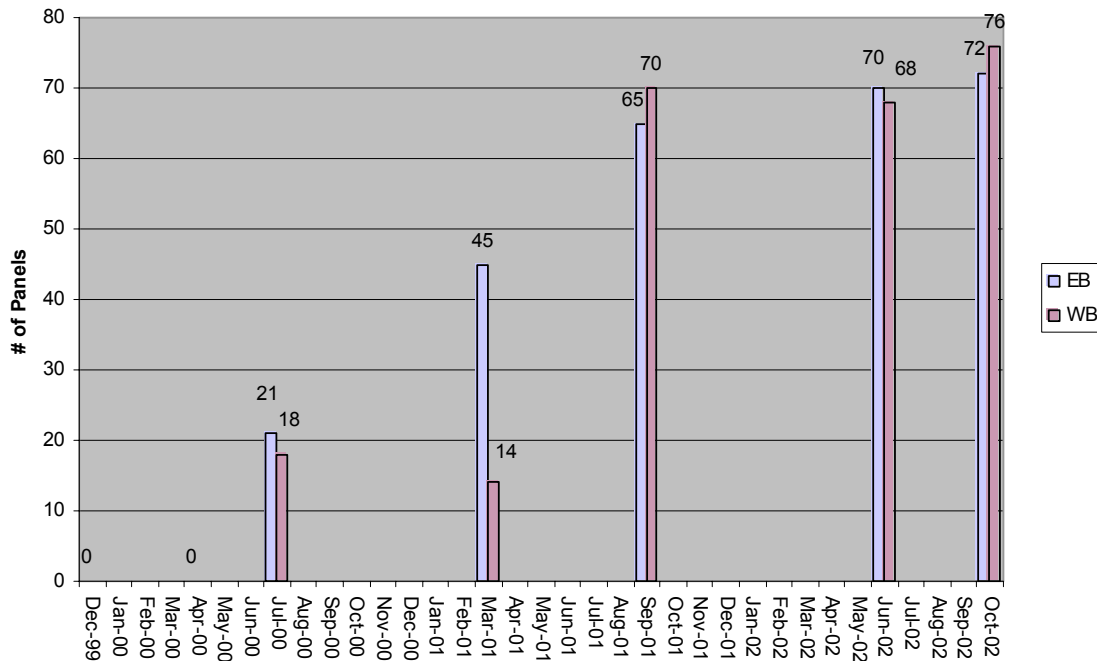


Figure 3. Number of Longitudinally Cracked Panels in the Five and Six Inch Whitetopping Sections.

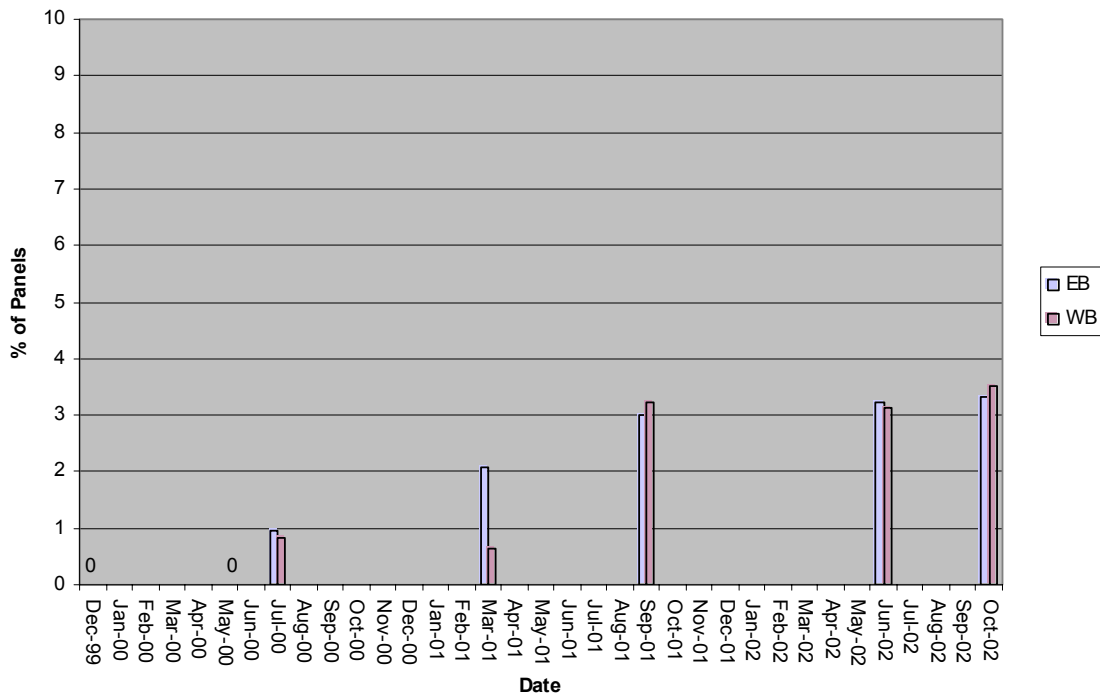


Figure 4. Percentage of Longitudinally Cracked Panels in the Five and Sixinch Whitetopping Sections.

longitudinally cracked panels at each of the inspections. One transverse crack, the full-width of the pavement, and three large spalls were also noted during this inspection. Most of the longitudinal cracks were 5 panels or less, with a few reaching 9 panels, and the long one, which was now up to 22 panels. The 22 panel-long crack was starting to show signs of opening up slightly and had very minor spalling in some spots, as can be seen in Figures 5 and 6.



Figure 5. Looking Down the Pavement at the Long Longitudinal Crack.



Figure 6. Closer Look at the Spalling

Since this was a job warranted by the contractor, the contractor cored the long longitudinal crack as well as the centerline joint. They found that the centerline joint did have a relief crack, which was full-depth. This ruled out late sawing of the centerline joint as a possible cause.

At this point, MDOT needed to determine the cause of the longitudinal cracking. FWD testing was conducted at several randomly selected cracks to check load transfer efficiencies (LTE) across the cracks. Tests were also conducted at the mid-point of non-cracked panels in the vicinity of the crack, and at the corner of cracked panels near the shoulder. LTE's across the four cracks selected were in the 71 to 82 percent range, which is fair. The actual deflections under the load plate at the 22 panel-long crack were 8.1 to 9.7 mils. This is slightly higher than mid-panel deflections (away from joints and cracks) in the vicinity, which were 7.0 and 7.9 mils. Deflections at the corners, however, were 13.0 to 15.2 mils, which may indicate poor support at the edge. Deflections at the other three cracks were 5.1 to 8.8 mils, which again is higher than mid-panel deflections of 4.3 to 5.6 mils. However, corner deflections for these cracks were 5.6 to 7.8 mils. This may explain why these three cracks are still in hairline condition, while the 22 panel-long crack with its higher corner deflections is starting to open and spall. The 22 panel-long crack is likely experiencing bending from less support under the right wheel path, resulting in a faster deterioration of the crack. In fact, this bending could be the cause of the longitudinal cracks to begin with.

The FWD data can be found in the Appendix.

Another tool utilized to investigate the longitudinal cracking problem is a Ground Penetrating Radar (GPR) unit. This is a relatively new piece of equipment at MDOT, having been purchased in late 2000. MDOT's unit is a 1 GHz, air-launched antenna used to get the pavement cross-section down to about three feet. In December of 2001, both lanes were surveyed with the GPR, being very careful to mark the locations of the longitudinal cracks in the data. One run down the center of the lane in each direction was made.

The GPR results can be found in the Appendix. The bottom of the concrete is marked with the top row dots, the bottom of the asphalt is marked with the mid depth dots, and the bottom of the base (when it could be located) is marked with the lower most dots. Concrete thickness does not appear to be a factor, since it varies from 4.8 to 8.3 inches at the longitudinal cracks. The asphalt thickness at the cracks averages 3.5 inches for the eastbound and 3.0 inches for the westbound. Fifteen random cores taken from the project immediately after construction showed the asphalt thickness averaged 4.0 inches in the eastbound lane, and 3.2 inches in the westbound lane. The cracks also did not appear to be located over areas where the asphalt and base layers dipped down, which would have been an indicator of support problems.

Ride quality numbers for the concrete sections can be seen in Table 3. Once again, the sections fall in to the "good" category, with the exception of Section 7. There is a small amount of older asphalt included at the end of the eastbound run and at the beginning of the westbound run, which happens to be the M-46/M-25 intersection. Section 7 ends just short of the intersection and for consistency reasons, from year to year, the intersection is used as the starting point for westbound and the ending point for eastbound.

Table 3. Ride Quality Numbers For Concrete Sections						
Section	Pre-Construction		April 2000		February 2003	
	EB	WB	EB	WB	EB	WB
4	62	66	49	52	46	49
5	73	67	50	50	48	48
6	63	63	53	52	50	49
7	81	84	54	60	55	62

EB = Eastbound; WB = Westbound

Ultra-Thin Whitetopping Section

Strictly speaking, this section is not a whitetopping according to American Concrete Paving Association definitions due to the original pavement being a composite. However, for the purposes of this report, and the study in general, it will be referenced as an ultra-thin whitetopping.

This section has many of its 3.3 foot by 3.3 foot (1 m by 1 m) panels showing distress. In the latest visual survey, 223 panels in eastbound and 233 panels in westbound have some form of distress. Figures 7 and 8 show the number and percentage, respectively, of distressed panels at each of the inspections. Most of the distress (90%) is cracking, with a few panels (10%) showing just spalling. Figures 9 through 14 show typical distresses.

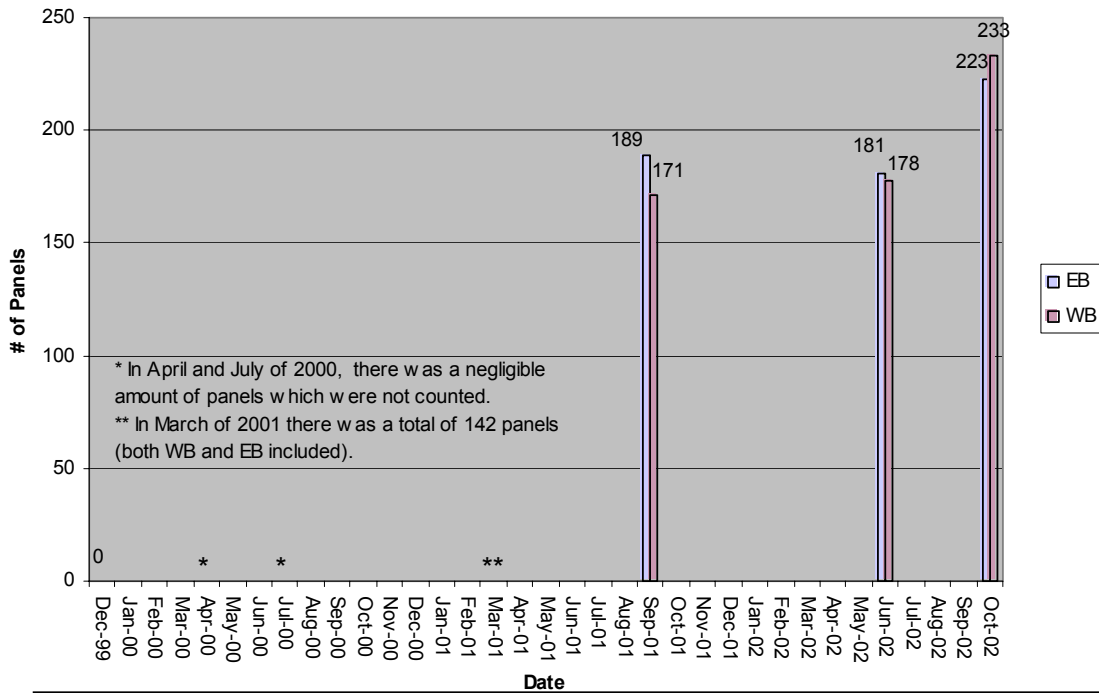


Figure 7. Number of Distressed Panels in the Ultra-Thin Whitetopping Section.

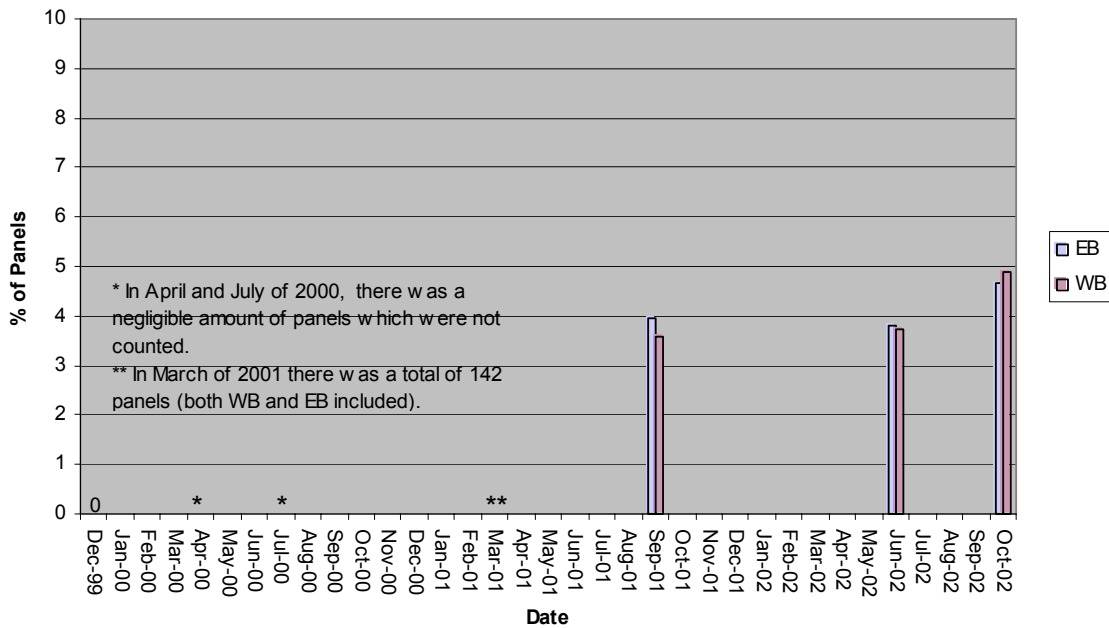


Figure 8. Percentage of Distressed Panels in the Ultra-Thin Whitetopping Section



Figure 9. Example of Transverse Cracking.



Figure 10. Example of Long Longitudinal Crack.



Figure 11. Example of Cracking Around the Joint Intersection.



Figure 12. Example of Multiple Cracks in a Panel.

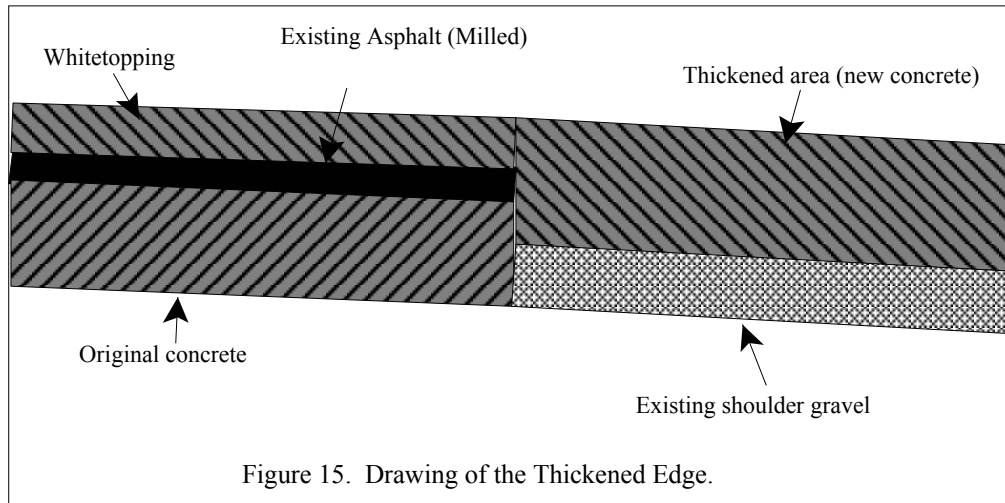


Figure 13. Another Example of Multiple Cracks.



Figure 14. Another Example of Transverse Cracking.

Approximately 80 percent of the distressed panels are over the area of the thickened edge. The thickened edge is shown in Figure 15 (full cross-section can be found in the Appendix). Several inches of shoulder gravel were removed for the thickened area.



During construction, the asphalt in this section was milled down to about 1-1/2 to 2 inches thick. Figure 16 shows what the edge of the asphalt looked like after milling. This edge is providing poor support for the new concrete surface, resulting in heavy cracking and shattering of panels above it. Secondary distresses such as spalling of the cracks and faulting, are also beginning to show up.

Ride quality numbers were previously reported in Table 3.



In 2000, a water main break necessitated the removal of four panels for repair work. These panels were in the eastbound direction at the very outside edge of the pavement (in the thickened edge area). They were replaced full-depth with concrete. It is not known if the village work crew made an attempt to tie the repairs to the surrounding concrete. To date, the new panels look very good except for a spall in one corner. Figure 17 shows what they looked like at the last inspection.

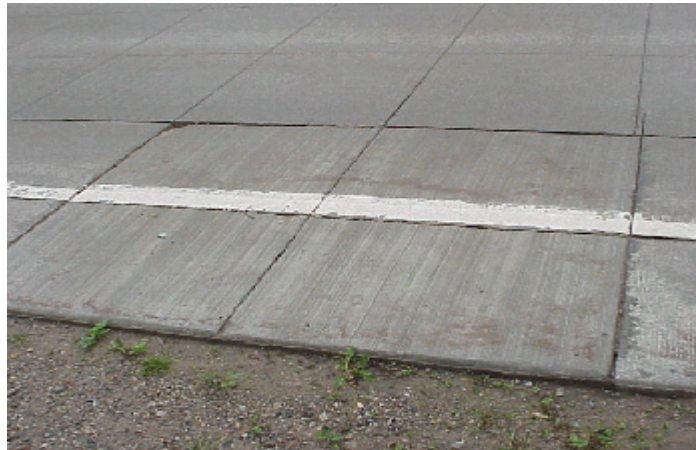


Figure 17. Replaced Panels from a Water Main Break.

(Four panels in the foreground)

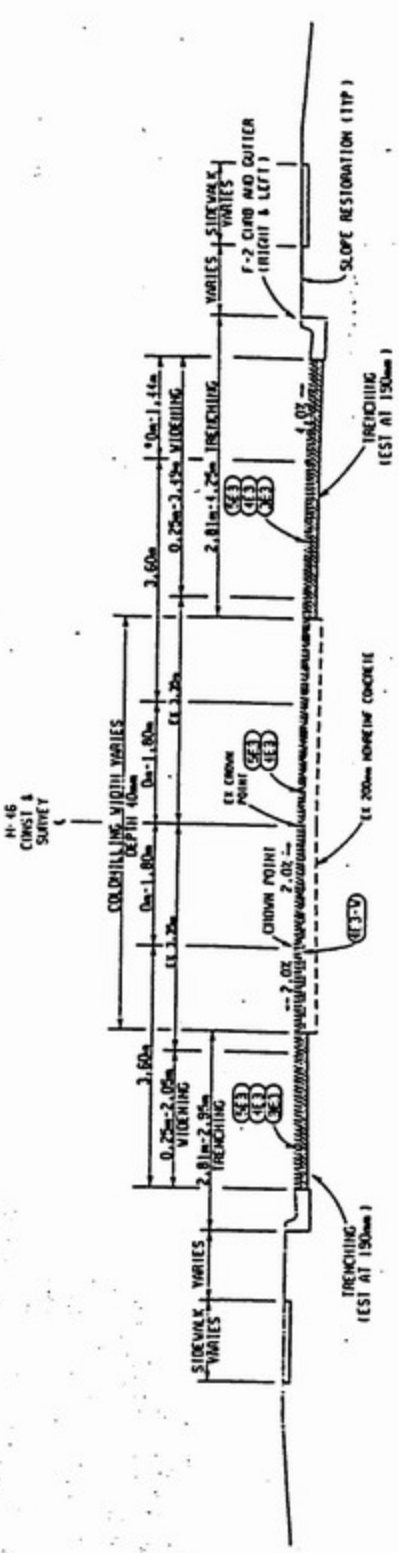
CONCLUSIONS

The visual evaluations and non-destructive testing to date support the following conclusions:

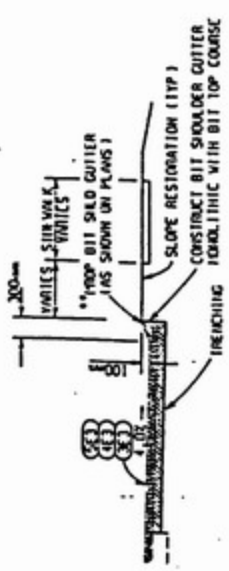
- The 5 inch (125 mm) and 6 inch (150 mm) thick concrete whitetopping sections are in good shape other than some longitudinal cracking.
- The longitudinal cracking may be due to bending about the center of the lane from poor support conditions under the right edge of the lane. The cracking is evenly distributed between the two lanes and the increase in quantity over time appears to be leveling off.
- The majority of the cracking in the ultra-thin whitetopping section is due to lack of (or differential) support at the edge of the underlying pavement.
- The thickened shoulder portion of the ultra-thin whitetopping section can be repaired full-depth successfully as evidenced by the water main work.
- Care should be taken to ensure good and even support under whitetopping pavement, especially at the edge of the existing pavement.
- The bituminous sections are in very good shape with minimal cracking.

Appendix

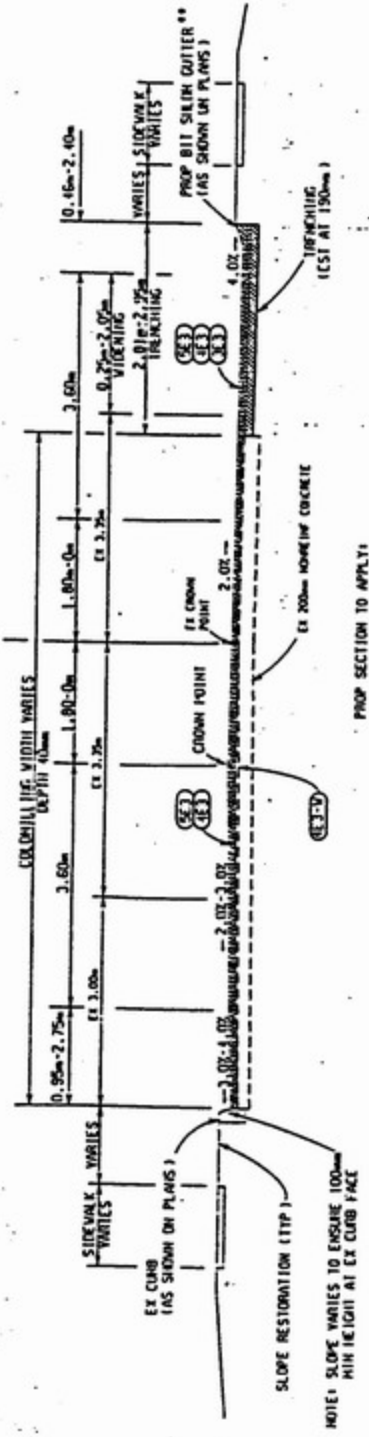
Typical Cross Sections



PROP SECTION TO APPLY:
 M-16
 STA 10+186.000 TO 10+646.000
 STA 10+368.000 TO 10+651.000



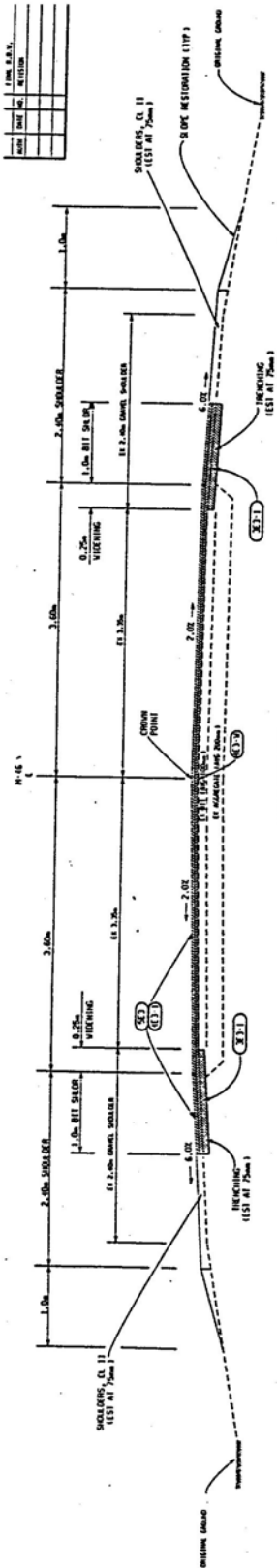
PROP SECTION TO APPLY:
 M-16
 STA 11+155.000 TO STA 11+380.000



PROP SECTION TO APPLY:
 M-16
 STA 11+055.000 TO 11+200.000

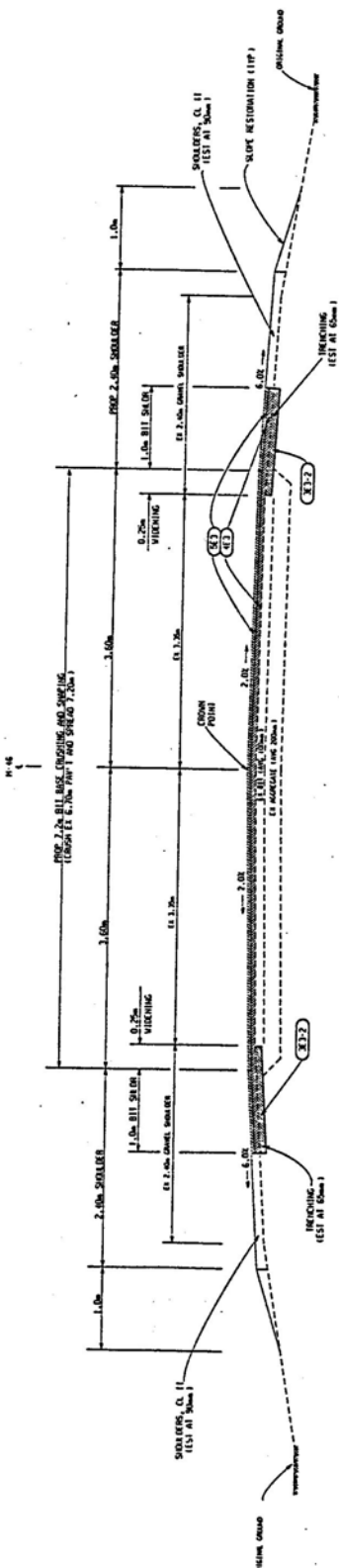
Section 1 (Both Typical)

NOTE: SLOPE VARIES TO ENSURE 100mm MIN HEIGHT AT EX CURB FACE

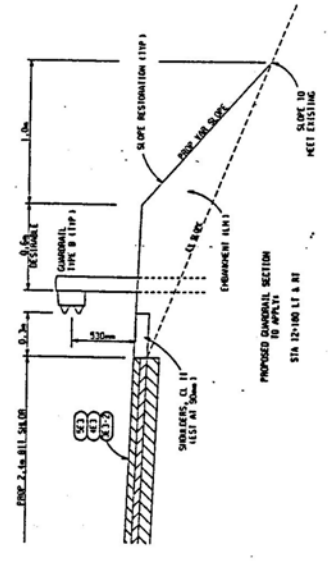


PROP SECTION TO APPLY
 N-46
 STA. 11+620.000 TO STA. 12+145.000
Section 2

NOTE: PAYMENT FOR GRADING OR EMBANKMENT METERS BEHIND THE SHOULDER IS TO BE INCLUDED IN THE PAY ITEM WHICH WILL BE PAID FOR SEPARATELY.



PROP SECTION TO APPLY
 N-46
 STA. 12+145.000 TO STA. 11+000.000 (R/O)
Section 3



PROPOSED GENERAL SECTION TO APPLY
 STA. 12+145.000

BITUMINOUS APPLICATION ESTIMATE
 (STA 11+620.000 TO STA 11+000.000)

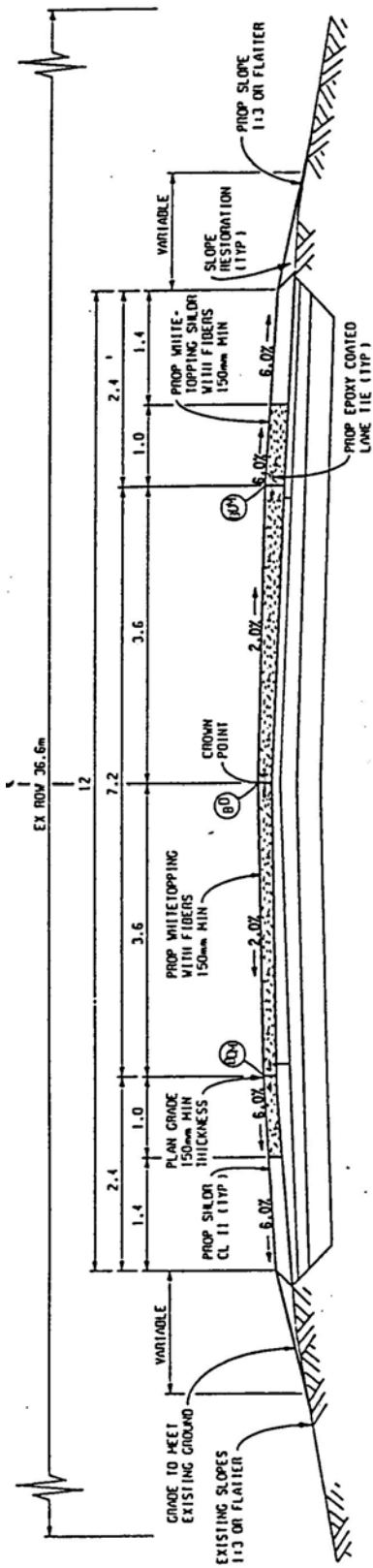
ITEM	UNIT	PER M ²	RATE	PERFORMANCE	REMARKS
4-3-1	BITUMINOUS MIXTURE 3-3	50kg	50kg	50-28	TOP COURSE, 40% + 240
4-3-2	BITUMINOUS MIXTURE 4-3	50kg	50kg	50-28	LEVELING COURSE
4-3-3	BITUMINOUS MIXTURE 4-3	WHITES	50-28	50-28	WEIGHING
4-3-4	BITUMINOUS MIXTURE 4-3	120kg	50-28	50-28	LEVELING COURSE
4-3-5	BITUMINOUS MIXTURE 3-3	175kg	50-28	50-28	BASE COURSE
4-3-6	BITUMINOUS MIXTURE 3-3	175kg	50-28	50-28	TOP COURSE APPROACH
4-3-7	BITUMINOUS MIXTURE 12A, 12B+11	210kg	50-28	50-28	LEVELING COURSE APPROACH
4-3-8	BITUMINOUS MIXTURE 12A, 12B+11	210kg	50-28	50-28	APPROACHES (CURE & GRIT)
			0-0-45 L		

FOR INFORMATION ONLY

QMDOT
 QUALITY MANAGEMENT DISTRICT

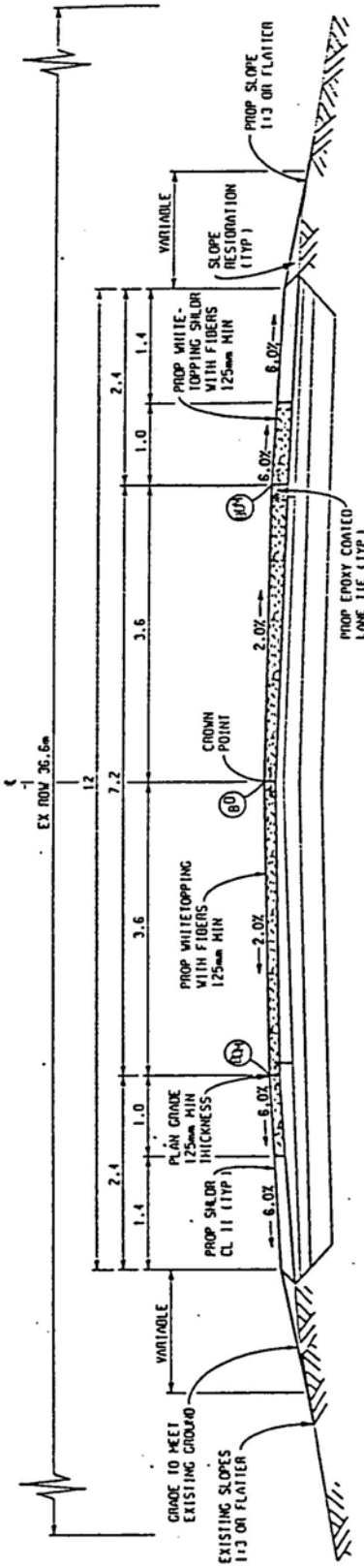
TYPICAL CROSS SECTIONS

DATE: 12/04/98
 SCALE: 1:1 NONE
 JOB NO.: 74062
 SECTION: 38023
 SECTION DATE: 11/03/98



PROPOSED MAINLINE SECTION TO APPLY:
 STA 17+320 TO STA 20+190

Section 5 (Section 4 similar, but without fibers.)

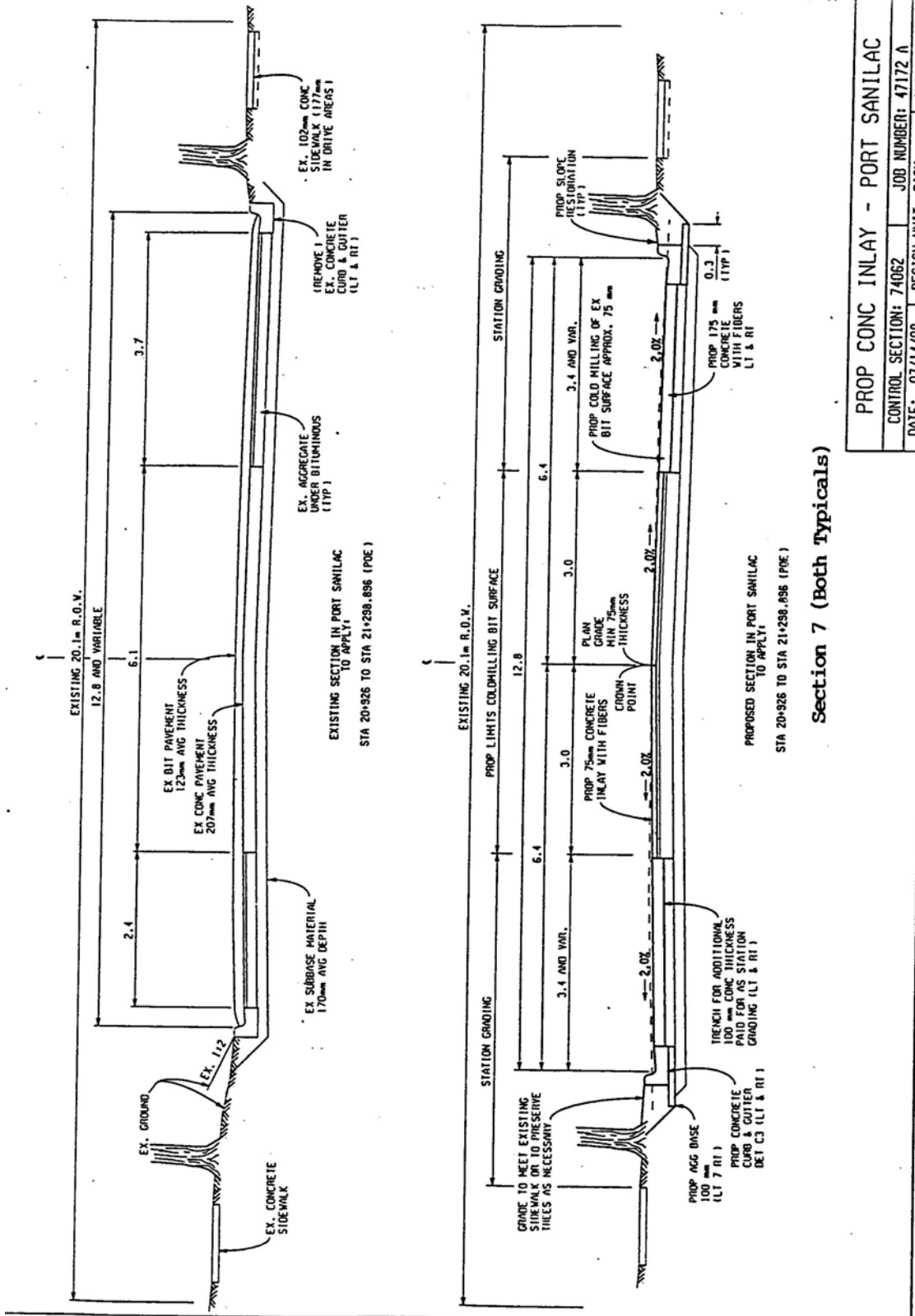


PROPOSED MAINLINE SECTION TO APPLY:
 STA 20+190 TO STA 20+494

Section 6

JOINT LEGEND
 (B) ... OPTIONAL OR MODIFIED JOINT ACCORDING TO STD PLAN R-41-B
 (A) ... OPTIONAL OR MODIFIED OR MODIFIED JOINT ACCORDING TO SPEC PROVISION

PROP CONC OVERLAY M-46		
CONTROL SECTION: 74062	JOB NUMBER: 47172 A	
DATE: 07/14/98	DESIGN UNIT: RICK	SHEET NO.



PROP CONC INLAY - PORT SANILAC		
CONTROL SECTION: 74062	JOB NUMBER: 47172 A	
DATE: 07/14/98	DESIGN UNIT: RICK	SHEET NO.

FWD Data from Longitudinal Crack Investigation

KUAB FWD FILE 47172E4.NOR
 Project : White Topping Project 2001
 Project Number : CS 74062 JN 47172
 Route : M-46
 Direction : EB
 Location : WCL Carsonville

FWD data at 4 selected long. cracks in the EB lane

Region : Bay
 Customer/Client : MDOT/Mike Eacker
 Operator : K.Bancroft
 Traffic Control : Megan Palmer, Santino Curtis
 Pavement Type : Flexible/Composite/Rigid
 Environment :
 Traffic : light
 Comments : Eacker, Sweeny GPR

Note: Calculate longitudinal load transfer D2/D0
 TJT load transfer - before D1/D0, after D4/D0

Date Created : #####
 Load Mode : 2 (3+3 buffers, 7 plates)
 Plate Radius : 5.91 (in)
 Extra Field Set : FLEXIBLE
 Drop Sequence : 22
 No of drops : 13
 Record Drop? : NY
 Drop Height : 1 2 3 4
 Impact Load : 5000 9000 15500 20500 lbf
 Sensor Number : 0 1 2 3 4 5 6 7 8
 Sensor Distance : 0.00 12.01 12.01 7.99 12.01 17.99 24.02 35.98 60.00 (in)
 Sensor Position : CENTER FRONT RIGHT BEHIND BEHIND BEHIND BEHIND BEHIND

Reference Offset : 0 m
 Testpoint spacing: 150 m

Distance	Load	D0	D1	D2	D3	D4	D5	D6	D7	D8	Air	Pave	Pvmt	Loc.	Pvmt	Crack	Joint	Crack	Mid Slab
m	lbf	mils	mils	mils	mils	mils	mils	mils	mils	mils	eF	eF	Cond	No.	Crack*	Sevty	LTE %	LTE %	LTE %
4424	9000	14.56	10.62	6.60	12.25	11.07	9.56	8.07	5.63	2.47	68	73	TJT	1	CORNR	BJT			72.96
4425	9000	13.56	11.28	5.65	14.14	11.98	10.28	8.62	5.92	2.52	68	73	TJT	1	CORNR	AJT			83.19
4426	9000	7.00	6.35	6.09	6.54	6.09	5.52	4.83	3.61	1.58	68	75	MID	2	NA	NA			90.76
4432	9000	8.11	7.25	5.78	7.39	6.76	5.91	5.01	3.38	1.51	69	77	LCK	3	LCK	NA			71.28
4453	9000	9.70	8.59	7.05	8.67	7.92	6.87	5.80	3.93	1.81	69	79	LCK	4	LCK	NA			72.67
4474	9000	8.85	7.22	6.15	7.91	7.30	6.40	5.48	3.95	1.64	70	78	LCK	5	LCK	NA			71.13
4496	9000	7.88	6.94	6.84	7.52	7.13	6.54	5.87	4.55	2.11	70	78	MID	6	NA	GOOD			88.07
4497	9000	15.18	8.40	9.85	12.65	11.33	9.72	8.15	5.68	2.60	69	76	TJT	7	CORNR	BJT			55.33
4497	9000	12.98	10.02	11.54	8.89	8.14	7.22	6.30	4.62	2.18	70	76	TJT	7	CORNR	AJT			77.22
5686 State Road																			
7307 Ridge Road North																			
7317 Ridge Road South																			
8756	9000	5.60	4.95	4.84	5.20	4.84	4.36	3.81	2.85	1.26	67	76	MID	8	NA	GOOD			88.34
8761	9000	7.54	6.54	6.45	6.59	6.00	5.25	4.49	3.25	1.55	67	75	TJT	9	CORNR	BJT			86.73
8761	9000	7.51	6.10	6.36	7.14	6.39	5.52	4.62	3.28	1.49	67	74	TJT	9	CORNR	AJT			81.22
8765	9000	5.90	5.01	4.63	5.32	4.88	4.24	3.60	2.56	1.09	67	77	LCK	10	LCK	NA			78.47
8928 Huron View Road																			
9925	9000	4.28	3.86	3.84	4.00	3.77	3.47	3.11	2.48	1.28	67	73	MID	11	NA	GOOD			90.19
9929	9000	7.88	6.44	6.88	6.65	6.03	5.27	4.59	3.43	1.66	67	74	TJT	12	CORNR	BJT			83.86
9930	9000	7.84	6.14	6.96	7.08	6.36	5.51	4.72	3.44	1.61	67	72	TJT	12	CORNR	AJT			78.32
9940	9000	5.22	4.56	4.31	4.82	4.49	4.06	3.60	2.81	1.42	67	73	LJT	13	LCK	NA			82.51
9944	9000	5.12	4.52	4.23	4.71	4.38	3.95	3.49	2.70	1.39	67	76	LJT	14	LCK	NA			82.61
10259	9000	5.35	4.83	4.84	5.06	4.78	4.37	3.93	3.10	1.50	67	75	MID	15	NA	GOOD			90.28
10264	9000	6.04	5.19	5.74	5.25	4.82	4.30	3.77	2.94	1.53	67	75	TJT	16	CORNR	BJT			85.88
10264	9000	5.56	4.58	5.16	5.51	5.05	4.52	3.95	3.05	1.55	67	74	TJT	16	CORNR	AJT			82.31
10268	9000	6.45	5.69	4.98	5.99	5.60	4.98	4.39	3.26	1.45	67	76	LCK	17	LCK	NA			77.26
10283	9000	8.77	7.35	6.51	8.14	7.53	6.59	5.73	4.13	1.57	67	75	LCK	18	LCK	NA			74.30

10533 Port Sanilac WCL
 10657 "checker board" whitetopping
 11359 poe M-25

* - CORNR represents tests across the transverse joint in the corner of the slab (by the shoulder)
 LCK represents tests transversely across the longitudinal crack
 MID represents tests at mid-slab (away from any joints or cracks)

GPR Results From Longitudinal Crack Investigation

M46EBWHITETOP-REFL-LAY.DZT

cs 74062, M-46 eb whitetopping test section between Carsonville and Pt. Sanilac

Created Dec, 20 2001, 12:51:34 Modified Dec, 21 2001, 10:42:10
Channel(s) 1 Samples/Scan 512 Bits/Sample 16
Scans/Second 160 Scans/Meter 1.64042 Meters/Mark 30.48
Dielectric Constant 6

CHANNEL 1 4108
Position -3 ns Range 20 ns
Range Gain (dB) 15.0
Vert IIR LP N =1 F =3000 MHZ
Vert IIR HP N =1 F =100 MHZ
Vert Boxcar LP F =5120 MHZ
Vert Boxcar HP F =480 MHZ
Reflection Picking
- Elevation Correction H=450 mm
- Calibration Plate Correction
Layer Interpretation
Number of Layers 3

23

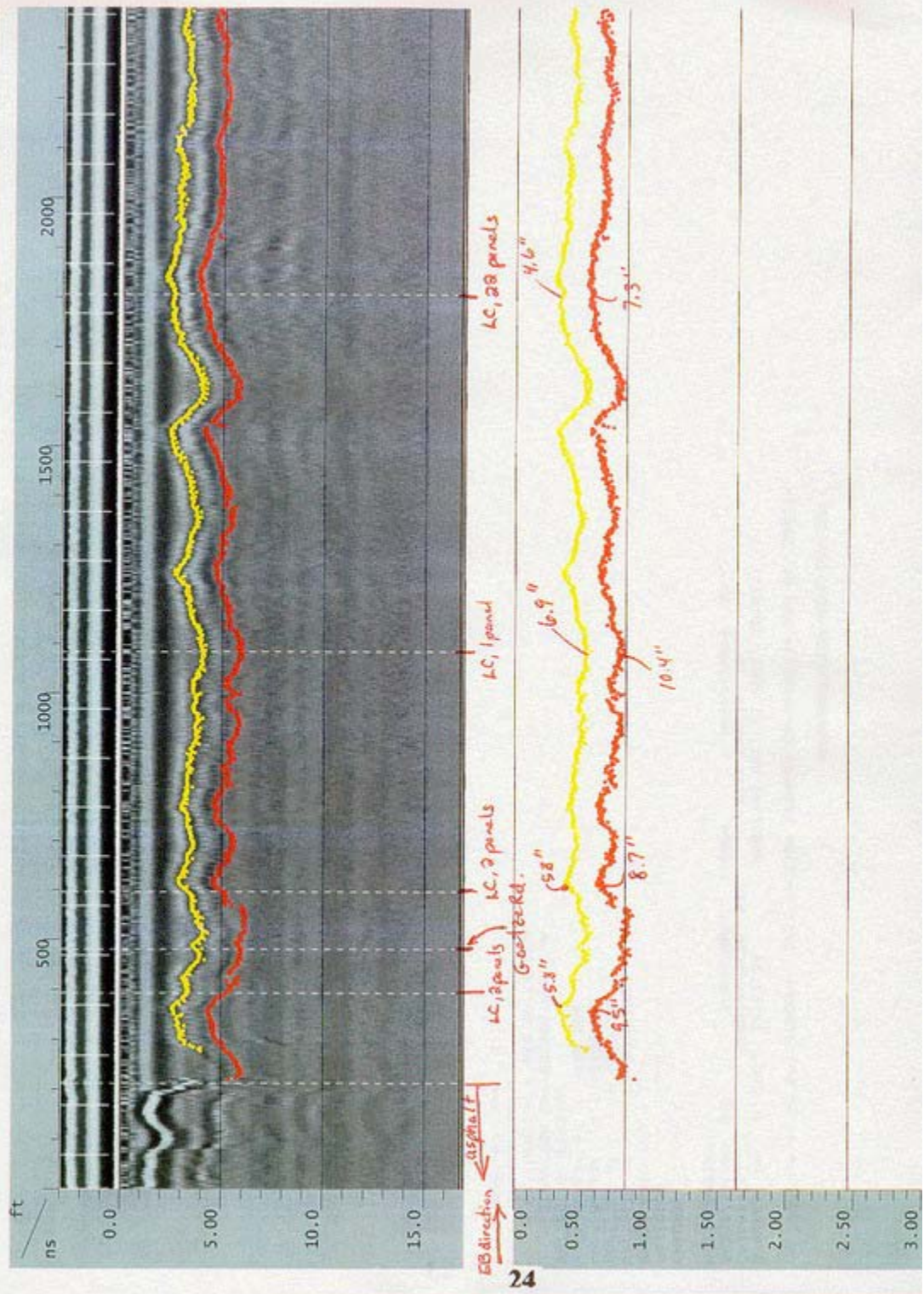
--Vertical dashed lines mark when the operator was over the center of a longitudinal crack or some reference point (an intersection, for example). Labels appear at the bottom of the lines. The radar antenna follows the operator over the point marked by about 13 feet after (to the right of) the mark on the printout.

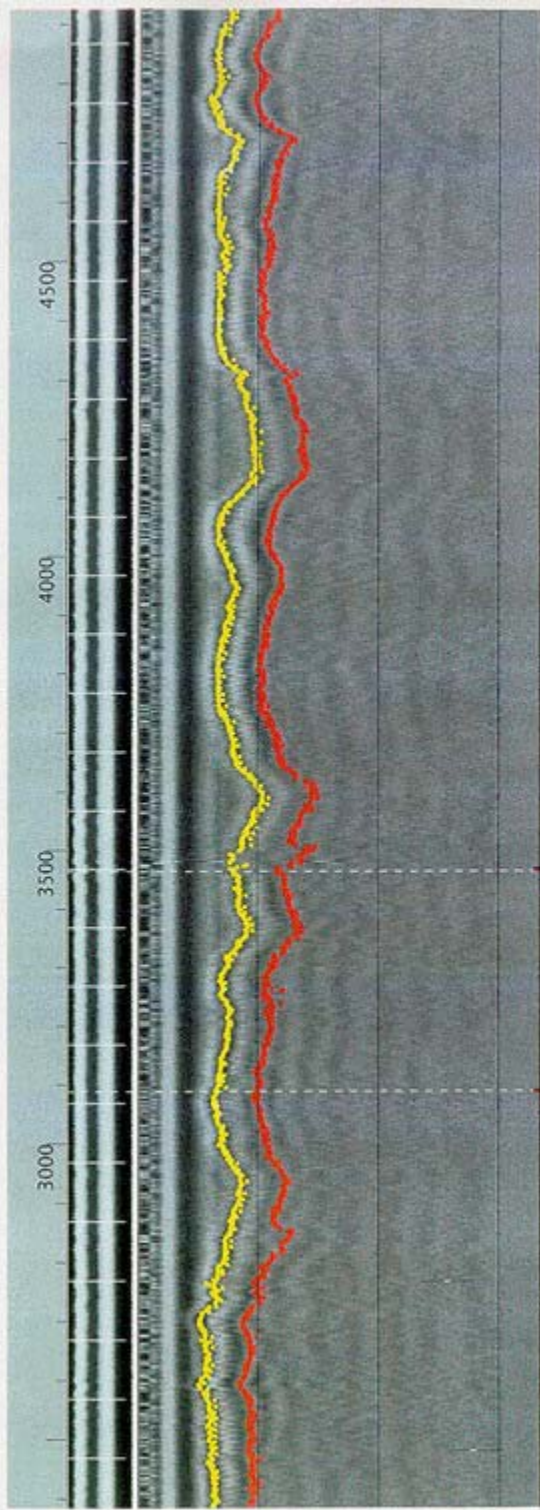
--LC = longitudinal crack

--Vertical scale on top graph is nanoseconds. Vertical scale on bottom graph is inches.

--Measurements written on the bottom graph are depths to the bottom of the pavement layers at the mark (dashed line). These are my interpretations of the radar output as to where the bottoms of the concrete and asphalt layers are. The scale is a little distorted in the printout. These numbers were picked off of the computer screen.

--Yellow represents bottom of concrete, red = bottom of asphalt, green = bottom of base





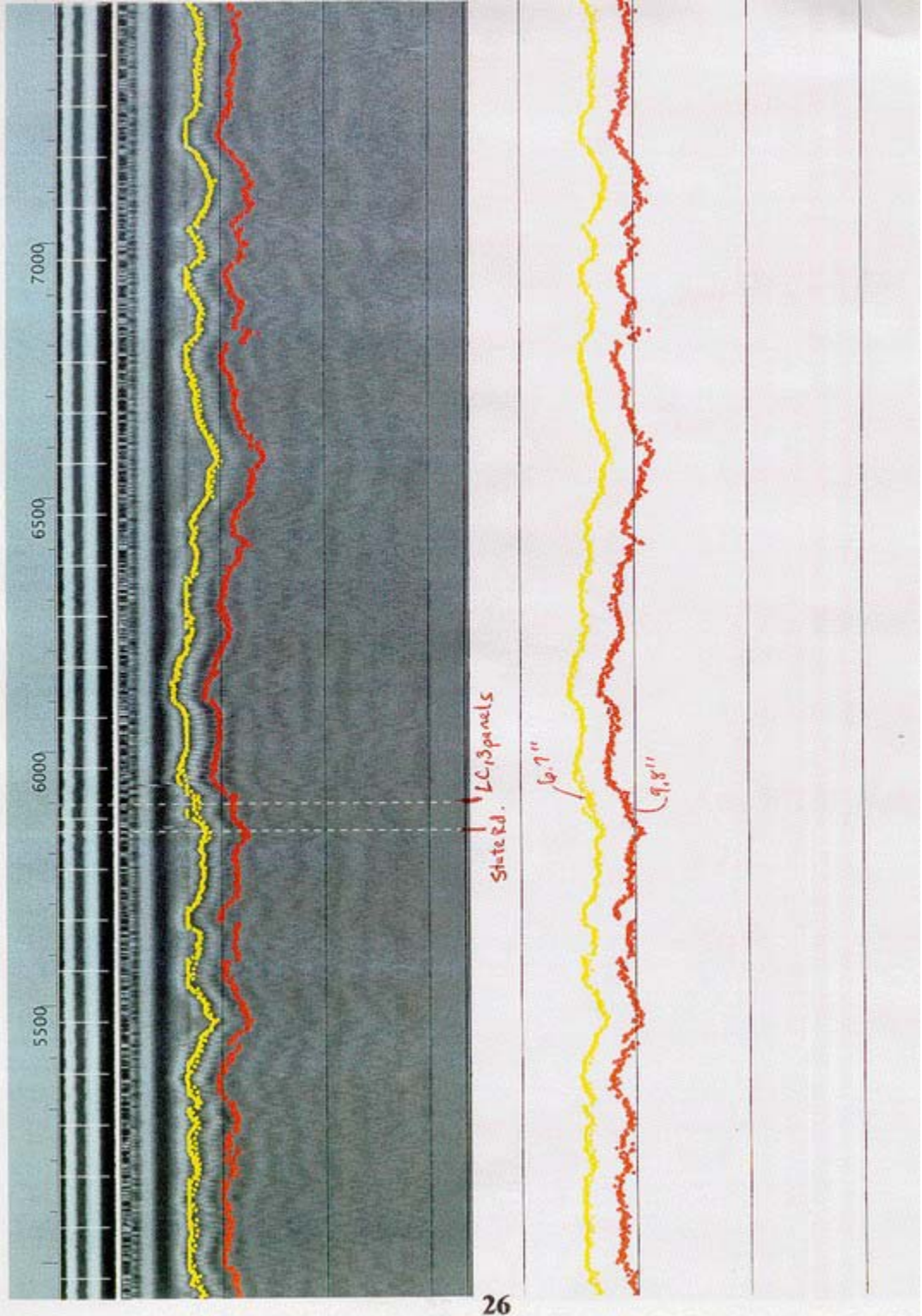
25

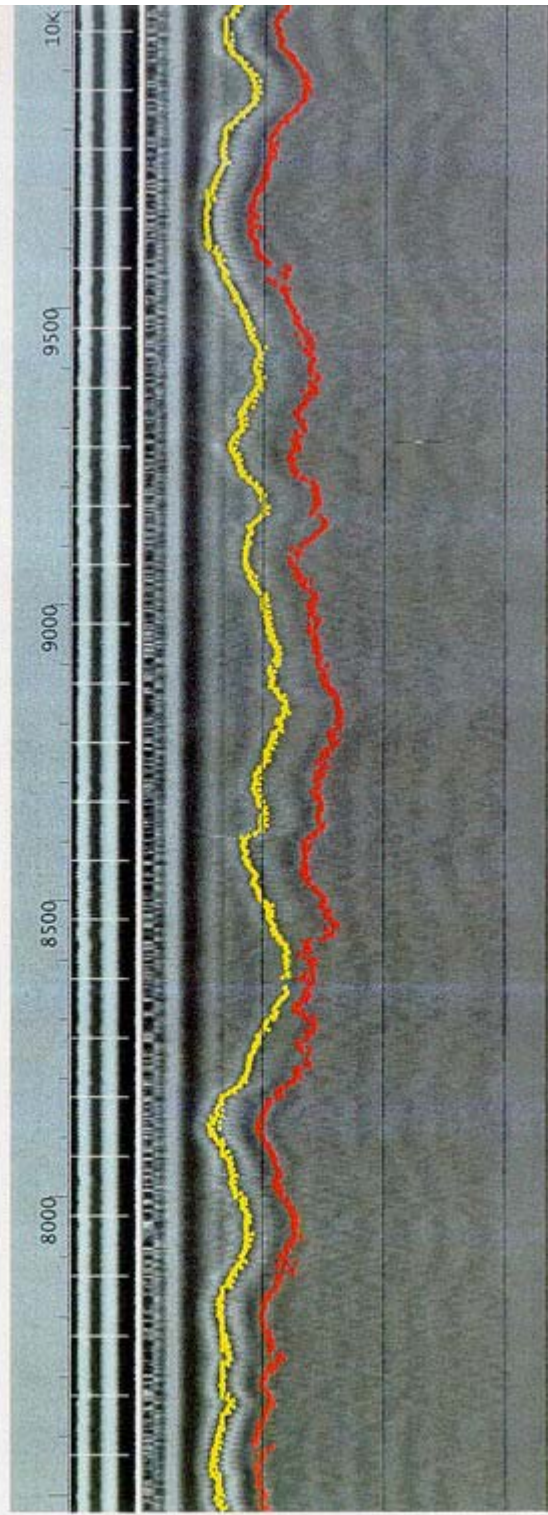
LC, Spools
Weigh-In-Motion
Device

5.9"

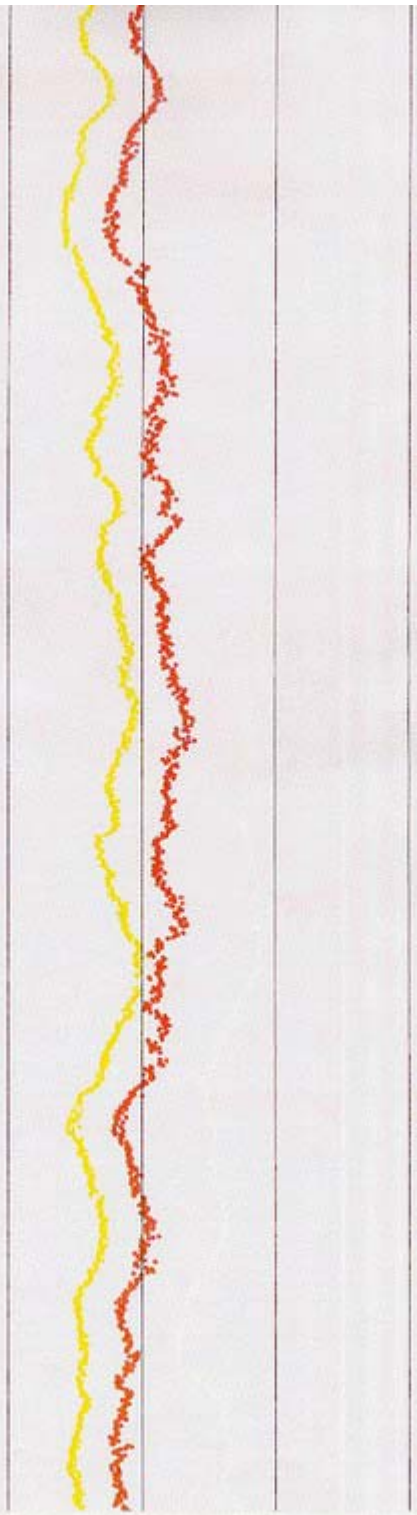
9.0"

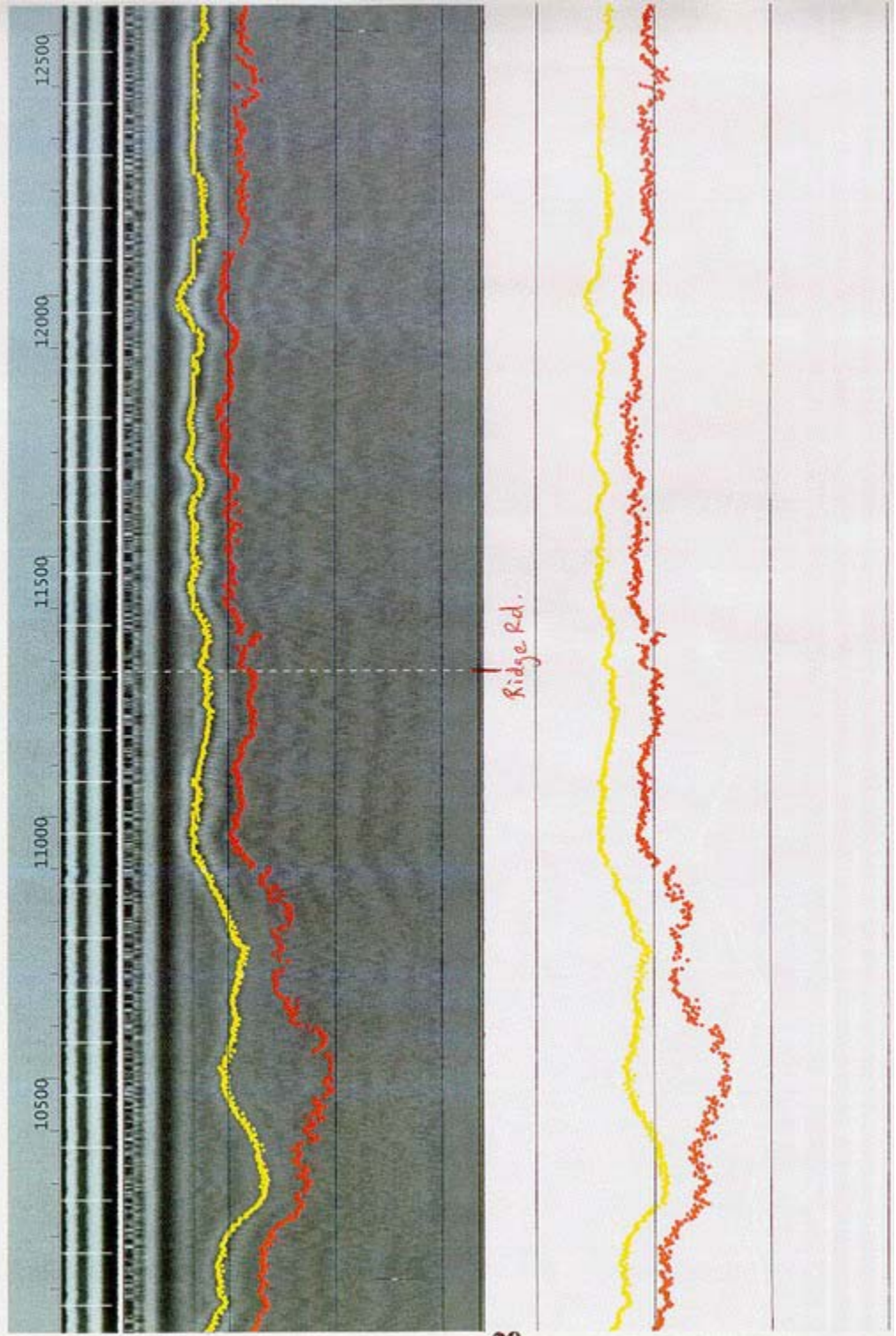


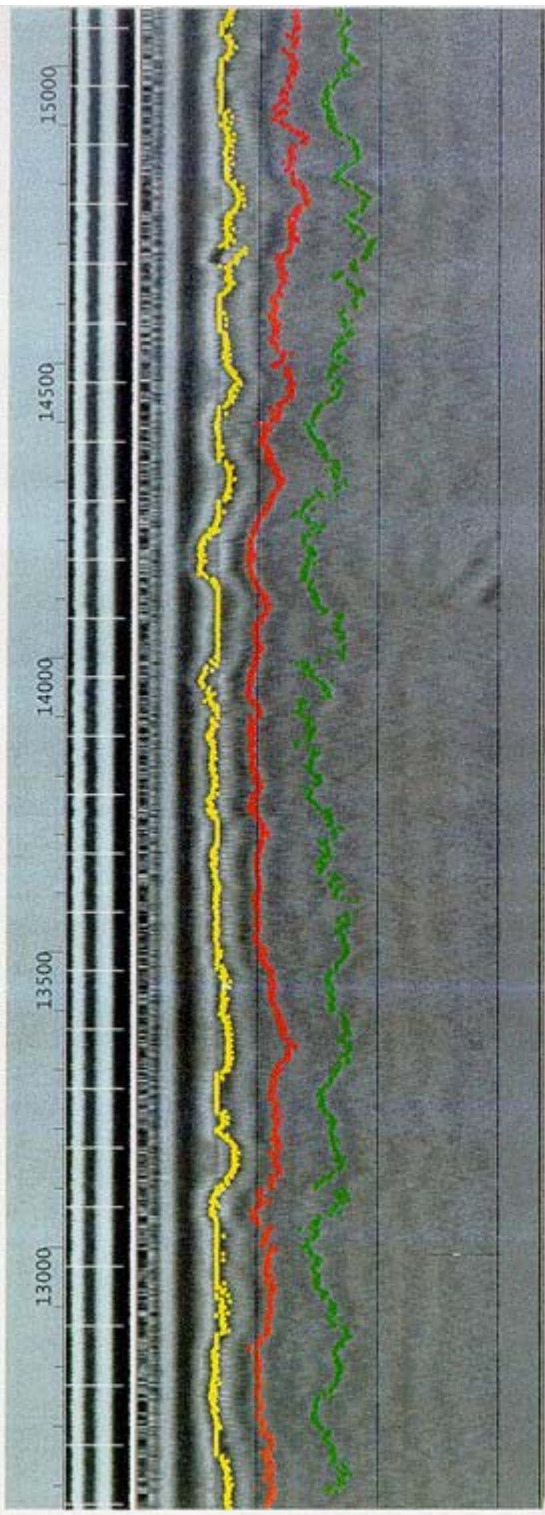




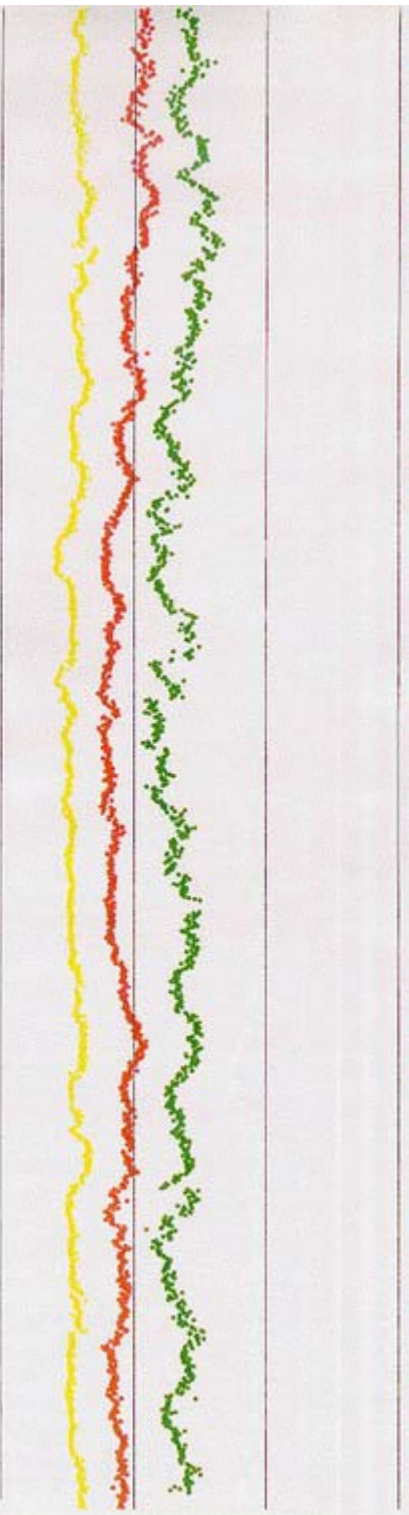
27

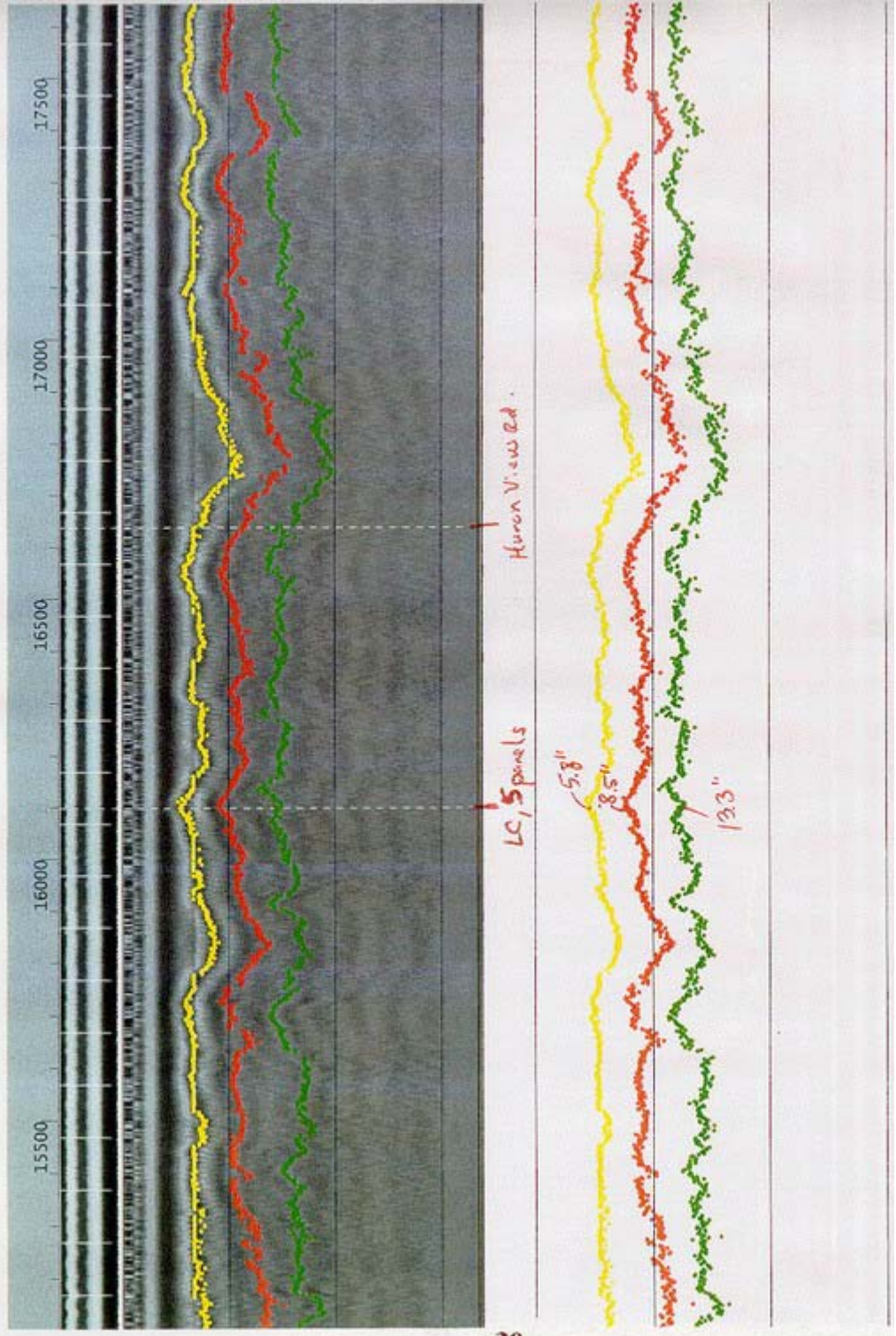


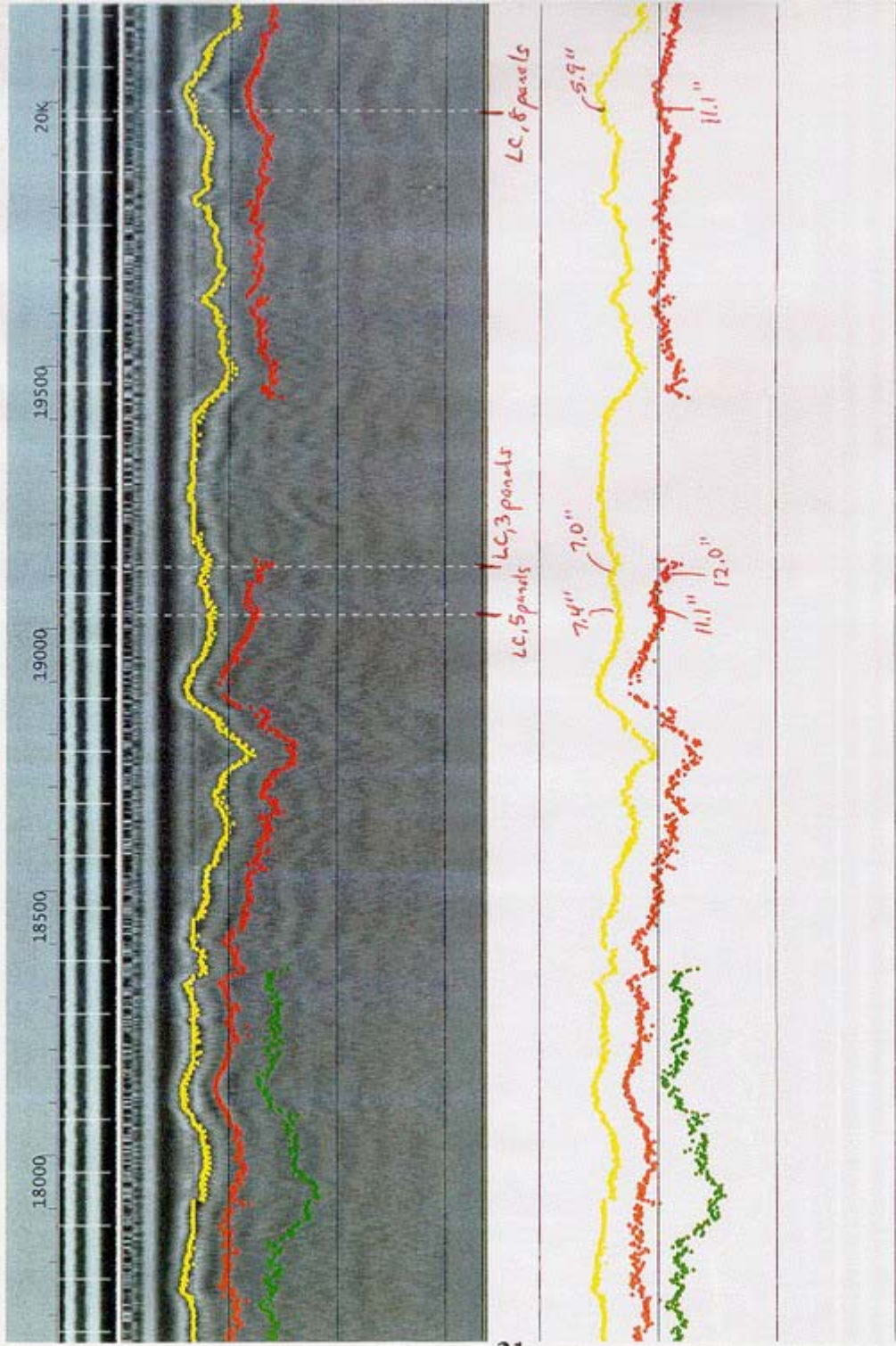


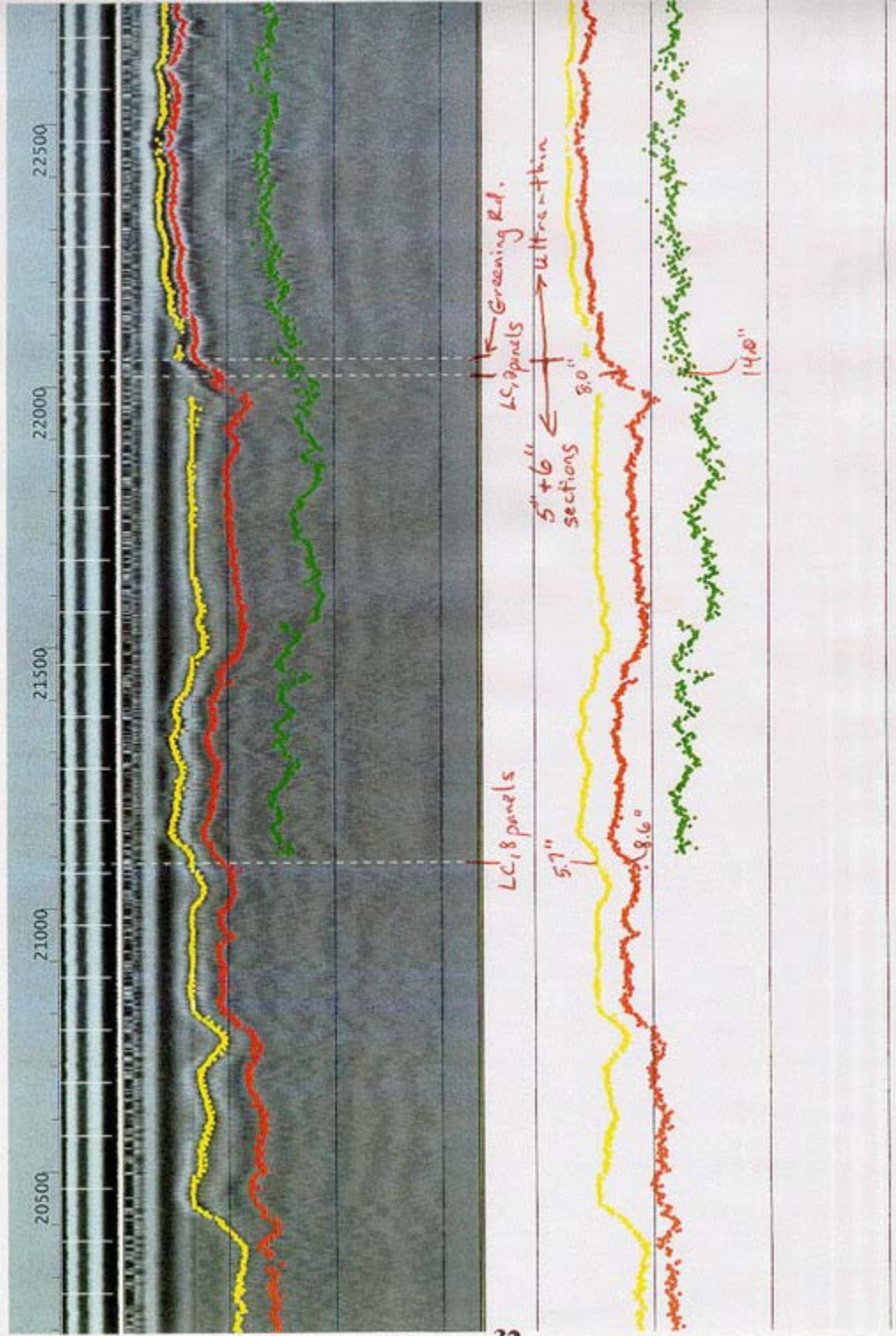


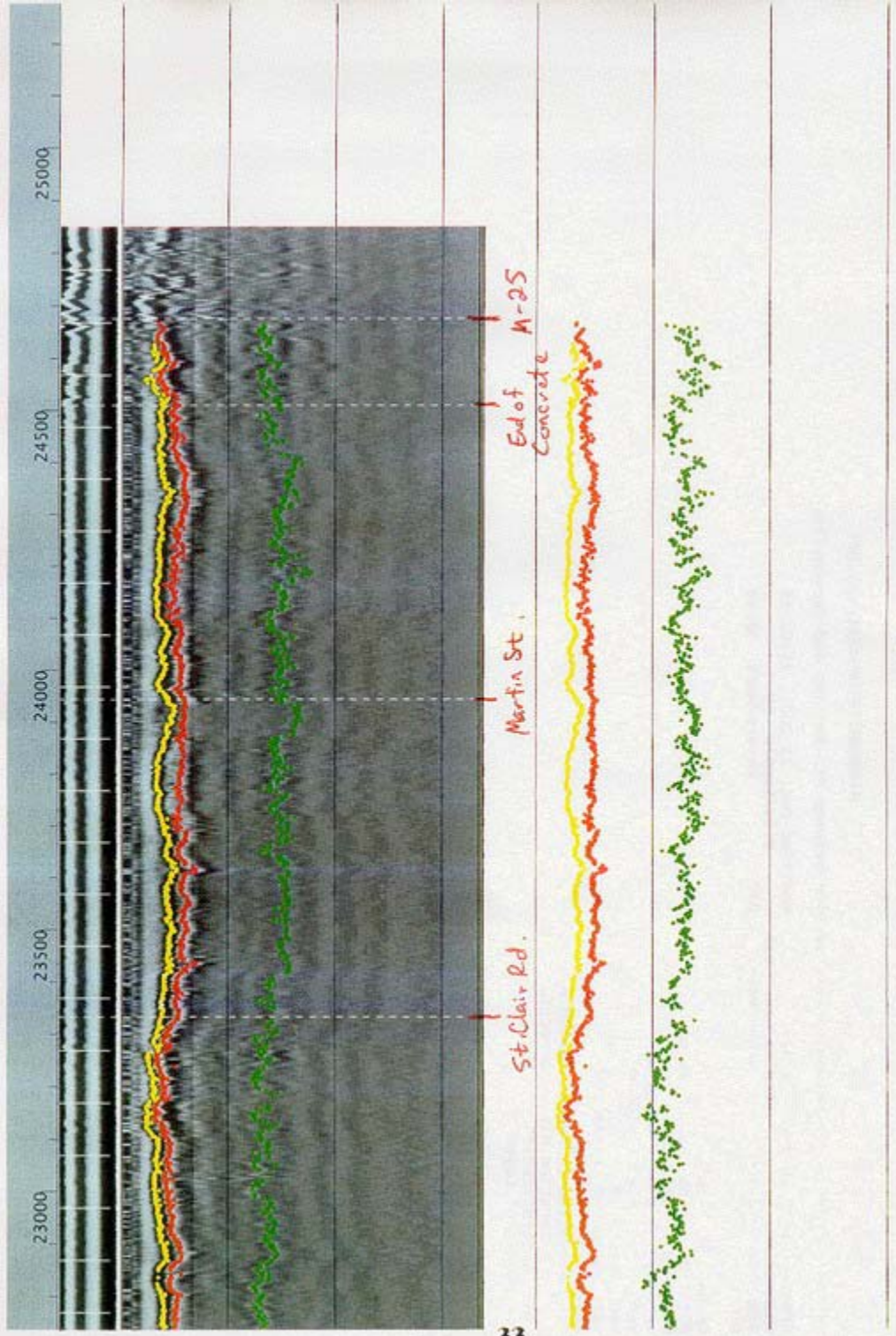
29









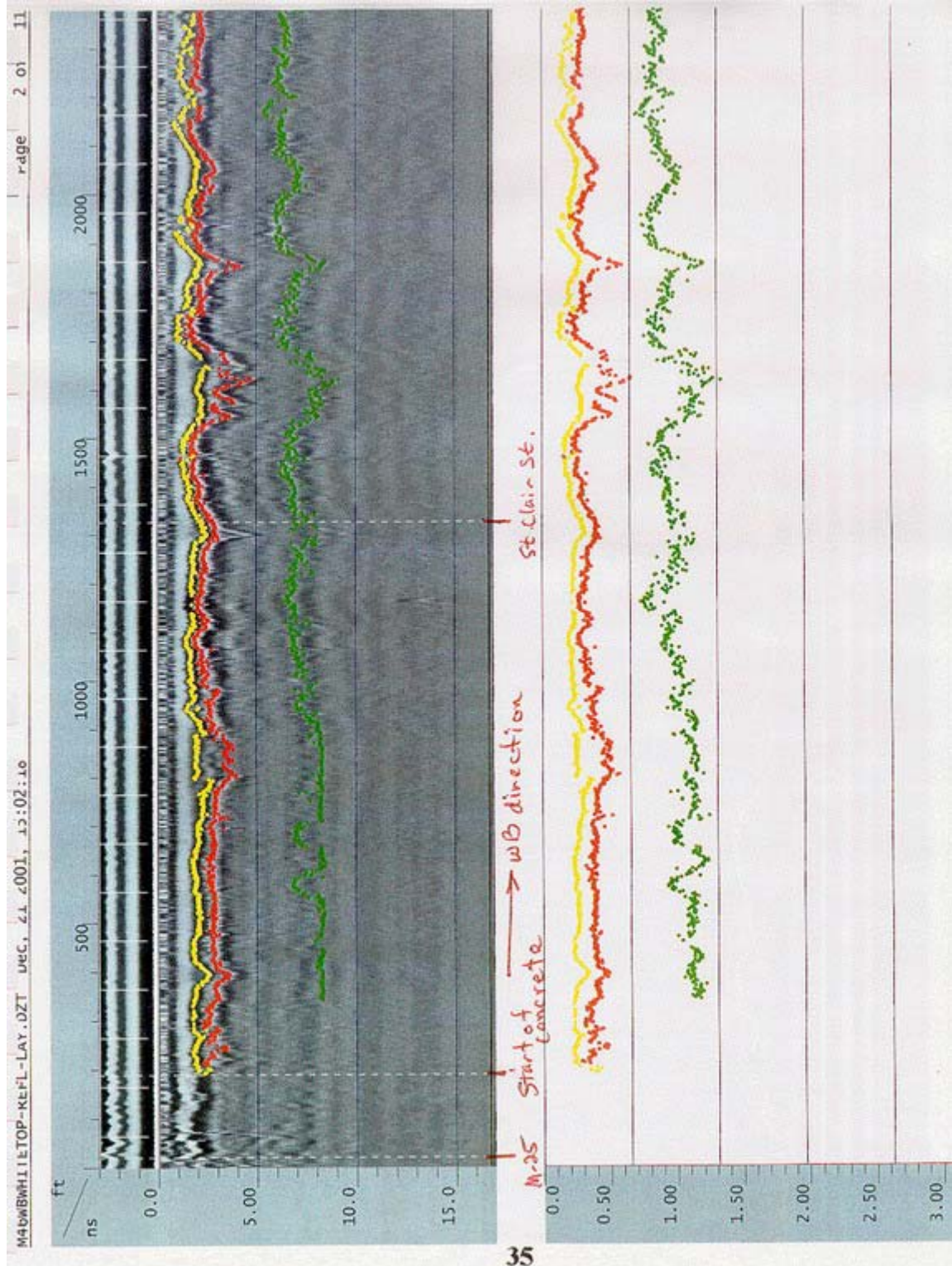


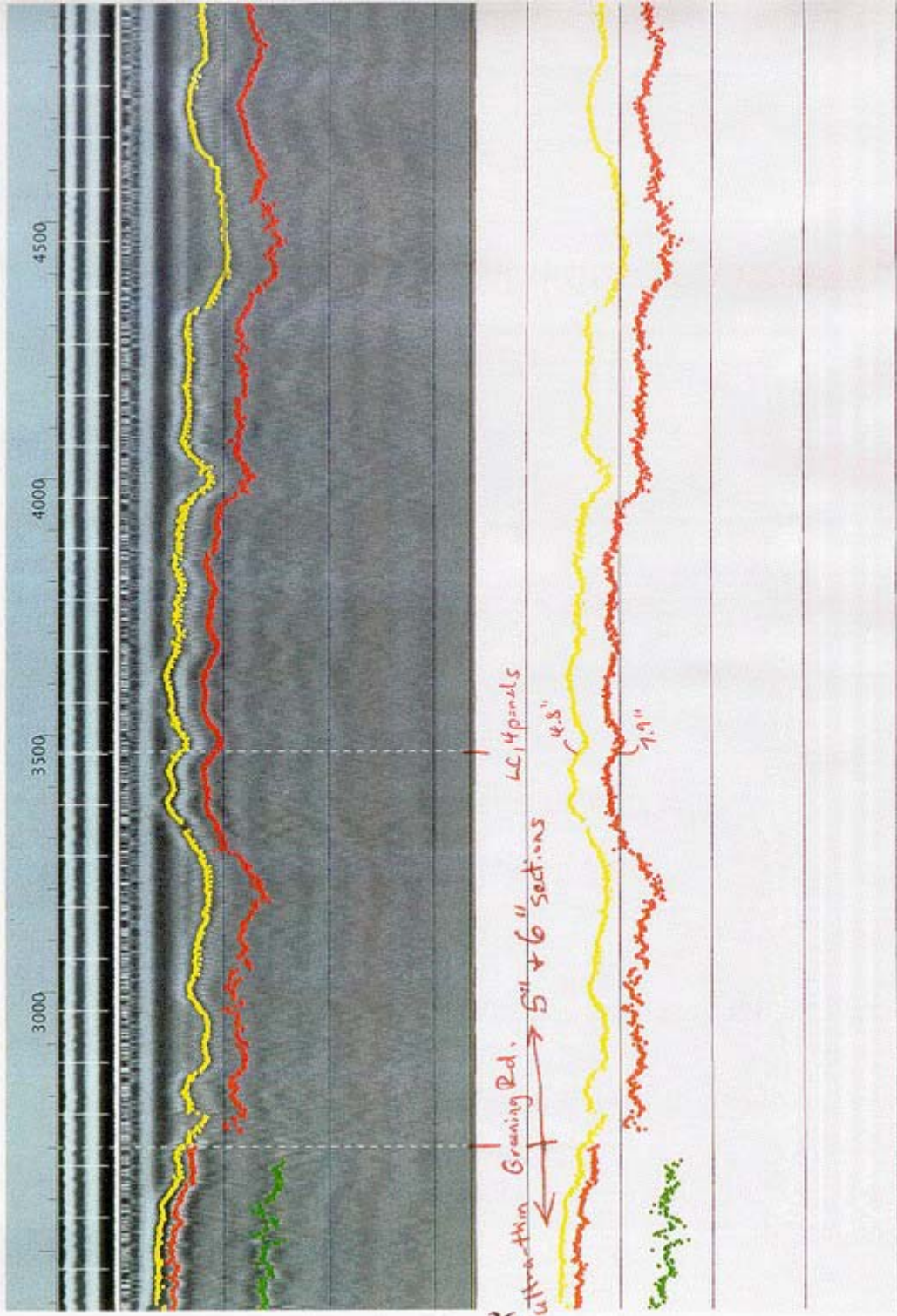
M46WBWHITETOP-REFL-LAY.DZT

cs 74062, M-46 wb whitetopping test section between Pt. Sanilac and Carsonville

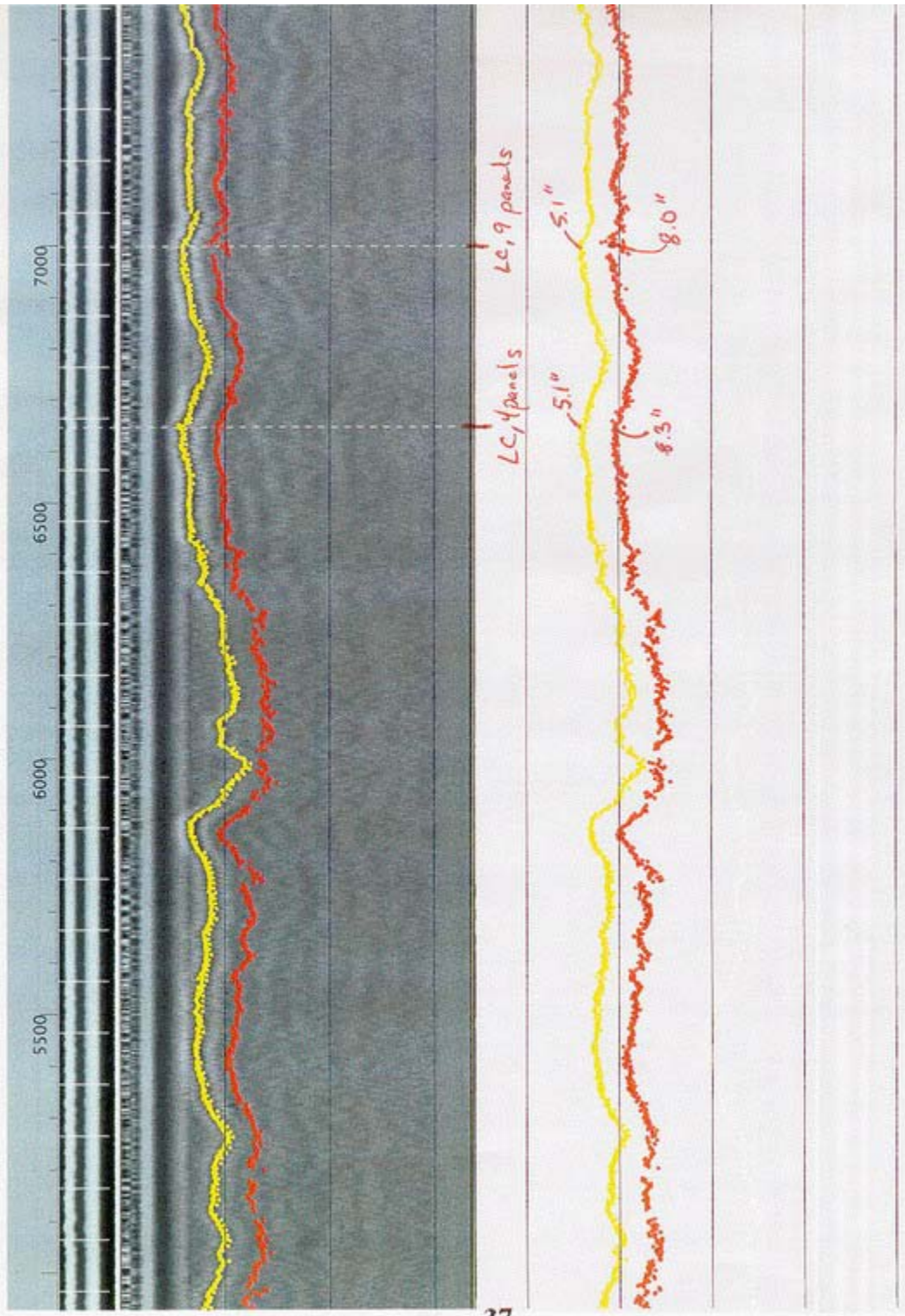
Created Dec; 20 2001, 12:42:26 Modified Dec, 21 2001, 15:02:18
Channel(s) 1 Samples/Scan 512 Bits/Sample 16
Scans/Second 160 Scans/Meter 1.64042 Meters/Mark 30.48
Dielectric Constant 6

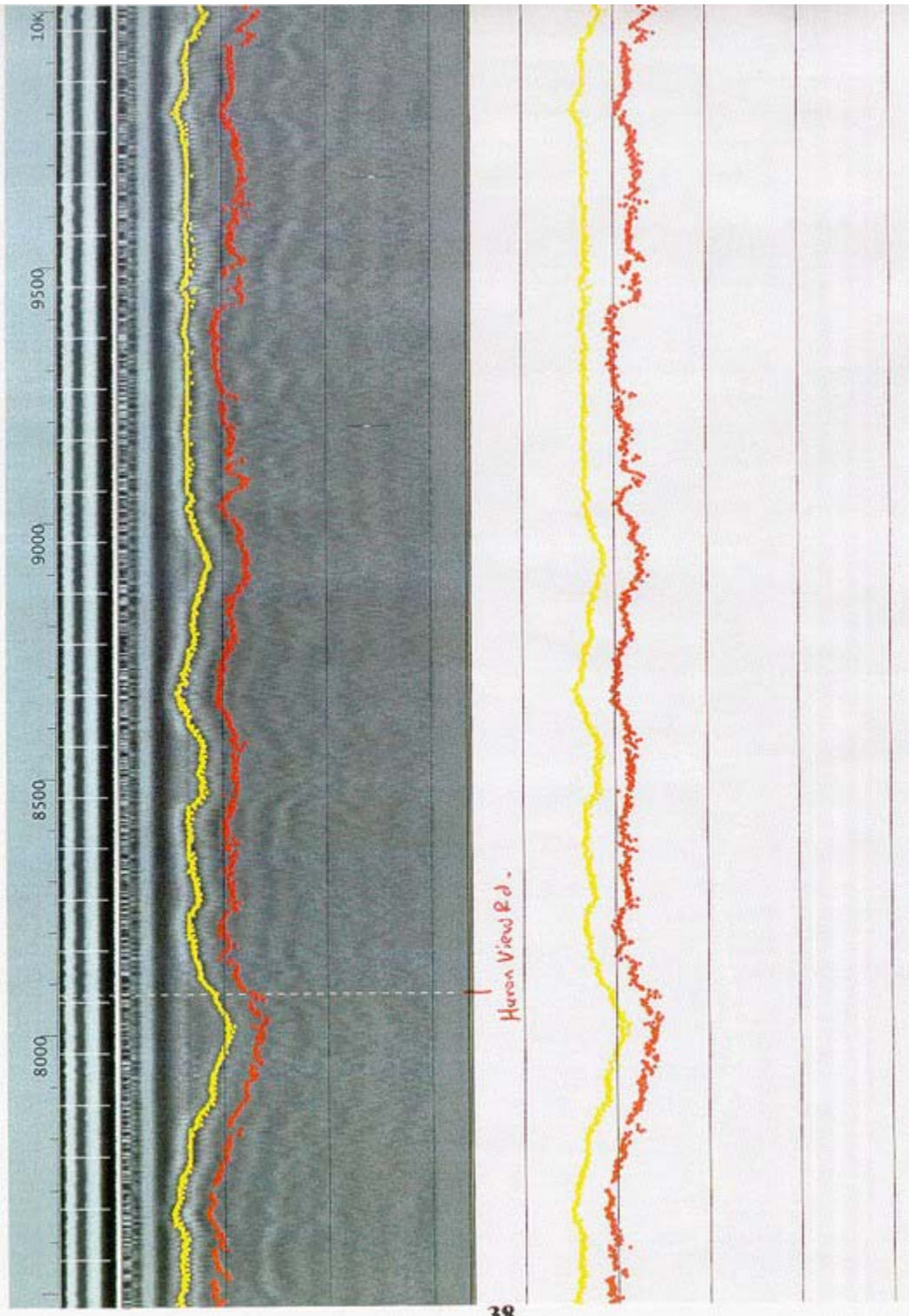
CHANNEL 1 4108
Position -3 ns Range 20 ns
Range Gain (dB) 15.0
Vert IIR LP N =1 F =3000 MHZ
Vert IIR HP N =1 F =100 MHZ
Vert Boxcar LP F =5120 MHZ
Vert Boxcar HP F =480 MHZ
Reflection Picking
- Elevation Correction H=450 mm
- Calibration Plate Correction
Layer Interpretation
Number of Layers 3

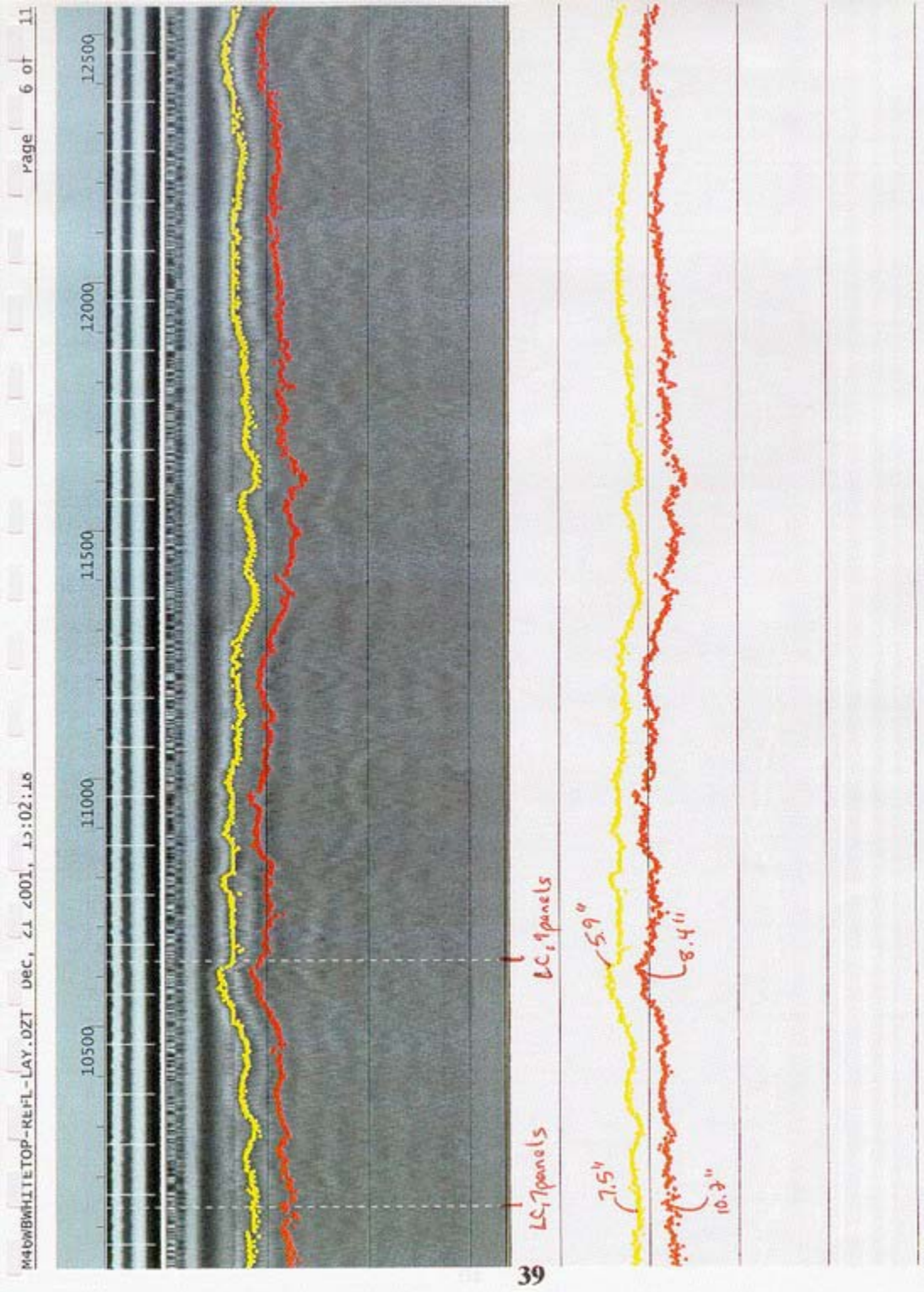


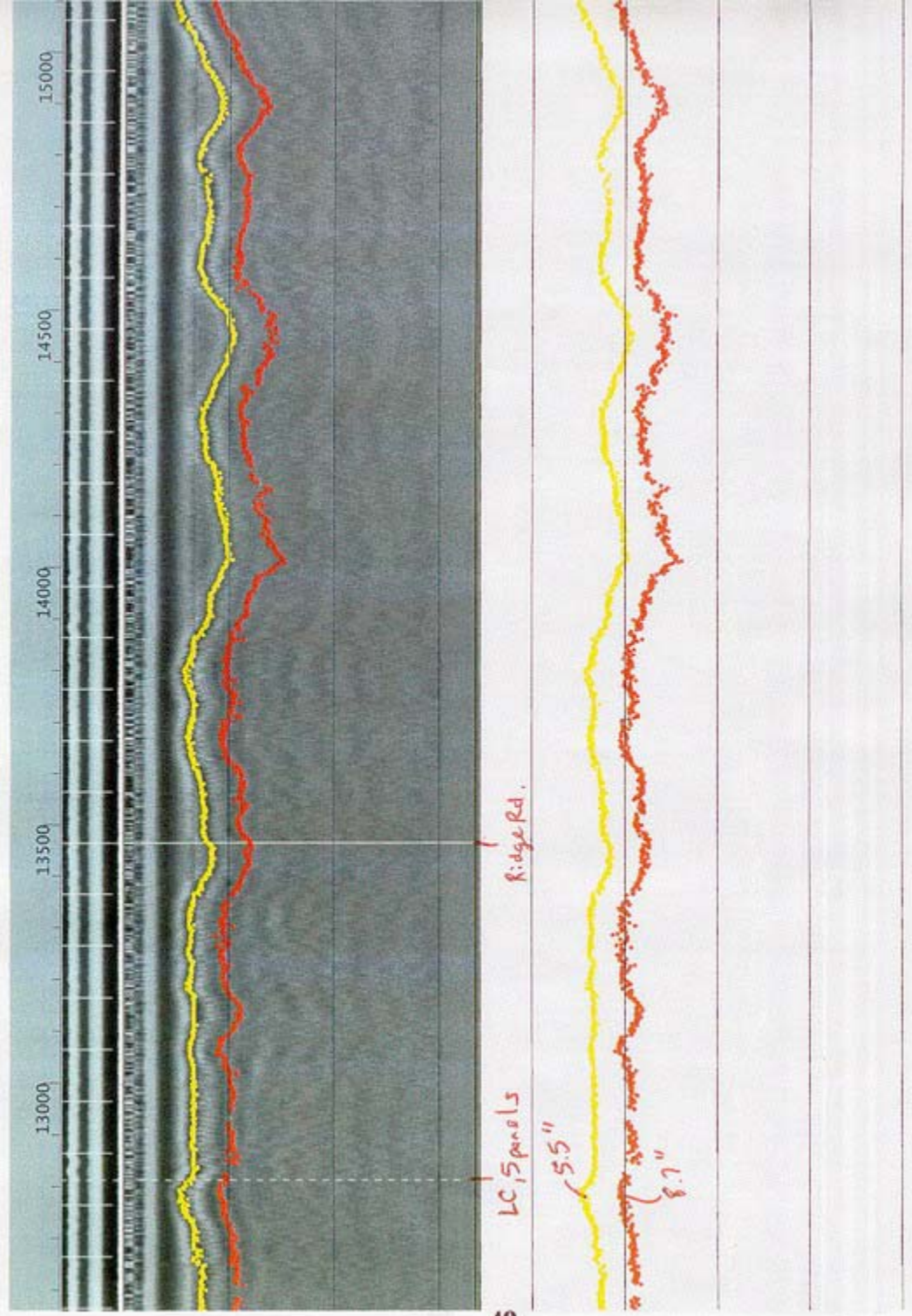


36

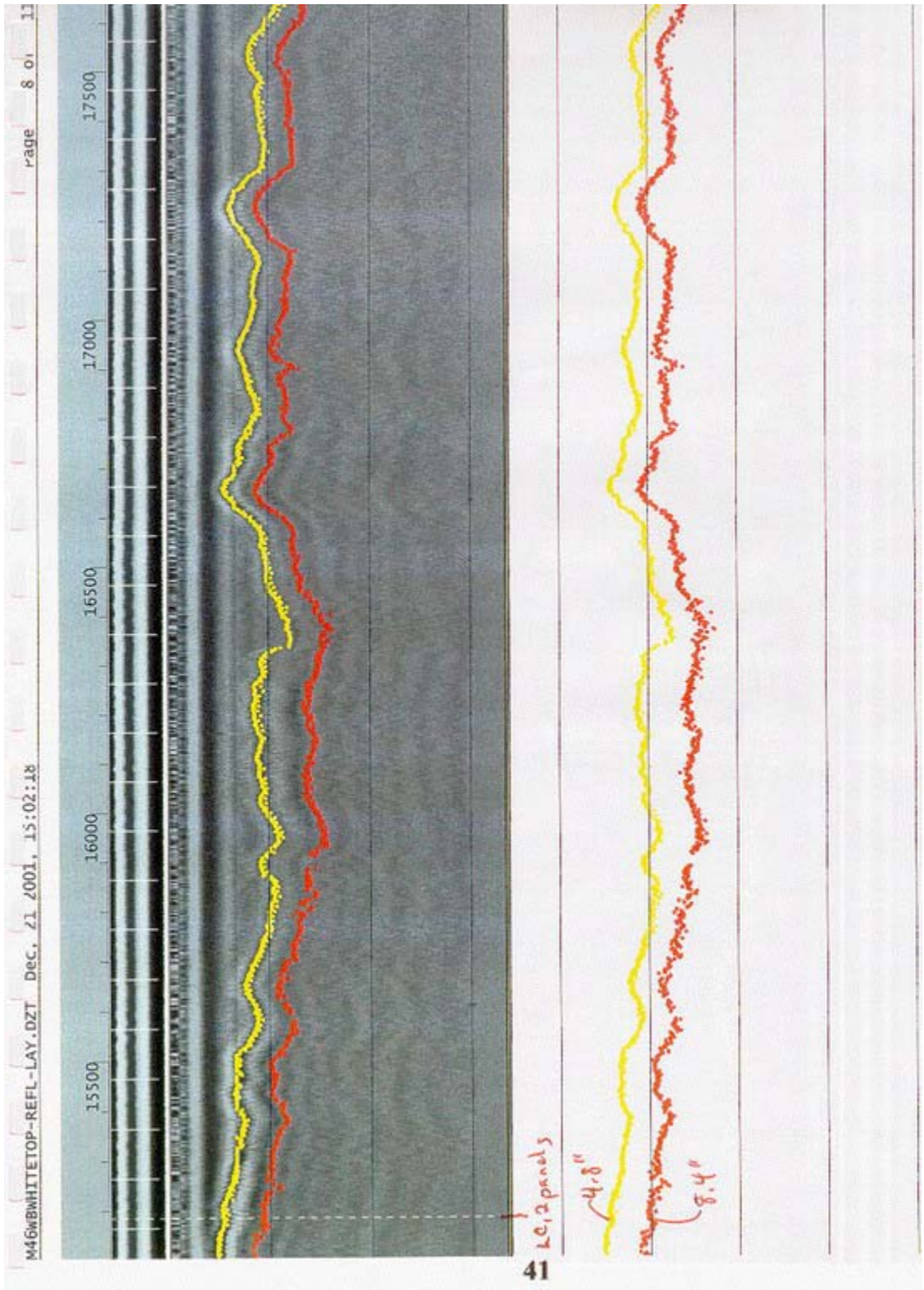


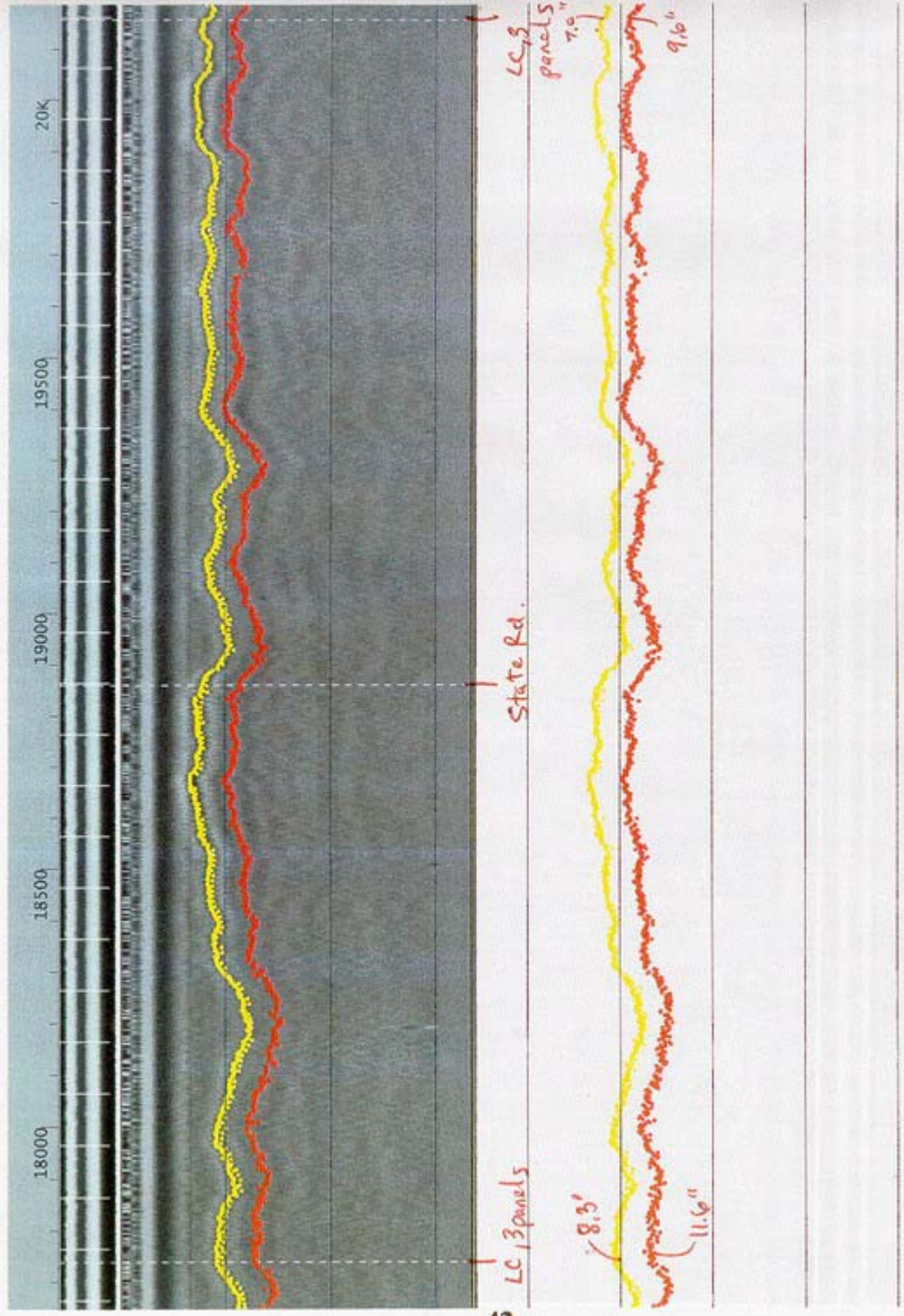






40





42

