STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

RESEARCH INVESTIGATION R 83-2

Work Plan 83-M&R-12

SUBJECT

Roadway structure investigation - U.S. Rte 2, Concord, Vermont MM 4.092 - 8.429.

PURPOSE OF INVESTIGATION

Document roadway condition and determine cause(s) of distress with emphasis on determining the proper method of reconstruction.

BACKGROUND INFORMATION

This investigation involved a 4.3 mile portion of U.S. Rte 2 in Concord, Vt. The roadway was constructed as new relocation in 1961 featuring two 12 foot lanes with 8 foot shoulders (Concord F 028-4(1)). The typical section included the following:

Sub-base of Crushed Gravel - Coarse Graded (20" deep in cuts, 16" deep in fills), Item 205-A.

3" Penetration Macadam Crushed Stone Base Course, Item 215.

3" Bituminous Concrete Pavement, Item 361-B.

The Route Log indicates additional pavement courses including a 1/2" plant mix in 1968, 1.3 miles of 1/4" plant mix in 1971, 2.1 miles of 1 1/8" plant mix in 1974, and 2.1 miles of 1/2" plant mix in 1975.

The project profile sheets show that 5360'± (24%) of the roadway is in cut, 16,115'± (71%) is in fill and 1185'± (5%) is approximately at grade.

FIELD INVESTIGATION

The field investigation included the following specific areas:

1) Observation wells were installed to monitor the water table elevation in two cut areas.
2) Six test pits were dug to observe the condition of the sub-base and pavement structure and to obtain samples for laboratory testing. Single test pits were dug in the project east and west of the area under investigation in order to compare the materials and conditions.
3) Crack and rutting surveys were conducted in the area of the test pits to record the type and extent of surface distress.
4) Six cores were taken from the pavement to record depth and obtain samples for laboratory testing.

FIELD OBSERVATIONS AND LABORATORY TEST RESULTS

Test Pits

Logs of the eight (8) test pits can be seen on pages 17 - 24.

Moisture Contents, Water Table and Ice Lens

At the time the test pits were dug, moisture levels were not significant in the various layers of material with the exception of test pit 1. At that location, moisture was observed seeping out of the interface between the penetration macadam and sub-base. The sub-base had moisture contents ranging from 11% to 18%. Very small localized pockets of moisture were also noted in test pits 2 and 4, both fill sections. Moisture levels in test pits 2, 3, 7, and 8 ranged from 5% to 9% in the gravel and 4% to 14% in the subgrade material.

Ice lenses were noted at scattered locations in test pit 1 excavated on March 23, 1983. Ice lenses were not observed in test pit 2 excavated on March 24 or in test pits 3-8 excavated on March 31 and April 1. The District Transportation Administrator has reported the presence of ice lenses in both cut and fill areas when examinations had been made during cold weather in past years.

Observation wells were placed in two cut sections where water was noted seeping from cracks in the shoulder pavement. The observation well at Station 235+70, 40' east of test pit 1 revealed a water level within 7" of the pavement surface. The wells at Station 224+00 disclosed the water table within 24" of the pavement surface 6' right of centerline and within 16" of the surface 17.5' left of centerline on the shoulder.

Several of the underdrain outlets were checked and found to be flowing; however, it could not be determined if the flow was from the roadway or the cut slopes.

Gravel Gradation

The 6 gravel samples obtained from the project were high in fines (see Table 1, page 4). Based upon the current gradation requirement, 3 of the 6 samples exceeded the allowed 50% passing the No. 4 sieve with the 6 samples averaging 49% passing. On the sand portion, all samples exceeded the 20% maximum passing the No. 100 seive with an average of 46%. All samples also exceeded the 12% limit on the No. 200 sieve with an average of 36%.

The sample from the adjacent easterly project met the No. 4 sieve requirement but exceeded the 100 and 200 sieve requirements with values of 31% and 22% respectively. The sample from the westerly project exceeded the No. 4, No. 100, and No. 200 requirements with values of 53%, 30%, and 21% respectively.

TABLE I

GRADATION OF CRUSHED GRAVEL FOR SUB-BASE
(COARSE GRADED)

GRADATION REQUIREMENTS			TEST HOLE NUMBER								
Sieve Size	1976 Spec. % Passing	1956 Spec. % Passing	1	2	3	4	5	7	Proj. Avg.	6*	8**
	(Total Sample)										
4 inches	95-100	100	100	100	100	100	100	100		100	100
No. 4	25-50	25-50	45	44	51	46	45	54	49%	36	53
	(Sand Portion)										
No. 4	100	100	100	100	100	100	100	100		100	100
No. 100	0-20	0-15	51	39	50	50	53	36	46%	31	30
No. 200	0-12	NA	41	28	40	40	43	27	36%	22	21
No. 270	NA	0-6	12	12	10	15	21	17	14%	15	12
(% total sample passing #200)			18	12	20	18	23	15	18%	8	11
(% total sample passing #270)			5	5	5	7	11	9	7%	5	6

Percent of Wear	1976 Spec.	Test Hole #3	Test Hole #6
40% Max.	(AASHTO T-96)	29.2	29.2
25% Max.	(AASHTO T-4)	10.9	10.8

*Located east of project
**Located west of project

Gravel Percent of Wear

All samples tested met the current wear requirements.

Pavement Condition and Values

Pavement surveys were made adjacent to 5 of the 6 test pit locations. The surveys revealed depressions in the pavement surface over and adjacent to transverse cracks averaging 9/16" in depth immediately above the cracks and tapering back to the normal grade over an average width of 34 inches.

Wheel path rutting was generally insignificant, averaging 3/16" with a maximum of 5/8".

An average of 351 linear feet of cracks was noted per 100 linear feet of 24 foot roadway. Transverse cracks made up 56 percent of the total. The remaining cracks included 42 percent longitudinal and 2 percent miscellaneous. The longitudinal cracks were generally not located in wheel path areas.

The shoulder pavement exhibited fewer transverse cracks and depressions over the area of the cracks were negligible.

Pavement cores taken from the project disclosed a range of 3 3/4" to 5 3/4" of bituminous concrete pavement. With the 3" penetration macadam course included, the total thickness of the bituminous material averaged 7 13/16 inches. Samples analyzed to date indicate an average asphalt content of 6.2% with recovered penetration values ranging from 35 to 58 with an average value of 43. (See Table 2, page 6). There was no evidence of stripping in the surface courses or the penetration macadam.

TABLE 2

ABSON RECOVERY ASPHALT RESULTS FROM ROADWAY CORES

Core #	Station	Bitumen % AC	Abs.Vis. 140° F Poises	Kine. Vis. 250° F Centistokes	Penetration
1					
Orig.Mix.	4.00	5.92	34,961	1711	35
Overlays	185+14 5' Rt.	6.16	19,567	1075	37
2					
Orig.	4.50	7.40	9,713	685	36
Orig.Top	211+54 5' Lt.	6.14	4,224	493	51
Overlays		5.45	11,373	800	40
3					
Orig.Bind.	4.73	6.16	7,752	615	38
Orig.Top	223+68 5' Lt.	6.05	11,740	702	40
Overlay-1968		6.66	7,488	681	44
Overlay-1974		6.09	18,030	848	38
4	4.96 235+82 5' Rt.	Not Processed. Cut Longitudinally With Diamond Saw For Visual Examination of Pavement Lifts.			
5					
Orig.Bind.	6.85	4.69	3,618	461	48
Orig.Top	335+61 5' Lt.	6.77	4,645	490	55
Overlays		6.33	5,482	558	58
6					
Orig.Mix.	8.42	6.52	12,268	989	40
Overlays	409+00 5' Rt.	6.82	8,989	717	46
Average Results		6.23	11,418	773	43

SUMMARY OF FINDINGS

The field investigation and laboratory testing disclosed the following significant findings:

1. At the time the test pits were dug, moisture levels were not significant in the various materials with the exception of test pit 1.

2. Observation wells placed in two wet appearing cut sections disclosed water levels within a range of 24" to 7" of the pavement surface.

3. Ice lens were noted in the first test pit excavated on March 23, 1983 but were not observed in additional pits excavated on March 24, March 31, or April 1, 1983.

4. All project samples of the sub-base of crushed gravel were high in fines with the sand portion averaging 46% passing the No. 100 sieve and 36% passing the No. 200 sieve. Samples from the adjacent easterly and westerly projects averaged 30% passing the 100 sieve and 21% passing the 200 sieve. All samples tested met the current wear requirements.

5. An average of 351 linear feet of cracks were noted per 100 linear feet of 24 foot roadway. Depressions in the pavement surface over and adjacent to transverse cracks averaged 9/16" in depth immediately above the cracks and tapered back to the normal grade over an average width of 34 inches. Wheel path rutting was generally insignificant, averaging 3/16" with a maximum of 5/8".

6. Pavement cores indicated an average thickness of 4 13/16 inches plus an estimated 3 inches of penetration macadam. The recovered asphalt had penetration values ranging from 35 to 58 with an average of 43.

DISCUSSION OF FINDINGS

The field observations and lab test results suggest that the high percentage of fines in the sub-base was the main factor which led to the distress found on the roadway in question. Other contributing factors included surface and capillary moisture, high water tables, frost action, and the development of ice lens.

The poor riding quality is primarily caused by depressions in the pavement surface over and adjacent to transverse cracks. The depressions are believed to have been caused by frost action and/or the loss or displacement of fines in the sub-base of crushed gravel resulting from the infiltration of surface water down through cracks. Pumping of both surface and subsurface water under traffic may have also contributed to the problem.

The fact that pavement distress is basically the same in high fills or wet cuts suggests that surface moisture may be more critical than sub-surface moisture sources.

The riding quality of the pavement is reported to be essentially the same during both summer and winter seasons. For that reason, the development of ice lens in both the sub-base of crushed gravel and the penetration macadam may be considered less significant than the problem with loss or movement of fines.

Following periods of rainfall, moisture can be seen seeping from cracks in the paved shoulders. The condition suggests that surface moisture is able to move through the coarse graded penetration macadam but is not able to dissapate through the less porous shoulder gravel.

Pavement cracking was significant but not unusually high at 351 feet per 100 feet of roadway. By comparison, Rte 66 in Randolph had 851'/100', Rte 4 in Sherburne had 679'/100', and Rte 2 in East Montpelier also constructed in 1961 has up to 1051'/100' of roadway. The absence of longitudinal wheel path cracking and wheel path rutting vaules averaging less than 1/4" suggests that the sub-base is providing significant support under traffic.

Recovered asphalt penetration values averaging 43 suggest that the existing bituminous concrete pavement would be suitable for hot recycling.

Fewer transverse cracks and related depressions were noted in the thinner shoulder pavement. The major differences between driving lane and shoulder typicals were the absence of the penetration macadam on the shoulders and the substitution of 3" of fine graded gravel in place of 3" of bituminous concrete pavement. The reduced level of distress may be due to lower traffic volume, improved drainage of the sub-base due to the adjacent slope line and differences in the flexibility provided by the penetration macadam versus the gravel.

POTENTIAL CORRECTIVE TREATMENTS

Potential corrective treatments include the following:

1. Remove all or a portion of the sub-base of crushed gravel and replace with specification material.
2. Remove a portion of the sub-base of gravel and place and thoroughly mix crushed stone or clean sand with the remaining gravel, with the intent of lowering the percent of fines.

3. Scarify and pulverize the 7 3/4"± of existing bituminous materials and thoroughly mix it with approximately 4" of the existing sub-base of crushed gravel. The resulting 12"± base would have an asphalt content in the range of 3% to 3 ¼% which would be sufficient to help bind the new base together without the addition of asphalt if properly blended and compacted at the optimum moisture content.

Should treatment 1 or 2 be selected, then hot recycling of the existing pavement should be considered.

The treatment selected for the 24' roadway should also be considered for shoulder areas to reduce the possibility of future drainage problems.

If the existing sub-base is not removed, underdrain should be installed in cut areas where the water table/moisture levels are high. Due to the high level of fines in the gravel, placement should be as close to the travel lane as possible to insure drainage from that area.

In the event that the method of corrective treatment does not reduce the percent of fines in the existing sub-base, the surface treatment should include provisions which would prohibit the future infiltration of surface moisture. At a minimum, cracks which develop in the pavement should be filled with rubberized asphalt as soon as possible.

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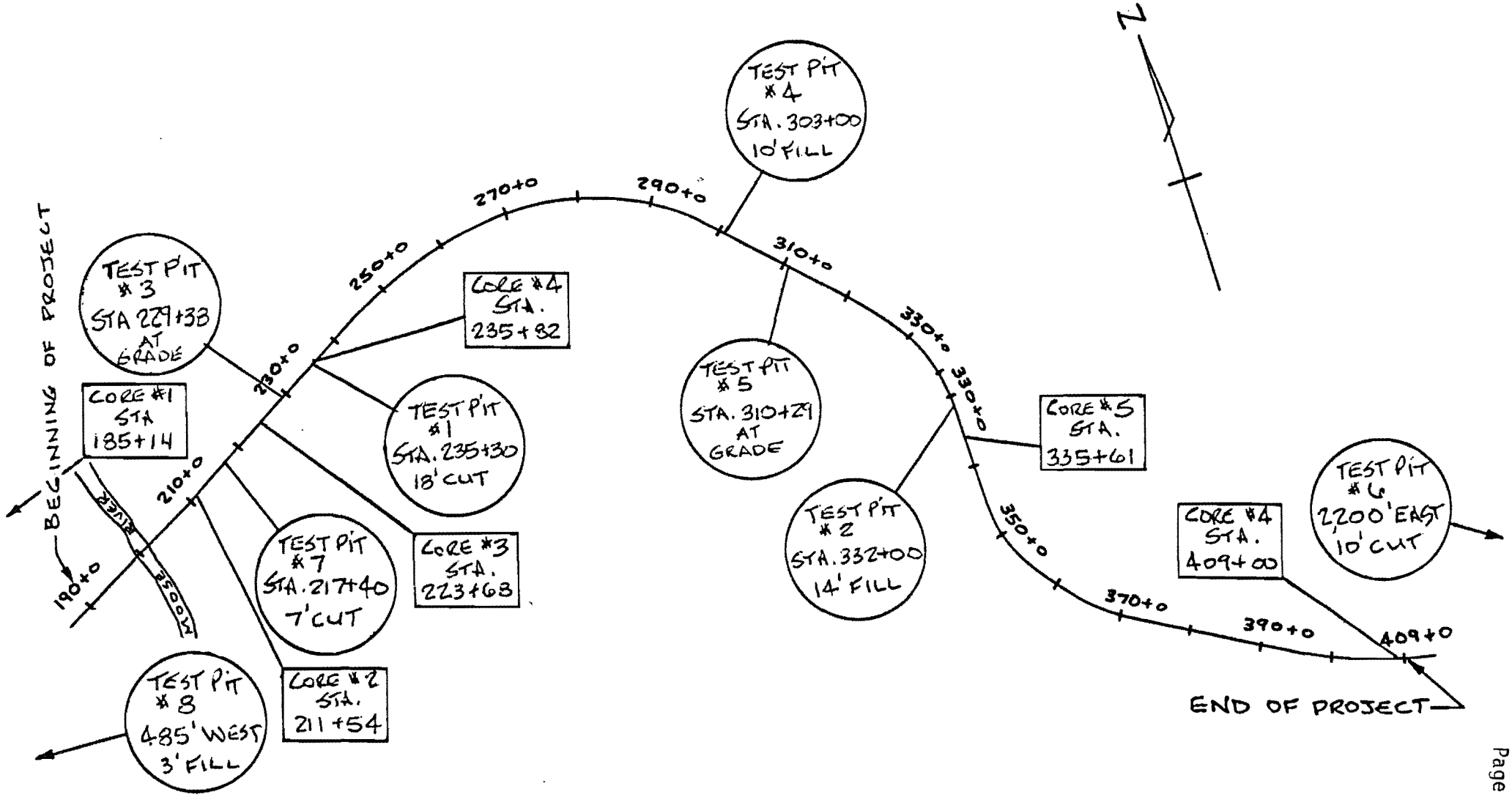
PROJECT PLAN VIEW

BEGIN PROJECT AT MM 4.092 = STA. 190+00



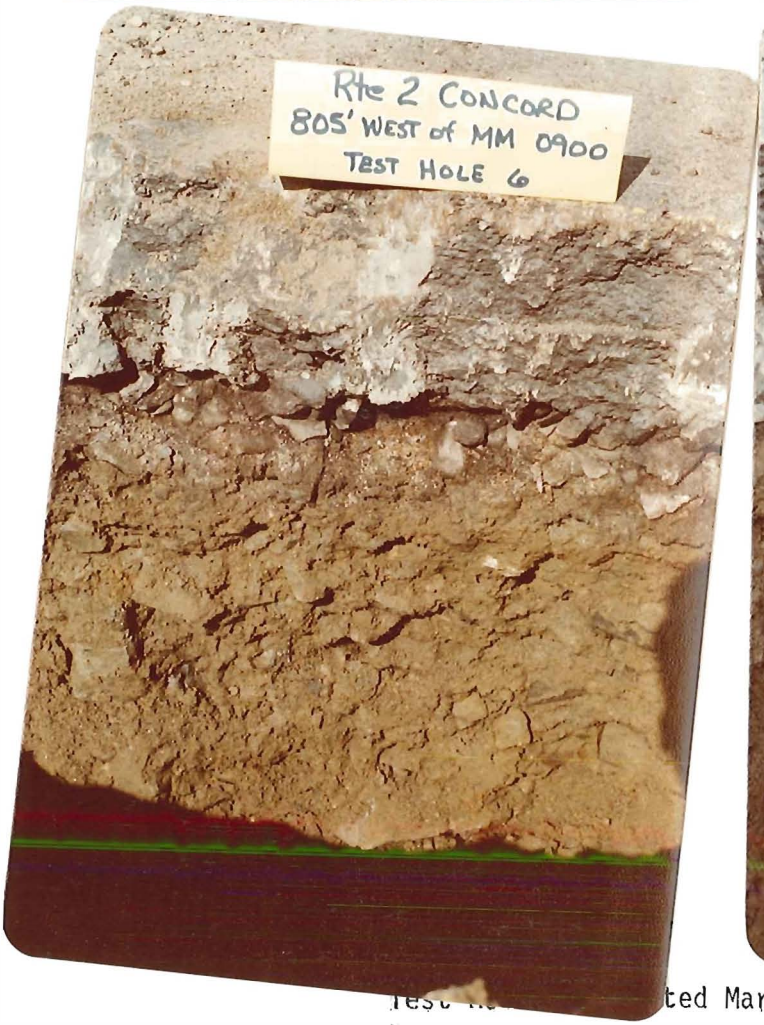
Water Seeping Out Of Macadam -
Sub-base Interface On Test Hole 1

Test Hole 1

Test Hole 2

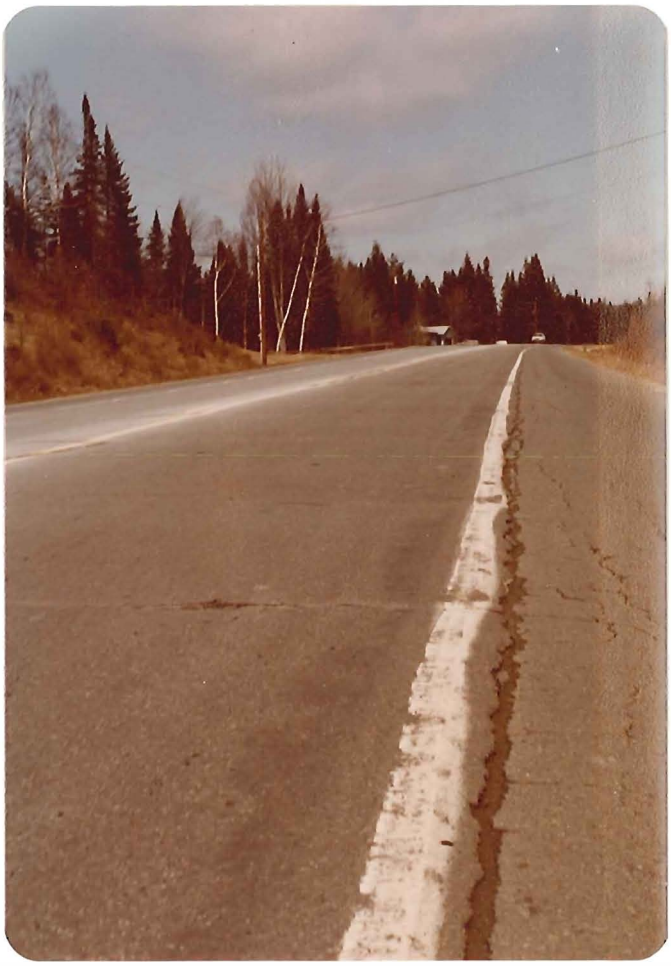
Rte 2 Concord
sta 303+00
TEST HOLE 4

Rte 2 Concord
sta 310+29
TEST HOLE 5


Rte 2 CONCORD
805' WEST of MM 0900
TEST HOLE 6

Rte 2 CONCORD
sta 217+40
TEST HOLE 7

Depression Over Transverse Crack In EB Lane



Note Depressions Over Transverse Cracks

Crew: ADAMS

Date: 3/23/83
Weather: CLEAR 20°-25°F

ROADWAY STRUCTURE LOG

PROJECT: RTE. 2 CONCORD

LOCATION: TEST PIT #1 STA. 235+30
12' RT. OF ℄ MM 4.950

DEPTH		COMMENTS
0'-3" 0'-6" 0'-9"	PAVEMENT 0" TO 9½"	NO VISIBLE MOISTURE
1'-0" 1'-3" 1'-6" 1'-9" 2'-0" 2'-3" 2'-6"	SUB-BASE 9½" TO 30"	POCKET OF WATER OBSERVED AT BOTTOM OF PENETRATION MACADAM. ICE LENSES VISIBLE. CRUSHED GRAVEL WITH SOME SILT MOIST
2'-9' 3'-0" 3'-3" 3'-6" 3'-9" 4'-0"	SUB-GRADE	

Crew: LANEA, FRAGOIA, HOUSTON, DUBOIS
Date: 3/31/83
Weather: CLOUDY 20°-25°F

ROADWAY STRUCTURE LOG

PROJECT: RTE. 2 CONCORD

LOCATION: TEST PIT #2 STA. 332+00
12' RT. OF ℄ MM 6.781

DEPTH		COMMENTS
0'-3"	PAVEMENT 0" TO 7"	NO VISIBLE MOISTURE
0'-6"		
0'-9"	SUB-BASE 7" TO 25"	CRUSHED GRAVEL W/ SOME SILT & STONES OVER 4" MOIST WATER POCKET @ 21"
1'-0"		
1'-3"		
1'-6"		
1'-9"		
2'-0"		
2'-3"	SUB-GRADE	
2'-6"		
2'-9'		
3'-0"		
3'-3"		
3'-6"		
3'-9"		
4'-0"		

Crew: FRASCOIA, HOUSTON, DUBOIS, LANZA
Date: 3/31/83
Weather: CLEAR 20°-25°F

ROADWAY STRUCTURE LOG

PROJECT: RTE. 2 CONCORD

LOCATION: TEST PIT #3 STA. 229+38
12' RT. OF ℄ MM 4.838

DEPTH	COMMENTS
0'-3" 0'-6" 0'-9"	PAVEMENT 0" TO 9" — NO VISIBLE MOISTURE
1'-0" 1'-3" 1'-6" 1'-9" 2'-0" 2'-3"	SUB-BASE 9" TO 26½" — SUB-BASE OF CRUSHED GRAVEL (COARSE GRADED) SILTY AND SLIGHTLY MOIST.
2'-6" 2'-9' 3'-0"	SUB-GRADE 26½" TO 38" — FINE SAND & STONES SLIGHTLY MOIST
3'-3" 3'-6" 3'-9" 4'-0"	

Crew: LANZA, FRASCOIA, HOUSTON, DUBOIS
Date: 4/1/83
Weather: CLOUDY 30°-35°F

ROADWAY STRUCTURE LOG

PROJECT: RTE. 2 CONCORD

LOCATION: TEST PIT #4 STA. 303+00
11' RT. OF ℄ MM 6.232

DEPTH		COMMENTS
0'-3"	PAVEMENT 0" TO 7"	NO VISIBLE MOISTURE
0'-6"		
0'-9"	SUB-BASE 7" TO 25½"	COARSE GRADED GRAVEL SILTY WITH SOME STONES OVER 4"
1'-0"		
1'-3"		
1'-6"		
1'-9"		
2'-0"		
2'-3"	SUB-GRADE	
2'-6"		
2'-9'		
3'-0"		
3'-3"		
3'-6"		
3'-9"		
4'-0"		

Crew: LANZA, FRASCOIA, HOUSTON, DUBOIS
Date: 4/1/83
Weather: CLOUDY 30°-35°F

ROADWAY STRUCTURE LOG

PROJECT: RTE. 2 CONCORD

LOCATION: TEST PIT #5 STA. 310+29
12' RT. OF ℄ MM 6.370

DEPTH		COMMENTS
0'-3"	PAVEMENT 0" TO 7"	NO VISIBLE MOISTURE
0'-6"		
0'-9"	SUB-BASE 7" TO 24"	CRUSHED GRAVEL SILTY, SOME STONES OVER 4"
1'-0"		
1'-3"		
1'-6"		
1'-9"		
2'-0"	SUB-GRADE	
2'-3"		
2'-6"		
2'-9'		
3'-0"		
3'-3"		
3'-6"		
3'-9"		
4'-0"		

Crew: LANZA, FRASCOIA, HOUSTON, DUBOIS
Date: 4/1/83
Weather: CLOUDY 30°-35°F

ROADWAY STRUCTURE LOG

PROJECT: RTE. 2 CONCORD

LOCATION: TEST PIT #6 MM 8.848
12' RT. OF ℄

DEPTH		COMMENTS
0'-3"	PAVEMENT 0" TO 7"	NO VISIBLE MOISTURE
0'-6"		
0'-9"	SUB-BASE 7" TO 27"	CRUSHED GRAVEL, COARSE SOME STONES OVER 4" SILTY
1'-0"		
1'-3"		
1'-6"		
1'-9"		
2'-0"		
2'-3"		
2'-6"	SUB-GRADE	
2'-9'		
3'-0"		
3'-3"		
3'-6"		
3'-9"		
4'-0"		

Crew: FRASCOIA, HOUSTON, DUBOIS, LANZA
Date: 4/1/83
Weather: CLOUDY 30°-35°F

ROADWAY STRUCTURE LOG

PROJECT: RTE. 2 CONCORD

LOCATION: TEST PIT #7 STA. 217+40
12' RT. OF ℄ MM 4.611

DEPTH		COMMENTS
0'-3"	PAVEMENT 0" TO 9"	NO VISIBLE MOISTURE
0'-6"		
0'-9"		
1'-0"	SUB-BASE 9" TO 29"	COARSE GRADED CRUSHED GRAVEL SILTY - FINE SAND SOME STONES OVER 4"
1'-3"		
1'-6"		
1'-9"		
2'-0"		
2'-3"		
2'-6"	SUB-GRADE 29" TO 38"	FINE SAND AND STONES
2'-9'		
3'-0"		
3'-3"		
3'-6"		
3'-9"		
4'-0"		

Crew: LANZA, FRASCOIA, HOUSTON, DUBOIS
Date: 4/1/83
Weather: CLOUDY 30°-35°F

ROADWAY STRUCTURE LOG

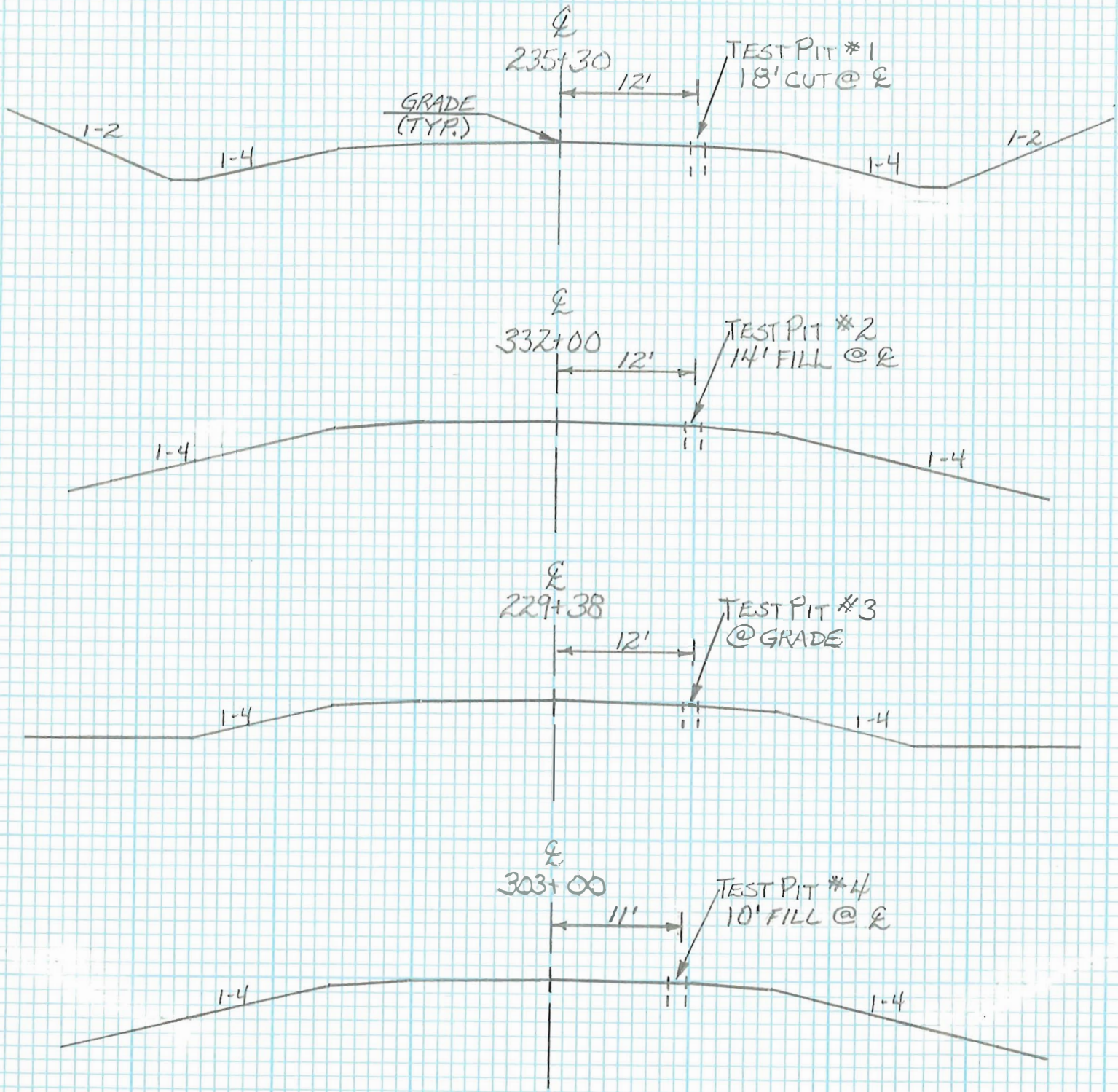
PROJECT: RTE. 2 CONCORD

LOCATION: TEST PIT #8 MM 4.000
12' LT. OF ℄

DEPTH		COMMENTS
0'-3"	PAVEMENT 0" TO 6½"	NO VISIBLE MOISTURE
0'-6"		
0'-9"	SUB-BASE 6½" TO 24½"	COARSE GRADED GRAVEL SILTY AND DAMP
1'-0"		
1'-3"		
1'-6"		
1'-9"		
2'-0"		
2'-3"	SUB-GRADE 24½" TO 29½"	FINE SAND, SMALL STONES DAMP AND SILTY
2'-6"		
2'-9'		
3'-0"		
3'-3"		
3'-6"		
3'-9"		
4'-0"		

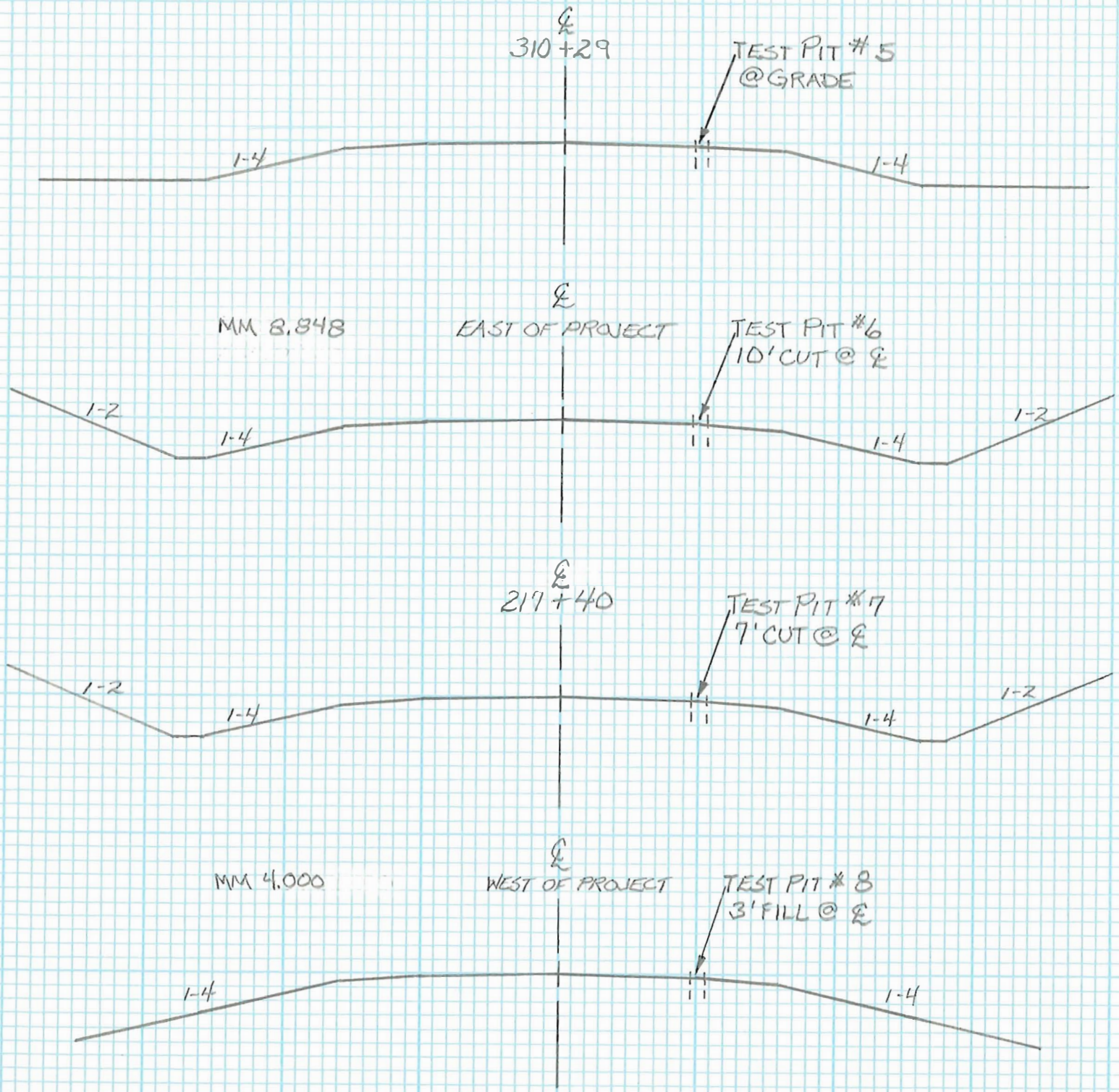
VERMONT A.O.T.
RESEARCH INVESTIGATION
R 83-2

CONCORD - U.S. RTE 2
TEST PITS



CROSS SECTIONS
SCALE: N.T.S.
DRAWN BY: N.H. DATE 4/83

CONCORD - U.S. RTE 2
TEST PITS



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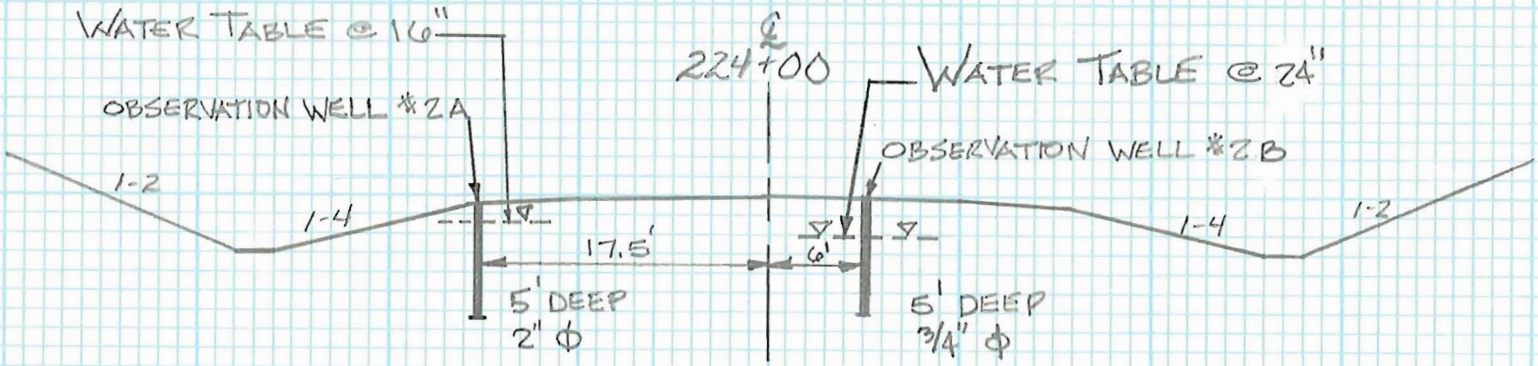
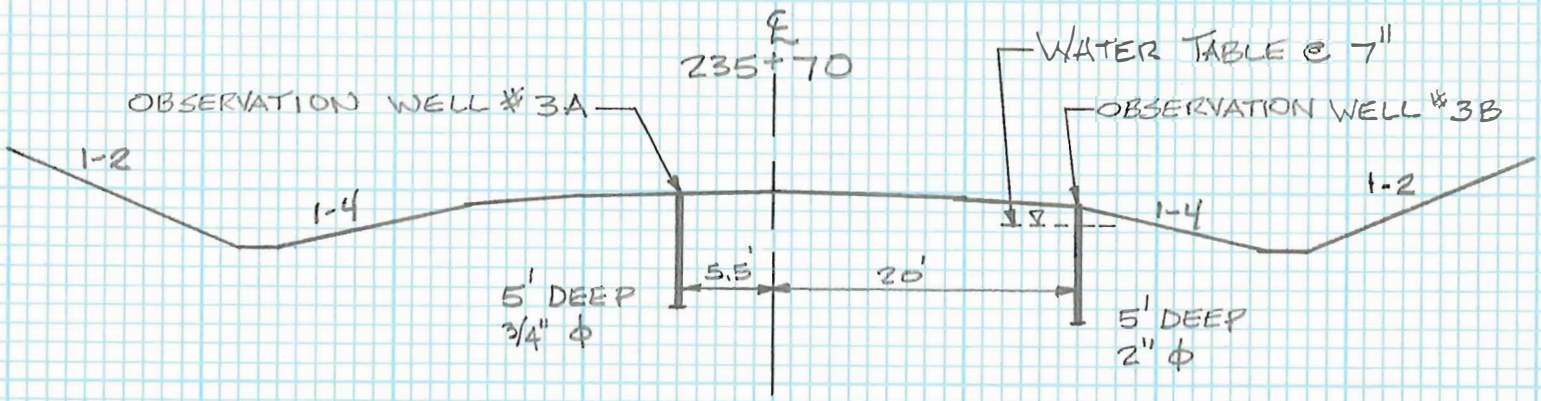
CONCORD - U.S. RTE. 2
OBSERVATION WELLS





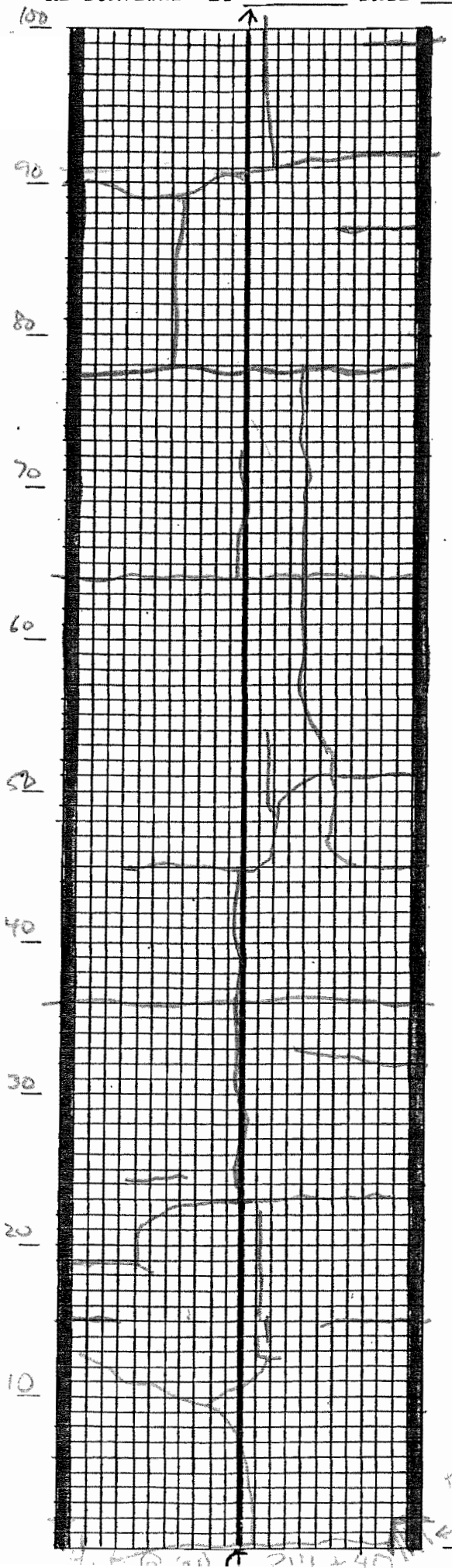
CROSS SECTIONS

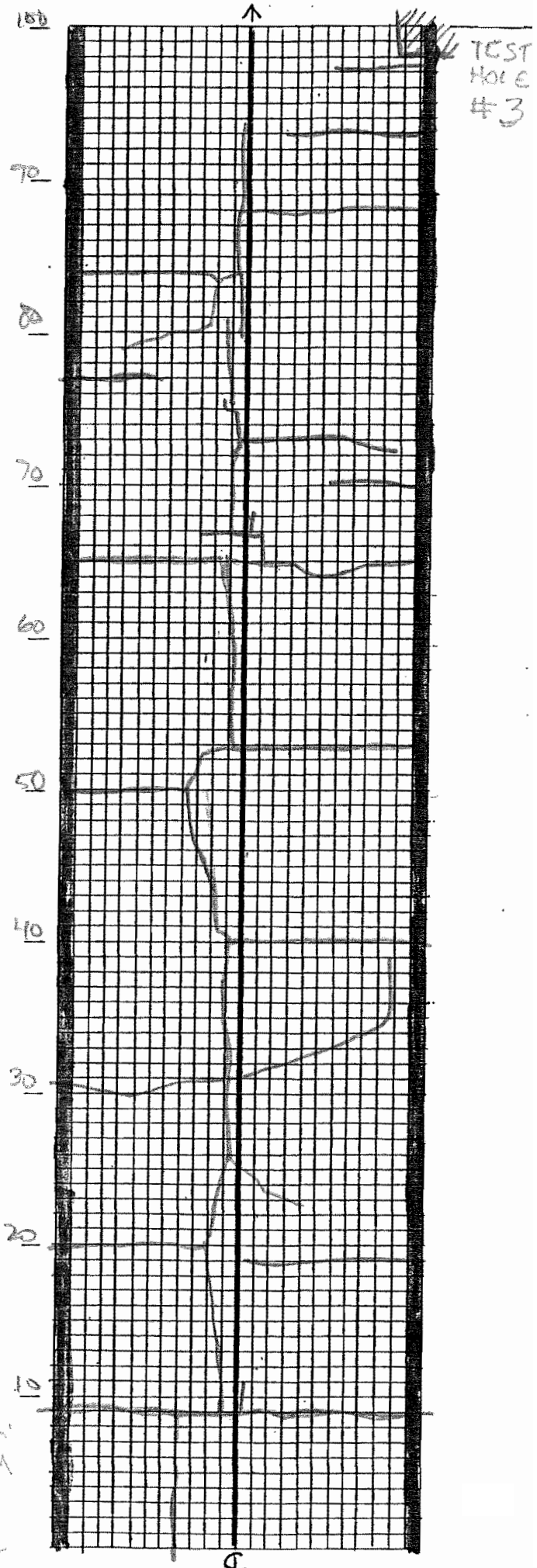
SCALE: N.T.S.

DRAWN BY: N.H. DATE 4/83

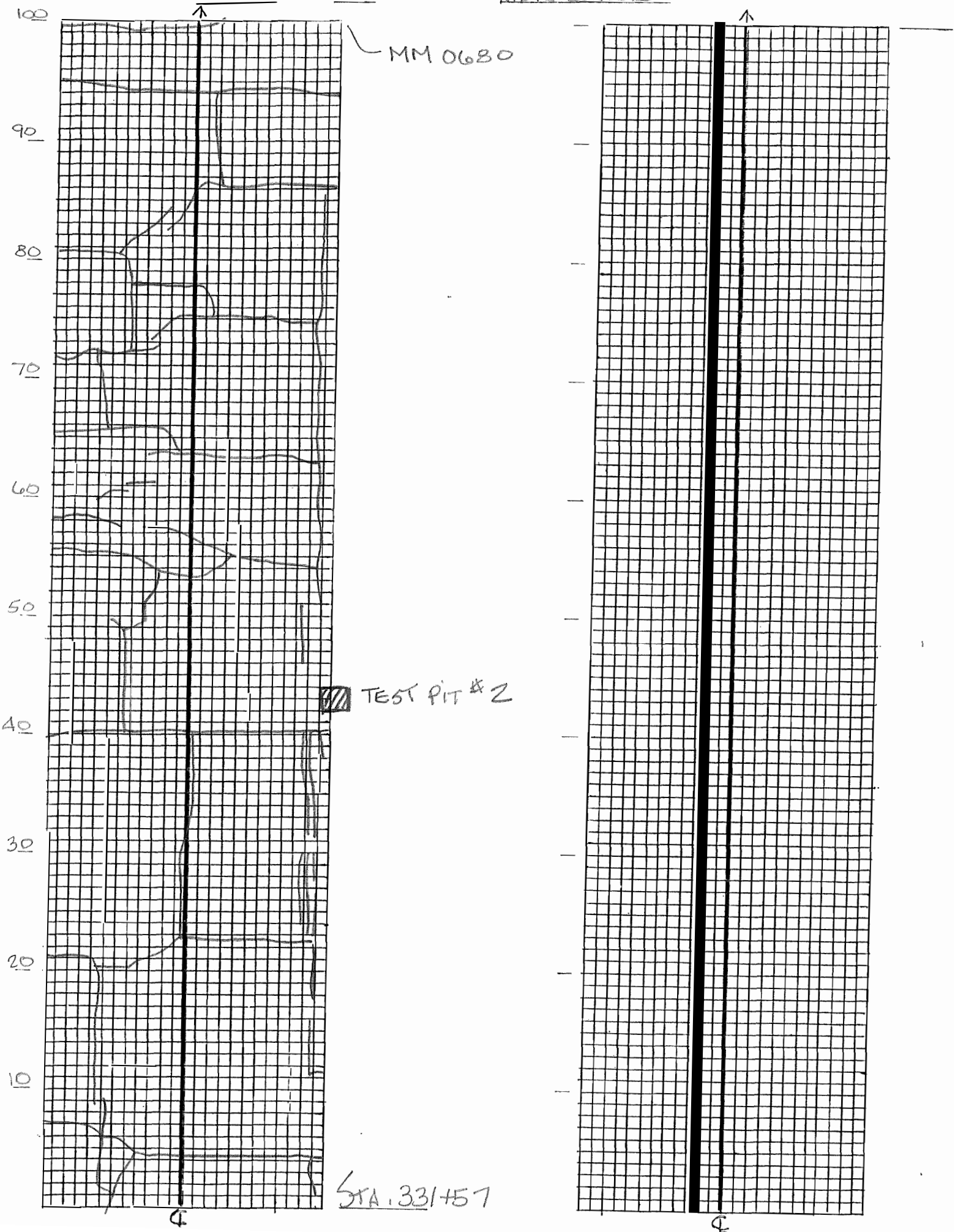
ORIG. SURVEY BY RF DH GD DATE 3.31.83 PAVEMENT CONDITION SURVEY

RE-SURVEYED BY _____ DATE _____ PROJECT Rte 2 Concord



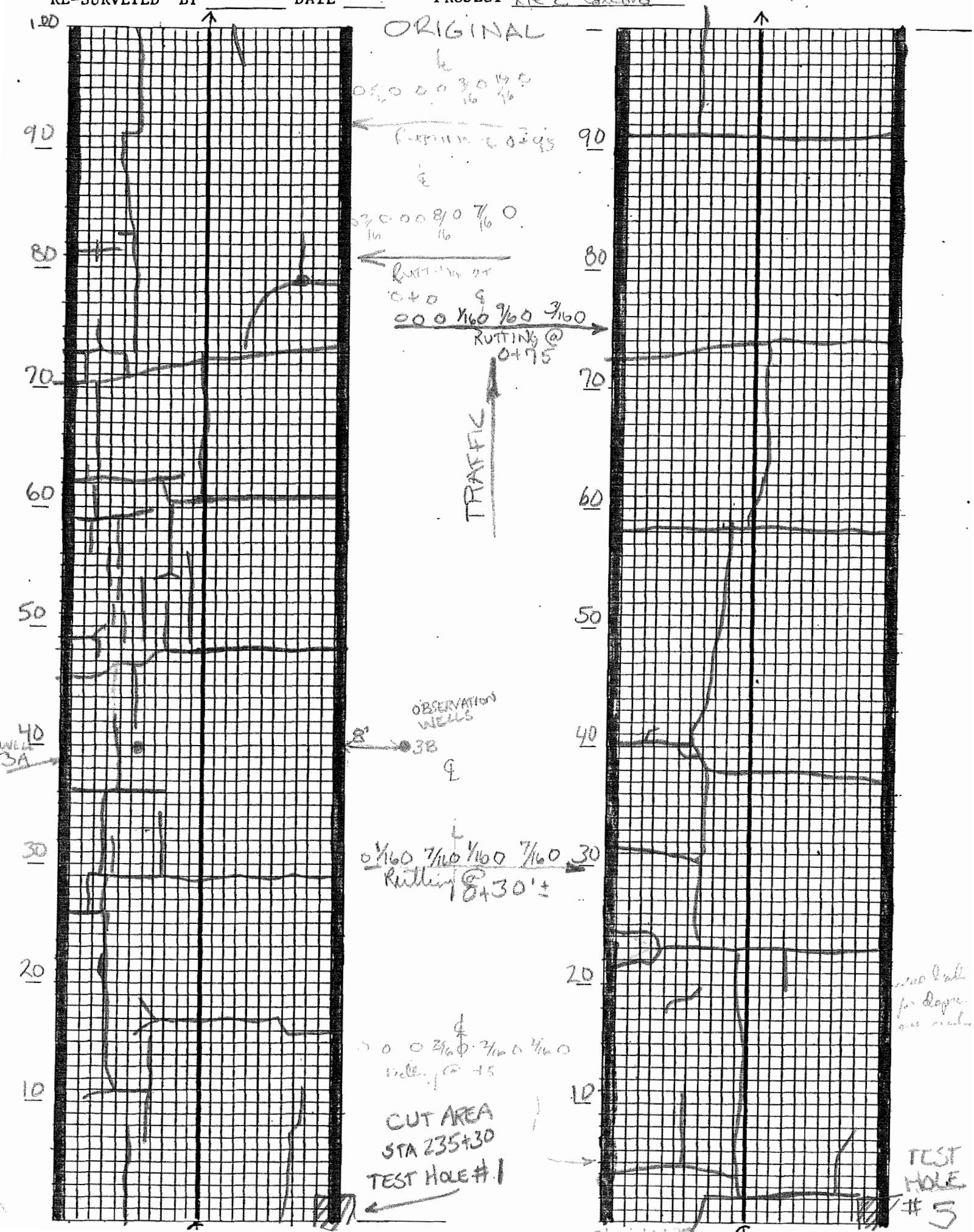


ORIG. SURVEY BY FRASCOIA DATE 3/31/83 PAVEMENT CONDITION SURVEY
RE-SURVEYED BY _____ DATE ____ PROJECT RTE. 2 CONCORD



ORIG. SURVEY BY [illegible] DATE 3·31·83 PAVEMENT CONDITION SURVEY

RE-SURVEYED BY _____ DATE ____ PROJECT Rte 2, Concord



Vermont Agency of Transportation
Materials & Research Division

CRACK COUNT SUMMARY SHEET

Location & Route CONCORD RTE. 2 Job Number
Experimental Feature Width of Roadway 24'

Code for Crack Type

Type A = Transverse from shoulder to shoulder
Type B = All other cracks of transverse nature
Type C = Longitudinal of any nature
Type D = Miscellaneous

	Date	Original 3/31/83	/ /	/ /	/ /	/ /	/ /	/ /	/ /
	Section #1								
TEST PIT #1	Type A	48							
	Type B	105							
	Type C	194							
	Type D	12							
	Total	359'							
	Avg./100' of roadway	359'							
	Section #2								
TEST PIT #2	Type A	96							
	Type B	164							
	Type C	220							
	Type D	13							
	Total	493							
	Avg./100' of roadway	493'							
	Section #3								
TEST PIT #3	Type A	48							
	Type B	154							
	Type C	103							
	Type D	9							
	Total	314							
	Avg./100' of roadway	314'							
	Section #5								
TEST PIT #5	Type A	72							
	Type B	89							
	Type C	101							
	Type D	2							
	Total	264							
	Avg./100' of roadway	264'							

CRACK COUNT SUMMARY SHEET

Location & Route CONCORD RTE. 2 Job Number _____
Experimental Feature _____ Width of Roadway 24'

Code for Crack Type

Type A = Transverse from shoulder to shoulder
Type B = All other cracks of transverse nature
Type C = Longitudinal of any nature
Type D = Miscellaneous

	Original							
Date	3/31/83	/ /	/ /	/ /	/ /	/ /	/ /	/ /
Section # 1								
Type A	96							
Type B	110							
Type C	111							
Type D	7							
Total	324							
Avg./100' of roadway	324'							
Section #								
Type A								
Type B								
Type C								
Type D								
Total								
Avg./100' of roadway								
Section #								
Type A								
Type B								
Type C								
Type D								
Total								
Avg./100' of roadway								
Section #								
Type A								
Type B								
Type C								
Type D								
Total								
Avg./100' of roadway								

TEST PIT #7

Frascoia (7)
Lanza
CF

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Montpelier, Vermont 05602

REPORT ON SAMPLE OF AGGREGATE

Report 4-5, 19 83

Laboratory No. A83 0056 Tested By Lavin

Name Crushed Gravel for Sub-base 301.25

Identification Marks

Submitted by Lanza Title Geologist Address

Sampled 3-31, 19 83 Received 4-1, 19 83 Testing Completed: 4-4-83

Sample from Test Pit #1 12' rt. of Sta 235+30

Quantity Represented 9½" - 30"

Source of Material Austin pit Concord

Location used or to be used Concord

Examined for Item 704.07

TEST RESULTS

Total Sample Sieve Size	% Passing
4 1/2"	
4"	
3 1/2"	
3"	
2 1/2"	100
2"	100
1 3/4"	90
1 1/2"	85
1"	76
3/4"	70
5/8"	
1/2"	63
3/8"	59
No. 4	45
No. 8	
No. 10	
No. 16	
No. 30	
No. 50	
No. 100	
No. 200	
No. 270	

Fineness Modulus % Coarser Than	
No. 100	49
No. 50	39
No. 30	29
No. 16	19
No. 8	8
No. 4	

Fineness Modulus = 1.44

Comments:

Sand Portion

51
41
12 dry

Percent of Wear

AASHTO T3
AASHTO T4
AASHTO T96

Fractured Faces, %

Thin & Elongated Pieces, %

Soundness, % Loss

S. J. Gage, P.E., Chief Engineer

By: R. F. Nicholson 1/B47
R. F. Nicholson, P.E., Materials & Research Engineer

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Montpelier, Vermont 05602

REPORT ON SAMPLE OF AGGREGATE

Report 4-5, 19 83

Laboratory No. A83 0054 Tested By Lavin

Name Crushed Gravel for Sub-base 301.25

Identification Marks

Submitted by Lanza Title Geologist Address

Sampled 3-31, 19 83 Received 4-1, 19 83 Testing Completed: 4-4-83

Sample from Test pit #2 Sta 332+00 12' rt. of ℄

Quantity Represented 7" - 25"

Source of Material Austin pit Concord

Location used or to be used Concord

Examined for Item 704.07

TEST RESULTS

Sieve Size	Total Sample % Passing
4 1/2"	
4"	
3 1/2"	
3"	
2 1/2"	100
2"	89
1 3/4"	85
1 1/2"	83
1"	70
3/4"	66
5/8"	
1/2"	61
3/8"	55
No. 4	44
No. 8	
No. 10	
No. 16	
No. 30	
No. 50	
No. 100	
No. 200	
No. 270	

Fineness Modulus % Coarser Than	
No. 100	61
No. 50	48
No. 30	35
No. 16	22
No. 8	9
No. 4	

Fineness Modulus = 1.75

Comments:

Sand Portion	
	39
	28
	12 dry

Percent of Wear

AASHTO T3
AASHTO T4
AASHTO T96

Fractured Faces, %

Thin & Elongated Pieces, %

Soundness, % Loss

S. J. Gage, P.E., Chief Engineer

By: R. F. Nicholson /RAT
R. F. Nicholson, P.E., Materials & Research Engineer

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REPORT ON SAMPLE OF AGGREGATE

Report 4-5, 19 83

Laboratory No. A83 0057 Tested By Lavin

Name Crushed Gravel for Sub-base 301.25

Identification Marks

Submitted by Lanza Title Geologist Address

Sampled 3-31, 19 83 Received 4-1, 19 83 Testing Completed: 4-4-83

Sample from Test hole #3 200' east of MM 0480

Quantity Represented 9" - 26" sample @ 17"

Source of Material Austin pit Concord

Location used or to be used Concord

Examined for Item 704.07

TEST RESULTS

Total Sample Sieve Size	% Passing
4 1/2"	
4"	
3 1/2"	100
3"	88
2 1/2"	88
2"	78
1 3/4"	78
1 1/2"	78
1"	74
3/4"	71
5/8"	
1/2"	65
3/8"	60
No. 4	51
No. 8	
No. 10	
No. 16	
No. 30	
No. 50	
No. 100	
No. 200	
No. 270	

Fineness Modulus % Coarser Than	
No. 100	50
No. 50	40
No. 30	30
No. 16	19
No. 8	8
No. 4	

Fineness Modulus = 1.47

Comments:

Sand Portion
50
40
10 dry

Percent of Wear

AASHTO T3
AASHTO T4 10.9
AASHTO T96 29.2
A Grading
Fractured Faces, %
Thin & Elongated Pieces, %
Soundness, % Loss

S. J. Gage, P.E., Chief Engineer

By: R. F. Nicholson RAF
R. F. Nicholson, P.E., Materials & Research Engineer

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REPORT ON SAMPLE OF AGGREGATE

Report 4-5, 1983

Laboratory No. A83 0058 Tested By Lavin

Name Crushed Gravel For Sub-base 301.25

Identification Marks

Submitted by Lanza Title Geologist Address

Sampled 3-31, 19 83 Received 4-1, 19 83 Testing Completed: 4-4-83

Sample from Test Pit #4 Sta 303+00 11' Rt. ℄

Quantity Represented 7" - 25½"

Source of Material Austin pit Concord

Location used or to be used Concord

Examined for Item 704.07

TEST RESULTS

Sieve Size	Total Sample % Passing
4 1/2"	
4"	
3 1/2"	
3"	100
2 1/2"	93
2"	83
1 3/4"	77
1 1/2"	68
1"	64
3/4"	62
5/8"	
1/2"	57
3/8"	54
No. 4	46
No. 8	
No. 10	
No. 16	
No. 30	
No. 50	
No. 100	
No. 200	
No. 270	

Fineness Modulus % Coarser Than	
No. 100	50
No. 50	40
No. 30	30
No. 16	19
No. 8	8
No. 4	

Fineness Modulus = 1.47

Comments:

Sand Portion

50	
40	
15 dry	

Percent of Wear

AASHTO T3
AASHTO T4
AASHTO T96

Fractured Faces, %

Thin & Elongated Pieces, %

Soundness, % Loss

S. J. Gage, P.E., Chief Engineer

By: R. F. Nicholson 1/9/87
R. F. Nicholson, P.E., Materials & Research Engineer

Frascoia (7)
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Montpelier, Vermont 05602

REPORT ON SAMPLE OF AGGREGATE

Report 4-5, 19 83

Laboratory No. A83 0063 Tested By Lavin

Name Crushed Gravel for Sub-base 301.25

Identification Marks

Submitted by Lanza Title Geologist Address

Sampled 3-31, 19 83 Received 4-1, 19 83 Testing Completed: 4-4-83

Sample from Test Pit #5 Sta 310+29 11' Rt. ℄

Quantity Represented 7" - 24"

Source of Material Austin pit Concord

Location used or to be used

Examined for Item 704.07.

TEST RESULTS

Total Sample Sieve Size	% Passing
4 1/2"	
4"	
3 1/2"	100
3"	95
2 1/2"	75
2"	75
1 3/4"	75
1 1/2"	71
1"	65
3/4"	60
5/8"	
1/2"	56
3/8"	53
No. 4	45
No. 8	
No. 10	
No. 16	
No. 30	
No. 50	
No. 100	
No. 200	
No. 270	

Fineness Modulus % Coarser Than	
No. 100	47
No. 50	37
No. 30	27
No. 16	16
No. 8	6
No. 4	

Fineness Modulus = 1.33

Comments:

Sand Portion

53
43
21 dry

Percent of Wear

AASHTO T3
AASHTO T4
AASHTO T96

Fractured Faces, %

Thin & Elongated Pieces, %

Soundness, % Loss

S. J. Gage, P.E., Chief Engineer

By: R. F. Nicholson /RAF
R. F. Nicholson, P.E., Materials & Research Engineer

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REPORT ON SAMPLE OF AGGREGATE

Report 4-5, 19 83

Laboratory No. A83 0055 Tested By Lavin

Name Crushed Gravel for Sub-base 301.25

Identification Marks

Submitted by Lanza Title Geologist Address

Sampled 3-31, 1983 Received 4-1, 19 83 Testing Completed: 4-3-83

Sample from Test Pit #6 805' west of MM 0900

Quantity Represented 7" - 27"

Source of Material Austin pit Concord

Location used or to be used Concord F 131-(11)

Examined for Item 704.07

TEST RESULTS

Total Sample Sieve Size	% Passing
4 1/2"	
4"	
3 1/2"	
3"	
2 1/2"	
2"	100
1 3/4"	80
1 1/2"	74
1"	63
3/4"	57
5/8"	
1/2"	51
3/8"	46
No. 4	36
No. 8	
No. 10	
No. 16	
No. 30	
No. 50	
No. 100	
No. 200	
No. 270	

Fineness Modulus % Coarser Than	
No. 100	69
No. 50	59
No. 30	47
No. 16	30
No. 8	12
No. 4	

Fineness Modulus = 2.17

Comments:

Sand Portion

31
22
15 dry

Percent of Wear

AASHTO T3
AASHTO T4 10.8
AASHTO T96 29.2
A Grading
Fractured Faces, %
Thin & Elongated Pieces, %
Soundness, % Loss

S. J. Gage, P.E., Chief Engineer

By: R. F. Nicholson /RAF
R. F. Nicholson, P.E., Materials & Research Engineer

Frascoia (7)
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Montpelier, Vermont 05602

REPORT ON SAMPLE OF AGGREGATE

Report 4-5, 19 83

Laboratory No. A83 0059 Tested By Lavin

Name Crushed Gravel for Su-bbase 301.35

Identification Marks

Submitted by Lanza Title Geologist Address

Sampled 4-1, 1983 Received 4-1, 19 83 Testing Completed: 4-4-83

Sample from Test pit #7 Sta 217+40 12' Rt. of ℄

Quantity Represented 9" - 29"

Source of Material Austin pit Concord

Location used or to be used Concord F 028-4(1)

Examined for Item 704.07

TEST RESULTS

Total Sample Sieve Size	% Passing
4 1/2"	
4"	
3 1/2"	
3"	
2 1/2"	100
2"	91
1 3/4"	91
1 1/2"	88
1"	85
3/4"	82
5/8"	
1/2"	73
3/8"	68
No. 4	54
No. 8	
No. 10	
No. 16	
No. 30	
No. 50	
No. 100	
No. 200	
No. 270	

Fineness Modulus % Coarser Than	
No. 100	64
No. 50	54
No. 30	43
No. 16	29
No. 8	14
No. 4	

Fineness Modulus = 2.04

Comments:

Sand Portion

36
27
17 dry

Percent of Wear

AASHTO T3
AASHTO T4
AASHTO T96

Fractured Faces, %

Thin & Elongated Pieces, %

Soundness, % Loss

S. J. Gage, P.E., Chief Engineer

By: R. F. Nicholson /RAZ
R. F. Nicholson, P.E., Materials & Research Engineer

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Frascoia (7)
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Montpelier, Vermont 05602

REPORT ON SAMPLE OF AGGREGATE

Report 4-5, 19 83

Laboratory No. A83 0060 Tested By Lavin

Name Crushed Gravel for Sub-base 301.25

Identification Marks

Submitted by Lanza Title Geologist Address

Sampled 4-1, 19 83 Received 4-1, 19 83 Testing Completed: 4-4-83

Sample from Test pit #8 opposite MM 0400 North side of road 12' lt. ℄

Quantity Represented 6.5" - 24.5"

Source of Material

Location used or to be used

Examined for Item 704.07

TEST RESULTS

Total Sample Sieve Size	% Passing
4 1/2"	
4"	
3 1/2"	
3"	100
2 1/2"	86
2"	86
1 3/4"	86
1 1/2"	86
1"	75
3/4"	72
5/8"	
1/2"	66
3/8"	62
No. 4	53
No. 8	
No. 10	
No. 16	
No. 30	
No. 50	
No. 100	
No. 200	
No. 270	

Fineness Modulus % Coarser Than	
No. 100	70
No. 50	59
No. 30	42
No. 16	25
No. 8	11
No. 4	

Fineness Modulus = 2.07

Comments:

Percent of Wear

AASHTO T3
AASHTO T4
AASHTO T96

Fractured Faces, %

Thin & Elongated Pieces, %

Soundness, % Loss

Sand Portion

30
21
12: dry

S. J. Gage, P.E., Chief Engineer

By: R. F. Nicholson /Ra7
R. F. Nicholson, P.E., Materials & Research Engineer

mlm

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Jerd
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Montpelier, Vermont 05602

REPORT ON SAMPLE OF ASPHALT CEMENT

Report 4-7, 19 83

Laboratory No. B83 0017 Tested By Stevens

Name Recovery of Asphalt From Solution by Abson Method

Identification Marks Investigative Certification No.

Submitted by Cookson Title Address

Sampled 3 31, 19 83 Received 4-5, 19 83 Testing Completed 4-5-83

Sample from Roadway Core #1

Quantity Represented Lbs. Net @ 60° F = Gals.

Source of Material

Location used or to be used Concord US 2

Examined for 702.01

TEST RESULTS	1T	1B
Specific Gravity 25°C/25°C		
Absolute Viscosity @ 140°F and 300 mm Hg Vacuum, poises	19567	34961
Kinematic Viscosity @ 275°F, centistokes	1075	1711
Penetration @ 77°F. 100 gm. 5 sec.	37	35
~~Flash Point (Cleveland Open Cup) °F.~~ Fines, Grams	3.03	3.89
Solubility in trichloroethylene, %		
Tests on Residue		
Loss on Heating, %		
Penetration of Residue, % of original		
Absolute Viscosity @ 140°F. poises		
Absolute Viscosity Ratio. ATFO/BTFO		
Penetration Ratio, ATFO/BTFO		

Comments:

This is an investigative sample.

S. J. Gage, P.E., Chief Engineer

By: R. F. Nicholson 10/87
R. F. Nicholson, P.E., Materials & Research Engineer

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Jerd
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REPORT ON SAMPLE OF ASPHALT CEMENT

Report 4-13, 19 83

Laboratory No. B83 0024 Tested By Stevens

Name Recovery of Asphalt from solution by Abson Method

Identification Marks Investigative Certification No.

Submitted by Cookson, Title Address

Sampled 3-31, 1983 Received 4-11, 19 82 Testing Completed 4-11-83

Sample from Core #2

Quantity Represented Lbs. Net @ 60° F = Gals.

Source of Material

Location used or to be used Concord US #2

Examined for 702.01

TEST RESULTS	6 top	6 original
Specific Gravity 25°C/25°C		
Absolute Viscosity @ 140°F and 300 mm Hg Vacuum, poises	8989	12268
Kinematic Viscosity @ 275°F, centistokes	717	989
Penetration @ 77°F. 100 gm. 5 sec.	46	40
Fines, grams		
~~Flash Point~~ (Cleveland Open Cup), °F.	1.65	1.56
Solubility in trichloroethylene, %		
Tests on Residue		
Loss on Heating, %		
Penetration of Residue, % of original		
Absolute Viscosity @ 140°F. poises		
Absolute Viscosity Ratio. ATFO/BTFO		
Penetration Ratio, ATFO/BTFO		

Comments:
This is an investigative sample only.

S. J. Gage, P.E., Chief Engineer

By: R. F. Nicholson

R. F. Nicholson, P.E., Materials & Research Engineer

jlm

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STATE OF VERMONT
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Montpelier, Vermont 05602

REPORT ON SAMPLE OF ASPHALT CEMENT

Report 4-7, 19 83

Laboratory No. B83 0018 Tested By Stevens

Name Recovery of Asphalt from solution by Abson Method

Identification Marks Investigative Certification No.

Submitted by Cookson Title Address

Sampled 3-31, 19 83 Received 4-6, 19 83 Testing Completed 4-6-83

Sample from Roadway Core #3 (original)

Quantity Represented Lbs. Net @ 60° F = Gals.

Source of Material

Location used or to be used Concord US 2

Examined for 702.01

TEST RESULTS	3b	3t
Specific Gravity 25°C/25°C	7752	11740
Absolute Viscosity @ 140°F and 300 mm Hg Vacuum, poises	615	702
Kinematic Viscosity @ 275°F, centistokes	38	40
Penetration @ 77°F. 100 gm. 5 sec.	1.79	1.55
Flash Point (Cleveland Open Cup), °F.		
Solubility in trichloroethylene, %		
Tests on Residue		
Loss on Heating, %		
Penetration of Residue, % of original		
Absolute Viscosity @ 140°F. poises		
Absolute Viscosity Ratio. ATFO/BTFO		
Penetration Ratio, ATFO/BTFO		

Comments:

This is an investigative sample.

S. J. Gage, P.E., Chief Engineer

By: R. F. Nicholson 10/17
R. F. Nicholson, P.E., Materials & Research Engineer

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REPORT ON SAMPLE OF ASPHALT CEMENT

Report 4-8, 19 83

Laboratory No. B83 0019 Tested By Stevens

Name Recovery of Asphalt from solution by Abson Method

Identification Marks Investigative Certification No.

Submitted by Cookson, Title Address

Sampled 3-31, 19 83 Received 4-6, 19 83 Testing Completed 4-6-83

Sample from Roadway Core #3

Quantity Represented Lbs. Net @ 60° F = Gals.

Source of Material

Location used or to be used Concord US #2

Examined for 702.01

TEST RESULTS	#3 1968	#3 1974
Specific Gravity 25°C/25°C	7488	18030
Absolute Viscosity @ 140°F and 300 mm Hg Vacuum, poises	681	848
Kinematic Viscosity @ 275°F, centistokes	44	38
Fines, Grams ~~Penetration~~ @ 77°F. 100 gm. 5 sec.	.60	.96
Flash Point (Cleveland Open Cup), °F.		
Solubility in trichloroethylene, %		
Tests on Residue		
Loss on Heating, %		
Penetration of Residue, % of original		
Absolute Viscosity @ 140°F. poises		
Absolute Viscosity Ratio. ATFO/BTFO		
Penetration Ratio, ATFO/BTFO		

Comments:

This is an investigative sample.

S. J. Gage, P.E., Chief Engineer

By: R. F. Nicholson 1/97
R. F. Nicholson, P.E., Materials & Research Engineer

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REPORT ON SAMPLE OF ASPHALT CEMENT

Report 4-15, 19 83

Laboratory No. B83 0026 Tested By Stevens

Name Recovery of Asphalt From Solution by Abson Method

Identification Marks Investigative Certification No.

Submitted by Cookson Title Address

Sampled 3-31, 19 83 Received 4-13, 19 83 Testing Completed 4-13-83

Sample from Roadway Cores #2 & 5

Quantity Represented Lbs. Net @ 60° F = Gals.

Source of Material

Location used or to be used Concord US #2

Examined for 702.01

TEST RESULTS

	#2 Orig. Binder	#5 Top Overlay
Specific Gravity 25°C/25°C		
Absolute Viscosity @ 140°F and 300 mm Hg Vacuum, poises	9713	5482
Kinematic Viscosity @ 275°F, centistokes	685	558
Penetration @ 77°F. 100 gm. 5 sec.	36	58
Fines, grams ~~Flash Point (Cleveland Open Cup)~~ °F.	1.54	2.68
Solubility in trichloroethylene, %		
Tests on Residue		
Loss on Heating, %		
Penetration of Residue, % of original		
Absolute Viscosity @ 140°F. poises		
Absolute Viscosity Ratio. ATFO/BTFO		
Penetration Ratio, ATFO/BTFO		

Comments:

This is an investigative sample only.

S. J. Gage, P.E., Chief Engineer

By: R. F. Nicholson RAF
R. F. Nicholson, P.E., Materials & Research Engineer

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REPORT ON SAMPLE OF ASPHALT CEMENT

Report 4-15, 19 83

Laboratory No. B83 0027 Tested By Stevens

Name Recovery of Asphalt From Solution by Abson Method

Identification Marks Investigative Certification No.

Submitted by Cookson Title Address

Sampled 3-31, 19 83 Received 4-14, 19 83 Testing Completed 4-14-83

Sample from Roadway Core #5

Quantity Represented Lbs. Net @ 60° F = Gals.

Source of Material

Location used or to be used Concord US 2

Examined for 702.01

TEST RESULTS	5 Orig.Top	5 Orig.Binder
Specific Gravity 25°C/25°C		
Absolute Viscosity @ 140°F and 300 mm Hg Vacuum, poises	4645	3618
Kinematic Viscosity @ 275°F, centistokes	490	461
Penetration @ 77°F. 100 gm. 5 sec.	55	48
Fines, grams ~~Flash Point (Cleveland Open Cup)~~, °F.	2.79	2.73
Solubility in trichloroethylene, %		
Tests on Residue		
Loss on Heating, %		
Penetration of Residue, % of original		
Absolute Viscosity @ 140°F. poises		
Absolute Viscosity Ratio. ATFO/BTFO		
Penetration Ratio, ATFO/BTFO		

Comments:

This is an investigative sample only.

S. J. Gage, P.E., Chief Engineer

By: R. F. Nicholson, P.E., Materials & Research Engineer

mlm

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

RESEARCH INVESTIGATION

Work Plan No. 83-M&R-12

Subject Roadway Structure Investigation - US Rte. 2, Concord MM4.092-8.429

Investigation Requested By Survey & Plans Engineer Date March 14, 1983

Date Information Required ASAP - Urgent

Purpose of Investigation Document roadway condition and determine cause(s) of distress with emphasis on determining the proper method of reconstruction.

Proposed Tests or Evaluation Procedure Excavate test pits in both cut and fill sections at locations between MM 4.092 and 8.429 for the purpose of observing, photographing, documenting, and sampling the various layers of material. Determine water table elevation in both travel lanes and shoulder areas with the installation of observation wells.

Collection of data, samples, and testing should include the following:

1) Thickness, observed density, void and moisture content of each material.
2) Asphalt content, penetration values and gradation of bituminous material.
3) Gradation and moisture content of sub-base and sub-grade materials.
4) Water table elevations including relationship to pavement and ditch line elevations.
5) Presence of ice lens.
6) Water flow from existing underdrain outlets.

Sub-base materials on the projects east and west of the area in question should be sampled by auger or test pit if necessary, to determine gradation and moisture content and/or any difference with the material in the problem area.

Proposal Discussed With Adams, Lanza, Brown Fraser, Chaffee Projected Manpower Requirements 30 man days

Investigation To Be Conducted By Materials & Research Personnel

Proposed Starting Date March 21, 1983 Estimated Completion Date April 1, 1983

Approval/Disapproval by Materials Engineer [illegible] 3-23-8

Comments by Materials Engineer

Materials & Research Division
Agency of Transportation
Date Typed: March 23, 1983

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