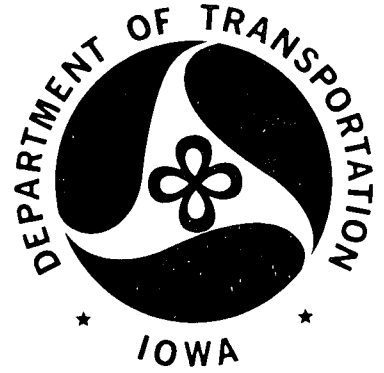
Iowa Highway Research Board
Project HR-9
28-Year Report

PERFORMANCE OF VARIOUS THICKNESSES OF P.C. CONCRETE SECONDARY PAVEMENT



Highway Division
August 1979
in cooperation with
Greene County
Secondary Road Department

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IOWA HIGHWAY RESEARCH BOARD

PROJECT HR-9

28-YEAR REPORT

PERFORMANCE OF VARIOUS THICKNESSES OF P.C. CONCRETE SECONDARY PAVEMENT

BY

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IN COOPERATION WITH
THE GREENE COUNTY
SECONDARY ROAD DEPARTMENT

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ABSTRACT

In 1951 Greene County and the Iowa Highway Research Board paved County Road E-33 from Iowa Highway No. 17 (now Iowa 4) to Farlin with various thicknesses (ranging from 4½ inches (11.4 cm) to 6 inches (15.2 cm)) of portland cement concrete pavement. The project, designated HR-9, was divided into ten research sections.

This formed pavement was placed on the existing grade. Eight of the sections were non-reinforced except for centerline tie bars and no contraction joints were used. Mesh reinforcing and contraction joints spaced at 29 ft.,7 in. (9.02 m) intervals were used in two 4½-inch (11.4 cm) thick sections. The concrete in one of the sections was air entrained. Signs denoting the design and limits of the research sections were placed along the roadway.

The pavement has performed well over its 28-year life, carrying a light volume of traffic safely while requiring no major maintenance. The 4½-inch (11.4 cm) thick mesh-reinforced pavement with contraction joints has exhibited the best overall performance.

INTRODUCTION

In 1951 Greene County Road E-33 from Iowa Highway No. 17 (now Iowa 4) to Farlin was paved with various thicknesses of portland cement concrete as Iowa Highway Research Board project HR-9. The project was a joint effort of Greene County and the Research Board to investigate the extent to which the design of a concrete pavement could be varied to reduce the cost through reducing the thickness.

The project originally consisted of two miles (3.2 km) of gravel road to be paved with three different thicknesses of concrete. Greene County, in approving their portion of the project, asked that an additional two miles (3.2 km) of the road be included, thus extending the pavement into Farlin.

PRE-CONSTRUCTION

In the spring of 1951 soil borings were taken and load bearing tests by the plate bearing method were performed to determine the suitability of the existing roadbed as a base for the pavement. The load bearing tests showed 4,100 feet (1,250 m) of unstable base and the soil borings indicated some areas in which there was a high water table and a subgrade which consisted mainly of clay loam (U.S. Bureau of Public Roads subgrade group No. A-6).

In these areas, vertical sand drains were constructed to provide for moisture movement. These drains were 6-foot (1.8 m)

deep, 7-inch (17.8 cm) diameter holes filled with clean sand and a solution of calcium chloride and water compacted with a mechanical vibrator. They were located on 5-foot (1.5 m) centers in five parallel lines in a checkerboard pattern. A total of 4,064 drains were constructed in the locations listed in Table 1.

Table 1. Location of Sand Drains

From Station*	3+50	to	11+25
	26+00		31+00
	47+00		53+00
	62+00		65+50
	87+00		99+50
	99+50		105+60

*Note: The project is stationed east to west

Other than constructing the sand drains, very little roadbed preparation was performed except for uniform distribution of the loose resurfacing aggregate. There was no major earthwork involved as the profile grade tolerence (the allowable variation between the finish grade and the existing grade) was 0.15 of a foot (0.046 m).

CONSTRUCTION

The four-mile (6.4 km) project was divided into ten sections of various lengths. Table 2 shows the locations and design of these sections.

Table 2.

Section No.	Thickness (inches)	Thickness (centimeters)	Reinforcement	Contraction Joint Spacing (feet)	Contraction Joint Spacing (meters)	Location From Station	Location to Station*
1	5	12.7	None	***		0+10	18+00
2	4½	11.4	Mesh	29.58	9.02	18+00	27+00
3	4½	11.4	None	***		27+00	35+00
4	5½	14.0	None	***		35+00	53+00
5	5	12.7	None	***		53+00	71+00
6	4½	11.4	Mesh	29.58	9.02	71+00	80+00
7	4½	11.4	None	***		80+00	89+00
8	5½	14.0	None	***		89+00	106+00
9	6	15.2	None	***		106+00	159+00
10	6AE**	15.2	None	***		159+00	211+15

*Project is stationed east to west
**AE = Air Entrained
***No contraction joints.

The concrete proportions were specified as Iowa State Highway Commission Mix No. 4A (Article 2301.12, 1948 Standard Specifications). The cement was Penn Dixie, Type 1 (Des Moines, Iowa), and the aggregates (sand and gravel) were supplied by Ferguson Diehl Company of Jefferson, Iowa.

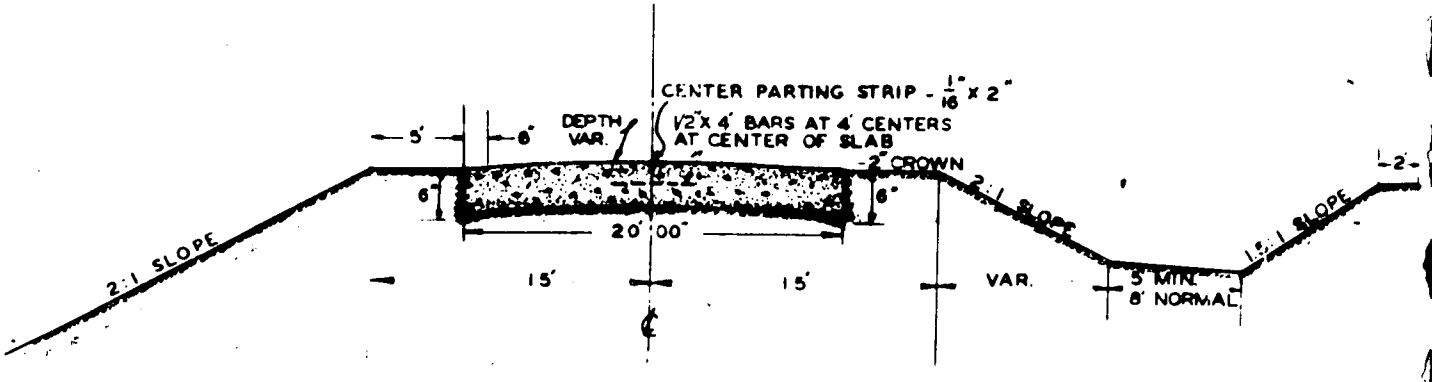
Table 3.

	Absolute Volume	Batch Quanities (lbs)	(kg)
Cement Minimum	0.096419	510	231
Water Approximate	0.161201	272	123
Aggregates:			
Fine Approx. (Sp.Gr.= 2.66)	0.371190*	1664	755
Coarse Approx. (Sp.Gr.= 2.69	0.371190	1682	763

*Aggregate absolute volumes and batch quantities were adjusted for the air entrained concrete.

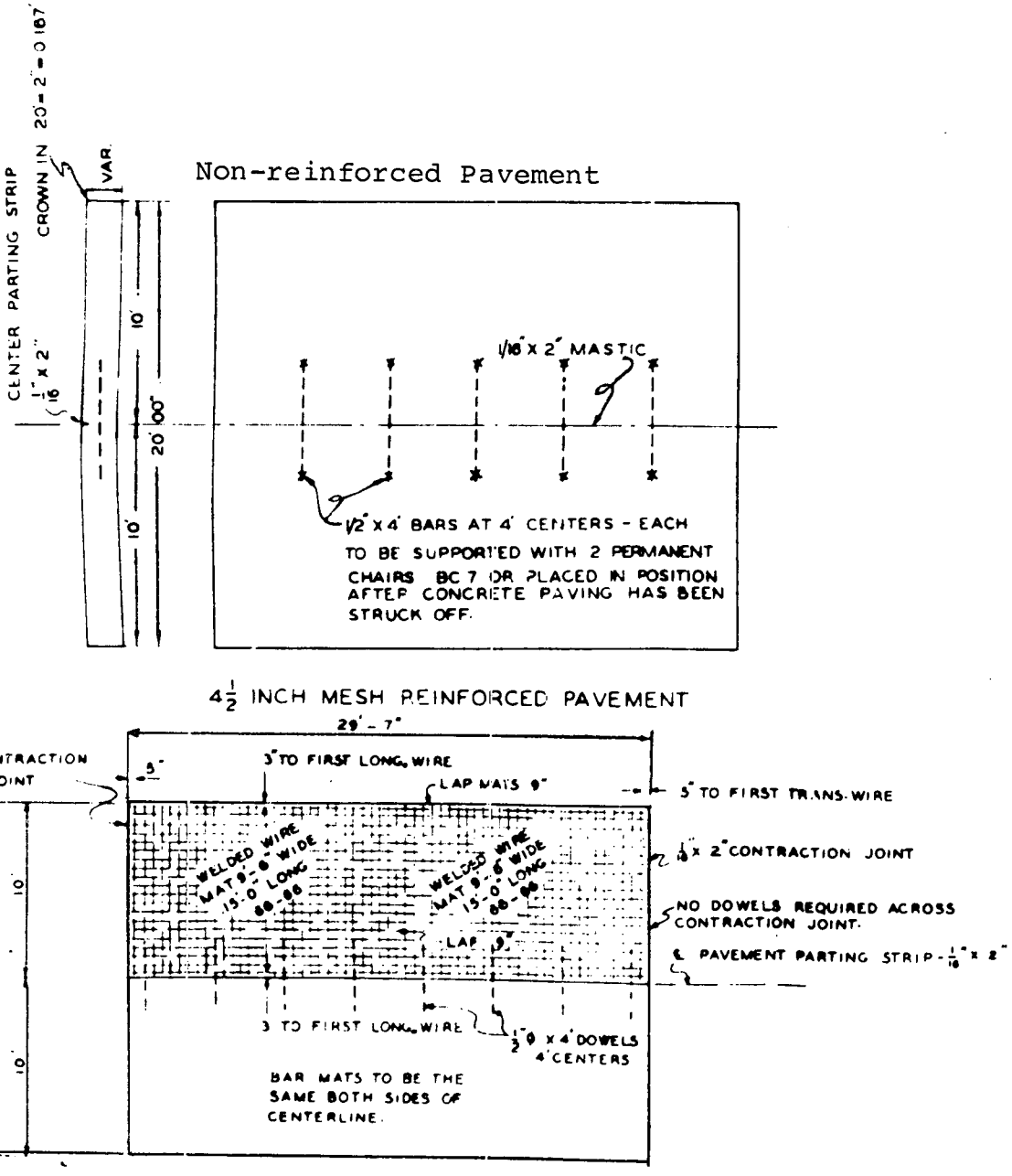
The 20-foot (6.1 m) wide pavement was built using the conventional equipment of that time. The concrete was dry-batched at a plant located in Farlin. The dry-batched concrete was mixed on site and deposited on subgrade paper between the in-place forms. These forms were 8 inches (20.3 cm) high, and since the pavement thickness specified were less than 8 inches (20.3 cm), the outer 6 inches (15.2 cm) on each side of the slab was thickened on a slope to the bottom of the form. Figure 1 shows a typical cross-section of the pavement.

Figure 1 - Cross Section of Pavement



All of the pavement designs utilized 4-foot (1.2 m) #4 (1.27 cm dia.) deformed steel re-bars placed on a 4-foot (1.2 m) centers across the centerline as tie bars. Two of the four 4½-inch (11.4 cm) thick sections were also reinforced with welded wire mesh. The layout for the non-reinforced and reinforced pavement is given in figure 2.

Figure 2 - Layout for Pavement



The joints in the slab were formed by placing pre-molded bituminous parting strips in the fresh concrete. A longitudinal joint was formed along the center of the slab. Other joints included days-work joints and contraction joints at the ends of the wire mats (29 ft.,7 in. (9.02 m) spacing) in the 4½-inch (11.4 cm) mesh reinforced sections.

When the additional two miles (3.2 km) of 6-inch (15.2 cm) pavement were added to the project, it was decided to use air entrained concrete in the last mile (1.6 km)(not a common practice at that time). This was accomplished by adding the air entraining agent (Brand name of Darex) in liquid form at the mixer.

RESEARCH SIGNING

Signs showing the thickness and reinforcing of the pavement were installed along the north right-of-way line of the project. They were placed at the ends of the sections, and arrows on the signs pointed to the section to which the information applied.

A non-conformity of the signs' text and the terms used in this report is that the non-reinforced sections are listed as dowel reinforced. The "dowel" term noted in the signs refers to the centerline tie bars.

These signs are still present on the project and are an aid to visitors in locating the various sections.

PERFORMANCE

Crack surveys were performed at various ages of the pavement. Three are sketched out in Appendix A.

Appendix B includes cracking tabulations for the pavement through May, 1965. Longitudinal cracking of the non-reinforced sections (Appendix B-2) began after the first year and increased steadily. The 4½-inch (11.4 cm) mesh reinforced sections showed no such cracking until the second year, but the amount then was more than the 4½-inch (11.4 cm) without mesh. As of 1965, the 5½-inch (14.0 cm) non-reinforced section had the least amount of longitudinal cracking. This performance may be due to the sand drains in the subgrade beneath one 5½-inch (14.0 cm) thick section and a portion of the other.

The average slab length (Appendix B-3) is the length of continuous pavement between cracks and/or joints. In 1951, shortly after construction, the average slab length for the non-reinforced sections without contraction joints was 133 ft. (40.5 m). Most of the transverse cracking occurred within the first year, reducing the average slab length to 40.5 ft. (12.4 m). Thereafter, random cracking progressed slowly and in 1965, the average slab length was 20 ft. (6.1 m). The 6-inch (15.2 cm) non-reinforced sections at that time exhibited the longest slab length, 23 ft. (7.0 m). The 5½-inch (14.0 cm) non-reinforced sections had a slab length of 19 ft. (5.8 m), while both the 5-inch

(12.7 cm) and the 4½-inch (11.4 cm) non-reinforced sections had an average slab length of 15 ft. (4.6 m).

The 4½-inch (11.4 cm) mesh-reinforced sections with contraction joints did not start random cracking until after the first year. Shortly after construction, the contraction joint spacing was 29 ft.7 in. (9.02 m) and by 1965 the average slab length had decreased to 22 ft. (6.7 m).

The volume of traffic over this project has been fairly constant over the years. The average daily traffic from 1957 to 1976 was approximately 270 vehicles per day. Appendix B-4 contains a table of the traffic volumes for that nineteen year period.

Over a 25-year period (1957 - 1976) in the life of the pavement, a grain elevator in Farlin increased the amount of truck traffic during the harvest season. A gravel pit operation one-half mile (0.8 km) east of Farlin also produced heavier loads on the road (1951 - 1977).

The quality of the concrete is very good. The 6-inch (15.2 cm) diameter cylinders formed during construction, when tested at the age of twenty-eight days, averaged over 5,500 pounds per square inch (psi) (390 kg/cm^2) with the majority of the cores testing near or above 8,000 psi (560 kg/cm^2). Average concrete strengths for various ages of pavement are shown in Appendix B-4.

The first ridability tests on this road were performed in 1955 using a Bureau of Public Roads type roughometer. The ride was determined in inches per mile (centimeters per kilometer): the amount of the vertical movement of the spring mounted single test wheel with respect to the trailer frame. The change in ride was determined by comparing the 1955 and 1979 data. These results show that the 4½-inch (11.4 cm) thick sections with mesh reinforcement are the smoothest riding of this road, and that they changed the least since 1955. (See Appendix B-5).

Maintenance of this pavement has been minimal. For most of its service, crack sealing has been sufficient. In more recent years, full depth patches have been installed to replace some small broken and distorted areas.

The crack survey of Appendix A and the photographs of Appendix C give an indication of the pavement condition. The general appearance of this roadway is good considering its age. The overall performance considering slab length, longitudinal cracking and change in riding quality is given in Table 4.

Table 4. Performance Summary

Section No.	Thickness (in.)	(cm.)	Average Slab Length* 1965 (ft.)	(m.)	Longitudinal Cracking (ft/sta)	(m/30.48 m)	Change in Riding Quality (1945 to 197[illegible] (in/mi)	(cm/km)
1,5	5	12.7	15	4.6	47.2	14.4	16.5	26.[illegible]
2,6	4½ mesh	11.4	22	6.7	46.0	14.0	3.0	4.[illegible]
3,7	4½	11.4	15	4.6	35.5	10.8	25.0	39.0
4,8	5½	14.0	19	5.8	12.7	3.9	13.5	21.[illegible]
9	6	15.2	26	7.9	20.4	6.2	17.5	27.[illegible]
10	6 AE	15.2	21	6.4	41.7	12.7	16.5	26.0

* Slab length = $\frac{\text{(length of section)}}{\text{(No. Transverse cracks + No. joints)}}$

COSTS

The pavement cost of the various sections are listed in Table 5. It is believed that these prices were greater than normal costs of pavement at the time of construction because of the extra work involved due to the research and resulting short sections.

Table 5. Pavement Costs

Section No.	Thickness (in.)	(cm.)	Cost per sq. yd. ($)	Cost per m^2 ($)
1,5	5	12.7	3.15	3.77
2,6	4½ mesh	11.4	3.42	4.09
3,7	4½	11.4	3.04	3.64
4,8	5½	14.0	3.26	3.90
9	6	15.2	3.38	4.04
10	6 AE	15.2	3.38	4.04

Additionally, the costs of the project are tabulated in the form of cost per section, cost per mile and cost per kilometer in Appendix B-6.

CONCLUSIONS

All designs utilized in the roadway have carried a light volume of traffic safely and with minimal maintenance for 28 years.

Longitudinal cracking has occurred in all of the sections throughout the life of the pavement. There is no obvious correlation between subgrade sand drain locations and longitudinal cracking.

The slab length for the non-reinforced pavement without contraction joints varies directly with the thickness of the concrete (23 ft. (7.0 m) for the 6-inch (15.2 cm) and 15 ft. (4.6 m) for the 4½-inch (11.4 cm)). The mesh reinforced pavement design with contraction joints results in slab lengths (22 ft. (6.7 m)) comparable to those of the 6-inch (15.2 cm) reinforced.

The 4½-inch (11.4 cm) thick design with mesh reinforcement has provided the best overall performance. This design, implemented on two sections, exhibited the least change in riding quality and the least amount of random transverse cracking as would be expected due to the use of contraction joints.

ACKNOWLEDGEMENTS

The author wishes to express appreciation to those who assisted in this report: Ronald Betterton, Greene County Engineer; Warren Raver of the Greene County Engineer's office; Clarence DeYoung, Assistanct Materials Engineer, Richarch Smith, and Jean Carter of the Office of Materials, Highway Division, Iowa Department of Transportation.

APPENDIX A

CRACK SURVEY

Crack surveys have been conducted on the project at various stages of the life of the road. Three surveys are shown on the following pages.

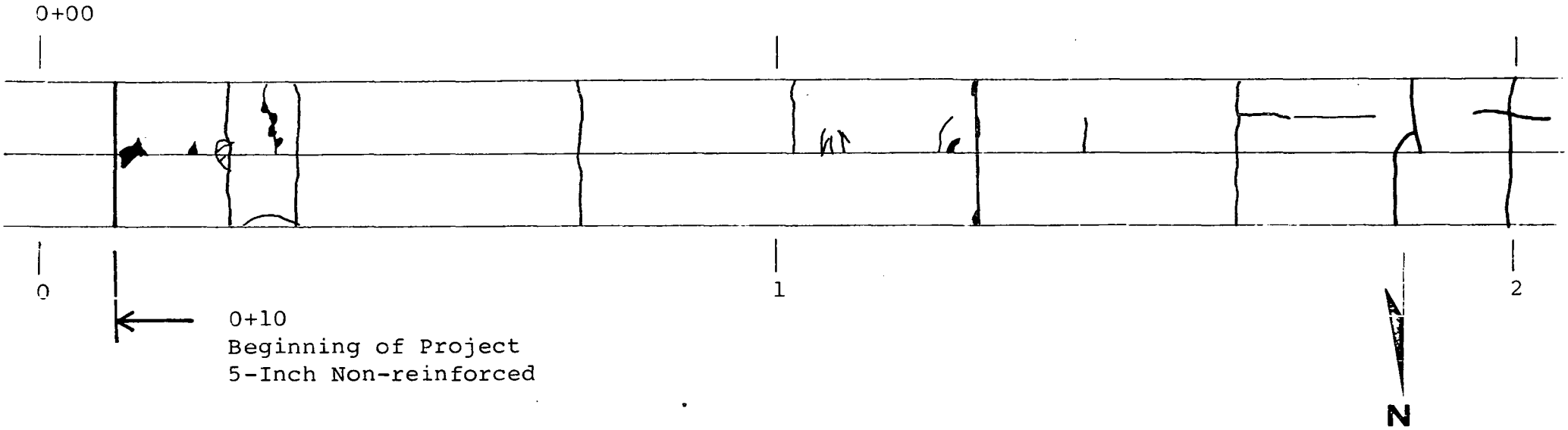
The earliest survey shown was conducted in the spring of 1953 by Iowa State Highway Commission personnel. The next survey shown was made in the fall of 1965 by the Des Moines office of the Portland Cement Association. The latest survey shown was by the author in the summer of 1979. It was a visual inspection of the roadway, with the changes in cracks since 1965 being sketched with respect to the older survey. Included in this survey is 2,000 feet of the six-inch thick sections (approximately 1,000 feet each of the air and non-air entrained pavements).

The surveys are color-coded as to the date conducted.

March, 1953 - Black

September, 1965 - Green

July, 1979 - Blue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2
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Beginning of Project
5-Inch Non-reinforced
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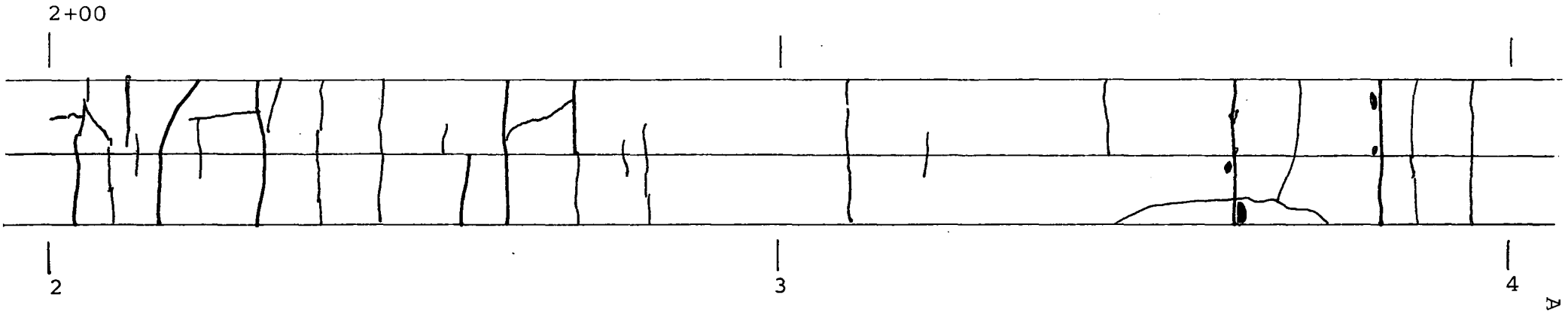
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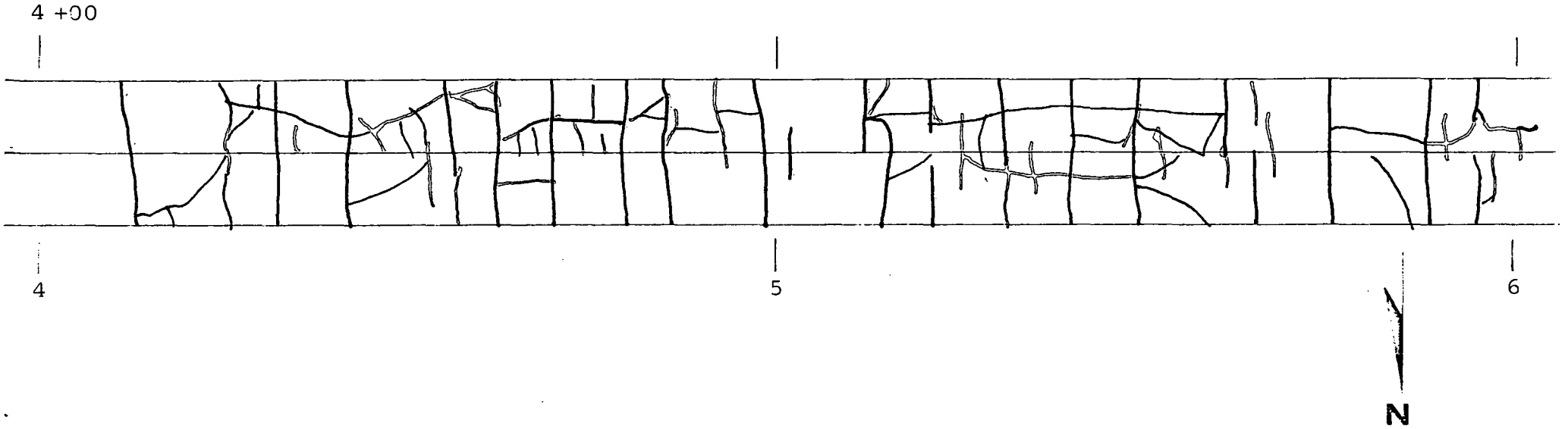
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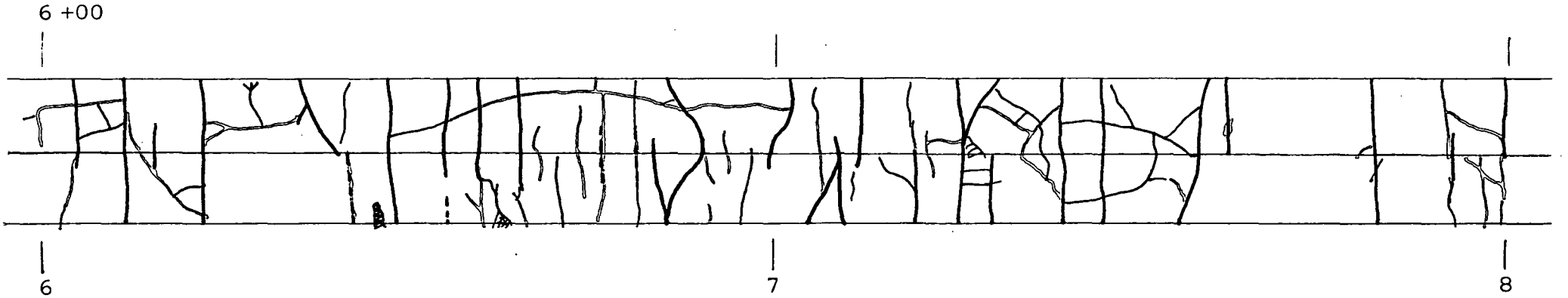
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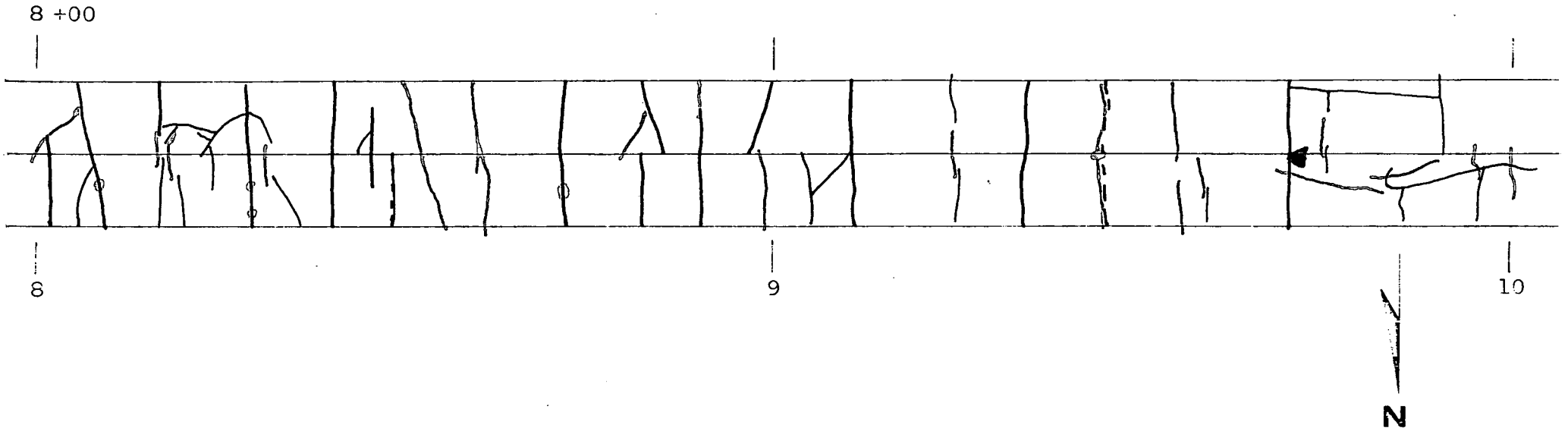
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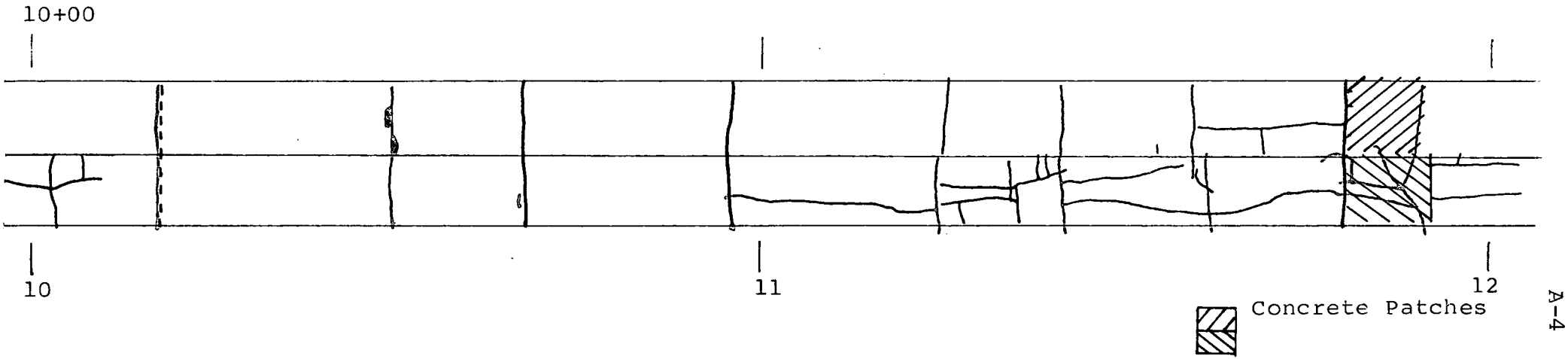
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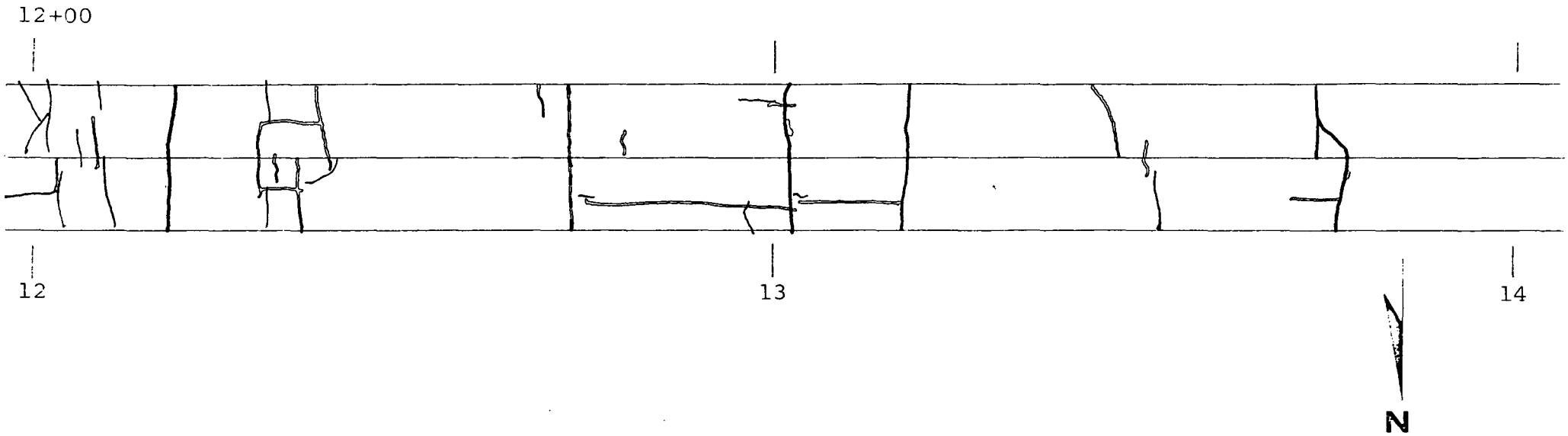
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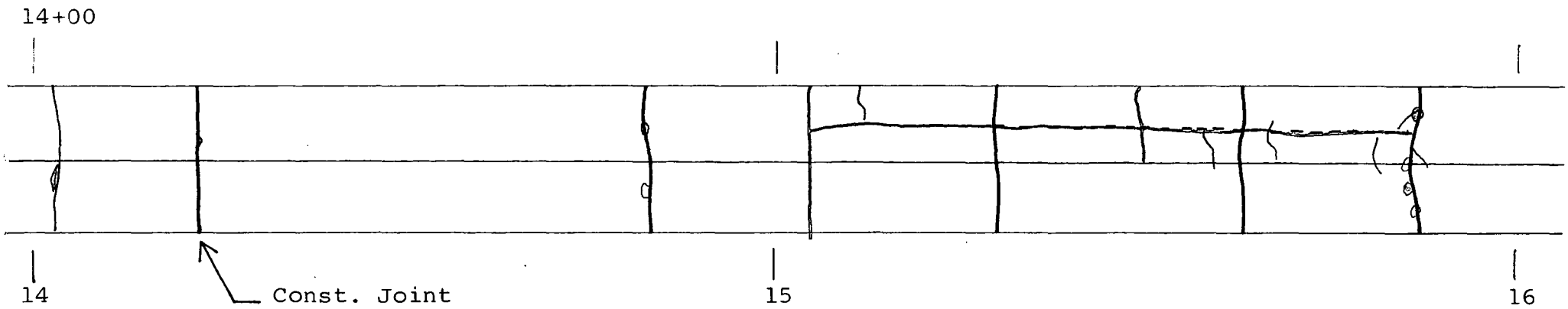
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Const. Joint
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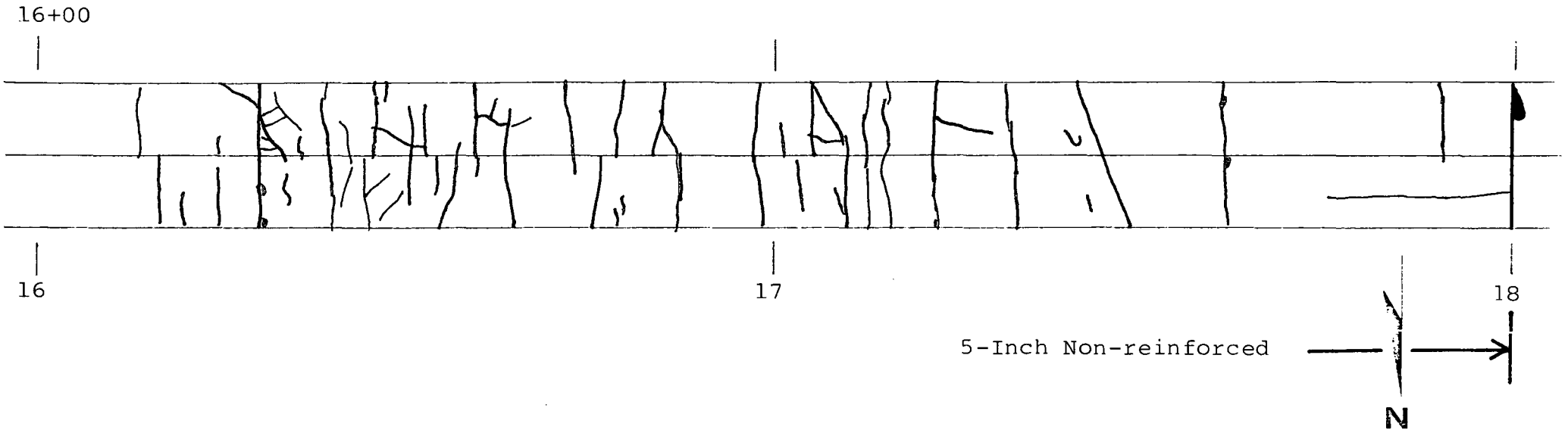
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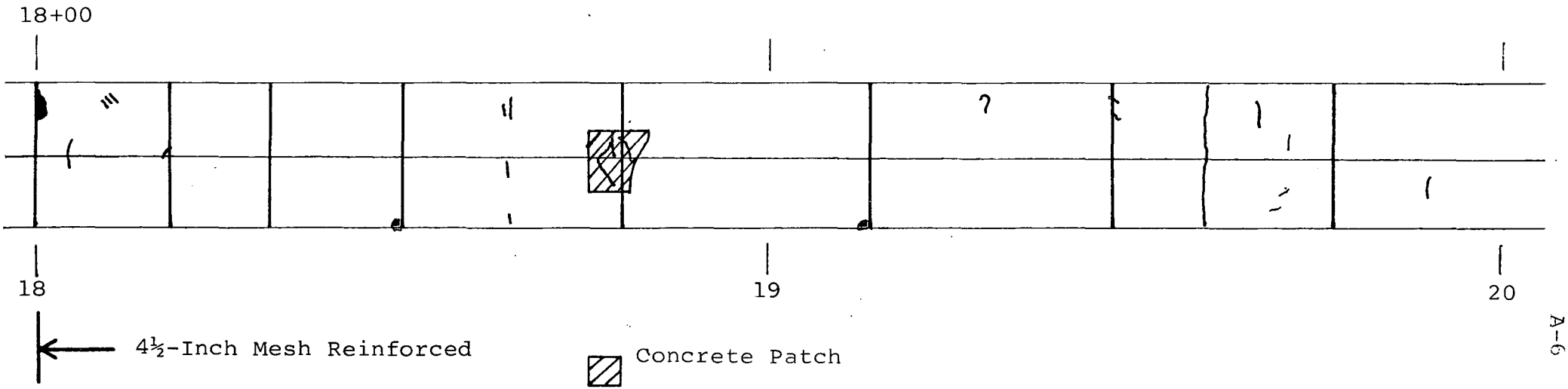
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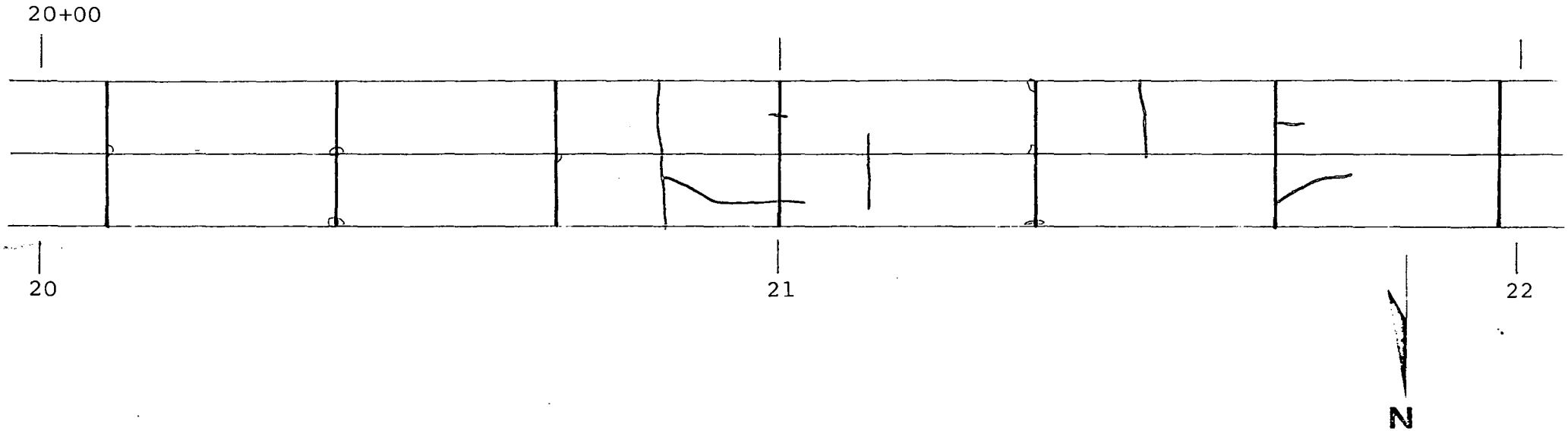
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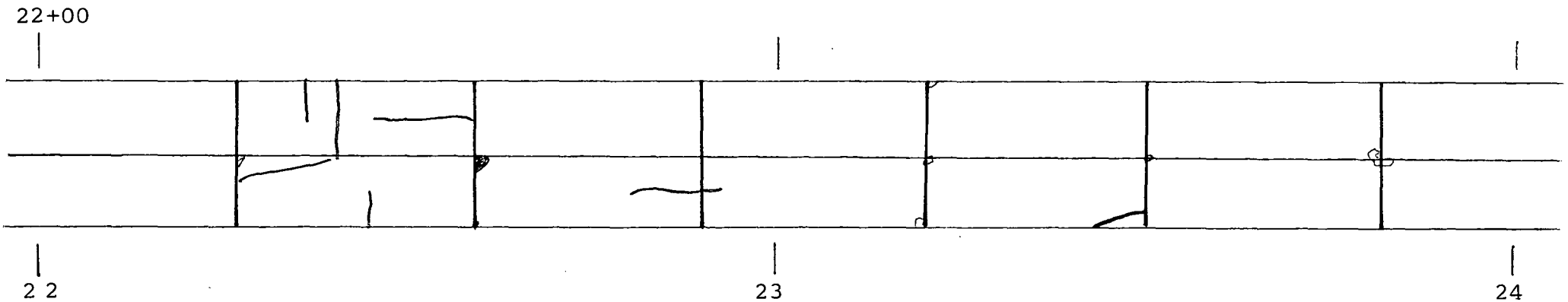
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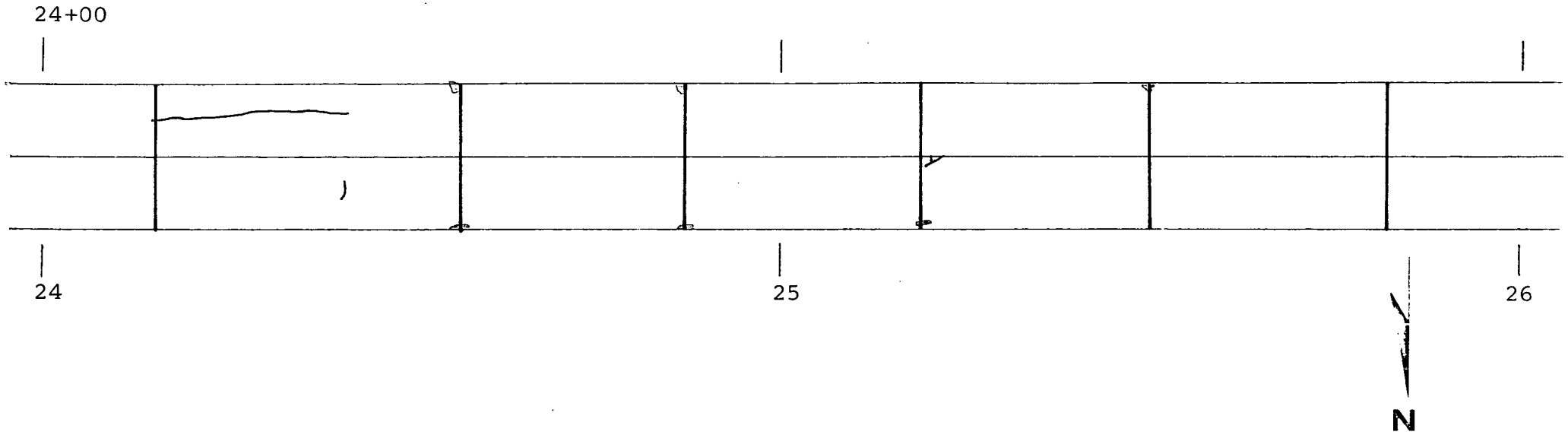
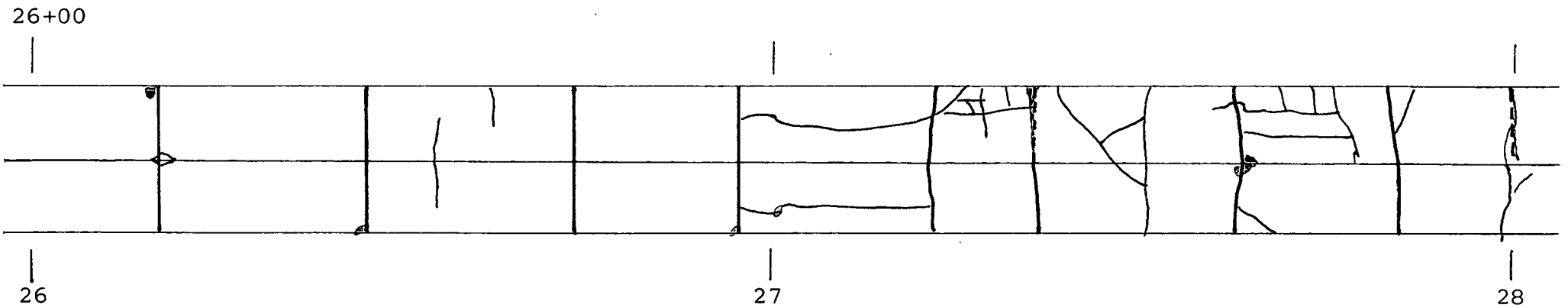
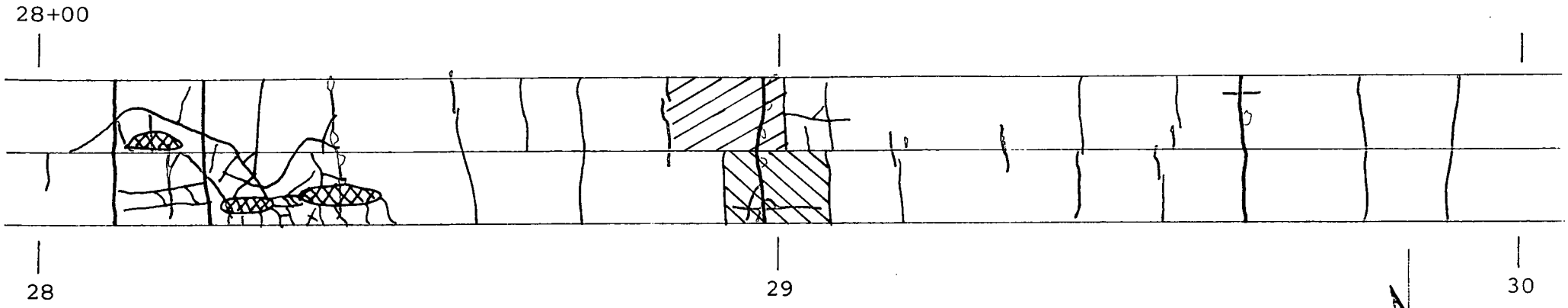




4½-Inch Mesh Reinforced — 4½-Inch Non-reinforced



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Asphalt Patches

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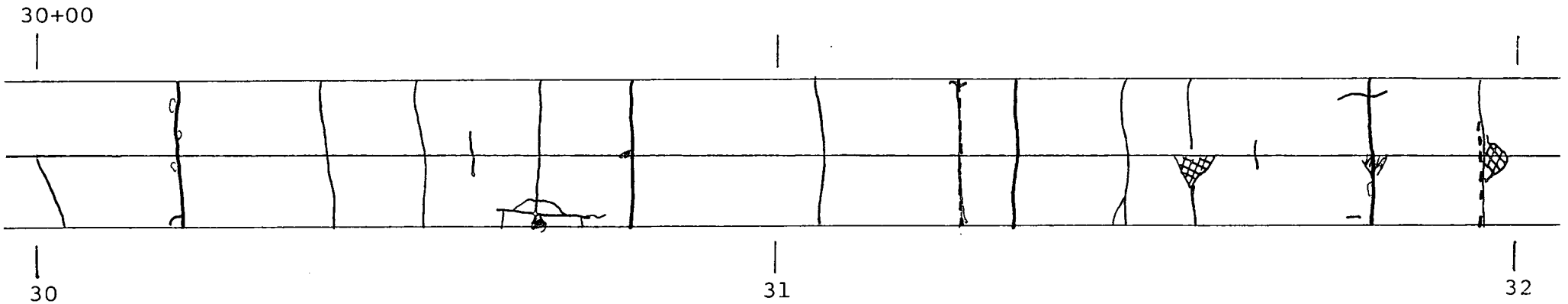

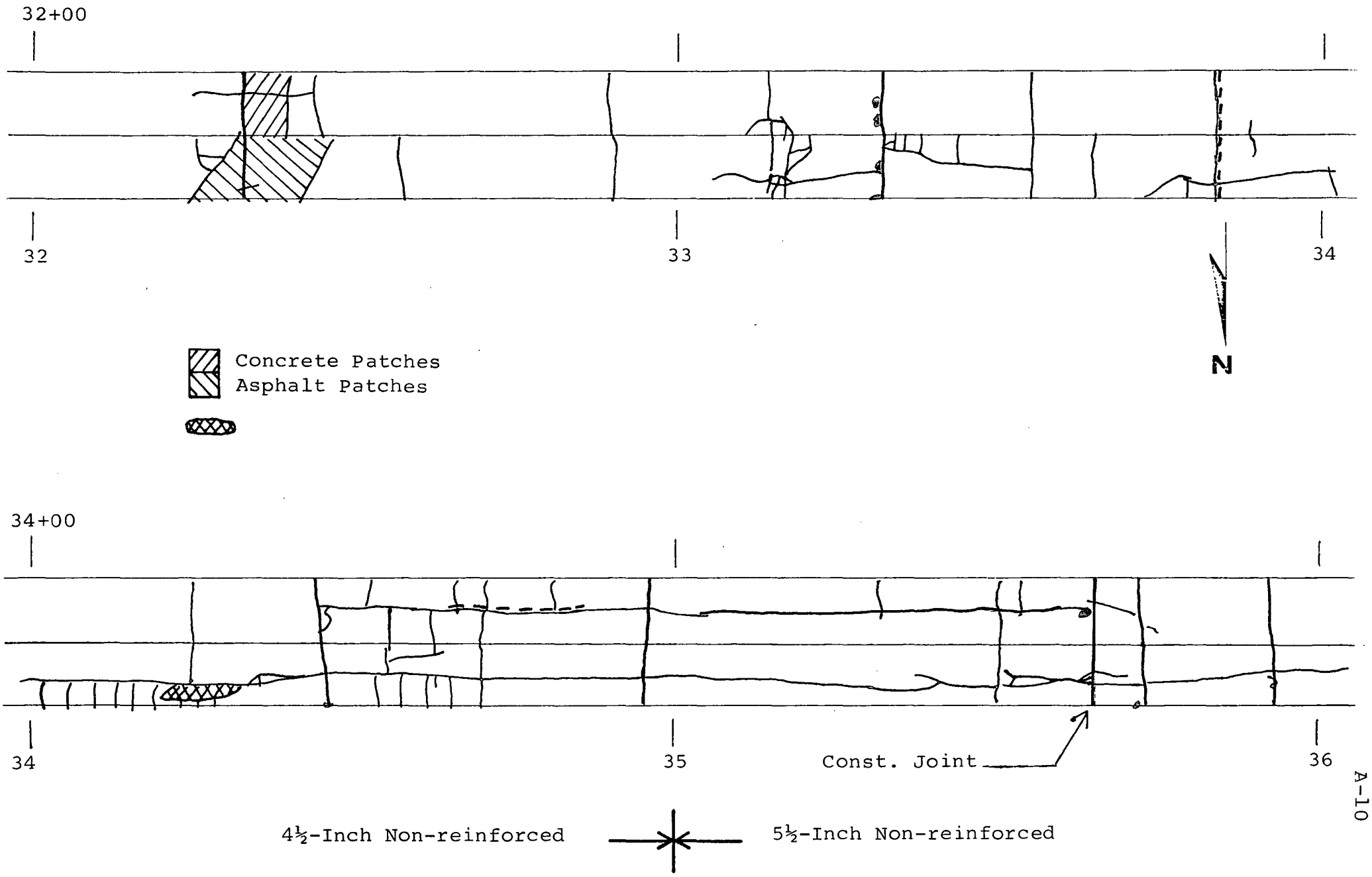
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Asphalt Patches
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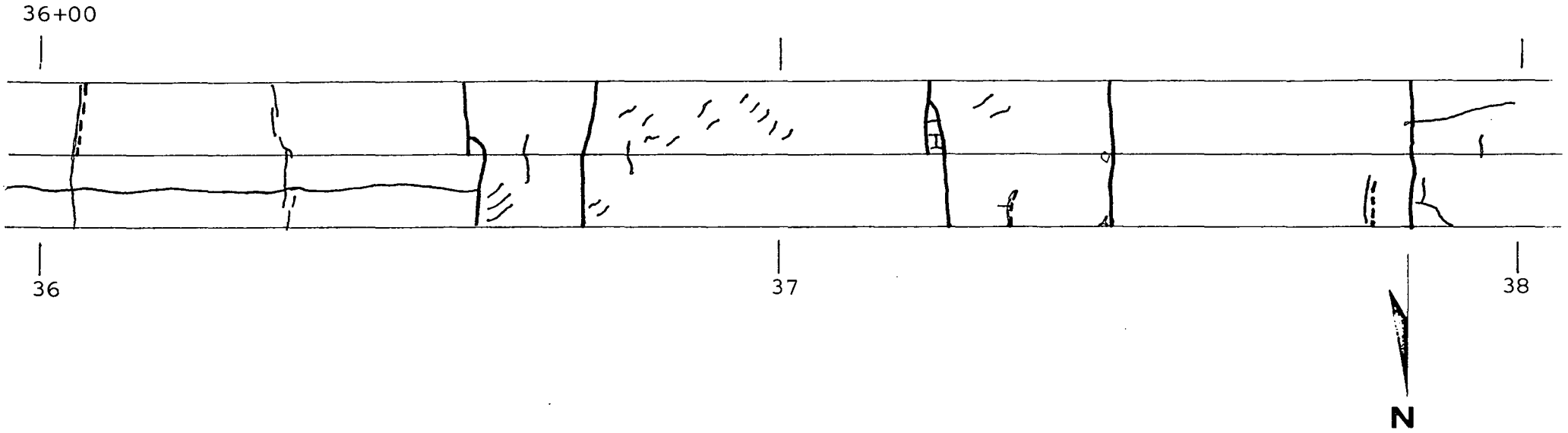
4½-Inch Non-reinforced
5½-Inch Non-reinforced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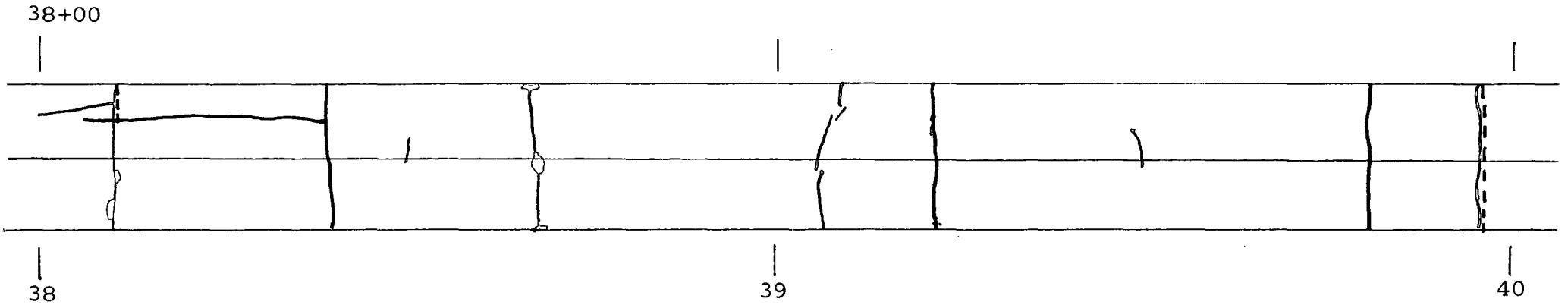
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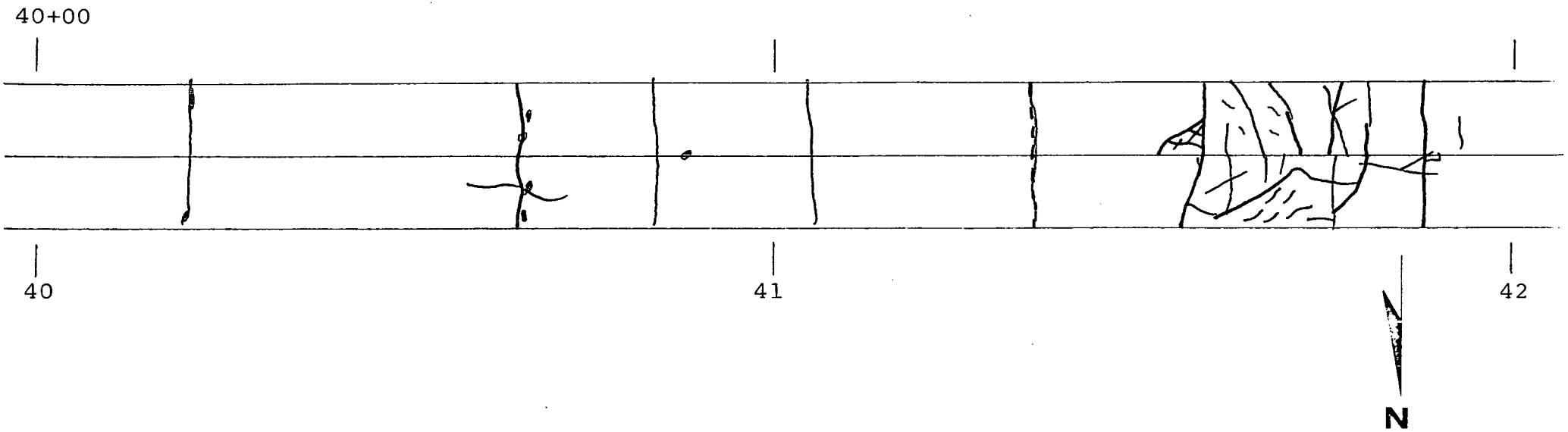
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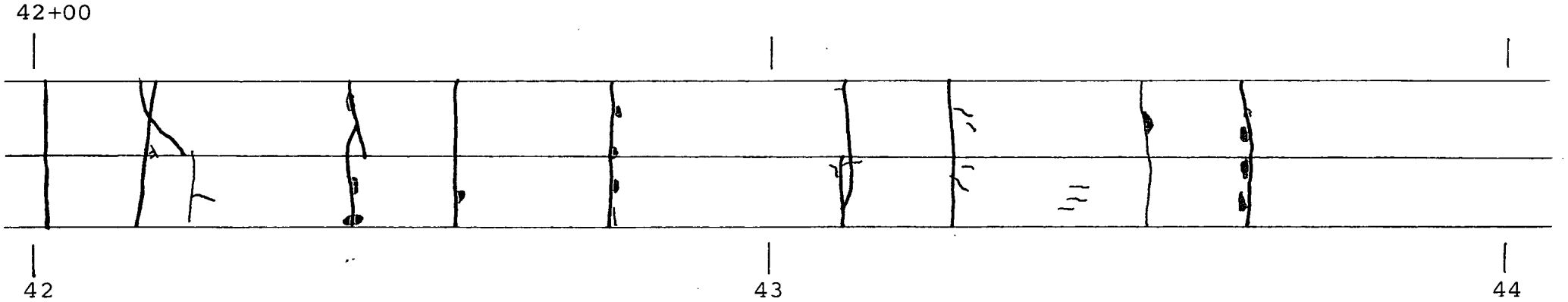
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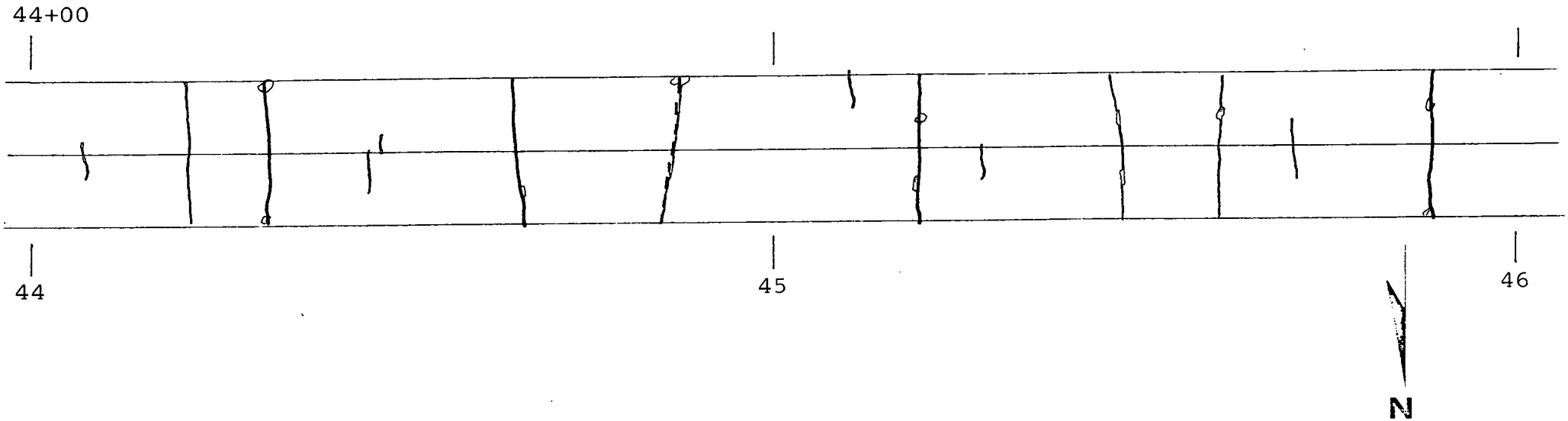
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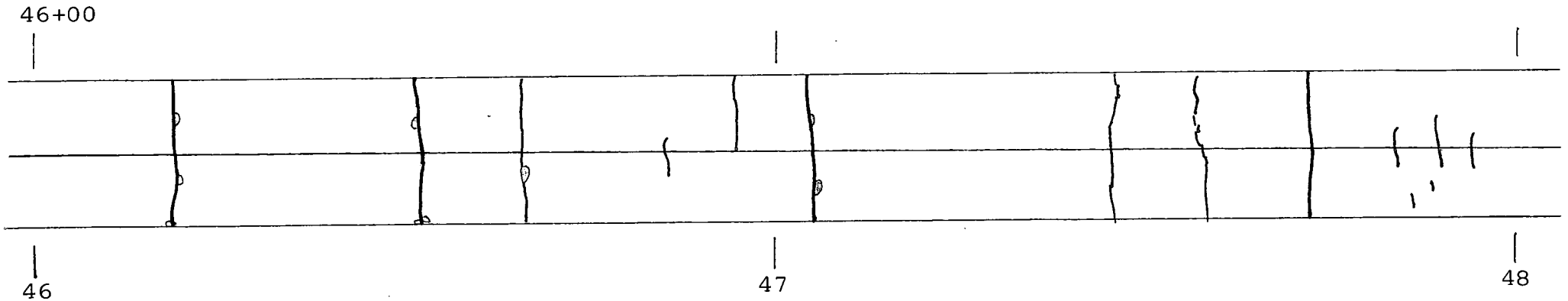
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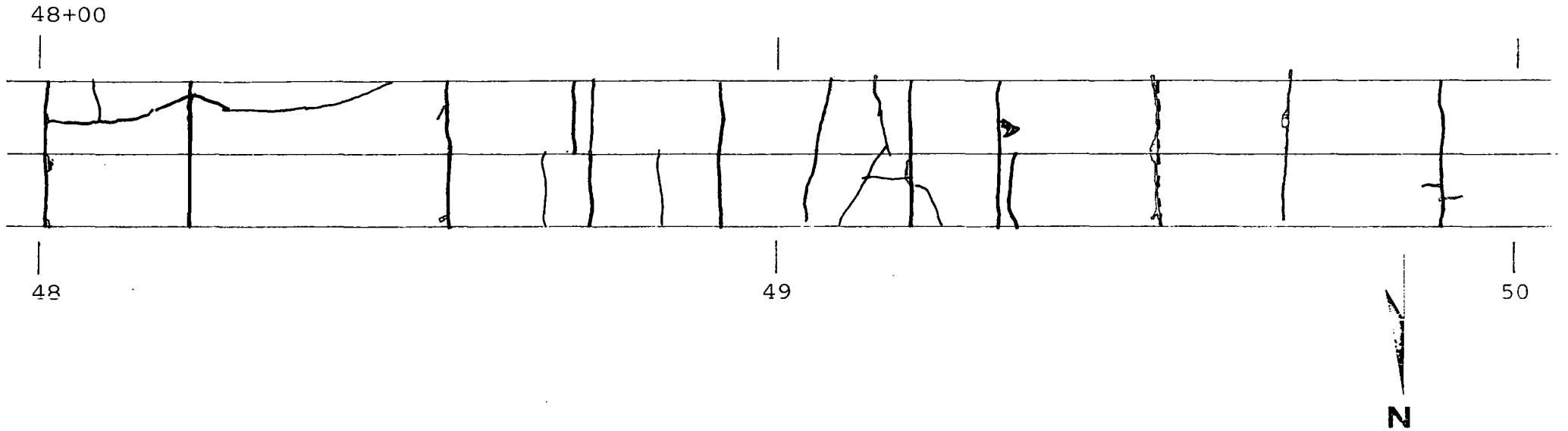
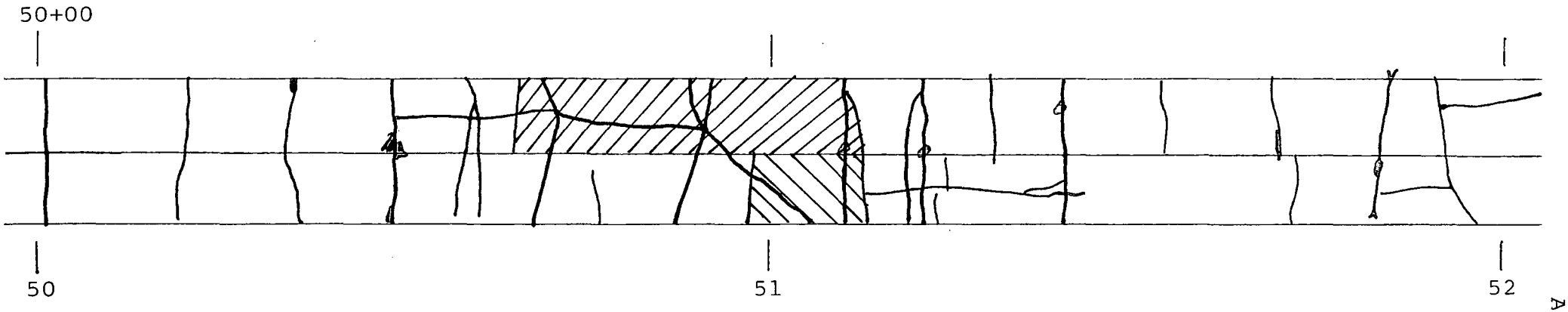
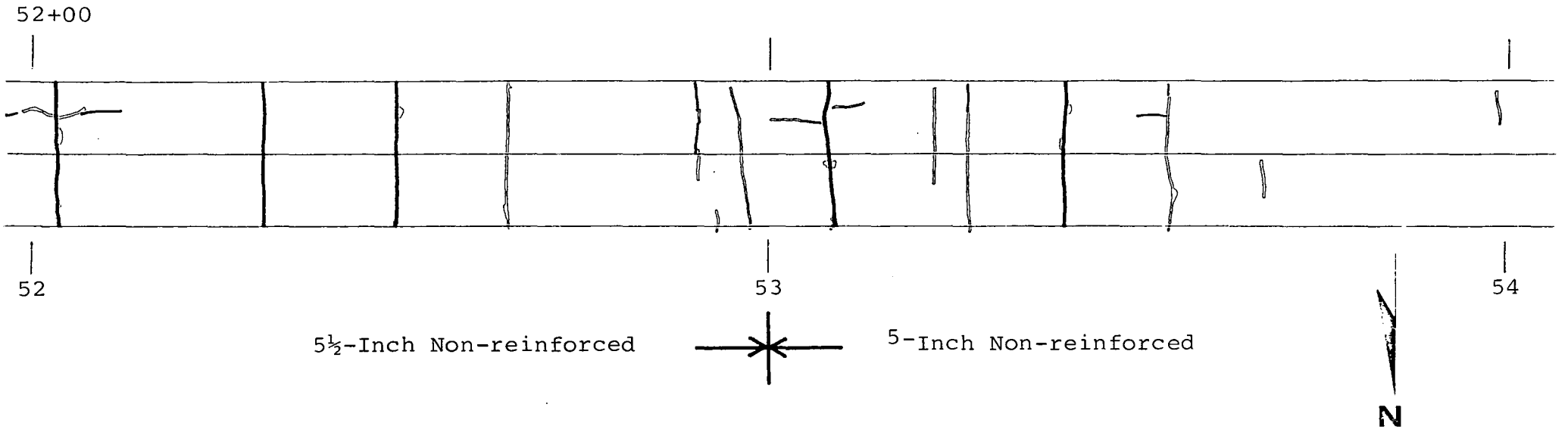
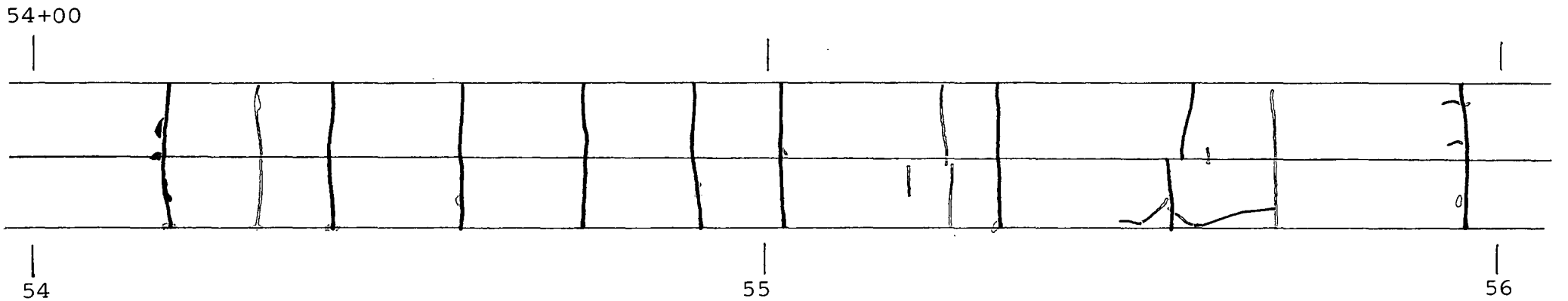
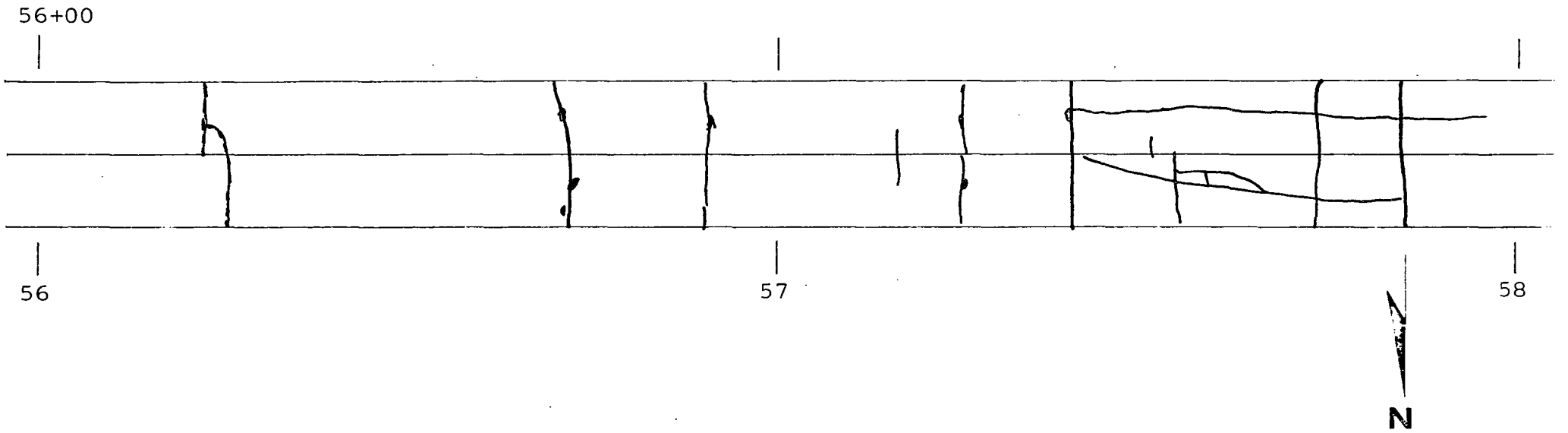


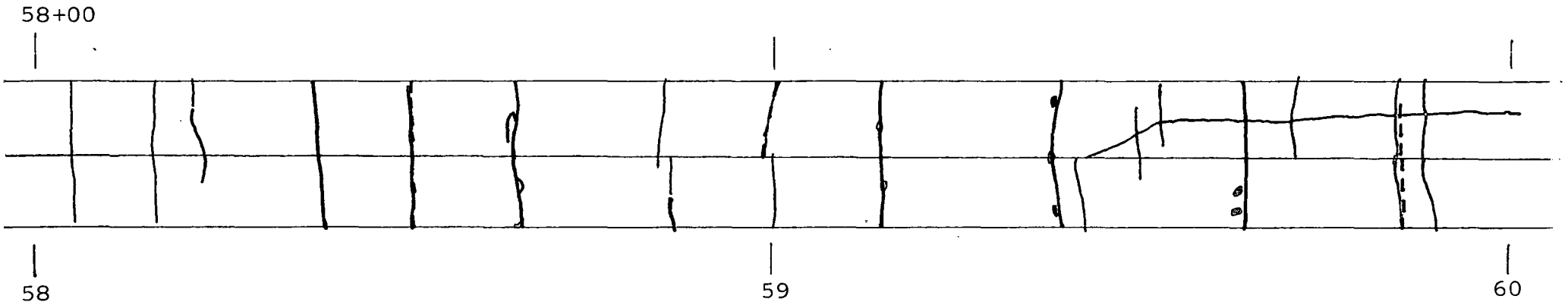


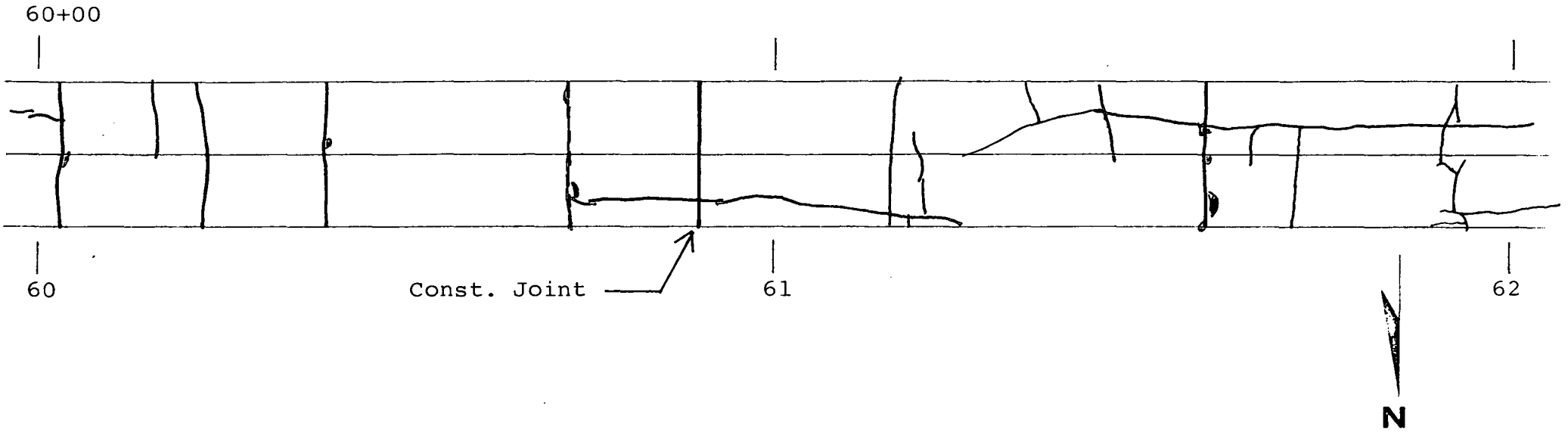
Concrete Patches

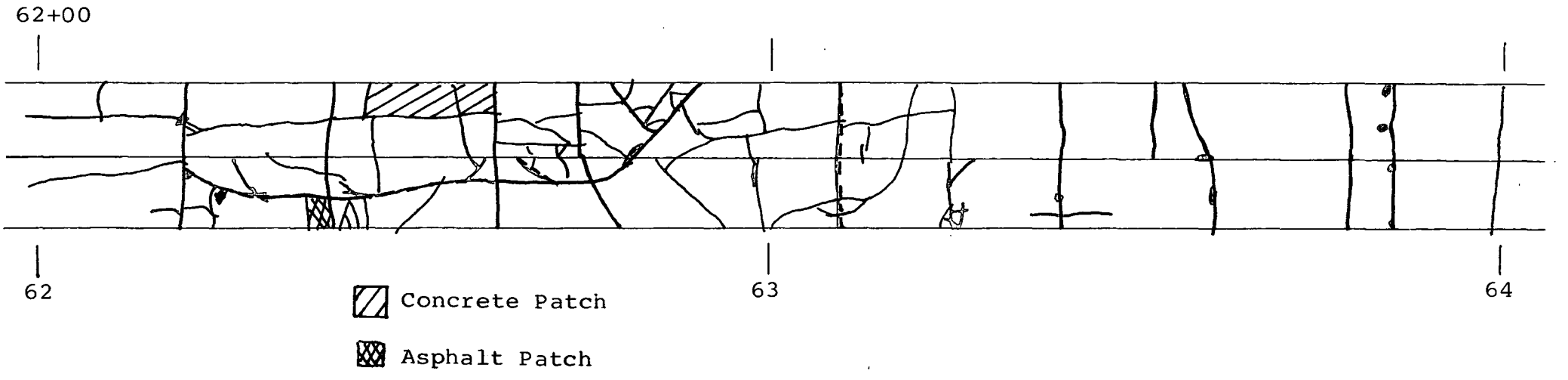

52+00
52
53
54
5½-Inch Non-reinforced
5-Inch Non-reinforced
N

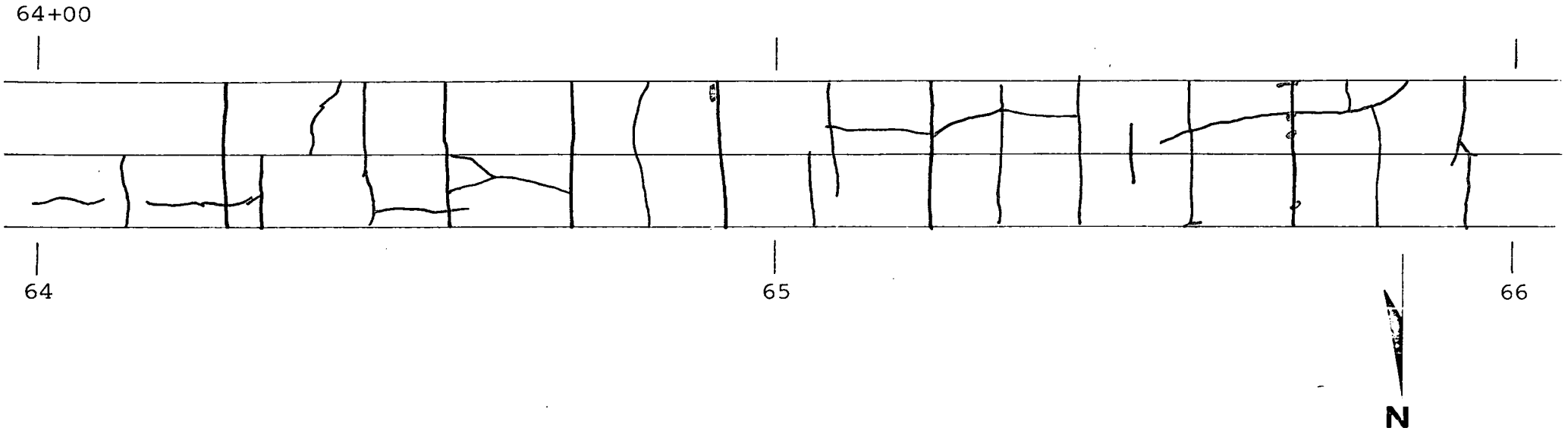

54+00
54
55
56

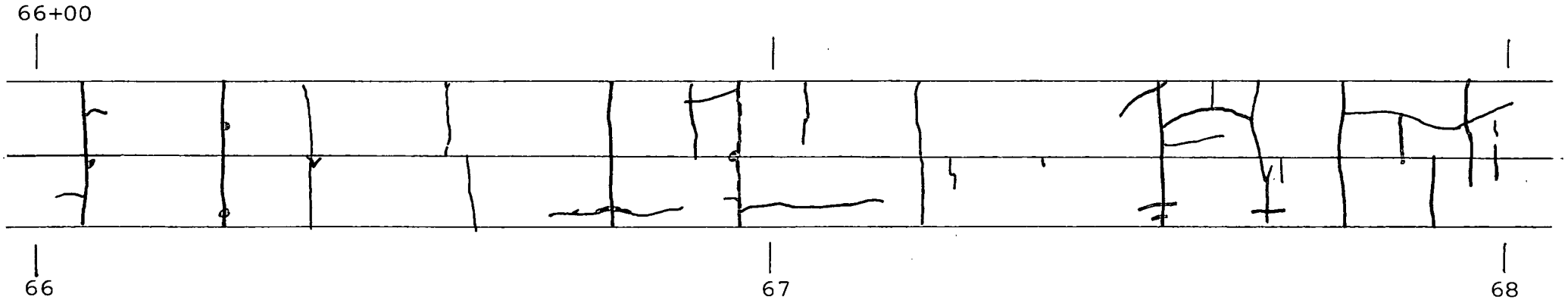

56+00
56
57
58
N

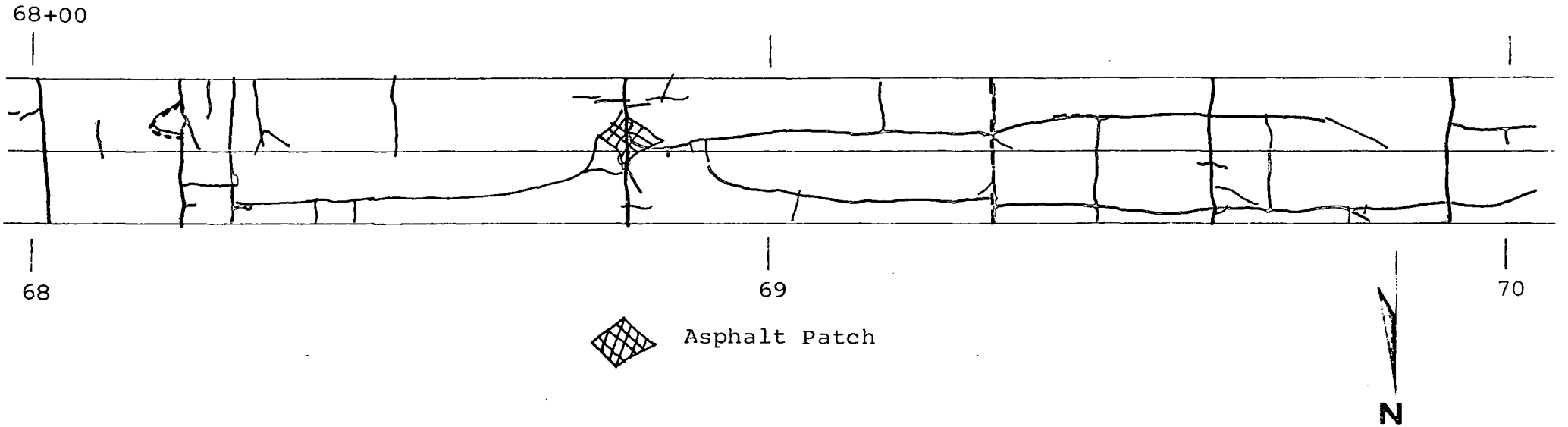

58+00
58
59
60

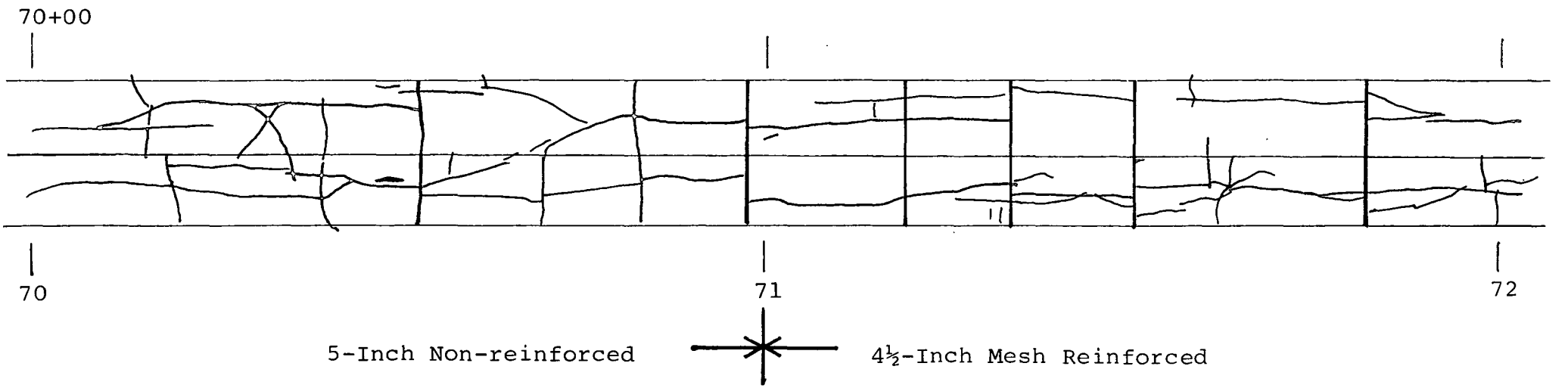

60+00
60
Const. Joint
61
62
N

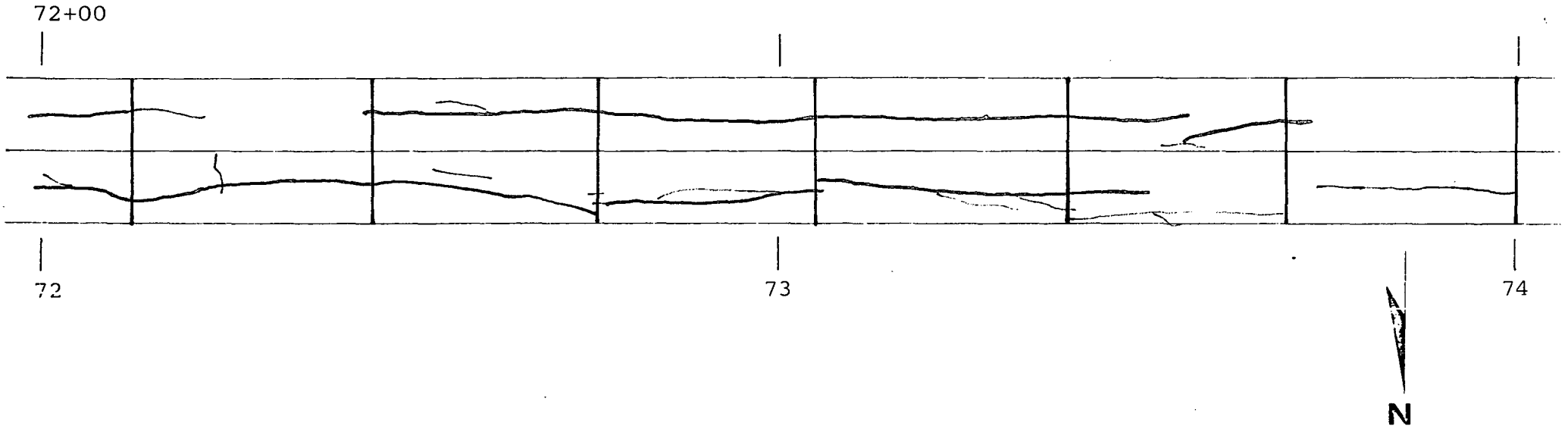

62+00
62
63
64
Concrete Patch
Asphalt Patch

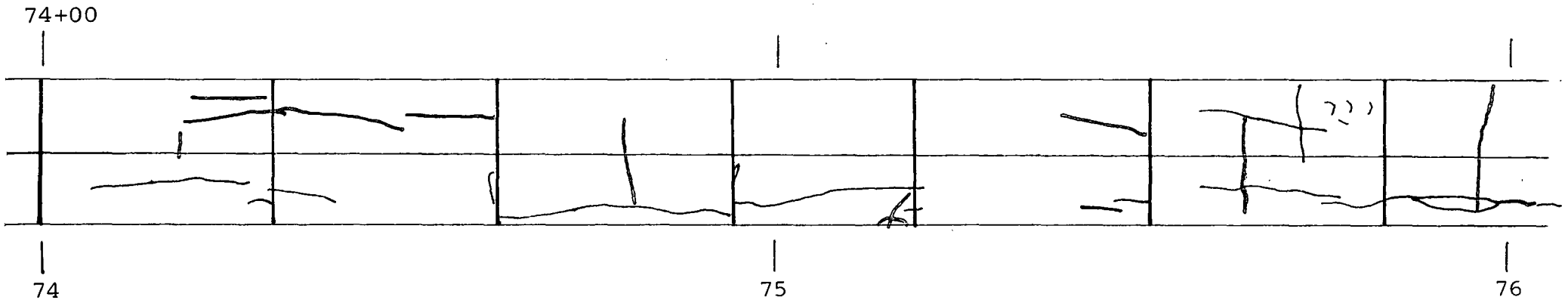

64+00
64
65
66
N

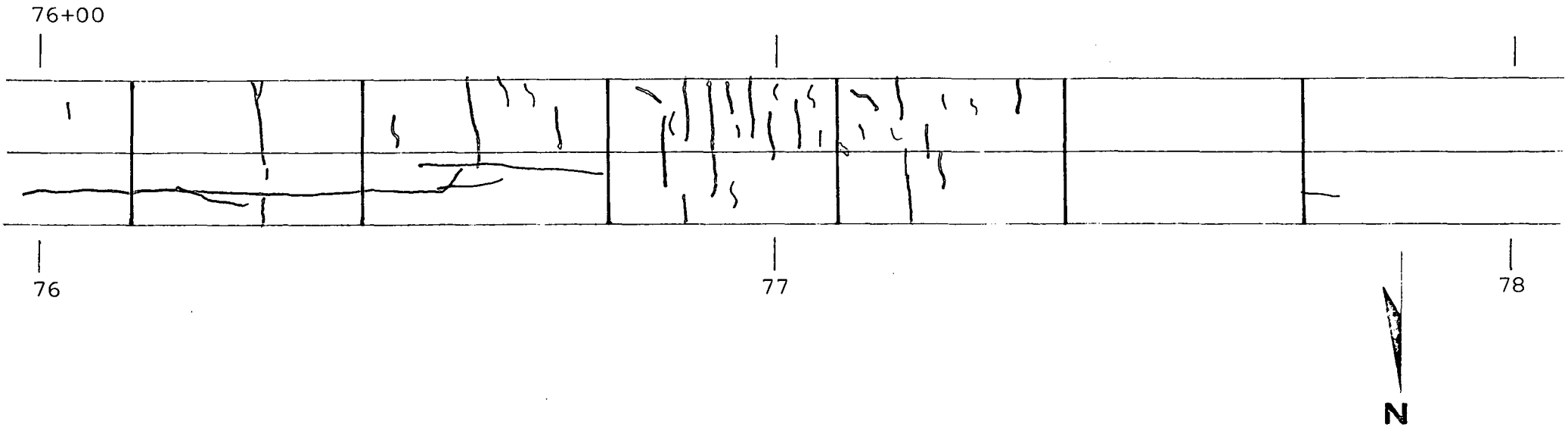

66+00
66
67
68

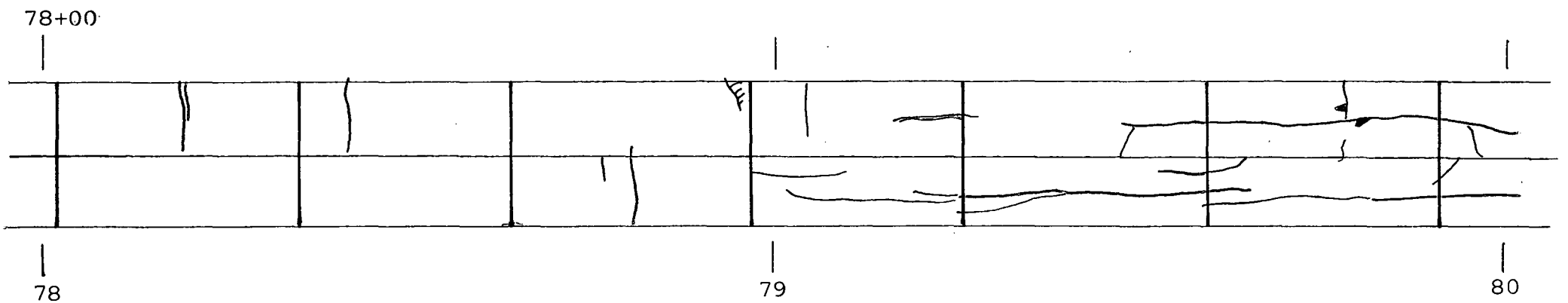

68+00
68
69
70
Asphalt Patch
N


70+00
70
71
72
5-Inch Non-reinforced
4½-Inch Mesh Reinforced

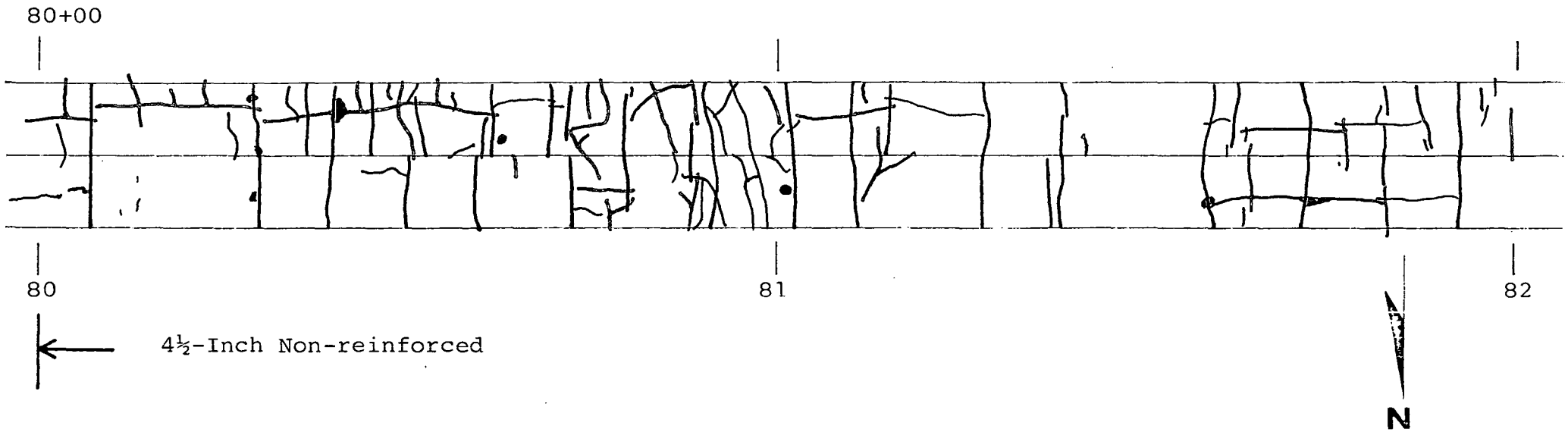

72+00
72
73
74
N

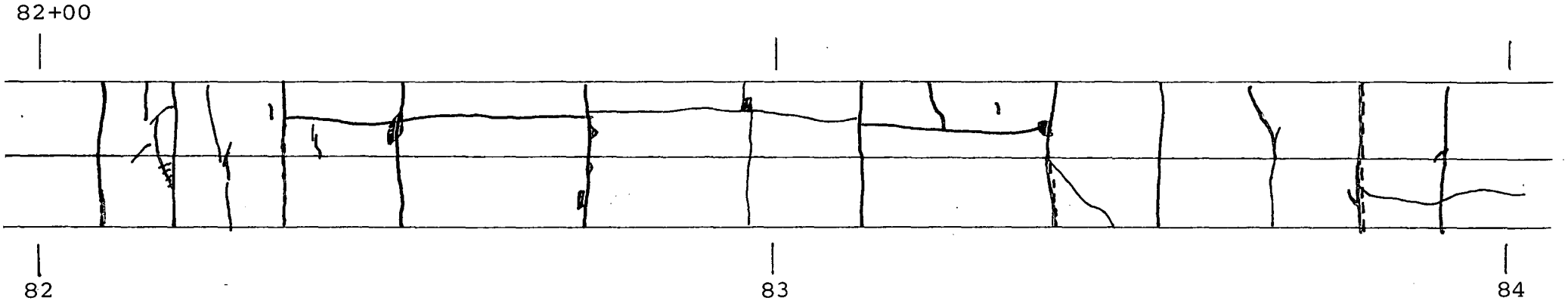

74+00
74
75
76

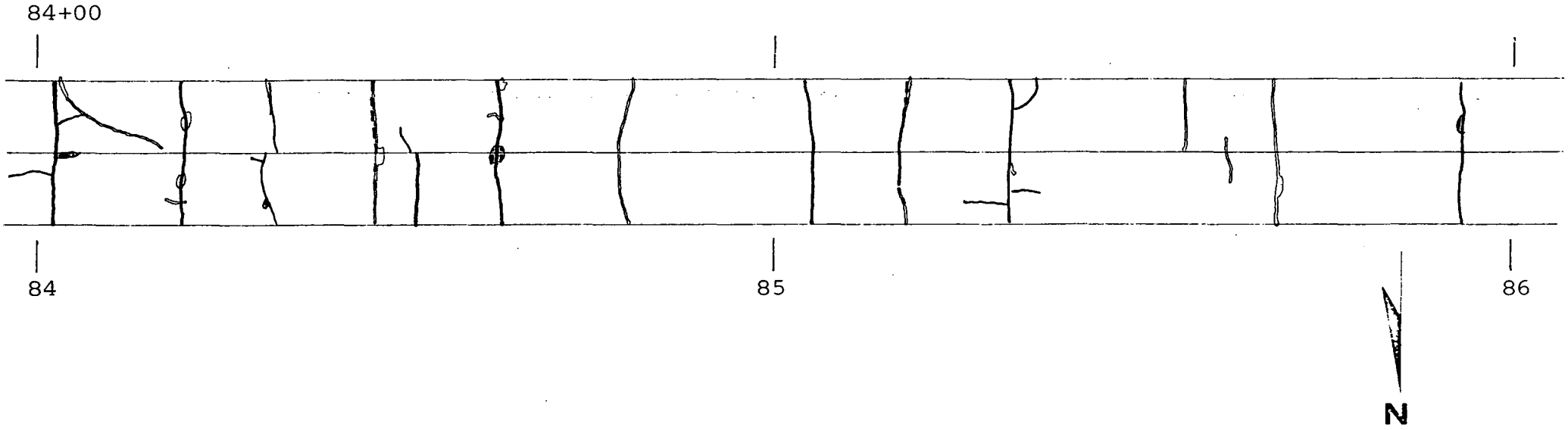


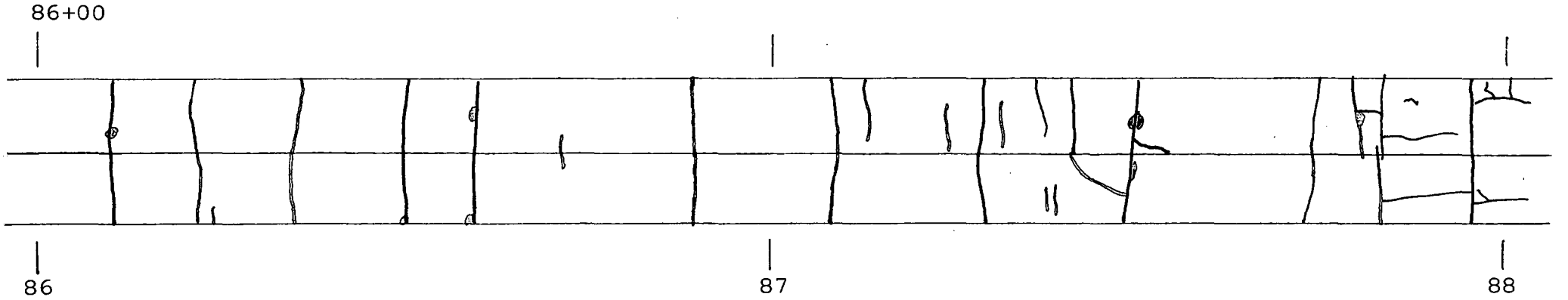


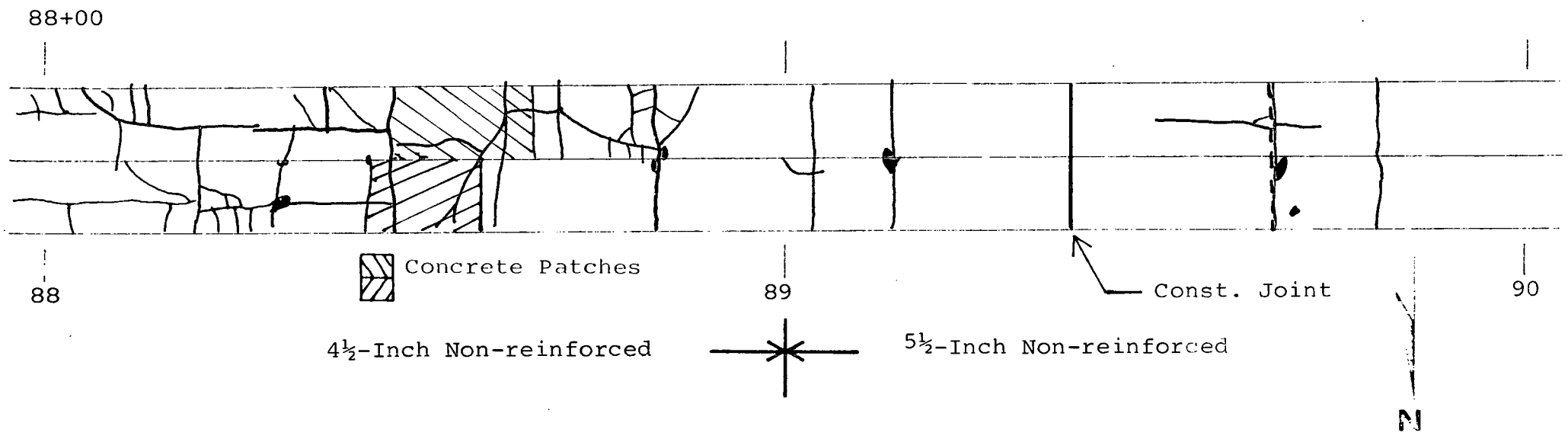
4½-Inch Mesh Reinforced

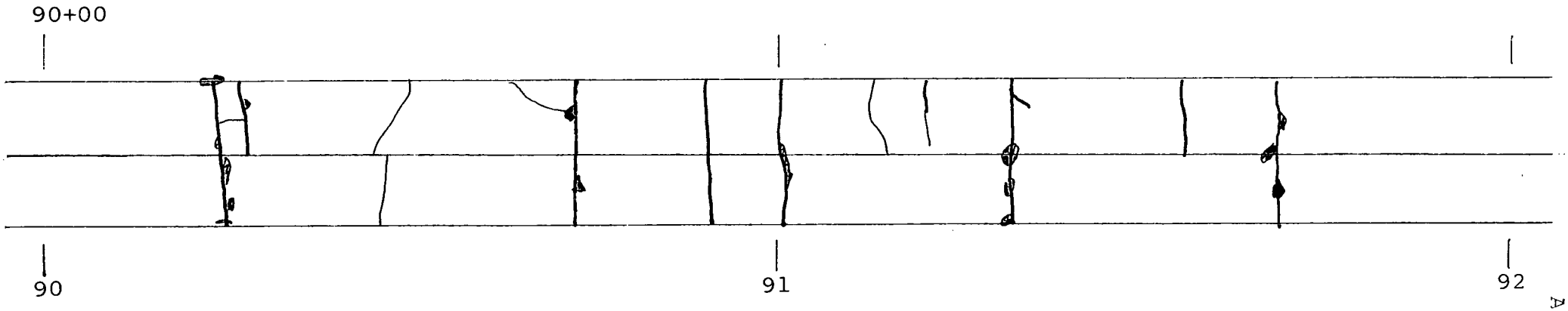

80+00
80
81
82
4½-Inch Non-reinforced
N

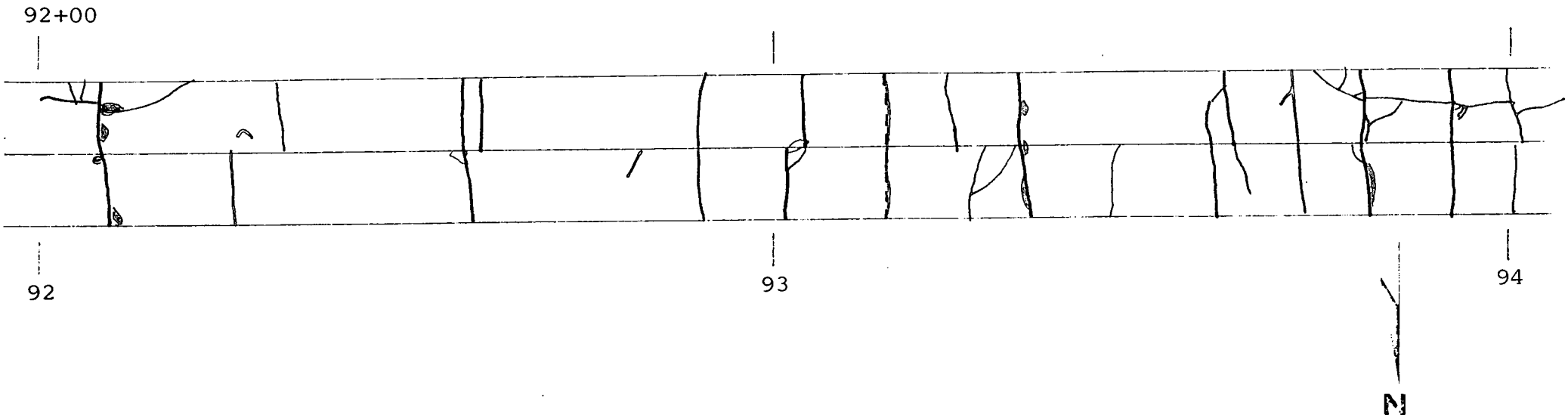

82+00
82
83
84

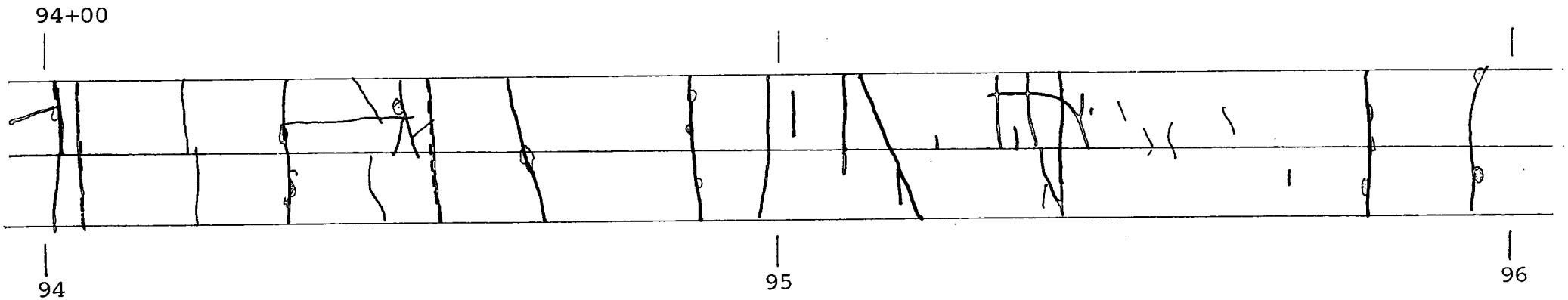

84+00
84
85
86
N

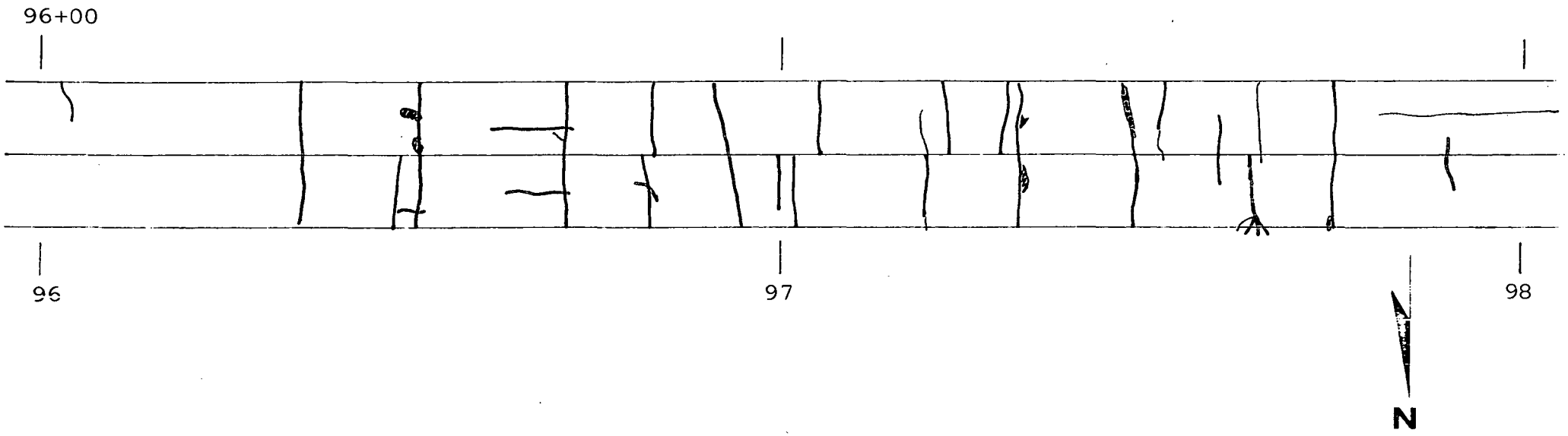

86+00
86
87
88

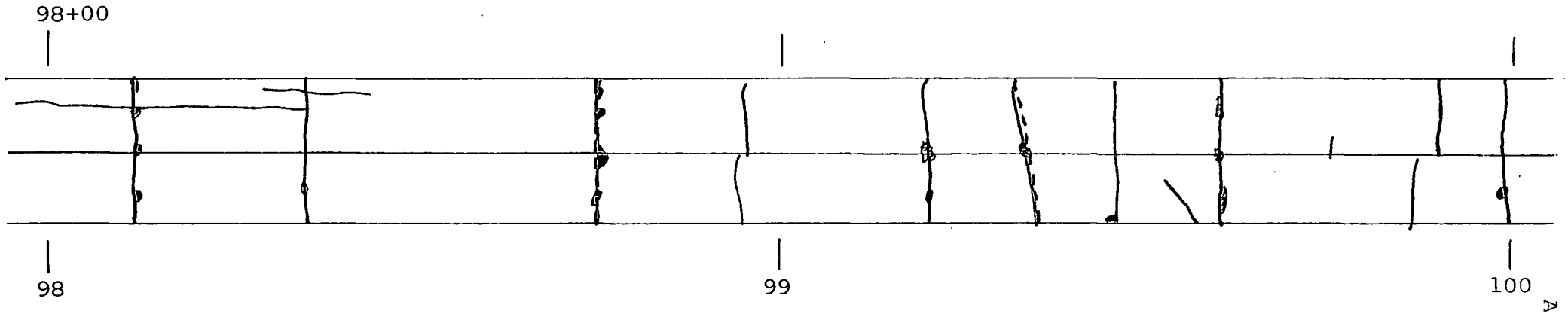

88+00
88
89
90
Concrete Patches
Const. Joint
4½-Inch Non-reinforced
5½-Inch Non-reinforced
N

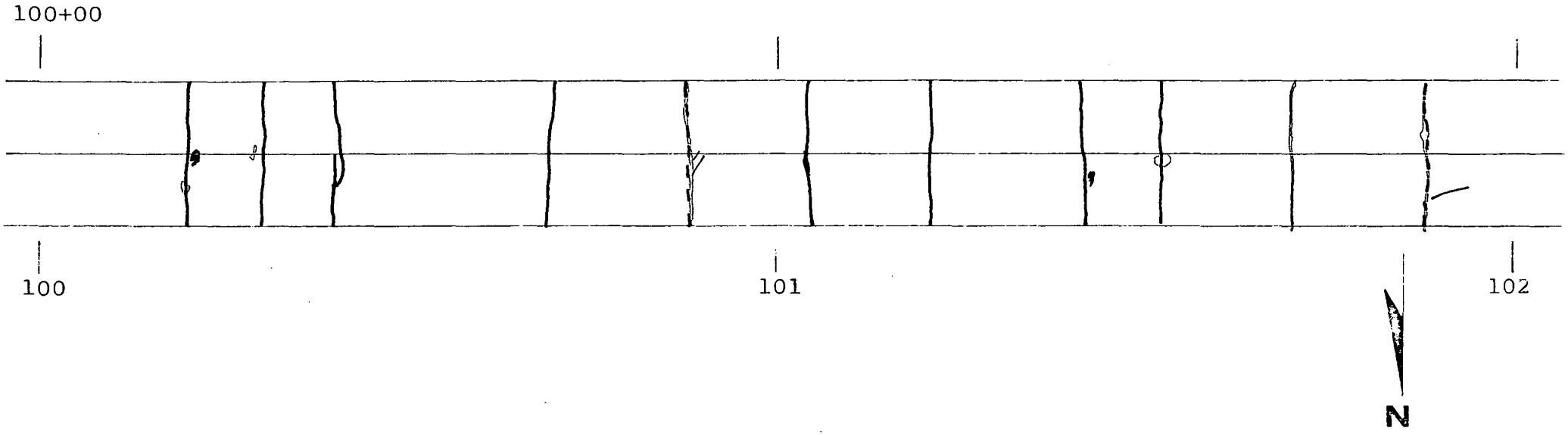

90+00
90
91
92

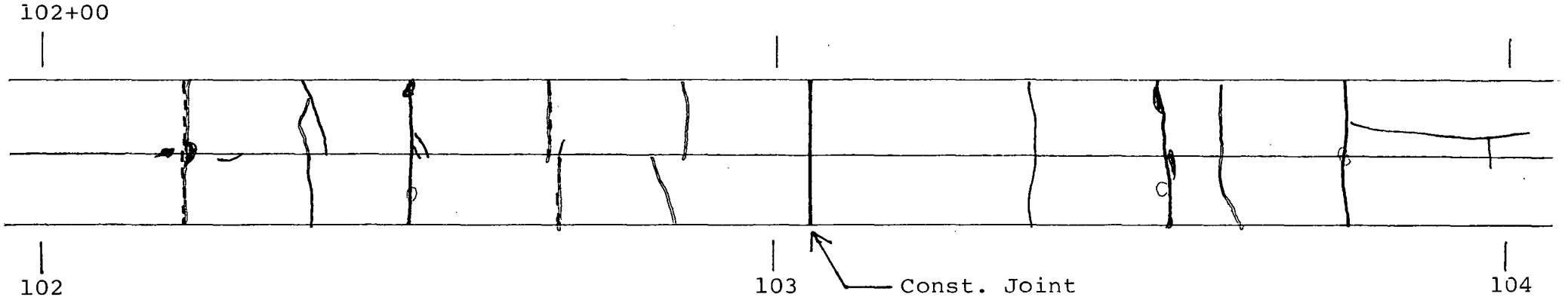

92+00
92
93
94
N

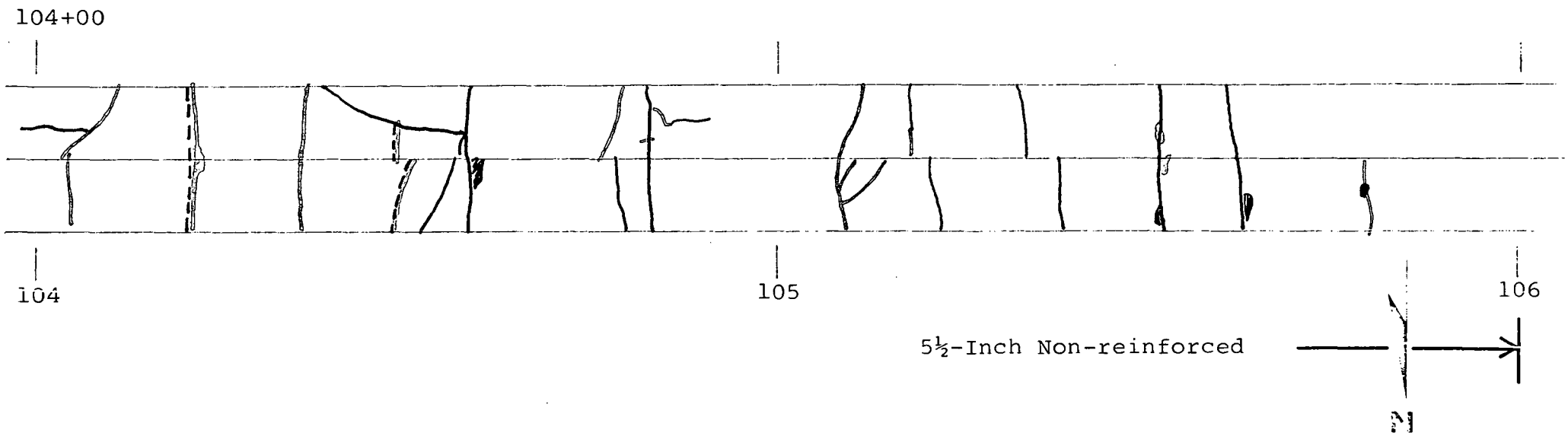

94+00
94
95
96


96+00
96
97
98
N


98+00
98
99
100


100+00
100
101
102
N


102+00
102
103
Const. Joint
104

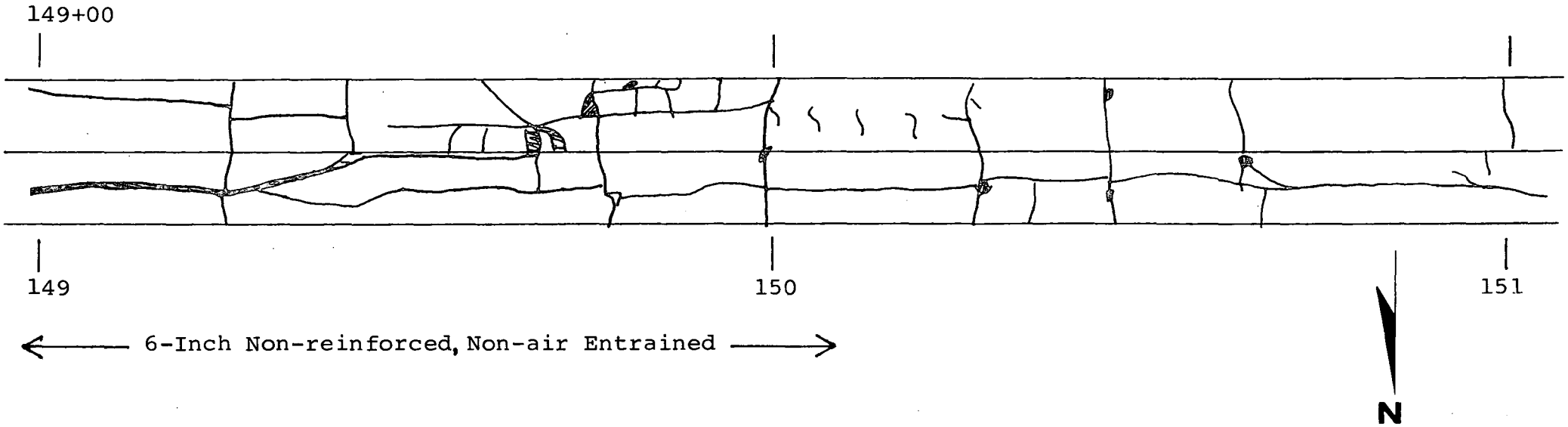

104+00
104
105
106
5½-Inch Non-reinforced

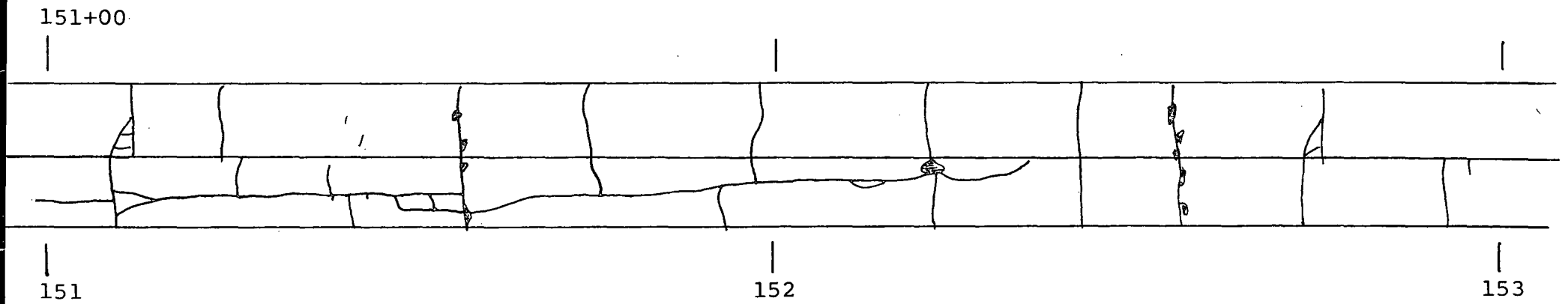
2000 FOOT SECTION

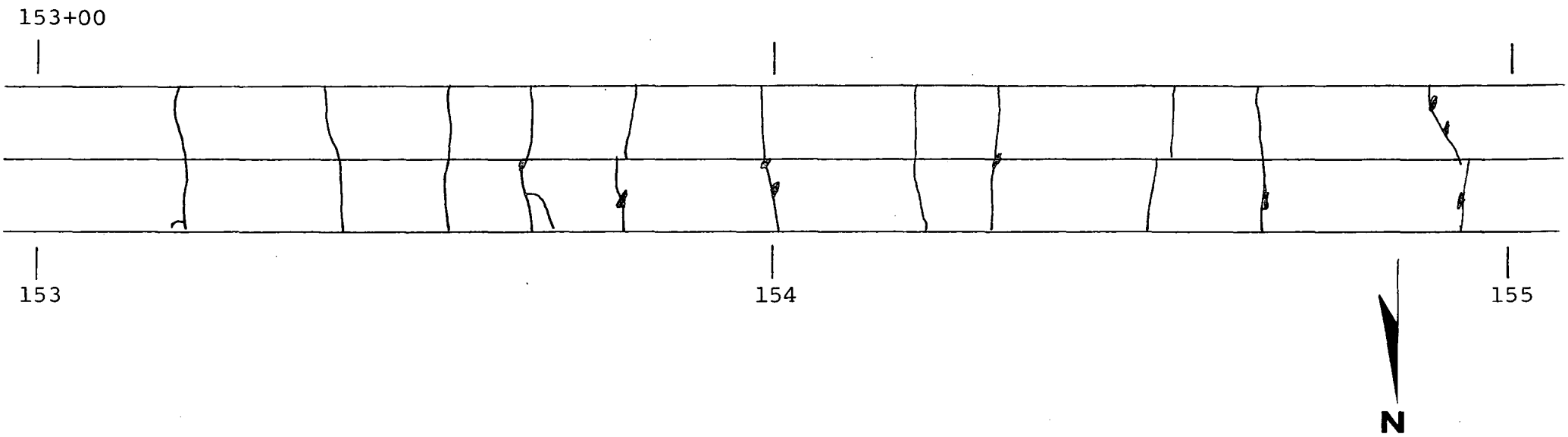
OF

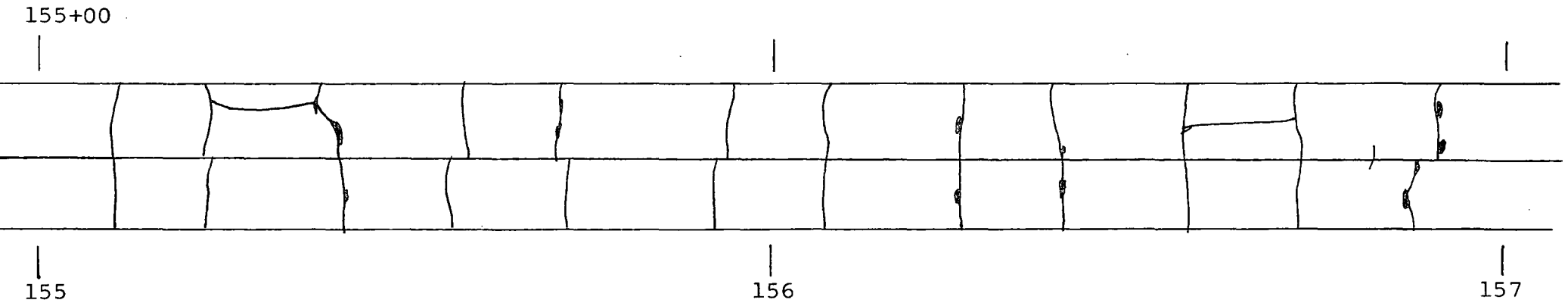
6- INCH THICK PAVEMENTS

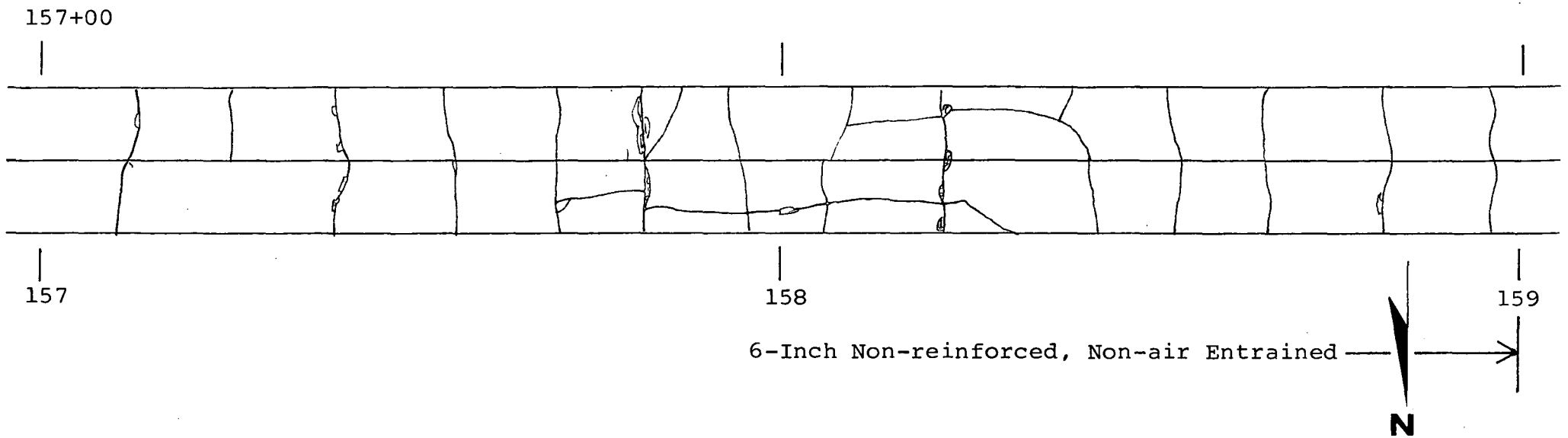
The following is a sketch of the cracks in the pavement as of July 1979. The locations of the cracks were obtained by visual inspection.

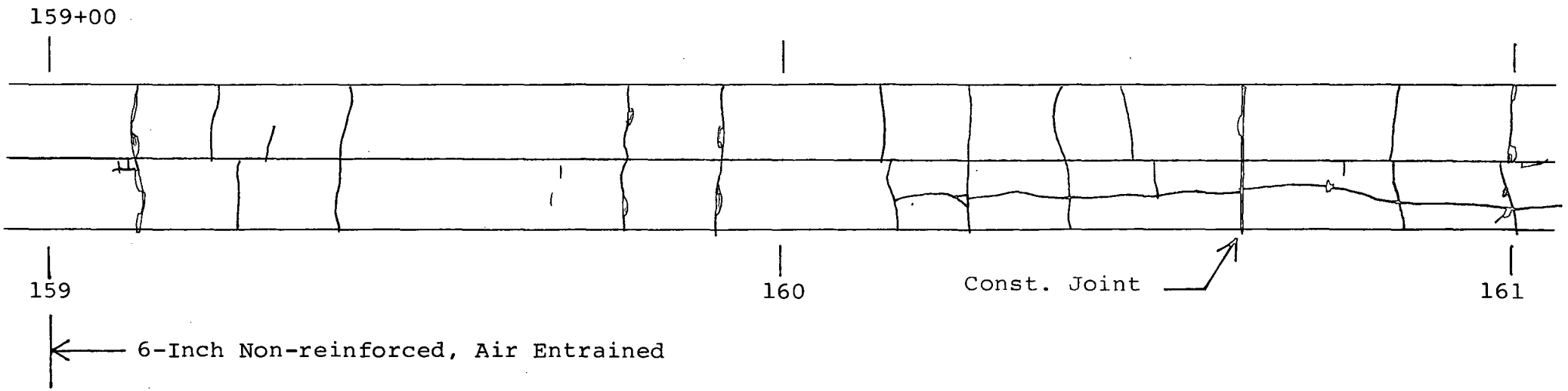

149+00
149
150
151
6-Inch Non-reinforced, Non-air Entrained
N

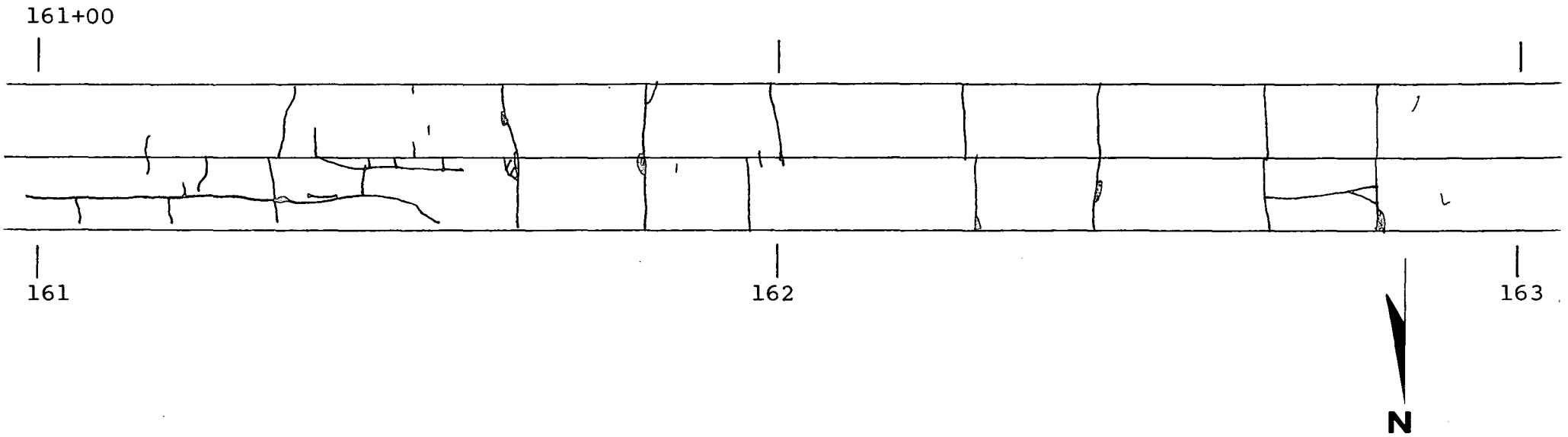

151+00
151
152
153

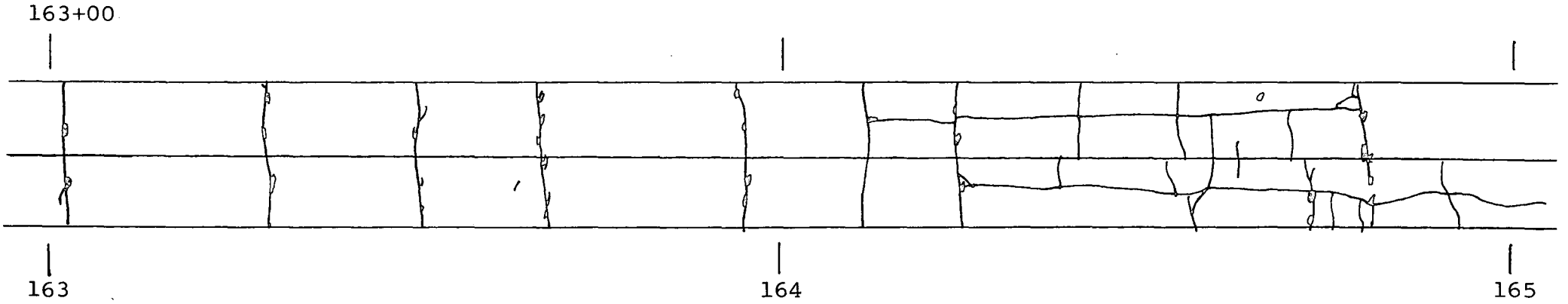

153+00
153
154
155
N

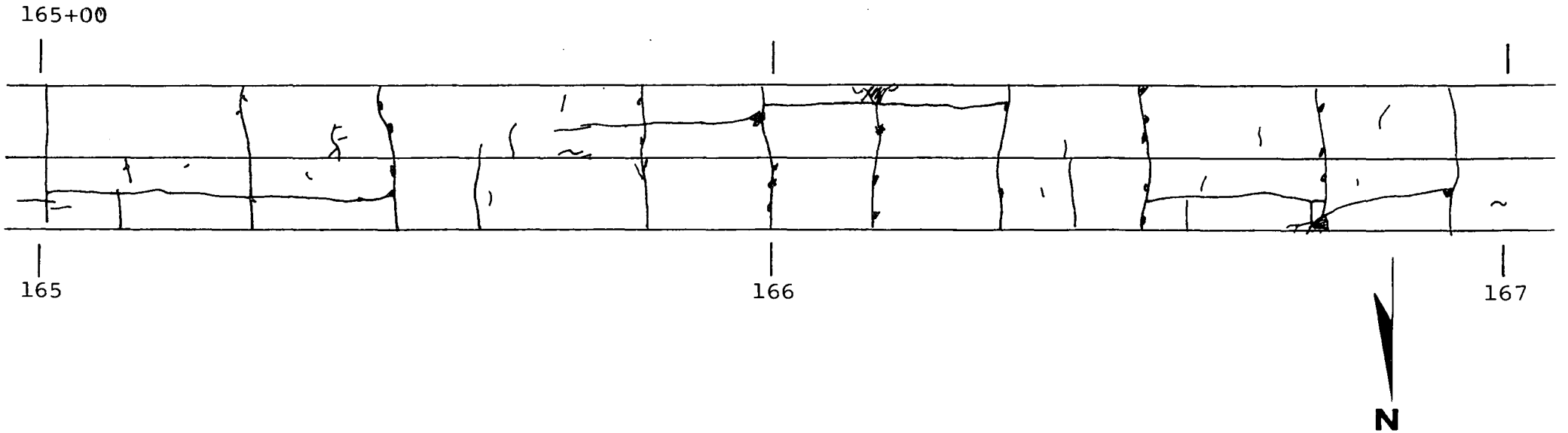

155+00
155
156
157

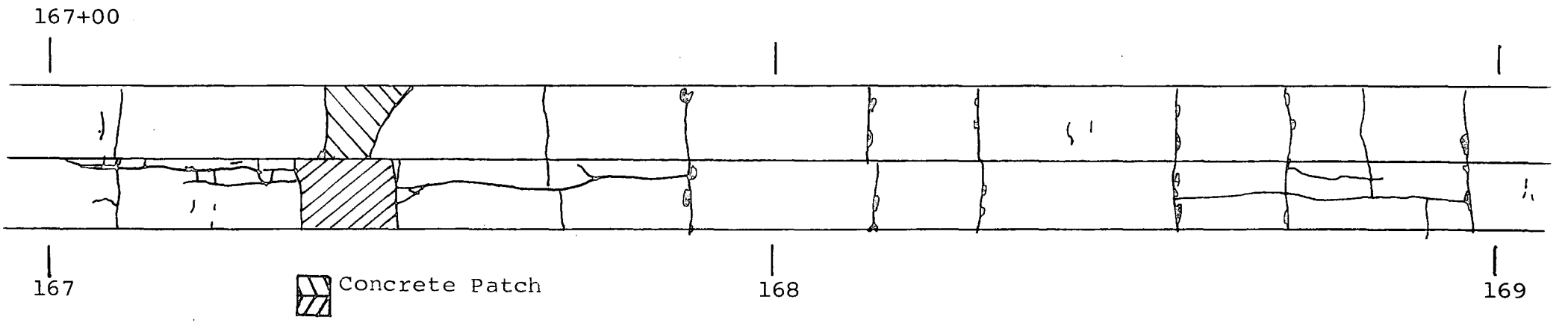

157+00
157
158
159
6-Inch Non-reinforced, Non-air Entrained
N


159+00
159
160
Const. Joint
161
6-Inch Non-reinforced, Air Entrained


161+00
161
162
163
N


163+00
163
164
165


165+00
165
166
167
N


167+00
167
168
169
Concrete Patch
6-Inch Non-reinforced, Air Entrained

APPENDIX B

Tables

IOWA STATE HIGHWAY COMMISSION
Materials Department

IOWA HIGHWAY RESEARCH PROJECT HR-9

CRACK SURVEY

Greene Co. Road "E" Iowa 17*to Farlin
(Const. Proj. SN-853 Greene Co. 1951)

Metric Conversions

1 ft. = 0.3048 m
1 station = 30.48 m
1 inch = 2.54 cm

Test Section	Length of Section (ft.)	Average Longitudinal Cracking (Feet per Station) Oct. 1951	Nov. 1951	Feb. 1952	Apr. 1952	Sept. 1952	Mar. 1953	Sept. 1953	June 1954	June 1955	June 1956	Apr. 1957	Sept. 1957	Sept. 1958	May 1965
5" Non-Reinf.** (Reg.)															
First Mile	1790	0.2	0.6	0.6	0.6	1.2	4.1	9.4	10.7	11.1	11.4	12.7	13.7	16.6	45.3
Second Mile	1800	0.0	0.0	0.0	0.8	3.7	5.6	12.1	13.7	14.7	16.8	18.6	20.0	33.8	49.1
Total	3590	0.1	0.3	0.3	0.7	2.4	4.9	10.7	12.2	12.9	14.1	15.7	16.8	25.2	47.2
4.5" Mesh Reinf. (Reg.)															
First Mile	900	0.0	0.0	0.0	0.0	0.0	0.0	6.4	6.6	6.8	6.8	8.4	9.3	11.2	15.8
Second Mile	900	0.0	0.0	0.0	0.0	0.0	0.0	14.9	15.9	15.9	17.4	27.7	31.2	37.4	76.3
Total	1800	0.0	0.0	0.0	0.0	0.0	0.0	10.7	11.2	11.3	12.1	18.1	20.3	24.3	46.0
4.5" Non-Reinf. (Reg.)															
First Mile	800	0.0	0.0	0.0	0.0	0.0	2.2	6.5	8.5	9.5	11.1	11.5	11.5	13.1	40.4
Second Mile	900	0.0	0.0	0.0	0.0	3.0	5.2	8.1	8.9	10.0	11.9	19.2	19.4	21.6	31.2
Total	1700	0.0	0.0	0.0	0.0	1.6	3.8	7.4	8.7	9.8	11.5	15.6	15.7	17.6	35.5
5.5" Non-Reinf. (Reg.)															
First Mile	1800	0.0	0.0	0.0	1.3	7.7	7.7	10.2	11.5	12.6	12.7	12.8	13.2	13.7	20.8
Second Mile	1700	0.0	0.0	0.0	0.0	1.1	1.1	1.4	1.6	1.8	2.4	2.6	2.9	2.9	4.1
Total	3500	0.0	0.0	0.0	0.7	4.5	4.5	5.9	6.7	7.4	7.7	7.9	8.2	8.4	12.7
6" Non-Reinf. (Reg.)	5066	0.0	0.0	0.0	0.0	2.8	4.1	7.3	7.3	7.4	7.7	8.0	8.0	8.6	20.4
6" Non-Reinf. (Air Entr.)	5302	0.0	0.0	0.0	0.3	2.1	2.3	5.3	6.7	9.5	11.0	15.1	15.4	18.8	41.7

*Iowa Highway No. 17 was changed to Iowa No. 4 in 1967
**Non-Reinf. refers to pavement with centerline tie-bars only.

IOWA STATE HIGHWAY COMMISSION
Materials Department

IOWA HIGHWAY RESEARCH PROJECT HR-9

CRACK SURVEY

Greene Co. Road "E" Iowa 17* to Farlin
(Const. Proj. SN-853 Greene Co. 1951)

Slab Length = (Length of Section) / (No. Transverse Cracks) & No. Joints

Test Section	Length of Section (ft.)	Number of Joints	Average Slab Length (Ft.) Oct. 1951	Nov. 1951	Feb. 1952	Apr. 1952	Sept. 1952	Mar. 1953	Sept. 1953	June 1954	June 1955	June 1956	Apr. 1957	Sept. 1957	May 1965
5" Non-Reinf. (Reg.)**															
First Mile	1790	2	69	45	42	39	22	20	17	16	15	15	14	14	13
Second Mile	1800	2	138	75	69	67	33	28	23	23	22	21	20	20	18
Total	3590	4	92	56	52	49	26	24	19	19	18	17	17	17	15
4.5" Mesh Reinf.(Reg.)															
First Mile	900	31	29	29	29	29	29	29	28	27	27	26	25	25	24
Second Mile	900	30	30	30	30	30	29	29	27	27	26	26	25	25	21
Total	1800	61	30	30	30	30	29	29	28	27	27	26	25	25	22
4.5" Non-Reinf. (Reg.)															
First Mile	800	0	133	100	80	73	52	42	33	31	28	27	26	26	20
Second Mile	900	1	60	56	50	47	21	19	16	15	15	14	14	14	12
Total	1700	1	81	71	61	57	29	25	21	20	19	18	18	18	15
5.5" Non-Reinf. (Reg.)															
First Mile	1800	2	138	86	62	60	32	30	27	26	25	23	22	22	20
Second Mile	1700	2	68	63	55	55	33	26	23	22	21	21	20	20	18
Total	3500	4	192	73	58	57	33	27	25	23	23	22	21	21	19
6" Non-Reinf. (Reg.)	5066	5	123	103	96	96	56	43	39	37	36	33	31	31	26
6" Non-Reinf. (Air-Entr.)	5302	5	177	143	129	129	59	43	36	33	31	27	25	25	21

*Iowa Highway No. 17 was changed to Iowa No. 4 in 1967

**Non-Reinf. refers to pavement with centerline tie-bars only.

Metric Conversion

1 ft. = 0.3048 m
1 in. = 2.54 cm

AVERAGE TRAFFIC IN VEHICLES PER DAY

Year	East Mile No. 1	2	3	West 4	Avg.
1957	250	241	241	265	249
1962	299	294	249	262	276
1967	353	329	271	295	312
1972	236	286	218	188	232
1976	315	272	238	258	271
Average	291	284	243	254	268

CONCRETE STRENGTHS

Section No.	Thickness (in.)	(cm)	Concrete Strength: 28 day cylinders (psi)	28 day cylinders (kg/cm^2)	260 day cores (psi)	260 day cores (kg/cm^2)	28 year cores (psi)	28 year cores (kg/cm^2)
1,5	5	12.7	5370	378	6060	426	8094	569
2,3,6 & 7	4½	11.4	5740	404	6220	437	7572	532
4,8	5½	14.0	5492	386	6240	439	7572	532
9	6	15.2	5895	414	6580	463	7820	550
10	6AE	15.2	5290	372	6235	438	7540	530
	Average		5560	391	6270	441	7720	543

RIDABILITY - 1979

(Ridability Index*)

Section No.	Thickness (in.)	(cm)	BPR** Roughometer Method
1,5	5	12.7	3.2
2,6	4½ mesh	11.4	3.4
3,7	4½	11.4	3.2
4,8	5½	14.0	3.2
9	6	15.2	3.2
10	6AE	15.2	3.3

* Ridability Index = Present servicability index (PSI) without deduction for cracking and patching

** BPR = Bureau of Public Roads

RIDING QUALITY BY THE BPR*TYPE ROUGHOMETER

(Inches Per Mile)

Section No.	Thickness (in.)	(cm)	1955 East	1955 West	1979 East	1979 West	Increase in Roughness East	Increase in Roughness West
1,5	5		111	113	131	126	20	13
2,6	4½ mesh	12.7	109	105	111	109	2	4
3,7	4½	11.4	107	107	127	137	20	30
4,8	5½	11.4	110	108	123	122	13	14
9	6	14.0	110	109	130	124	20	15
10	6 AE	15.2	109	100	126	116	17	16

(Centimeter Per Kilometer)

1,5			175	178	207	199	32	21
2,6			172	166	175	172	3	6
3,7			169	169	200	216	31	47
4,8			174	170	194	193	20	23
9			174	172	205	196	31	24
10			172	158	199	183	27	25

*BPR = Bureau of Public Roads

PAVEMENT COSTS

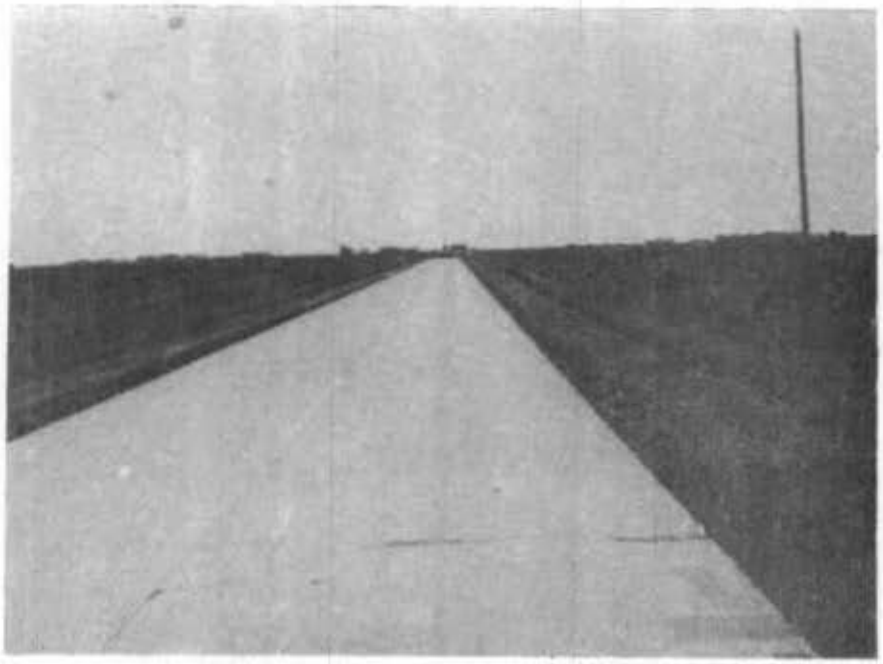
Section No.	Thickness (ft)	Thickness (cm)	Length (ft)	Length (m)	Section Cost ($)	Cost per Mile ($)	Cost Per Kilometer ($)
1,5	5	12.7	3590	1094	25,130.07	36,960.10	22,965.94
2,6	4½ mesh	11.4	1800	549	13,680.00	40,128.00	24,934.38
3,7	4½	11.4	1700	518	11,484.51	35,669.54	22,164.02
4,8	5½	14.0	3500	1067	25,355.63	38,250.78	23,767.93
9	6	15.2	5066	1544	38,824.71	40,464.76	25,143.64
10	6 AE	14.2	5302	1616	38,997.76	38,835.94	24,131.54
				Miscellaneous costs	9,080.98		
				TOTAL COST	162,553.66		

APPENDIX C

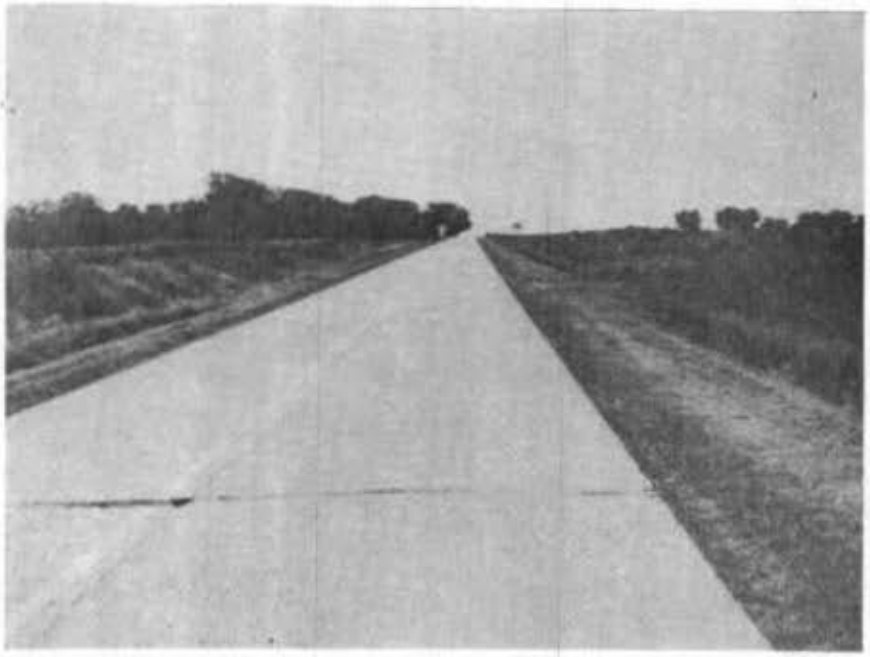
Photographs

of

Various Thicknesses of Pavement

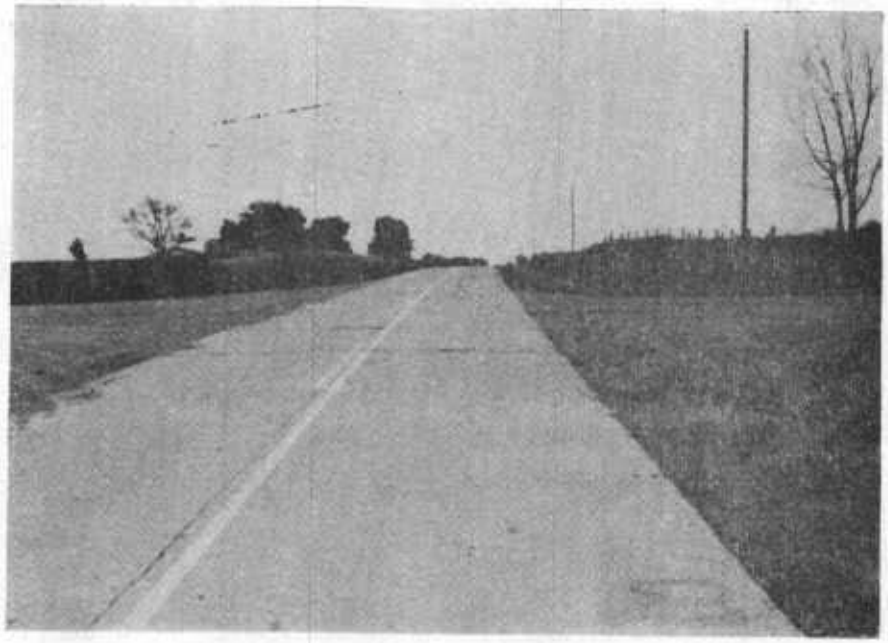


5-inch Non-Reinforced
(12.7 cm)



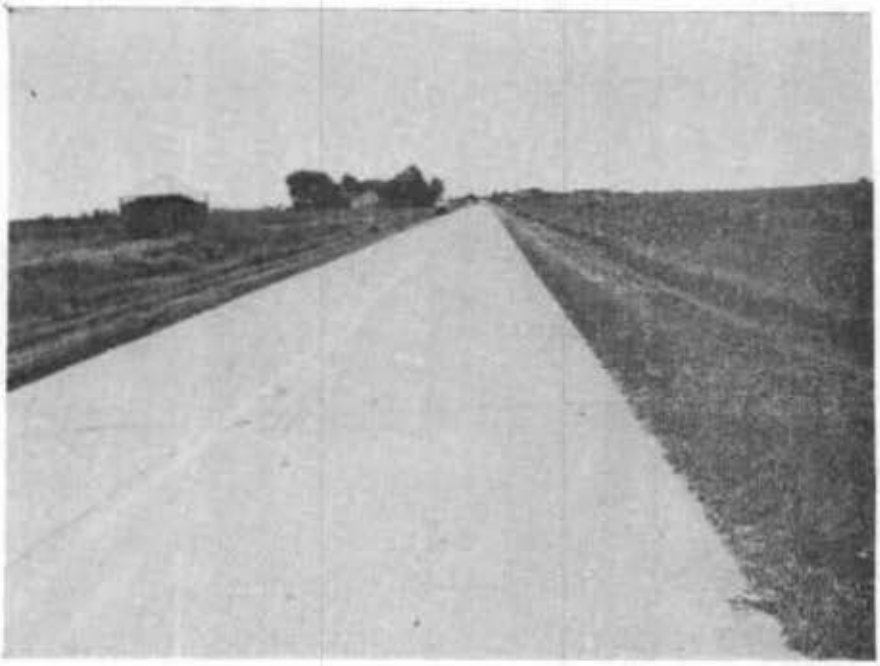
4½-inch Mesh Reinforced
(11.4 cm)

4½-inch Non-Reinforced
(11.4 cm)



5½-inch Non-Reinforced
(14.0 cm)

6-inch Non-Reinforced
(15.2 cm)



6-inch Non-Reinforced Air Entrained
(15.2 cm)