Research Report
KTC-94-8

FOLLOW-UP INSPECTION OF PREMATURE CRACKING ON THE NATIONAL TURNPIKE, JEFFERSON COUNTY

by

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in cooperation with
Transportation Cabinet
Commonwealth of Kentucky

and

Federal Highway Administration
U.S.Department of Transportation

March 1994

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
KTC-94-8		

4. Title and Subtitle

Follow-Up Investigation of Premature Cracking on the National Turnpike, Jefferson County

5. Report Date
March 1994

6. Performing Organization Code

7. Author(s)
L. J. Fleckenstein and David L. Allen

8. Performing Organization Report No.6
KTC-94-8

9. Performing Organization Name and Address

Kentucky Transportation Center
College of Engineering
University of Kentucky
Lexington, KY 40506-0043

10. Work Unit No. (TRAIS)

11. Contract or Grant No.
Federal Aid Research Task 49
Project F841-1(39)

12. Sponsoring Agency Name and Address

Kentucky Transportation Cabinet
State Office Building
Frankfort, KY 40622

13. Type of Report and Period Covered

14. Sponsoring Agency Code

15. Supplementary Notes

Publication of this report was sponsored by the Kentucky Transportation Cabinet in cooperation with the U.S. Department of Transportation, Federal Highway Administration

16. Abstract

This report discusses the investigation of the premature cracking that has been occurring on the National Turnpike, Jefferson County since 1989. A report was issued in 1990, KTC-90-5. This report documents performance to date. A detailed distress survey was performed evaluating each slab throughout the project site.

The distress survey indicates that substantial pavement cracking has occurred since the last visual inspection in 1990.

An intense maintenance program is recommended.

17. Key Words		18. Distribution Statement
Subgrade Stiffness	Settlement	Unlimited
Portland Cement	Cracking	
Load Transfer	Rock Stabilization	
FWD Testing		

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	39	

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INTRODUCTION

The National Turnpike, in Jefferson County (Project No. F 841-1(39)) was completed on May 3, 1989. At the recommendation of the Department of Highways' Geotechnical Branch, a considerable amount of subgrade stabilization was performed during construction. However, pavement cracking and settlement occurred throughout the project since project completion. On September 27, 1989, the Kentucky Transportation Cabinet and Federal Highway Administration requested the Kentucky Transportation Center staff to investigate the cause of the premature pavement failure and suggest possible remedial actions.

In March 1990, Research Report KTC-90-5, "Investigation of Premature Cracking on the National Turnpike, Jefferson County" was completed. In September and October 1993, KTC personnel conducted a follow-up inspection of the National Turnpike. This report includes a discussion of the findings that were documented in the original survey and presents the latest information.

Brief Overview of 1989-1990 Conditions

During the initial survey of the National Turnpike (1989-1990) five locations were identified where cracks in the slabs were associated with adjacent curb inlets and manholes. It was suspected that compaction around these inlets probably was not sufficient and did not provide adequate support for the slabs.

Additional distress was observed in two major areas where pavement damage appeared to be concentrated. The first area was from Station 84+50 to approximate Station 86+00, in the vicinity of Sinclair Street. The second major area of distress was from Station 108+20 to Station 113+20, near the south end of the project. Available cone penetrometer data indicated the subgrade was weaker in the vicinity of Sinclair Street.

Falling Weight Deflectometer data taken in 1990 showed the stiffness of the pavement structure was greater in the southbound lanes than in the northbound lanes. The southbound lanes were constructed largely on the old roadbed. It appeared the subgrade under the old structure had consolidated and was probably stiffer, and consequently, provided better support to the new structure.

Several dips in slab elevation were observed in the area of Sinclair Street and near the south end of the project.

A No. 3 stone was used in approximately 12-inch and 24-inch layers during construction to stabilize the subgrade. There appeared to be little or no difference in behavior between the 12-inch sections and the 24-inch sections. Considerable settlement was observed between Station 72+00 to 78+00 from 1989 to 1990. This area of the project had no stone layer. It appears that the addition of at least 12 inches of stone was beneficial.

The No. 3 stone did not meet the filter requirement for the DGA; therefore, it is possible that fines from the DGA may be filtering into the stone.

The subgrade soils consisted largely of silts with a large proportion of clay (25 to 35 percent). Repeated-load tests indicated that extremely small stresses in the saturated subgrade may produce significant deformations in the subgrade that could be reflected in settling of the slabs.

The northbound lanes were opened to traffic on July 8, 1988. In July and August of that year, the project area received abnormally high amounts of rainfall. The southbound lanes were opened to traffic on December 14, 1988. The previous month (November 1988) received well above the normal rainfall. It is suspected this excess moisture may have saturated and weakened the subgrade of the new pavement.

Water well data indicate the subgrade is probably in a state of near saturation for a large portion of the year.

Level elevations taken in 1989-1990 indicated that some shifting and settlement of the slabs had occurred since construction. The northbound lanes had settled more than the southbound lanes. Most settlement occurred from Station 72+00 to Station 78+00, area that has no stone layer. A second area where considerable settlement has occurred is from Station 85+00 to Station 95+00. This is in the area of Sinclair Street.

VISUAL SURVEY 1993

In August 1993, a detailed visual inspection was conducted of the study area. Distress which had occurred since the 1990 survey is logged on the distress data sheets in red (Appendix A). As indicated in Table 1, the southbound lanes had approximately 35 feet of additional cracking (13.4 % increase), the median had 25 feet of additional cracking (41.0 % increase), and the northbound side had approximately 360 feet of new cracking (82 % increase). A significant increase in spalling was also noted in the northbound lanes (Table 2).

A total of 79 slabs have been identified that will most likely need replacement. In 1990, 59 slabs were identified. Since this time, 20 additional slabs are showing signs of distress. Of the 59 specified in 1990, 13 of the 59 slabs are continuing to crack, and 16 adjacent slabs are also cracking. Significant faulting and cracking was observed at Station 82+12 and Station 75+04. Both of these stations are located adjacent to manholes (storm drains). The slabs needing to be replaced are identified by station numbers in Table 3.

RI data from 1989 to 1992 indicate that the northbound lanes have decreased at a more rapid rate on the southern end of the project from Fairdale Road to KY 841 (Milepost 2.669-3.011), and the southbound side has decreased at a more rapid rate on the north end of the project from KY 841 to KY 1065 (Milepost 3.011-3.661) (Table 4).

CONCLUSIONS

From the visual evaluation conducted in 1993, it is evident that the pavement is deteriorating at a more rapid rate on the northbound side due to the large increase in cracking since the 1990 survey.

Surface spalling also appears to be occurring at a more rapid rate in the northbound lanes.

Significant faulting and cracking were observed at Station 82+12 and Station 75+04. Both of these stations are located adjacent to manholes (storm drains). It appears that substantial settlement is still occurring around the some of the storm drains.

RECOMMENDATIONS

In 1990, several recommendations were made and those recommendations are reported here.

1. It is recommended that pavement distresses continue to be monitored every six months.

2. Longitudinal edge drains placed at the back of the curbs would help to intercept any surface water that infiltrated through the joints of the pavement and would otherwise become trapped at the interface between the DGA and the base of the slab. The edge drains would probably help to reduce pumping of the slab and the consequent loss of DGA fines. These edge drains are recommended. However, in all likelihood, this would alleviate only part of the problem. Edge drains would not significantly help the weak subgrade because the drains could not be placed sufficiently deep to effectively drain the subgrade.

3. An intensive and aggressive maintenance program is also recommended. Any future faulting at joints and/or new cracks should be maintained by grinding. Pavement undersealing could be used to help maintain grade. In some instances, as slabs and joints deteriorate, complete replacement is recommended. If a comprehensive maintenance program is implemented, the pavement may provide most of its original design life.

4. Significant faulting and cracking was observed at Station 82+12 and Station 75+04. Both of these stations are located adjacent to manholes (storm drains). These slabs need to be replaced. Table 3 also indicates several other slabs that need to be replaced.

TABLE 1. SLAB CRACKING IN LINEAR FEET BETWEEN (1989-1990) AND (1990-1993)								
(89-90) SOUTHBOUND	(90-93) SOUTHBOUND	PERCENT INCREASE SOUTHBOUND	(89-90) MEDIAN	(90-93) MEDIAN	PERCENT INCREASE MEDIAN	(89-90) NORTHBOUND	(90-93) NORTHBOUND	PERCENT INCREASE NORTHBOUND
261	296	13.4	61	86	41.0	441	801	81.6

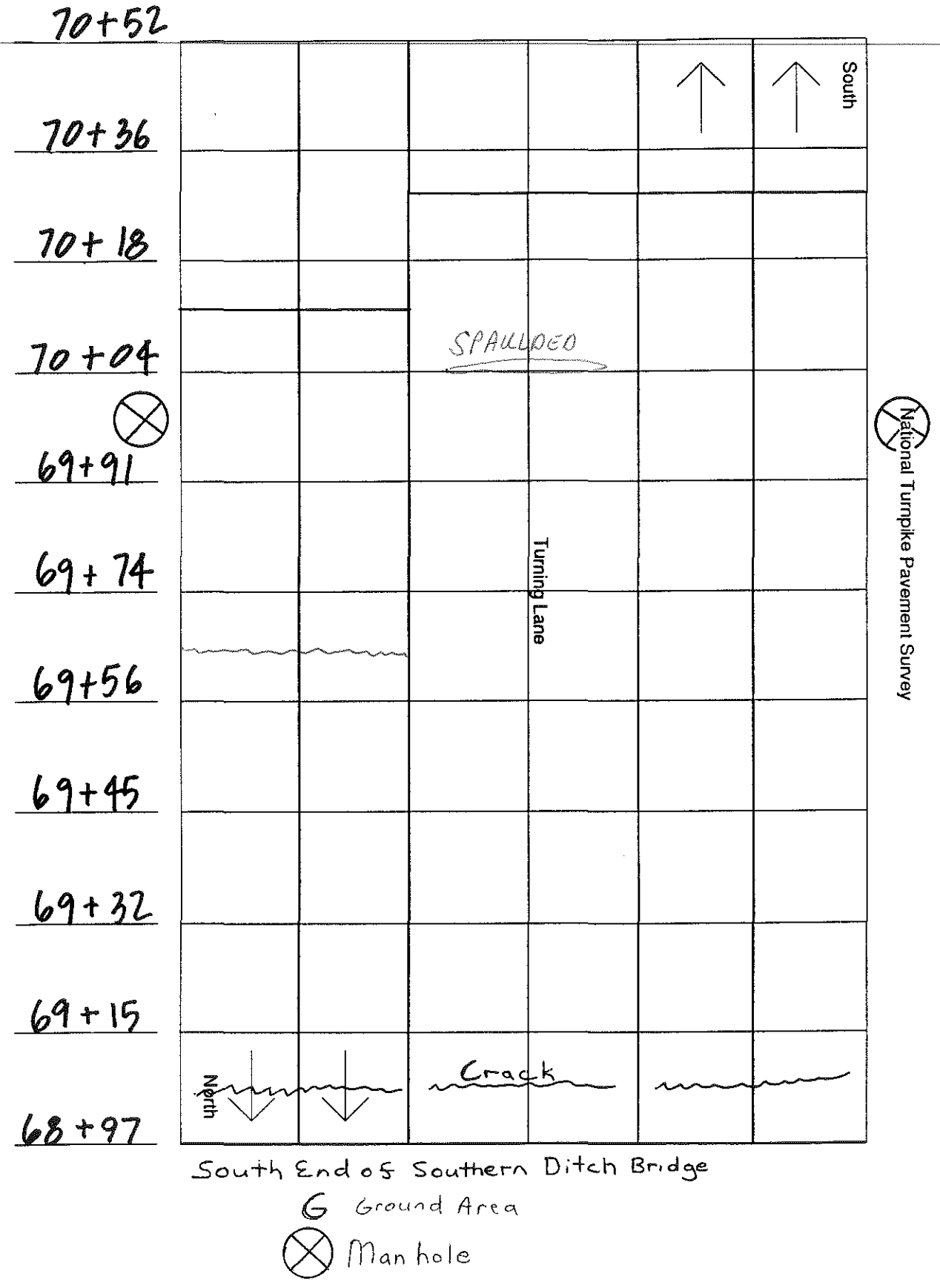
TABLE 2. NUMBER OF SPALLED AREAS BETWEEN (1989-1990) AND (1990-1993)					
(89-90) SOUTHBOUND	(90-93) SOUTHBOUND	(89-90) MEDIAN	(90-93) MEDIAN	(89-90) NORTHBOUND	(90-93) NORTHBOUND
1	3	0	1	3	13

TABLE 3. RECOMMENDED SLABS TO BE REPLACED				
YEAR DEFINED	STATION	DIRECTION	LANE	CRACKING SINCE LAST SURVEY
1993	69+56	Northbound	Both Lanes	New Crack
1989-1990	74+96	Northbound	Outside	Additional Cracking
1993	75+04	Northbound	Outside	New Crack
1993	75+58	Northbound	Outside	New Crack
1989-1990	78+14	Northbound	Both Lanes	
1993	78+32	Northbound	Both Lanes	New Crack
1989-1990	79+95	Northbound	Both Lanes	
1993	81+94	Northbound	Outside Lane	New Crack
1989-1990	82+12	Northbound	Outside Lane	Additional Cracking
1989-1990	84+79	Southbound	Both Lanes, Plus Turning Lanes	
1989-1990	84+98	Southbound	Outside Lane	
1989-1990	85+58	Southbound	Both Lanes	
1989-1990	91+46	Southbound	Outside Lane	
1993	92+07	Northbound	Both Lanes	New Crack
1993	95+60	Northbound	Inside Lanes	New Crack
1993	102+52	Southbound	Both Lanes, Plus Turning Lanes	New Crack
1989-1990	103+07	Southbound	Outside Lane	
1989-1990	104+33	Southbound	Both Lanes	
1989-1990	106+02	North and Southbound	Both Lanes	New Crack
1989-1990	106+19	Southbound	Outside Lane	

TABLE 3. RECOMMENDED SLABS TO BE REPLACED (CONTINUED)				
1989-1990	108+19 - 108+62	Southbound	Outside Lane	
1989-1990	108+80 - 108+94	Southbound	Inside Lane	
1989-1990	108+62	Southbound	Inside Lane	
1989-1990	108+45 - 108+80	Northbound	Both Lanes	Additional Cracking
1989-1990	109+25-109+43	Northbound	Both Lanes	Additional Cracking
1993	109+56	Northbound	Outside Lane	New Crack
1989-1990	109+68	Northbound	Outside Lane	Additional Cracking
1989-1990	109+25	Southbound	Both Lanes, Plus Turning Lane	Additional Cracking
1993	109+86	Northbound	Outside Lane	New Crack
1989-1990	110+03	Northbound	Outside Lane	Additional Cracking
1989-1990	110+16	Northbound	Inside Lane	
1989-1990	111+06	Northbound	Both Lanes	
1989-1990	112+09	Northbound	Outside Lane	
1989-1990	112+70 - 112+89	Northbound	Both Lanes	Additional Cracking
1989-1990	113+06	Northbound	Both Lanes	Additional Cracking
1993	116+69	Northbound	Both Lanes	New Crack
1989-1990	116+83	Northbound	Inside Lane	
1989-1990	116+95 - 117+30	Northbound	Inside Lane	Additional Cracking
1993	117+56	Northbound	Both Lanes	New Crack
1993	117+74	Northbound	Inside Lane	New Crack

TABLE 4. NATIONAL TURNPIKE RI DATA				
MILEPOST (2.669 - 3.011)			MILEPOST (3.011 - 3.661)	
DATE	NORTHBOUND	SOUTHBOUND	NORTHBOUND	SOUTHBOUND
11/6/89	1.74	1.74	2.23	2.13
5/7/90	1.34	1.66	1.54	1.76
6/5/91	1.38	1.53	1.84	1.66
6/17/92	1.46	----	1.63	----
AVERAGE RI----->	1.48	1.64	1.81	1.14

Appendix A
Concrete Slab Distresses 1993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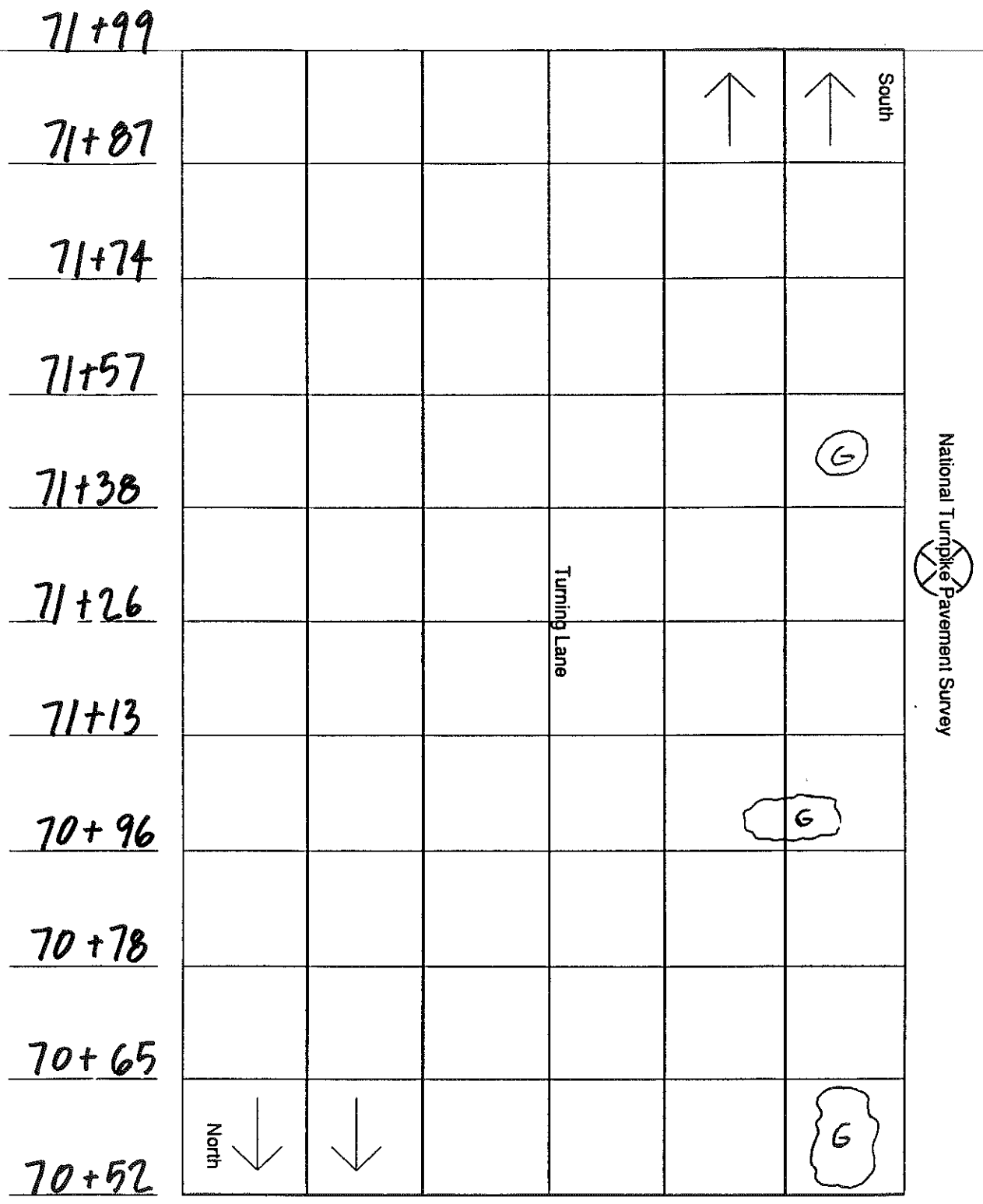
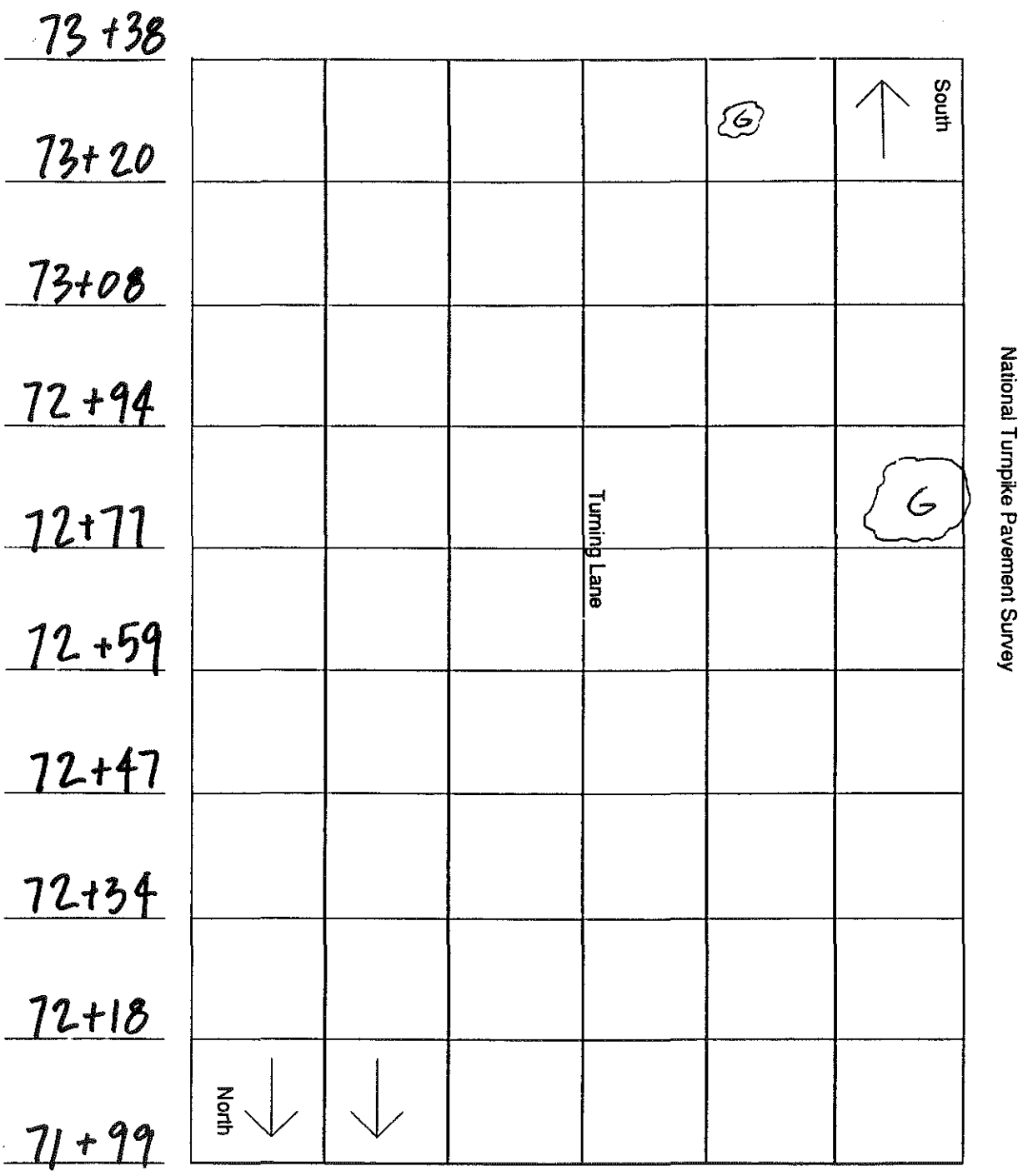
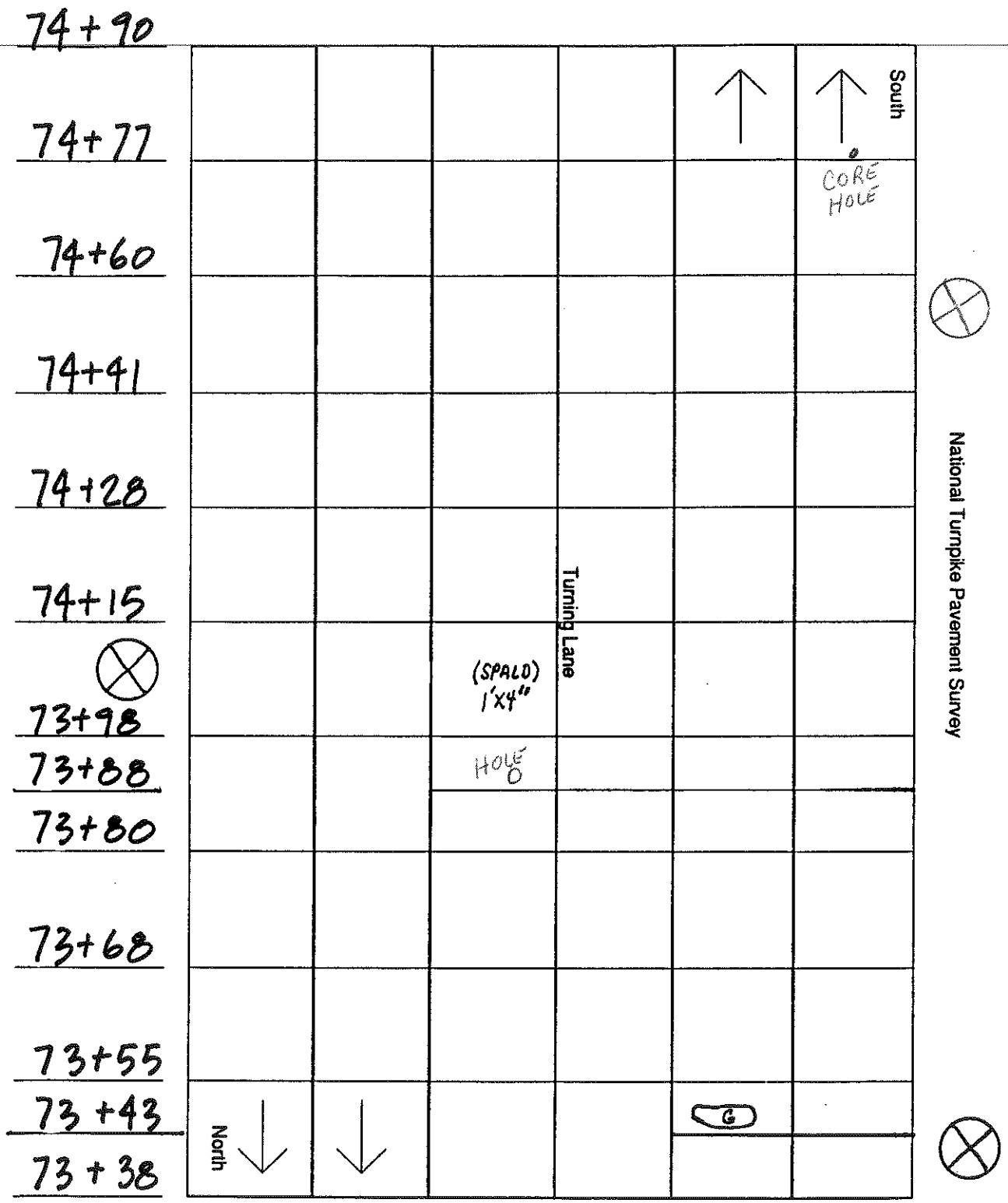
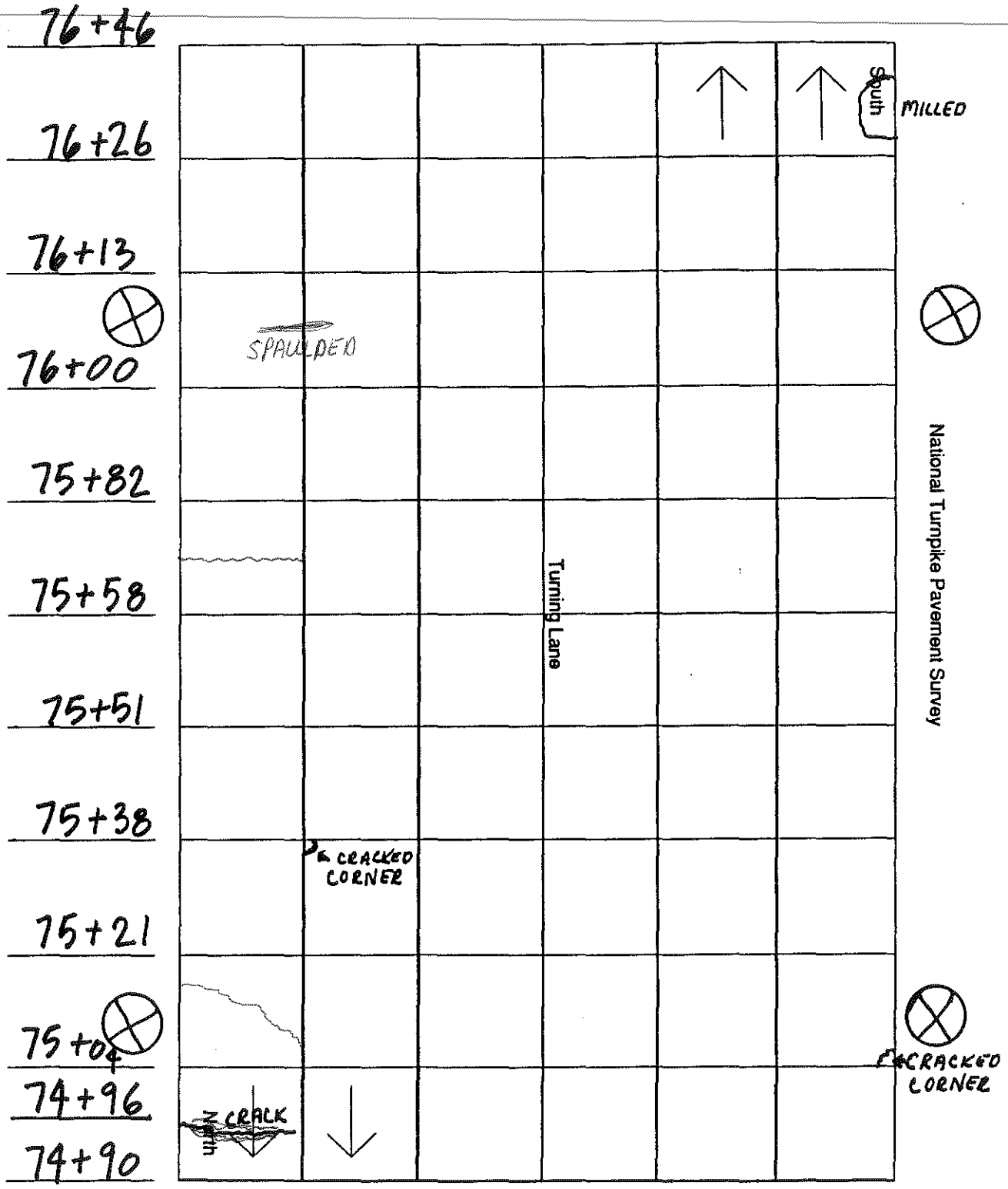
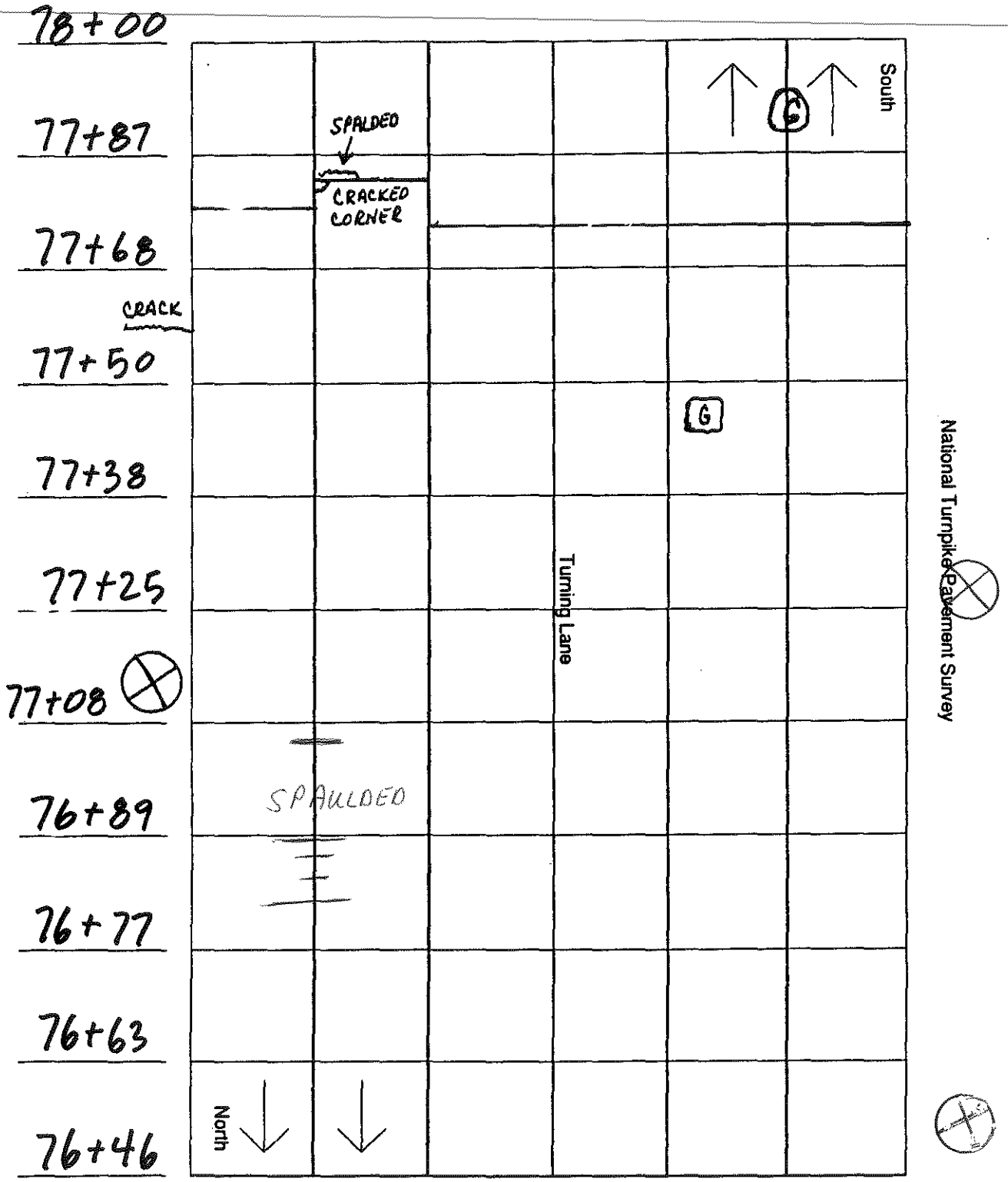
70+36
70+18
70+04
69+91
69+74
69+56
69+45
69+32
69+15
68+97
South
SPALLDED
Turning Lane
National Turnpike Pavement Survey
North
Crack
South End of Southern Ditch Bridge
Ground Area
Manhole

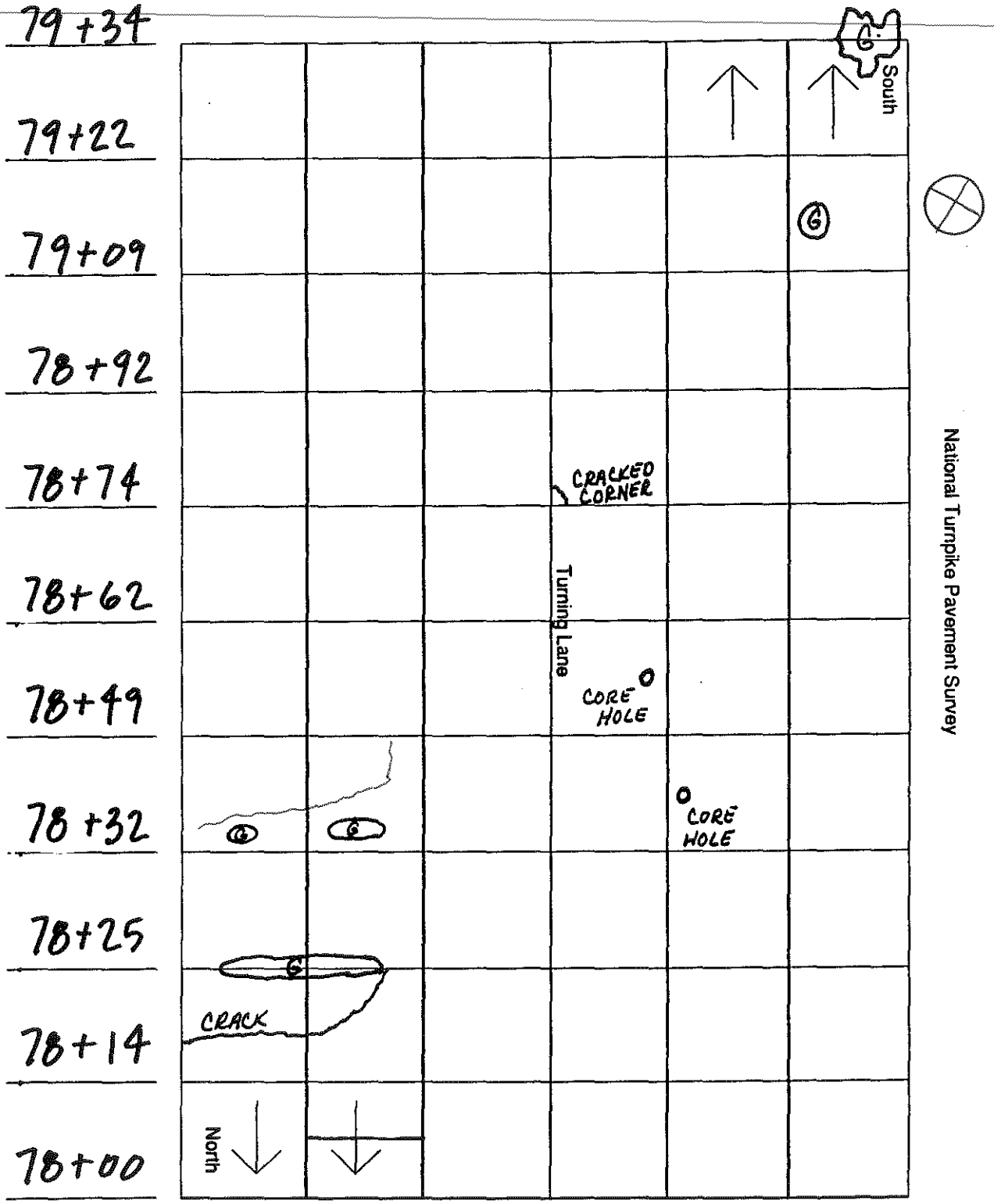

71+99
71+87
71+74
71+57
71+38
71+26
71+13
70+96
70+78
70+65
70+52
South
North
Turning Lane
G
G
G
National Turnpike Pavement Survey


73+38
73+20
73+08
72+94
72+77
72+59
72+47
72+34
72+18
71+99
South
North
Turning Lane
National Turnpike Pavement Survey


74+90
74+77
74+60
74+41
74+28
74+15
73+98
73+88
73+80
73+68
73+55
73+43
73+38
South
CORE HOLE
Turning Lane
(SPALD) 1'X4"
HOLE
North
National Turnpike Pavement Survey


76+46
76+26
76+13
76+00
75+82
75+58
75+51
75+38
75+21
75+04
74+96
74+90
South
MILLED
SPALLED
Turning Lane
National Turnpike Pavement Survey
CRACKED CORNER
CRACKED CORNER
CRACK
North


78+00
77+87
77+68
77+50
77+38
77+25
77+08
76+89
76+77
76+63
76+46
SPALDED
CRACKED CORNER
CRACK
SPAULDED
G
G
South
North
Turning Lane
National Turnpike Pavement Survey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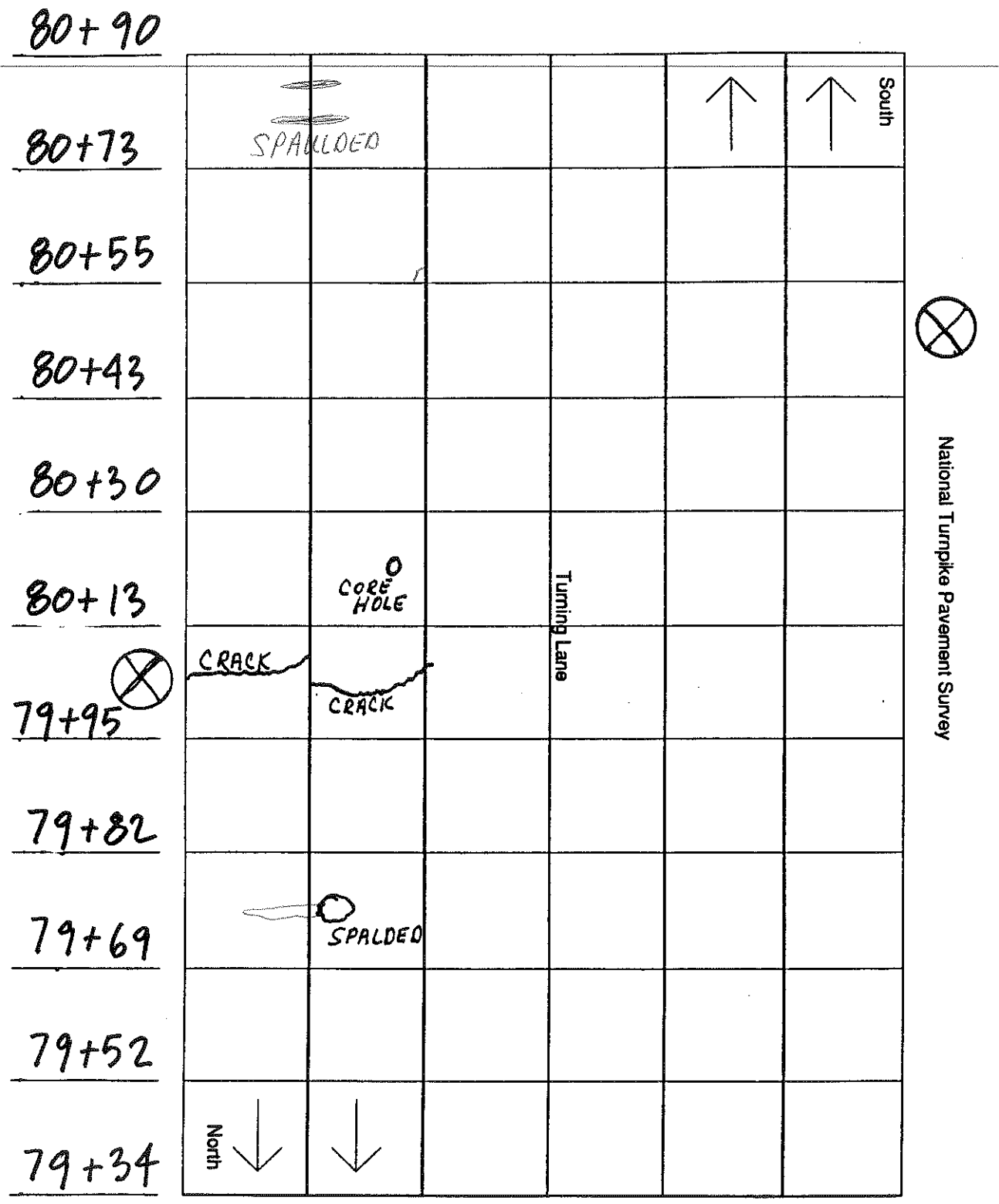
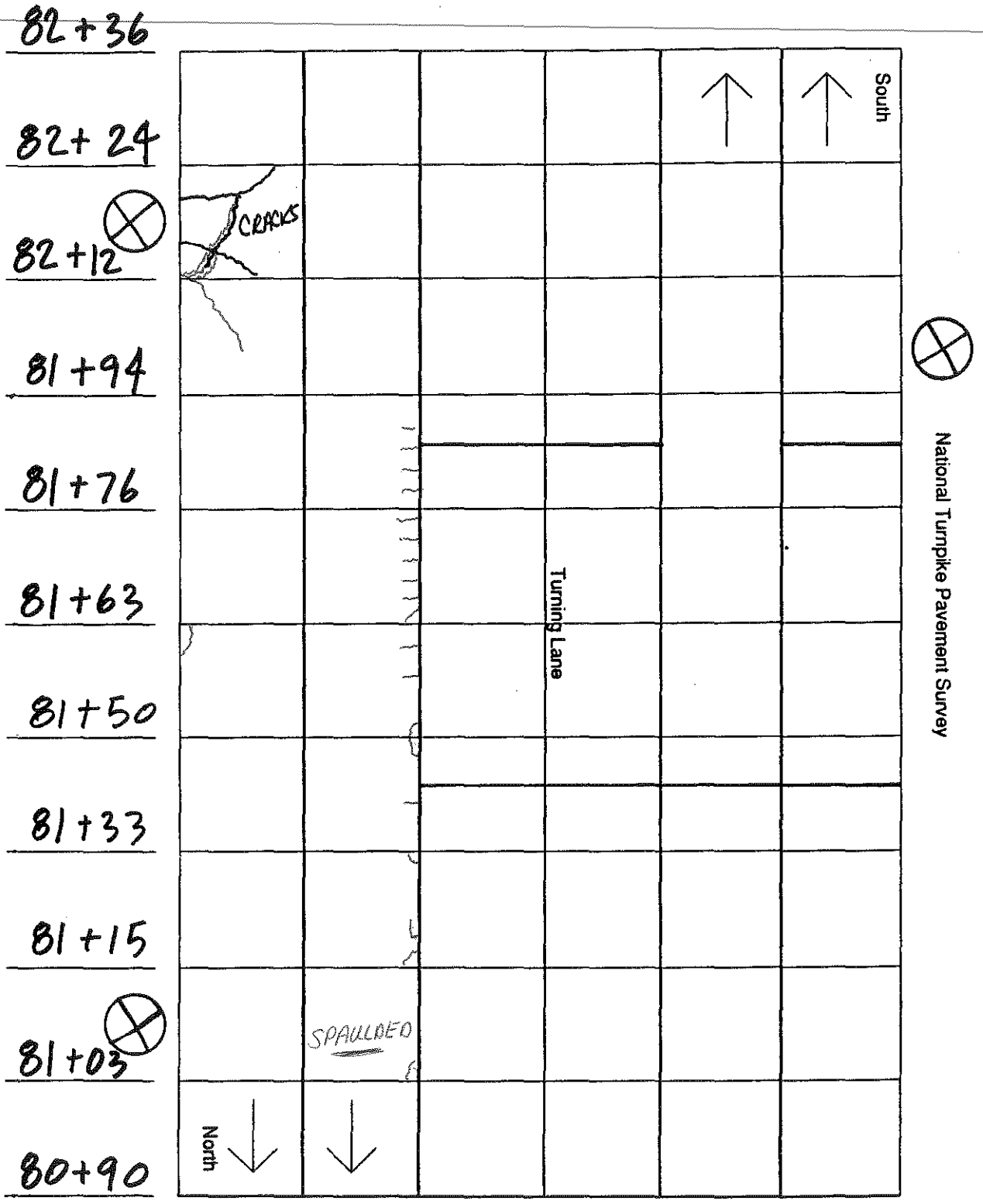
79+22
79+09
78+92
78+74
78+62
78+49
78+32
78+25
78+14
78+00
South
North
CRACKED CORNER
Turning Lane
CORE HOLE
CORE HOLE
CRACK
National Turnpike Pavement Survey


80+90
80+73
80+55
80+43
80+30
80+13
79+95
79+82
79+69
79+52
79+34
SPALLOED
CORE HOLE
CRACK
CRACK
SPALDED
South
Turning Lane
North
National Turnpike Pavement Survey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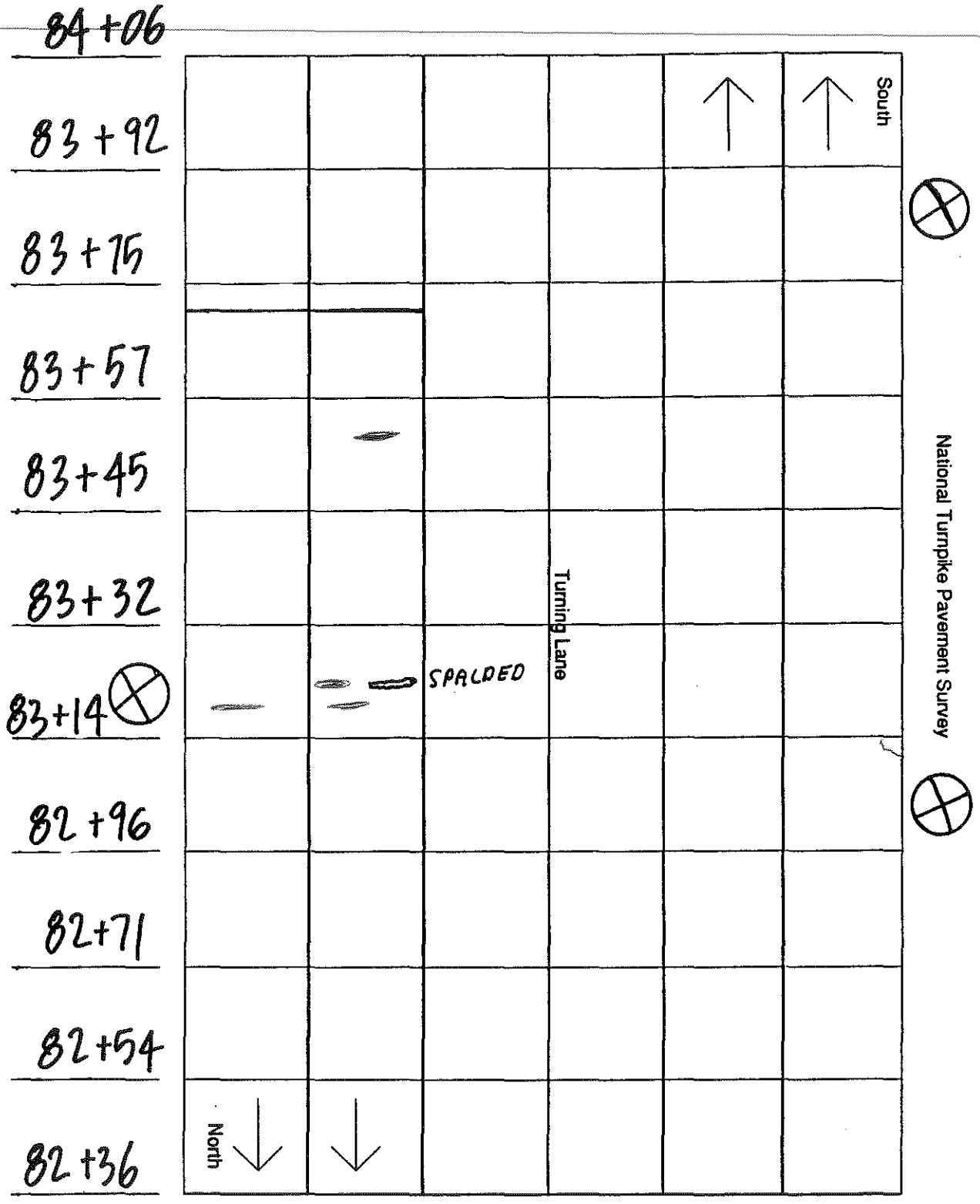
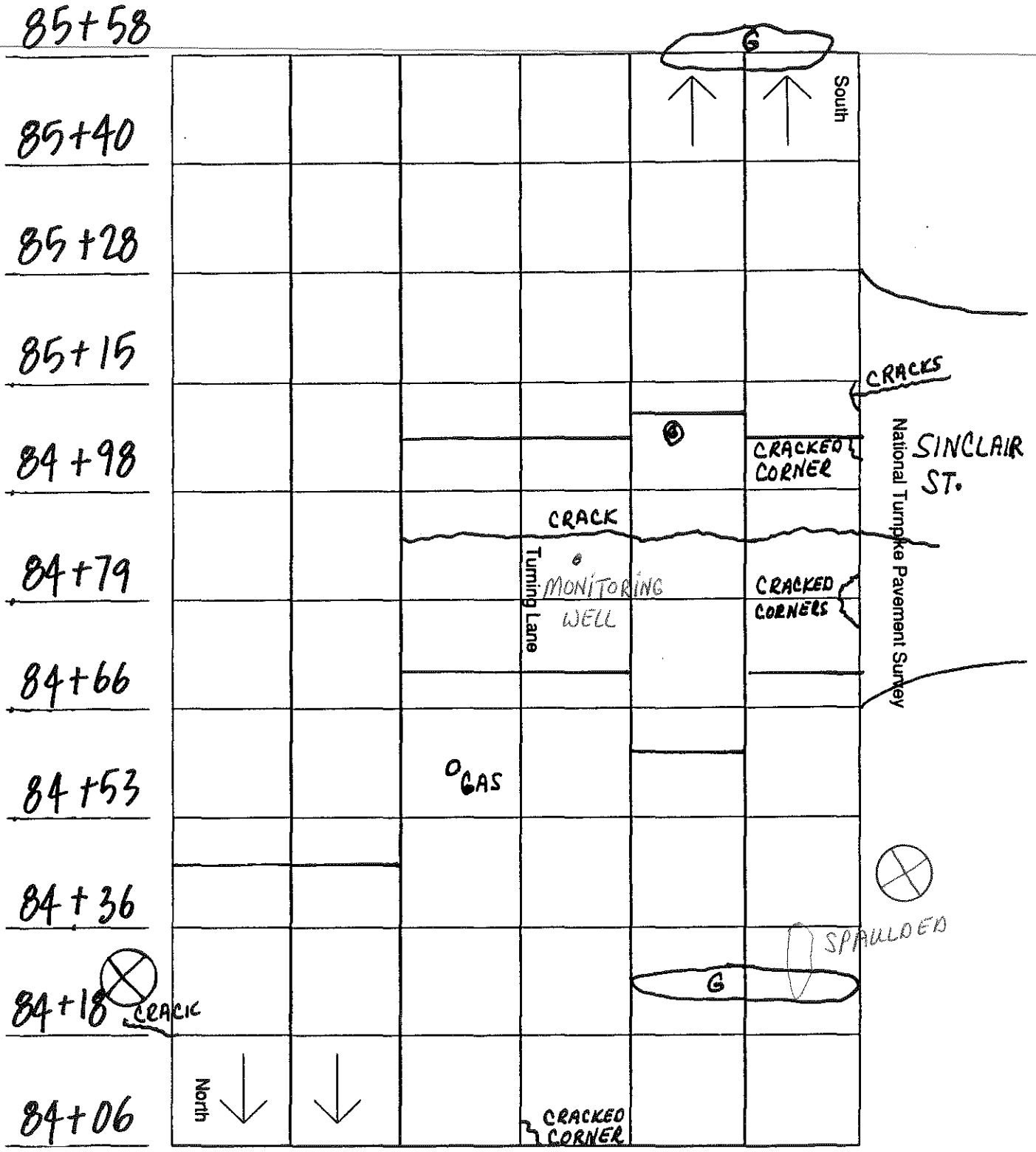
82+24
82+12
81+94
81+76
81+63
81+50
81+33
81+15
81+03
80+90
CRACKS
SPALLED
South
North
Turning Lane
National Turnpike Pavement Survey


84+06
83+92
83+75
83+57
83+45
83+32
83+14
82+96
82+71
82+54
82+36
South
North
Turning Lane
SPALDED
National Turnpike Pavement Survey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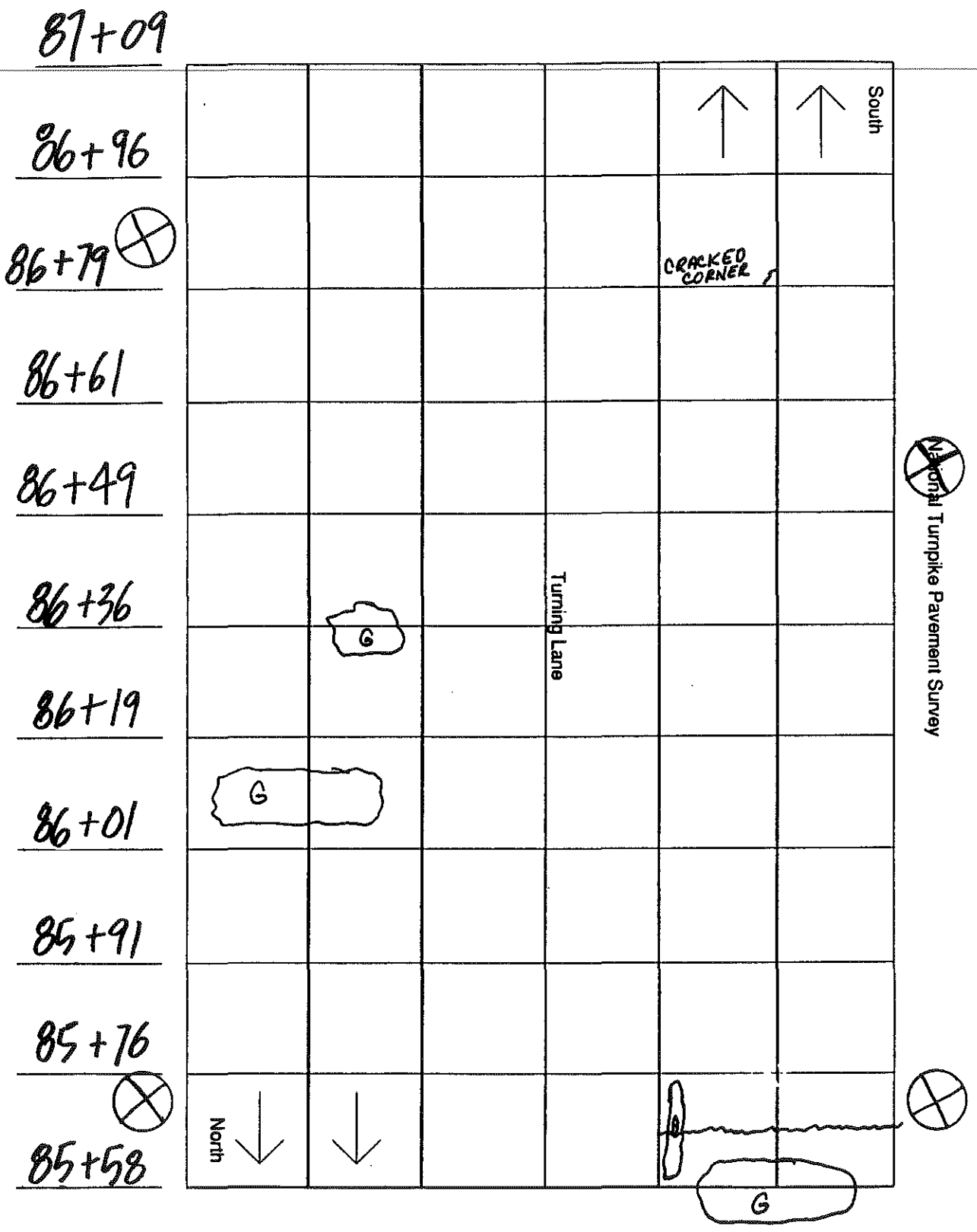
85+40
85+28
85+15
84+98
84+79
84+66
84+53
84+36
84+18
84+06
South
North
Turning Lane
National Turnpike Pavement Survey
SINCLAIR ST.
CRACKS
CRACKED CORNER
CRACK
MONITORING WELL
CRACKED CORNERS
GAS
SPALLED
CRACK
CRACKED CORNER
G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86+96
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86+61
86+49
86+36
86+19
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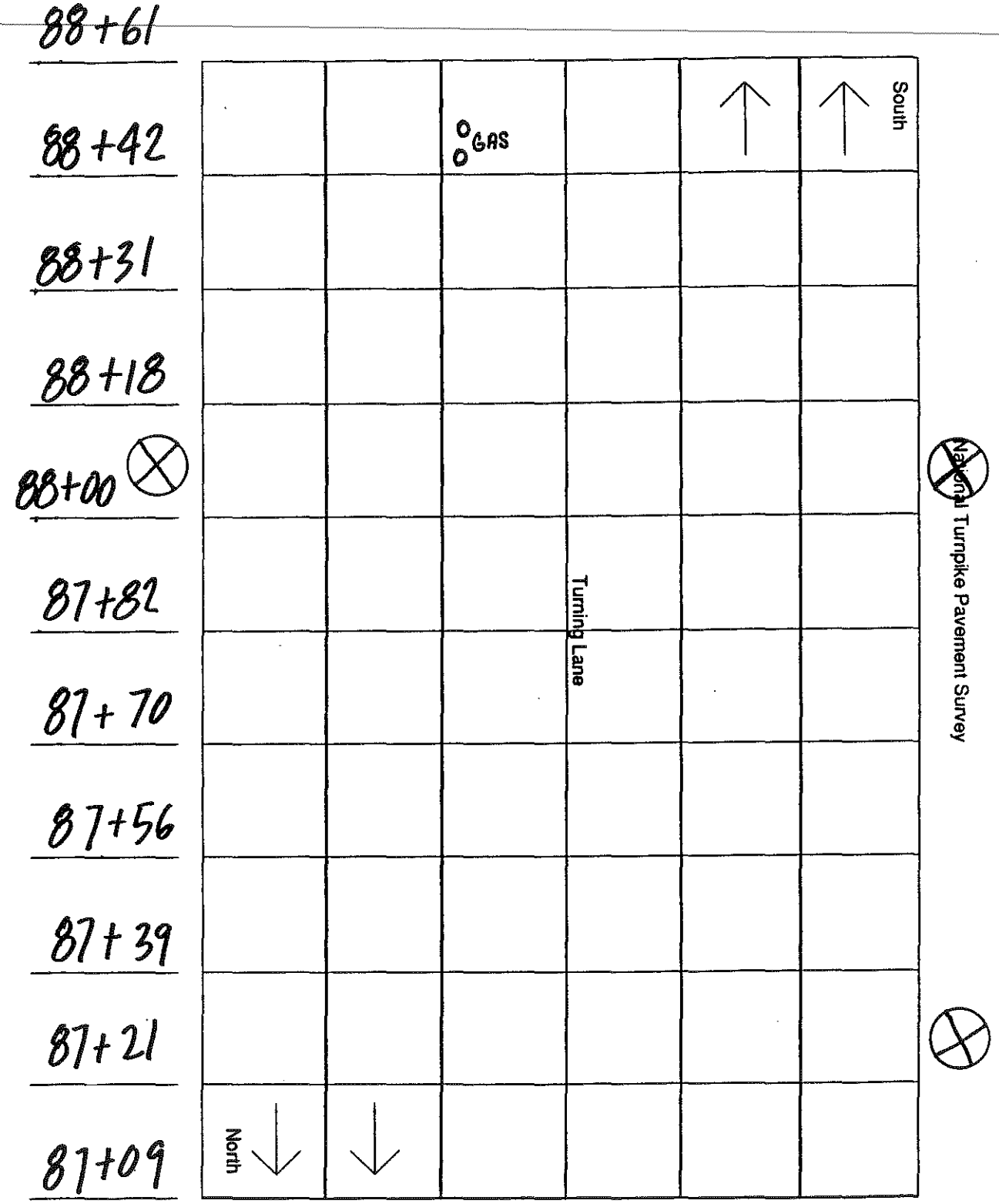
85+76
85+58
South
North
Turning Lane
CRACKED CORNER
National Turnpike Pavement Survey
G
G
G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88+42
88+31
88+18
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87+56
87+39
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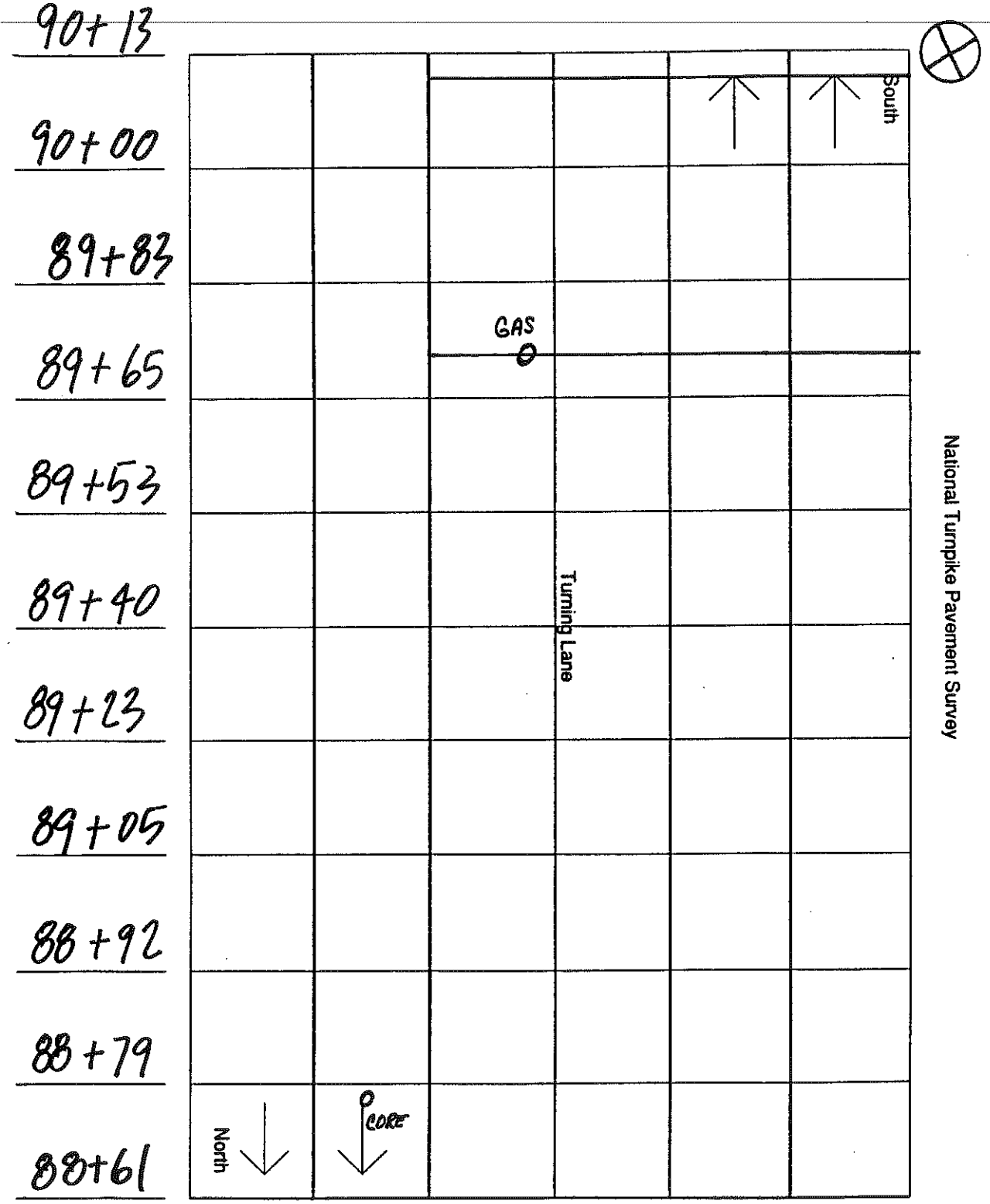
87+09
GAS
Turning Lane
South
North
National Turnpike Pavement Survey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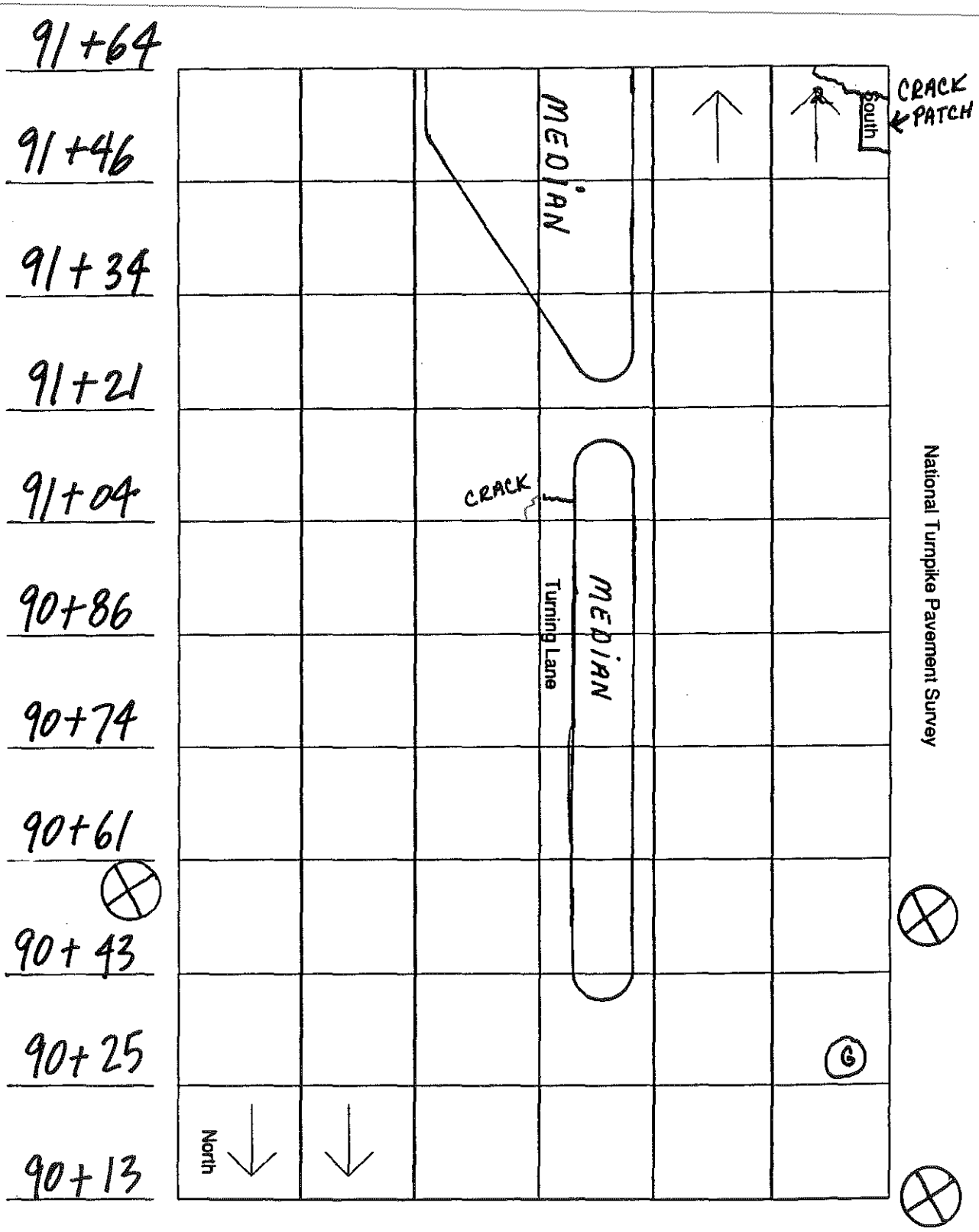
90+00
89+83
89+65
89+53
89+40
89+23
89+05
88+92
88+79
88+61
South
GAS
Turning Lane
North
CORE
National Turnpike Pavement Survey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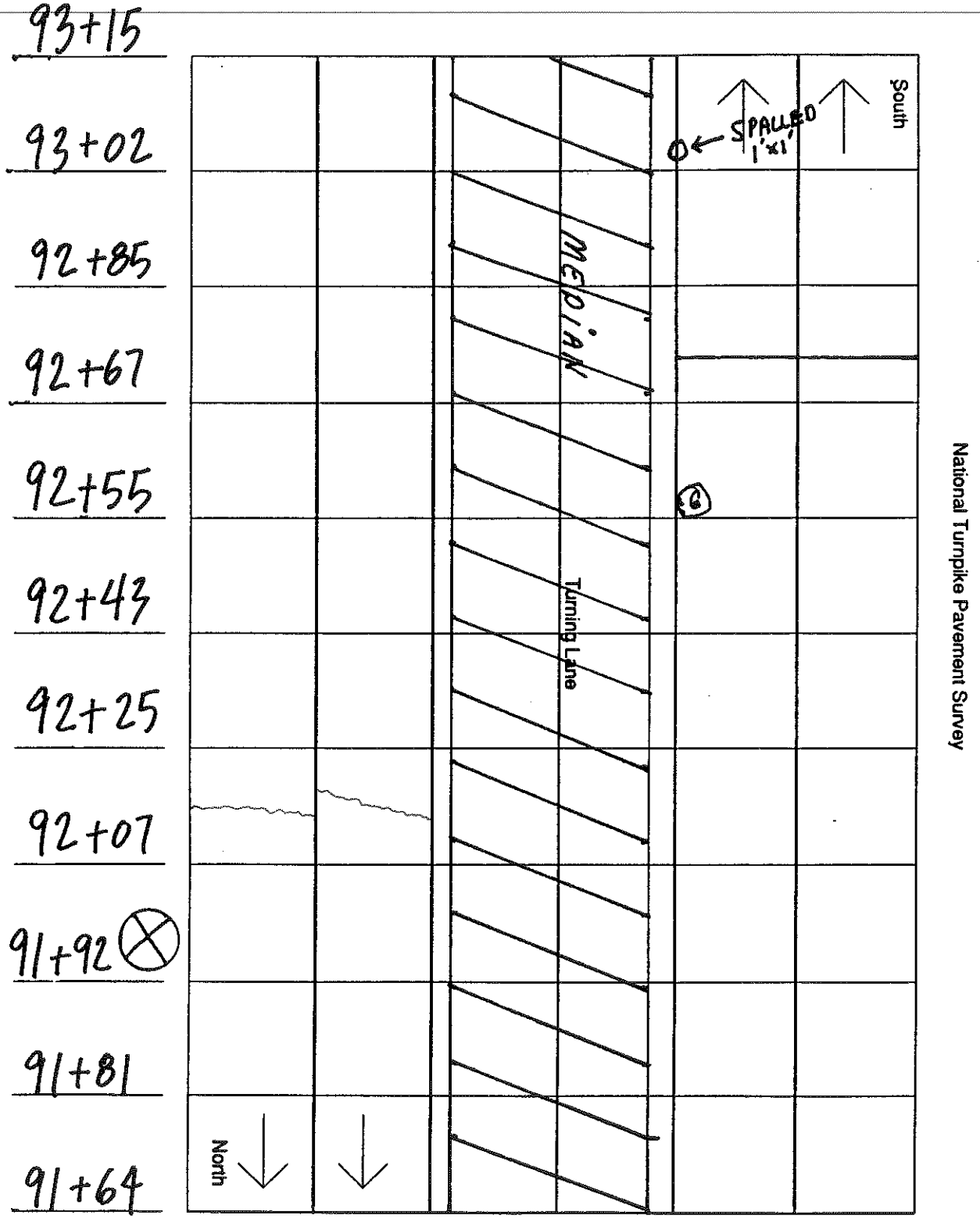
91+46
91+34
91+21
91+04
90+86
90+74
90+61
90+43
90+25
90+13
MEDIAN
CRACK
MEDIAN
Turning Lane
South
CRACK PATCH
North
National Turnpike Pavement Survey



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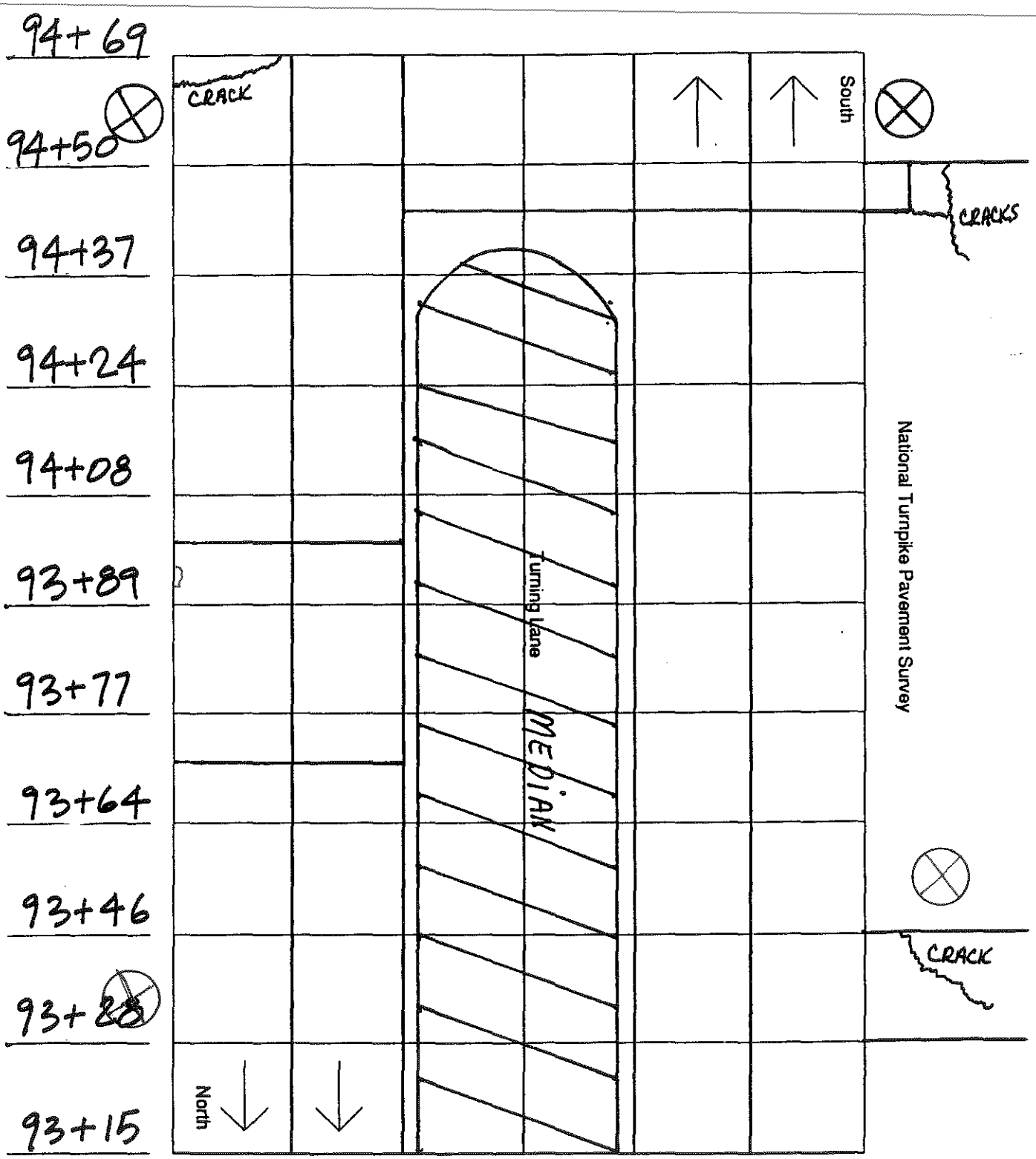
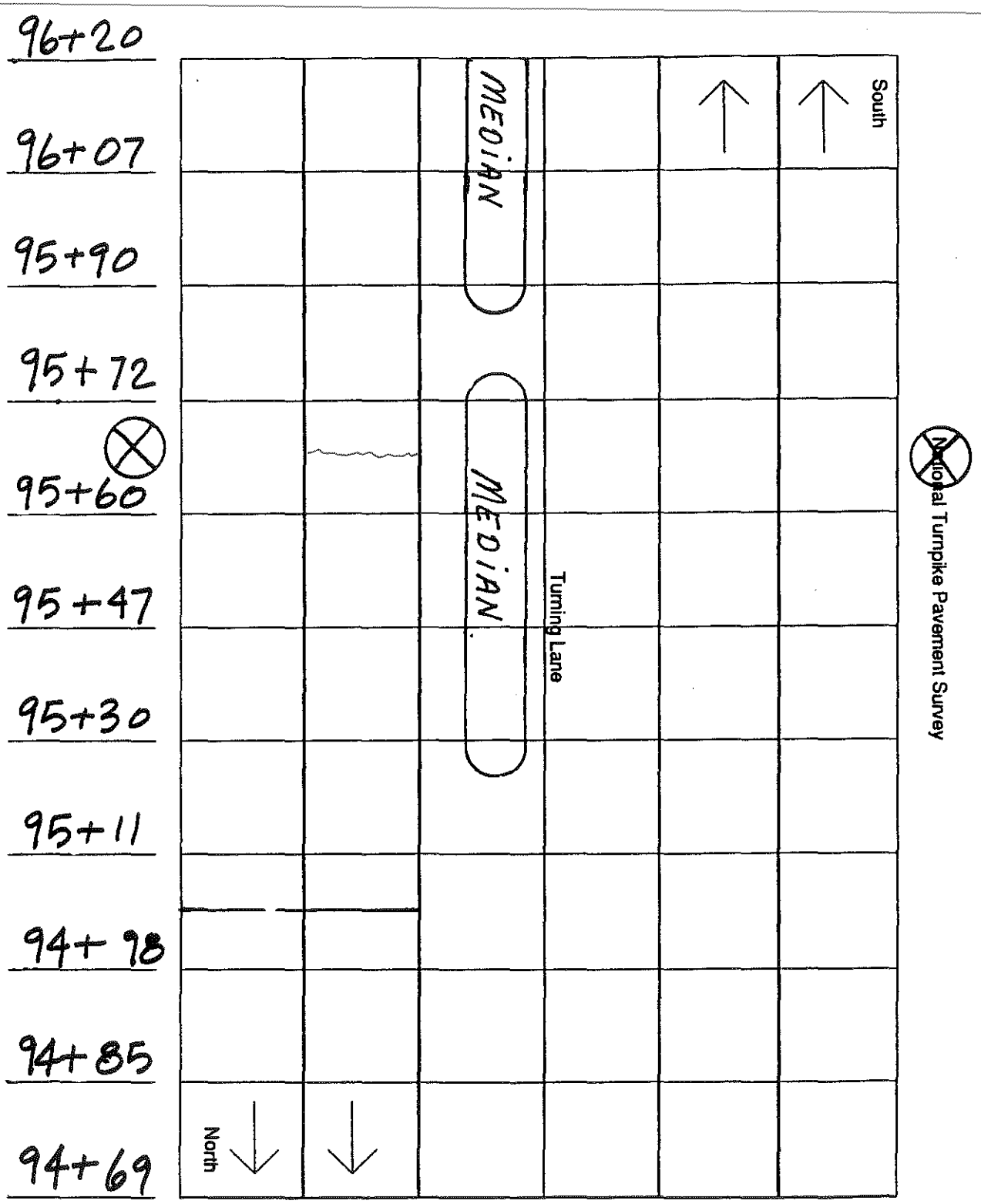
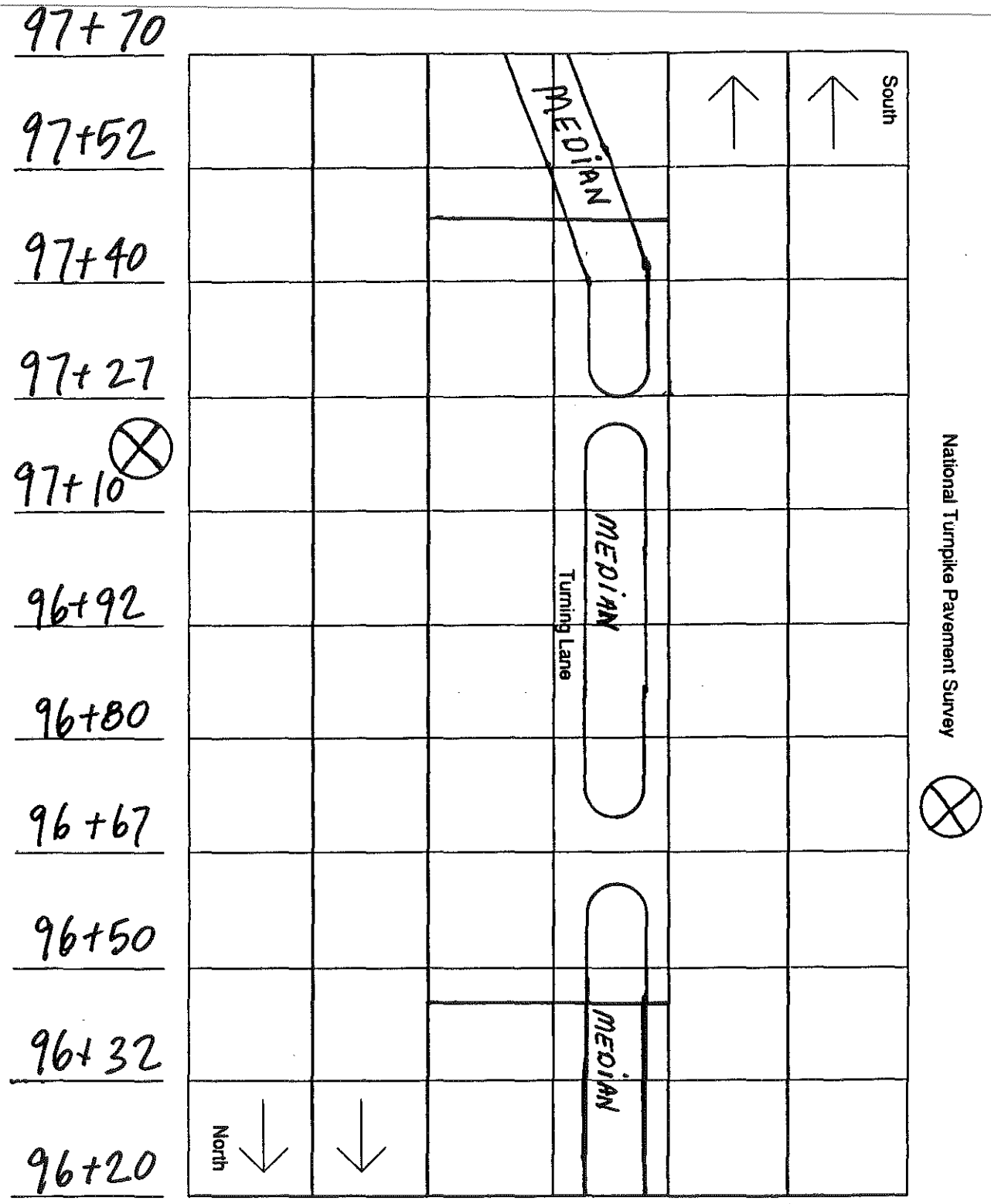

94+69
94+50
94+37
94+24
94+08
93+89
93+77
93+64
93+46
93+28
93+15
CRACK
South
CRACKS
Turning Lane
MEDIAN
National Turnpike Pavement Survey
CRACK
North


96+20
96+07
95+90
95+72
95+60
95+47
95+30
95+11
94+98
94+85
94+69
MEDIAN
MEDIAN
Turning Lane
South
North
National Turnpike Pavement Survey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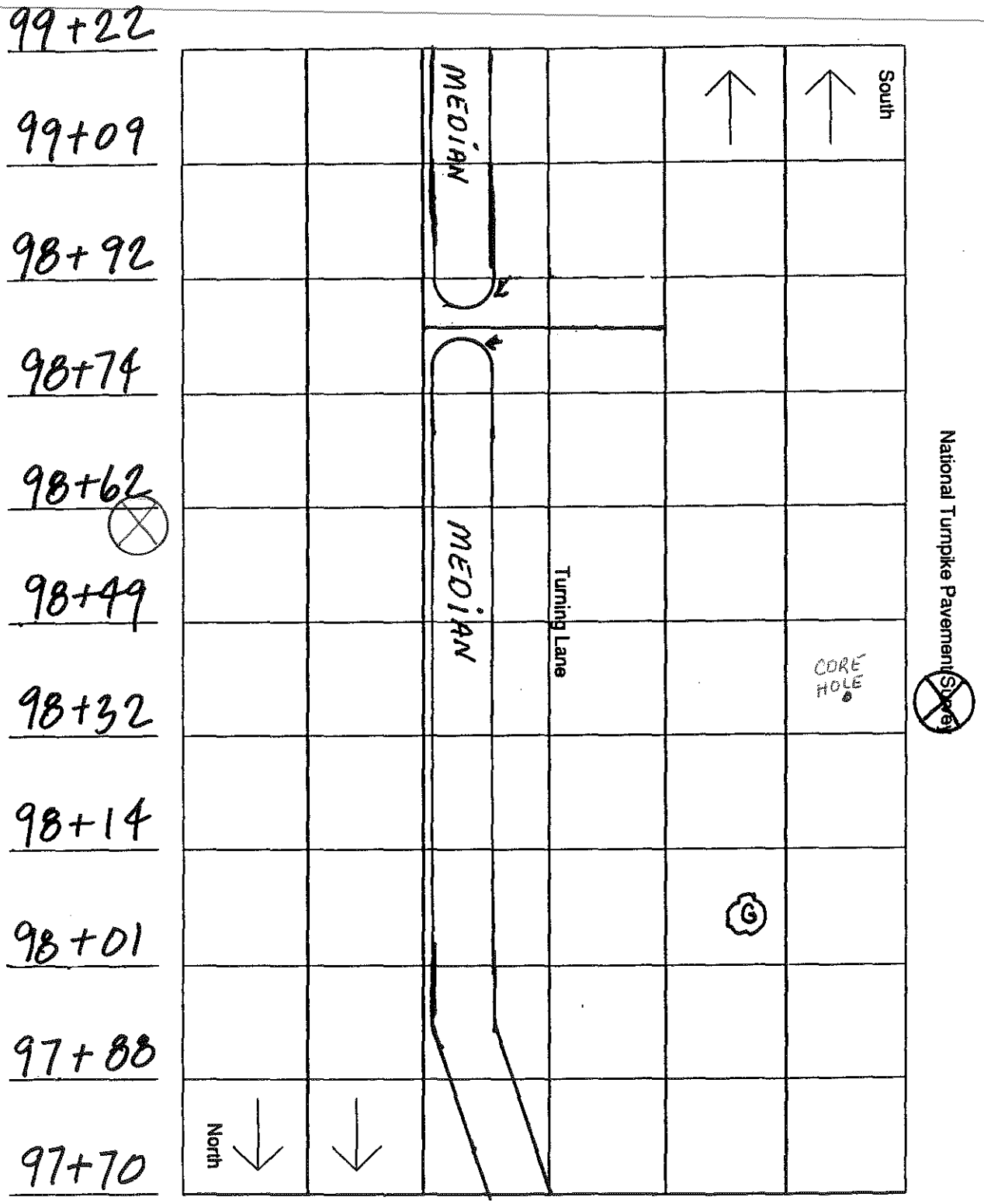
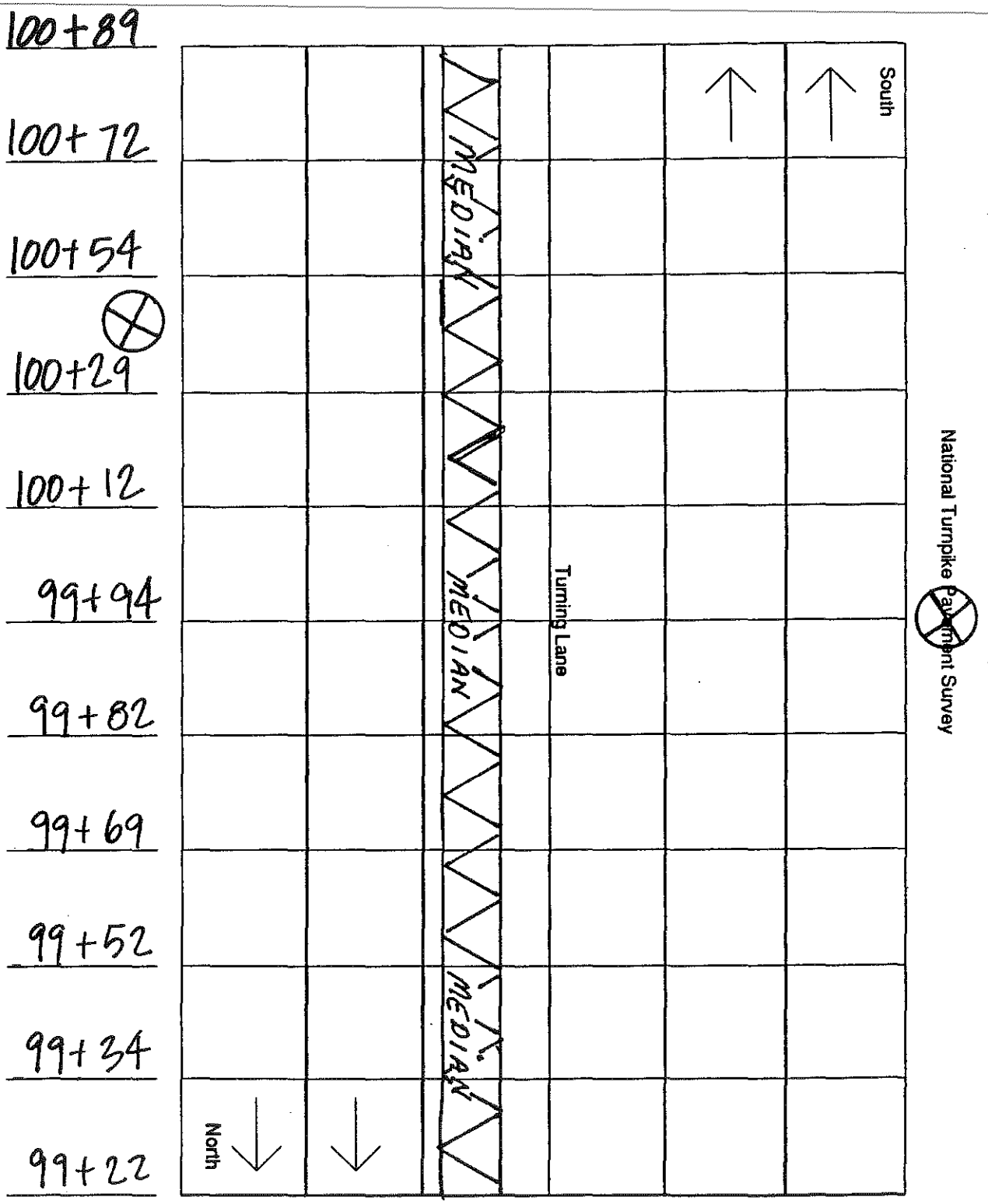
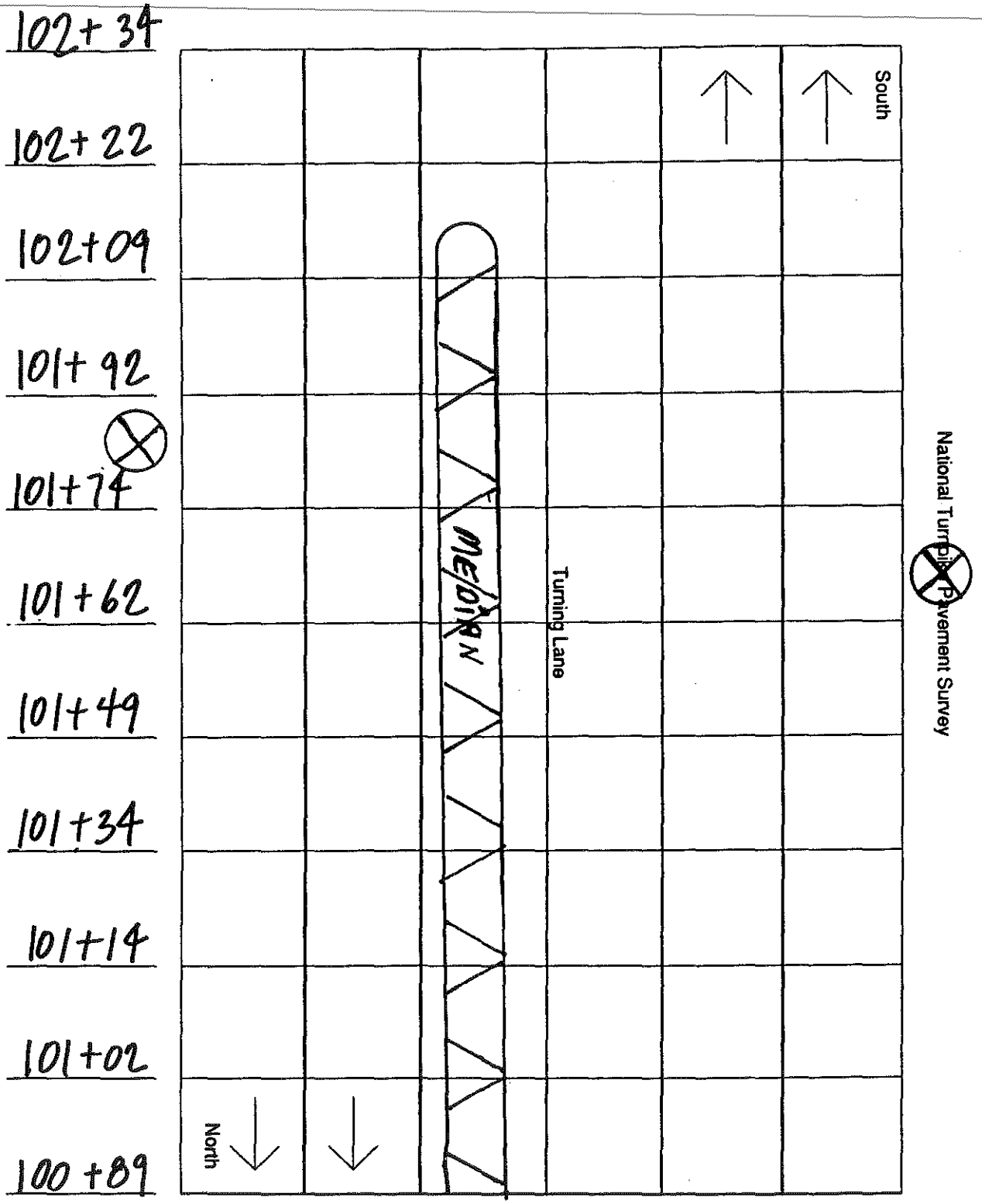
97+40
97+27
97+10
96+92
96+80
96+67
96+50
96+32
96+20
South
North
MEDIAN
MEDIAN
Turning Lane
MEDIAN
National Turnpike Pavement Survey


99+22
99+09
98+92
98+74
98+62
98+49
98+32
98+14
98+01
97+88
97+70
South
North
MEDIAN
MEDIAN
Turning Lane
CORE HOLE
National Turnpike Pavement Survey


100+89
100+72
100+54
100+29
100+12
99+94
99+82
99+69
99+52
99+34
99+22
South
North
MEDIAN
MEDIAN
MEDIAN
Turning Lane
National Turnpike Pavement Survey


102+34
102+22
102+09
101+92
101+74
101+62
101+49
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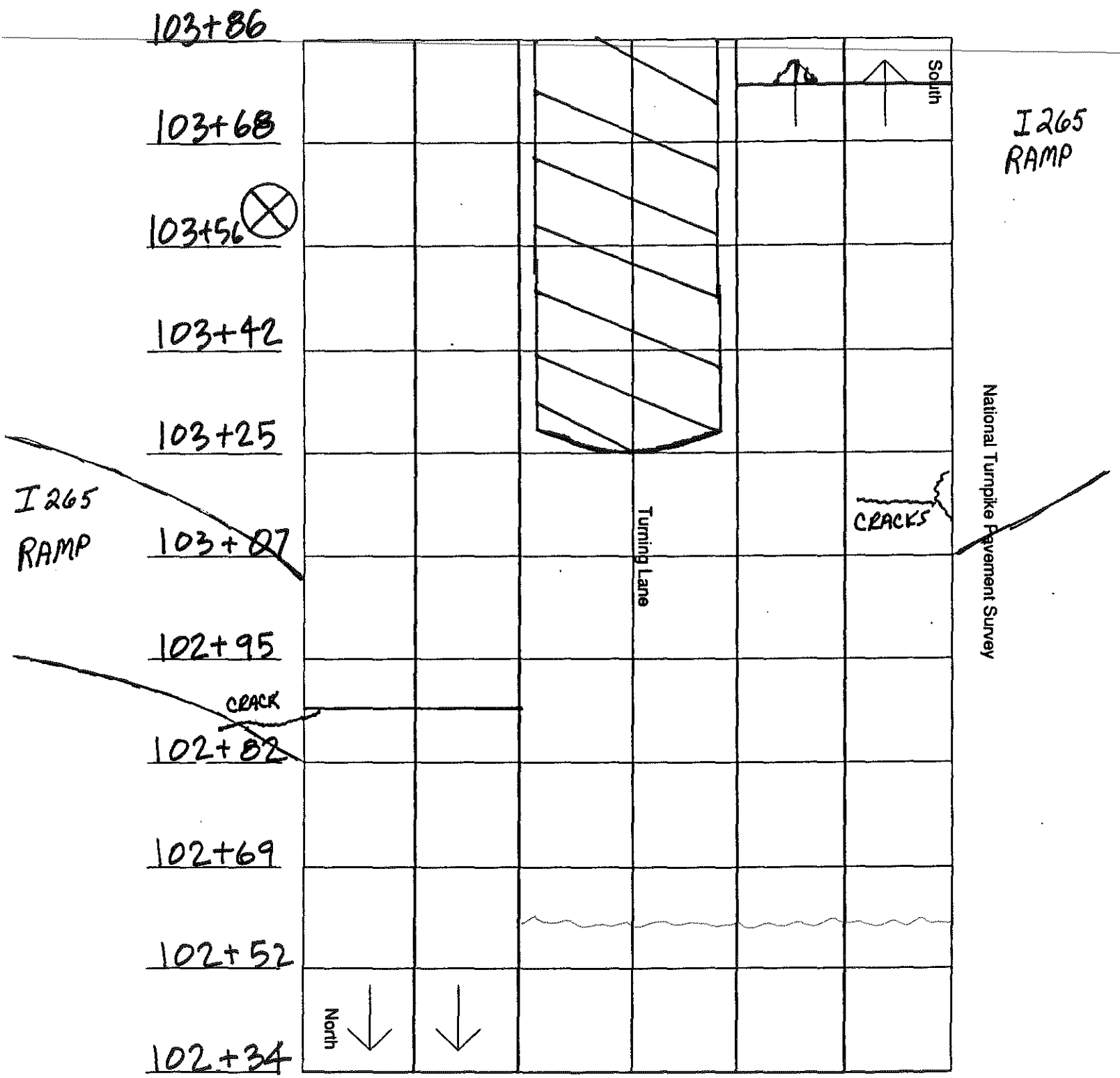
101+14
101+02
100+89
South
North
Turning Lane
MEDIAN
National Turnpike
Pavement Survey


103+86
103+68
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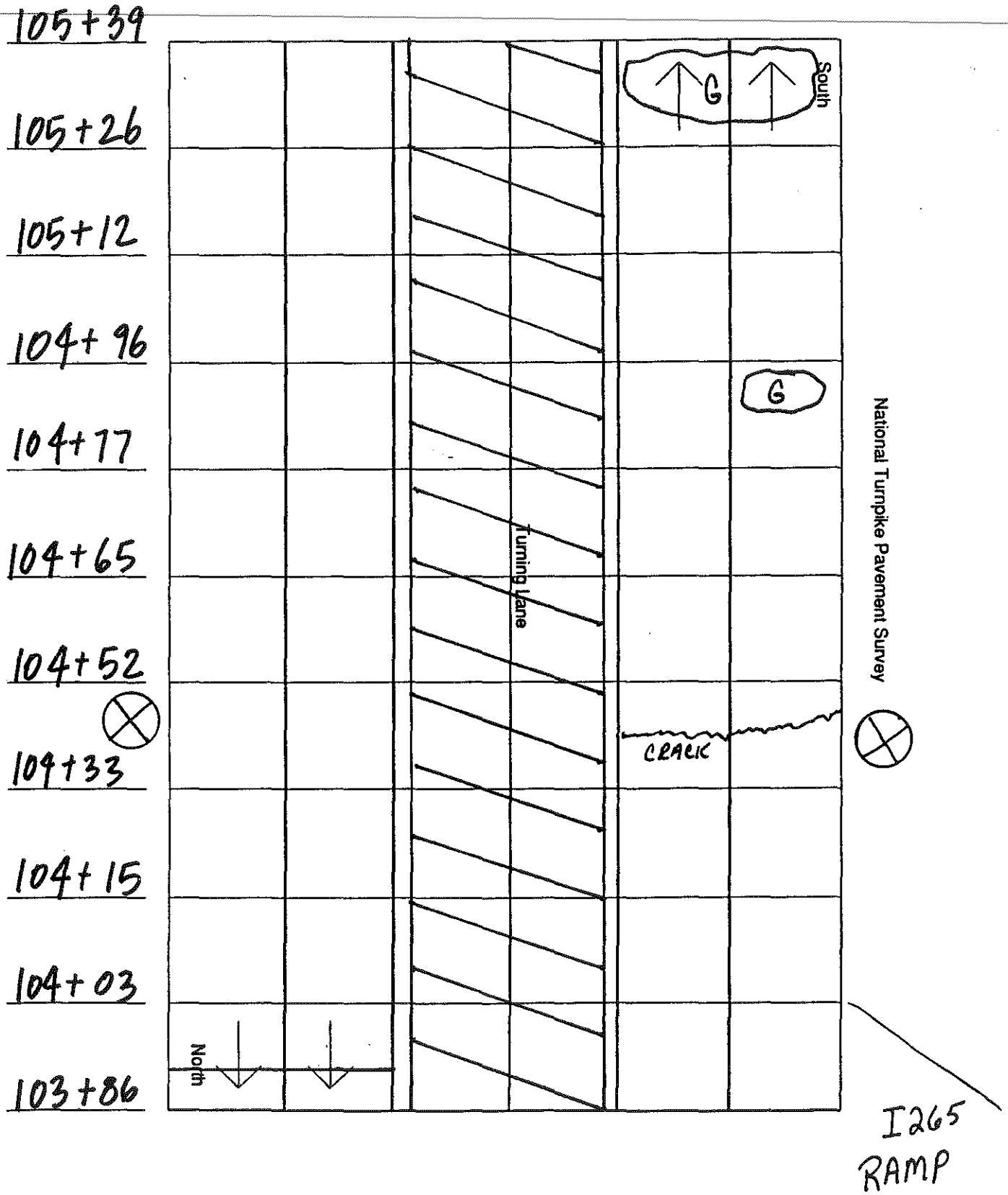
I 265 RAMP
South
North
Turning Lane
CRACKS
CRACK
National Turnpike Pavement Survey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104+77
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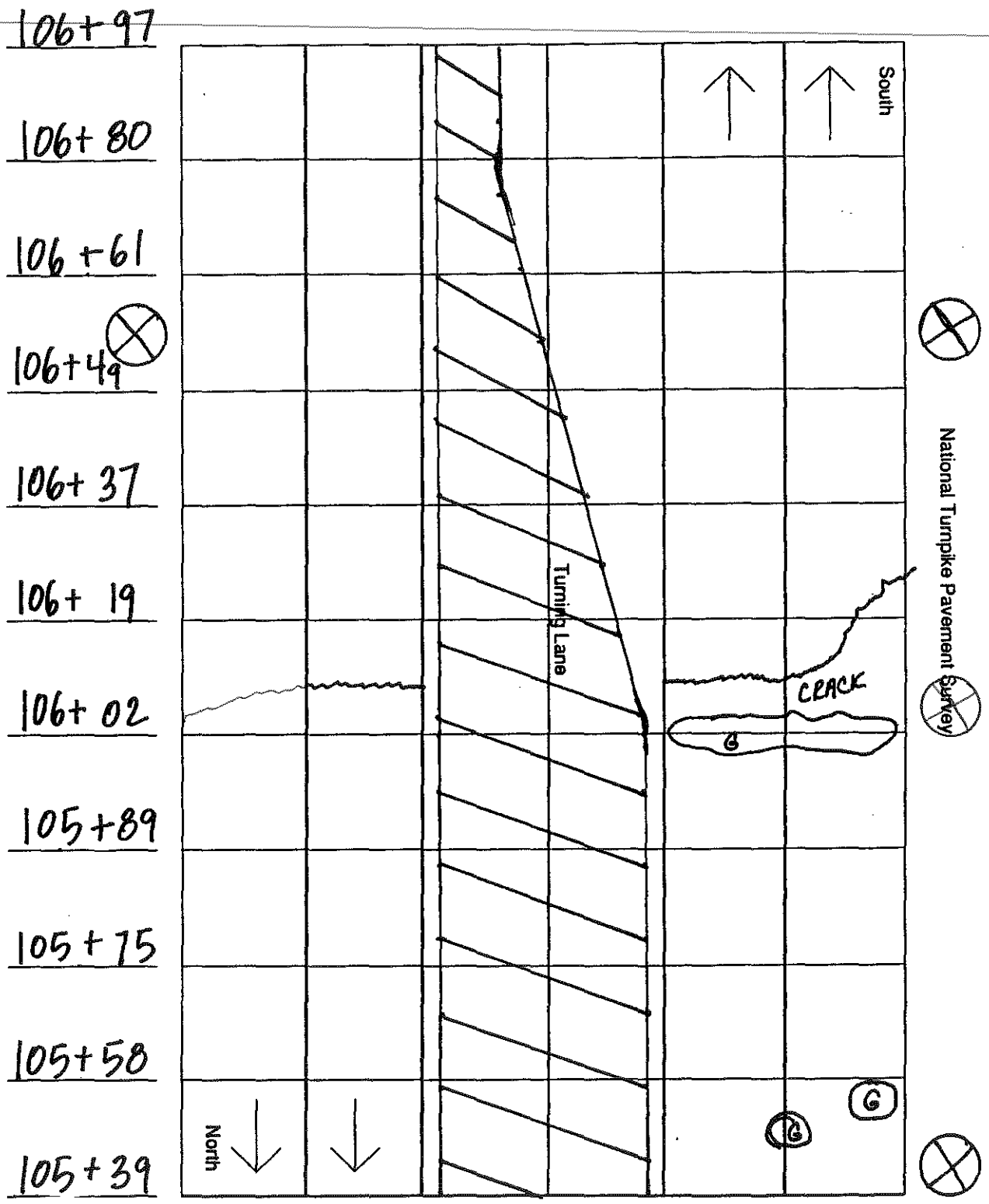
G
G
Turning Lane
CRACK
North
National Turnpike Pavement Survey
I265
RAMP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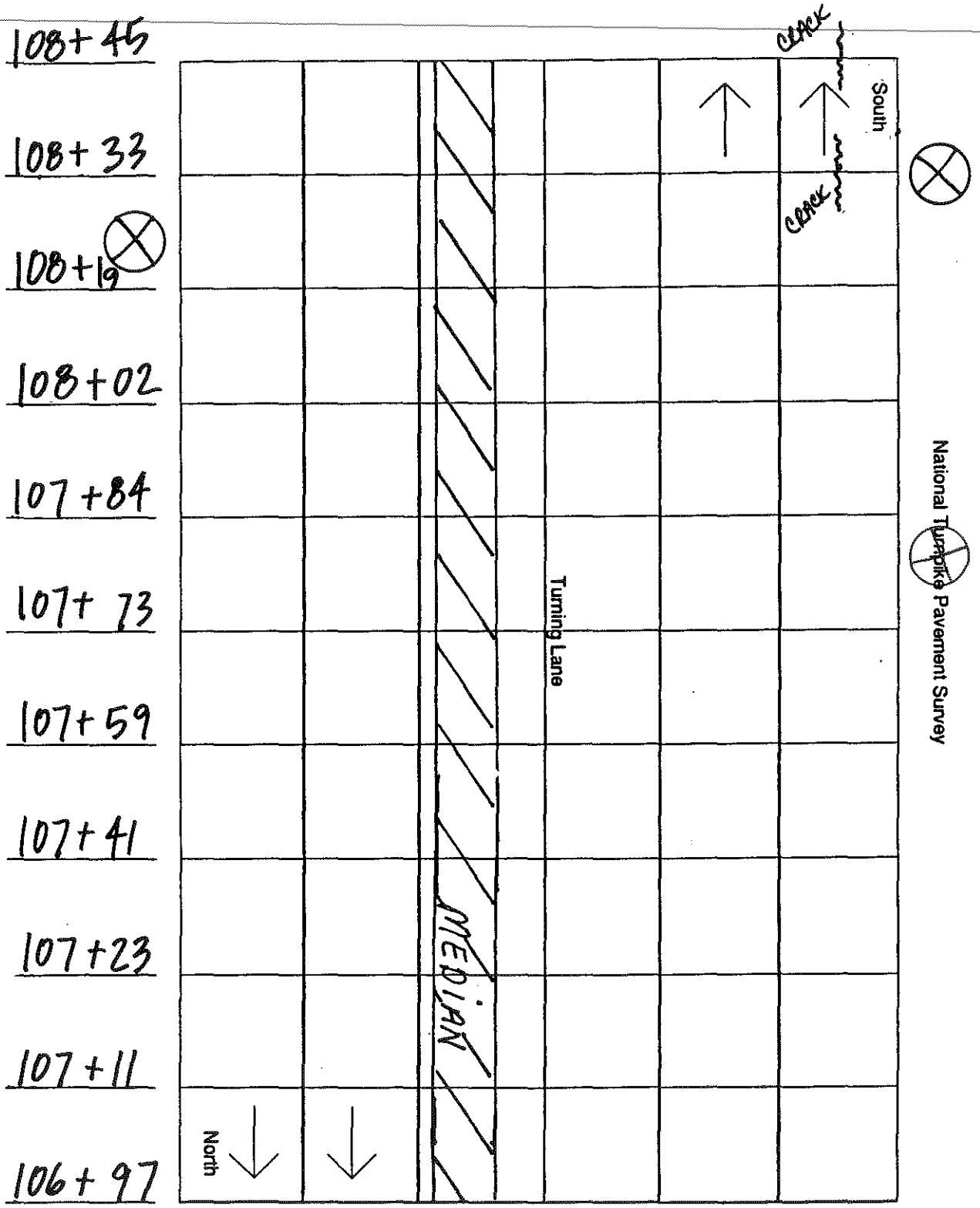
South
North
Turning Lane
CRACK
National Turnpike Pavement Survey


108+45
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108+02
107+84
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107+11
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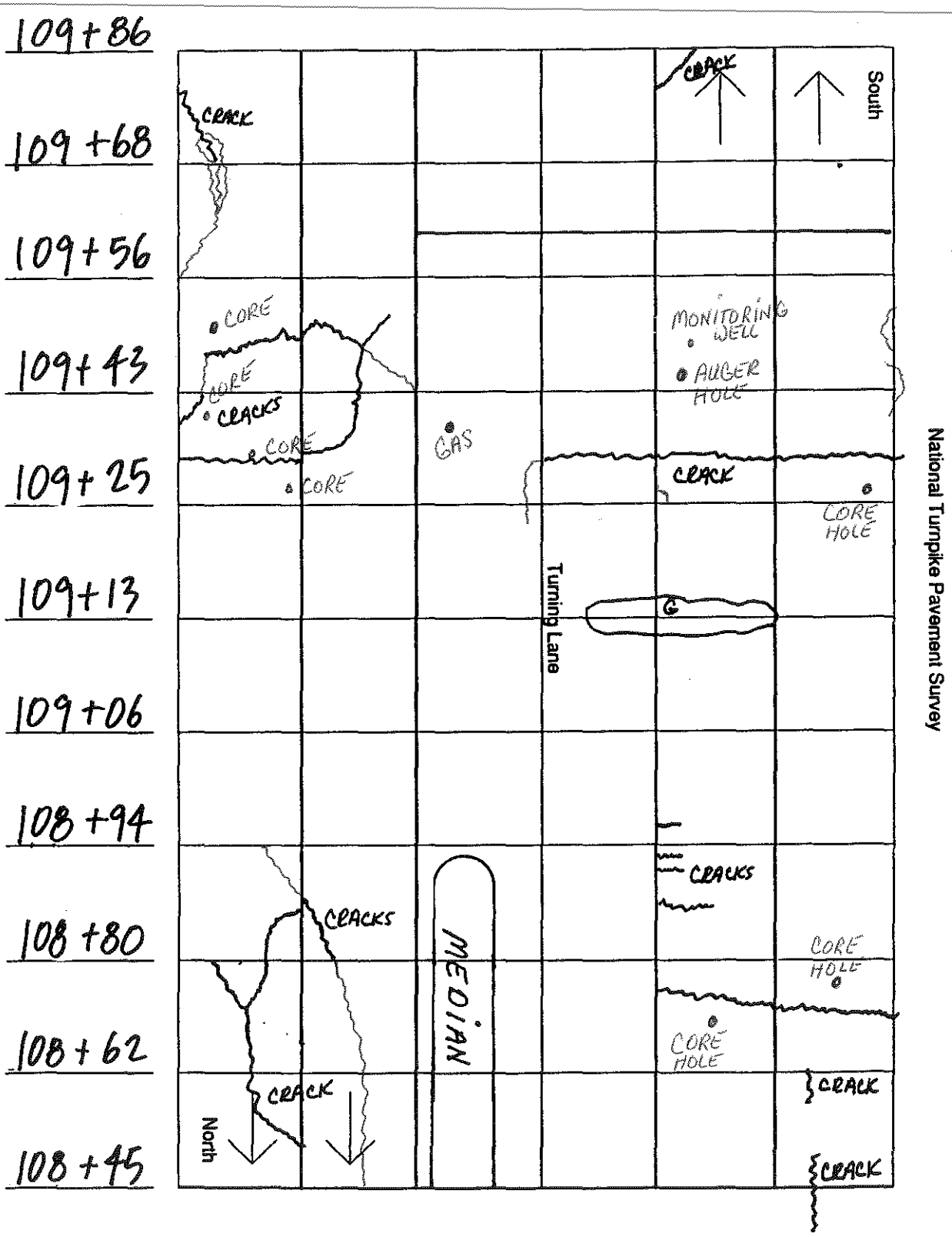
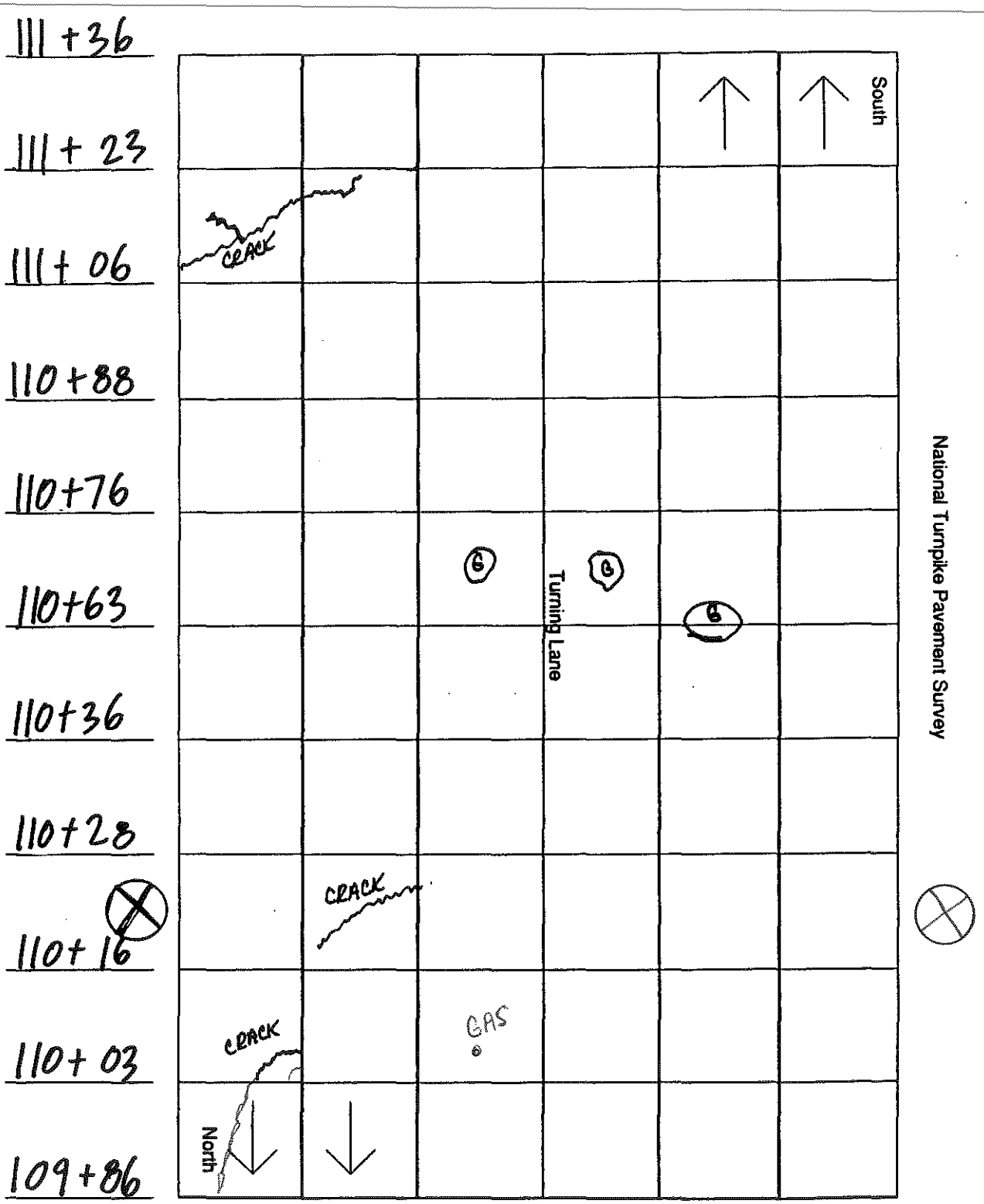
CRACK
CRACK
South
North
Turning Lane
MEDIAN
National Turnpike Pavement Survey



National Turnpike Pavement Survey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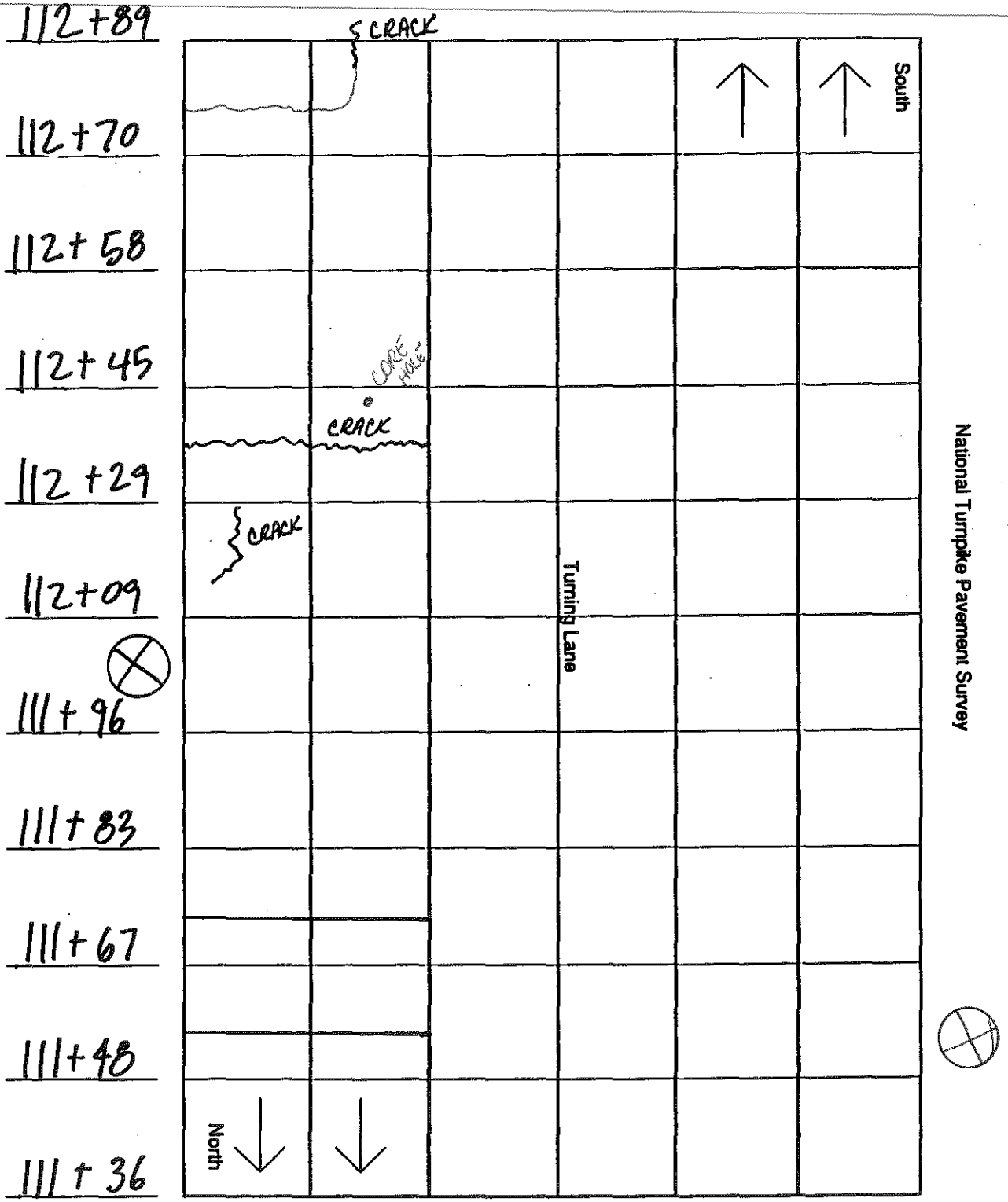
South
North
National Turnpike Pavement Survey
Turning Lane
CRACK
CRACK
CRACK
GAS


112+89
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112+58
112+45
112+29
112+09
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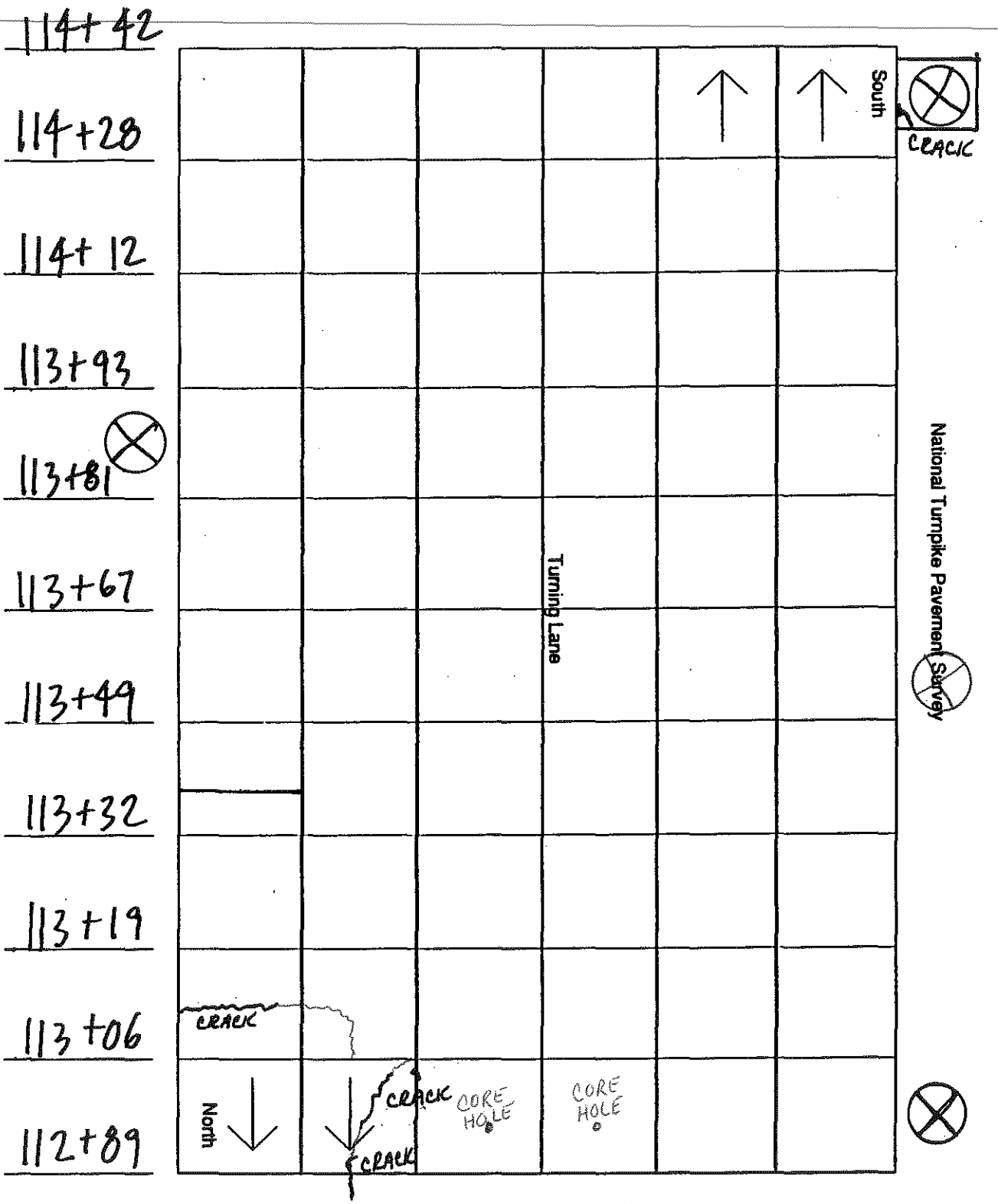
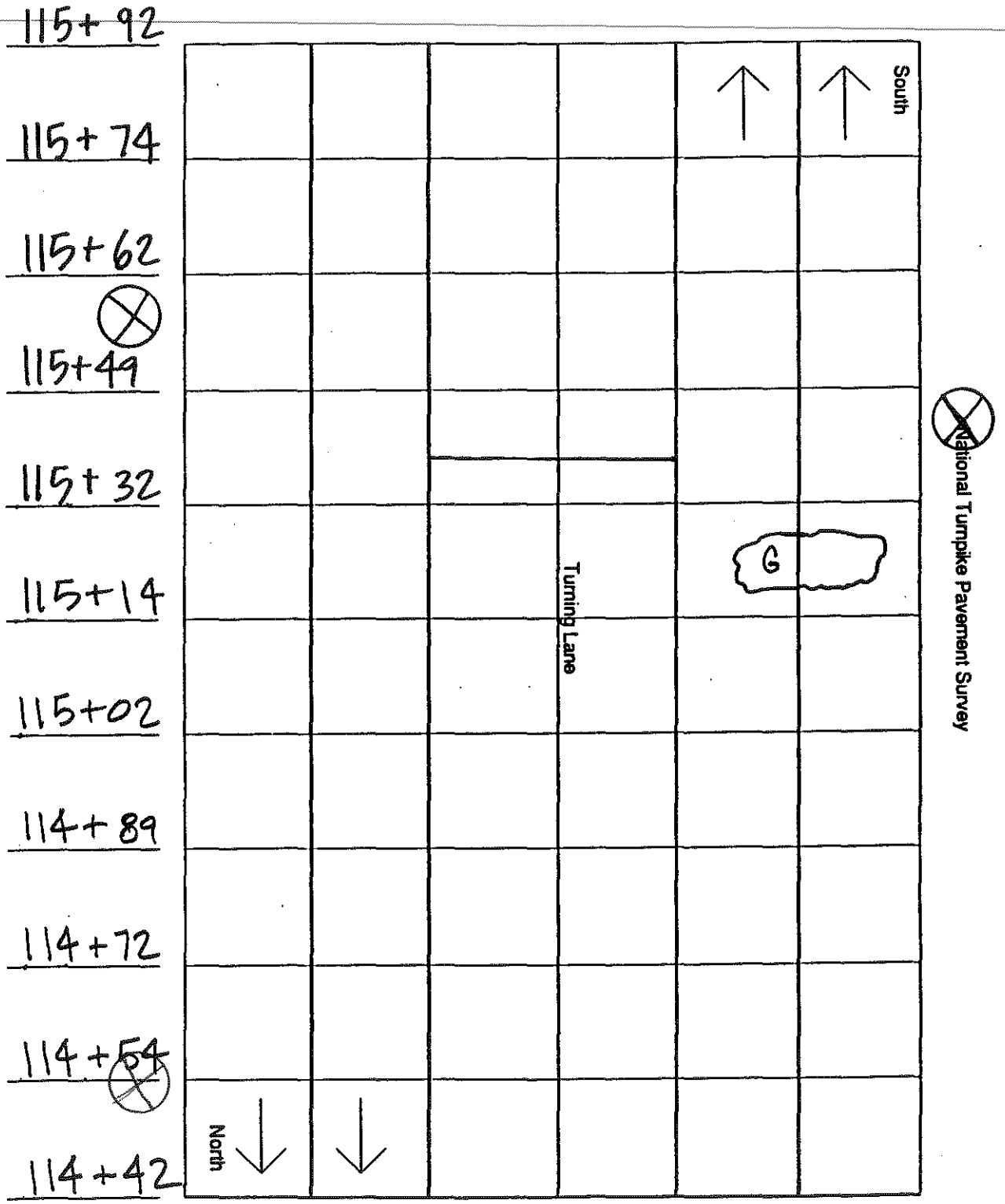
CRACK
CRACK
CORE HOLE
CRACK
South
North
Turning Lane
National Turnpike Pavement Survey


114+42
114+28
114+12
113+93
113+81
113+67
113+49
113+32
113+19
113+06
112+89
South
CRACK
National Turnpike Pavement Survey
Turning Lane
CRACK
North
CRACK
CRACK
CORE HOLE
CORE HOLE


115+92
115+74
115+62
115+49
115+32
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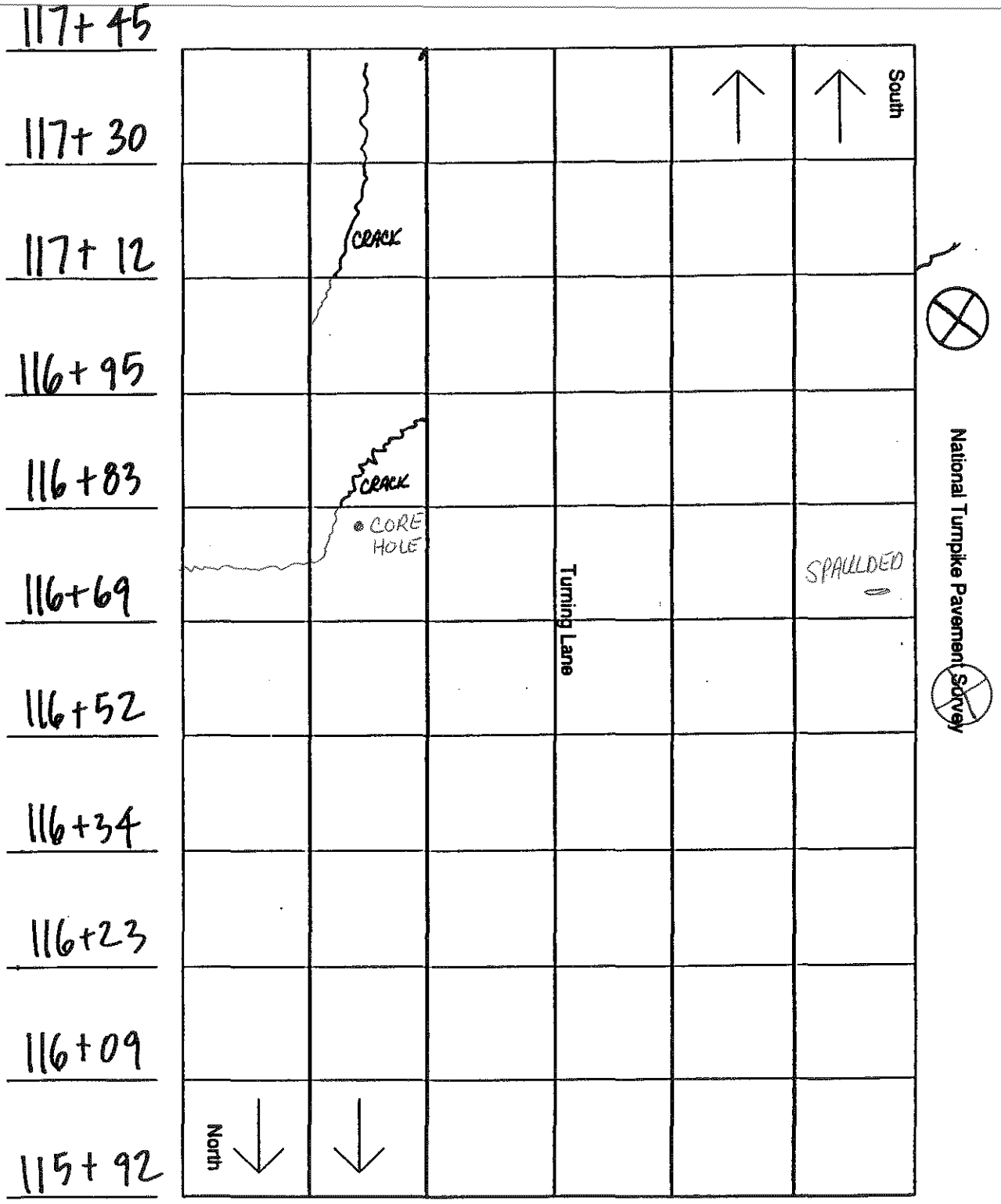
115+02
114+89
114+72
114+54
114+42
South
North
Turning Lane
G
National Turnpike Pavement Survey


117+45
117+30
117+12
116+95
116+83
116+69
116+52
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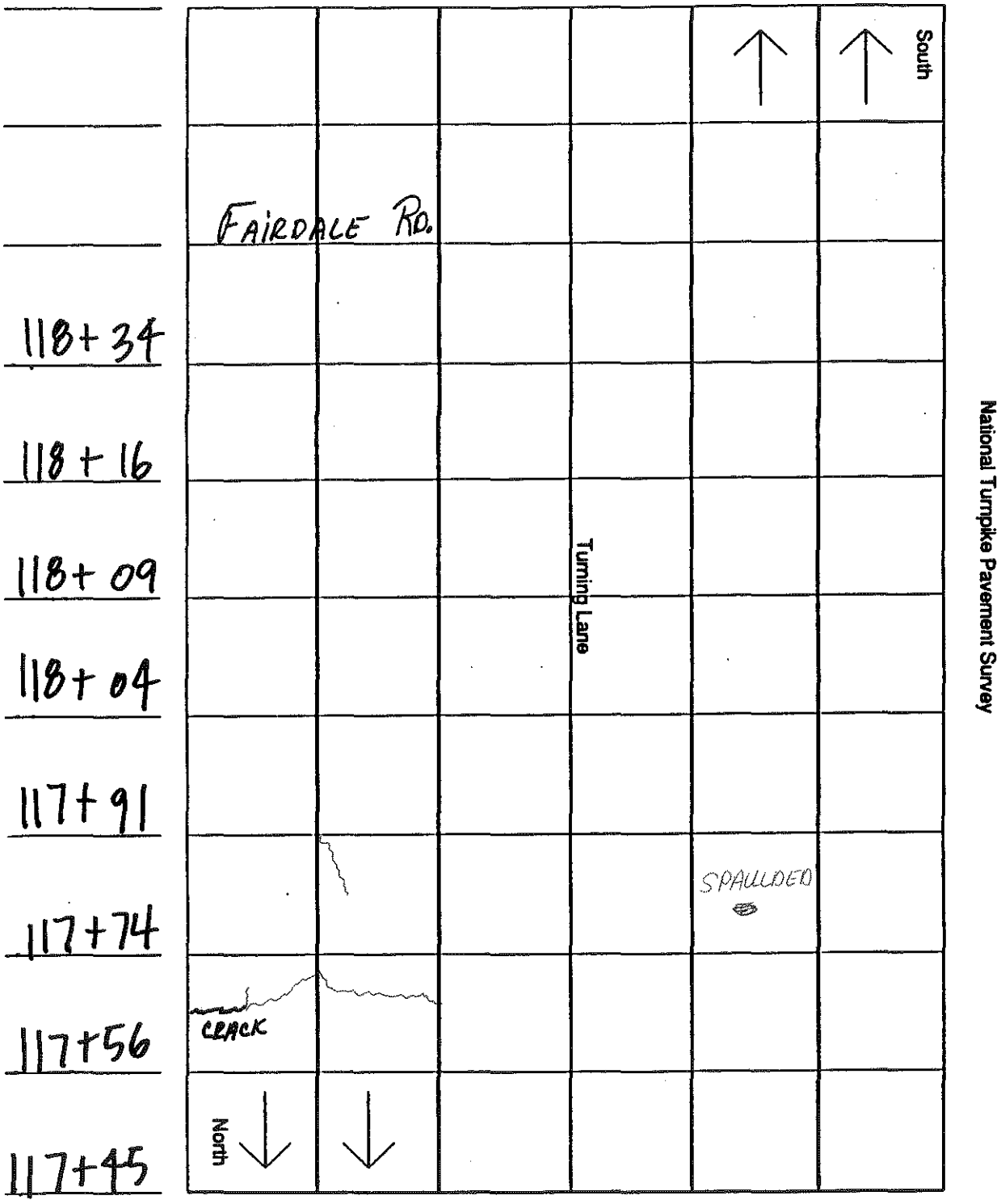
116+09
115+92
South
North
CRACK
CRACK
CORE HOLE
SPALLDED
Turning Lane
National Turnpike Pavement Survey


South
FAIRDALE RD.
118+34
118+16
118+09
118+04
117+91
117+74
117+56
117+45
Turning Lane
SPALLDED
CRACK
North
National Turnpike Pavement Survey