NORTH DAKOTA
DEPARTMENT OF TRANSPORTATION

# MATERIALS AND RESEARCH DIVISION

Experimental Study No. NDEP 91-03

**Evaluation of 3M's Stamark Pliant Polymer Pavement Marking Tape A380, Applied on Edge and Skip Lines**

## Final Report

Project IR-094-8(113)350

April 1996

**Prepared by**


**NORTH DAKOTA DEPARTMENT OF TRANSPORTATION**
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U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

# EXPERIMENTAL PROJECT REPORT

## EXPERIMENTAL PROJECT

EXPERIMENTAL PROJECT NO. [1]
STATE YEAR NUMBER SUF.
N D 9 1 - 0 3

CONSTRUCTION PROJ. NO. [8]
IR-094-8(113)350

LOCATION [28]
Cass County

EVALUATION FUNDING [48]
1 [X] HP&R
2 [ ] CONSTRUCTION
3 [ ] DEMONSTRATION
4 [ ] IMPLEMENTATION

NEEP NO. [49]

PROPRIETARY FEATURE? [51]
[X] YES
[ ] NO

## SHORT TITLE

TITLE [52]
3M Stamark Pliant Polymer Pavement Marking Tape, A380, Applied on Edge and Skip Lines

## THIS FORM

DATE [140]
MO. YR.
0 4 - 9 6

REPORTING [144]
1 [ ] INITIAL
2 [ ] ANNUAL
3 [X] FINAL

## KEY WORDS

KEY WORD 1 [145] TRAFFIC

KEY WORD 2 [167] CONTROL

KEY WORD 3 [189] LANELINES

KEY WORD 4 [211] PLASTIC

UNIQUE WORD [233] POLYMER

PROPRIETARY FEATURE NAME [255] 3M A380

## CHRONOLOGY

Date Work Plan Approved: MO. YR. 0 5 - 9 1 [277]

Date Feature Constructed: MO. YR. 0 7 - 9 1 [281]

Evaluation Scheduled Until: MO. YR. 0 6 - 9 6 [285]

Evaluation Extended Until: MO. YR. 0 6 - 0 0 [289]

Date Evaluation Terminated: MO. YR. [ ] - [ ] [293]

## QUANTITY AND COST

QUANTITY OF UNITS *(Rounded to whole numbers)*
2 0 5 3 [297]

UNITS [305]
1 [ ] LIN. FT.
2 [X] S.Y.
3 [ ] S.Y.-IN.
4 [ ] C.Y.
5 [ ] TON
6 [ ] LBS.
7 [ ] EACH
8 [ ] LUMP SUM

UNIT COST *(Dollars, Cents)* [306]
4 8 60

## AVAILABLE EVALUATION REPORTS

[ ] CONSTRUCTION [315]
[ ] PERFORMANCE
[X] FINAL

## EVALUATION

CONSTRUCTION PROBLEMS [318]
1 [X] NONE
2 [ ] SLIGHT
3 [ ] MODERATE
4 [ ] SIGNIFICANT
5 [ ] SEVERE

PERFORMANCE [319]
1 [ ] EXCELLENT
2 [X] GOOD
3 [ ] SATISFACTORY
4 [ ] MARGINAL
5 [ ] UNSATISFACTORY

## APPLICATION

[320]
1 [ ] ADOPTED AS PRIMARY STD.
2 [ ] PERMITTED ALTERNATIVE
3 [X] ADOPTED CONDITIONALLY
4 [ ] PENDING
5 [ ] REJECTED
6 [ ] NOT CONSTRUCTED

*(Explain in Remarks if 3, 4, 5, or 6 is checked)*

## REMARKS

[321] When inlaid, material lasted longer and had less damage. Good reflectance. Expensive.

[700]

FORM FHWA 1461 (REV. 8-79)

Previous Editions are Obsolete

Experimental Study ND 91-03

# Evaluation of 3M's Stamark Pliant Polymer Pavement Marking Tape, A380, Applied on Edge and Skip Lines

## Final Report

Project IR-094-8(113)350

April 1996

Written By
Clifford Kuntz

## Disclaimer

The contents of this report reflect the views of the author or authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not reflect the official views of the North Dakota Department of Transportation or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

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# 3M's STAMARK A380 PLIANT POLYMER PAVEMENT MARKING TAPE

**Project IR-094-8(113)350 & M-8-984(029)004**
**NDEP 91-03**
**Final Report**

## INTRODUCTION

This report will address 3M's Stamark Pliant Polymer Pavement Marking Tape system. The report, with photos and observations, will present the findings of a five-year evaluation on this marking system and other marking systems. The report will address the performance and durability of the marking system and include comments from the Fargo District. Materials and Research will also include their comments and recommendations on the use of this tape and other methods used for marking systems.

## LOCATION

Project IR-094-8(113)350, 1.472 miles in length, is located on I-94 from Station 175+00 to 252+71.67, appendix A. The second project, M-8-984(029)004, 0.398 miles in length, is located on the 25th Street Interchange from Station 14+03 to 35+05, appendix A. Both projects were tied and located in Fargo, North Dakota.

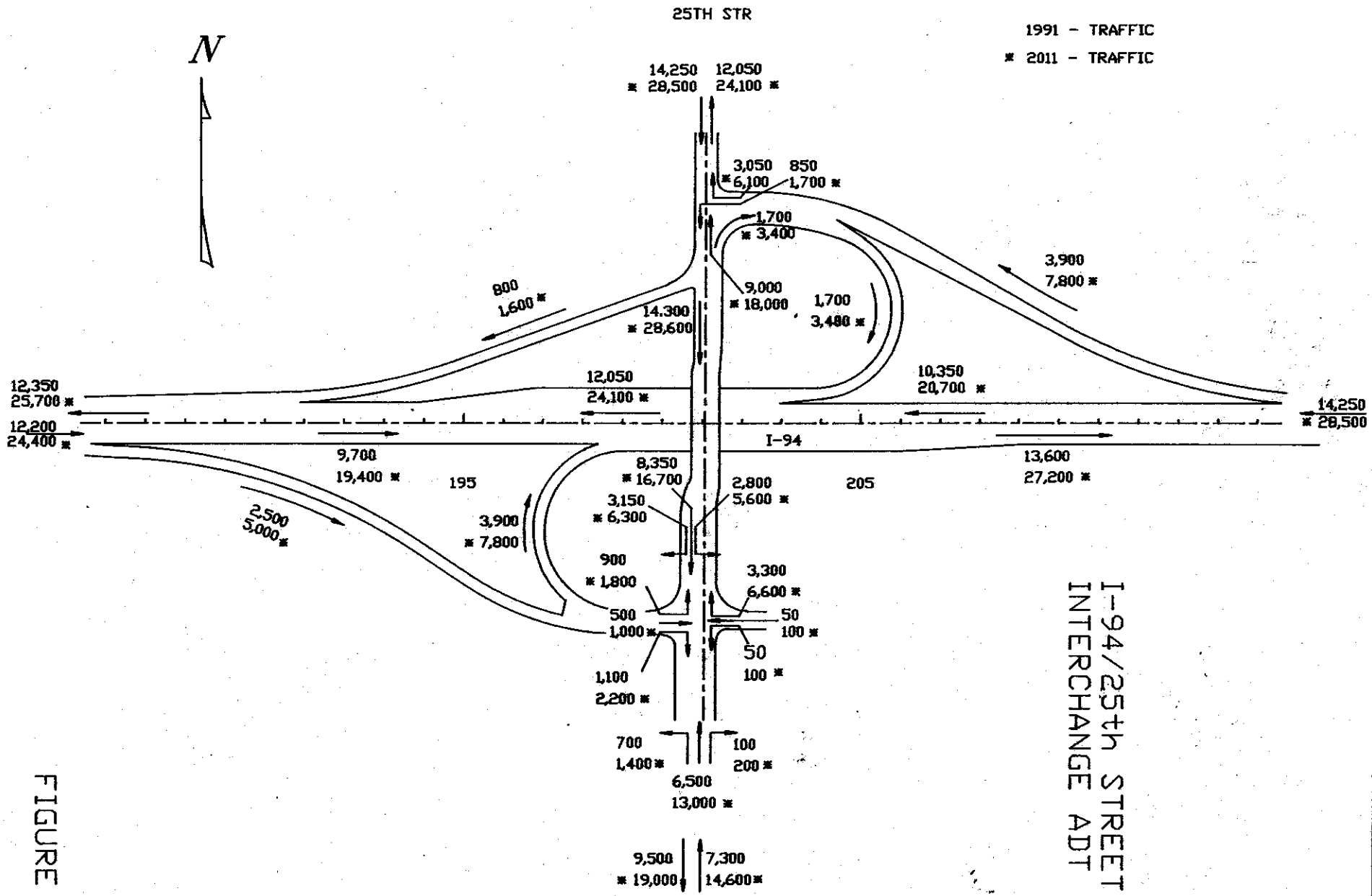
## TRAFFIC DATA

The traffic on this segment of Interstate highway has one of the highest traffic volumes in the State. The data for I-94 and 25th Street, including the on and off ramps, is shown in figure 1 on the next page of this report. The data in figure 1 was obtained in 1991.

## MATERIAL SPECIFICATIONS

The designation for 3M's Stamark Pliant Polymer Pavement Marking Tape system is A380 for the white marking material and A381 for the yellow marking material.

Specifications for A380 and A381 series tape are as follows: the reflective tape can be




I-94/25th STREET
INTERCHANGE ADT

FIGURE 1

used for both overlay or inlay applications. The overlay portion of the specification does not apply for this area as will be shown later in this report. The tape thickness is 65 mils at peaks and 20 mils in valleys (mil is equal to 0.001"). The marking tape has a waffle type design on the top portion of the tape, photo one and two. In photo one and two the yellow A381 tape was used for clarity. Viewing the photos of the white A380 tape, the reflectance off the white did not show the waffle type design as clear as the yellow tape. The skid resistance is 45bpn (bpn stands for British Portable Number which translates into Skid Resistance Test). The reflectivity for the tape is: white 700, yellow 500, appendix B.

Photo 1 - A381 material. Showing waffle shape material

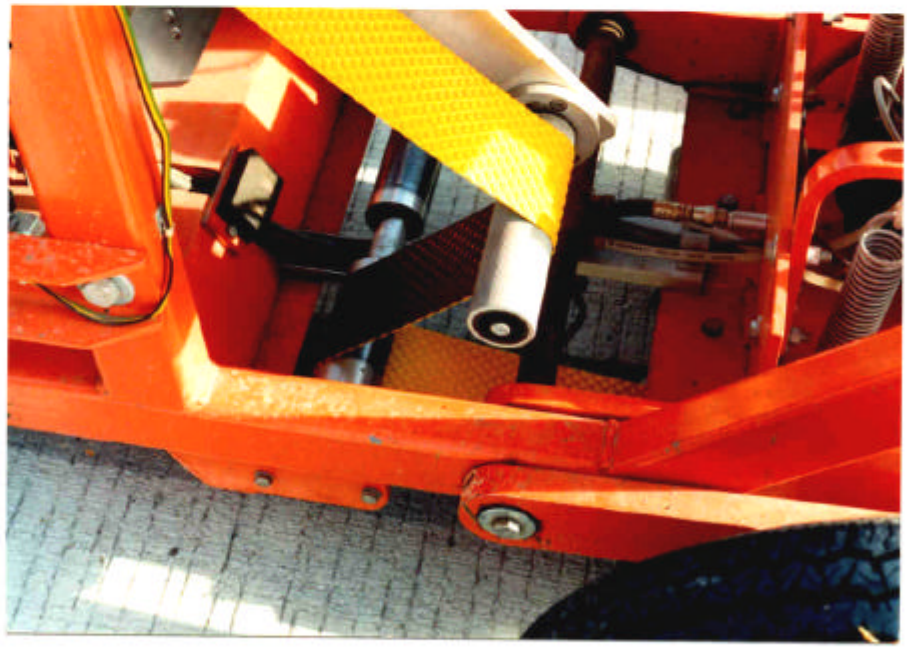


Photo 2 - A381 material. Showing waffle shape material

## PURPOSE AND SCOPE

Due to high volumes of traffic and the desire to make a first impression to out-of-state travelers, the North Dakota Department of Transportation (NDDOT) selected this area to evaluate the performance of 3M's Stamark Pliant Polymer Pavement

Polymer Pavement Marking Tape system, designation A380 for white marking material and A381 for yellow marking material.

The purpose of this experimental project had three points of interest. One was to decide if the A380 and A381 marking tape system could withstand the high ADT's in a city the size of Fargo, North Dakota. The second point of interest to the State was how well would the marking system withstand the wear of snow plow blades running over and on the surface of the marking material. The final observation will address the ability of the marking system to maintain its reflectance over time.

To evaluate the three points of interest, the State selected a site with a high ADT. After the location was selected, it was decided to compare how the marking system would perform on a concrete surface and on an asphalt surface.

The objective of this study has been to evaluate 3M's Stamark Pliant Polymer Pavement Marking Tape on a concrete and on an asphalt surface. The marking system was used to mark edge, center line skips, and channelizing lines. This final report will present the findings and recommend when and where this type of pavement marking system should be used.

## FINAL EVALUATION

3M's Stamark Pliant Polymer Pavement Marking Tape system was placed in July, 1991. The pavement marking system looked great, the retroreflectivity readings were good, and night observations were excellent, see photos three and four. Photo three is an example of tape overlaid on a concrete surface. Photo four is an example of tape inlaid into an asphalt pavement. The only concern was, how well would the overlaid pavement marking system withstand one winter of snow plows?

Photo 3 - Overlaid A380 & A381 marking material. Photo taken in 1991

This report could end here because the marking system failed after one winter. It did not fail because of lack of

reflectance but because of snow plow damage after one winter.

One item, among many, to consider when selecting a marking system is the height the marking material will protrude above the pavement surface. A marking system placed on North Dakota highways is not only subjected to normal wearing conditions but also snow plow blades that keep State roads clear of ice and snow. Snow plow blades will damage any marking material but the cost of a painted marking material is small in comparison to a tape marking system. The A380 and A381 material is expensive and to get only one year of service is not cost effective. Something has to be done to protect the marking material.

Photo 4 - Inlaid A380 & A381 marking material. Photo taken in 1991

As stated in the material specification section of this report, the A380 and A381 material has a thickness of 65 mils at the peak of the marking tape down to 20 mils in the valleys of the waffle shaped pattern. It became apparent, after one winter, the marking system would not last two winters. Photo five and six are an example of the damage the marking material experienced after one winter.

Photo 5 - Overlaid A380 marking material damaged by snow plow.

Initially, it was thought, to protect the raised pavement marking from snow plow

damage, wheels could be mounted on the bottom of the snow plow blades, figure 2. The small wheels were mounted on the bottom of the blade for keeping the bottom of the blade from setting on top of the pavement. This method protected the raised pavement marking but it did not remove the snow completely. To get the snow or ice off the road completely the operators would be forced to tilt the blade forward, setting the blade closer to the pavement. Once the blade was set closer to the pavement, the bottom of the blade would shave off the upper portion of the

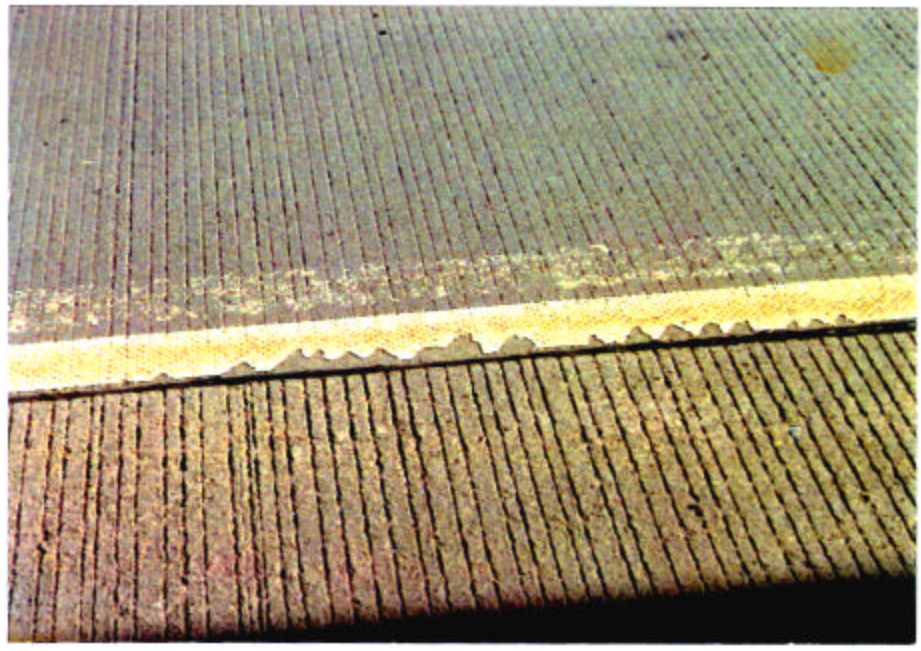


Photo 6 - Overlaid A380 marking material damaged by snow plow.

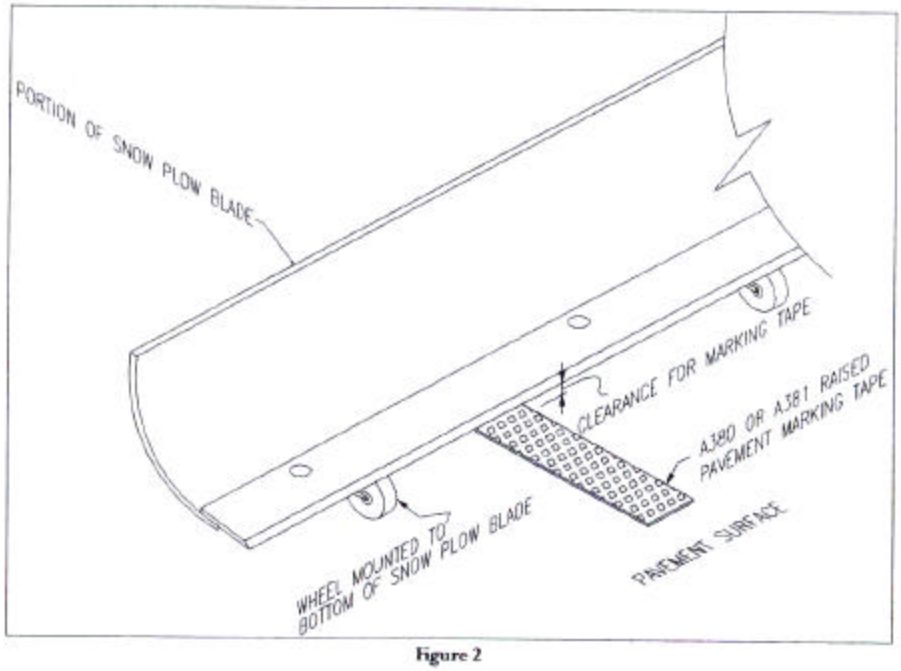



Figure 2

marking tape, photo seven. Look closely at and to the left of the transverse joint. Notice that the raised portion of the tape was shaved off. Unfortunately, the portion of the tape shaved off, contains the glass beads, figure 3. It is the glass beads that give the reflectance back to the motorist. Without the beads, the pavement marking system is rendered useless. If snow or ice is not removed from the pavement, the marking system is covered and rendered useless anyway. The snow plow operator had no choice but to adjust the blade to remove the material covering the marking system.

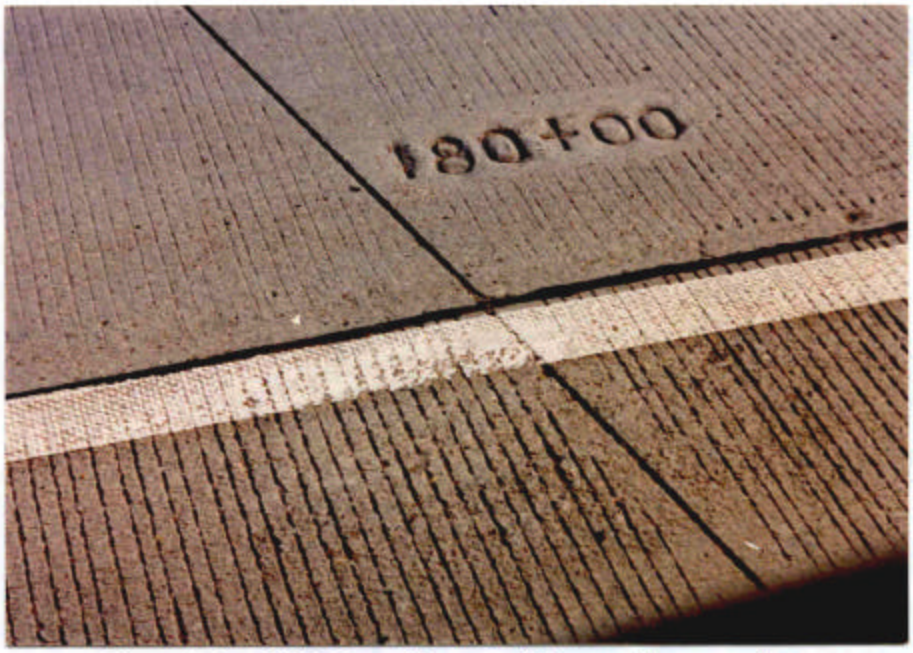



**Photo 7 - Overlaid A380 marking material damaged by snow plow.**

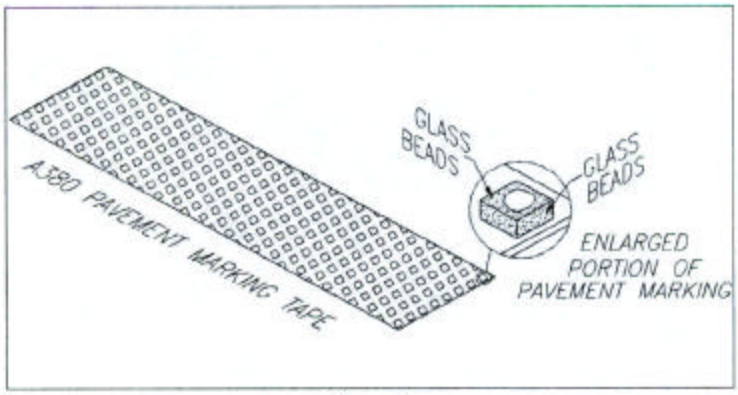



**Figure 3**

After this project was completed, there were two projects constructed the following years that required removal of some of the new marking system. The new projects were on the east and west side of the new marking system. One project was the Tri-Level bridge, west and next to the new marking system. The second project was adjacent and east of the newly laid marking system and that was the Red River bridge project. After these projects were complete, the same marking system was placed but this time the marking material was inlaid into the concrete, photo eight and nine. The inlaid marking material was placed in 1993. Photo eight is an overview of the marking material. Photo nine is a close-up of the marking tape placed into the groove. The grooved or ground surface is approximately 4-1/2 inches wide and 1/16 inch deep.

Photo 8 - Inlaid A380 marking material. I-94 Fargo, North Dakota

A day and night view observation was made and the material looked good. The center line skips were undamaged from snow plows and reflectance looked good. These observations were consistent throughout the length of the project.

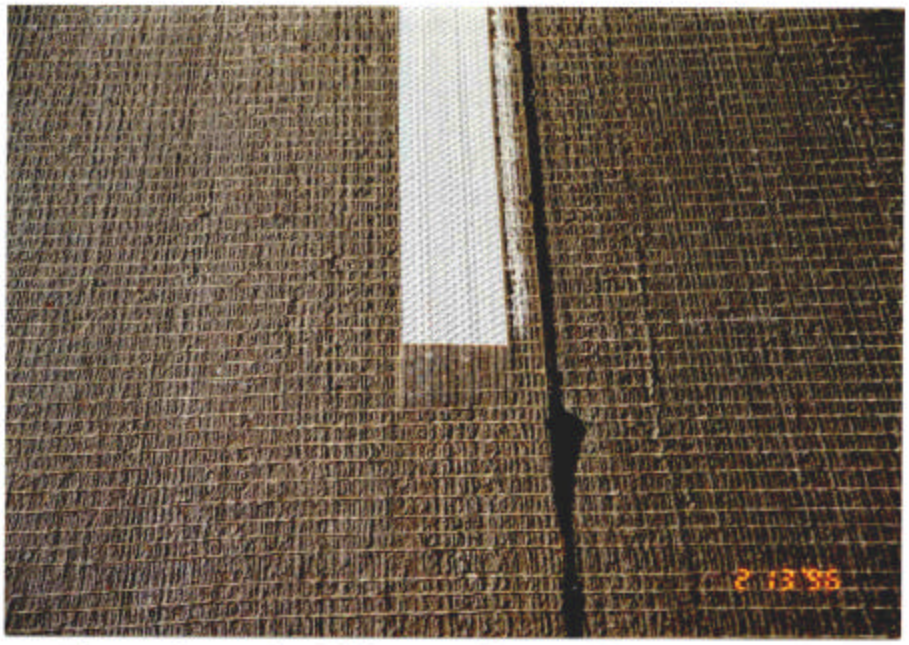



Photo 9 - Close-up of an inlaid A380 marking material on a concrete surface.

This marking system has been down almost three years and no sign of the material

failing was detected. The Fargo District is satisfied with the result the inlaying process has done for them.

There are two other sections of I-94 that have inlaid A380 marking tape. One project was done west and east of Steele, North Dakota. This was a seal coat project. Before the seal coat was placed, A380 center lines skips were placed and covered for protection from the seal coat operations. After the seal coat was placed and cured the covering was removed. The seal coat was done in the summer of 1995 and the marking material looks great.

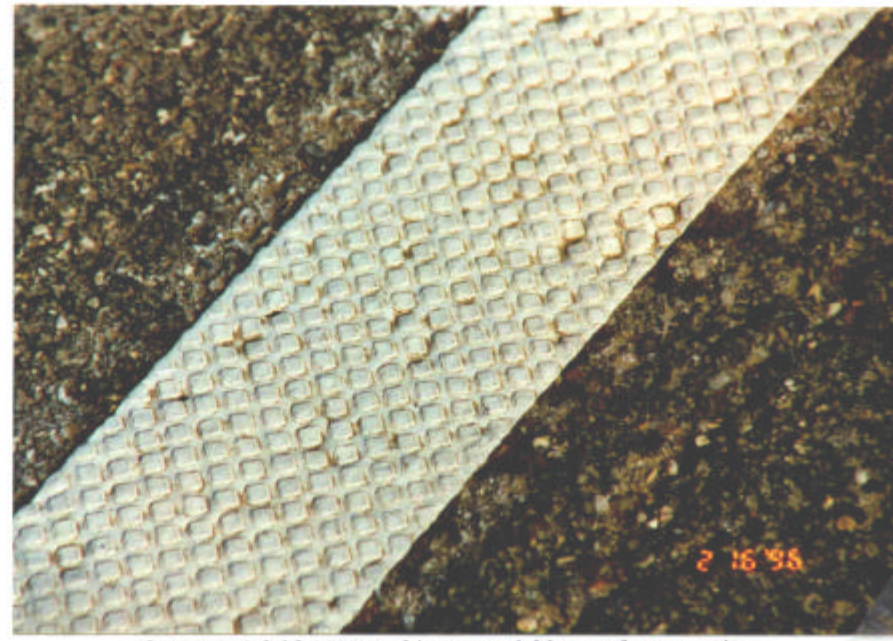



Photo 10 - Inlaid A380 marking material in a seal coat project.

Day and night observations were made in this section and reflectance is excellent. The marking system was well defined. The marking system showed no signs of fading as painted marking systems usually experience.

In February 1996 an inspection was made. As shown in photos ten and eleven the marking material does not show any damage from snow plows. This was consistent throughout the section of roadway that inlaid the marking material.

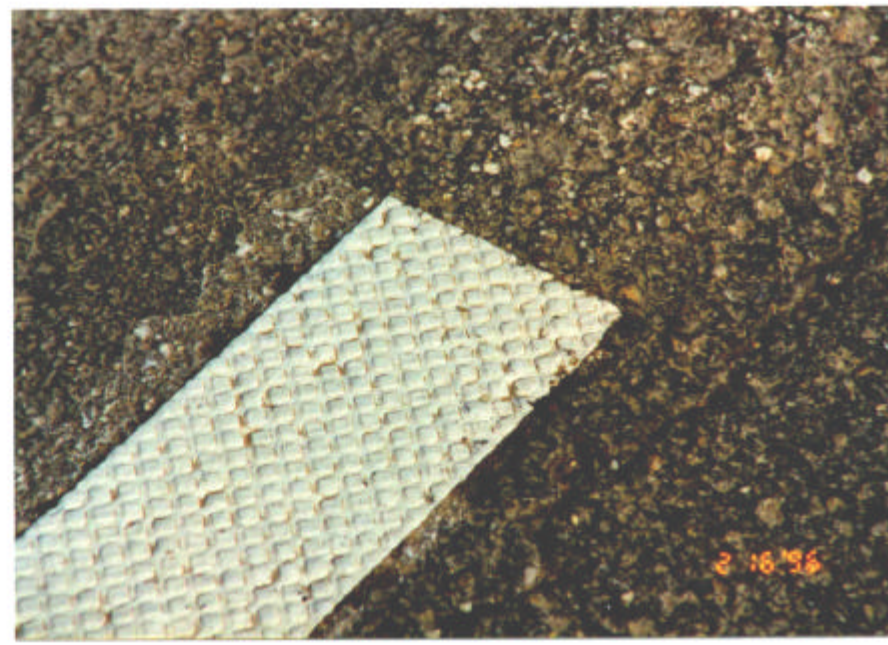



Photo 11 - Inlaid A380 marking material in a seal coat project.

Photo twelve is an overview of where the inlaid material stopped and the painted marking system started. By this photo, Materials and

Research is trying to show the difference between the two marking systems. In the background of the photo is the inlaid material and the foreground is the painted marking material. Notice the clarity and difference between the two systems.

Day and night observations were made and the 3M inlaid marking material looks great. The A380 inlaid center line looks clear, well defined, and no intermediate faded marking as seen in the foreground.

Photo 12 - Inlaid A380 marking material in background and painted marking material in foreground.

The second project that inlaid A380 marking material is on I-94, east bound center line skips, east of Casselton. Photo thirteen and fourteen are examples how the marking tape looks throughout the length of the project. This marking material was placed in the summer of 1995. These photos were taken in February 1996. While in this area, Materials and Research did not notice one damaged centerline skip. The edges of the marking material were still adhering to the concrete surface. There was a thermoplastic marking material we evaluated in the summer of 1993 and this material began failing before snowplows did their damage. The edges of the thermoplastic marking material began failing within two or three months after it was placed.

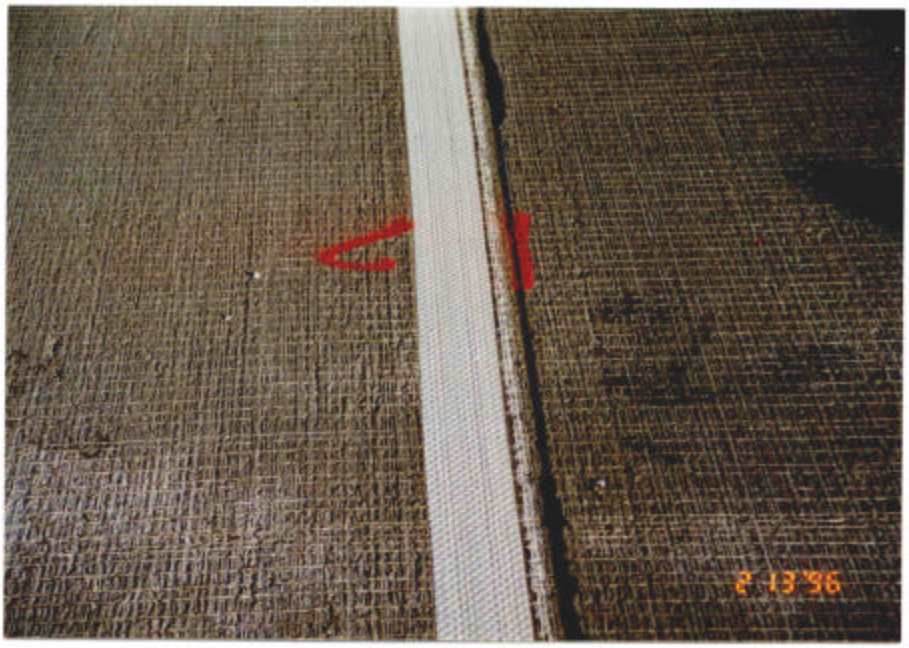



Photo 13 - Inlaid A380 marking material.

East of the Casselton

project to west of the West Fargo interchange on I-94 is a section of A380 marking material overlaid on the concrete surface. In this section of roadway Materials and Research observed

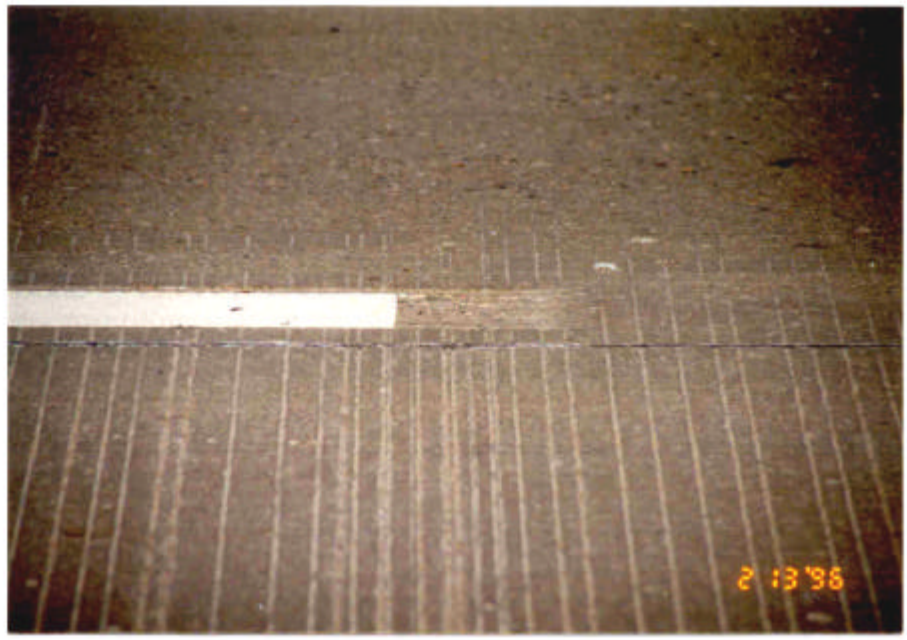



Photo 14 - Inlaid A380 marking material into a concrete surface.

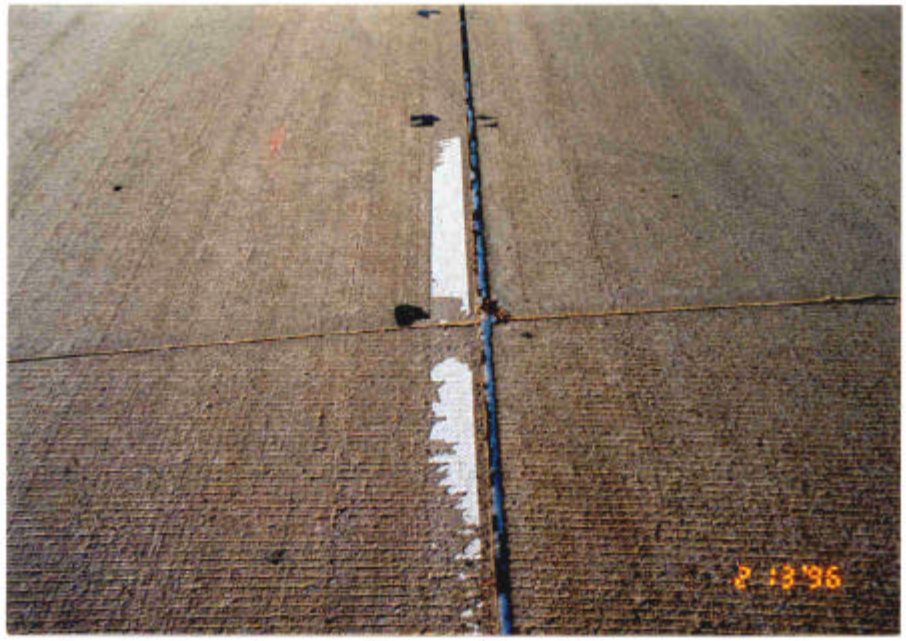



Photo 15 - Damaged A380 marking material overlaid onto a concrete surface.

extensive snow plow damage, see photo fifteen. This was typical for most of the centerline skips on the overlaid section. This type of damage was observed until the next inlaid section was reached. The next inlaid section was near the Tri-Level bridge in Fargo, North Dakota.

Photo 16 - Inlaying A380 marking material into a freshly placed asphalt.

In 1991 when the A380 and A381 marking material was placed on I-94, a section of asphalt, north and south of the 25th Street Interchange, and a stretch of asphalt on 21st Avenue South, east of 25th Street, was inlaid with A380 and A381 marking material, see photo sixteen. The roller in photo sixteen is pressing the marking material into the hot asphalt. This photo was taken in July of 1991. Photo seventeen was taken in 1992, a year after photo sixteen was taken. The marking material is soiled because of construction in the surrounding area but still no apparent snow plow damage was observed. In 1996, photo eighteen was taken. Notice the snow plow damage on the "O" in the word "ONLY". Materials and Research does not know

Photo 17 - First sign of snow plow damage after 5 years of service.

when this damaged occurred but the marking material looks good after being placed five years ago.

Photo 18 - First sign of snow plow damage after 5 years of service.

Photo nineteen was taken in 1996. This is a photo of the yellow center line on 21st Avenue South, east of 25th Street. This marking material, A381, was placed five years ago. Although it shows snow plow and wearing damage, the waffles are still present. When this marking material was placed, Materials and Research felt the contractor waited too long

Photo 19 - Close-up of A381 marking material. Wear and snow plow damage.

before rolling over the marking material. One consequence of waiting too long for the roller to go over the marking material is that the material will not seat or compress into the hot asphalt. This will result in the waffles extending above the surrounding surface. This problem could have been avoided if the contractor had seated the marking material farther into the asphalt.

Photo 20 - Damaged stop bar.

Another problem the Fargo District experienced was at the stop bars and crosswalks. Initially the stop bar and crosswalk was marked with 3M's 5730 material. The material could not withstand stresses imposed on it from vehicles stopping and turning. 3M and Swanston Equipment Company replaced, at no cost to the State, the damaged 5730 marking material and replaced it with a heavier A420 material, photo twenty and twenty-one. The damages in the last two photos are the result of maintenance equipment.

Photo 21 - Damaged crosswalk.

## CONCLUSION

If the overlaid marking material is judged on its ability to withstand snow plow blades, then it has failed. If we judge the marking material on its ability to give back to a motorist a distinct line to follow when driving through, then 3M's A380 and A381 is excellent material. One thing

Materials and Research has observed is the ability of the A380 and A381 material to hold its brightness and clarity over time. Over the years of evaluating marking material, this material does not fade as readily as other marking material evaluated. This material gives a good clear and distinct pattern to follow. Materials and Research highly recommend 3M's A380 and A381 marking material only if it is inlaid.

It is not feasible or cost effective to mark all of the State's highways with 3M's A380 and A381 marking material. But if we consider all the administrative costs associated with putting together stripe plans and contracts that we do each year then maybe it would be cost effective. The State should consider using 3M's A380 and A381 marking material in areas of high traffic, dangerous curves, dangerous approaches, etc. We could mark these areas with paint once a year or every other year but they began fading the moment the marking material is placed.

## COSTS

When A380 and A381 was placed, it cost the State $5.40/ft$^2$. The grooved material placed in 1994 or 1995 cost the State $5.15/ft for an 8 inch wide groove. It cost the State $2.39/ft for a 4 inch wide groove.

# Appendix A

JOB# 1

| FHWA REGION | STATE | PROJECT | SHEET NO. |
|---|---|---|---|
| 8 | N.D. | IR-094-8(113)350<br>M-8-984(029)004 | 1 |

## DESIGN DATA

I-94

| Traffic | Average Daily | | | Est. 30th Max. Hr. |
|---|---|---|---|---|
| Current (1989) | 10,700 Pass. | 1,100 Trucks | 11,800 Total | 1,200 |
| Forecast (2009) | 18,500 Pass. | 2,000 Trucks | 20,500 Total | 2,100 |

Design Speed 70 MPH
Traffic Classification "M"
Minimum Sight Distance (Stopping) 625'
Minimum Sight Distance (Safe Passing)
Minimum Passing Sight Distance for Marking
Bridges $H_S20$

# NORTH DAKOTA
# DEPARTMENT OF TRANSPORTATION

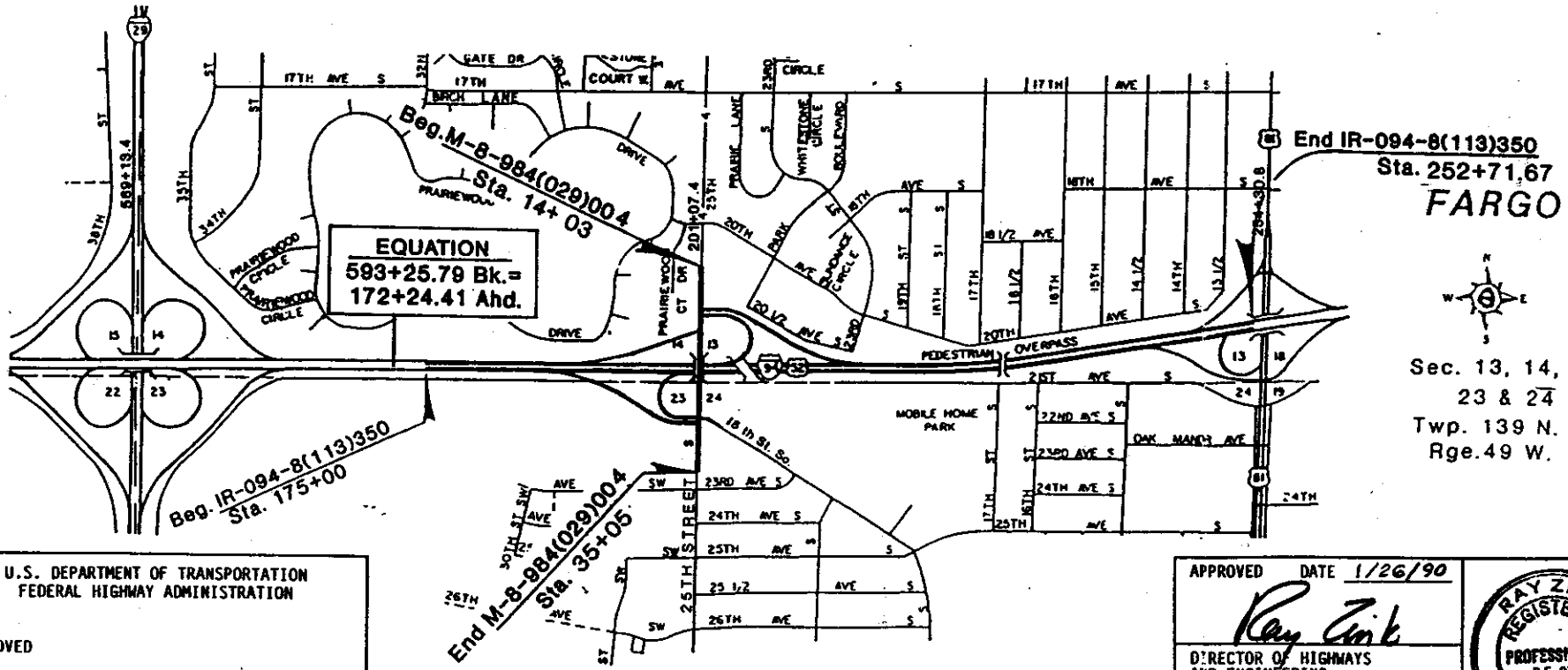
CASS COUNTY
IR-094-8(113)350
M-8-984(029)004
GRADING, SURFACING, SEWER, STRUCTURAL, LIGHTING, SIGNING, MARKING, AND INCIDENTALS

**GOVERNING SPECIFICATIONS:**

Standard Specifications for Road and Bridge Construction, adopted by the North Dakota State Highway Department, November 1986, shall apply to all North Dakota Department of Transportation contracts, standard drawings currently in effect, and other contract provisions submitted herein.

**LENGTH OF PROJECT**

| Project | Miles-Gross | Miles-Net |
|---|---|---|
| IR-094-8(113)350 | 1.472 | 1.472 |
| M-8-984(029)004 | 0.398 | 0.398 |




U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

APPROVED

DIVISION ADMINISTRATOR DATE

APPROVED DATE 1/26/90

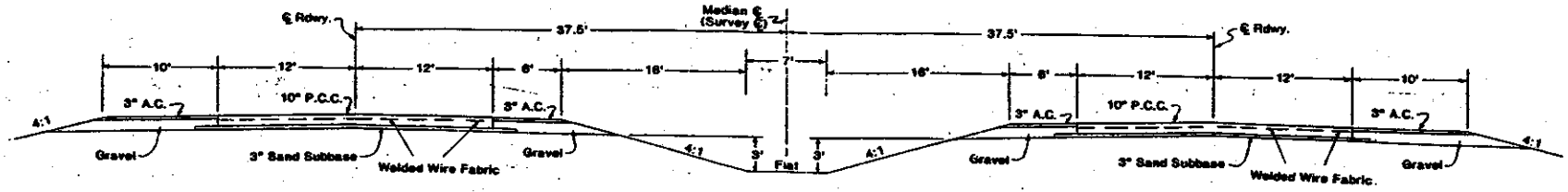
DIRECTOR OF HIGHWAYS AND ENGINEERING
NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

RAY ZINK REGISTERED PROFESSIONAL ENGINEER P.E. 972 NORTH DAKOTA

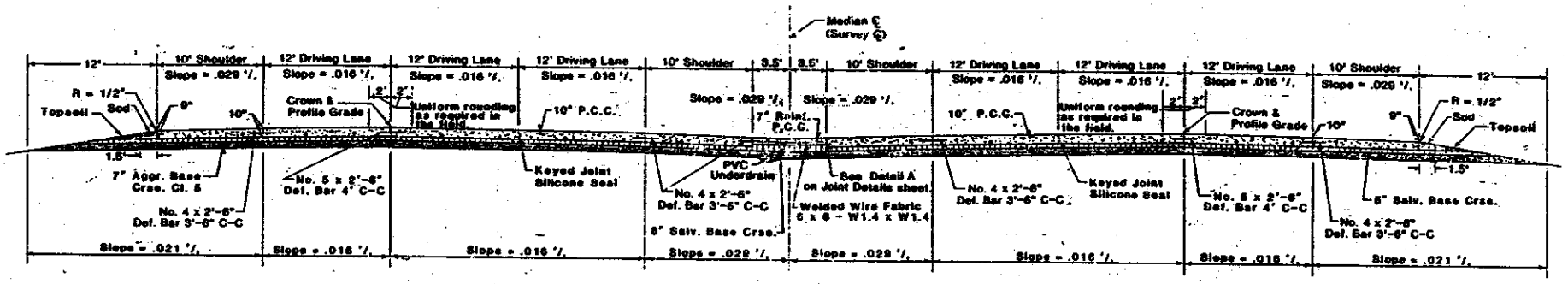
| FEDERAL AID PROJECT | STATE | FED. AID PROJ. NO. | SHEET NO. |
|---|---|---|---|
| 5 | N.D. | IR-094-6(113)350 | 28 |

# TYPICAL SECTIONS

## I-94

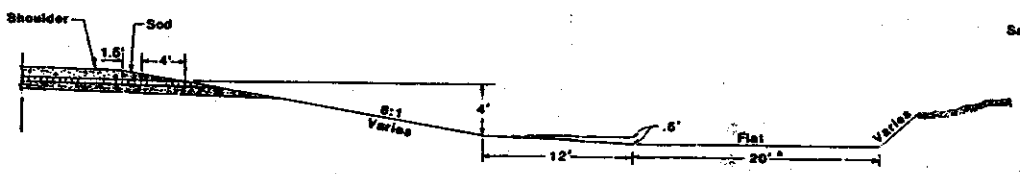



Existing Section



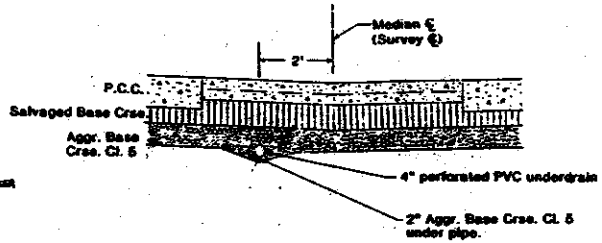

STA. 175+00 TO 184+85.4
STA. 208+08.3 TO 233+38.5
STA. 248+00 TO 250+75

## SHOULDER - DITCH DETAIL




*20' length may vary to allow backslope to tie within R/W.

## PERFORATED PVC UNDERDRAIN DETAIL

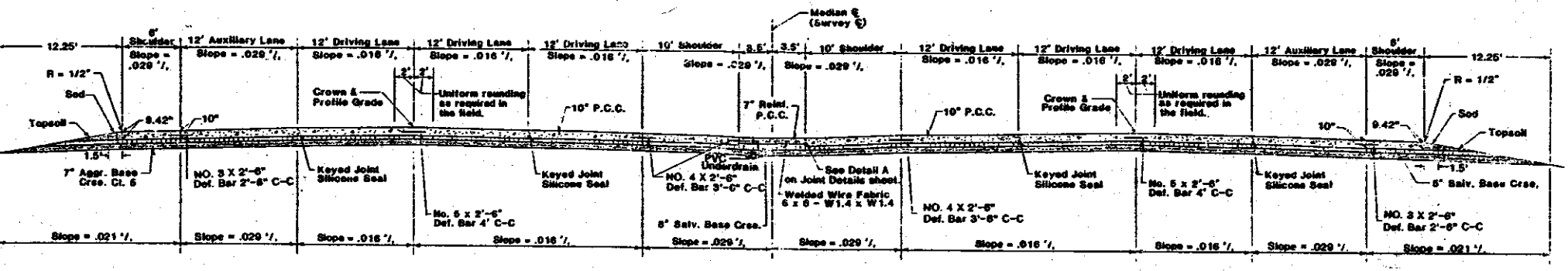



Note: Underdrain shall be placed on the left side of survey centerline prior to station 201+07.14 and on the right of survey centerline after station 201+07.14.

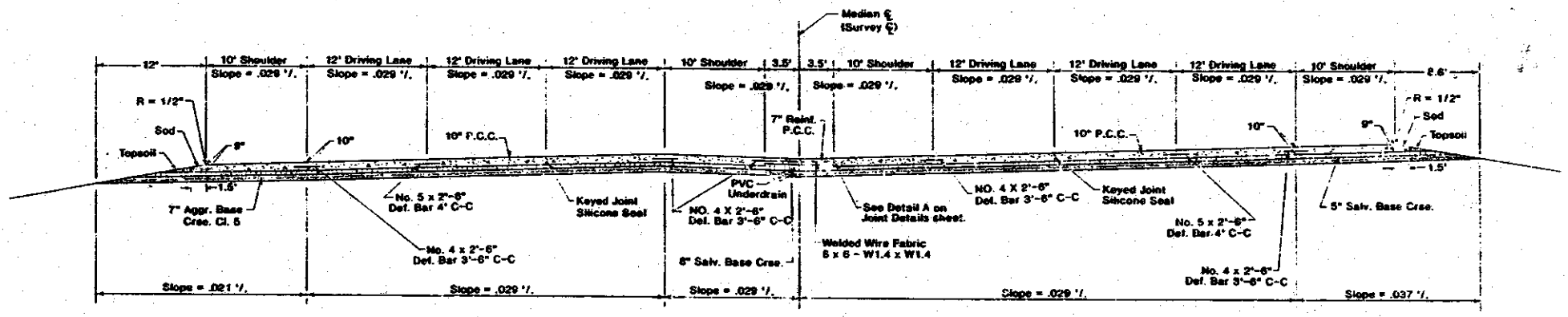
| | | | |
|---|---|---|---|
| 8 | N.D. | IR-094-8(113)350 | 24 |

# TYPICAL SECTIONS

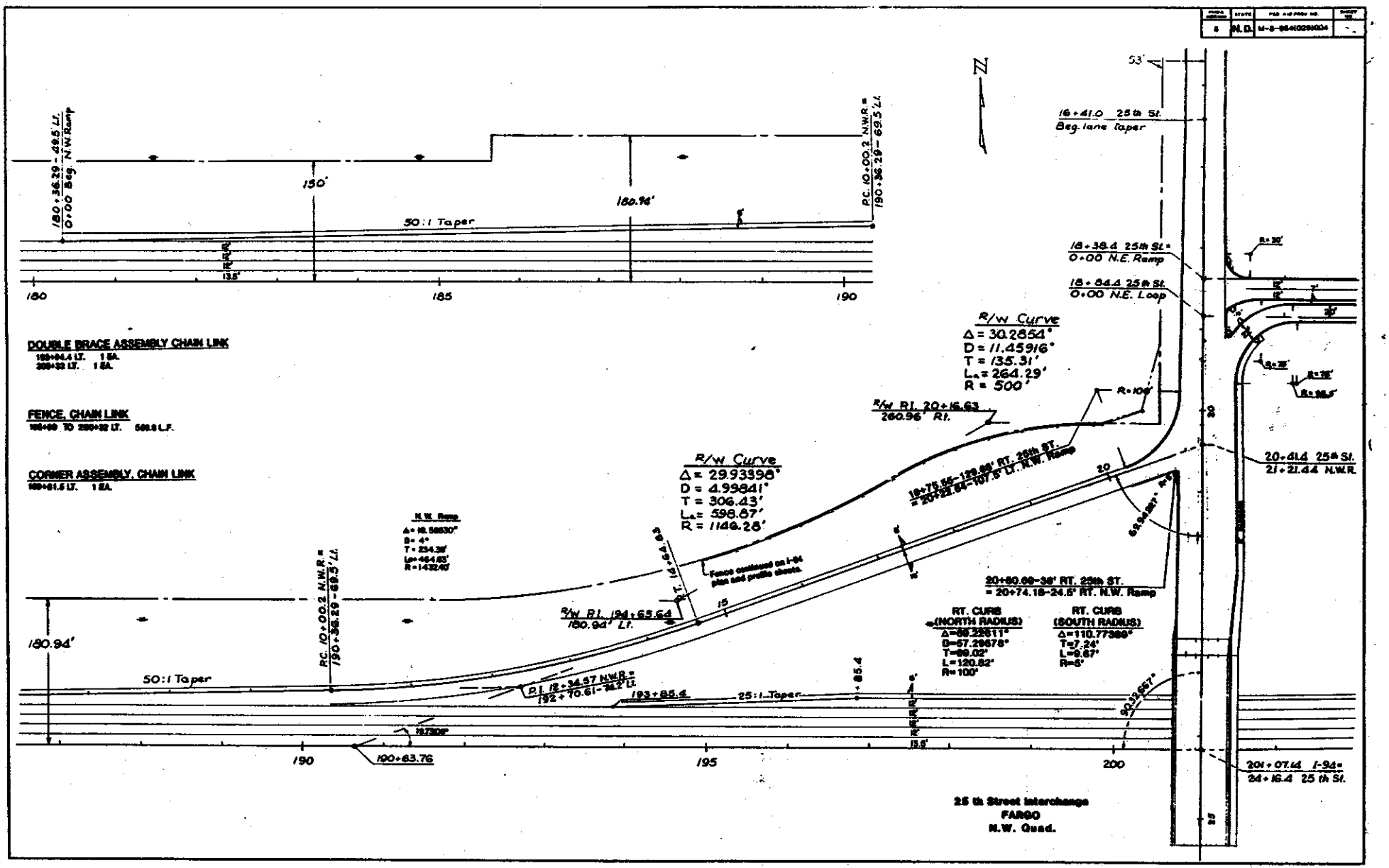
## I-94



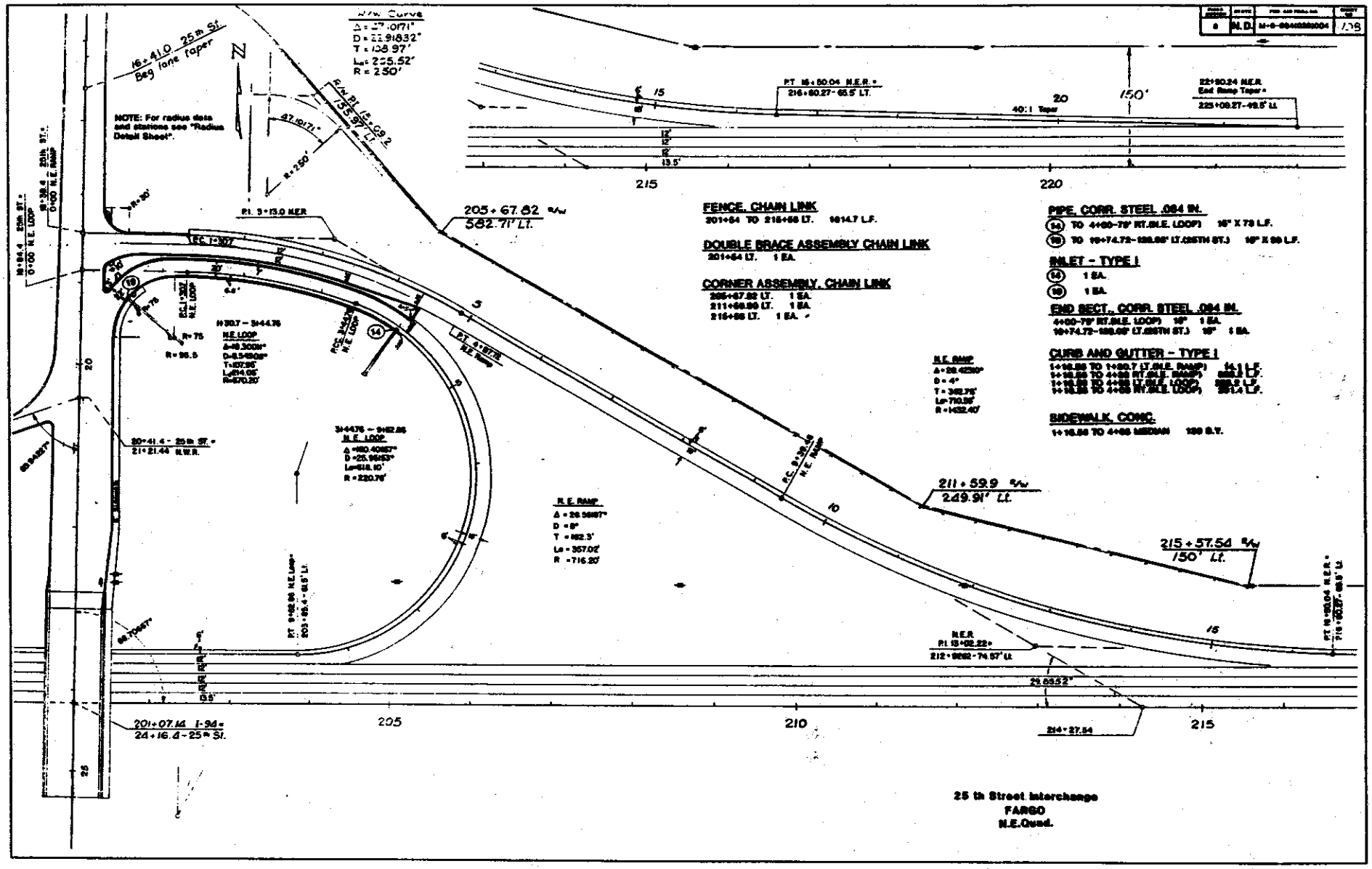

STA. 199+05.3 TO 203+85.4
STA. 240+57.98 TO 240+96.5

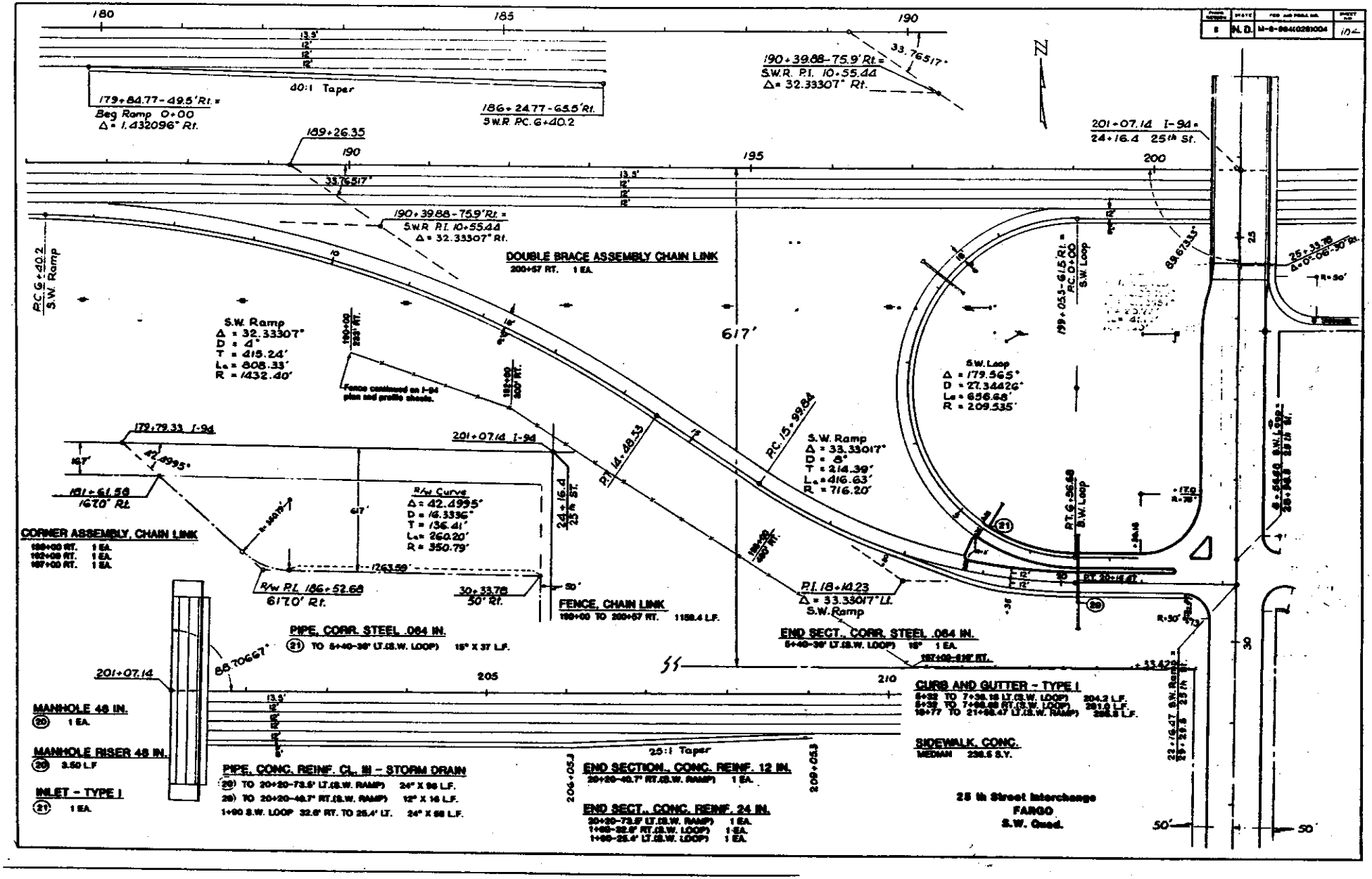



Full Superelevation Section

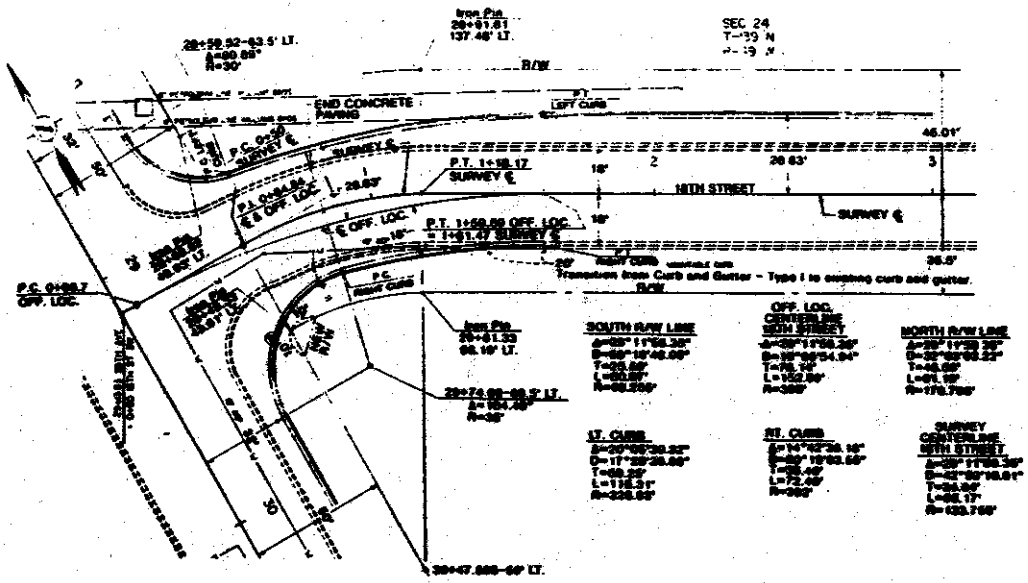


DOUBLE BRACE ASSEMBLY CHAIN LINK
FENCE, CHAIN LINK
CORNER ASSEMBLY, CHAIN LINK
50:1 Taper
180.94'
150'
180
185
190
195
200
R/W Curve
Δ = 30.2854°
D = 11.45916°
T = 135.31'
Lc = 264.29'
R = 500'
R/W Curve
Δ = 29.93398°
D = 4.99841°
T = 306.43'
Lc = 598.87'
R = 1146.28'
R/W P.I. 20+16.63
260.96' Rt.
R/W P.I. 194+65.64
180.94' Lt.
P.C. 10+00.2 N.W.R. = 190+36.29 - 69.5' Lt.
180+36.29 - 49.5' Lt. 0+00 Beg. N.W. Ramp
16+41.0 25th St. Beg. lane taper
18+38.4 25th St. = 0+00 N.E. Ramp
18+84.4 25th St. 0+00 N.E. Loop
20+41.4 25th St. 21+21.44 N.W.R.
20+60.69-38' RT. 25th ST. = 20+74.18-24.5' RT. N.W. Ramp
RT. CURB (NORTH RADIUS)
RT. CURB (SOUTH RADIUS)
Δ=110.77389°
T=7.24'
L=9.67'
R=5'
R=100'
R=106'
R=30'
R=75'
R=96.5'
N.W. Ramp
Fence continued on I-94 plan and profile sheets.
P.I. 12+34.57 N.W.R. = 192+70.61-74.2' Lt.
193+85.4
25:1 Taper
190+63.76
201+07.14 I-94 = 24+16.4 25th St.
25 th Street Interchange
FARGO
N.W. Quad.


NOTE: For radius data and stations see "Radius Detail Sheet".
FENCE, CHAIN LINK
DOUBLE BRACE ASSEMBLY CHAIN LINK
CORNER ASSEMBLY, CHAIN LINK
PIPE, CORR. STEEL .064 IN.
INLET - TYPE I
END SECT., CORR. STEEL .064 IN.
CURB AND GUTTER - TYPE I
SIDEWALK, CONC.
N.E. RAMP
N.E. LOOP
25 th Street Interchange
FARGO
N.E.Quad.



DOUBLE BRACE ASSEMBLY CHAIN LINK
200+57 RT. 1 EA.
S.W. Ramp
Δ = 32.33307°
D = 4°
T = 415.24'
Lc = 808.33'
R = 1432.40'
Fence continued on I-94 plan and profile sheets.
S.W. Loop
Δ = 179.565°
D = 27.34426°
Lc = 656.68'
R = 209.535'
S.W. Ramp
Δ = 33.33017°
D = 8°
T = 214.39'
Lc = 416.63'
R = 716.20'
R/W Curve
Δ = 42.4995°
D = 16.3336°
T = 136.41'
Lc = 260.20'
R = 350.79'
CORNER ASSEMBLY, CHAIN LINK
FENCE, CHAIN LINK
PIPE, CORR. STEEL .064 IN.
END SECT., CORR. STEEL .064 IN.
CURB AND GUTTER - TYPE I
SIDEWALK, CONC.
MANHOLE 48 IN.
MANHOLE RISER 48 IN.
INLET - TYPE I
PIPE, CONC. REINF. CL. III - STORM DRAIN
END SECTION., CONC. REINF. 12 IN.
END SECT., CONC. REINF. 24 IN.
25 th Street Interchange
FARGO
S.W. Quad.




**REMOVAL OF CURB AND GUTTER**
0+53.5 TO 3+09 LT. 246.5 L.F.
0+53.5 TO 1+59.59 RT. 106.1 L.F.

**CURB AND GUTTER - TYPE I**
0+58.75 TO 3+09 LT. 246.6 L.F.
0+63.83 TO 1+61.47 RT. 73.0 L.F.

| FINAL REGION | STATE | FED AID PROJ NO | SHEET NO |
|---|---|---|---|
| 8 | N D | M-8-984(029)004 | 12 |

BENCH MARKS

| NO | DESCRIPTION | LOCATION | ELEV |
|---|---|---|---|
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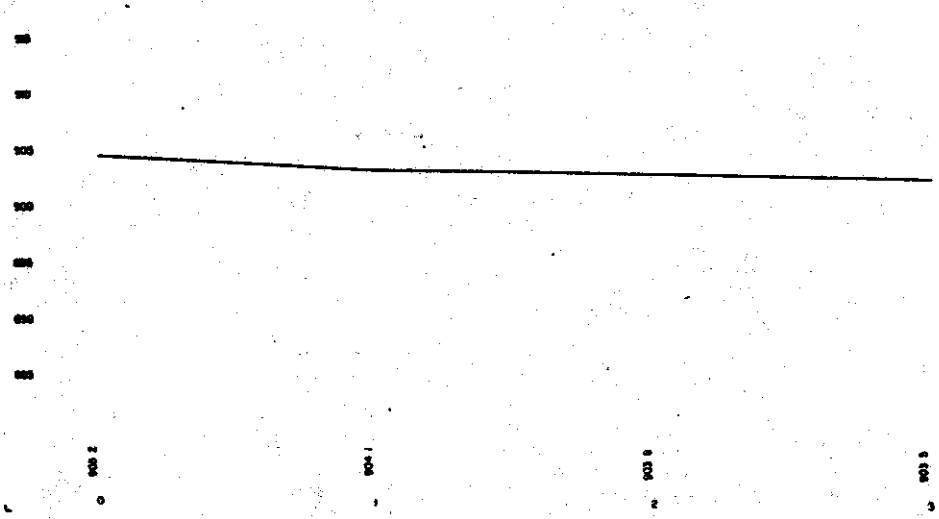
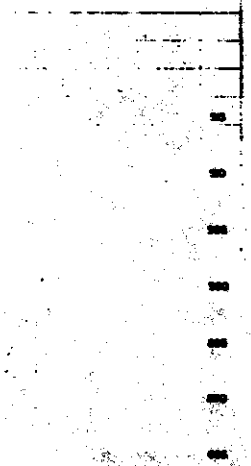
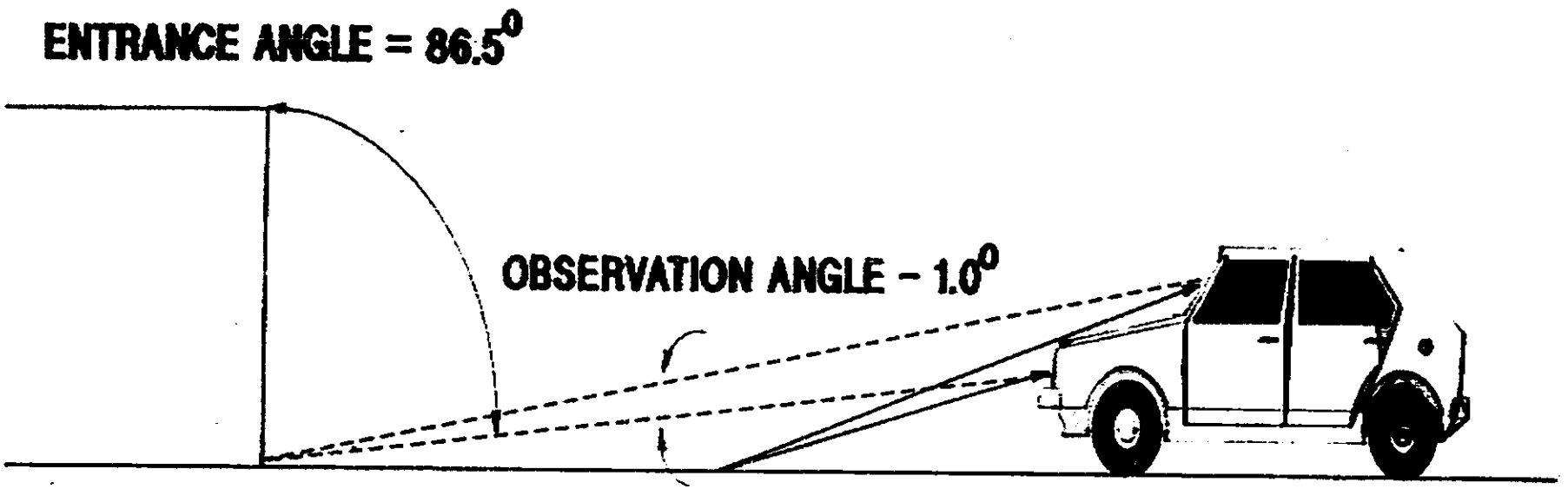




# Appendix B

**ENTRANCE ANGLE IS WHERE THE LIGHT FROM THE CAR STRIKES THE MARKING UP TO 90°.**

**OBSERVATION ANGLE IS WHERE THE LIGHT FROM THE CAR STRIKES THE MARKING END AND IS RETURNED TO THE DRIVER.**