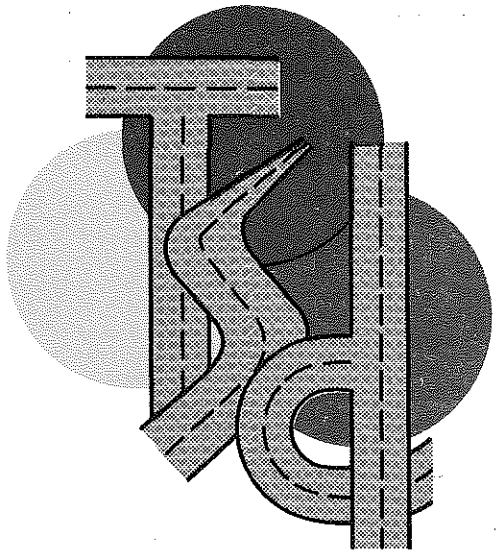
Evaluation of Five
Safety Improvement Projects
TSD-422-80



TRAFFIC and SAFETY DIVISION

MICHIGAN DEPARTMENT OF STATE HIGHWAYS
AND TRANSPORTATION

MICHIGAN DEPARTMENT
OF
TRANSPORTATION

Evaluation of Five Safety Improvement Projects

TSD-422-80

By
R. E. Maki
L. D. Bunker

in cooperation with

The Federal Highway Administration

Through Task Order No. Three, "Implementation of Highway Safety Project Evaluation Procedures" under Basic Agreement DOT-FH-11-9211

December, 1980

Preface

This evaluation was undertaken to satisfy a need for the uniform presentation of the results of highway improvements thus producing a nationwide data base to provide for the most cost-effective expenditure of funds.

The projects evaluated were funded through the Michigan Safety (Ms) Program, a 100 percent state funded program in existence since fiscal 1965-66. These five projects were selected to present the different types of improvements that have been characteristic of this program. All were of recent construction at the time of selection to eliminate bias from knowledge of "after period" accident experience. This presents a data collection problem in some cases as only 2½-year "after" accident experience is available at this time.

The format follows the procedural guide developed as part of this project and treats each improvement project in a different section of the report. Data is presented in a manner that facilitates comparison, before and after the improvement.

The experimental plan in all cases is a modified "before and after." Accident experience before and after the improvement is included in the analysis with a histogram showing accident experience at similar sites. This is the ultimate in control group comparisons, though our presentation is more qualitative than quantitative in this respect.

MIDAS Comparison

A computer model was developed to identify sites with correctable accident patterns independent of the number of total accidents.

Detailed information on this model is included in a report by Thomas L. Maleck, P.E., entitled The Michigan Dimensional Accident Surveillance Model, A Report of Progress, Michigan Department of Transportation, Lansing, April, 1978.

Principally the concept is to aggregate locations with similar geometric and environmental characteristics into cells and evaluate accident parameters.

Histograms are generated showing the accident experience at locations with the particular cell type being studied. Those locations with accident experience deviating from the mean by some predetermined statistical level are printed out.

For the purpose of this report we will attempt to show that the project locations were, in fact, significantly different than their peers in the "before period" but they did not deviate significantly from the mean in the "after period," according to their Measures of Effectiveness (MOE's). By using this model, we can show that a deviate can be transferred to the new cell type with accident experience near the mean after improvement. Even more important than what happens to the study site in these comparisons is that little change is noted in the control group as a whole.

Since the model must be constantly updated when major geometric changes are effected at any location, we may find some errors in cell grouping for those locations of recent construction.

Table of Contents

Introduction

The report is divided into five parts, A through E, with each part devoted to an evaluation of an individual project of a type common to the Michigan Safety (Ms) Program.

A uniform format is followed that first introduces the reader to the site via "before and after" pictures and then proceeds with a narrative introduction and background history. Anticipated project benefits are compared to study results. Study parameters are then presented, following the intent of the procedural guide as close as reader comfort will permit. Necessary items are included, such as Purpose of Project, Objectives, Measures of Effectiveness, and Data Requirements.

Following these preliminaries, the actual comparison of "before and after" data is shown with explanation of exposure factor calculations where needed. The appropriate accident summary table is then exhibited and economic analysis follows. MIDAS comparisons are subsequently discussed.

At the back of each section the bulk of the study data can be found. This includes the location map, graphical summary sheets for "before and after" manual traffic surveys, a geometric sketch of the improvement (if helpful), and additional photographs. Collision diagrams were omitted (except for Part A) in favor of the summary tables.

Following Part E is the study summary of recommendations and conclusions which discusses the evaluation procedure, rather than individual project evaluations.

PART A

M-43 at AB Avenue

Northbound BEFORE

Northbound AFTER

Part A

Introduction

The intersection of M-43 (32nd Street) and M-43 (AB Avenue), Richland Township, Kalamazoo County, was improved to facilitate a route turn operation by providing a storage lane for left turns and a clear sight triangle. (See map and sketch, pages 9 and 13.) Construction period was 9/15/75 - 10/10/75 at a cost of $78,000 including $7,000 right-of-way costs.

M-43 in this area is a rural 2-lane, two-way roadway carrying 6,000 vehicles a day and winding north from Kalamazoo to Hastings. Although the alignment is not very good throughout this section, one particular location was isolated as having significant correctable accident experience that could be alleviated through reconstruction with funding by the Safety (Ms) Program. The trunkline turns north to east at a right angle while 32nd Street continues north on tangent. The southbound nontrunkline leg is under stop control and the trunkline free flows. The northbound through movement was actually a left turn from the trunkline with no storage area and also limited sight distance to the east (oncoming trunkline traffic).

Problems were encountered not only with this conflict but also with lost control run-off-road accidents. By making the trunkline alignment more visible, it was conceivable that almost all associated accidents could be eliminated.

Total accidents were reduced from 24 in the three years before the project to 2 in the three years after representing a yearly dollar savings of $34,300. When this benefit is compared to the cost over an assumed 20-year project life, the benefit cost ratio is 4.0.

Study Parameters

Purpose of Project: Reduce total accident experience and related injuries through reduction in run-off-road and angle accidents.

Objective: Determine the effect of the project in reducing total, run-off-road, and angle accidents and associated injuries.

Measures of Effectiveness:

1. Percent change in total accidents.

2. Percent change in run-off-road and right-angle accidents.

3. Percent change in associated injuries.

Data Requirements:

Total accidents (by severity and type)
Run-off-road and angle accidents (by severity)
Manual turning volume counts
Project cost
Construction period

Parametric Comparison

Determination of exposure factors for the intersection of M-43 at M-43 (AB Avenue)

Use		
	8/17-18/72	Survey
	6/13-14/78	Survey

1972 24-hour approach volumes

822
2630
1870
5322

1978 24-hour approach volumes

853
2270
3100
6223

6223
-5322
901

$\frac{901}{5322}$ = 17% increase

Using linear growth, traffic increased almost 12 percent between midpoints of the "Before and After" periods 1973 and 1977.

The summary table for "before and after" accident and exposure data, Table A1, shows three years accident experience before and after, as well as estimated average exposure volumes based on 1972 and 1978 traffic surveys. Intersectional rates are used since the section is less than 0.1 mile.

The Poisson technique was selected for significance testing at the 95 percent confidence level. The reductions in total, angle, and run-off-road accidents are significant.

Economic Analysis

Initial cost of project paid in 1976 = $78,000

Assume changes in maintenance costs are minimal

Annual average benefits

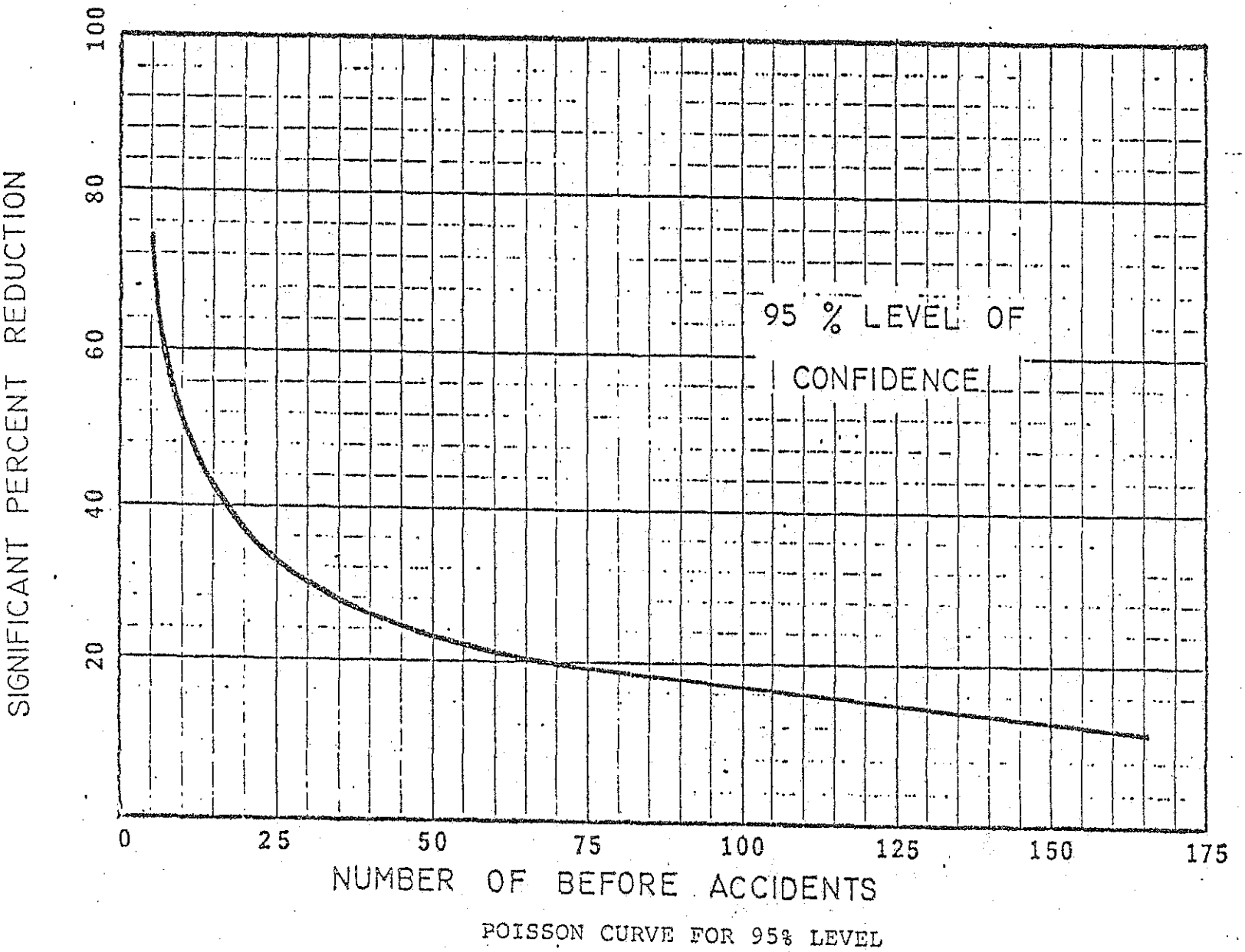
a. No fatalities reduced

b. 5.7 personal injuries reduced
3.67 property damage only accidents reduced

M-43 @ AB Avenue

Table A-1: Data Summary Table For The Before and After Study

Data Variables	Full 1972, 1973 & 1974 Before	Full 1976, 1977 & 1978 After
Accidents		
Total (PDO, I(I), F(K)	24 (13, 11(17), 0)	2 (2, 0, 0)
ROR (PDO, I(I), F(K)	10 (4, 6(11), 0)	0
Angle (PDO, I(I), F(K)	5 (3, 2(3), 0)	0
Severity		
Above		
Exposure		
Average Daily Approach Volumes	5480	5950
MV (Million Vehicles)	6	6.5
Rates		
Total (PDO, I, F)/MV	4.0 (2.2, 1.8, 0)	.31 (.31, 0, 0)
ROR (PDO, I, F)/MV	1.7 (.67, 1.0, 0)	0
Angle (PDO, I, F)/MV	.83 (.5, .33, 0)	0



POISSON CURVE FOR 95% LEVEL

c. 1.33 run-off-roadway PDO accidents reduced
3.67 ROR injuries reduced
1.0 angle PDO accidents reduced
1.0 angle injuries reduced

Use 1977 National Safety Council figures:
$5500 for an injury
$800 for PDO

The estimated service life for this project is 20 years with zero salvage value. Interest rate selected: 9 percent.

Equivalent Uniform Annual Cost and Benefit

$$EUAC = (I)CR^{i}_{n} + K - (T)SF^{i}_{n}$$
$$(K=0,\ T=0)$$

$$EUAC = \$78,000\ (.1096) = \$8,580$$

Since the study period is relatively short, an average value was used for each injury and property damage accident reduced rather than determining the equivalent uniform annual benefit of the present worth of the sum of individual yearly benefits.

EUAB = 5.7 x 5500 = $31,400
3.67 x 800 = $ 2,900
$34,300

$$\frac{\$34,300}{\$\ 8,580} = 4.0 = B/C$$

For simplicity, an interest rate of zero is often used in this analysis. The supporting logic for this is that safety funds must be spent each year and not invested and that inflated injury costs outpace increases in construction costs or interest rates.

A method commonly used in ranking candidates for the Safety (Ms) Program has been a simple time of return (TOR) of investment method. In this case the TOR is:

$$\frac{\$78,000}{\$34,300} = 2.3 \text{ years}$$


STUDY LOCATION
BARRY
LINE
R.10 W.
R.9 W.
85°-30'
85°-20'
TO HASTINGS
RICHLAND JUNCTION
RICHLAND
YORKVILLE
GULL LAKE
GULL LAKE
AUGUSTA
HOWLANDSBURG
R I C H L A N D
R O S
C H A R L E
C O M S T O C K
GALESBURG
COMSTOCK
RECREATION PARK
MORROW POND
WADDLE FARM AIRPORT
FORT CUST RESERVATI
LONG L.
DUCK L.
MILLER L.
GRASSY L.
WINTERGREEN L.
STONY L.
GRAHAM L.
BUTTER FIELD L.
THREE LAKES
SHERMAN L.
GRASS L.
OATHMAN L.
CAMPBELL L.
SCHOONOVER L.
LYONS L.
PORTAGE L.
BLUE L.
BURNHA L.
KALAMAZOO RIVER
PENN CENTRAL
Brook Co.
Augusta Cr.
Gull Lake Outlet
Comstock
Gull Cr.
SPRINKLE ST.
E MICHIGAN
CELERY ST.
RIVER
TRANS.
AUGUSTA DR.
MILLER
DE AVE.
EF
FG AVE.

MIDAS Comparisons
M-43 (AB Avenue) at 32nd Street

The following two pages are portions of the MIDAS printouts before and after the improvement. In this case the "before" data for our study location is really applicable for only nine months due to construction late in 1975, but the illustration is clear. During that 9-month period, this intersection experienced three injury accidents (printout is in order of control section rather than number of accidents) and is listed as an outlier.

The histogram graphically displays the distribution of locations with the headed cell parameters. (Note that this analysis is limited to locations that had at least one accident.)

There were 592 locations that had one accident, 158 that had two, 38 that had three, etc. Any location that experienced three or more total accidents is considered suspect. While the accident type being studied here is total injury accidents, it may be any other combination of type and severity; that is, run off road - property damage only, angle - injury, etc.

On the facing page is the "after" printout with similar characteristics. Note that the average 24-hour trunkline volume increased 6 percent and that average accident experience increased 2 percent. The study location had zero accidents and did not appear in the listing.

When dealing with such low numbers of accidents, the yearly accident experience is quite erratic. Note that very few of the locations appear on both lists even though no changes were made. To analyze such locations several years of data are combined to get meaningful results.

Thus the fact that M-43 and AB Avenue did not appear on the after histogram is less important then the fact that the control group as a whole did not change appreciably, the average remaining near 1.4 accidents per location. (We have shown the reduction at the study location to be significant using the Poisson Test.)

Closer examination of the data beneath the two histograms shows that the number of locations is different, being 818 before and 877 after. MIDAS formerly would only assign Average Daily Traffic to a site if it experienced one accident. Thus we are limited to only those locations that, in fact, did experience at least one accident.

As indicated earlier, our use of MIDAS for control group comparisons in this report is qualitative. If the experimental plan chosen had been before and after with control sites, expected accident experience would have been used to determine reductions and these values used in the economic analysis.

STATEWIDE,RURAL,INTER,NON-SIG. ,ADT 3000-15000,1975INJ

TOTAL ACCIDENTS BEFORE

NUMBER OF LOCATIONS

```
          1         2         3         4         5         6
ACC*123456789012345678901234567890123456789012345678901234567890123
  0*
  1*XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX  592
  2*XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX  158
  3*000000000000000000000000000000000000000
  4*00000000000000000000
  5*000000
  6*000
  7*00
```

ACCIDENT TYPE = 1
LOCATIONS = 818
AVE 24HR VOLUME= 6688
AVE ACCIDENTS = 1.418
UPPER LIMIT = 2.990

HIGH HAZZARD LOCATIONS-= 68

Study site appears

CSECT	MP	ACC	ROUTE	XROAD/MIDBLOCK	LOCAL GOV'T COUNTY
6072	9.52	3	US-23	AT JCT.M-65	OMER CITY ARENAC CO
11071	7.55	3	M-140	AT NAPIER AVENUE	BAINBRIDGE TBERRIEN
13011	1.57	4	M-37	AT BOWNE ROAD	BEDFORD TWP CALHOUN
13031	13.60	3	M-66	AT 8 DR N	BATTLE CREEKCALHOUN C
14031	9.22	3	M-62	AT BRICK CHURCH ROAD	JEFFERSON TPCASS CO
14042	0.00	3	US-12	AT M-205,5 PT HWY	MASON TWP CASS CO
15091	11.19	4	US 131	AT M75/WALLON JCT	MELROSE TWP CHARLEVOI
18011	12.56	4	M 115	AT HARDING RD S	SURREY TWP CLARE
18022	4.08	3	US10BR	RURAL MIDBLOCK IN	CLARE CITY CLARE
18041	14.70	4	M61/US27BR	AT SECOND ST	HARRISON CTYCLARE
19021	0.82	3	I-968L	AT FRANCIS RD	WATERTOWN TPCLINTON C
22031	1.21	3	US-141	AT JCT US2,US-141	QUINNESEC VIDICKINS
24011	4.90	3	US 31/M 68	AT PARKVIEW DR	RESORT TWP EMMET
25092	2.00	5	M-15	AT RICHFIELD ROAD	RICHFIELD T GENESEE C
25092	8.00	4	M-15	AT DODGE ROAD	FOREST TWP, GENESEE
28011	2.45	3	US 31	AT JCT M137	GREEN LK TWPGR TRAV
28012	0.99	3	US31/M37	AT RENNIE SCHOOL RD	BLAIR TWP GR TRAVER
28051	9.91	3	M 37	AT TOWNHALL RD	BLAIR TWP GR TRAVER
34011	13.66	4	M-91	AT STOREY RD	BELDING CITYIONIA C
39082	4.61	4	M43-M89	AT G AVENUE	COMSTOCK TWPKALAMAZ
39082	4.67	3	M43-M89	AT 27TH STREET	COMSTOCK TWPKALAMAZOO
39082	10.94	3	M43-M89	AT 32ND AVE-AB AVENUE	COMSTOCK TWPKALAMAZ
41031	5.28	5	M-37	AT 68TH ST	CALEDONIA TWKENT CO
41031	7.55	4	M-37	AT 52ND ST	PARIS TWP KENT CO
41031	8.72	6	M-37	AT 44TH ST	PARIS TWP KENT CO
41033	10.50	3	M-37	AT 13 MILE RD	SPARTA TWP KENT CO
41051	6.02	3	M-44	AT KNAPP ST	GRAND RAPIDSKENT CO
41101	0.00	4	M-44	AT US-131	PLAINFIELD TKENT CO
44031	4.33	3	M-53	AT DRYDEN ROAD	ALMONT TWP, LAPEER

STATEWIDE,2L2W,RURAL,INTER,NON-SIG, ,ADT 3-15000,1977INJ

TOTAL ACCIDENTS AFTER

NUMBER OF LOCATIONS

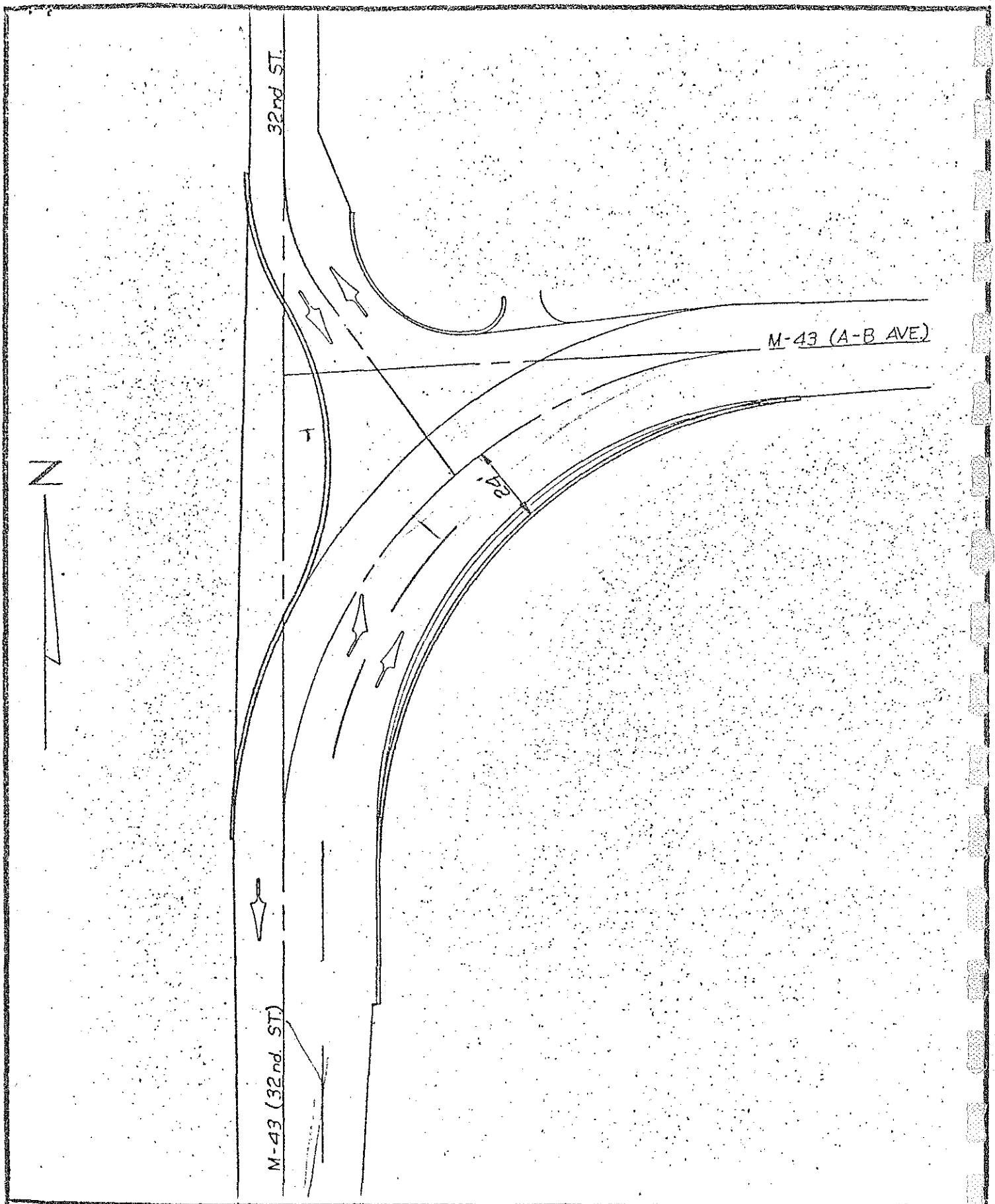
```
          1         2         3         4         5         6
ACC*12345678901234567890123456789012345678901234567890123456789012345678901234
  0*
  1*XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX  638
  2*XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX  147
  3*000000000000000000000000000000000000000000000000000000000000000000000000
  4*00000000000000000000
  5*00000000
  6*000
  7*0
  8*00
```

Study site does not appear

ACCIDENT TYPE = 1
LOCATIONS = 877
AVE 24HR VOLUME= 7118
AVE ACCIDENTS = 1.447
UPPER LIMIT = 2.990

HIGH HAZZARD LOCATIONS-= 92

CSECT	MP	ACC	ROUTE	XROAD/MIDBLOCK	LOCAL GOV'T COUNTY
3021	0.40	4	M-89	RURAL MIDBLOCK IN	SAUGATUCK TPALLEGAN C
8011	1.02	4	M-38	RURAL MIDBLOCK IN	BARAGA VILL,BARAGA
11071	13.00	3	M-140	AT DAN SMITH ROAD	WATERVLIET TBERRIEN C
13031	11.52	3	M-66	AT B DR S	LEROY TWP CALHOUN C
14031	1.49	3	M-62	AT MAY STREET	ONTWA TWP CASS COUN
14042	0.00	3	US-12	AT M-205,S PT HWY	MASON TWP CASS COUN
14061	1.52	5	M60,M62,M60	AT HUNTLEY STREET	HOWARD TWP CASS COUN
14101	1.78	3	M-152	AT TOWNHALL ROAD S	SILVER CREEKCASS COUN
19061	9.00	3	M-21	AT FRANCIS RD	BENGAL TWP CLINTON
21021	6.36	3	US-2,US-41	AT CR 521 S,,CR 533 N	HYDE VILLAGEDELTA COU
24011	10.30	3	US 31/M 68	AT PICKEREL LAKE RD	BEAR CRK TWPEMMET
24031	3.77	3	US 131	AT INTERTOWN RD	BEAR CREEK TEMMET
25091	9.60	3	M-15	AT LIPPINCOTT RD,	DAVISON TWP,GENESEE C
25101	5.90	3	M-57	AT ELMS ROAD	VIENNA TWP, GENESEE C
25101	8.97	3	M-57	AT JENNINGS ROAD	VIENNA TWP, GENESEE C
25102	1.76	4	M-57	AT LEWIS ROAD	THETFORD TWPGENESEE C
25102	2.77	4	M-57	AT BRAY ROAD	THETFORD TWPGENESEE C
28011	6.18	4	US 31	AT STATE ST	BLAIR TWP GR TRAVER
28012	4.61	3	US31/M37	AT FRANKE RD	GARFIELD TWPGR TRAVER
28013	7.02	3	US31/M72/M37	AT 5 MILE RD	ACME TWP GR TRAVER
29021	6.43	4	M-57	AT ELY HWY	EVILLE TWP GRATIOT
29041	0.97	3	M-46	AT FERRIS RD	NEVILLE TWP GRATIOT
37022	3.95	3	M-20	AT SHEPARD RD	CHIPPEWA TWPISABELLA
38061	12.34	3	M-60	AT FAIRWAY DR,	SPRNG ARBR TJACKSON C
38071	4.94	3	M-50,US127BR	AT MILES DR,	NAPOLEON TWPJACKSON C
38073	12.20	3	M-50	AT RIVES JCT RD,	BLACKMAN TWPJACKSON C
39042	7.81	3	BL94,M96,M43	AT 33RD STREET	COMSTOCK TWPKLMZOO CO
40011	11.12	3	U131/M72/M66	AT S JCT M72/M66	KALKASKA TWPKALKASKA
[illegible]			[illegible]	[illegible]	CALEDONIA TWKENT CO



STATE OF MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC & SAFETY DIVISION	AUTH. NO.	DRAWN	M-43 (32nd ST.) @ M-43 (A-B AVE.)
	CONT. SEC.	DATE	
	REF.	SCALE	
	SHEET OF	PLAN 50682 - 15	SICHLAND TWP. KALAMAZOO CO.

M-43 at AB Avenue

Sight Restriction
BEFORE

Clear Vision
AFTER

STATE OF MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

Form 1763
(Formerly 1533-A)
Previous editions may be used until 10/72

BEFORE
VEHICLE VOLUME COUNT
GRAPHIC SUMMARY SHEET

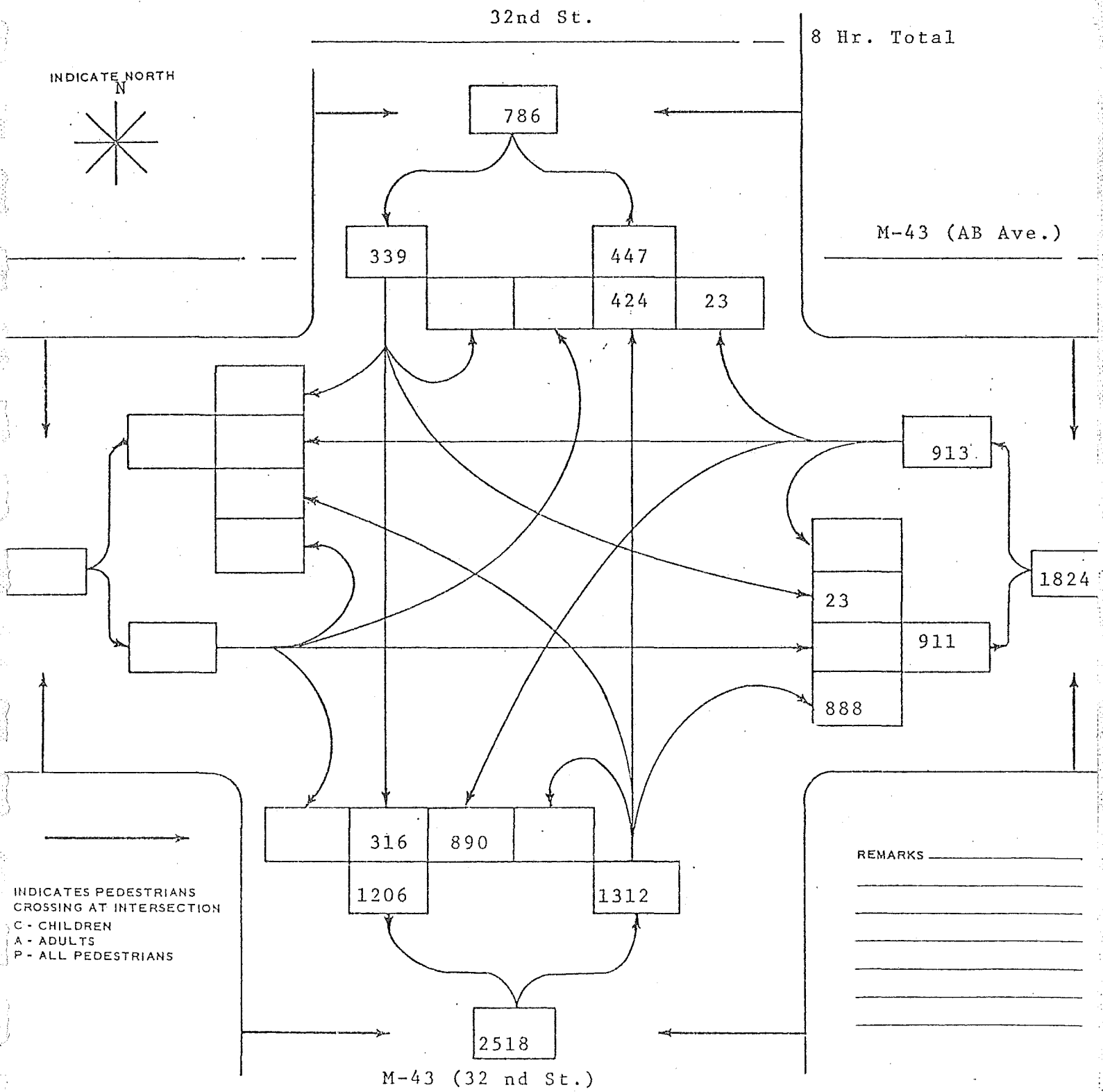
Study # 272

DATE 8-17/18-72 DAY Thur-Fri COUNTY Kalamazoo TIME

TWP., VILLAGE OR CITY Richland WEATHER Hot

INTERSECTION OF M-43(32nd St.)at M-43(AB Ave.)

2P	TO 6P
7A	TO 9A
11A	TO 1P



INDICATES PEDESTRIANS CROSSING AT INTERSECTION
C - CHILDREN
A - ADULTS
P - ALL PEDESTRIANS

REMARKS

1763 (7/75)

VEHICLE VOLUME COUNT

GRAPHIC SUMMARY SHEET

Study #038

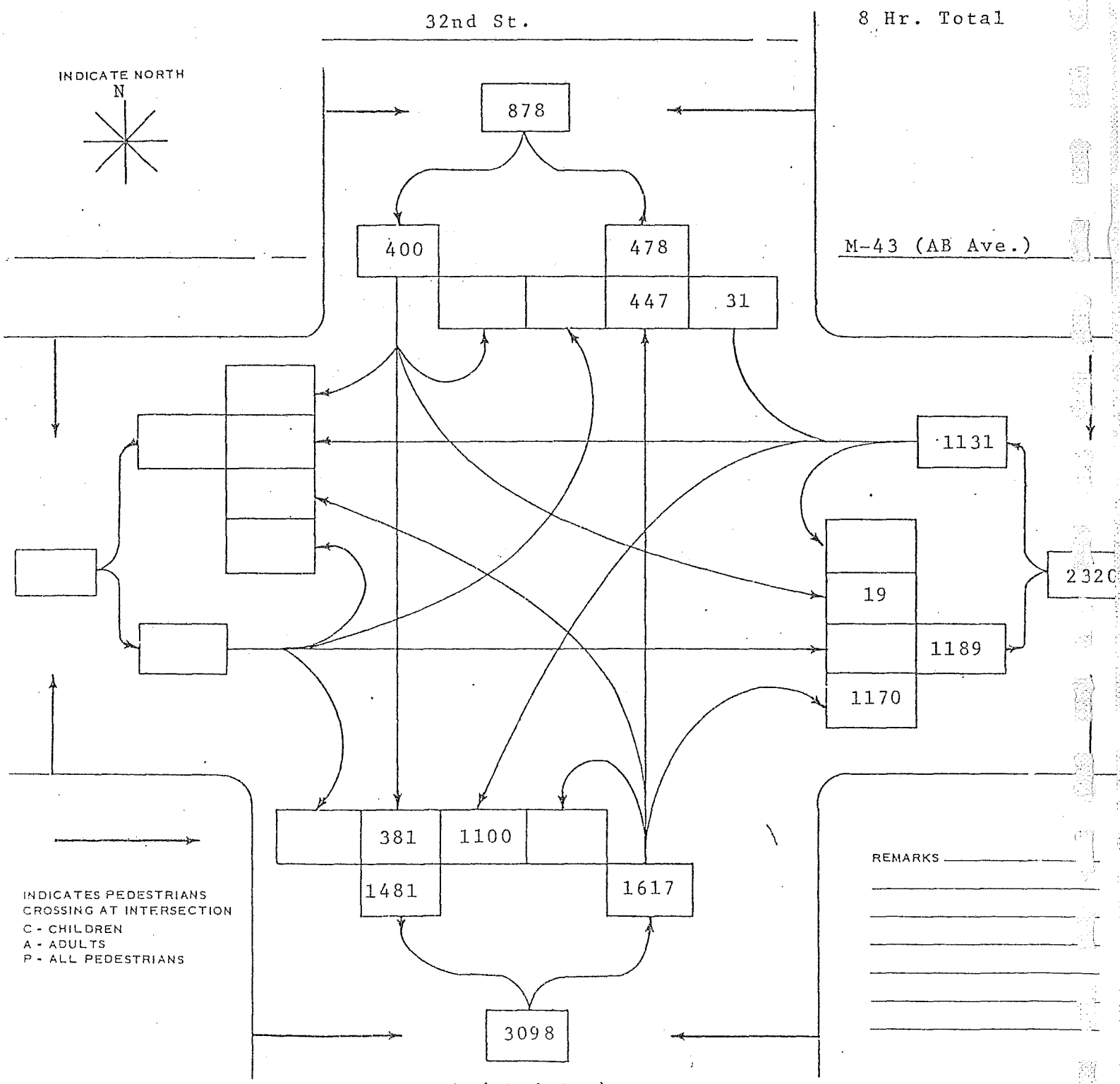
AFTER

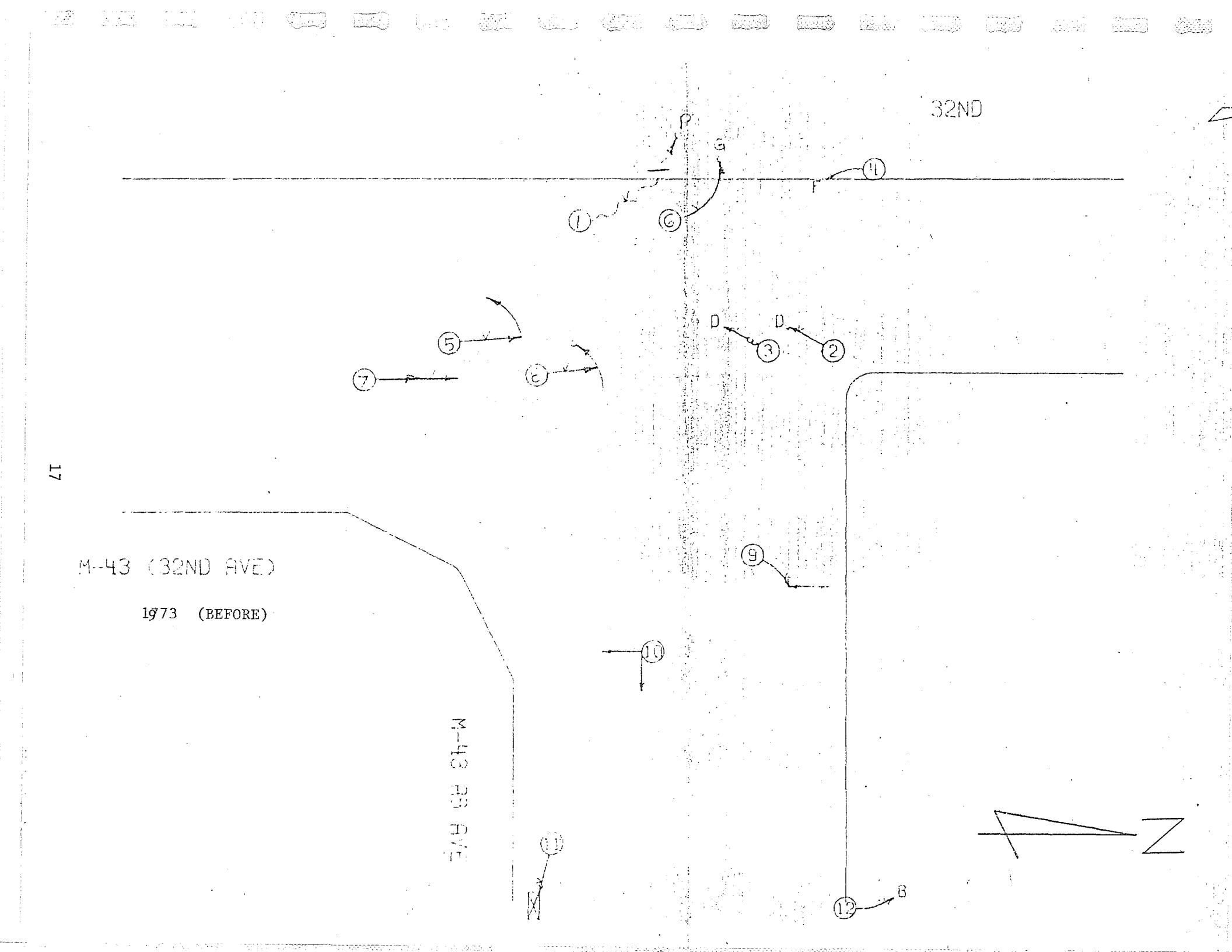
DATE 6/13-14/78 DAY Tues/Wed. COUNTY Kalamazoo

TWP., VILLAGE OR CITY Richland WEATHER Clear

INTERSECTION OF M-43(32nd St.) @ M-43(AB Ave.)

TIME			
2P	TO	6P	
7A	TO	9A	
11A	TO	1P	




32ND
M-43 (32ND AVE)
1973 (BEFORE)
M-43 (32ND AVE)
P
G
F
D
D
B
1
2
3
4
5
6
7
8
9
10
11
12
N

PERIOD 1973 MICHIGAN DEPARTMENT OF STATE HIGHWAYS PAGE 1 OF 1

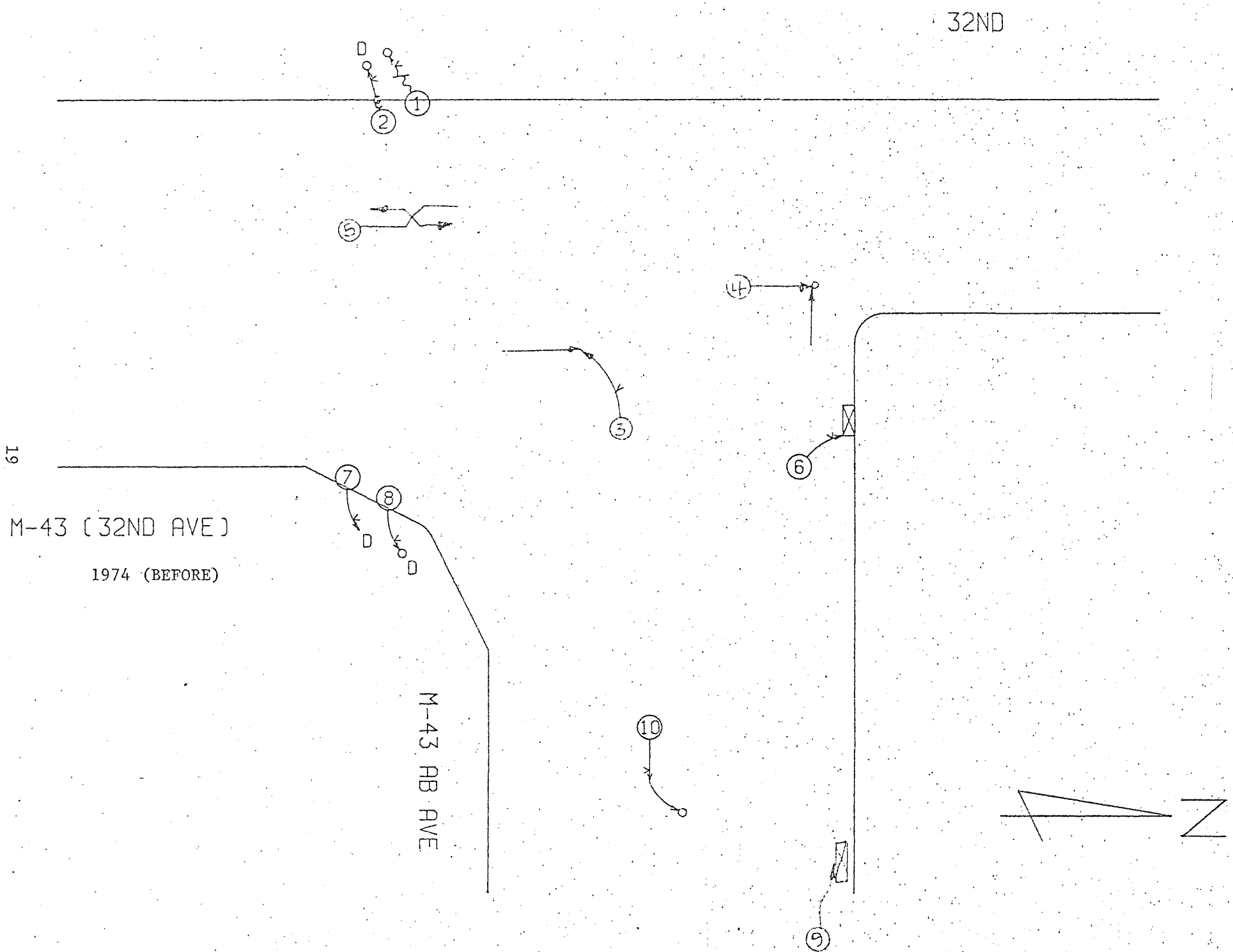
PLAN NO. 50378 SUPPLEMENT TO COLLISION DIAGRAM DATE 12NOV74

CONTROL SECTION 39082 MP 10.890 - 11.040

ACC. NO.	CONT. SEC.	MILE. PT.	ACCID. RPT.NO.	DATE	DAY	TIME	SEVERITY K	SEVERITY I	SEVERITY PD	LIGHT COND.	PAVMT. COND.	HAZ. ACT.	TOT. VEH.	OBJ. HIT
1	39082	10.940	186253	8-23-73	THU	11AM-NOON	0	1	X	DAY	WET	FAST	1	P
2	39082	10.940	173273	8- 2-73	THU	10PM-11PM	0	1	X	DNL	DRY	FAST	1	D
3	39082	10.940	247048	11-16-73	FRI	08PM-09PM	0	0	X	DNL	WET	FAST	1	D
4	39082	10.940	172364	7-29-73	SUN	11AM-NOON	0	0	X	DAY	DRY	OTHER	1	F
5	39082	10.940	192561	9- 4-73	TUE	06AM-07AM	0	0	X	DUS	WET	N-YLD	2	
6	39082	10.940	186254	8-30-73	THU	02AM-03AM	0	1	X	DNL	DRY	FAST	1	G
7	39082	10.940	102617	5- 8-73	TUE	10PM-11PM	0	0	X	DNL	WET	L-CTR	2	
8	39082	10.940	228423	10-30-73	TUE	08PM-09PM	0	1	X	DNL	DRY	N-YLD	2	
9	39082	10.950	172363	7-28-73	SAT	03PM-04PM	0	0	X	DAY	WET	FAST	2	
10	39082	10.950	116769	6- 7-73	THU	11PM-MDNT	0	0	X	DNL	DRY	NONE	2	
11	39082	11.040	131715	6- 8-73	FRI	02PM-03PM	0	0	X	DAY	DRY	CLOSE	1	2
12	39082	10.990	211202	10- 4-73	THU	01AM-02AM	0	0	X	DNL	DRY	FAST	1	B

SUMMARY

SEVERITY -	TOTAL	12	FTL.	0(0)	INJ.	4(4)	PD.	8				
PVMT.COND. -	DRY	7	WET	5	ICE	0	UNKN.	0				
LIGHT COND. -	DAY	4	DUSKY	1	DK-SL	0	DK-NL	7	UNKN.	0		


32ND
D
1
2
5
4
3
6
19
7
8
M-43 (32ND AVE)
D
D
1974 (BEFORE)
M-43 AB AVE
10
9

PERIOD 1974 MICHIGAN DEPARTMENT OF STATE HIGHWAYS PAGE 1 OF 1

PLAN NO. 0 SUPPLEMENT TO COLLISION DIAGRAM DATE 1FEB76

CONTROL SECTION 39082 MP 10.890 - 11.110

ACC. NO.	CONT. SEC.	MILE. PT.	ACCID. RPT.NO.	DATE	DAY	TIME	SEVERITY K	SEVERITY I	SEVERITY PD	LIGHT COND.	PAVMT. COND.	HAZ. ACT.	TOT. VEH.	OBJ. HIT
1	39082	10.930	171419	9- 3-74	TUE	03PM-04PM	0	0	X	DAY	DRY	FAST	1	
2	39082	10.910	177110	9-13-74	FRI	02PM-03PM	0	1	X	DAY	DRY	FAST	1	D
3	39082	10.940	270826	12- 9-74	MON	05PM-06PM	0	0	X	DUS	ICE	N-YLD	2	
4	39082	10.940	218229	11-19-74	TUE	06AM-07AM	0	2	X	DNL	WET	N-YLD	3	
5	39082	10.940	126109	7- 6-74	SAT	10PM-11PM	0	1	X	DNL	DRY	NONE	2	
6	39082	10.950	102010	5-19-74	SUN	10PM-11PM	0	0	X	DNL	DRY	FAST	1	2
7	39082	10.950	218233	11- 9-74	SAT	02AM-03AM	0	0	X	DNL	WET	FAST	1	D
8	39082	10.950	133968	6-24-74	MON	02PM-03PM	0	3	X	DAY	DRY	FAST	1	D
9	39082	10.980	24548	1-17-74	THU	11PM-MDNT	0	0	X	DNL	ICE	FAST	1	2
10	39082	11.040	183348	9-15-74	SUN	09PM-10PM	0	1	X	DNL	DRY	CLOSE	2	

SUMMARY

SEVERITY -	TOTAL	10	FTL.	0(0)	INJ.	6(12)	PD.	4				
PVMT.COND. -	DRY	6	WET	2	ICE	2	UNKN.	0				
LIGHT COND. -	DAY	3	DUSKY	1	DK-STL	0	DK-NL	6	UNKN.	0		

PART B

BL-94 (Michigan) at Lovell

Curbed Median Divider
BEFORE

Curbed Median Divider
AFTER

Part B

Introduction

A section of BL-94 (Michigan) from just east of BL-94 (Stadium) to east of Main Street, city of Kalamazoo, Kalamazoo County, was resurfaced with a skid resistant overlay. The total project cost of $76,000 included geometric revisions to effect turning throat widening (see map and sketch, pages 33 and 34).

The project was completed in two steps, with the geometric changes being done during August of 1976 and the skid resistant overlay applied in 1977 (with construction dates from 6/23/77 to 8/28/77). Thus there will be some inherent overlap of study periods. Measurements of Effectiveness were selected to minimize interference and the two improvements will be treated separately. This allows for a 3-year before and after evaluation of the geometric changes but only 2½ years after for the surface treatment.

The project site is located near Western Michigan University in the city of Kalamazoo, population 85,000. The trunkline carried 27,000 cars a day according to 1975 data. There are four intersecting major city streets within the study area as well as another major trunkline. This study will compare before-and-after wet surface accident experience in the entire section as well as left-turn related accident experience at Lovell Street where a dual left-turn movement was needed from a capacity standpoint. Only two lanes were available on the trunkline to turn into and this resulted in several sideswipe accidents. In addition, Lovell Street (one-way) continues on to the north through this intersection and many accidents involved vehicles going through to the north in the left lane colliding with left-turn vehicles from the right curb lane. Overhead lane assignment signing denoting through movement from right curb lane only was not effective.

The improvement resulted in cutting back a median divider and widening the trunkline slightly to open the throat for this turn as well as narrowing the opposing street opening to allow through movements from the curb lane only (sketch page 34).

The estimated benefit of $55,000/year was derived by assuming that the percentage of wet to total accidents would be reduced to the district average for each year if the skid coefficients were increased to acceptable levels. Standard ASTM skid tests showed values averaging 0.30 at 40 miles per hour before resurfacing and values averaging 0.43 after. Also included in this estimate is assumed elimination of all left-turn accidents at Lovell Street.

Year	Total Accs.	Wet Accs.	% Wet Surface Accs.	Dist. Average % Wet
1976	181	81	45	20
1975	122	61	50	21
1974	102	40	40	25
Total	405	182		

Dual Left-Turn Accidents at Lovell Street

Year	No. of Accs.
1976 (Construction)	7
1975	17
1974	10
Total	34

The actual benefit in accident savings was computed to be $110,000/year based on the elimination of 49 accidents with 13 injuries. Left-turn accidents were reduced 80 percent and wet surface accidents decreased 62 percent.

Study Parameters

Purposes of project:

1. Reduce total accident experience by reducing wet surface accident experience.

2. Reduce left-turn accidents at Lovell Street.

3. Reduce injuries associated with above accidents.

Objectives:

1. Determine the effect of the project on total accident experience.

2. Determine the effect of the project on wet surface accident experience.

3. Determine the effect of the project on left-turn accident experience at Lovell Street.

4. Determine the effect of the project on injuries associated with above accidents.

Measures of Effectiveness:

1. Percent change in total accidents by severity, number, and rate.

2. Percent change in wet surface accident experience.

3. Percent change in left-turn accident experience at Lovell Street.

4. Percent change in associated injuries.

The experimental plan will be a modified before-and-after.

Data Requirements:

Total accidents (by type and severity)
Wet surface accidents (by type and severity)
Left-turn accidents at Lovell (by severity)
Manual turning volume counts at Lovell
Project cost

Construction period
Before-and-after wet surface friction skid tests
Rainfall Data

Parametric Comparison

Determination of exposure factors for the intersection of Lovell at BL-94 Michigan-Stadium:

1975 Survey 4/1-2/75
1978 Survey 12/11-12/78

1975 8-hour manual volumes	1975 machine 24-hour approach volumes
3902	10,109 (High)
5588	11,214
4417	8,318
13,907 x 2 = 27,814	29,641

1978 8-hour manual volumes	1978 machine 24-hour approach volumes
5121	9,142 (Low)
6735	14,424
4839	8,264
16,695 x 2 = 33,390	31,830

(As a rule of thumb, a good estimate of the 24-hour volume is twice the standard [7 a.m.-9 a.m., 11 a.m.-1 p.m., 2 p.m.-6 p.m.] 8-hour count.)

Based on the above, use 28,000 for 1975
use 33,000 for 1978

1974 = 26,300 1976 = 29,700 1977 = 31,400 1979 = 34,800
Assuming linear relationship

Midpoint of before volume = 27,150 After = 32,200

The dual left-turn increased 10 percent from 2974 to 3263 in eight hours.

The summary table for "before and after" accident and exposure data, Table B1, shows intersection accident rates as well as number of accidents by type, for the 3-year before and 3-year after periods.

Reductions in total, left-turn, and left-turn injury accidents are significant at the 95 percent level using the Poisson curve. This represents a significant change in all applicable measures of effectiveness.

Economic Analysis

Initial cost of project in 1976 = $19,000
(geometric changes only)

Table B-1: Data Summary Table For The Before and After Study

Data Variables	3 Years Before	3 Years After
Accidents		
Total Accidents	138	88
Left-Turn Accidents	42	8
Severity		
Fatal Accidents	0	0
Personal Injury Accidents	27(31)	19(27)
Left-Turn Injury Accidents	5(7)	1(1)
Exposure		
Average Daily Traffic	27,150	32,200
Million Vehicles	29.6	35.2
Rates		
Total Accidents/MV	4.66	2.50
Left-Turn Accidents/MV	1.42	.23
Fatals/MV	0	0
Personal Injury Accidents/MV	.91	.52
Left-Turn Personal Injury Accidents/MV	.17	.03

Assume changes in maintenance costs are minimal.

Annual average benefits:

1. No fatalities reduced

2. Yearly average of 6/2 = 3 left-turn injuries reduced

   Yearly average of 30/3 = 10 left-turn PDO accidents reduced

1978 National Safety Council figures:

$5,800 for an injury
$850 for property damage only

The estimated service life for this project is 20 years with zero salvage value. Interest rate selected: 9 percent.

Equivalent Uniform Annual Cost and Benefit

$$EUAC = (I)CR_n^i + K - (T)\ SF_n^i$$
$$(K = 0,\ T = 0)$$

$$EUAC = 19{,}000\ (.1096) = \$2{,}082$$

$$EUAB = 3.0 \times 5800 = \$17{,}400$$
$$10 \times 850 = \underline{\ 8{,}500}$$
$$\$25{,}900$$

Since the study period is relatively short an average value was used for each injury and property damage accident reduced rather than annualizing the present worth of the sum of individual yearly benefits.

The benefit/cost ratio is:

$$\frac{\$25{,}900}{\$\ 2{,}082} = 12.44$$

The effect of the skidproofing portion of the project has been neglected in this analyses. The entire skidproofing project will now be analyzed separately.

Parametric Comparison

Summary Table B-2 shows the accident and exposure data with the resulting rates for three years before and 2½ years after data. Note that only mainline volumes are used and that the section length was 0.6 miles and section rates are given.

Reductions in the following accident types were significant at the 95 percent confidence level using the Poisson curve. Since volumes increased only slightly, numbers rather than rates are used in this analysis.

Table B-2: Data Summary Table For The Before and After Study

Section length = 0.6 mile

Data Variables	3 Years Before	2½ Years After
Accidents		
Total Accidents	419	241
Rear-End Accidents	186	88
Wet Surface Accidents	179	58
Severity		
Fatals	0	0
Personal Injury Accidents	62(81)	47(65)
Wet Surface Personal Injury Accidents	29(41)	6(9)
Exposure		
Average Daily Traffic	27,000	27,000
Million Vehicle Miles	17.7	14.8
Rates		
Total Accidents/MVM	23.7	16.3
Rear-End Accidents/MVM	10.5	6.0
Wet Surface Accidents/MVM	10.1	3.9
Personal Injury Accidents/MVM	3.5	3.2
Wet Surface Personal Injury Accidents/MVM	1.64	.41

*Weather station records indicate little change in rainfall

Average Total Accidents/Year	$\frac{140-96}{140} = 31\%$
Average Rear-End Accidents/Year	$\frac{62-35}{62} = 44\%$
Average Wet Surface Accidents/Year	$\frac{60-23}{60} = 62\%$
Average Wet Surface Personal Injury Accidents/Year	$\frac{9.7-2.4}{9.7} = 75\%$

Economic Analysis

Initial cost of project in 1977, $57,000

Annual average benefits:

1. No fatalities reduced

2. Ten wet surface personal injuries reduced

3. Thirty wet surface property damage only accidents reduced

1978 National Safety Council Figures:

$5,800 for an injury
$ 850 for PDO

The estimated service life for the surface is 15 years with zero salvage value. Interest rate selected: 9 percent.

Equivalent Uniform Annual Cost and Benefit

$EUAC = (I)CR^{i}_{n}+K-(T)SF^{i}_{n}$ (K=0, T=0)

EUAC = $57,000(.1241)=$7,074

EUAB = 10 x $5800 = $58,000
30 x $ 850 = $25,500
$83,500

The benefit cost ratio is:

$$\frac{\$83,500}{\$\ 7,074} = 11.8$$

The investment again was fully returned through accident savings within the first year after improvement.

MIDAS Comparison

BL-94 at Lovell Street

Looking at the histograms on the next two pages note that, compared to its peers (4-lane two-way signalized locations with trunkline ADT of 25 to 36 thousand vehicles), the intersection of BL-94 (Michigan) and Lovell Street had the highest left-turn property damage accident experience with 17. This is far above the average of 2.5 and also above the upper limit of 4.1.

There was little change in the average daily traffic of the locations, and the change in the average number of left-turn accidents from 2.5 to 2.0 is largely attributed to the reduction at Lovell Street from 17 to 1. (A check of 1977 accident experience showed that there was only one left-turn accident at Lovell Street, a property damage only.)

STATEWIDE,4L2W,STRIP,SIGNAL,ADT 25-36000,1975PD

LEFT TURN

NUMBER OF LOCATIONS

```
                1         2         3         4         5         6
ACC*12345678901234567890123456789012345678901234567890123456789012345678901234
  0*XXXXXXXXXXXXXX
  1*XXXXXXXXXXXX
  2*XXXXXXX
  3*XXXX
  4*X
  5*00
  6*00
  7*
  8*0
  9*00
 10*
 11*
 12*0
 13*
 14*
 15*
 16*
 17*0
```

ACCIDENT TYPE = 4
LOCATIONS = 47
AVE 24HR VOLUME= 29762
AVE ACCIDENTS = 2.532
UPPER LIMIT = 4.123

HIGH HAZZARD LOCATIONS== 9

CSECT	MP	ACC	ROUTE	XROAD/MIDBLOCK	LOCAL GOV'T COUNTY
25072	6.01	9	M-54	AT DAVISON/M-21	FLINT CITY GENESEE C
28013	2.00	8	US31/M72/M37	AT E JCT M37/GARFIELD	TRAVERSE CTYGR TRAVER
33011	5.71	12	M-99	AT ST JOSEPH/US-27	LANSING INGHAM
39041	3.51	17	I94BL,US-131	AT LOVELL STREET	KLMZOO CITY KLMZOO CO
63053	3.33	6	US-10	AT WARREN STREET	WATERFORD T OAKLAND C
63131	1.24	9	M-150	AT WATTLES/17 MILE RD	PONTIAC CITYOAKLAND C
73062	4.65	6	M-46	AT JCTM-47,MIDLAND RD	SAGINAW TWP SAGINAW C
73062	7.01	5	M-46	AT WHEELER STREET	SAGINAW CITYSAGINAW C
77091	0.35	5	US-25 BR	AT 10TH/SCOTT AVES.	PT.HURON CY.STCLAIR C

STATEWIDE,4L2W,STRIP,SIGNAL,ADT 25-36000,1977PD

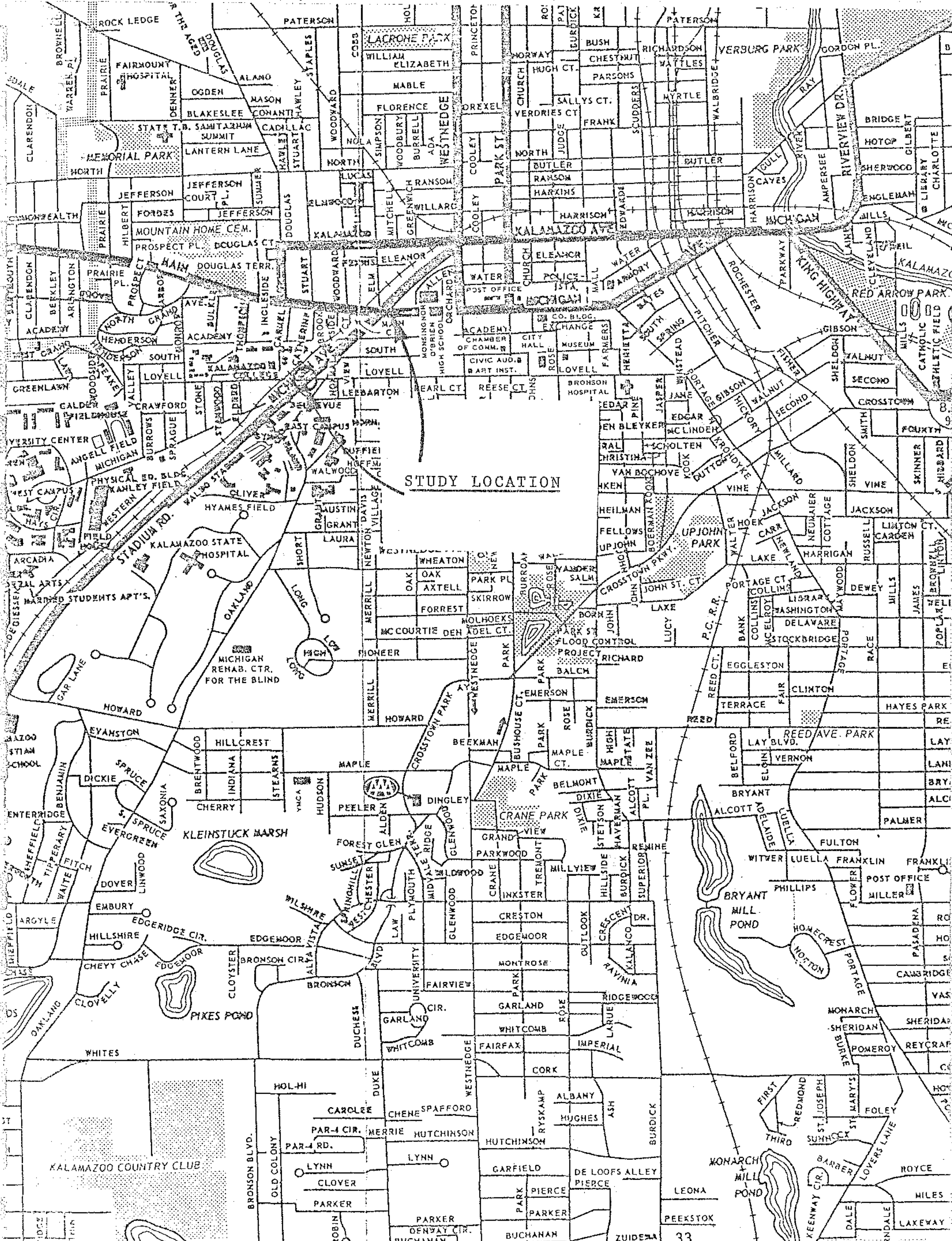
LEFT TURN

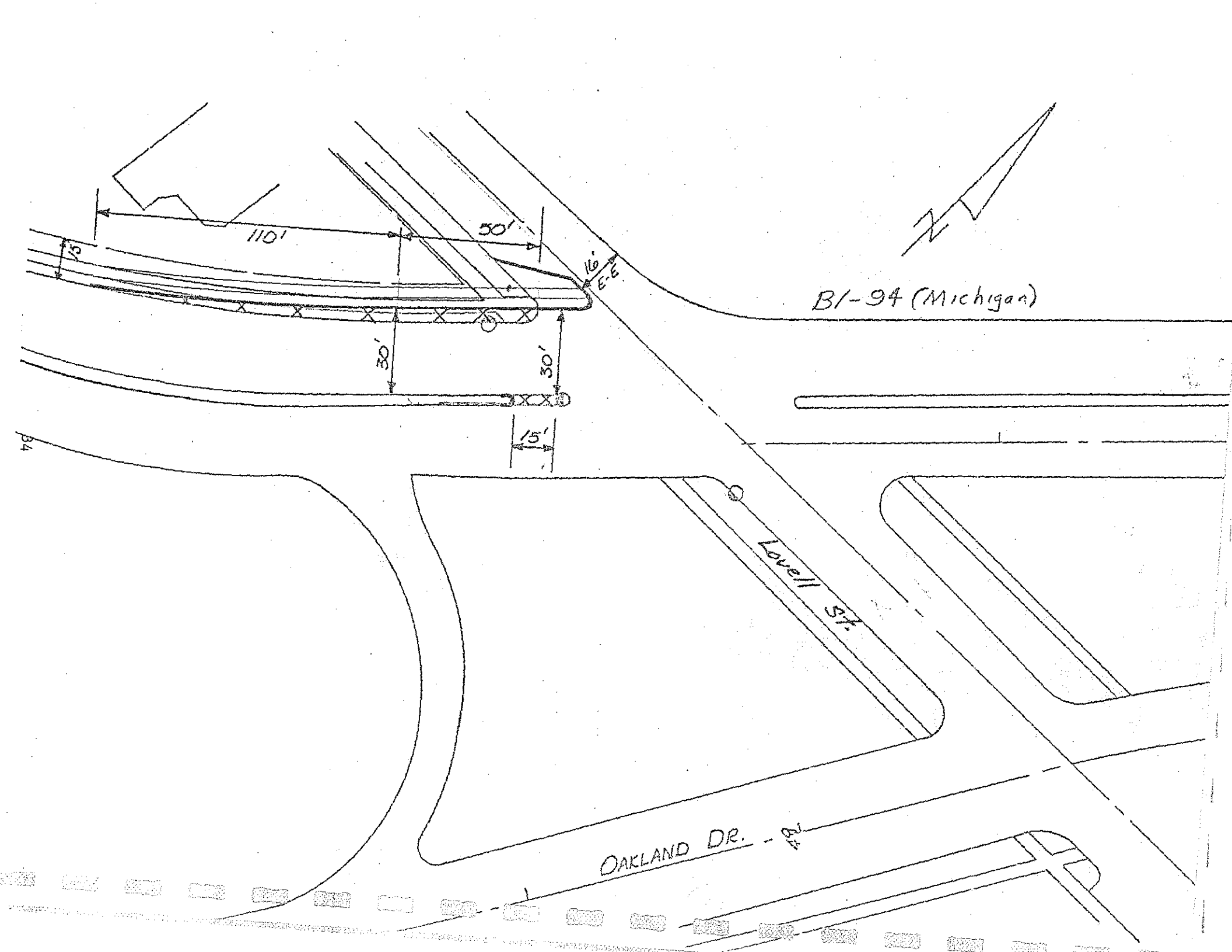
NUMBER OF LOCATIONS

```
                1         2         3         4         5         6
ACC*12345678901234567890123456789012345678901234567890123456789012345678901234
  0*XXXXXXXXXXXXXXXXXXXXXXXX
  1*XXXXXX
  2*XXXXXXX
  3*XXXX
  4*00
  5*
  6*0
  7*00
  8*00
  9*
 10*00
ACCIDENT TYPE   =  4
LOCATIONS       =     49
AVE 24HR VOLUME=  29459
AVE ACCIDENTS   =  1.959
UPPER LIMIT     =  3.359

HIGH HAZZARD LOCATIONS--    9
```

CSECT	MP	ACC	ROUTE	XROAD/MIDBLOCK	LOCAL GOV'T COUNTY
9032	2.44	7	M-13,I-75BL	AT JENNY STREET	MONITOR TWP BAY COUNT
28013	2.00	10	US31/M72/M37	AT E JCT M37/GARFIELD	TRAVERSE CTYGR TRAVER
33011	4.70	8	M-99	AT MT HOPE AVE	LANSING INGHAM
39082	0.23	10	M43-M89	AT RIVERVIEW AVENUE	KLMAZOO CITYKALAMAZOO
50021	0.98	4	M-59	AT CASS STREET	STLG.HTS. CYMACOMB CO
73062	4.65	8	M-46	AT JCTM-47,MIDLAND RD	SAGINAW TWP SAGINAW C
73062	7.44	4	M-46	AT ELM STREET	SAGINAW CITYSAGINAW C
81032	3.03	7	US-12,M-17	AT PROSPECT ST.	YPSILANTI CYWASHTENAW
81032	3.08	6	US-12,M-17	AT E. JCT. M-17,ECORS	YPSILANTI CYWASHTENAW


STUDY LOCATION
KALAMAZOO AVE.
MICHIGAN AVE.
STADIUM RD.
WESTNEDGE
PARK ST
CROSSTOWN PKWY.
PORTAGE
KING HIGHWAY
RIVERVIEW DR.
LACROHE PARK
VERBURG PARK
MEMORIAL PARK
MOUNTAIN HOME CEM.
FAIRMOUNT HOSPITAL
STATE T.B. SANITARIUM
KALAMAZOO STATE HOSPITAL
MICHIGAN REHAB. CTR. FOR THE BLIND
KALAMAZOO COLLEGE
EAST CAMPUS
WEST CAMPUS
ANGELL FIELD
WALDO STADIUM
HYAMES FIELD
KANLEY FIELD
PHYSICAL ED. BLDG.
UNIVERSITY CENTER
MARRIED STUDENTS APT'S.
POST OFFICE
CITY HALL
MUSEUM
CHAMBER OF COMM.
CIVIC AUD. & ART INST.
BRONSON HOSPITAL
CO. BLDG.
EXCHANGE
POLICE STA.
ARMORY
RED ARROW PARK
CATHOLIC ATHLETIC FIELD
UPJOHN PARK
FLOOD CONTROL PROJECT
REED AVE. PARK
CRANE PARK
KLEINSTUCK MARSH
PIXES POND
BRYANT MILL POND
MONARCH MILL POND
KALAMAZOO COUNTRY CLUB
P.C. R.R.
YMCA
HOWARD
MAPLE
WHITES
CORK
PARKER
BUCHANAN
OAKLAND
BRONSON BLVD.
EVANSTON
HILLCREST
CHERRY
DINGLEY
EDGEMOOR
FAIRVIEW
GARLAND
WHITCOMB
CRESTON
MONTROSE
BURDICK
ALCOTT
BRYANT
FULTON
FRANKLIN
PHILLIPS
MILLER
LOVELL
SOUTH
ACADEMY
JEFFERSON
NORTH
BUTLER
RANSOM
HARRISON
PATERSON


110'
50'
15'
16'
E-E
30'
30'
15'
BI-94 (Michigan)
Lovell St.
OAKLAND DR.
94

STATE OF MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

Form 1763
(Formerly 1533-A)

VEHICLE VOLUME COUNT
GRAPHIC SUMMARY SHEET
BEFORE

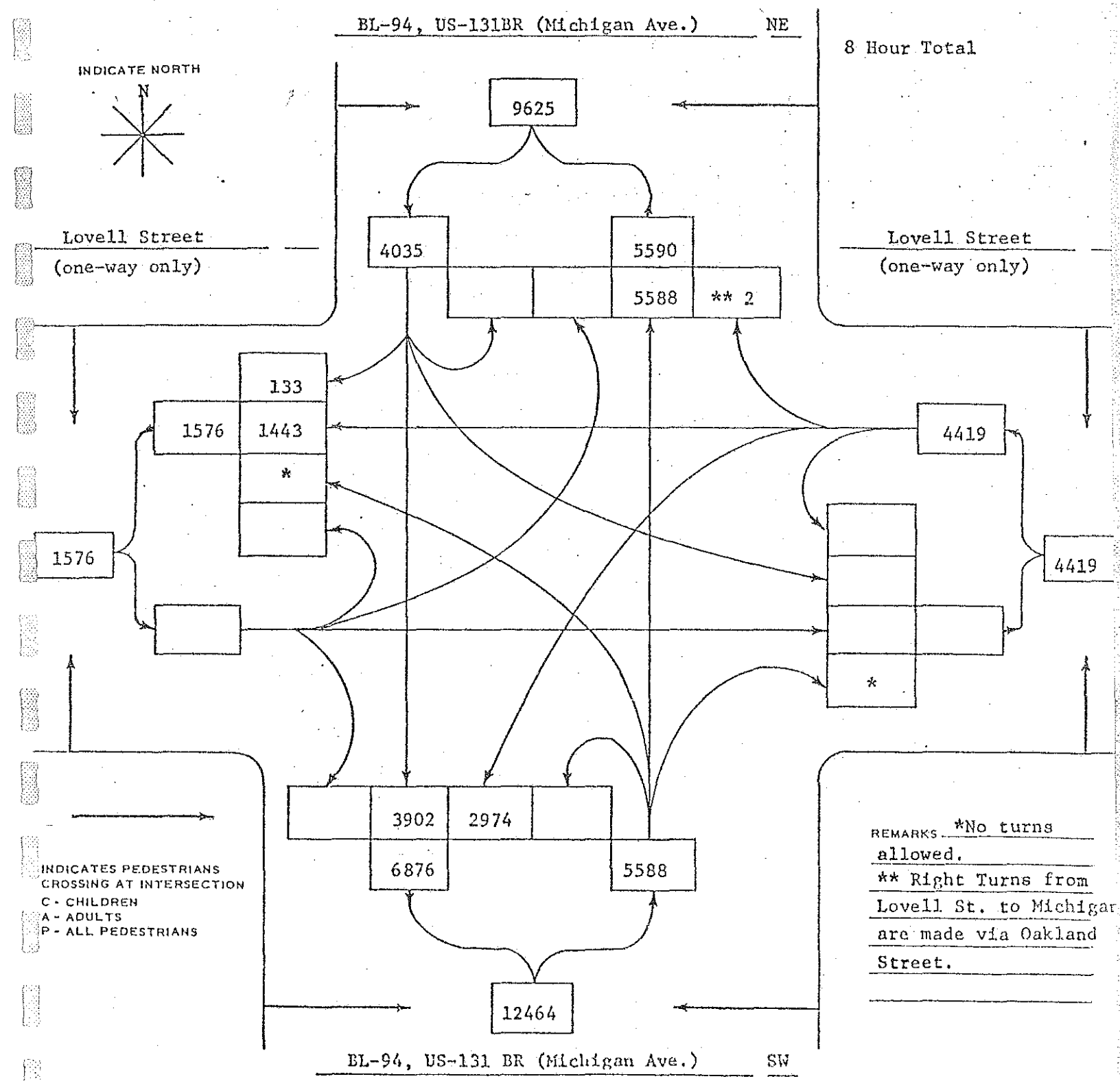
Study #132

DATE 4-1/2-75 DAY Tues- Wed COUNTY Kalamazoo

TWP., VILLAGE OR CITY Kalamazoo WEATHER

INTERSECTION OF BL-94, US-131BR (Michigan Avenue) at Lovell Street

TIME		
4P	TO	6P
7A	TO	9A
11A	TO	1P
2P	to	4P



INDICATES PEDESTRIANS CROSSING AT INTERSECTION
C - CHILDREN
A - ADULTS
P - ALL PEDESTRIANS

REMARKS *No turns allowed.
** Right Turns from Lovell St. to Michigar are made via Oakland Street.

1763 (7/75)

VEHICLE VOLUME COUNT

GRAPHIC SUMMARY SHEET

Study #402

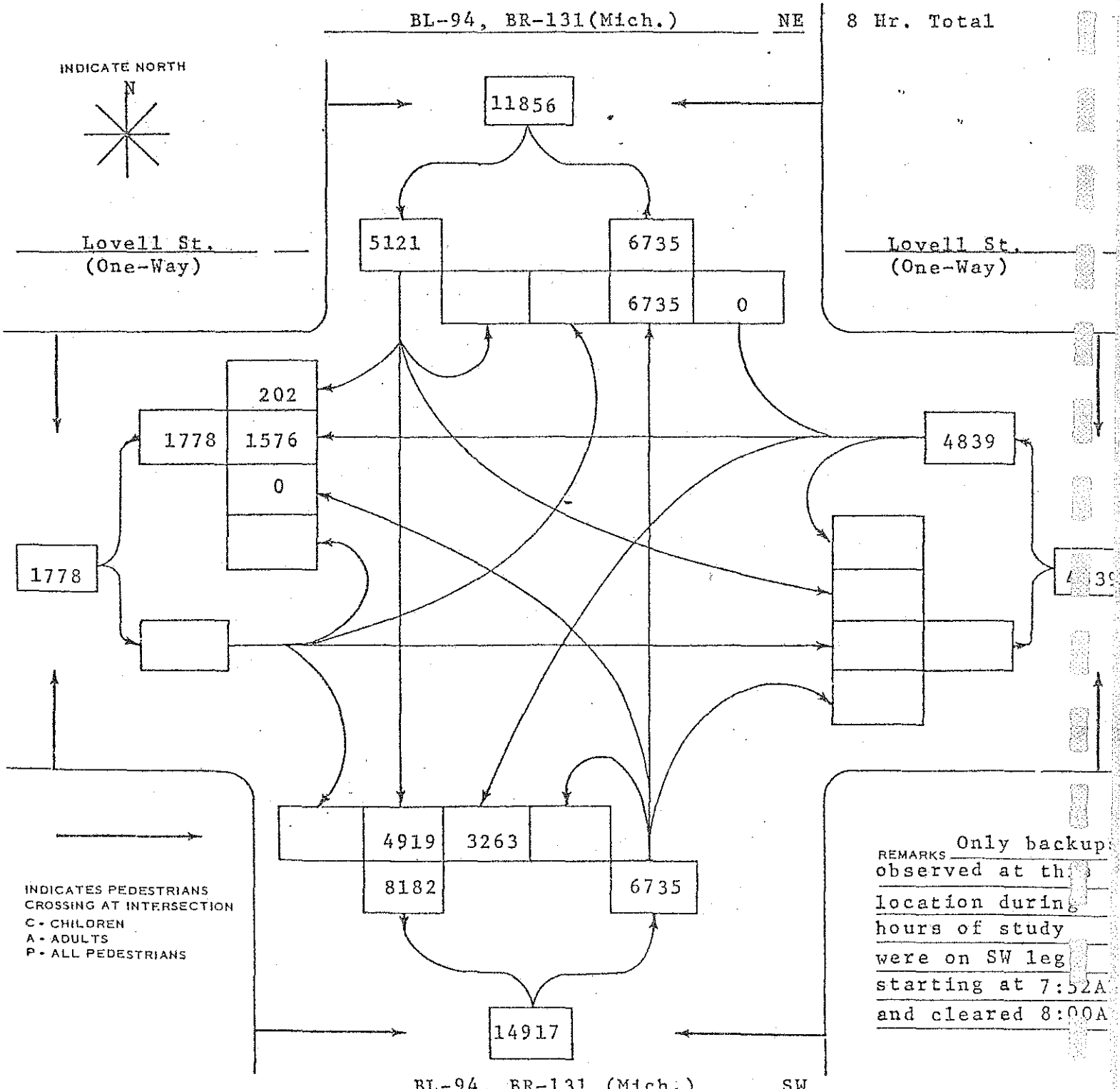
AFTER

DATE 12/11-12/78 DAY Mon/Tues COUNTY Kalamazoo TIME

TWP., VILLAGE OR CITY Kalamazoo WEATHER Snow

INTERSECTION OF I-94BL, US-131BR(Michigan) @ Lovell St.

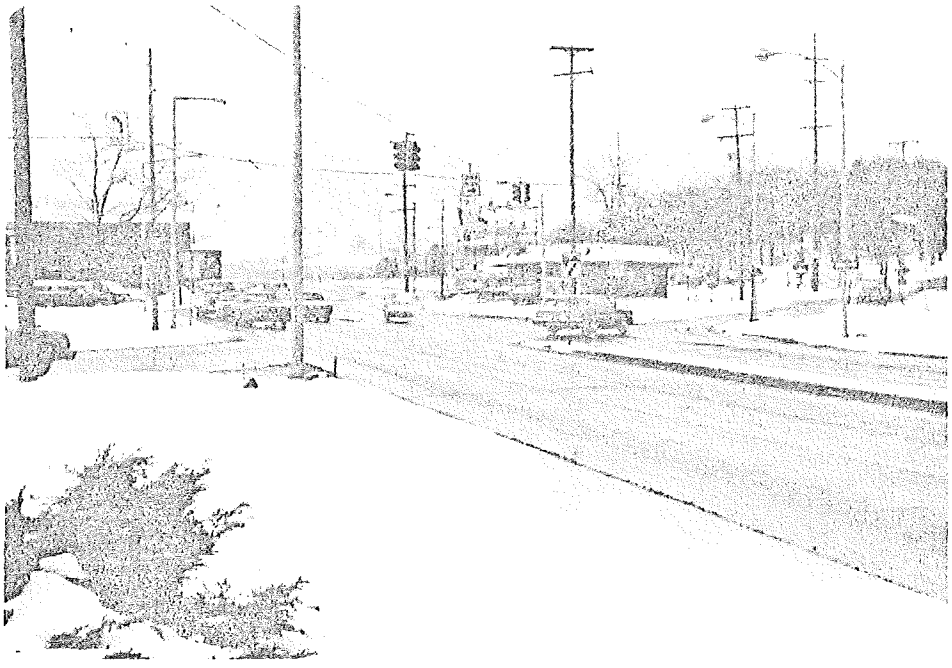
11A	TO 1P
2P	TO 6P
7A	TO 9A



REMARKS Only backups observed at this location during hours of study were on SW leg starting at 7:52A and cleared 8:00A

BL-94 (Michigan) at Lovell
Dual Left Turn

BEFORE

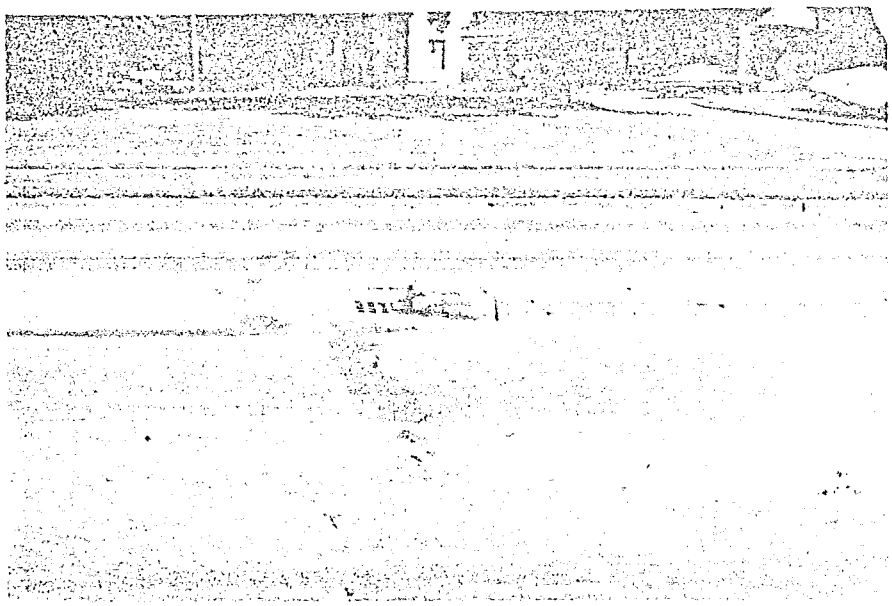


AFTER

BL-94 (Michigan at Lovell
Farside Throat

Open BEFORE

Narrow AFTER



Close-up -Nose of Curb
Median Divider
BEFORE

Nose of Divider Removed
AFTER

PART C

Westbound
BEFORE

Westbound
AFTER

Part C

Introduction

M-60 is a rural 2-lane two-way facility that intersects Moscow Road "teeing" in from the south in Spring Arbor Township, Jackson County. The improvement was the addition of a passing flare on the trunkline, as well as a right-turn lane. In addition, an overhead flashing beacon was installed to better define the intersection.

The project was constructed from 7-14-76 to 8-17-76 at a cost of $48,000.

In this area M-60 had a 1975 average daily traffic of 5200 vehicles. Though the accident experience was not extremely high, a correctable pattern of left-turn rear-end accidents of high severity qualified this location for inclusion in the Safety (Ms) Program. During the 3-year period, 1973 through 1975, there were 24 total accidents, with 10 left-turn rear-end accidents susceptible to correction. These rear-end accidents resulted in a total of 16 injuries and one fatality. (In our analysis we did not use the full dollar value for a fatality, over $100,000, but rather used a weighted injury value, approximately $6,000 in this case). The anticipated benefit was $17,000/year (1976 estimate).

Study Parameters

Purpose of Project:

1. Reduce total accidents and associated severity by reducing left-turn and rear-end accidents.

Objective:

1. Determine the effect of the project on total accident experience and related severity, especially left-turn and rear-end accidents.

Measures of Effectiveness:

1. Percent change in total accidents, specifically left-turn and rear-end related accidents and associated severity.

The experimental plan will be a modified before and after.

Data Requirements:

Total accidents (by severity and type)
Trunkline left-turn rear-end accidents (by severity)
Traffic volumes (manual turning movement counts)
Total project cost
Construction period

Parametric Comparison

Summary Table C1 shows numbers and rates of accidents for three years before and three years after the improvement. Though the reductions appear to be

C-1: Data Summary Table For The Before and After Study

Data Variables	3 Years Before	3 Years After
Accidents		
Total Accidents	24	8
Left-Turn Rear-End Accidents	5	2
Severity		
Fatal Accidents	1(1)(3)	0
Total Personal Inj. Accidents	9(19)	5(8)
Left-Turn Rear-End Inj. Acc.	1(1)(3) 4(12)	1(2)
Exposure		
Average Daily Traffic	9,900	11,100
Million Vehicles	10.8	12.1
Rates		
Total Accidents/MV	2.22	.66
Left-Turn Rear-End Acc./MV	.46	.17
Fatals/MV	.09	.00
Personal Inj. Acc./MV	.83	.41
Left-Turn Rear-End Personal Inj. Acc./MV	.46	.08

good, they are not statistically significant at the Poisson 95th percentile level.

The results may prove to be significant when a longer study period is used or when this project is grouped with similar ones to get a significantly large data base.

No economic analysis can be performed at this time.


STUDY LOCATION
SPRING ARBOR
PARMA
SANDSTONE
WOODVILLE
REYNOLDS
MUNICIPAL
AIRPORT
BROOKLINE
JACKS
HORTON
HANOVER
LIBERTY
S P R I N G
A R B O R
H A N O V E R
L I B E R T
CENTRAL
TRANSPORTATION
COMPANY
SPRING ARBOR LAKES
LIME L
CROSS L
HORSESHOE L
PINE HILLS L
FOX L
FAREWELL L
ROUND L
HINMAN L
SPENCER L
CRISPELL L
BIG GRAND L
MIRROR L
BROWN L
FINTON
MICH. SOUTHERN
Sandstone Cr.
River
MICHIGAN
MC CAIN
SLAYTON RD.
KIBBY
HAIRES STA
RIDGEWAY
VROOMAN
HORTON
MATHEWS
HAMMOND
SEARS
COCHRAN
TRIPP
HATCH
COATS RD.
DANCER RD
TYGH
CRISPELL
LINDSEY
KIMMEL
CROUCH
WICKWIRE
BADER
BUCKMAN
STONEY POINT RD
LAKE SHORE
WILDWOOD RD
CUFF RD
FOWLER
VICARY
REYNOLDS
MOSCOW
PRESTON
SPRINGBROOK
THORNE
DALE
MAPLE
JACKSON
WAITE
SUTFIN
ADAMS
GROVER
STRAT
ROUNDTREE
CROSS
WEEKS
BOWERMAN
TEFT
EMERSON
CHAPEL
MATHEWS
RIEGEL
HARRINGTON
DEARING
SANDSTONE
BUNTING
OBRIEN
HILLS
ARBOR
ROBINSON
MAYNARD
BROWN
PARMA
PARSON
SCOTT
94
BL 94
60
50
BR 127

MIDAS Comparisons

M-60 at Moscow Road

The following histograms are for similar roadway and volume characteristics as those for M-43 at AB Avenue, but in this case the accident type was specified as rear-end property damage only rather than total injury. Only locations that experienced at least one property damage accident are included in the calculations, but many experienced no rear-end property damage accidents.

Again note the lack of repetition of many locations on the lists due to randomness at intersections of low accident frequency. While the M-60, Moscow Road intersection appears on the "before" histogram and not on the "after" is not of great interest to us, note the average rear-end accident change from 0.319 before to 0.266 after.

STATEWIDE,2L2W,RURAL,INTERSECTION,NON-SIGNAL,ADT 3000-15000,1975PD

REAR END

```
                    NUMBER OF LOCATIONS
              1         2         3         4         5         6
ACC*12345678901234567890123456789012345678901234567890123456789012345
  0*XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX  884
  1*XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX  250
  2*XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
  3*000000000000
  4*00
  5*
  6*00
ACCIDENT TYPE   = 3
LOCATIONS       =  1186
AVE 24HR VOLUME=  6535
AVE ACCIDENTS   = 0.319
UPPER LIMIT     = 2.990
```

HIGH HAZZARD LOCATIONS-- 16

CSECT	MP	ACC	ROUTE	XROAD/MIDBLOCK	LOCAL GOV'T COUNTY
3072	20.00	3	M40, M89	RURAL MIDBLOCK IN	HOLLAND CITYALLEGAN C
11052	8.95	3	US31,33	RURAL MIDBLOCK IN	ST JOSEPH CIBERRIEN C
18011	12.56	6	M 115	AT HARDING RD S	SURREY TWP CLARE
37011	1.91	4	US-27BR	AT MISSION ROAD	UNION TWP ISABELLA
38061	10.55	4	M-60	AT MOSCOW RD.	SPRNG ARBR TJACKSON C
41051	7.00	3	M-44	AT 3 MILE RD	GRAND RAPIDSKENT CO
46062	4.06	3	US-223	AT TREAT HIGHWAY	ADRIAN CITY LENAWEE C
50022	3.01	6	M-59	AT HAYES ROAD	MAC./CLINT TMACOMB CO
59031	0.50	3	M-91	AT JENKS RD	EUREKA TWP MONTCALM
70041	14.10	3	M-45	AT 48TH AVE	PEARLINE VILOTTAWA CO
76061	7.10	3	M-21	AT COPE DRIVE	MIDDLEBURY TSHIAWASSE
77091	2.83	3	M-136	AT KRAFFT ROAD	FT.GRATIOT TSTCLAIR C
79061	13.12	3	M-81	AT WALK STREET	INDIANFIELDSTUSCOLA C
81031	14.02	3	US-12	AT STATE RD.	PITTSFIELD TWASHTENAW
81102	0.57	3	M-14	AT PROSPECT RD.	SUPERIOR TWPWASHTENAW
81102	1.34	3	M-14	AT CURTIS RD.	SUPERIOR TWPWASHTENAW

STATEWIDE,2L2W,RURAL,INTERSECTION,NON-SIGNAL,ADT 3000-15000,1977PD

REAR END

```
                    NUMBER OF LOCATIONS
              1         2         3         4         5         6
ACC*123456789012345678901234567890123456789012345678901234567890123
  0*XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX 1028
  1*XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX  253
  2*XXXXXXXXXXXXXXXXXXXXXXXXX
  3*00000
  4*0000
  5*
  6*
  7*0
  8*0
ACCIDENT TYPE   = 3
LOCATIONS       =  1318
AVE 24HR VOLUME=  6910
AVE ACCIDENTS   = 0.266
UPPER LIMIT     = 2.990

HIGH HAZZARD LOCATIONS==  11
```

CSECT	MP	ACC	ROUTE	XROAD/MIDBLOCK	LOCAL GOV'T COUNTY
11052	21.13	3	US31,33	RURAL MIDBLOCK IN	ST JOSEPH CIBERRIEN C
12022	5.18	3	US-12	AT QUINCY GRANGE ROAD	QUINCY TWP BRANCH CO
23041	15.47	4	M-43	AT JENNE ST	GRAND LEDGE EATON
39082	2.75	4	M43-M89	AT H .-MAPLE AVENUE	KLMAZOO TWP KALAMAZOO
39102	2.74	3	M-89	AT 37TH STREET	RICHLAND TWPKALAMAZOO
41031	5.28	3	M-37	AT 68TH ST	CALEDONIA TWKENT CO
44042	7.75	3	M-21	AT LK. PLEASANT RD/CR	ATTICA TWP. LAPEER CO
50022	3.01	8	M-59	AT HAYES ROAD	MAC./CLINT TMACOMB CO
61073	0.26	4	US-31BR	AT S WHITEHALL RD	WHITEHALL TWMUSKEGON
77033	1.94	4	M-25	AT METCALF ROAD	BURTCHVILLE STCLAIR C
81031	14.02	7	US-12	AT STATE RD.	PITTSFIELD TWASHTENAW

STATE OF MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

Form 1533-A
(Rev. 5/65)

BEFORE

VEHICLE VOLUME COUNT
GRAPHIC SUMMARY SHEET

Study #34

DATE 3-30/31-72 DAY Thur.-Fri. COUNTY Jackson TIME

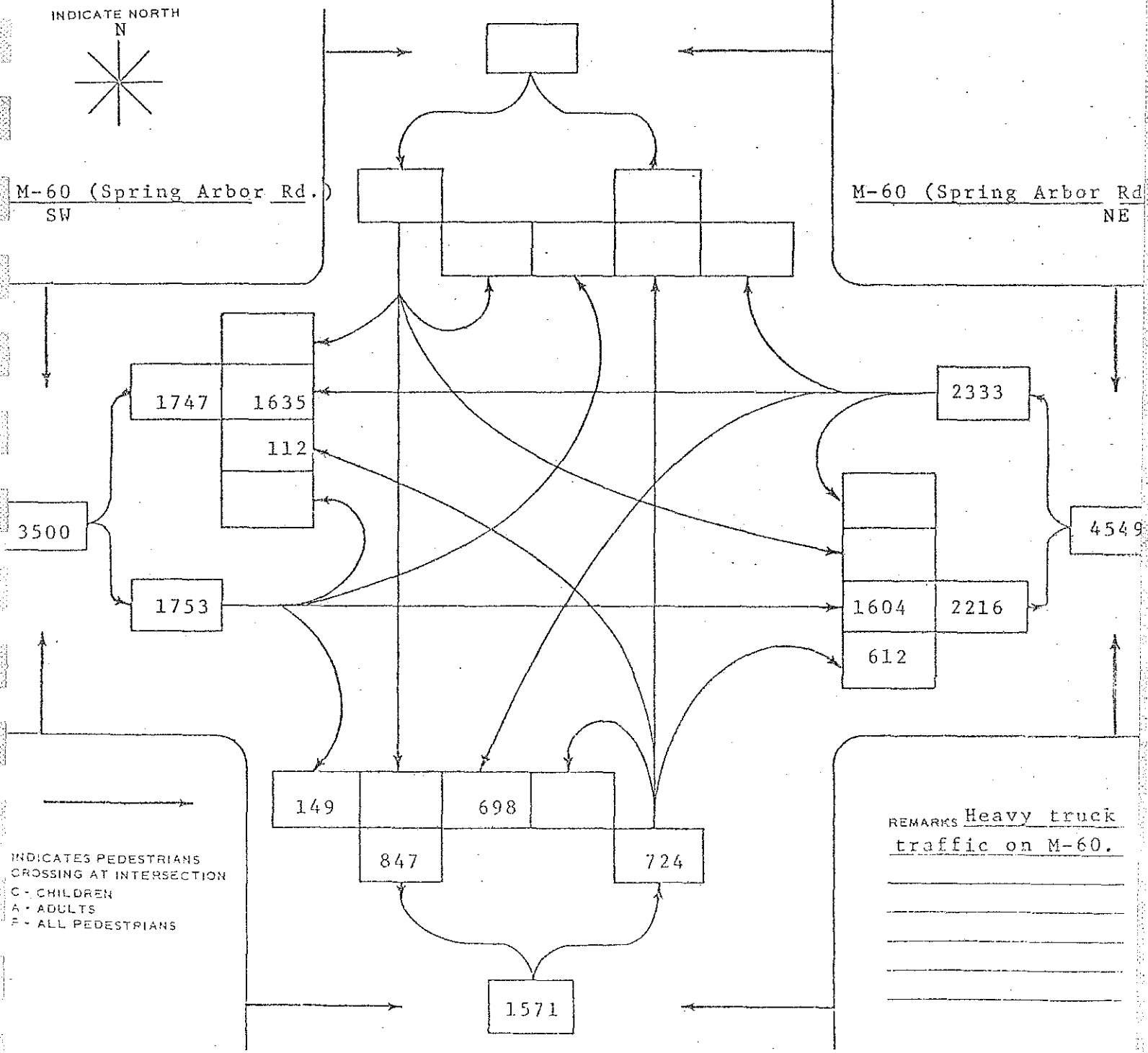
TWP., VILLAGE OR CITY Spring Arbor WEATHER

INTERSECTION OF M-60 (Spring Arbor Rd.) at Moscow Rd.

11A	TO	1P
2P	TO	6P
7A	TO	9A

8 HOUR TOTAL

INDICATE NORTH
N



INDICATES PEDESTRIANS CROSSING AT INTERSECTION
C - CHILDREN
A - ADULTS
P - ALL PEDESTRIANS

REMARKS Heavy truck traffic on M-60.

1783 (7/75)

VEHICLE VOLUME COUNT

GRAPHIC SUMMARY SHEET

Study #034

AFTER

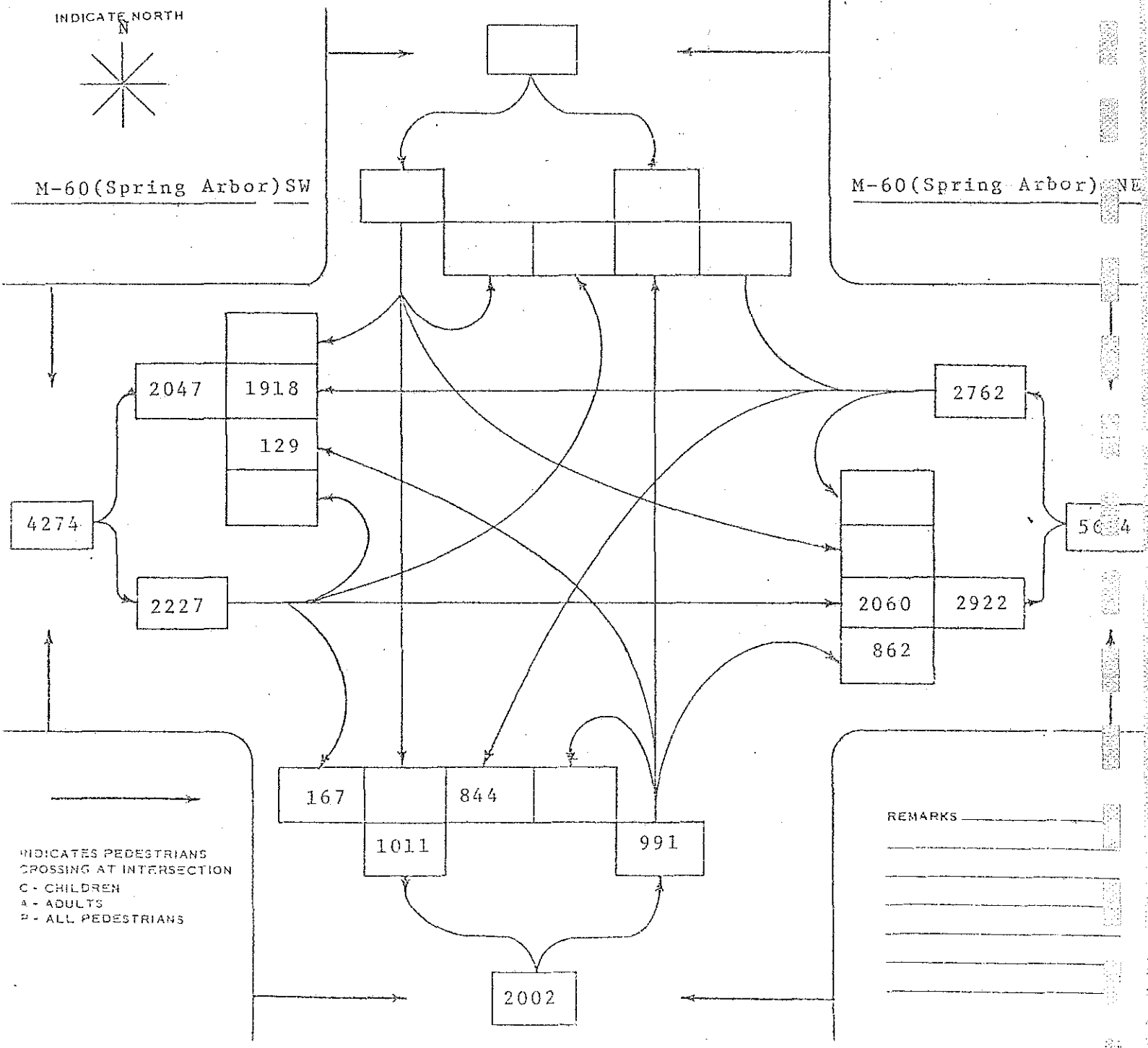
DATE 8/8-9/78 DAY Tues/Wed. COUNTY Jackson

TWP., VILLAGE OR CITY Spring Arbor WEATHER Clear

INTERSECTION OF M-60(Spring Arbor Rd.) @ Moscow Rd.

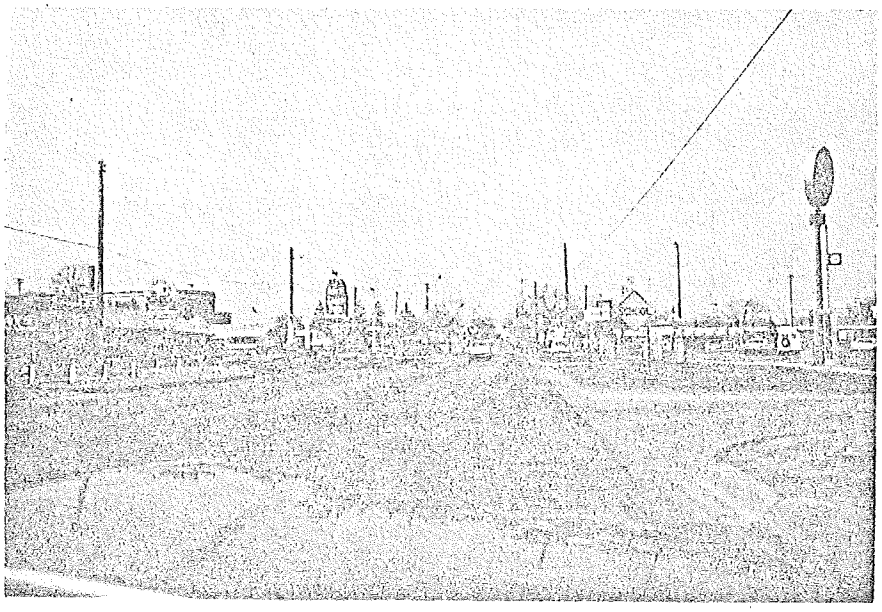
TIME		
11A	TO	1P
2P	TO	6P
7A	TO	9A

8 Hr. Total



PART D

BL-94 (Michigan) at Kroger



BEFORE

AFTER

Part D

A one-half mile section of BL-94 (Michigan) in a strip commercial area between Ganson Street and US-127 in Blackman Township, Jackson County, was widened from four to five lanes. The project cost was $489,000 including acquisition of right-of-way, and construction took place between September of 1976 and July of 1977.

BL-94 (Michigan) through this area was a 4-lane roadway east of the city of Jackson, population 46,000, that carried an average of 20,000 vehicles per day in 1975. Roadside environment is strip commercial that had intensified to the point where turning movements and accidents justified reconstruction. There is also a signalized intersection, Dettman Road, in this section that experienced a disproportionate number of left-turn related accidents.

Previous studies on similar developed areas showed significant reductions in left-turn and rear-end type accidents after reconstruction. The anticipated benefit was $50,000 per year (1976 estimate) which may appear low when compared with the large initial expenditure. It was felt that the accident experience would increase greatly as the development continued if no action was taken. It should be noted that this project was delayed for two years due to problems with acquisition of right-of-way.

The following analysis shows that there was a significant reduction in most measures of effectiveness when the period after construction was compared to that of the one before. Dollar savings in injury/fatals and property damage accidents amounted to $186,000 per year. The benefit/cost ratio is 3.5.

Study Parameters

The Major Purpose of the Project:

1. Reduce total accident experience and related severity primarily through reduction in left-turn and rear-end accidents.

Major Objective of Study:

1. Determine the effect of the project on the above.

Measures of Effectiveness:

1. Percent change in total accidents.

2. Percent change in left-turn and rear-end accidents.

3. Percent change in driveway related accidents.

4. Percent change in associated injuries.

Data Requirements:

Total accidents (by severity and type)
Left-turn accidents and rear-end accidents (by severity)
Traffic volumes (manual turning movement at drives and Dettman Road)
Project cost
Construction period

Parametric Comparison

Summary Table D1 contains accident and exposure data for three years before and 2½ years after the improvement. Section rates are shown although there is a major signalized intersection included, as well as several driveways. Graphical summary sheets for the driveway volume counts on pages and show redistribution of traffic necessitated by the closure of drive No. 2 and geometric revisions at Ganson-Peach.

Statistically significant changes in two of the measures of effectiveness are apparent, total accidents and left-turn accidents. The Poisson curve for 95 percent level was again used.

Economic Analysis

Initial cost of project paid in 1977 = $489,000

Neglect charges in maintenance costs.

Annual benefits:

a. The fatality reduced will be treated as a combined injury/fatality

b. An annual average of 22.7 personal injury/fatalities reduced. 11.5 property damage only accidents reduced

c. Left-turn accidents were reduced from an average of 20 per year to seven

Use 1978 National Safety Council Figures

$5,800 for an injury
$ 850 for PDO

The weighted injury/fatality value is $7,550.

The estimated service life for this project is 20 years with zero salvage value. Interest rate selected: 9 percent.

Equivalent Uniform Annual Cost and Benefit:

$$EUAC = (I)CR_n^i + K\text{-}(T)SF_n^i$$
$$(K=0,\ T=0)$$

EUAC = $489,000 (.1096) = $53,600

Table D-1: Data Summary Table For The Before and After Study

Data Variables	3 Years Before	2½ Years After
Accidents		
Total Accidents	247	145
Left-Turn Accidents	59	18
Rear-End Accidents	44	41
Severity		
Fatal Accidents		0
Total Personal Injury Accidents	77(124)	32(49)
Left-Turn Personal Inj. Acc.	18(31)	3(5)
Rear-End Personal Inj. Acc.	12(18)	8(9)
Exposure		
Average Daily Traffic	33,400	35,600
Million Vehicle Miles	18.3	16.3
Rates		
Total Accidents/MVM	13.50	8.90
Left-Turn Accidents/MVM	2.68	1.66
Rear-End Accidents/MVM	2.40	2.52
Fatals/MVM	.05	0.0
Personal Injury Accidents/MVM	4.21	1.96

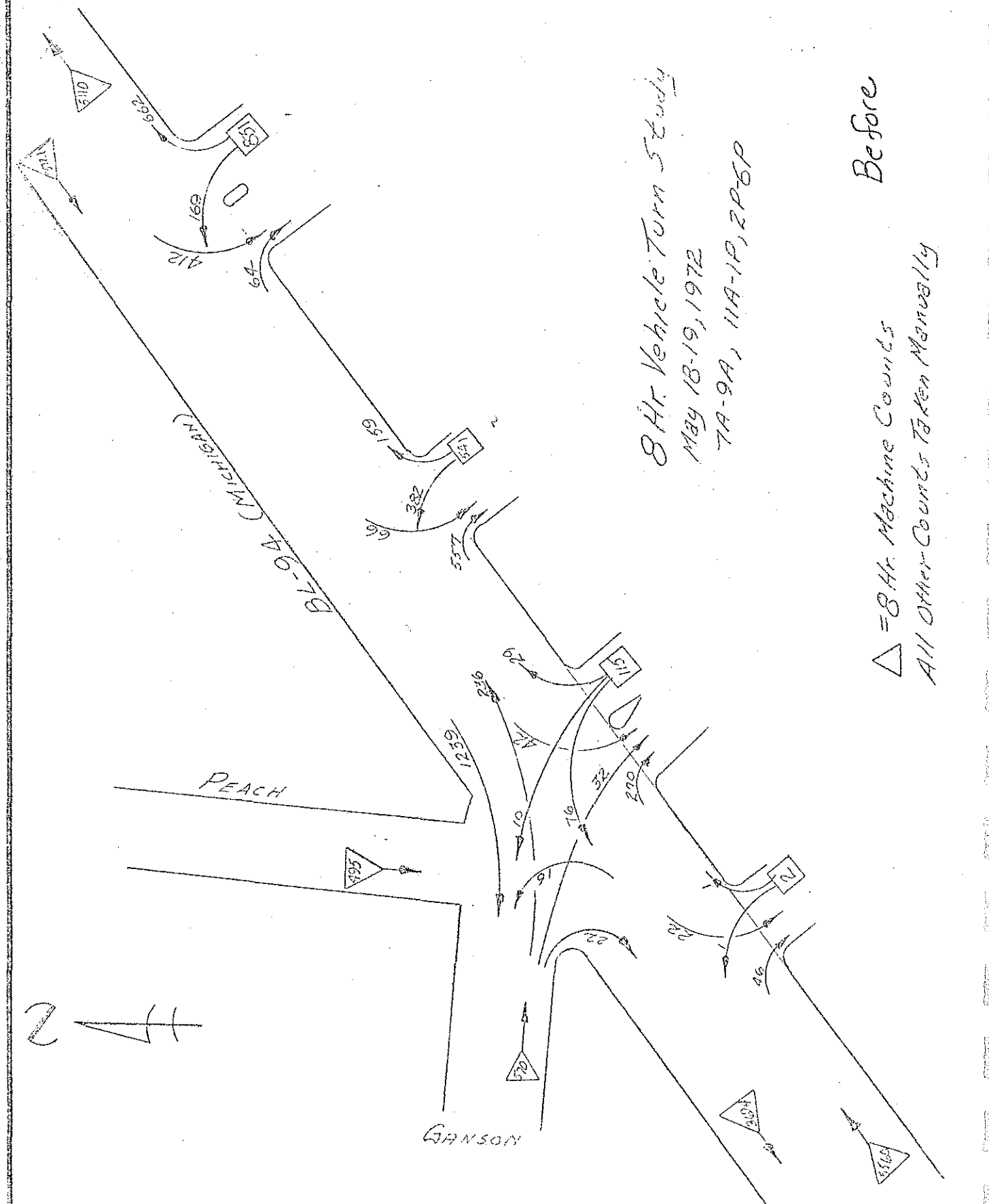
Again an average value was used for the annual benefit using the weighted injury value of $7,550 and PDO of $850.

$$\begin{aligned} 22.7 \times \$7{,}550 &= 176{,}000 \\ 11.5 \times \$\ 850 &= \underline{\ 10{,}000} \\ &\quad \$186{,}000 \end{aligned}$$

$$B/C = \frac{\$186{,}000}{\$\ 53{,}600} = 3.5$$

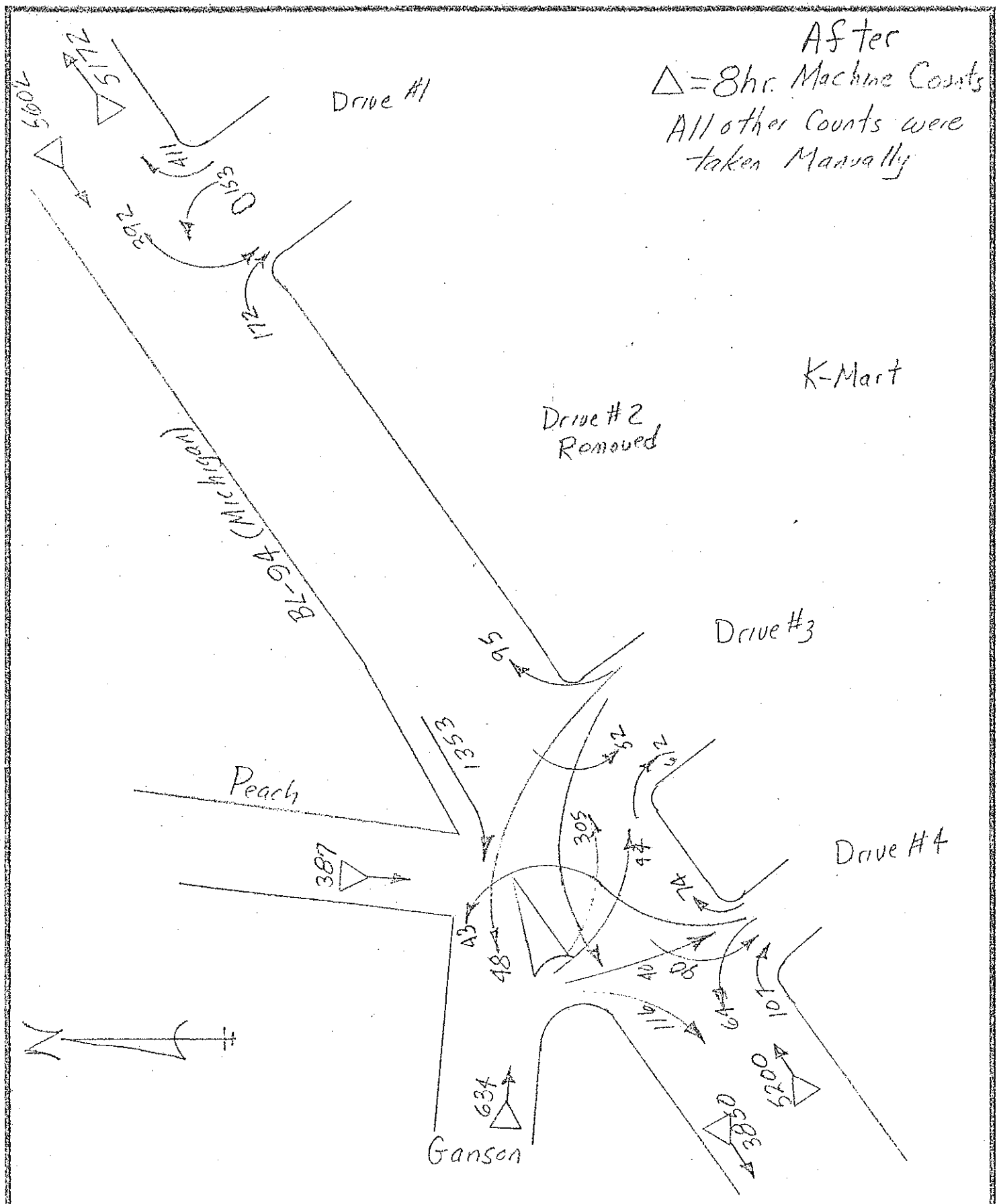
Using the simplified zero interest approach, our estimated updated TOR (time of return) is:

$$\$489{,}000/\$186{,}000 = 2.6 \text{ years}$$



STATE OF MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC & SAFETY DIVISION	AUTH. NO.	DRAWN gs	BL-94 (Mich.) @ Gamson - Peach & K-Mart Drives Blackman Twp. Jackson Co STT# 821
	CONT. SEC. 38083	DATE 6-20-72	
	REF.	SCALE None	
	SHEET 1 OF 1	PLAN	

FORM 1595 (REV. 10-68)



STATE OF MICHIGAN DEPARTMENT OF STATE HIGHWAYS TRAFFIC & SAFETY DIVISION	AUTH. NO.	DRAWN 15 (REA)	BL-94 (Mich) @ Ganson - Peach and K-Mart Drives Blackman Twp Jackson Co
	CONT. SEC.	DATE 8-9/10-78	
	REF.	SCALE	
	SHEET OF	PLAN	

STATE OF MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

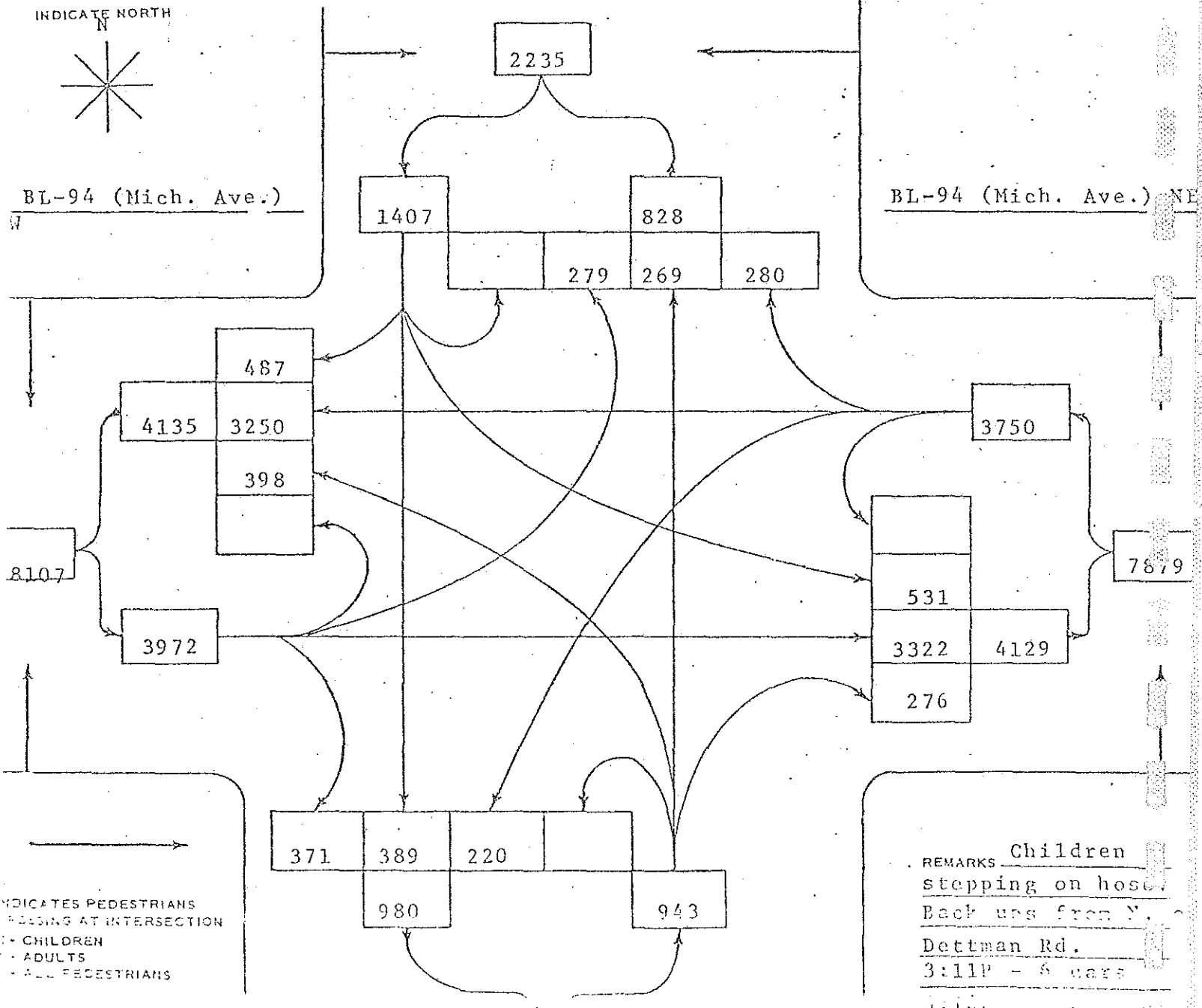
Form 1533-A
(Rev. 5 65)

BEFORE

VEHICLE VOLUME COUNT
GRAPHIC SUMMARY SHEET

DATE 3-29-72 DAY Wednesday COUNTY Jackson TIME
TWP., VILLAGE OR CITY Jackson WEATHER Cloudy 6A TO 9A
INTERSECTION OF BL-94 (Mich. Ave.) at Dettman Rd. 11A TO 1P
3P TO 6P

8 Hr. Total



INDICATES PEDESTRIANS
CROSSING AT INTERSECTION
- CHILDREN
- ADULTS
- ALL PEDESTRIANS

REMARKS Children stepping on hose.
Back ups from N. Dettman Rd.
3:11P - 6 cars
3:15P - 3 cars
3:17P - Clear

1763 (7/75)

VEHICLE VOLUME COUNT

GRAPHIC SUMMARY SHEET

Study #035

AFTER

DATE 8/9-10/78 DAY Wed/Thur COUNTY Jackson TIME

TWP., VILLAGE OR CITY Blackman WEATHER Clear | 2P TO 6P

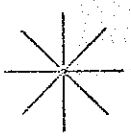
INTERSECTION OF BL-94(Michigan) @ Dettman Rd. | 7A TO 9A

| 11A TO 1P

Dettman Rd.

8 Hr. Total

INDICATE NORTH



BL-94(Mich.) SW

BL-94(Mich.) NE

2553

1475

1078

404

321

353

553

5160

3947

660

4549

9896

9164

468

4736

3793

4615

354

539

454

249

1242

1335

2577

Dettman Rd.

INDICATES PEDESTRIANS CROSSING AT INTERSECTION

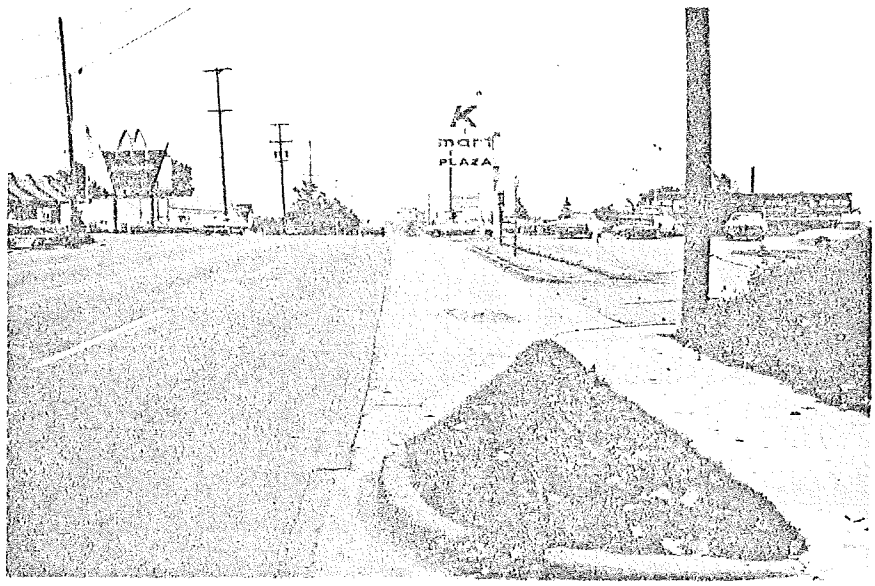
C - CHILDREN

A - ADULTS

P - ALL PEDESTRIANS

REMARKS

BL-94 (Michigan) at K-Mart

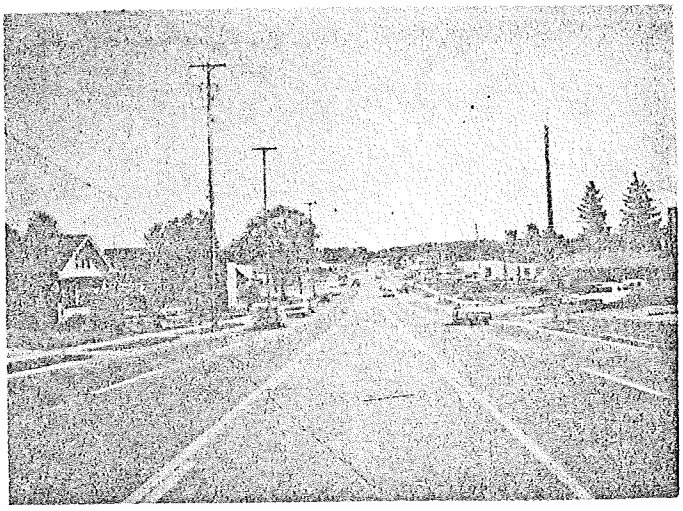


BEFORE

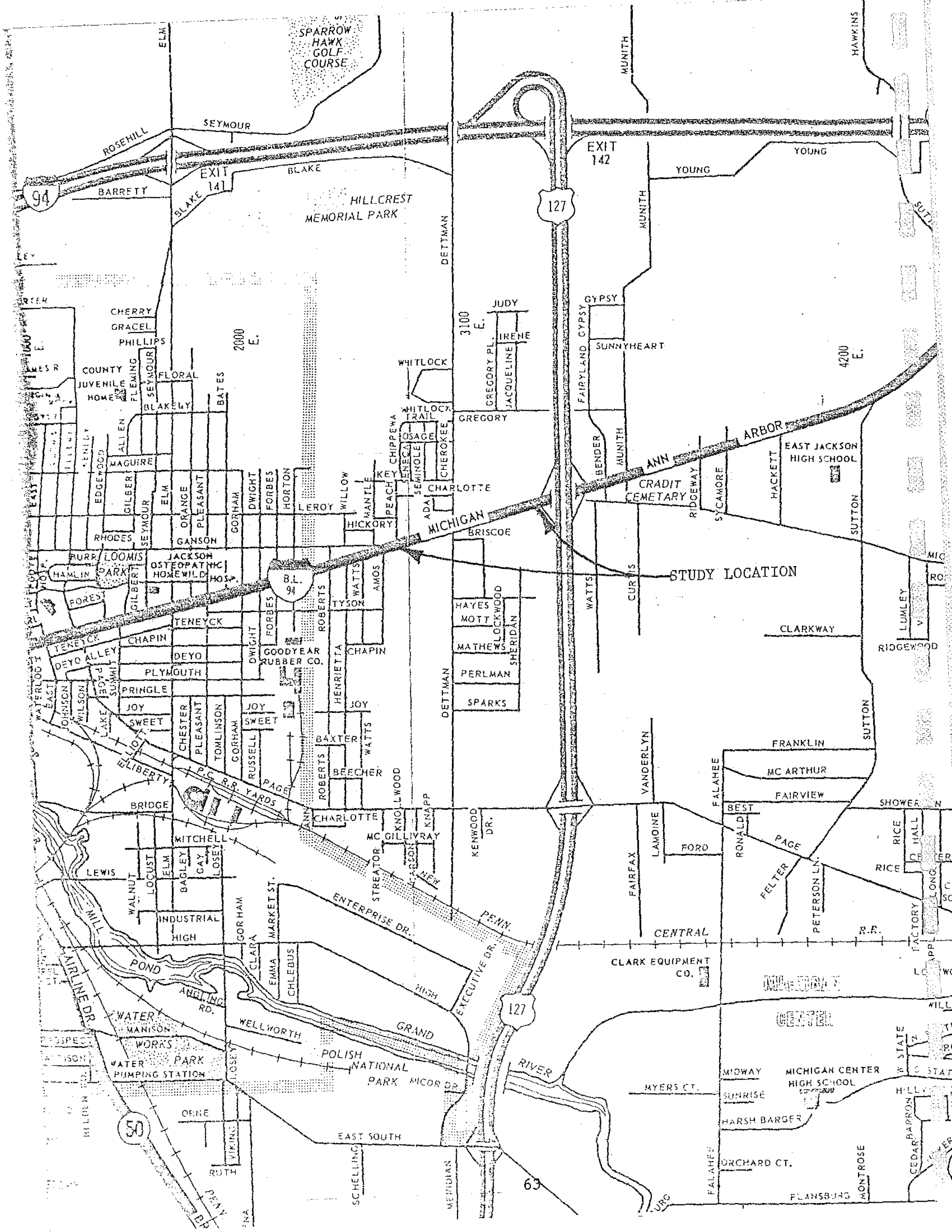
AFTER

BL-94 (Michigan) Looking East
From K-Mart

BEFORE



AFTER


SPARROW HAWK GOLF COURSE
SEYMOUR
ROSEHILL
BARRETT
EXIT 141
BLAKE
HILLCREST MEMORIAL PARK
EXIT 142
127
YOUNG
MUNITH
HAWKINS
DETTMAN
2000 E.
3100 E.
4200 E.
JUDY
IRENE
GYPSY
SUNNYHEART
FAIRYLAND
GREGORY PL.
JACQUELINE
WHITLOCK
WHITLOCK TRAIL
GREGORY
CHERRY
GRACEL
PHILLIPS
COUNTY JUVENILE HOME
FLORAL
BLAKELY
BATES
MAGUIRE
EDGEWOOD
GILBERT
ELM
ORANGE
PLEASANT
GORHAM
DWIGHT
FORBES
HORTON
LEROY
WILLOW
MANTLE
KEY
PEACH
CHIPPEWA
OSAGE
SENECA
SEMINOLE
CHEROKEE
CHARLOTTE
ADA
HICKORY
RHODES
GANSON
BRISCOE
MICHIGAN
ANN ARBOR
BENDER
CRADIT CEMETARY
RIDGEWAY
SYCAMORE
HACKETT
EAST JACKSON HIGH SCHOOL
SUTTON
LOOMIS PARK
HAMLIN
JACKSON OSTEOPATHIC HOSP.
HOMEWILD
B.L. 94
FOREST
ROBERTS
WATTS
AMOS
TYSON
STUDY LOCATION
CURTIS
HAYES
MOTT
LOCKWOOD
SHERIDAN
MATHEWS
PERLMAN
SPARKS
CLARKWAY
LUMLEY
RIDGEWOOD
TENEYCK
CHAPIN
DEYO ALLEY
DEYO
PLYMOUTH
PRINGLE
JOY
SWEET
GOODYEAR RUBBER CO.
HENRIETTA
WATERLOO
EAST
JOHNSON
WILSON
LAKE
PAGE
SUMMIT
CHESTER
TOMLINSON
RUSSELL
BAXTER
BEECHER
VANDERLYN
FRANKLIN
MC ARTHUR
FAIRVIEW
FALAHEE
ELLIOTT
LIBERTY
P.C. R.R. YARDS
BRIDGE
MITCHELL
KNOLLWOOD
KNAPP
MC GILLIVRAY
KENWOOD DR.
LAMOINE
FAIRFAX
FORD
BEST
RONALD
SHOWER
RICE
HALL
FELTER
PETERSON LN.
FACTORY
LONG
LEWIS
WALNUT
LOCUST
BAGLEY
GAY
LOSEY
STREATOR
NEW
MILL POND
INDUSTRIAL
HIGH
MARKET ST.
ENTERPRISE DR.
PENN.
CENTRAL
R.R.
CLARA
EMMA
CHLEBUS
EXECUTIVE DR.
CLARK EQUIPMENT CO.
AIRLINE DR.
WATER WORKS PARK
MANISON
ANGLING RD.
WELLWORTH
GRAND
POLISH NATIONAL PARK
MICOR DR.
RIVER
WATER PUMPING STATION
MIDWAY
MICHIGAN CENTER HIGH SCHOOL
MYERS CT.
SUNRISE
HARSH BARGER
50
ORNE
VIKING
RUTH
EAST SOUTH
SCHELLING
MERIDIAN
ORCHARD CT.
MONTROSE
FLANSBURG
CEDAR
BARRON
STATE

PART E

M-24 at Flint Street
Looking South

BEFORE

AFTER

Part E

Introduction

This project involved widening M-24 in the village of Lake Orion, Oakland County, from four lanes to five to provide a center lane for left turns at Flint Street as well as a short section to Shadbolt Street, an adjacent crossroad. Construction occurred between June and October in 1977 at a cost of $214,000 including right-of-way costs.

Background History and Analysis: Lake Orion, population 3,000, is located in the southeast portion of the state approximately 30 miles north of the heart of Detroit. M-24 is a major north-south route carrying 25,000 vehicles per day. In the vicinity of Flint and Shadbolt Streets, the trunkline cross section was four lanes with curb and gutter. The M-24, Flint Street intersection is signalized. Studies showed that the south to eastbound left-turn movement was 697 in the standard 8-hour manual survey. A consistent, correctable pattern of rear-end and head-on left-turn accidents was defined. (Work was delayed for two years due to right-of-way acquisition.)

Previous before-and-after studies performed on this type of project revealed a reduction of approximately 50 percent in trunkline left-turn and rear-end type accidents.

This table shows three years of accident experience with only the trunkline rear-end and left-turn accidents shown in the "Susceptible to Reduction" column. Based on past experience, when computing expected reductions, the improvement is assumed to cause no increase in other types of accidents.

Year	Total Accs.	Susceptible to 50% Reduction	
1973	30	8 prop. damage	8 inj. (18 injured)
1974	39	16 prop. damage	12 inj. (18 injured)
1975	42	15 prop. damage	8 inj. (21 injured)
Total	111	39	28 inj. (57 injured)

The anticipated annual benefit through accident reduction was $50,000/year (1976 estimate). Analysis of before and after data indicates the actual benefit to be $72,000 and the benefit/cost ratio to be 3.1.

Study Parameters

Purpose of Project:

1. Reduce total accident experience and associated injuries by significantly reducing trunkline rear-end and left-turn accidents.

2. Reduce associated left-turn delay and signal violation (several turns were occurring on red).

The objectives of the evaluation are:

1. Determine the effect of the project on total accidents.

2. Determine the effect of the project on the severity of accidents.

3. Determine the effect of the project on left-turn and rear-end accidents and related severity.

4. Determine the effect on left-turn delays and signal violations.

Measures of Effectiveness:

1. Percent change in total accidents.

2. Percent change in injuries.

3. Percent change in left-turn and rear-end accidents.

4. Percent change in left-turn delays and signal violations.

Data Requirements:

Total accidents (by type and severity)
Trunkline left-turn and rear-end accidents (by severity)
Traffic volumes (manual turning movement counts)
Delay and signal indication observance study
Total project cost
Construction period

Parametric Comparison

Summary Table E-1 shows three years before and 2½ years after accident experience and exposure data based on traffic surveys conducted in 1972 and 1978.

Total accidents were reduced 38 percent which is significant at the Poisson 95 percent level of confidence.

Economic Analysis

Initial cost of project paid in 1977 = $214,000

Neglect charges in maintenance costs

Annual Benefits:

a. No fatals reduced.

b. 11.4 personal injuries reduced, 7.3 PDO accidents reduced.

c. Left-turn and rear-end accidents were reduced from 23 to 11.

Table E1: Data Summary Table For The Before and After Study

Data Variables	3 Years Before	2½ Years After
Accidents		
Total Accidents	118	63
Trunkline Rear-End Acc.	28	20
Trunkline Left-Turn Acc.	42	7
Severity		
Personal Injury Acc.	36(63)	13(24)
Trunkline Rear-End Personal Inj. Acc.	7(11)	2(2)
Trunkline Left-Turn Personal Inj. Acc.	15(33)	4(10)
Exposure		
Average Daily Traffic	33,700	36,000
Million Vehicles for 3 Years and 2½ Years	36.9	33.8
Rates		
Total Accidents/MV	3.20	1.86
Personal Injury Acc./MV	.98	.38
Trunkline Rear-End Personal Inj. Acc./MV	.19	.06
Trunkline Left-Turn Pesonal Inj. Acc./MV	.41	.12

Use 1978 National Safety Council Figures:

$5,800 for an injury
$ 850 for PDO

The estimated service life for this project is 20 years with zero salvage value. Interest rate selected: 9 percent.

Equivalent Uniform Annual Cost and Benefit:

$$EUAC = (I)CR^{i}_{n} + K\text{-}(T)SF^{i}_{n}$$
$$(K=0,\ T=0)$$

$$EUAC = \$212,000\ (.1096) = \$23,235$$

A single value was again used for the annual benefit using $5,800 per injury reduced and $850 for PDO eliminated.

$$\begin{aligned} 11.4 \times \$5,800 &= \$66,120 \\ 7.3 \times \$\ 850 &= \underline{\$\ 6,205} \\ &\quad \$72,325 \end{aligned}$$

$$B/C = \frac{\$72,325}{\$23,230} = 3.11$$

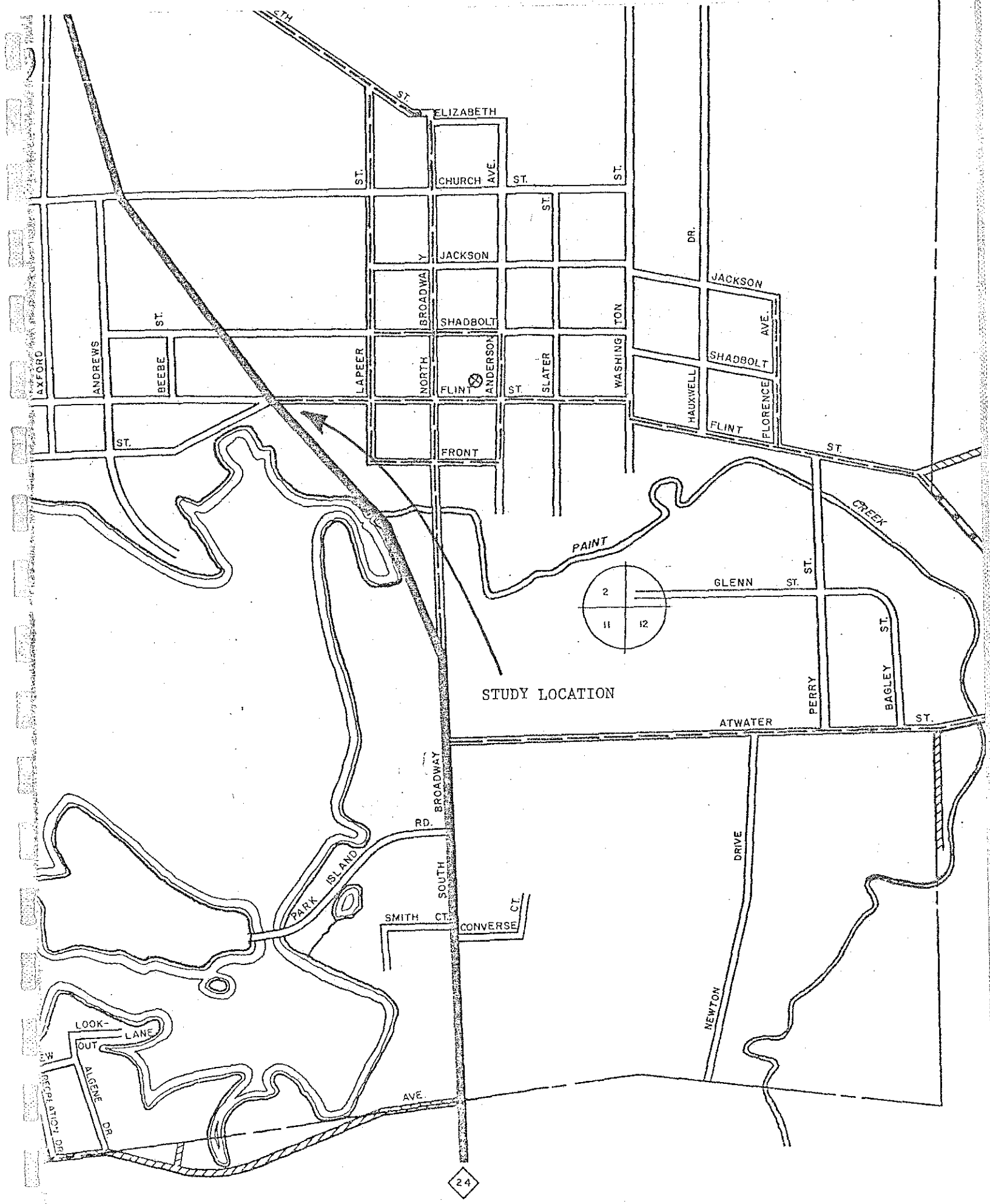
Using the simplified zero interest approach, our estimated updated TOR (time of return) is:

$$\frac{\$212,000}{\$\ 72,325} = 2.9 \text{ years}$$

Comparison of Left-Turn Data
M-24 at Flint Street

	3-8/9-72 Survey	4-24-78 Survey	Change %
Southbound Left Turn			
volume	697	1007	+ 44
opposing thru	4236	6315	+ 49
opposing left	119	169	+ 42
left turn on amber	110	212	+ 93
left turn on red	27	97	+260
left turn delay over 1'	0	4	-
Westbound Left Turn			
volume	998	1084	+ 9
opposing thru	165	182	+ 10
opposing left	78	96	+ 23
left turn on amber	37	59	+ 60
left turn on red	4	5	+ 25
left turn delay over 1'	3	0	-100%

Though little statistical significance should be assumed in comparing these two samples, it appears that the increase in capacity afforded by the project was overcome by the volume increases and the number of signal violations increased rather than decreased. One then questions the relationship between signal violations and accident experience.


ELIZABETH ST.
CHURCH AVE.
JACKSON ST.
SHADBOLT ST.
FLINT ST.
FRONT ST.
ANDREWS ST.
BEEBE ST.
AXFORD ST.
LAPEER
NORTH
BROADWAY
ANDERSON
SLATER
WASHINGTON
DR.
JACKSON
SHADBOLT AVE.
HAUXWELL
FLORENCE
FLINT ST.
PAINT CREEK
GLENN ST.
2
11
12
STUDY LOCATION
ATWATER ST.
PERRY
BAGLEY ST.
BROADWAY RD.
PARK ISLAND
SOUTH
SMITH CT.
CONVERSE CT.
DRIVE
NEWTON
LOOK-OUT LANE
ALGENE DR.
AVE.
24

MIDAS Comparisons

M-24 at Flint Street

Histograms presented on the next two pages are for demonstration only and show the study location appearing in 1975 but not in 1977 for the parameters given; left-turn accidents at 4-lane, two-way signalized intersections with average daily traffic between 25,000 and 36,000 vehicles. Since the construction occurred in 1977, no inference can be made here. The format for MIDAS was changed in 1978 from injury only accidents to total so no comparison is available for the "after" year.

STATEWIDE,4L2W,STRIP,SIGNAL,ADT 25-36000,1975INJ

LEFT TURN

BEFORE

NUMBER OF LOCATIONS

```
          1         2         3         4         5         6
ACC*12345678901234567890123456789012345678901234567890123456789012345
  0*XXXXXXXXXXXXXXXXXXXXXXXXXX
  1*XXXXXXXXX
  2*XXXXXX
  3*0
  4*0000
  5*0
  6*
  7*0
```

ACCIDENT TYPE = 4
LOCATIONS = 48
AVE 24HR VOLUME= 29849
AVE ACCIDENTS = 1.083
UPPER LIMIT = 2.990

HIGH HAZZARD LOCATIONS-- 7

CSECT	MP	ACC	ROUTE	XROAD/MIDBLOCK	LOCAL GOV'T	COUNTY
50031	6.55	5	M-97	AT MASONIC ROAD	FRAZER CITY	MACOMB CO
63041	17.64	7	M-59	AT CASS LAKE ROAD	WATERFORD T	OAKLAND C
63041	18.62	4	M-59	AT VOORHEIS ROAD	WATERFORD T	OAKLAND C
63053	1.51	4	US-10	AT ANDERSONVILLE ROAD	WATERFORD T	OAKLAND C
63112	7.32	4	M-24/I-75 BL	AT FLINT/LAKE STS.	LK. ORION CY	OAKLAND C
63131	1.24	3	M-150	AT WATTLES/17 MILE RD	PONTIAC CITY	OAKLAND C
73062	7.01	4	M-46	AT WHEELER STREET	SAGINAW CITY	SAGINAW C

STATEWIDE,4L2W,STRIP,SIGNAL,ADT 25000-36000,1977INJ

LEFT TURN AFTER

NUMBER OF LOCATIONS

```
             1         2         3         4         5         6
ACC*123456789012345678901234567890123456789012345678901234567890123
  0*XXXXXXXXXXXXXXXXXXXXX
  1*XXXXXXXXXXX
  2*XXXXXXX
  3*000
  4*000
  5*0
ACCIDENT TYPE  = 4
LOCATIONS      =    47
AVE 24HR VOLUME= 29055
AVE ACCIDENTS  = 1.085
UPPER LIMIT    = 2.990

HIGH HAZZARD LOCATIONS--   7
```

CSECT	MP	ACC	ROUTE	XROAD/MIDBLOCK	LOCAL GOV'T	COUNTY
28013	2.00	4	US31/M72/M37	AT E JCT M37/GARFIELD	TRAVERSE CTYGR	TRAVER
33011	4.70	3	M-99	AT MT HOPE AVE	LANSING	INGHAM
39082	0.23	3	M43-M89	AT RIVERVIEW AVENUE	KLMAZOO CITY	KALAMAZOO
73062	3.95	4	M-46	AT RIVER ROAD	SHIELDS VILL	SAGINAW C
73062	4.65	5	M-46	AT JCTM-47,MIDLAND RD	SAGINAW TWP	SAGINAW C
73062	5.83	4	M-46	AT CENTER ROAD	SAGINAW TWP	SAGINAW C
73062	7.44	3	M-46	AT ELM STREET	SAGINAW CITY	SAGINAW C

STATE OF MICHIGAN
DEPARTMENT OF STATE HIGHWAYS

Form 1533-A
(Rev. 5/65)

VEHICLE VOLUME COUNT
GRAPHIC SUMMARY SHEET

Study #346

DATE 3-8/9-72 DAY Wed.-Thurs. COUNTY Oakland TIME

TWP., VILLAGE OR CITY Lake Orion WEATHER

INTERSECTION OF M-24 (Lapeer Rd.) and Flint St.

BEFORE

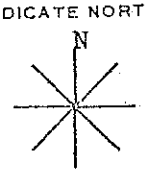
2P TO 6P

7A TO 9A

11A TO 1P

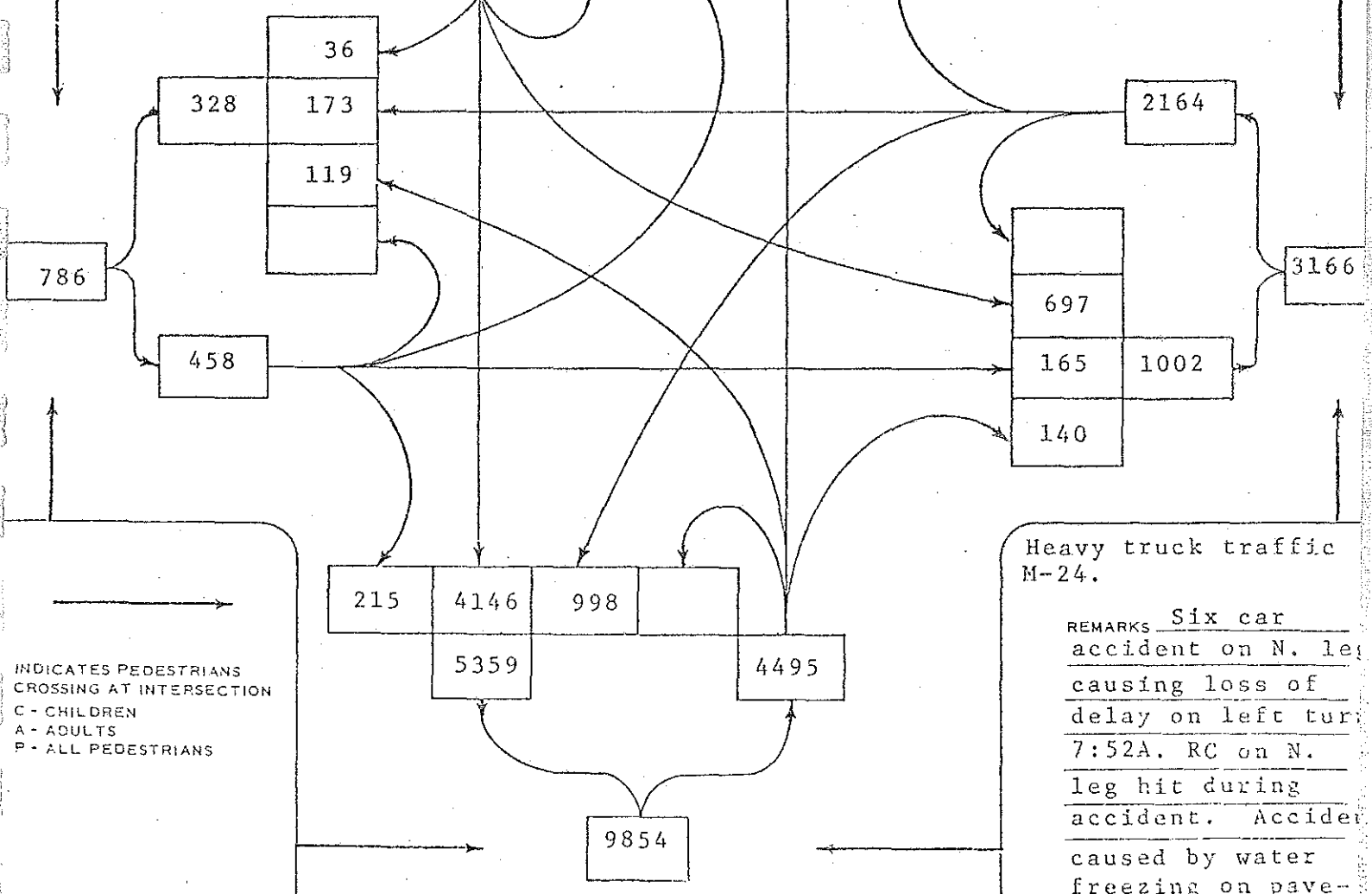
NW M-24 (Lapeer Rd.) 8 Hour Total

INDICATE NORTH



Flint St.

Flint St.



INDICATES PEDESTRIANS CROSSING AT INTERSECTION
C - CHILDREN
A - ADULTS
P - ALL PEDESTRIANS

M-24 (Lapeer Road) 75 SE

Heavy truck traffic M-24.

REMARKS Six car accident on N. leg causing loss of delay on left turn 7:52A. RC on N. leg hit during accident. Accident caused by water freezing on pavement. Intersection was clear at 8:42.

1763 (7/75)

VEHICLE VOLUME COUNT

GRAPHIC SUMMARY SHEET

Study #033

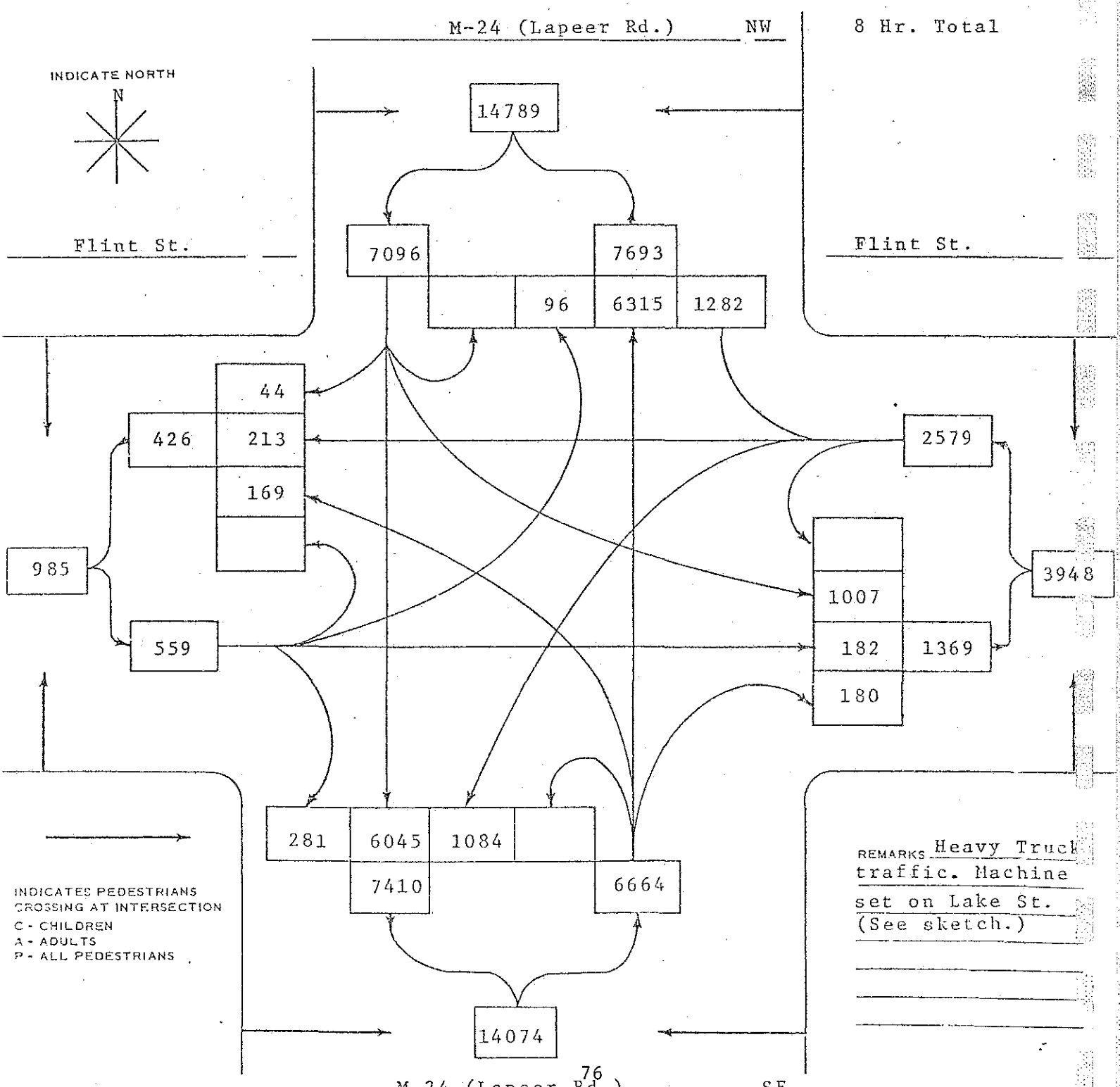
AFTER

DATE 4/24-25/78 DAY Mon/Tues COUNTY Oakland TIME

TWP., VILLAGE OR CITY Lake Orion WEATHER Cloudy | 11A TO 1P

INTERSECTION OF M-24 (Lapeer Rd.) @ Flint St. | 2P TO 6P

	7A TO 9A



INDICATES PEDESTRIANS CROSSING AT INTERSECTION
C - CHILDREN
A - ADULTS
P - ALL PEDESTRIANS

REMARKS Heavy Truck traffic. Machine set on Lake St. (See sketch.)

M-24 at FLINT Street
Looking North

BEFORE

AFTER

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Perhaps the most important contribution the workshop participants can make is to objectively analyze the work they have performed these past months preparing the evaluation and offer recommendations for future evaluation of projects.

In general, the procedures are quite straightforward and easy to follow. At the onset the requirements for listing objectives and purposes and measures of effectiveness seemed trivial, but they are important in setting up a study plan, of less importance for inclusion in a final report.

It is our feeling now, as was the consensus of those at the September 1977 evaluation seminar, that too much of the Student Manual is devoted to functions A through D which involve rather rudimentary tasks. More training is required in functions E, F, and G which involve the parametric comparisons, statistical significance, and economic analysis. The methods followed in evaluating these five projects were quite effective in determining project success or failure. If any one area requires more emphasis it is the statistical significance testing portion as well as statistical design of study sample sizes and measures of effectiveness.

Our use of MIDAS has demonstrated its benefits as both a surveillance tool in selecting locations for improvement and as an evaluation tool as the ultimate in control group comparison.

The cost of this evaluation training (including this report) is about $9,000 or 1 percent of the total cost of the five projects evaluated. The cost of the projects and the evaluation were returned to the taxpayers in less than three years.

12-10-80
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