TRAFFIC ENGINEERING DEMONSTRATION PROJECT ON U.S. 52 BYPASS

INVENTORY, ANALYSIS AND RECOMMENDATIONS

MAY 1966
NO. 8

by

G. A. SHUNK
AND
H. L. MICHAEL

Joint Highway Research Project

PURDUE UNIVERSITY
LAFAYETTE INDIANA

Progress Report

TRAFFIC ENGINEERING DEMONSTRATION PROJECT

ON U.S. 52 BYPASS; LAFAYETTE, INDIANA

INVENTORY, ANALYSIS AND RECOMMENDATIONS

To: G. A. Leonards, Director
Joint Highway Research Project

May 10, 1966

From: H. L. Michael, Associate Director
Joint Highway Research Project

File: 8-7-4
Project: C-36-66D

The attached Summary Report entitled "Traffic Engineering Demonstration Project on U.S. 52 Bypass; Lafayette, Indiana, - Inventory, Analysis, and Recommendations" was prepared by G. A. Shunk and H. L. Michael of our staff. It is a summarization of all work done to date in this study. It presents recommendations for work to be undertaken by the State Highway Commission to improve the operative efficiency of the highway. The work recommended is of such a nature as to be generally applicable to similar situations elsewhere in Indiana and other states to improve the efficiency and safety of traffic movement at minimal expenditure.

This work was undertaken in order to guide the State in improving efficiency of the facility until major reconstruction becomes possible. The effectiveness of the improvements recommended and made will be measured and used to develop a simulation model which will permit the prediction of the effects of similar improvements on other facilities, thereby presenting a tool for evaluation of benefits to be received. Several projects outlined in this report have already been implemented as a result of earlier preliminary recommendations to the State.

The report is presented for the record and will be submitted to the State Highway Commission and the Bureau of Public Roads for review and comment.

Respectfully submitted, S.T.

Harold L. Michael

Harold L. Michael, Secretary

HLM:sat

Attachment

Copies: F. L. Ashbaucher
J. R. Cooper
J. W. Delleur
W. L. Dolch
W. H. Goetz
W. L. Grecco
G. K. Hallock
F. S. Hill
J. F. McLaughlin
F. B. Mendenhall
R. D. Miles
J. C. Oppenlander
W. P. Privette
M. B. Scott
K. B. Woods
E. J. Yoder

Progress Report

TRAFFIC ENGINEERING DEMONSTRATION PROJECT
ON U.S. 52 BYPASS; LAFAYETTE, INDIANA
INVENTORY, ANALYSIS, AND RECOMMENDATIONS

By

Gordon A. Shunk
Research Assistant

And

Harold L. Michael
Associate Director

Joint Highway Research Project

Project No.: C-36-66D
File No.: 8-7-4

Prepared as Part of an Investigation

Conducted by

Joint Highway Research Project
Engineering Experiment Station
Purdue University

in cooperation with

Indiana State Highway Commission

and the

Bureau of Public Roads
U S Department of Commerce

Not Released for Publication

Subject to Change

Not Reviewed by
Indiana State Highway Commission
or the
Bureau of Public Roads

Purdue University
Lafayette, Indiana

May 10, 1966

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES

Continued

APPENDIX FIGURES

LIST OF TABLES

APPENDIX

INTRODUCTION

Traffic congestion on city streets is currently a major problem of nearly every urban area in the United States. This condition is the result of increases in travel demand far beyond the capability of existing streets to carry traffic. The resulting congestion is causing strangulation of central business areas as people avoid constriction and seek desire satisfaction in areas accessible by less restricted traffic facilities. When no better alternatives exist, congestion contributes to loss of productive time and increased travel costs as people require more time to reach their destination and drive carelessely in attempting to circumvent congestion situations.

Congested conditions also exist on arterial highways in suburban areas. In this situation, however, travelers usually are not sufficiently familiar with the area to be able to select an alternate to the marked route and must, therefore, deal with the problem in whatever manner they feel necessary. The result of passive acceptance of the congested situation is the inefficiency of increased travel time. The result of drivers' attempts to eliminate delay may be an accident and injury or death. The problem presented to the highway engineer is, therefore, one of improving the traffic carrying capabilities of streets and highways in order to satisfactorily serve travel desires.

Congestion can be attributed to several factors, most of which may be grouped under either of two general headings. The more abvious of the two is inadequacy of the existing physical facility. This condition is difficult and expensive to remedy. The less recognizable situation is lack of complete utilization of the physical facility available. This latter condition is usually relatively easily and inexpensively remedied if the effectiveness of traffic engineering techniques is known and the ability to apply these is within the grasp of persons responsible.

The project reported here was designed to demonstrate the effectiveness of applied traffic engineering for attaining the ultimate operating potential of an arterial highway in a suburban area. Its seeds were in the work done by the U. S. Bureau of Public Roads on Wisconsin Avenue in Washington, D. C. The Wisconsin Avenue Study demonstrated that application of traffic engineering principles could yield significant results in the improvement of traffic operation on an urban arterial street. The present project proposed to demonstrate how these same techniques could yield similar improvements for a different situation, the suburban arterial highway. This type facility was chosen because of its similarity to several situations in Indiana, as well as other states, and the generalized applicability that could thereby be derived. It is felt that results obtained here will be helpful to the State Highway Commission in decisions relating to how to utilize limited available funds for improving existing facilities so as to obtain maximum benefit for each dollar spent. The results will also demonstrate means of obtaining temporary relief for areas badly in need thereof, but for which remedial major construction is currently financially infeasible.

THE STUDY

The U. S. 52 Bypass of Lafayette, Indiana, was the location chosen for study, principally because of its proximity to the University (Figure 1).

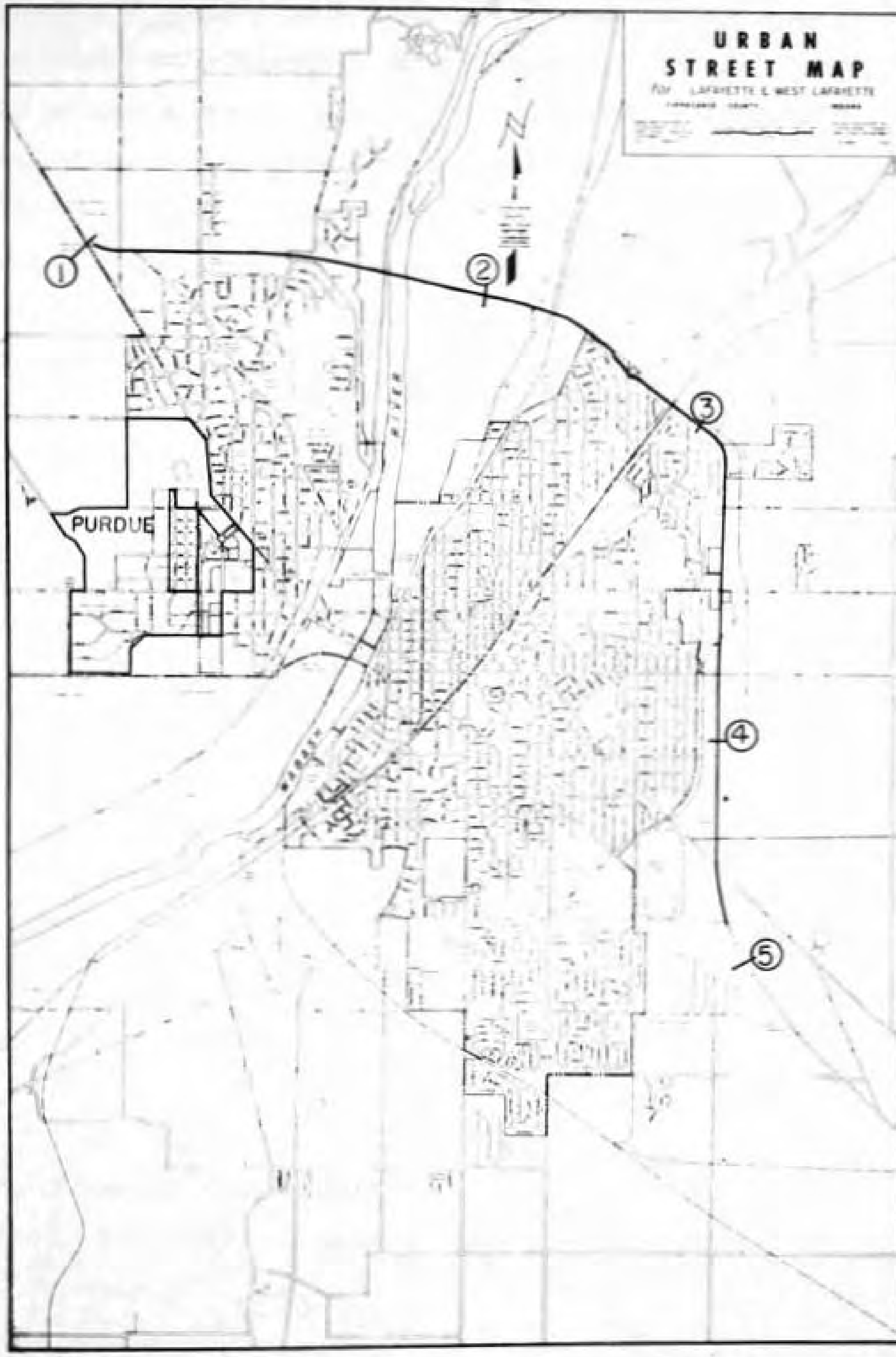


FIGURE 1 LOCATION OF CONTROL COUNTERS AT BOUNDRIES OF COUNTING SECTIONS

This location is the principal bottleneck on a heavily traveled route between Chicago and Indianapolis. It is a typical suburban area arterial highway on which no access control has been exercised (Figure 2), and it is badly in need of improvement. Readily available funds are nowhere near sufficient for the type of improvement that is presently necessary. Existing physical and operating conditions were studied in depth, and are summarized in this report. Inventories and analyses of accidents, speed and delays of traffic flow were also made. These studies were reported in detail in two previous reports and are summarized here. The effectiveness of improvements recommended in this report will also be estimated by use of a mathematical simulation model. Details of the model and results of such tests will be presented in subsequent reports.

PROCEDURE

The inventories of existing conditions were conducted between August 1, 1964, and July 1, 1965, and included the following surveys:

A. Physical Conditions
    1. Highway geometrics
    2. Physical dimensions other than geometrics
    3. Type and intensity of marginal development
B. Traffic Conditions
    1. Traffic volume
    2. Turning movements
    3. Vehicle classification
    4. Travel character analysis
C. Accidents
D. Speed-and-Delay

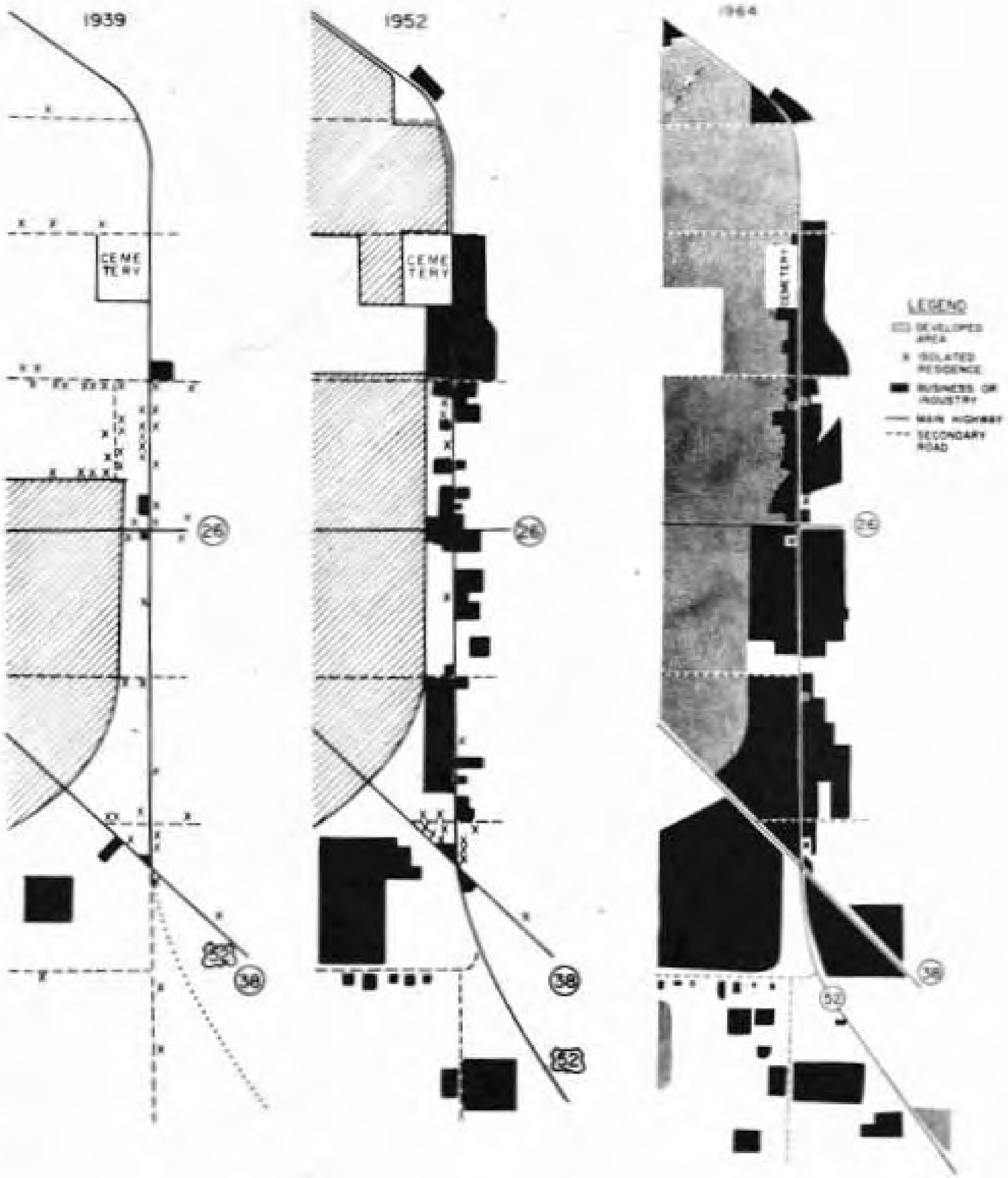


FIGURE 2 DEVELOPMENT ALONG PORTION OF THE U.S. 52 BY-PASS FOR 1939, 1952 AND 1964.

The data was gathered by the staff of the Joint Highway Research Project with the cooperation of the Indiana State Highway Commission, the Indiana State Police, and police and public works agencies of the cities of Lafayette and West Lafayette.

Physical Conditions

The inventory of geometric features utilized plans for the original construction of the present facility. This construction was completed in 1937 and has since been modified in only minor respects except for the addition of two lanes and a transition to a divided crossection at the south end in 1943. Information obtained from the plans included horizontal and vertical curvature, right-of-way width, intersection angles, and stationing of control points. The physical features are summarized in Table A1. (Tables and Figures with an "A" prefix number are in the appendix)

The Bypass is 41,954 feet long from the north end tangent to the Teal Road intersection. There are 15 intersections, 8 of which are signalized. The maximum horizontal curvature is 3.0 degrees and the steepest grade is 6.0 percent. The roadway is centered on a 100 foot right-of-way except at one location where only 78 feet is available for a distance of 1100 feet.

Pavement type and quality are consistent for the entire length of the facility: a deteriorating bituminous overlay on Portland Cement Concrete. Underlying concrete is heaving, causing roughness at many locations. At several locations "extra" lanes used to relieve locally severe constrictions are of substantially lower quality than the main pavement. These lanes were constructed as a maintenance activity and have a thin layer of bituminous material over the aggregate shoulder (Table A1 (4)). Shoulder quality and width are inconsistent. The area measured was that other than turf, adjacent to the pavement, and includes three informal rest areas. The width of maintained shoulder is ten feet at most locations (Table A1 (5)).

Development along the facility was cataloged by use of aerial photography, and each developed parcel was classified according to function. Width of driveways as well as estimated AADTs are shown in Table A2. The only quantitative measure of the influence of driveways is that inferred from the results of the regression analyses of accidents and travel speed-and-delay,which is discussed in a later section of this report. Because of the small number of samples, no attempt was made to correlate specific land uses with location, accidents, or delays.

Land use along the Bypass was summarized on a front-footage basis for informational purposes and is shown in Table 1. Land use along intersecting facilities was cataloged in only a general manner by inspection of aerial photographs and field reconnaissance and is given in the intersection analysis portion of each recommendation. Figure A9 shows a general orientation of the bypass and development along the route.

Traffic Conditions

Measurement of traffic volumes utilized pneumatic actuated equipment. In order to utilize a control counting technique, the facility was broken into sections and a hierarchy of control counters established. The sections

TABLE 1

FUNCTIONAL LAND USE

OF

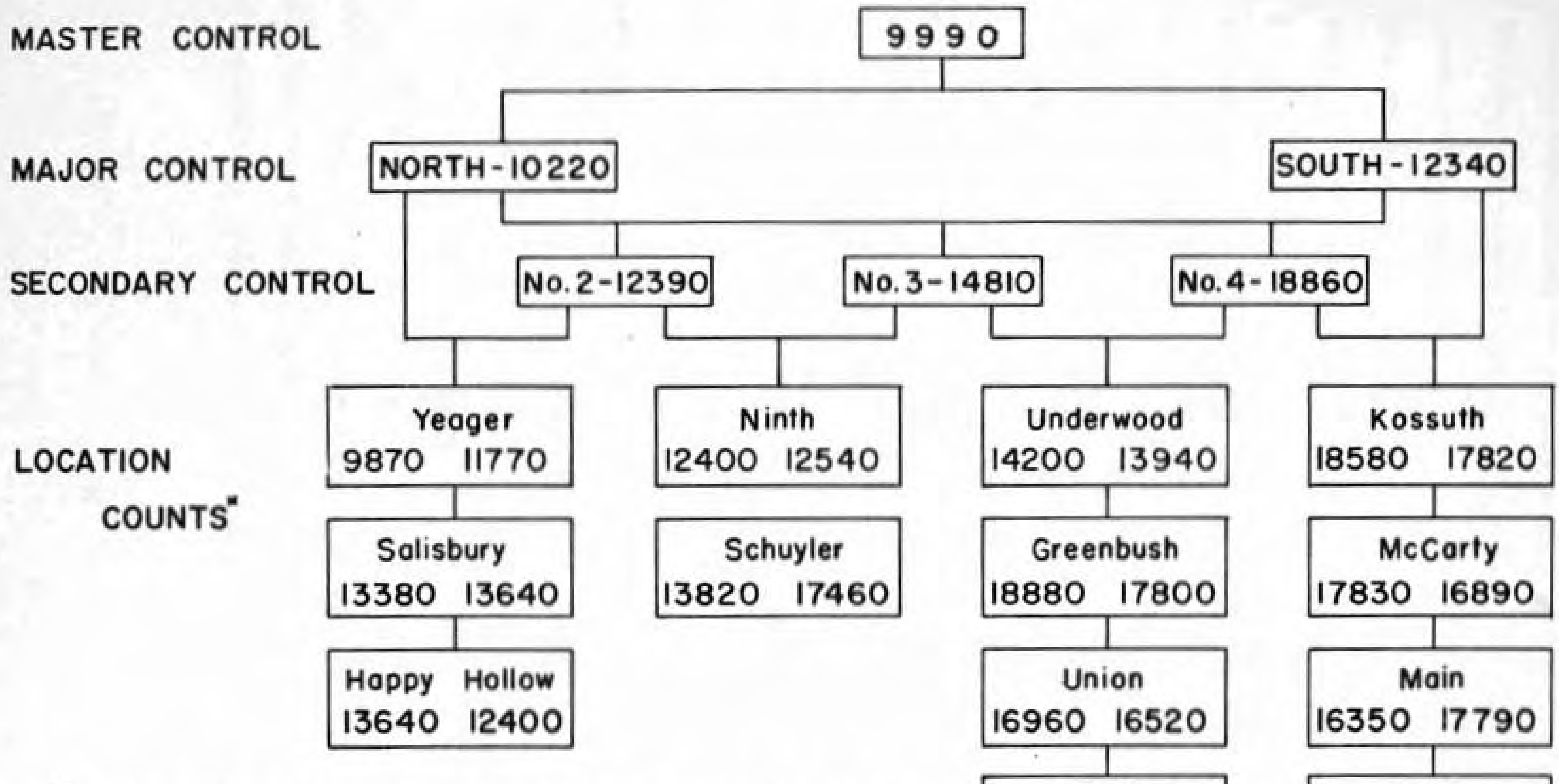
BYPASS MARGINAL DEVELOPMENT

Land Use	Percent
Residential	7.3
Retail Commercial	19.8
Wholesale Commercial	0.1
Services and Offices	2.7
Manufacturing Industrial	12.4
Non-Manufacturing Industrial	1.9
Public and QuasiPublic Buildings	0.5
Public and QuasiPublic Open Space	2.2
Other Open Space and Miscellaneous	53.1

(Figure 1) were designed according to the section length criterion of the simulation model and were four in number.

The master control counter was an Automatic Traffic Recorder (ATR) station operated by the State Highway Commission south of Lafayette on U. S. 52. It was possible to obtain nearly complete data from this counter for the year during which the local volume counting was done and thereby calculate a true AADT. The major control counters, located at the ends of the Bypass, were operated during any period when counting was being done. The AADT at these counters was calculated by multiplying the average ratio of their counts to the ATR counts by the AADT of the ATR. These AADT values were then used as a basis for calculating AADT at Bypass locations. Secondary control counters were located at the boundaries of given sections. These were operated whenever any traffic counting was being done in the section. AADT for each secondary control was based on those of major control. AADT for counts within sections was based on those for secondary control at the section boundaries. The hierarchy was arranged in this manner in order to minimize variation due to diversity of location. Accuracy of the volume counts was paramount in order to achieve a valid calibration of the simulation model. The AADT of all control locations are summarized in a hierarchical representation in Table 2. AADT of each intersection approach is given in Figure A1. Daily variation of major control is shown in Figure A2.

Signalized intersections were counted for four full days including a weekend; non-signalized intersections were counted for at least 24 hours, including either a Tuesday or a Thursday. Driveways were counted manually for one hour during business hours. Establishments with periodic



* INTERSECTION VOLUMES SHOWN ARE TOTAL VOLUMES FOR THE NORTH AND SOUTH BYPASS APPROACHES TO RESPECTIVE INTERSECTIONS

BYPASS AADT VOLUMES AND COUNTING HIERARCHY

TABLE 2

demands were counted for one hour at both peak and non-peak periods. Estimated driveway AADT is given in Table A2. Turning movements at all intersections (Figure A1) were tabulated manually during the afternoon peak and several non-peak hours, at a time when automatic traffic counters were in operation at that location. Directional breakdowns were made at all major and secondary control locations. That at secondary control location No. 3 is shown in Figure A3. Vehicular classification was done manually, directionally at each section boundary on one week day, from noon until 6 P.M. (Table A11). One station was counted for 24 hours to establish the hourly pattern (Figure A4).

The analysis of travel character, that is the through or terminal nature, was done using a "headlights on" technique during a weekday in the autumn. The object of the survey was to estimate what percentage of the traffic approaching the area on the five main routes (including two approaches of U.S. 52) is truly through traffic. It is felt that these results will serve as a good base for a sufficient estimate of the traffic that will be diverted from the present facility upon completion of the proposed I-65 bypass east of Lafayette. The figures were necessarily gross but sufficiently accurate for the use intended and are presented in Table 3.

The simulation model currently being developed from the Indiana University SIMCAR program requires accurate vehicular arrival rates, that is headway distributions, at the entrance and exit of all sections. Such data was obtained utilizing modified pneumatic traffic counters as detectors and a multi-pen graphic recorder to indicate the times

TABLE 3

SUMMARY

"HEADLIGHTS ON"

TRAVEL CHARACTER SURVEY

(Survey Conducted November 4, 1965, 8:00 a.m. to 5:00 p.m.)

OUTBOUND

Location	Trucks	Through	%	All Vehicles	Through	%
U.S. 52 North	604	447	74	2108	1157	55
Indiana 25	394	88	22	2145	256	12
Indiana 26	229	43	19	1132	164	14
Indiana 38	171	21	12	1212	115	9
U.S. 52 South	637	390	61	2771	934	34
Total Outbound	2035	989	49	9368	2626	28
Inbound	2443	---	40	10898	---	24
			44			26

of vehicle arrivals. This data was obtained directionally at each secondary and major control station. Data was collected at one location in morning and evening peak and non-peak hours on 2 weekdays and a weekend. Other locations were surveyed between 1 p.m. and 7 p.m. on one weekday. The results of these surveys are shown in Figure A5.

Speed-and-Delay *

The speed-and-delay study determined locations of consistent speed reduction and delay utilizing an "average car" method for determination of travel times on the facility. Forty runs were made in each direction, travelling the full length of the Bypass each time. This yielded a total of 400 samples in interrupted flow (signalized intersections) and 800 samples in uninterrupted flow. Runs were made on weekdays in daylight, in good weather, and were done at various times during the day, including the noon and evening peak periods and non-peak periods between 8:00 a.m. and 6:00 p.m. Field data collected included time to traverse study subsections and elapsed time of and reason for stop and slow-down delays. Travel speeds of various subsections are represented in Figure 3. A summary of the speed and delay data is presented in Table A3. The subsections used in the speed-delay study are depicted in Figure 4.

* Treadway, T. B., An Analysis of Travel Speed and Delay on a High-Volume Highway; Purdue University, Joint Highway Research Project; Lafayette, Indiana; June, 1965.

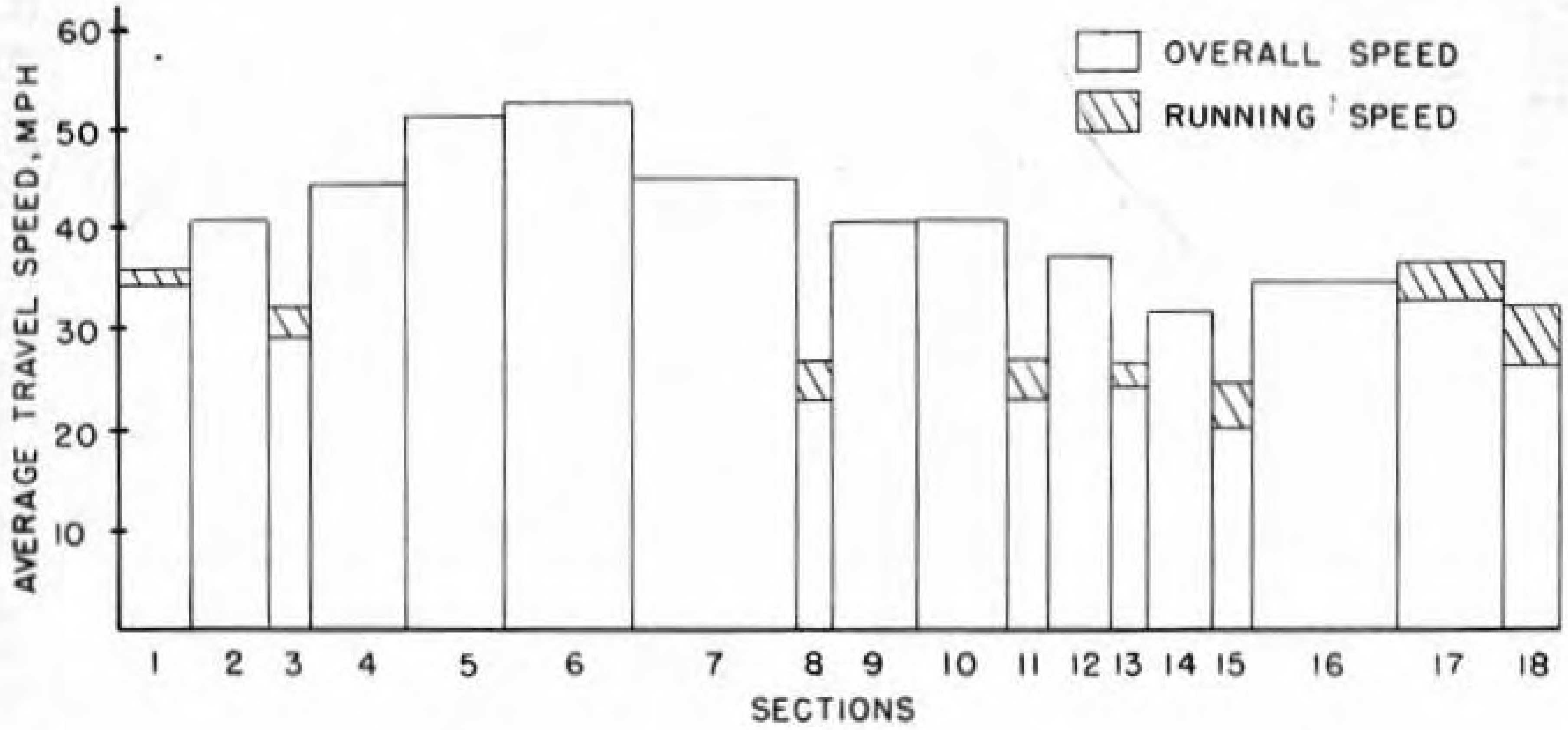


FIGURE 3 AVERAGE TRAVEL SPEEDS FOR SECTIONS

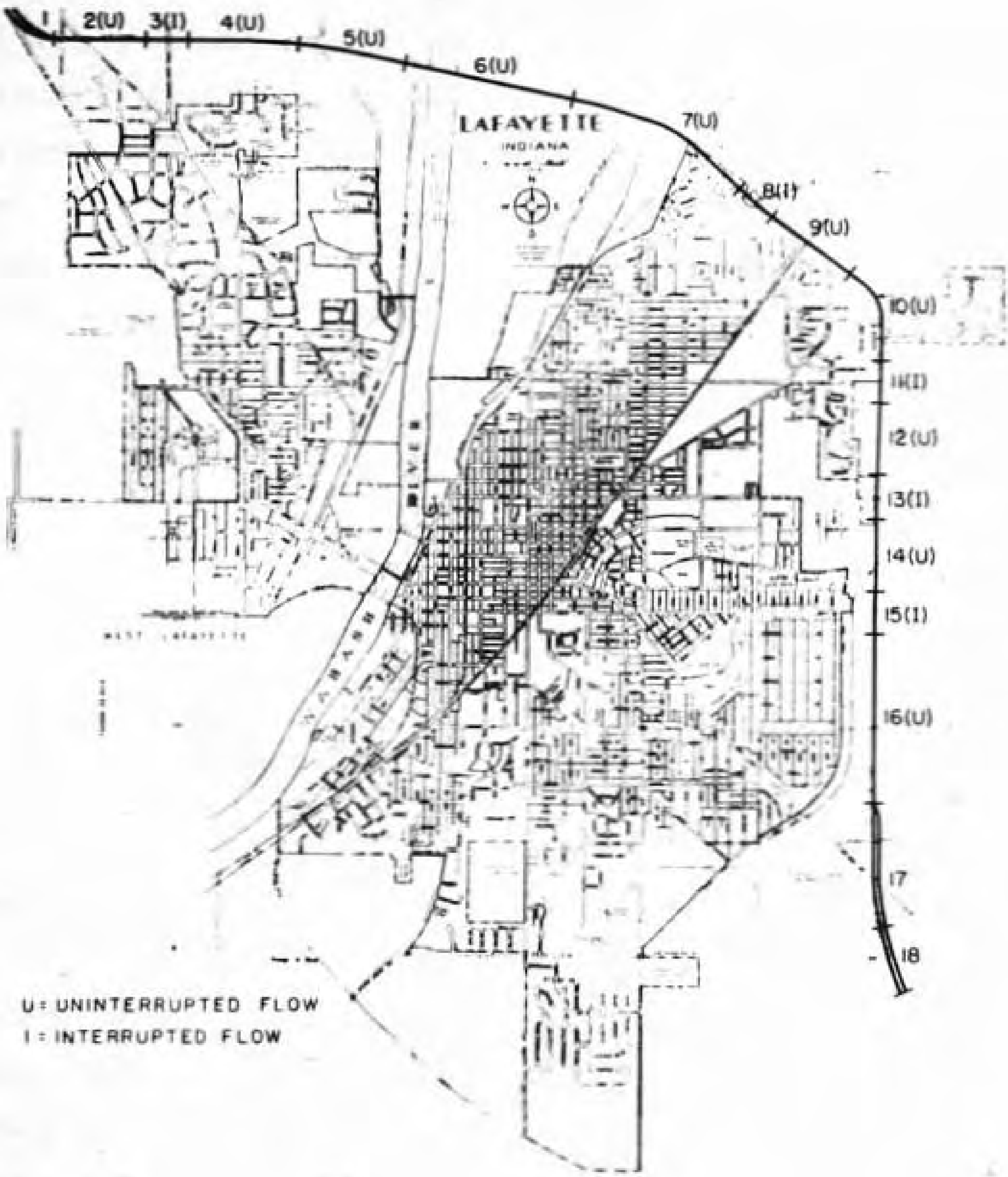


FIGURE 4 TEST SECTIONS OF U.S. 52 BYPASS SPEED-DELAY

Accidents *

A study of historical accident records and contributory conditions constituted the final major investigation of the facility. This analysis encompassed all accidents occurring between January 1, 1961, and December 31, 1963, including 834 accidents with 374 injuries and 10 deaths. Substantial portions of this data were obtained from the Accident Records Section of the Indiana State Police. Supplementary accident data was obtained from local police departments. Historical data on physical features and development were supplied by the Indiana State Highway Commission and local agencies. Sufficient information on the history of development was available from these sources to preclude the necessity of examining building permit records.

ANALYSIS

The previous reports of this project have been largely devoted to extremely detailed statistical analyses of existing physical and operational conditions on the Bypass. These works have emphasized the influence of various factors on speed, delay, and accident propensity. They have delineated locations of high accident frequency and severe speed restriction and implied the conditions which must be modified if improvement is to be realized. Further mathematical analysis is being conducted in connection with development of the computer program to simulate operation of the facility.

* Peterson, A. O., An Analysis of Traffic Accidents on a High-Volume Highway; Purdue University, Joint Highway Research Project; Lafayette, Indiana; July, 1965.

The analysis utilized statistical procedures to evaluate the coexistence of various physical and operational conditions with fluctuations in speed and delay. The multivariate and multiple linear regression analyses delineated several factors which appear to be significantly related to the occurrence of speed reduction and delay. Highest overall travel speeds in uninterrupted flow conditions were attained in areas where commercial development was sparse. The presence of urban and absence of rural development were also correlated with decreases in speed. The single most important and significant factor was that describing stream friction conditions. This included effects of volume, roadway capacity and the proximity of traffic signals.

Results of the interrupted flow analysis indicated peak period volumes, topography, and cross street volume affected speed and delay significantly. Green time ratio of signals, intersection approach grade, and length of turning lane were elements of these factors and thus affected both speed and delay. A summary of the statistical analyses of travel speeds and delays is shown in Table A4.

The accident data were analyzed by several statistical techniques, including regression and quality control. A map depicting subsections used in the accident analysis is Figure A6. The purpose of this multiple analysis was to emphasize deficiencies as well as to compare the results given by various methods.

It was found that 57% of all reported accidents occurred within 100 feet of an intersection. Regression equation variables found significant most often in equations predicting various accident rates at intersections represented Bypass green-time at signals, maximum observed approach speed, and cross street and Bypass volume. Total width of driveways and total number of commercial establishments were statistically significant factors in occurrence of type II (marginal) accidents. By-pass percent green and percent left-turns were significant for type I (intersection) accidents. Number of commercial establishments and total width of driveways per mile were statistically significant for prediction of non-intersection accident rates. Commercial establishments per mile was most often the most significant variable for predicting non-intersection accident rates.

Further analysis of the accident data by statistical quality control techniques indicated that only Teal Road of all intersections was statistically out of control. No non-intersection areas were out of control although several were consistently above or below the mean non-intersection involvement rate.

Ranking of various study sections according to several variations of accident rate consistently showed Teal Road to be the most dangerous intersection and Yeager Road the safest (Table A5). Similar ranking of non-intersection areas showed those in which marginal development is dense and driveway incidence high to be consistently atop the list (Table A6). Figures 5 and 6 show three year accident rates for intersection and non-intersection areas respectively. Figure 7 is a location spot map of 1963 accidents.

Collision-condition diagrams proved very valuable for assigning causes of accidents. Such diagrams summarize accidents by type and precise location. They indicate physical conditions in existence at the time of the accident in such a manner that specific contributory

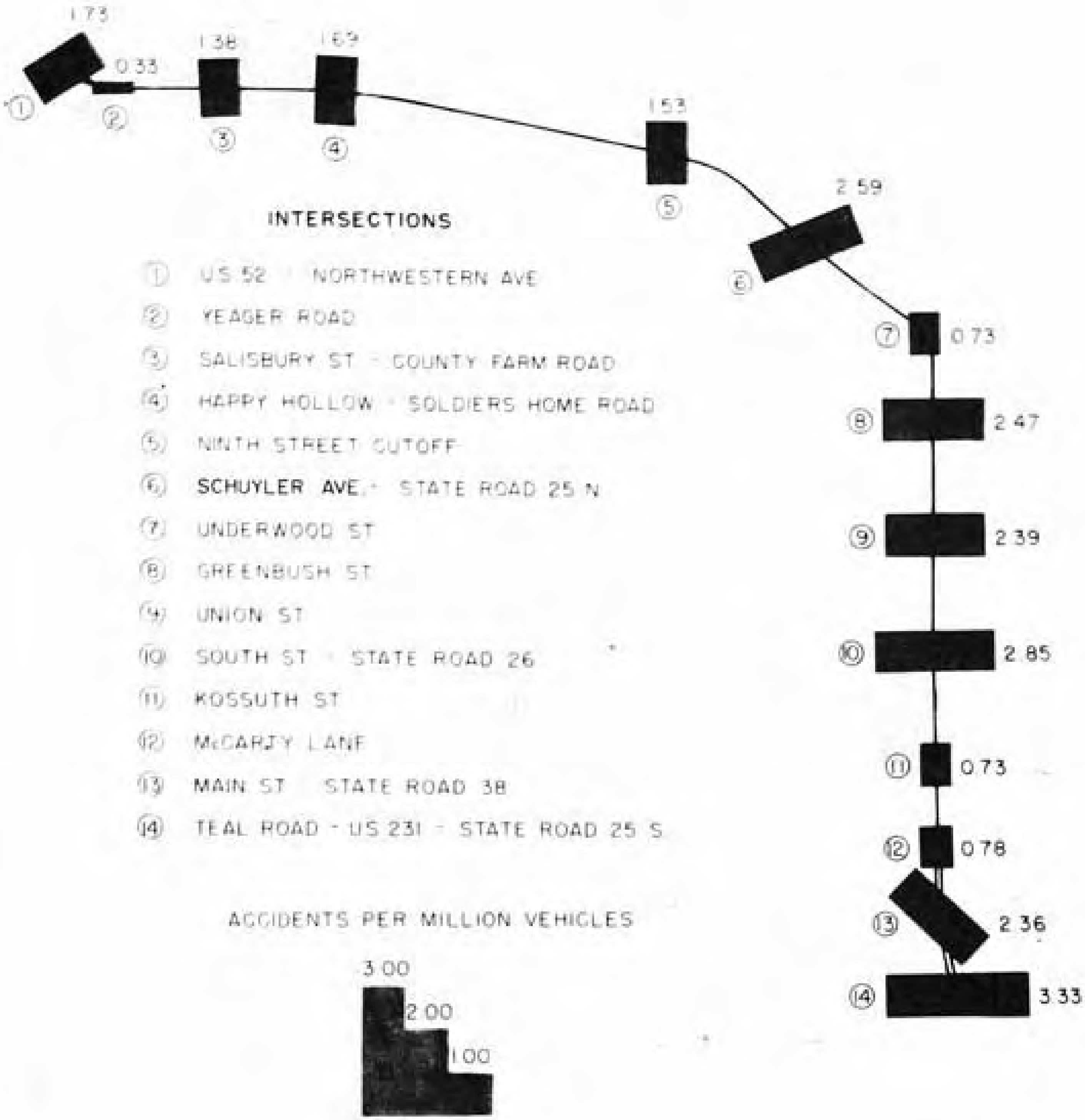


FIGURE 5 AVERAGE ANNUAL INTERSECTION ACCIDENT RATE FOR 1961, 1962 AND 1963.

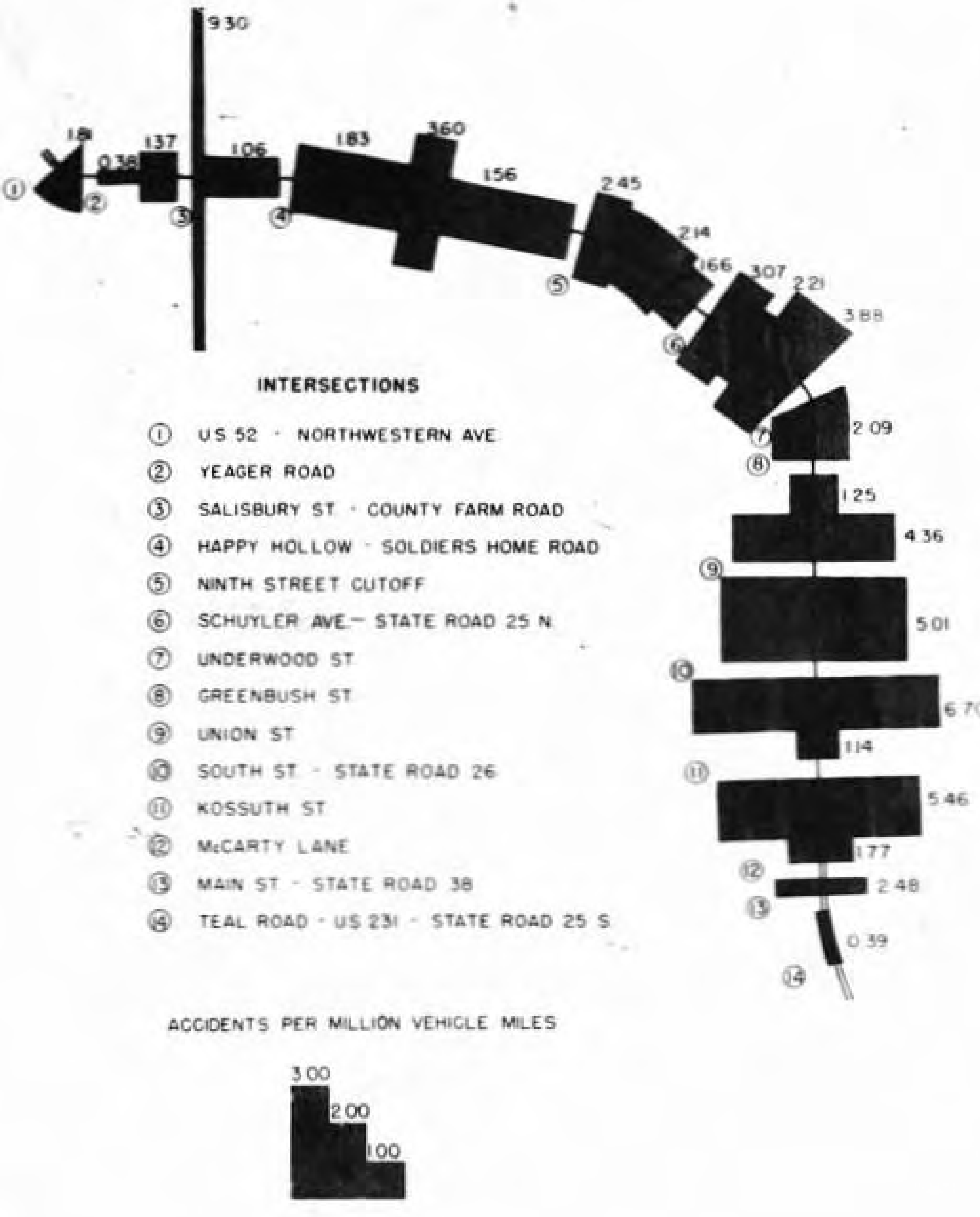


FIGURE 6 AVERAGE NONINTERSECTION ACCIDENT RATES ON THE U.S. 52 BY-PASS FOR 1961, 1962 AND 1963.

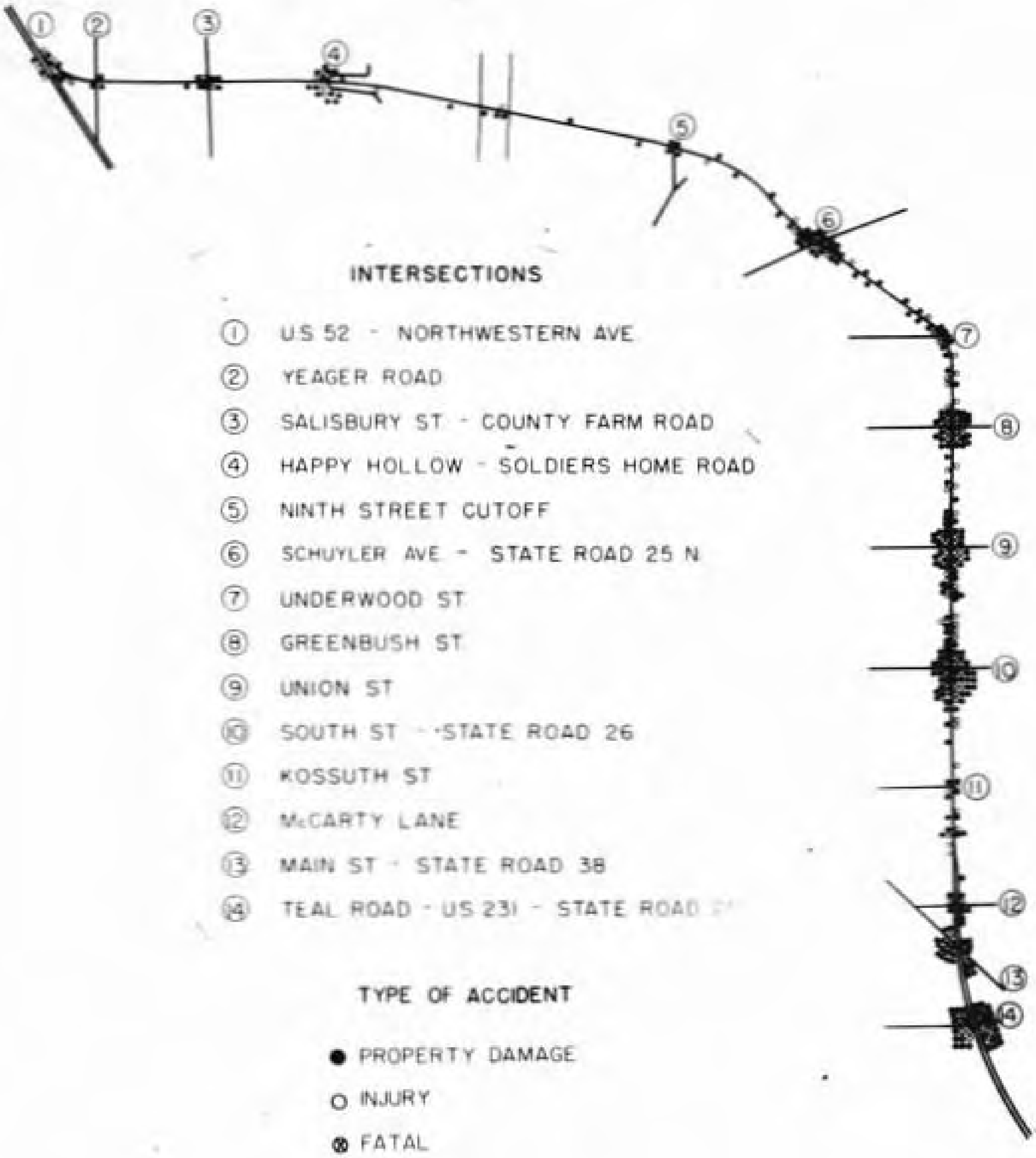


FIGURE 7 1963 ACCIDENT SPOT MAP FOR THE U.S. 52 BY-PASS.

situations are more evident. A sample collision-condition for Teal Road in 1963 is shown in Figure 8.

Installation of traffic signals during the study period appeared in each of three instances to be related to an increase in rear-end and lane-change accidents. Accidents involving vehicles on cross-streets decreased as did the number of right-angle and left-turn types involving vehicles on any approach. Rear-end collisions increased by 400% at Indiana 38. At that location, Bypass travelers were involved in all types of accidents more than twice as often as previously, and cross traffic was involved 75% as often as during the pre-signal period. Teal Road rear-end and lane-change accidents increased eight-fold, while only left-turn accidents were reduced.

Installation of a "passing blister" in one location seemed to reduce accidents of all types. A substantial number of accidents at all locations concerned lane changes, usually for the purpose of by-passing a left-turning vehicle. Similarly, sideswipes occurred abundantly at locations where recovery lanes beyond the intersection were too short to permit an easy merger of two vehicles crossing side by side; this type of accident could also be attributed to inadequate lane use designation. Half of all non-intersection accidents occurred on 1.6 miles of non-intersection length, the location of dense roadside development. Fifty-eight percent of these accidents were concerned with marginal movements. Table A7 summarizes the types of non-intersection accidents. Above average (6.87 per M.V.M.) accident rates occurred between 1 a.m. and 2 a.m., the only night hours throughout the year with such a distinction (Figure 9). Figure A7

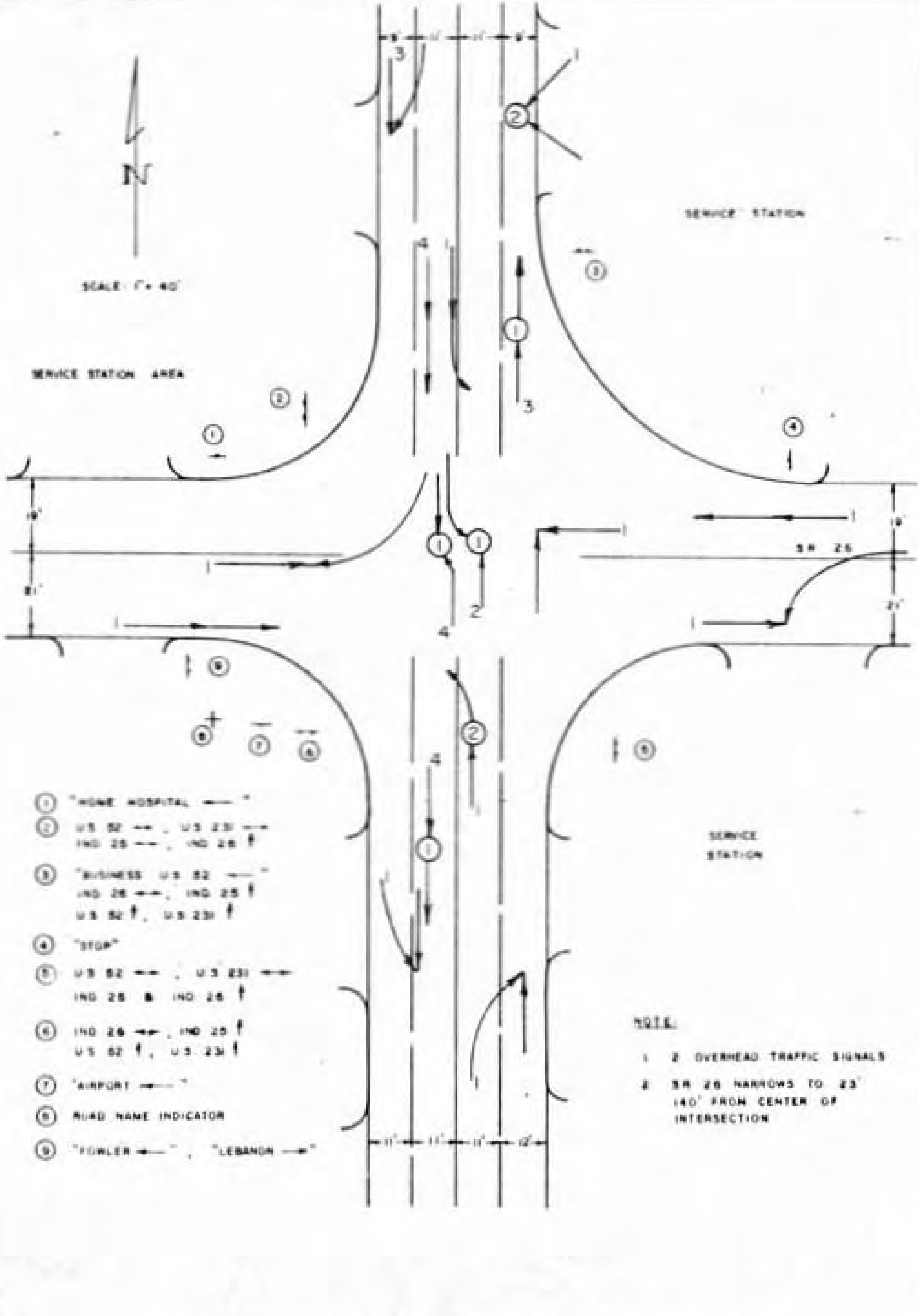


FIG. 8 - U.S. 52 BY-PASS & S.R 26

1963

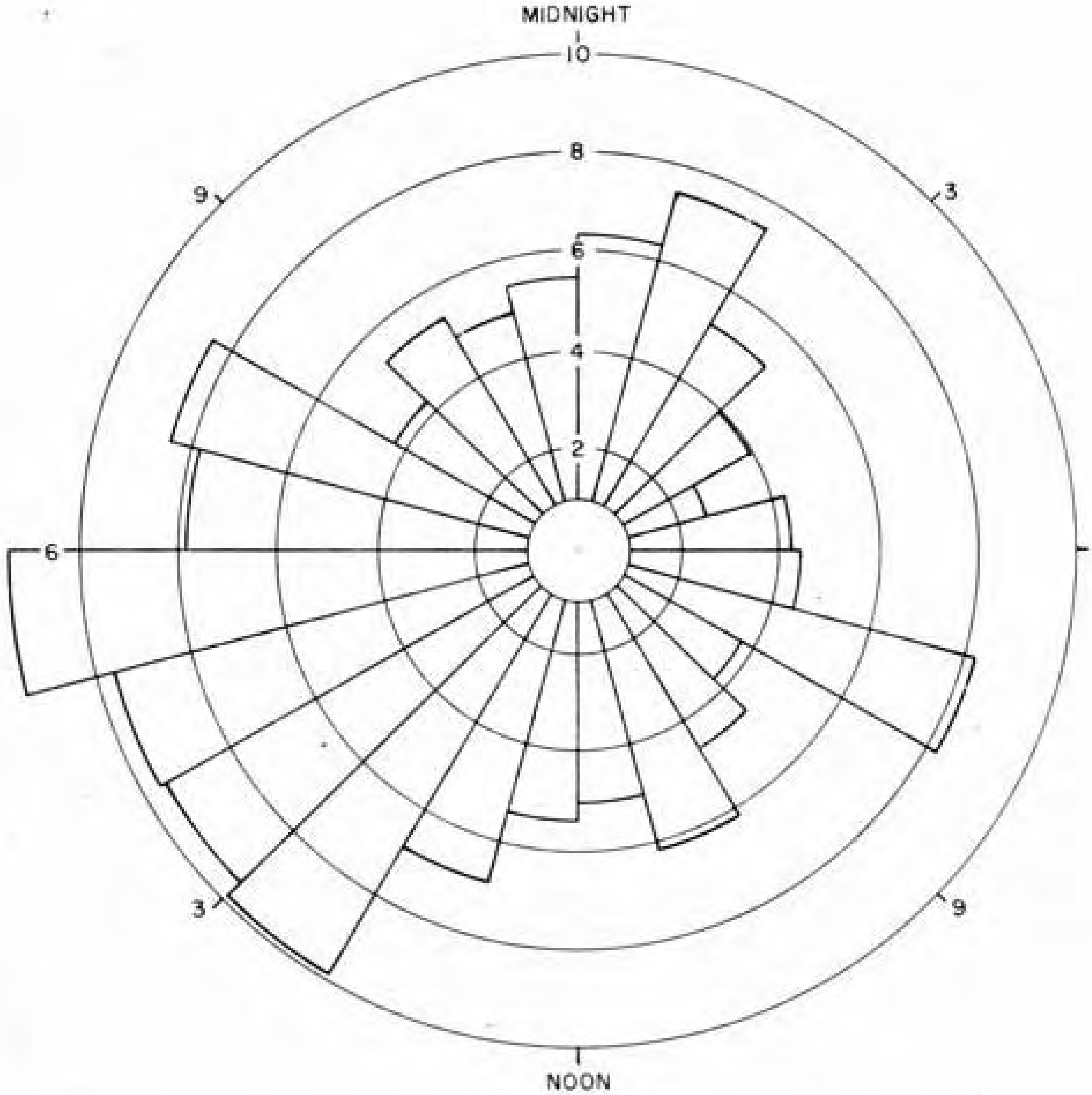


FIGURE 9. AVERAGE ANNUAL ACCIDENTS PER MILLION VEHICLE MILES BY HOUR OF DAY FOR 1961, 1962 AND 1963.

displays some interesting figures on accident involvement rates of several groups. While these results present excellent guidelines for remedial and preventive action, examination of the collision-condition summary is more useful for determining specific improvements necessary. Collision diagrams were presented in detail in the previous report * on accident analysis and will not be reproduced here.

An analysis of lane capacity was conducted in connection with the speed-delay and accident studies. This involved observing operation of existing "extra" lanes at several intersections during local peak periods, i.e. under conditions when possible capacity could be attained. The number of vehicles entering the intersection from the extra lanes was tabulated during each "loaded" cycle throughout the peak period. This process was repeated for several peak periods at each of several high volume intersections having such lanes. The results indicated that lanes of this type and condition handle only about one-third the theoretically possible capacity of a similar lane which is properly designed and constructed.

Practical capacity of all intersections was computed by accepted techniques. The capacity and volume of each intersection is given in Table A8; Table A9 gives non-intersection section capacities and volumes. An analysis of existing signal cycle allocations versus those theoretically desirable according to existing volumes is shown in Table A10.

Computation of AADT at all counter locations involved calculating the ratio of the volume for each hour at a given location to that for the identical hour at each of its next higher order control counters. These ratios were then averaged,

* Ibid.

within a particular control, and the average ratios were multiplied by the respective control AADT values, computed previously by a similar process. The resulting two AADT values for the given location were averaged to yield the final AADT (Figure A1). Driveway AADT was computed by expending the one hour count according to the general pattern of similar establishments and the relative importance of that particular hour in the day's total traffic.

The remainder of the analysis was somewhat subjective and descriptive, based on common traffic engineering statistics and variability. By examining the physical situations in light of operational conditions, it was possible to recommend standard traffic engineering modifications to improve traffic movement. Such standard techniques are explained in great detail in the first report of the Wisconsin Avenue Study * by the Bureau of Public Roads. It would be redundant to do more here than mention that these are the techniques proposed for use on the Lafayette Bypass.

RECOMMENDED IMPROVEMENTS

The improvements proposed will be presented in three stages, based on the extent of work required and the cost involved. Stage I improvements will involve minimal expenditure and in most cases should be easily financed by regularly budgeted operation and maintenance funds. This work will primarily involve operational modifications and in some cases minor reconstruction. Stage II will entail extensive traffic

* U. S. Department of Commerce, Bureau of Public Roads; "Increasing the Traffic-Carrying Capability of Urban Arterial Streets", U. S. Government Printing Office; Washington, D. C., May, 1962.

engineering work and more involved construction. These changes can be planned for an annual period and budgeted accordingly. Stage III work will involve major reconstruction for which long range fiscal planning is required.

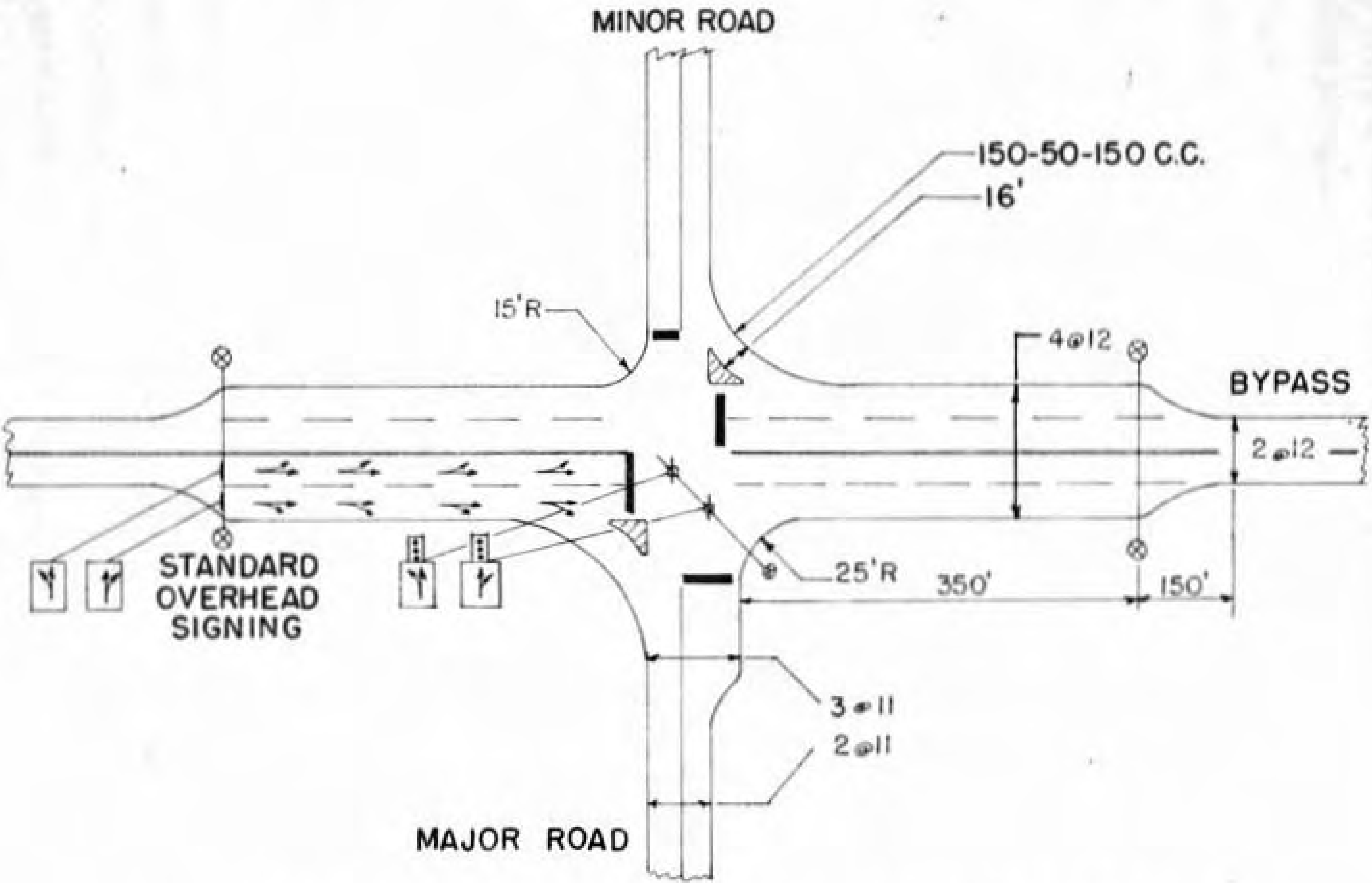
The effectiveness of all proposed improvements will be estimated by the simulation model and the results compared to the results of before and after evaluations which will be conducted in this research. Improvements found to be truly beneficial and effective and economically justifiable will be recommended for use on similar facilities. It is desirable that as much first stage work as possible be implemented immediately in order to reduce the economic loss to travelers on the Bypass.

Stage I-Traffic Engineering

General Recommendations

1. Efficient utilization of available intersection area must be achieved. Turn lane confusion can be reduced by placing clear, precise over-head signing and pavement marking to define the proper use of existing lanes. Signs should be placed well in advance of an intersection; pavement marking should include turn arrows and stop-lines at all locations. Consistent lane-use assignment will assist drivers and improve compliance. Unless otherwise noted the inside arrival lane should be marked for left-turn-and-through and the outside lane for right-turn-and-through. Figure 10 shows a typical intersection layout with recommended marking and signing procedures. The standards in this example should be the guide for upgrading all intersections.

2. The use of two lanes for through movement, as made in recommendation 1, is feasible only if adequate



TYPICAL 4 LANE UNDIVIDED INTERSECTION

FIGURE 10

merging-recovery lanes are available on the opposite approach. This can be achieved by improving the size and condition of supplementary lanes, including both bypass and recovery lanes (see Figure 10). In connection with well operated signals, good quality lanes will carry more nearly the possible capacity of the roadway. Reconstruction should take into account heavy commercial vehicles that use the road and design pavements accordingly.

3. The existing traffic signal system and its operation are principal factors in delay and accidents on the facility. Since cross movement cannot be eliminated, the necessary signals should be operated to serve traffic with maximum efficiency. Phase timing must be set with careful regard for the approach volumes presented in this report (Table A10). Operation should be coordinated where intersections are closely spaced. Interconnection of such signals would be desirable with use of volume-density equipment considered.

4. Improvement of signal face visibility is paramount. This can be accomplished by using dual large red faces with background shields on the signal head. Elimination of electrical advertising using flashing and red lights would be desirable.

5. Installation of signals was seen in the accident analysis to increase collision experience. Care must be taken to avoid installation of unnecessary or unwarranted control devices. No traffic signal should be installed unless it satisfies the warrants of the Manual of Uniform Traffic Control Devices.

6. In order to ensure safe and efficient utilization of available road-

way, the pavement must be marked in a manner clearly understood at all times by all motorists. Center, edge, and no-passing zone lines should be placed at least twice yearly at all necessary locations.

7. Safety considerations require construction and maintenance of adequate shoulders where buffer lanes are not available. Until such time as the roadway can be widened, the shoulders should be brought to and maintained at a ten foot wide, aggregate standard throughout the facility.

8. Strict enforcement of existing traffic, encroachment and access regulations is vital to proper operation of any facility. All types of right-of-way encroachment and shoulder use must be prohibited and continually enforced if the problem of marginal friction is to be minimized. Points of access to private property must be kept to a minimum and designed properly. Driveways must be clearly delineated by curbing or other means so they do not spread to become broad open expanses. The curbing or other means must be sufficiently far from the roadway to permit a full shoulder or deceleration lane. No unauthorized access can be permitted. Improper use of marked lanes must be discouraged if intersections are to function correctly.

9. Remove all redundant and unnecessary informational signing within the right-of-way. These signs are subconsciously distracting to drivers and cause sight distance restrictions. Many are useless either because they are too small, too far from the roadway, or are obstructed in some manner (Figure 11).

10. Be extremely discerning and exacting when issuing permits for points of access.

FIGURE 11 SIGNS PLACED IN RIGHT OF WAY

FIGURE 12 GOOD DRIVEWAY DELIMITATION AND RECOVERY LANE

a. Do not permit a driveway if a more desirable means of access is available.

b. Limit the points of access to one unless there is sufficient volume or other warrant for more.

c. Where feasible, permit only entrance from the Bypass with exit onto a cross street.

d. Require an adequate deceleration lane and curbing to delimit the driveway.

e. Serve several establishments with one entrance or a frontage road arrangement to limit the number of access points.

f. Grant access permission with the understanding that use of a frontage road will be required when construction of one becomes feasible.

11. Improve existing physical and access situations in whatever manner possible.

a. Eliminate existing physical restrictions of sight distance and physical obstructions near the roadway.

b. Consolidate existing driveways where feasible by use of frontage roads.

c. Reduce the number of entrances per establishment to a minimum, requiring entrance from the Bypass and exit to cross streets where feasible.

d. Require precise delimitation of all existing entrances and improvement of acceleration lanes. Figure 12 shows an example of good driveway definition.

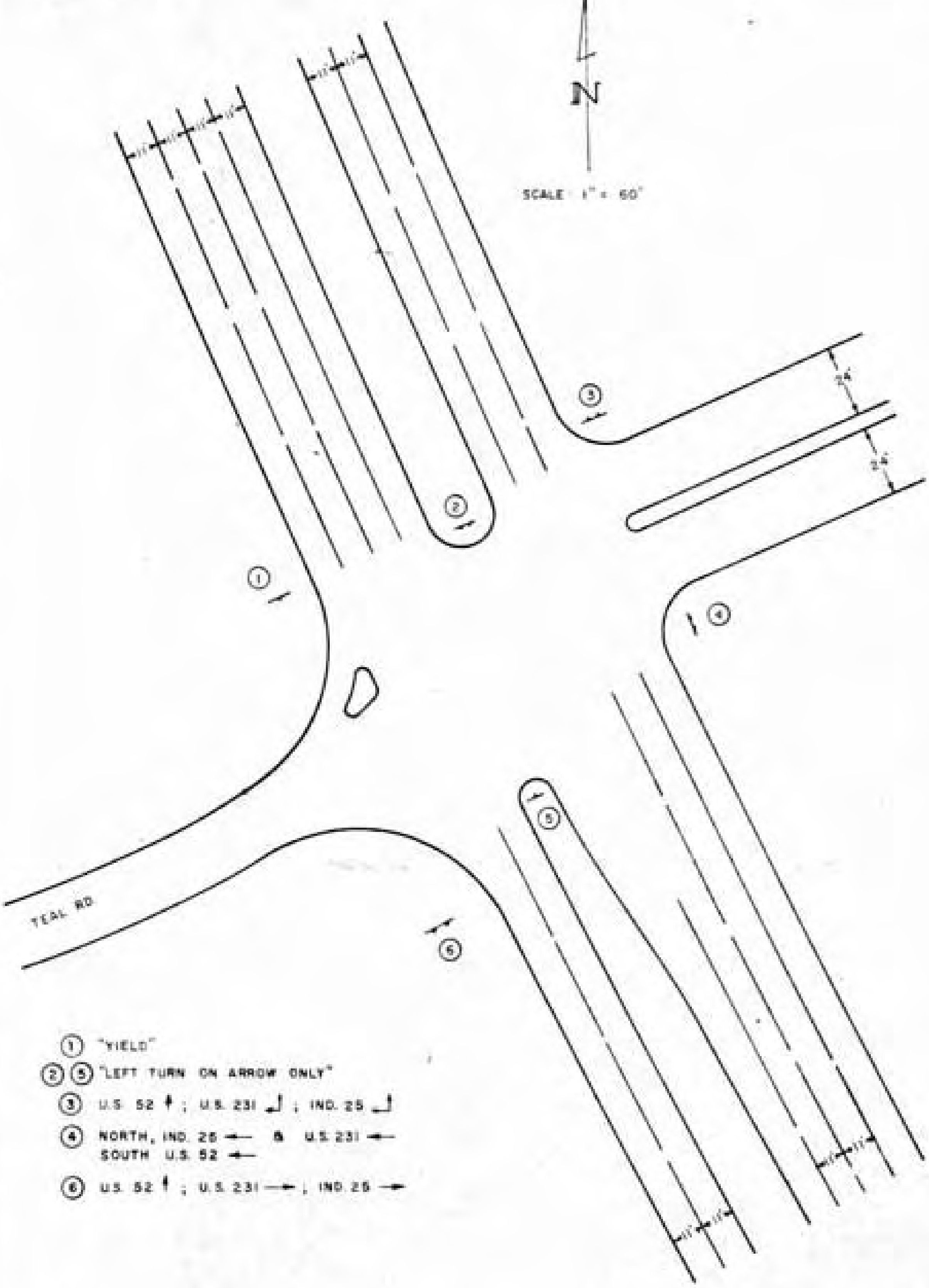
Specific Recommendations - Intersections

1. Teal Road - Indiana 25 - U.S. 231 South; Figure 13

This intersection serves traffic of the K-Mart shopping center and a developing residential area south of Lafayette. The West approach carries Indiana 25 to the Bypass as well as traffic to some industrial development south and west of the city.

The accident analysis demonstrated that this is the worst intersection on the Bypass. It was consistently on top for all rankings of accident rates and was statistically out of control for all three years analyzed. Following construction of a commercial entrance (the east approach) in October, 1962, and installation of traffic signals in January, 1963, substantial increases were noted in all but left-turning accidents. Bypass and northbound vehicles were involved more than three and four times the previous rates respectively, and injuries tripled. Lane-change and rear-end accidents increased eight times. Conditions indicate a lack of awareness of the presence of the traffic signal, due in part to the fact that Teal is the first stop encountered by northbound drivers after a long uninterrupted 60 mph section.

Since the east approach does not aline with that from the west (Figure 14), through traffic on Teal must jog slightly. Vehicles turning from Teal must zig-zag to complete their maneuver without blocking opposing through and left-turning movements. Another anomaly of orientation concerns the location of entrances to the shopping center parking lot. The signals at the Indiana 38 intersection can be bypassed by short-cutting across the parking area between the Teal intersection and a point on the east approach



NOTE:

10 OVERHEAD SIGNALS

FIG. 13 - U.S. 52 BY-PASS & TEAL ROAD

FIGURE 14 TEAL ROAD- POOR APPROACH ALIGNMENT

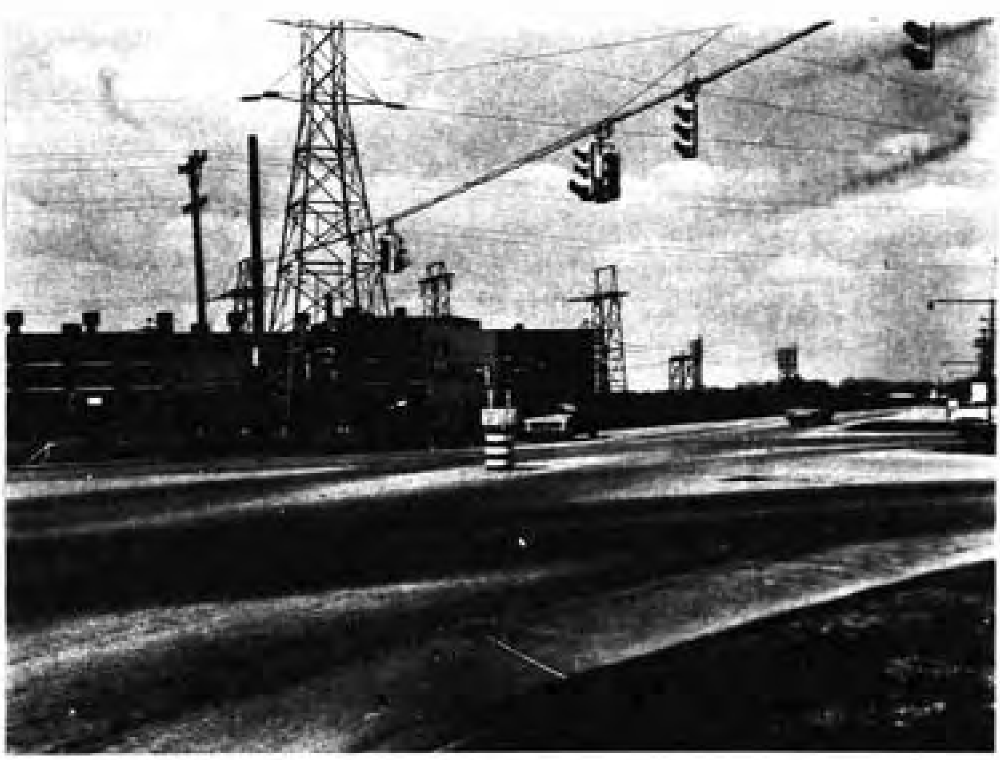


FIGURE 15 MAIN STREET-BARREL TO CONTROL LEFT TURNING VEHICLES

of Indiana 38. Several accidents have occurred between vehicles doing this and others in the parking area. An idea of the magnitude of this movement can be inferred from the volume at the Teal east approach during hours when the shopping center is not open for business. On some days, over 300 vehicles use the parking area entrances during the ten hour period (11 p.m. - 9 a.m.) commencing an hour after the store closes and ending an hour prior to its reopening. These movements are during normally low volume hours. The volume during the 7 - 8 a.m. period often exceeds 100 vehicles. The volume during normal daytime hours can therefore be assumed quite sizeable. A facility to properly satisfy this movement and relieve the Indiana 38 intersection would be desirable.

The speed analysis indicated that the greatest differential between operating and average running speeds existed at the Teal Road intersection. This can be attributed primarily to the absence of smooth traffic flow between Teal and Indiana 38. Substantial delay and confusion exist for left-turners from the Teal approaches, due again to the geometry. If either queue is several cars in length, it blocks the progress of opposing vehicles unless unusual maneuvering is employed.

a. Install additional warnings of the impending intersection on the south approach. There should be two sets of signs, the nearer with flashing yellow lights. Route markers should also be placed farther south. Place speed limit reduction signs farther from the intersection in order to slow traffic to a speed at which the signs and situation ahead can be comprehended.

b. In line with a comprehensive program of signal improvement, the system at Teal Road should be interconnected with that at Indiana 38, only 1750 feet to the north.

c. Add a protected left-turn phase to provide for the heavy movement from the Teal west approach, and decrease the through movement phase for the exit traffic from the shopping center.

d. Improve approach indications and left-turn markings on both Bypass approaches. Indicate "left-turn on arrow only."

e. Improve the outside lane on the Teal west approach. This lane is narrow and has very little shoulder. Overhead signing here would improve lane use compliance.

f. Because of the large area of the intersection, an all-red phase to clear the intersection would be desirable.

g. Improve approach signing and delimitation of the right-turn lane from the north approach.

2. State Road 38 - Main Street, Figure 16

Main Street is a principal north-south arterial of Lafayette. The traffic here is primarily interested in reaching residential areas on the city's south side and the central business district. Indiana 38 serves a rural area where considerable suburban development has recently begun.

Heavy left-turn movements from both Bypass approaches are the problem at this location. The barrel currently employed to remedy the situation should have been only a temporary expedient (Figure 15). Accidents here

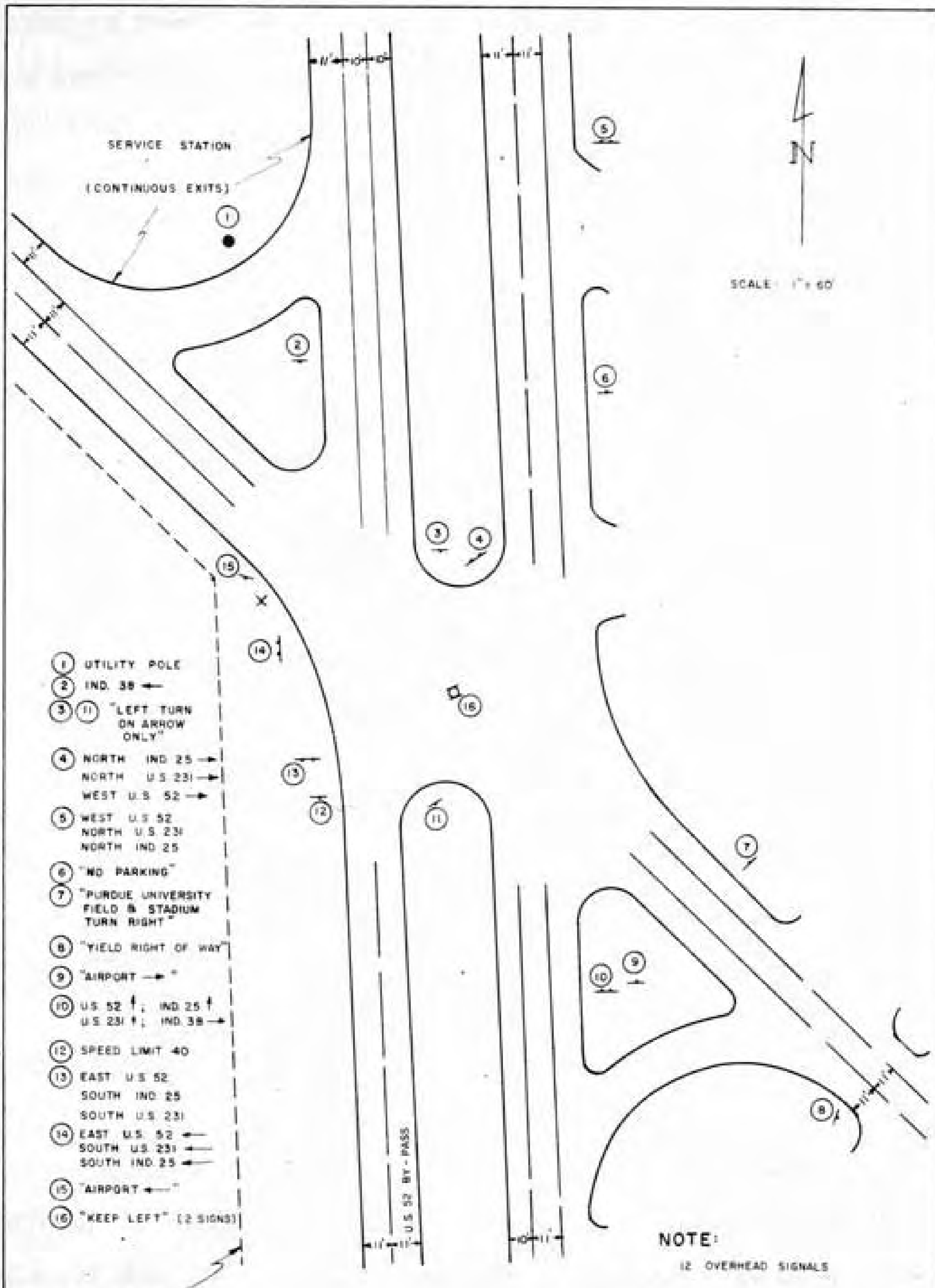


FIG. 16 - U.S. 52 BY-PASS & S.R. 38

are typical of those found where signals exist and occur at only a slightly greater rate than the overall average. Delays can be attributed primarily to the lack of signal coordination with the system at Teal Road. The approaches are too wide for decision clarity. The lack of driveway definition in the northwest quadrant is a problem.

a. Interconnect the signal system with that at Teal.

b. Place pavement stripe markings in the intersection to channalize vehicles making left-turns from the Bypass approaches, and eliminate the barrel. Include an actuated left-turn phase for these approaches when upgrading the signal system. Also improve lines separating the left-turn from the through lanes.

c. Channelize right-turns from the east approach under signal control. Channelized right-turns for the Bypass approaches should be under stop-sign control. The right-turn lane from the north approach should be marked and delimited better.

d. Addition of lane use indicators for southbound traffic well in advance of the intersection can be achieved since a similar lane use situation exists at McCarty Lane.

e. Construct curbing or use guard posts to improve delimitation of driveways in the northwest quadrant.

3. McCarty Lane

Four right-angle collisions and six involving lane-change maneuvers occurred during the studied period. The lane-change accidents occurred most often in the southbound lanes, indicating confusion over the lane expansion situation and vehicles turning left onto McCarty. The cross street is a low volume facility serving a tributary area of minor importance. The cross street approaches are not in very good condition, but there does not appear to be sufficient justification for increasing present capacity. There is no significant delay situation at the intersection.

a. Construct median left-turn lanes for both Bypass approaches, including proper signing and marking. There is adequate median width to accomodate these.

b. Paint stop-lines and place large stop signs on the McCarty approaches at a location that will permit good visibility of traffic on the Bypass.

c. Driveways in the northeast and southwest quadrants are poorly defined and should be better delimited by curbing or guard posts.

4. Kossuth Street

This street serves a residential and industrial area. The principal problem here concerns vehicles turning between Kossuth and the south Bypass approach. Vehicles turning left from the Bypass were involved in ten accidents during the studied period. Vehicles turning right onto the Bypass were a factor in several others. The waiting required to obtain an acceptable gap is often great, causing drivers to take chances in order to enter traffic. Delay to southbound Bypass traffic is minimal due to existence of a right-turn lane. Delay to northbound Bypass traffic is great because of the heavy left-turn movement and inadequacy of the existing "passing blister" and east shoulder. The differential between operating and average running speeds was the second largest found.

A driveway recently constructed opposite the west approach promises to be troublesome in the future. Entrances to the commercial establishment in the southwest quadrant are poorly delimited.

a. Construct a longer, wider, and better surfaced lane for bypassing of vehicles turning left from the northbound lane. Include proper use signing and delimitation, marking the present northbound lane for left-turn-and-through.

b. Improve marking of the existing right-turn lane for southbound traffic.

c. Close entrances to the burned-out commercial establishment in the southwest quadrant where cross-cutting is occurring.

d. Construct curbing on the Kossuth approach and repave as necessary. Mark two east-bound lanes, one for right and one for left-turning traffic, and a stop-line with a large stop sign properly situated for good visibility.

e. Install a flasher warning light over the intersection.

f. Require curbing or guard posts for improved delimitation of driveways on the east side of the Bypass. Include a stop-line and stop sign on the newly constructed access road to a trailer park.

5. South Street - State Road 26, Figure 17

This is the principal access route to the Bypass from Lafayette and a well traveled highway in its own right. It handles the heaviest volume of any intersection studied and ranks second in accident occurrence. These accidents were not as severe as elsewhere and were principally of the rear-end and left-turn types. There were also a few lane-

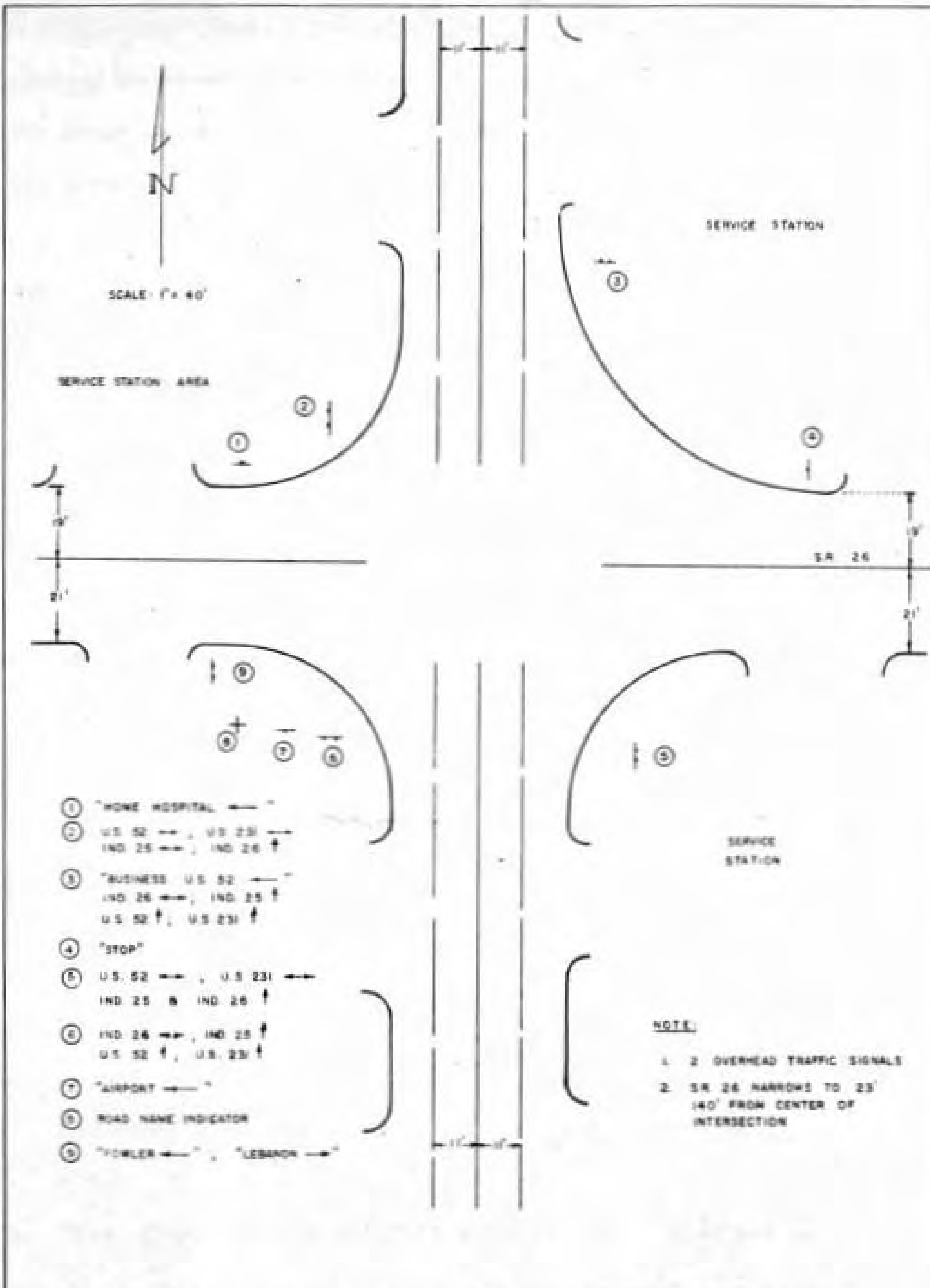


FIG. 17 - U.S. 52 BY-PASS & S.R. 26

change collisions. These types of accidents occur where unprotected left-turning movements exist. There are heavy left-turn movements from the south and west approaches. A heavy right-turn movement exists from the north approach; the left-turn here is not a large proportion but is a heavy volume. Recent studies have indicated a definite need for left-turn relief at this location.* The existing outer lanes on the north and south approaches are woefully inadequate for the volume, speed, and weight of vehicles using them to bypass left-turners. The present signal cycle is very long and heavily favors the Bypass; no separate left-turn phases are included. As a result, all traffic, especially left-turns, from the cross street is delayed excessively. There is confusion over proper lane use and interference from nearby driveways in all quadrants. Sign encroachment on the right-of-way is prevalent here (Figure 11).

a. The outer lanes on the Bypass approaches are narrow, short, and poorly surfaced. Recovery lanes on these approaches are especially in need of improvement. Mark the center lanes for left-turn-only on all approaches.

b. Revise the signal cycle. Shorten the total cycle and allocate time relative to current volumes (Table A10). Include protected left-turn phases for the Bypass approaches. The desirable green time for these volumes yields much too long a total cycle time.

c. This intersection is sufficiently close to Union Street to

* Shaw, R. B., "Evaluation of Delays and Accidents at Intersections to Warrant Construction of a Median Lane," Purdue University, Joint Highway Research Project; Lafayette, Indiana; March, 1966.

permit effective operation of interconnected signals. There are no intermediate cross-streets, and the volume of traffic makes platooning necessary since passing is very restricted.

d. Increase the radius of curbing in the northwest and southeast quadrants in order to permit low speed right-turns, and include channelization. These right-turns should be placed under stop-sign control.

e. Closing or further restricting the driveway onto Indiana 26 in the northeast quadrant is necessary to prevent cross-cutting. This should be done in connection with channelization for the right-turn movement. This right-turn should remain under signal control.

f. Entrance and exit curb cuts for each service station at this intersection should be minimized and redesigned for safe and channelized movement.

6. Union Street, Figure 18

This intersection serves commercial and residential areas and is a direct connector to West Lafayette. The north approach is on a grade and commercial development on the west side of both Bypass approaches is intensive. Passing and recovery lanes are worse than at any other location. Minor street cross traffic is relatively light. Once again, as at all other signalized intersections, rear-end, lane-change, and left-turn accidents dominated, involving primarily Bypass traffic. Left-turns from the north approach are insignificant; those from the south are very heavy. The cross-street approach from the west is very good; the approach from the east is in poor condition

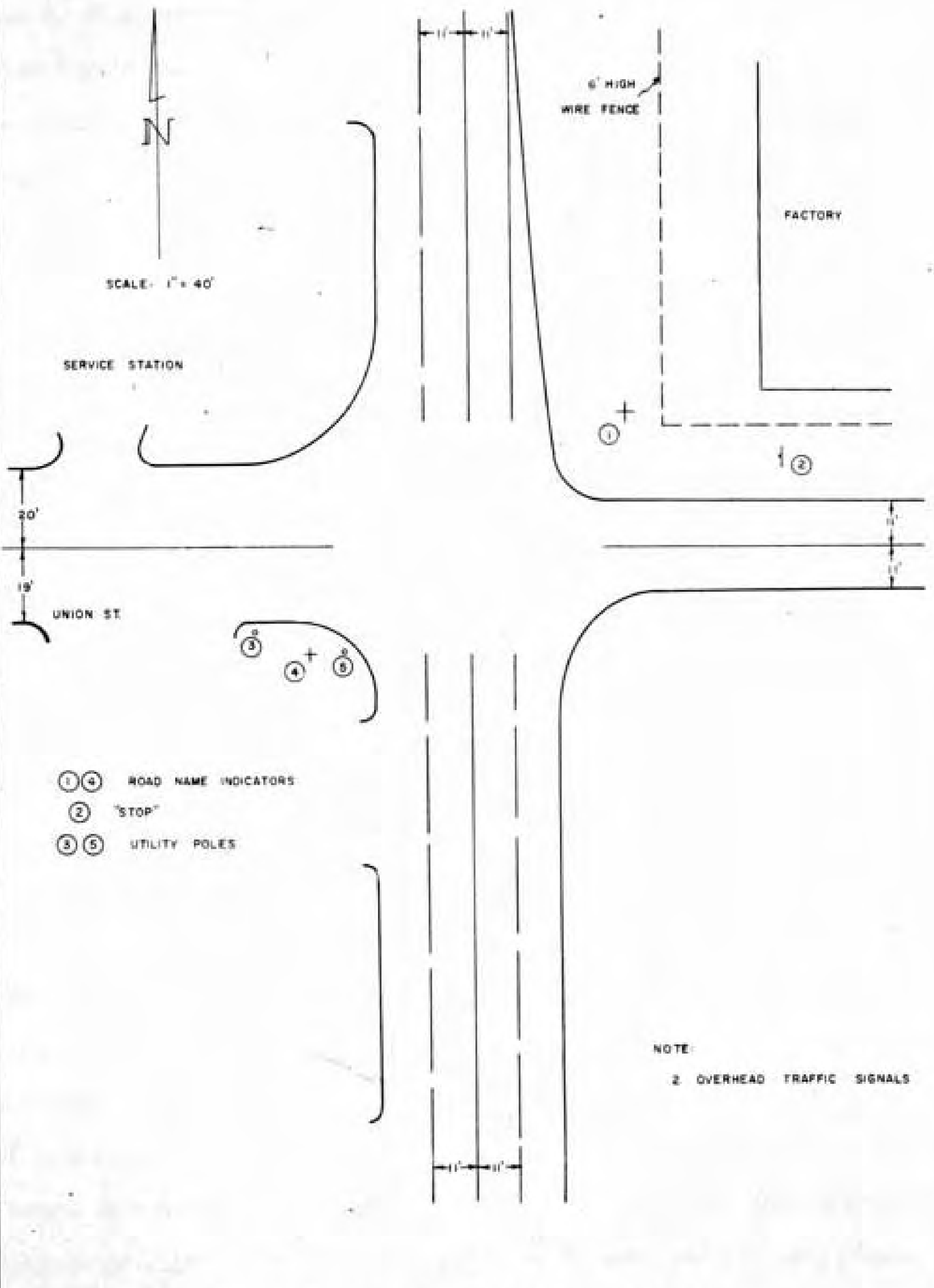


FIG. 18 - U.S. 52 BY-PASS & UNION

but carries little traffic. Significant delay to southbound traffic was due to slow starting of trucks stopped on the grade. Faster vehicles try to pass the slow starters, and this leads to conflicts in the outside approach lane and the recovery lane. Passing left-turners in the northbound stream can also cause trouble because of the very short recovery lane (75 foot taper) next to which is a ditch and a soft unimproved shoulder.

a. Increase the length, width, and surface quality of outer approach and recovery lanes. This is especially necessary for the recovery lane on the south side in order to permit smooth merging without hazard. Mark the outer lane on the south approach for right-turn-and-through; mark the center lane for left-turn-only.

b. Eliminate right-of-way encroachment of signs and mail boxes on the west side of the Bypass. Close the two entrances nearest the intersection from each service station.

c. An exclusive left-turn phase for the south and north approaches combined with right-turns from the east and west would be desirable.

d. Remove the bus stop in the southeast quadrant.

7. Greenbush Street, Figure 19

This is currently a low volume street serving established residential and commercial areas west of the Bypass. A large residential area currently being developed to the east can be expected to increase traffic on the east approach substantially over the presently low volume. The accidents are typical of signalized locations, principally rear-end and lane-change.

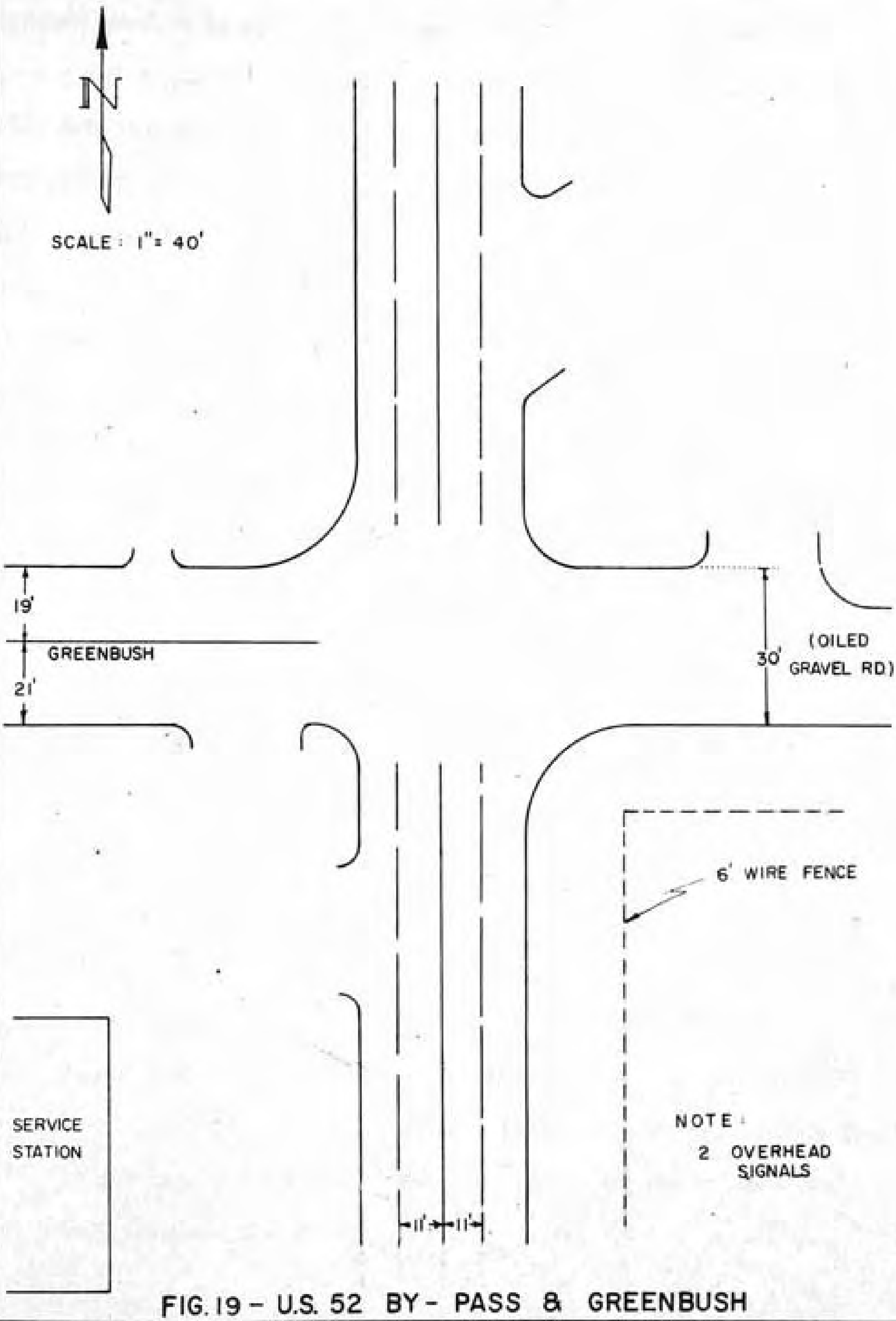


FIG. 19 - U.S. 52 BY-PASS & GREENBUSH

The recovery lanes for Bypass traffic are again very poor, that for southbound traffic being extremely short due to a right-of-way constriction. A crest vertical curve through the intersection flattens to the south. Substantial delay here can be attributed to slow acceleration of stopped commercial vehicles at the traffic signal and the protected left-turn phase for the south approach. The left-turn movement here is here is not as heavy as at the two previously discussed locations. The special phase is questionably warrented and is a severe detriment to operation of the intersection. The very need for the signal is questionable at present, but will surely exist soon due to the new residential development.

a. Remove the protected left-turn phase of the signal and reallocate cycle time in line with current volumes. Revision of the signal phasing could well include interconnection with Union and South. These three intersections are relatively close, and heavy traffic moves in a platoon manner.

b. Extend and improve both Bypass recovery lanes. Place drain tile in the ditch in front of the cemetery and extend the recovery lane over it; improve shoulders as well. Improve the shoulder on the east edge of the south approach to permit easier right-turns.

c. Remove the right-turn only sign on the right lane of the north approach. Mark this lane for right-turn-and-through and designate it for use by commercial vehicles. Mark the center lane for left-turn-and through.

d. Closure of one entrance onto the Bypass at the service stations in the northeast and southwest quadrants is desirable. Under the present situation cross-cutting does occur.

8. Underwood Street

This residential service street, with a "T" intersection, has relatively low volumes. All accidents involved left-turning movements, mostly from the northbound lane. This may be due to the fact that the intersection is located on a curve. Sight distance is limited for all approaches.

a. Construct a lane to permit passing of left-turn traffic from the northbound lane. The center lane should be marked left-turn-and-through. Improve and mark the right-turn lane on the north approach.

b. Prohibit signs in the right-of-way in the northwest quadrant. This is one cause of restricted sight distance for southbound traffic and that turning left from Underwood. Place the stop-line and large stop sign for Underwood sufficiently far out to permit good sight distance in both directions.

c. Close the curb cut on the east side of the Bypass. It is no longer used and creates driver concern.

d. Mark two turning lanes on the Underwood approach.

9. Beech Lane, County Road, Darby Lane

These three facilities are very low volume service routes to residential areas. Beech is very well constructed. The surface on the County Road approach is poor requiring severe slowing prior to turning into it. Both have excellent sight distance. Sight distance at Darby is poor for both directions but can be remedied by removing shrubbery and other objects in the right-of-way.

10. Schuyler Street-Indiana 25 (North), Figure 20

This rural highway is a main route to northeastern Indiana from Lafayette. All Lafayette-bound traffic on Indiana 25 continues on Schuyler to the center of the city. Most Bypass traffic uses this street to reach areas on the city's north side. The intersection ranks third in accidents per million vehicles. One third of these were a result of improper lane usage or lane-changes. There were also nine right-angle collisions and thirteen of the rear-end type. Delays are not especially excessive here since the intersection is level and has sufficient area to permit maneuvering around waiting vehicles. A very hazardous situation exists in both western quadrants due to termination of city streets at the Bypass (Figure 21 and 22). Driveways in the northeastern quadrant are very poorly defined (Figure 23).

a. The vast open area of the intersection calls for extensive channelization. This should be done in coordination with widening and lane assignment as indicated in Figure 24.

b. Close openings onto the Bypass from Stillwell and Monon Streets, and of 24th, 25th, and 26th Streets (Figure 25). These can all be served readily from the 24th Street entrances to Schuyler. The present condition causes apprehension for southbound drivers ascending the hill to the north approach and leaving the intersection on the south approach.

c. Cooperation with the Devon Plaza Motel should be sought to erect a barrier to prevent cross-cutting of their parking lot to reach 26th Street (Figure 25). The driveways in the northeast

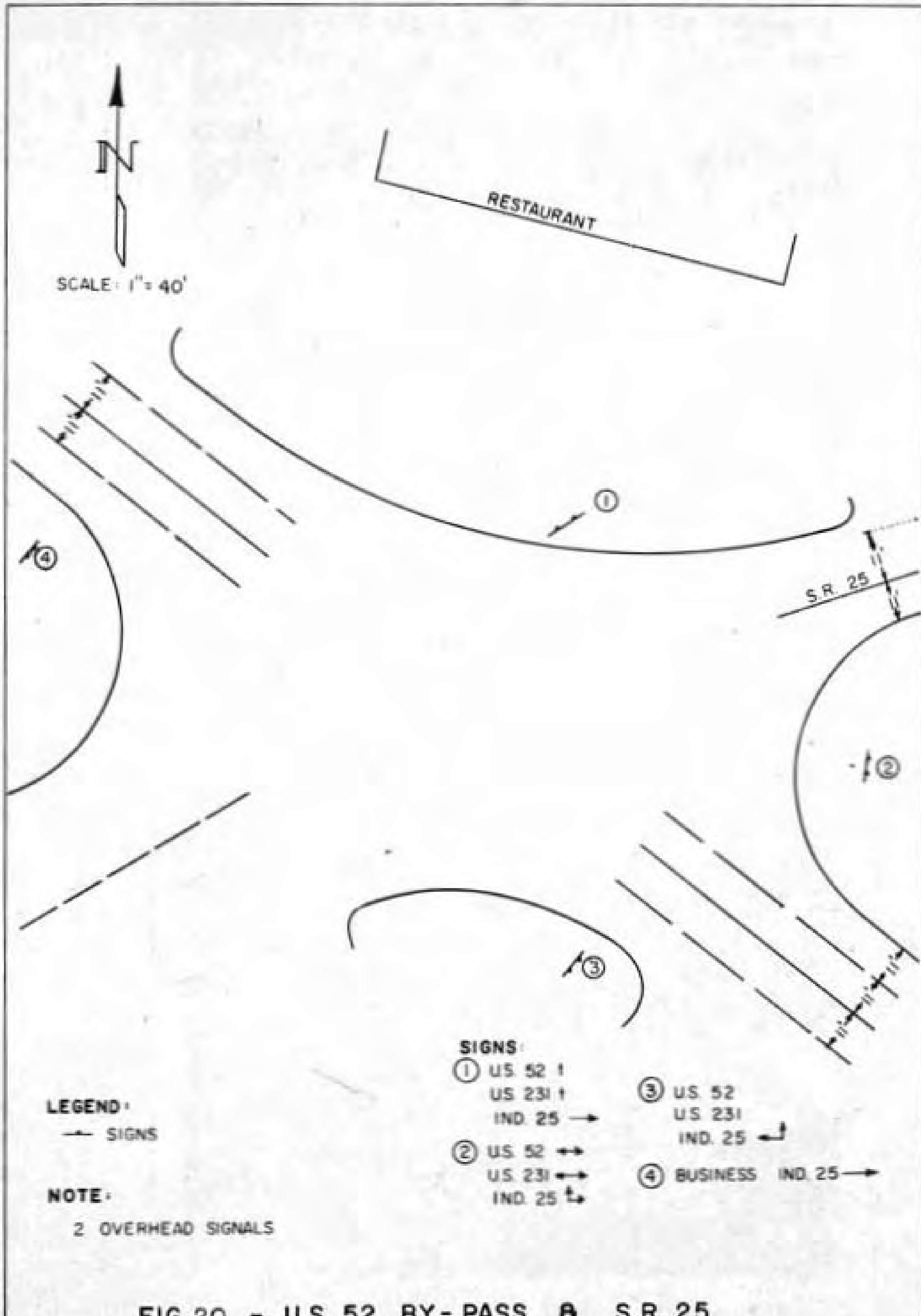


FIG. 20 - U.S. 52 BY-PASS & S.R. 25

FIGURE 21 NORTHWEST QUADRANT OF INDIANA 25 INTERSECTION - POOR DRIVEWAY DELIMITATION

FIGURE 22 NORTHEAST QUADRANT OF INDIANA 25 INTERSECTION - POOR DRIVEWAY DELIMITATION

FIGURE 23 INDIANA 25 - SCHUYLER STREET INTERSECTION WITH U.S. 52 BYPASS; EXISTING SITUATION

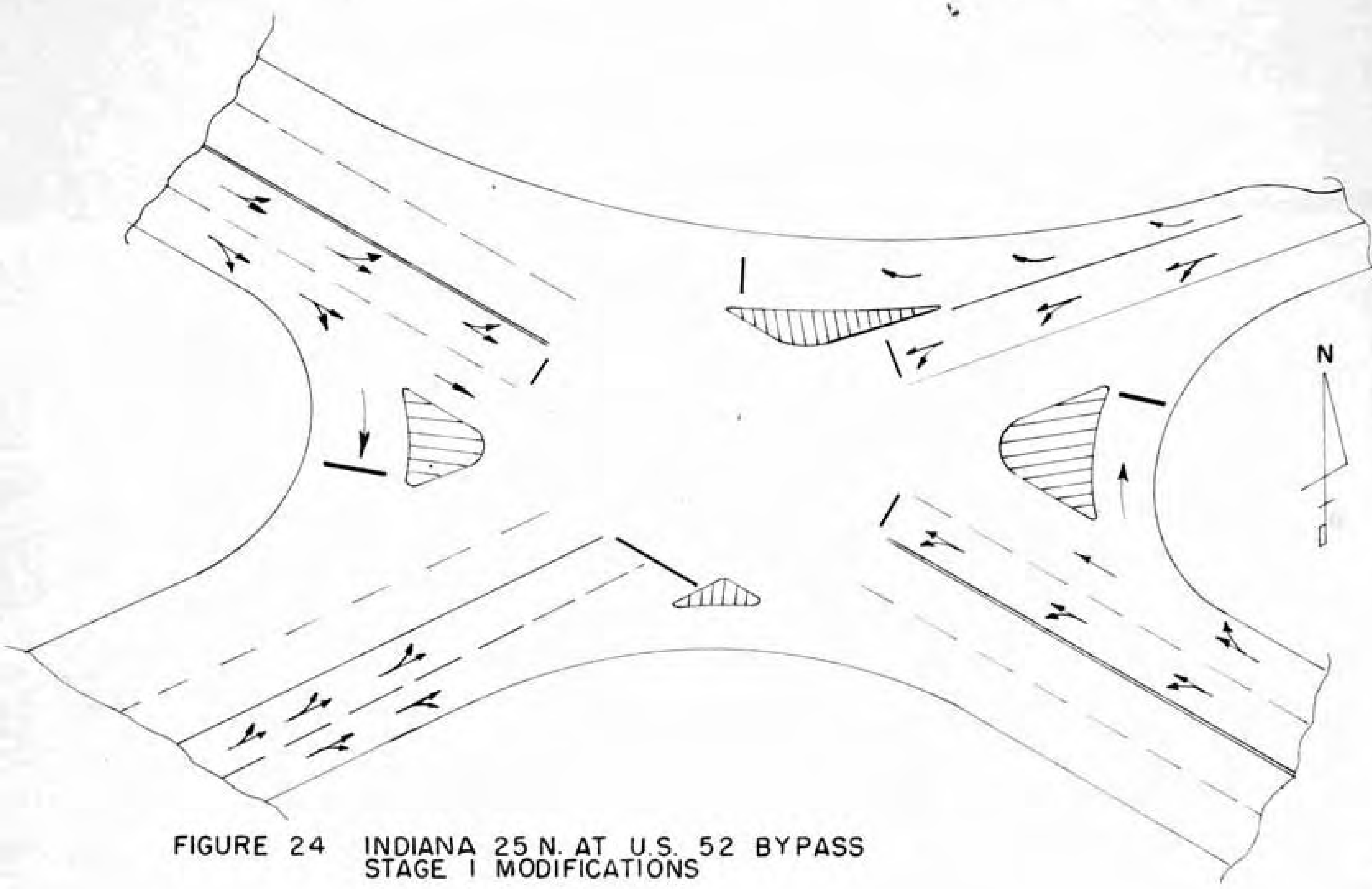


FIGURE 24 INDIANA 25 N. AT U.S. 52 BYPASS
STAGE I MODIFICATIONS

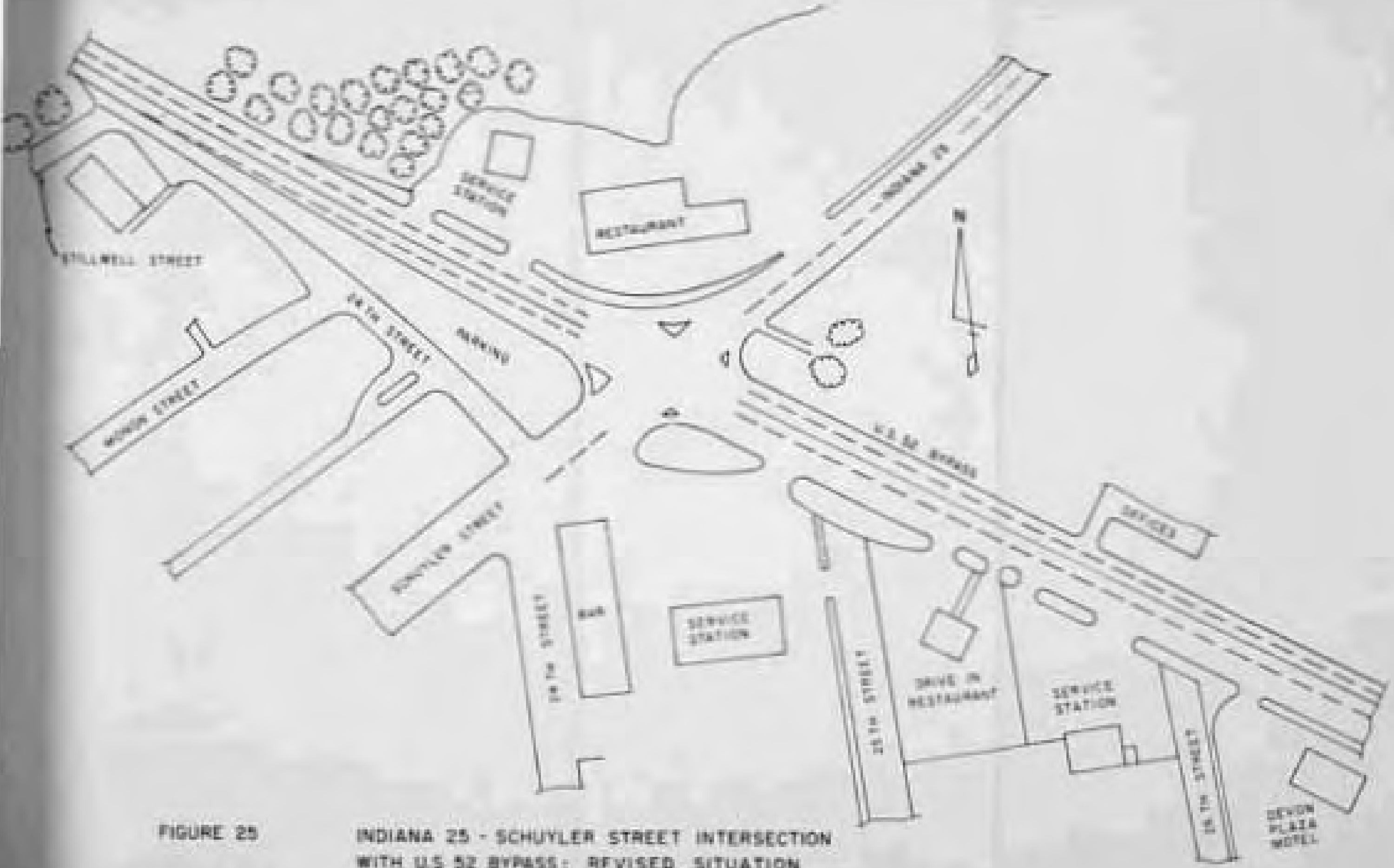


FIGURE 25 INDIANA 25 - SCHUYLER STREET INTERSECTION WITH U.S. 52 BYPASS; REVISED SITUATION

quadrant should be modified to improve delimitation, reduce open area and reduce cross-cutting.

d. Addition of flashers to signs warning approaching motorists of the impending signal is needed, especially on the north approach.

11. Ninth Street (Cutoff)

This rather low volume, industrial service route operates well, especially since addition of the lane for bypassing vehicles turning left from the northbound lane. Accidents here were reduced substantially by this addition. Two access roads on the north present slight problems due to driver apprehension. The right-turn lane for southbound traffic also functions well. The Ninth Street approach is in poor condition.

a. The recovery lanes for both Bypass directions should be lengthened and improved.

b. The Ninth Street approach should be widened and resurfaced to accomodate three lanes, two for right- and left-turns onto the Bypass. Sight distance to the south is not good; the only improvement that can be easily realized is relocation of the fence in the southeast quadrant.

12. Happy Hollow-Soldiers Home Road (S.R. 443), Figure 26

This intersection poses one of the worst problems on the Bypass because of topographic effects on design, operation and sight distance. The intersection is atop a long down-grade to the east on which there are a "humpback" and a truck climbing lane. This route is the only currently feasible means of access to the urban area from mushroom-

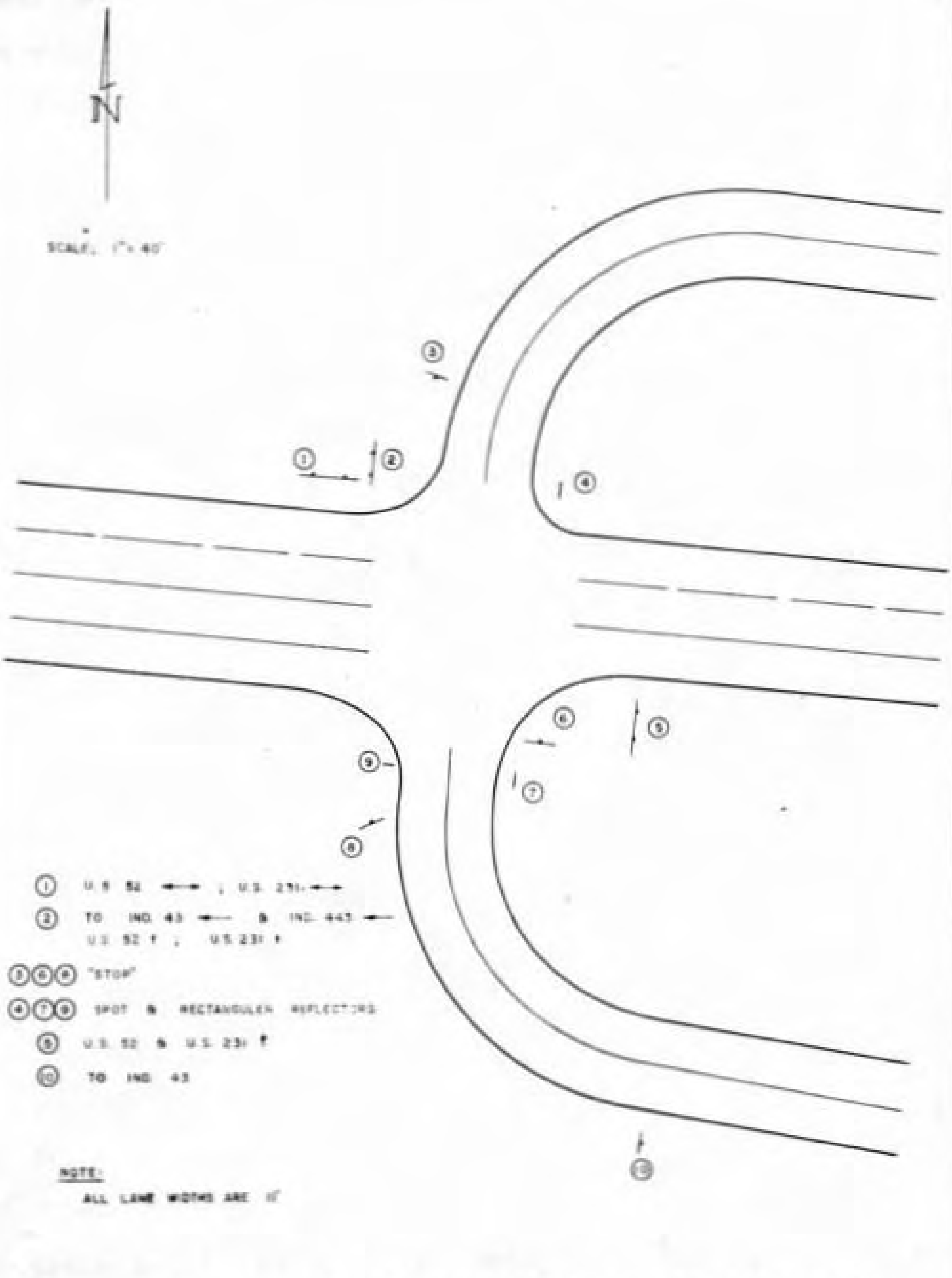


FIG. 26 - U.S. 52 BY-PASS & HAPPY HOLLOW

ing residential developments to the north. The principal movements are left turns from the cross street approaches and the returning right turns of this traffic. There is a new commercial establishment immediately west of the intersection. Accidents here were nearly 50 per cent right-angle. One third were rear-end collisions, most involving Bypass traffic waiting to turn onto the cross street. About 75 per cent of the accidents involved westbound Bypass vehicles, for and of whom sight distance is severly restricted by the humpback. Delays to cross-street traffic are severe due to driver reluctance to accept gaps because of the sight distance situation. The recovery lane for southbound Bypass traffic is poor, causing delay to people reluctant to bypass turners and slowing those who do. The situation here will be impossible to solve in a satisfactory manner without substantial construction. The most effective recommendations are those in Stage II.

a. Extend and improve the recovery lane for southbound Bypass traffic.

b. Broaden the north approach of Soldiers' Home Road and construct a longer taper on the Bypass to act as an acceleration lane for right-turning vehicles.

c. On both cross-street approaches mark lane lines and lane use designations. Place stop-lines sufficiently far out to permit good sight distance but prevent interference with Bypass traffic.

d. Mark the right-turn lane from the west Bypass approach. Also improve lane use markings on the hill climbing lane near the top of the hill for northbound traffic on the Bypass.

e. Install overhead flasher lights to warn approaching traffic.

f. Post speed regulations to reduce the speed of passenger vehicles ascending the hill to 45 miles per hour.

These improvements are only temporary measures to make the best of a difficult situation. The first Stage II work undertaken should be that for this location.

14. Salisbury Street-County Farm Road, Figure 27

This road provides access to central West Lafayette and a new residential area north of the Bypass. It carries relatively low volumes except at peak hours. The semi-actuated signal is, therefore, ideal for the service necessary although a fixed time signal is warranted. Accident severity seemed to increase subsequent to installation of the signal, but the pattern of accident types was as would be expected. Delay was no worse than would be expected in a signalized situation and somewhat better than at fixed-time signals. The south and east approaches are well designed. The north and west approaches are not nearly so well done as those opposite.

a. Widen the outside lanes on the west approach: on the right side for right-turning and through vehicles and on the left for a recovery lane.

b. Increased warning for the intersection is apparently necessary. This can be best accomplished by increasing the size of signal faces and using double red faces on each head.

15. Yeager Road

This intersection carries an insignificant volume except at peak hours. It is principally a service road for the McClure Research Park,

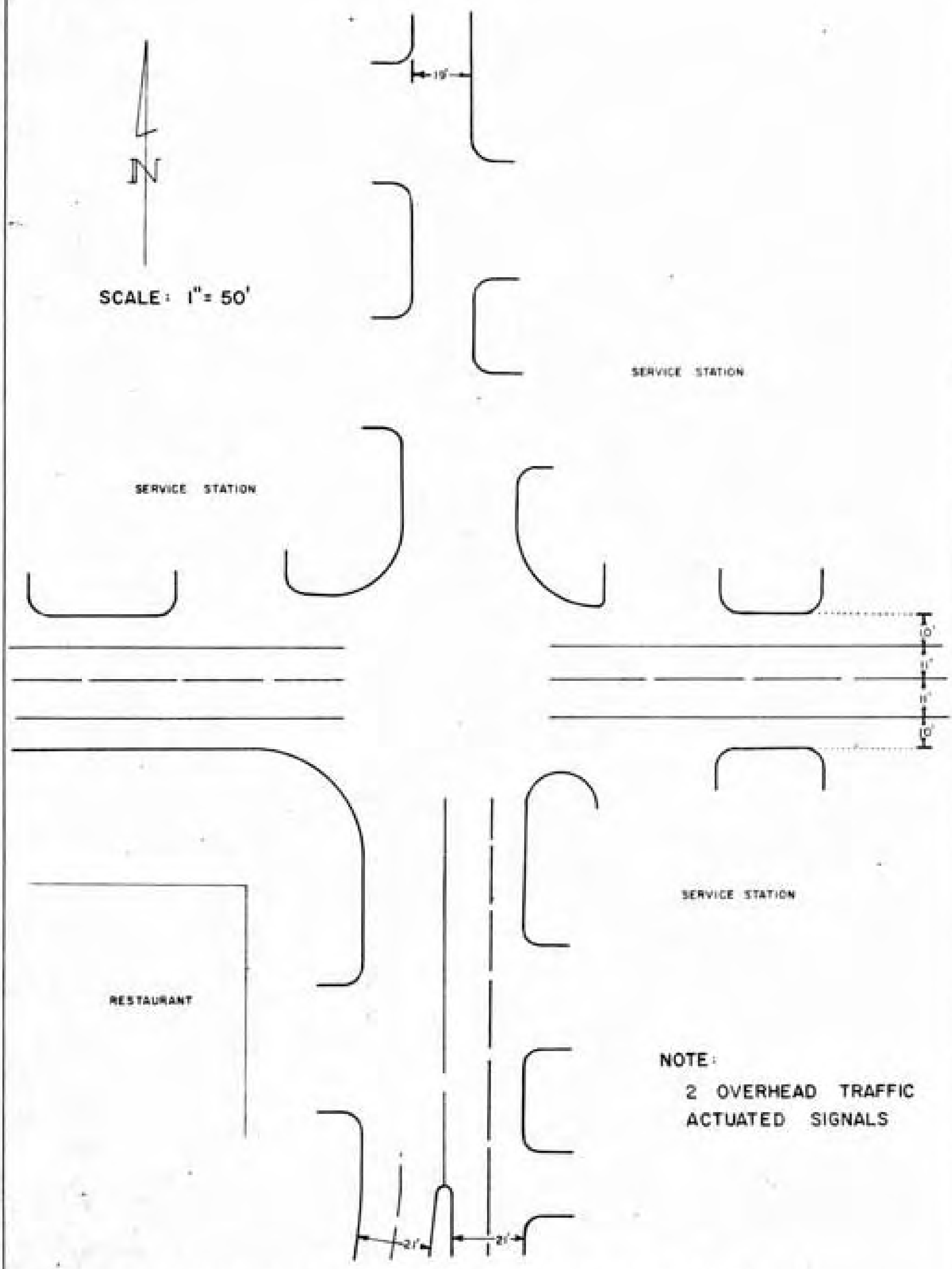


FIG. 27 - U.S. 52 BY-PASS & SALISBURY

although residential development on both sides of the Bypass is becoming heavy. All approach aprons are very good. A semi-actuated signal has been installed since completion of the speed-delay survey.

a. All approaches have sufficient area to be marked for two lanes of arrival traffic.

b. Operate the signal on flasher at all times except peak hours, when it would be semi-actuated.

16. Northwestern Avenue-U.S. 52 North, Figure 28

This is the principal means of access to Purdue. Heavy traffic on all approaches appears well acclimated to the present control situation and would suffer should these conditions be revised. The major conflicts occur in four locations. Southbound vehicles turning to the Bypass fail to yield the right-of-way to northbound Northwestern Avenue traffic. Vehicles turning onto inbound Northwestern Avenue from northbound Bypass lanes conflict with northbound Northwestern Avenue traffic. There is friction in southbound traffic as vehicles move left preparatory to turning onto the Bypass. Traffic northbound on Northwestern moving left in anticipation of the merge with traffic northbound from the Bypass experiences the same problem. The best solution to problems here appears to lie in reconstruction.

a. Erect additional signs for southbound traffic sufficiently far in advance of the intersection to permit decision making and maneuvering with ease. Place yellow flashers on the last warning sign encountered. Place a red flasher aimed north for traffic in the left-turn lane.

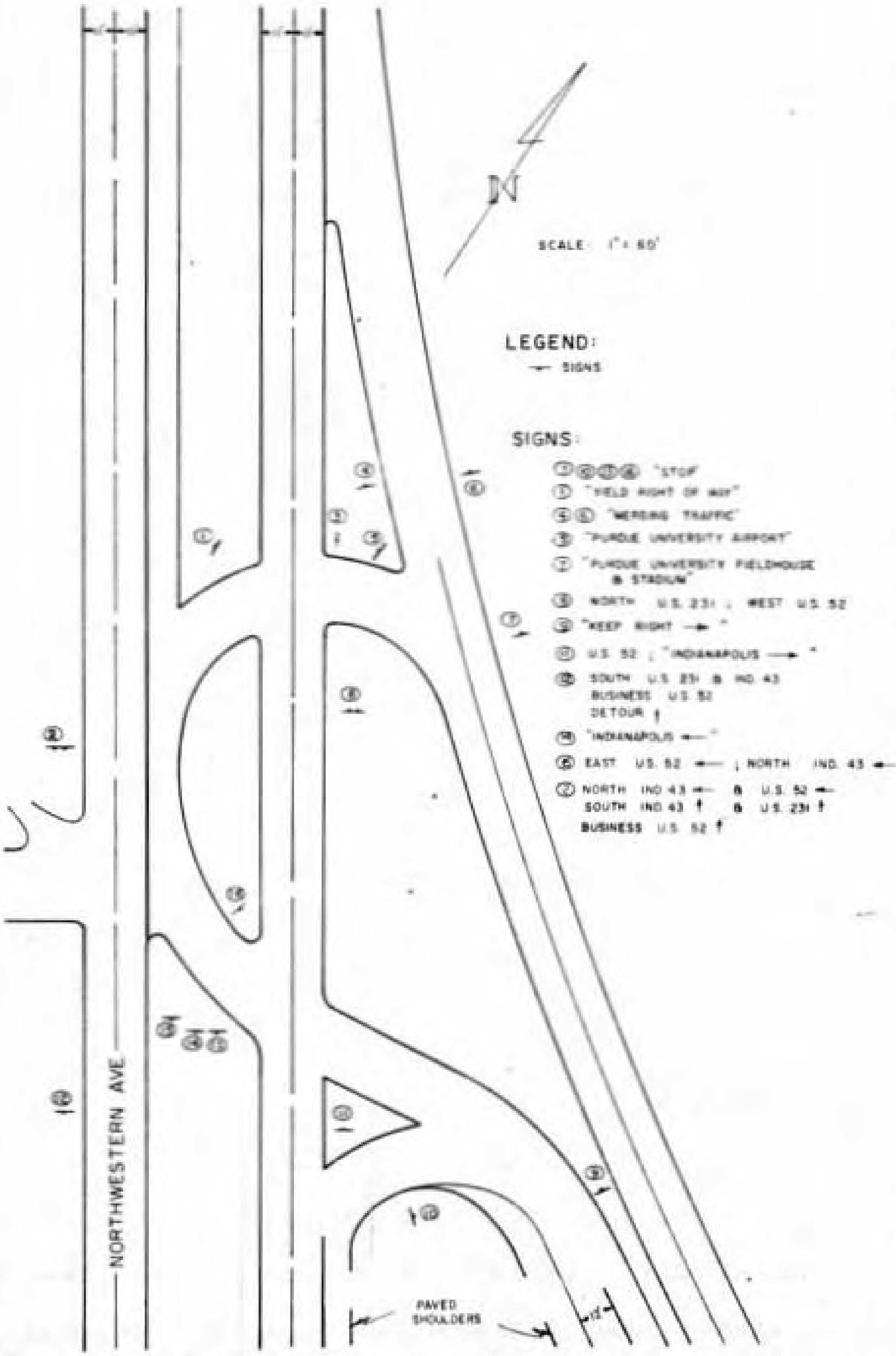


FIG. 28 U.S. 52 BY-PASS & NORTHWESTERN AVE.

b. Use pavement markings and overhead signing to move northbound Northwestern Avenue traffic to the left lane in order to permit a smooth merge with northbound traffic from the Bypass.

c. Place two large stop signs at both lanes encountered by traffic turning left from the Bypass to inbound Northwestern Avenue. Care should be taken so these signs do not interfere with the line of sight.

d. Close the existing turn-around in the median near the merger point of the northbound lanes.

e. Remove the yellow no-passing line in the northbound Bypass feeder lane. This causes confusion for vehicles that desire to turn left to inbound Northwestern Avenue.

Specific Recommendations-Non-Intersection Areas

These areas are generally of less trouble than intersections because there is less opportunity for conflict. The principal problems in non-intersection areas are the result of marginal constriction. It is an accepted fact that narrow lanes and proximity of physical obstacles have an adverse effect on the freedom of movement a driver feels. It is also recognized that marginal factors suggesting potential conflict have an adverse effect as well. Multiple entrances and extensive area open for use by vehicles entering or leaving the highway cause apprehension to drivers moving on the highway and thus adversely affect their speed and increase unnecessary delay. But from another point of view, this effect is probably not as great as would be desirable. While concerned about the possible egress from such entrances, the moving driver does not consider the danger too great because he is innately familiar with the lower probability of an actual conflict situation due to low traffic volume. The driver is thus not as prepared for conflict as he would be at, say, an intersection. The result of conflicts that do occur may, therefore, be relatively more severe than at intersections. Marginal friction, whether physical or operational, has an adverse effect on traffic from both accident and efficiency standpoints. The areas discussed below may be located in Figures A8 and A9.

1. Trader Horn Commercial Complex-Station 37 + 40L; Figure 29

The volume to this location is relatively low due to the nature of the establishments. The complex could well be served by one drive of two lanes, although due to the frontage covered, two drives may be necessary. The principal problem is elimination of the broad expanse of access area.

2. Emergency Areas-Stations 95+00L, 95+00R, 140+50L

The use of these areas for rest purposes is the problem. The best solution is designation of these areas as "for use in emergency only". Unnecessary use of these areas increases vehicle conflict as adequate acceleration and deceleration area is not available or designed.

3. The situation in the western quadrants at the Schuyler Street-Indiana 25 intersection was discussed in the previous recommendations for that intersection.

4. The overpass of the Wabash Railroad should have wider and better maintained shoulders.

FIGURE 29 EXAMPLE OF POOR DRIVEWAY DELIMITATION

FIGURE 30 EXCESSIVE NUMBER OF LOW VOLUME ENTRANCES

5. Railroad Yard-Station 208+00L

Define a single point of access.

6. Skelgas-Station 218+00L

Prohibit shoulder parking and access to the commercial facility located here as access is by the adjacent county road.

7. Stations 250+57 to 259+27R, Figure 30

There are many low volume drives located close together on the west side along this stretch. Consolidation is feasible, and a service road would be desirable.

8. Best-Built-Station 225+00L

This area also has much too broad an expanse for use of customers. The entire complex could be served by two drives at most, possibly only one.

9. Silver Park Motel-Station 233+58R

Again a much too broad expanse of open drive for the traffic served; designate one entrance.

10. County Highway Garage-Station 238+12R

Prohibit shoulder parking. Reduce width of access drive allowing drives at either end of the curb or fence.

11. National Homes-Station 278+56R, Figure 31

The closeness of the operations at this facility to the Bypass is extremely bad. The company is using all but a few feet of shoulder in a densely developed high volume section. The effect of this constriction on traffic operation is enormous. Lights on the posts (see Figure 31) holding cables at the edge of the roadway are very distracting at night.

FIGURE 31 EXCESSIVE ROADWAY FRINGE IMPINGEMENT AT NATIONAL HOMES

The situation has been made even more severe by installation of a semi-actuated, poorly operated signal (see Figure 31) for use by trucks of the company to cross the Bypass. Aggregate delay to Bypass traffic makes the signal unjustifiable. There is no alternative but to widen the right-of-way and remove the signal. The present use is definitely not in the interests of Bypass travelers.

12. Station 309+00R

Use of the median and shoulder areas by Highway Commission maintenance crews for equipment and personal vehicle parking should be eliminated.

<u>Stage II-Minor Construction</u>

The improvements recommended in this section are sufficiently extensive to preclude their financing from regular operation or maintenance funds. They are, however, modest enough to permit their being undertaken with no more than year to year budgetary planning. These recommendations will be listed in the order deemed most desirable for implementation.

1. Happy Hollow-Soldiers Home Road

The problems here concern the steep down-grade immediately east of the intersection. If the intersection could be moved to a more nearly level area the sight distance and commercial vehicle acceleration problems would be reduced and installation of a signal would be feasible. It is recommended that the intersection be moved west of its present location to near Station 54+00, location of a recently granted point of access.

This location would have sufficient stopping sight distance for vehicles on the east approach to permit installation of a traffic signal. The current intersection would be terminated completely and the cross-road approaches extended on frontage roads to the point of intersection (Figure 32). The automobile sales establishment at Station 66+73 would have access to the frontage road only. Bypass approaches would be four lanes each to match the cross section at the Salisbury intersection (1900 feet west) and carrying through the truck climbing lane from the hill. The outside southbound lane would be tapered for a reasonable recovery distance to meet the present situation on the hill.

There is sufficient right-of-way available for 20 foot frontage roads on either side of four 11 foot lanes on the Bypass, allowing also for a marginal divider between the Bypass and the frontage roads. The frontage road on the south side should be constructed on the alignment which the southbound roadway will follow when the Bypass is widened and realigned in this area. The frontage road on the north side within the current right-of-way could still be used subsequent to the Stage II work. The cross-street approaches should have three lanes each to permit easy right-turns and through movements.

Two possible alternative solutions to this problem exist. One of these, prohibition of all but right turns at this intersection, would be workable if Cumberland Boulevard (north of the Bypass) were extended to Soldiers' Home Road. This prohibition could best be accomplished by installation of a four foot wide barrier medial island through the area of conflict (Figure 33). Traffic turning left and crossing from the

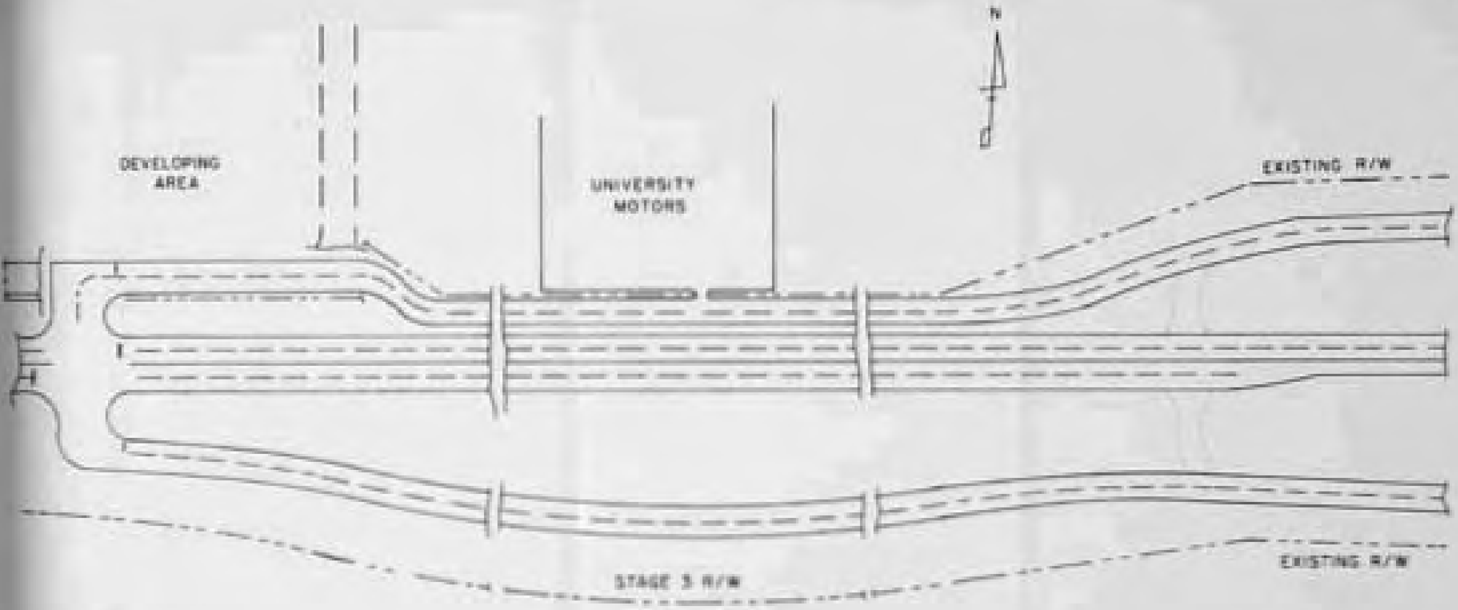


FIGURE 32 HAPPY HOLLOW - SOLDIERS HOME ROAD INTERSECTION WITH U.S. 52 BYPASS; STAGE 2 RECOMMENDED MODIFICATIONS

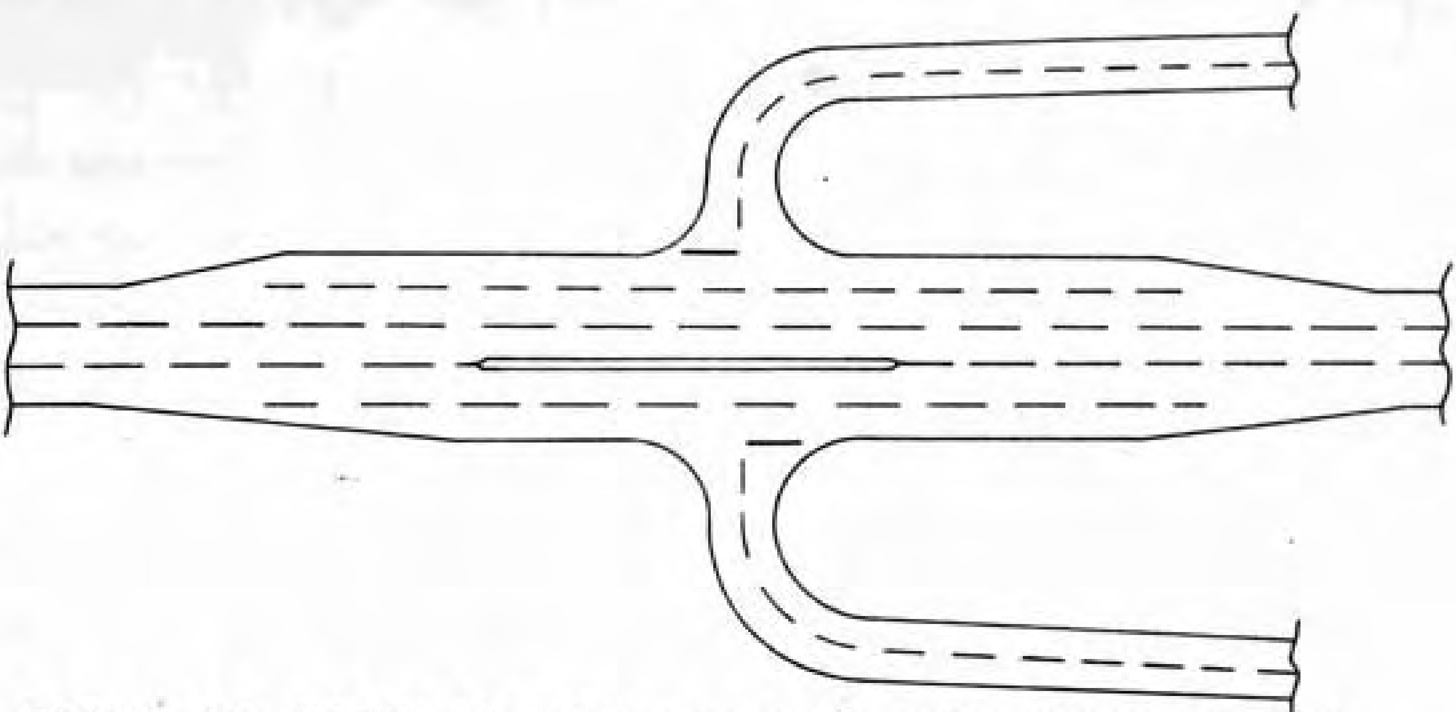
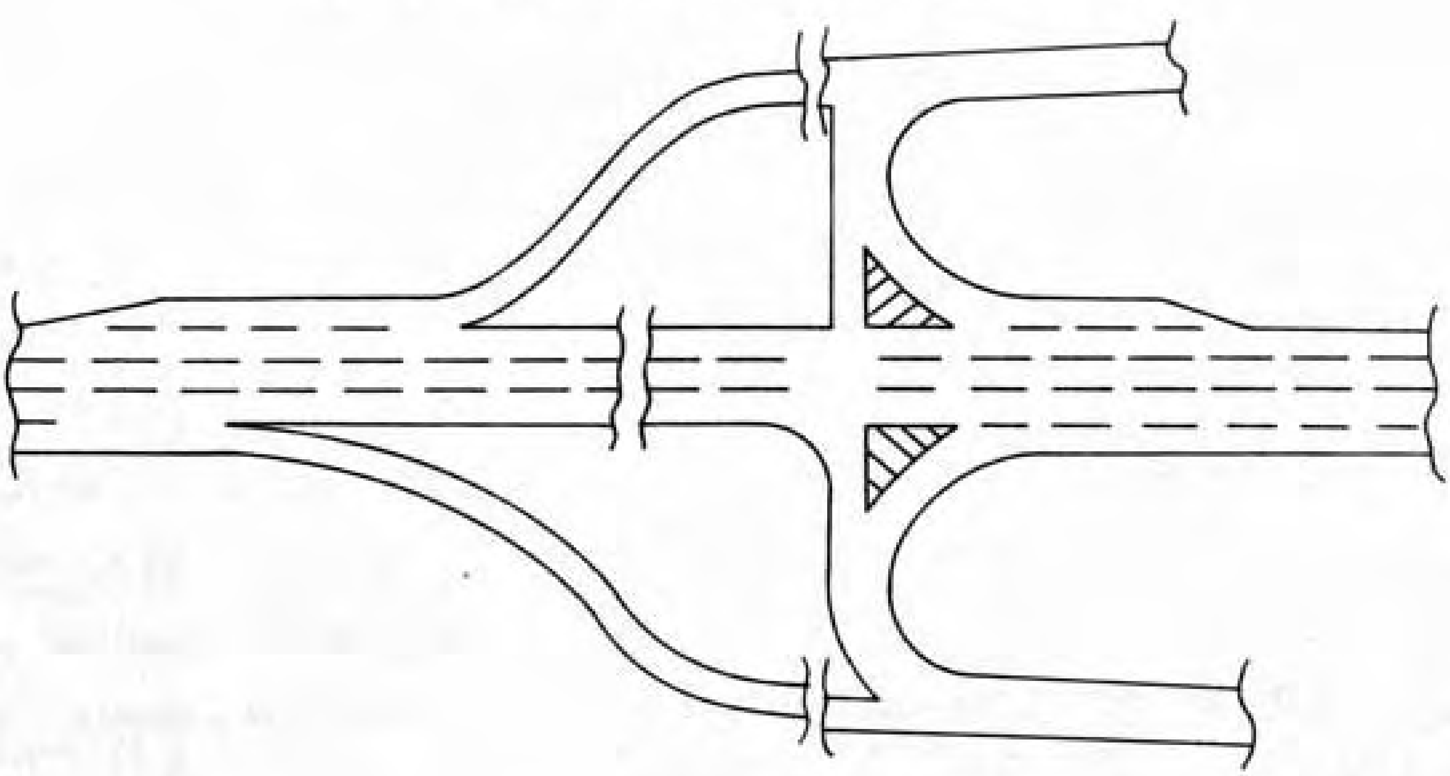


FIGURE 33. HAPPY HOLLOW - SOLDIER'S HOME ROAD AT U.S. 52 BYPASS: STAGE 2, ALTERNATE 1

FIGURE 34 HAPPY HOLLOW - SOLDIER'S HOME ROAD AT U.S. 52 BYPASS: STAGE 2, ALTERNATE 2



north approach could then use Cumberland to Salisbury, and the Salisbury Street intersection for access to the Bypass. Salisbury (County Farm) Road would no doubt be rather overloaded for its present condition. There would also probably be considerable resistance to the heavy traffic situation on Cumberland from property owners in the Barberry Heights residential area. But since the situation would be temporary, it might be managed. Through and left turning traffic from the south (Happy Hollow) approach to the intersection would have to use other local streets to get to the Bypass, and would probably select more direct routes of access. The right turns could be channelized and facilitated with merging-acceleration lanes.

The second alternative is movement of the intersection down the grade 350 feet with continued operation of the intersection similar to that employed at present. This solution would permit safe sight distance both directions from the intersection. Use of the present intersection by interchanges with the west Bypass approach would also still be possible (Figure 34).

Neither of these two alternatives were considered as desirable as the solution proposed. The first was rejected because of its extreme dependence on the contingencies of acceptance and action by local groups; improvement of this intersection must not be postponed any longer than necessary. The second was discounted because it solves only the sight distance problem and does not improve ease of traffic movement.

2. Median Left Turn Lanes

Widening the cross section to a four lane urban type with a median

(Figure 35 and 36) should be undertaken at several intersections. At each location median left-turn lanes with actuated left-turn signal phases would be included. The wider cross-section proposed is in line with the recommendation of Stage III and actually is a first step in this direction. Existing right-of-way is adequate for this cross-section at all locations proposed.

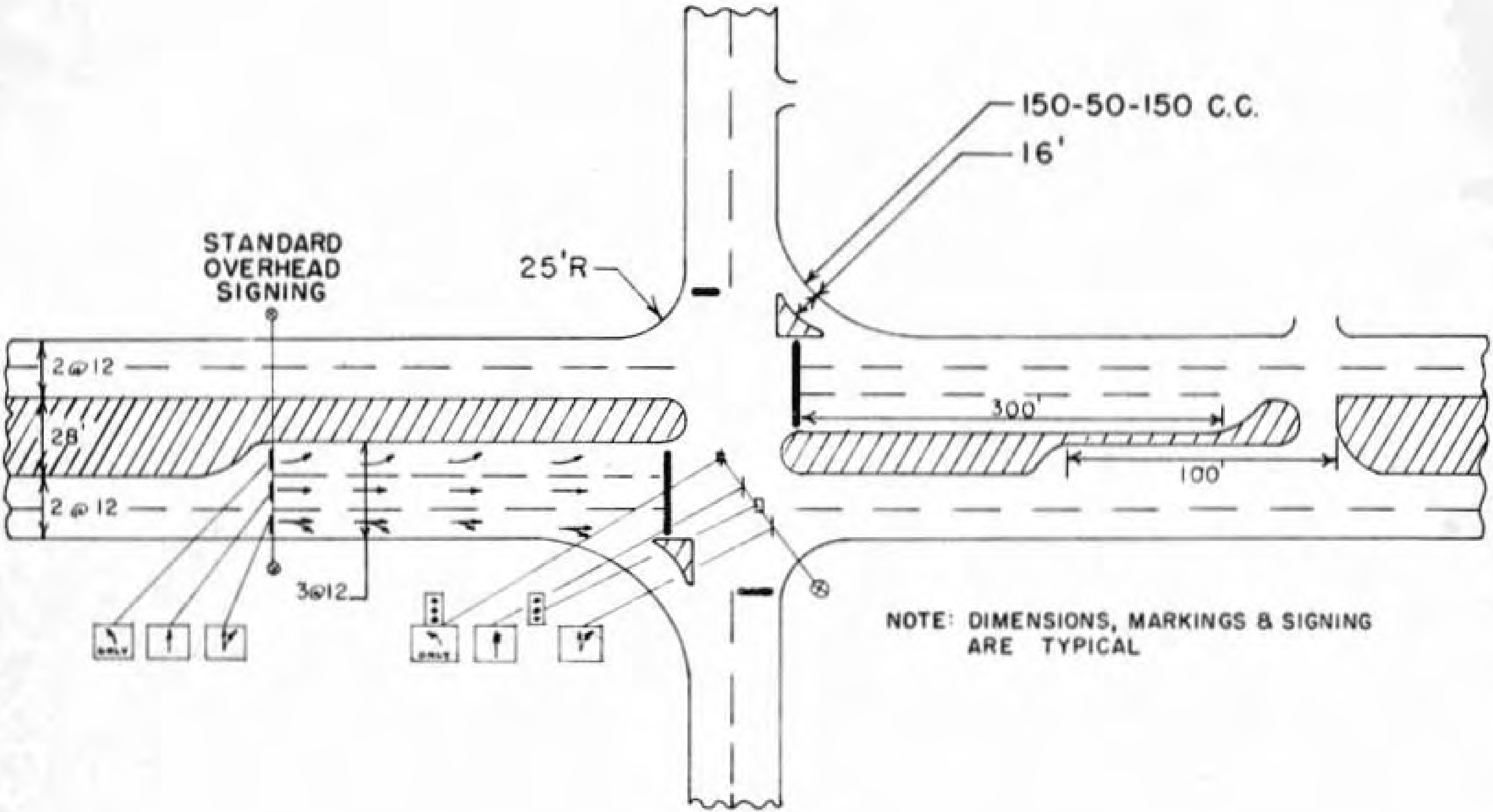
The locations at which construction of this type is recommended as soon as possible are the Salisbury Street, Indiana 25, Indiana 26, and Union Street intersections. This situation already exists at the Indiana 38 and Teal Road locations. It is not recommended for the Happy Hollow intersection in lieu of the Stage II improvement and space restrictions discussed previously.

3. Teal Road

Relocation of both cross-street approaches is recommended. The work proposed here would be done in several steps (Figure 37).

a. Construct a connector road along the south edge of the K-Mart property between U.S. 52 and Indiana 38. Land for this is available, and the facility has been sanctioned by the Area Planning Commission. Figure 38 shows a fence which is on the line the new road would take. The road would serve movements currently interchanging between the south and east approaches of the U.S. 52-Indiana 38 intersection and would eliminate cross-cutting of the K-Mart parking lot.

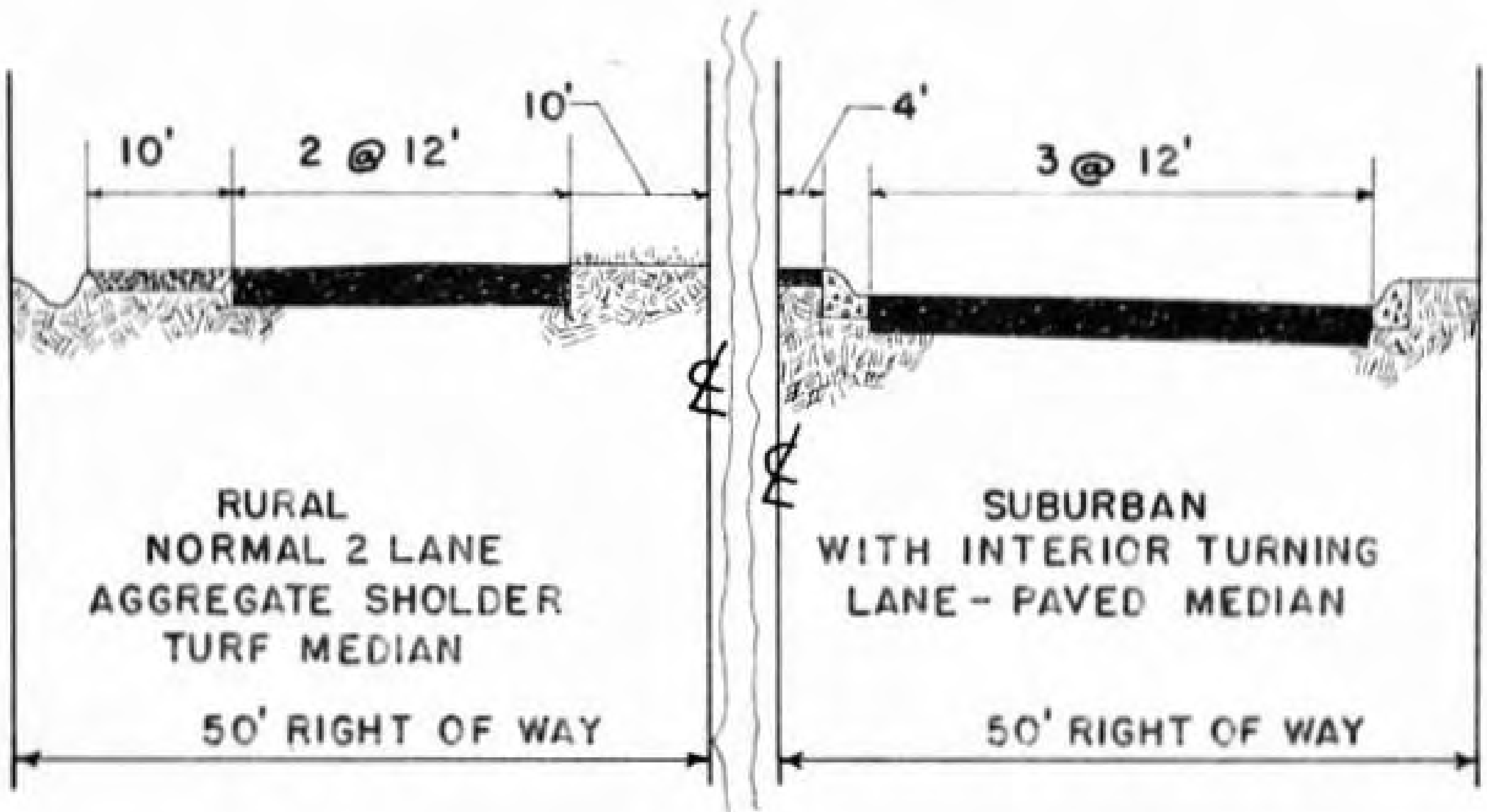
b. Close the present main K-Mart drive onto U.S. 52 replacing it by a new entrance onto the new connector road. This should



STAGE III

TYPICAL 6 LANE INTERSECTION
WITH MEDIAN

FIGURE 35



STAGE III

TYPICAL CROSS SECTION

FIGURE 36

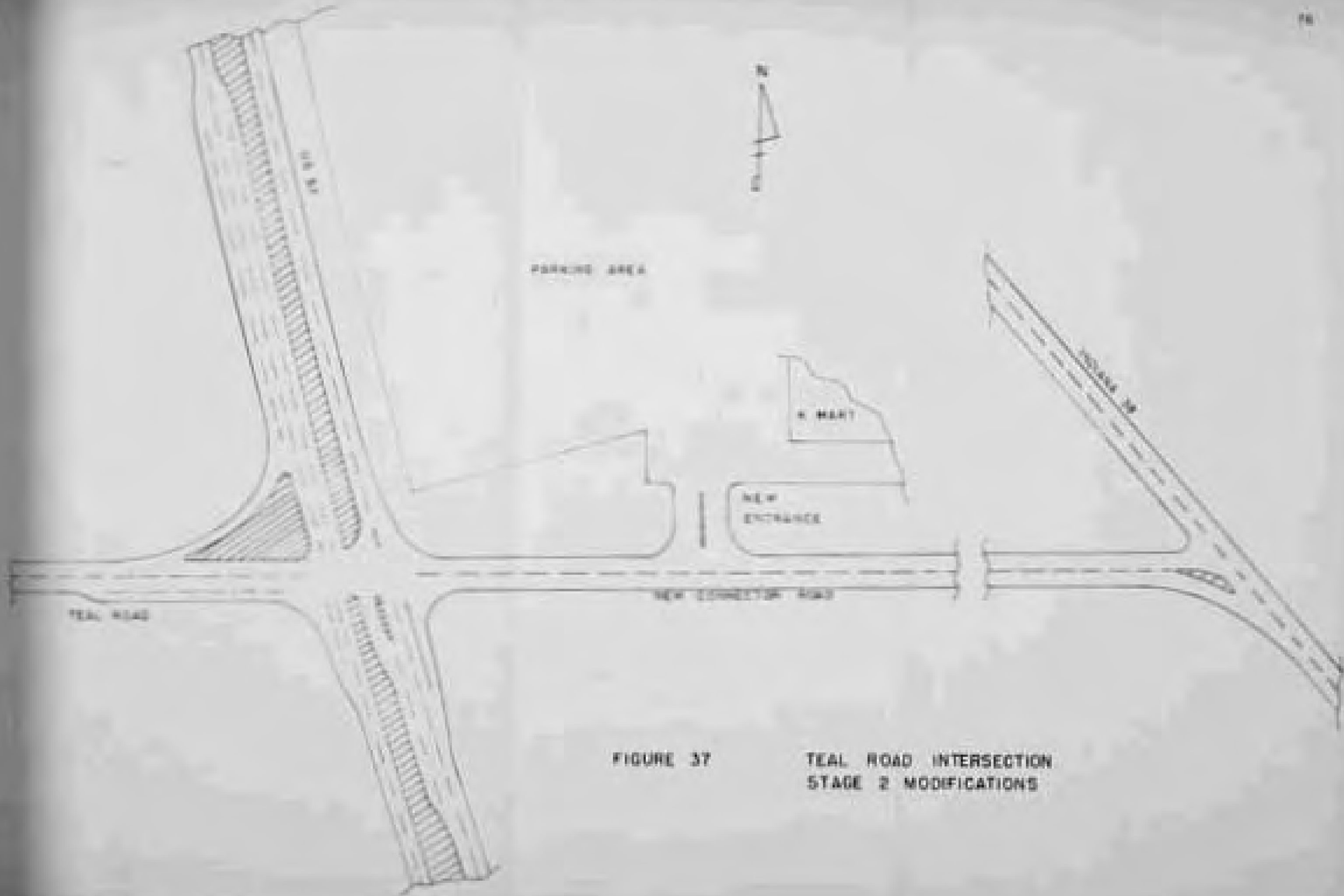


FIGURE 37 TEAL ROAD INTERSECTION
STAGE 2 MODIFICATIONS

FIGURE 38 PROPOSED CONNECTOR BETWEEN TEAL ROAD AND INDIANA

be acceptable to the K-Mart management now that patronage has been established.

c. Carry Teal Road straight, in line with the existing tangent section to intersect U.S. 52. The approach will then align with that of the new connector. The intersection will not be at 90 degrees, but this is not too important since there will be signal control.

d. Right-turns from southbound U.S. 52 could use the existing Teal Road approach as a ramp with Yield control at the terminus. U.S. 52 should retain median left-turn lanes with a shielded, actuated phase. All other movements would be made without special channelization. The U.S. 52 approaches will be 4 lanes in addition to the median left-turn lanes. The cross-street approaches will have three lanes, one for receding traffic. The two for that approaching will be designated right-and-through and left-turns-only. An all red phase should be employed to clear the intersection because of the large area involved.

Stage III-Major Construction

This work involves financing of such magnitude as to require long range fiscal planning. Preparation should be started now to enable completion of these improvements within the next five years.

Reconstruct the Bypass to provide a minimum of four-lanes of traffic at all locations. The opposing traffic flows should be separated by a median, and median left-turn lanes should be added for virtually every intersection and crossover. The section should be of urban design where-ever development is considerable, and entrances to abutting property should be minimized by consolidation and definition. Necessary channelization at large intersection areas should be properly designed. An overpass and interchange should be constructed for Soldiers Home-Happy Hollow Road. An interchange should be constructed at the intersection of the Bypass and Northwestern Avenue. Additional structures will also be required at the Wabash River and over the two railroads which are now overpassed. Further study is necessary to evaluate the need for an additional interchange of the Bypass with the facility serving traffic from the future I-65.

Plans for such improvements have received preliminary approval, and the Indiana State Highway Commission is proceeding with planning for this construction.

CONCLUSION

This report has dealt with measures to improve existing conditions on the Bypass. It has set down improvements which will assist traffic in traversing the facility safely and with less delay. These recommendations have varied in extent and effect, and similarly in cost. But this work is not uniquely adaptable or effective for this location. It may be assumed to produce similar results wherever applied. Such then is the thesis of this demonstration project: to show how effective such relatively minor work can be for improving operative efficiency of any high volume arterial highway.

In retrospect there is a tendency to look more deeply than for a solution to the problem in order to understand the very existence of the conditions. A major portion of the charge for this situation must certainly be laid to the lack of legal powers to limit access. Current legislative practice and powers do recognize the value of access control and no high type facility need ever again be built under this cloud. In at least the present instance, however, the problem can also be traced in some measure to breakdown in the proper administration of those limited powers available. Had adequate authority been exercised over construction and maintenance of access drives and other roadway and traffic aspects, the current problem might not be of the magnitude seen. By strict surveillance and maintenance of such manageable aspects of traffic design and operation, less controllable factors will not have such detrimental effect.

The recommendation for Stage III improvements is being implemented by the Indiana State Highway Commission but will not be completed for approximately five years. A few of the improvements recommended in Stage I have already been implemented by the Highway Commission from preliminary recommendations made to them several months ago from this research. Because heavy volumes of traffic will be using the Bypass for the next few years prior to completion of Stage III improvements, it is hoped that all or a substantial part of the Stage I and Stage II recommendations can be implemented at an early date. As one of the objectives of this research is to evaluate the effectiveness of each improvement, it is requested that the programming of improvements be done in coordination with the staff of the research project, so that such an analysis can be made. Certainly some of the improvements recommended should be completed at a very early date.

BIBLIOGRAPHY

1. Berry, D. S., "Evaluation of Techniques for Determining Over-All Travel Time," Proceedings, Highway Research Board, Volume 31, 1952, pp. 429-440.

2. Berry, D. S., and C. J. Van Til, "A Comparison of Three Methods for Measuring Delay at Intersections," Traffic Engineering, Volume 25, December 1954, pp. 93-99.

3. Determining Travel Time, Procedure Manual 3B, National Committe on Urban Transportation, 1958.

4. Dixon, W. J., Biomedical Computer Programs, Health Sciences Computing Facility, University of California, Los Angeles, January 1, 1964, pp. 169-184, 233-257.

5. Hall, E. M., and G. Stephen, Jr., "Travel Time-An Effective Measure of Congestion and Level of Service, Proceedings, Highway Research Board, Volume 38, 1959, pp.511-529.

6. Harman, H. H., Modern Factor Analysis, Chicago, The University of Chicago Press, 1960.

7. Highway Capacity Manual, U. S. Department of Commerce, Bureau of Public Roads, Washington, D. C., U. S. Government Printing Office, 1950, pp.35-102.

8. Matson, T. M., W. S. Smith, and F. W. Hurd, Traffic Engineering, New York, McGraw-Hill Book Company, Inc., 1955, pp. 327-334.

9. Oppenlander, J. C., "Multivariate Analysis of Vehicular Speeds," Record 35, Highway Research Board, 1963, pp. 41-77.

10. Ostle, B., Statistics in Research, Ames, Iowa, The Iowa State University Press, 1963.

11. American Association of State Highway Officials, Road User Benefit Analyses for Highway Improvements, American Association of State Highway Officials, 1960.

12. Bureau of Public Roads, Increasing the Traffic-Carrying Capability on Urban Arterial Streets, Bureau of Public Roads, 1962.

13. Michael, H. L., "By-Passes - Their Use, Effect and Control," Purdue University Road School Proceedings, 1953.

14. Woo, John C. H., "Correlation of Accident Rates and Roadway Factors," Thesis, Purdue University, 1957.

15. A Policy on Geometric Design of Rural Highways; American Association of State Highway Officials; Washington, D. C.; 1954.

BIBLIOGRAPHY (Continued)

16. A Policy on Arterial Highways in Urban Areas; American Association of State Highway Officials, Washington, D. C.; 1954.

17. Manual on Urban Traffic Control Devices; published by U. S. Department of Commerce, Bureau of Public Roads; Washington, D. C.; June, 1961.

18. Manual of Traffic Engineering Studies; published by Institute of Traffic Engineers; Washington, D. C.; 1964.

APPENDIX

DATA FOR U.S. 52 BYPASS
LAFAYETTE, INDIANA
AUGUST, 1964 TO JUNE, 1965

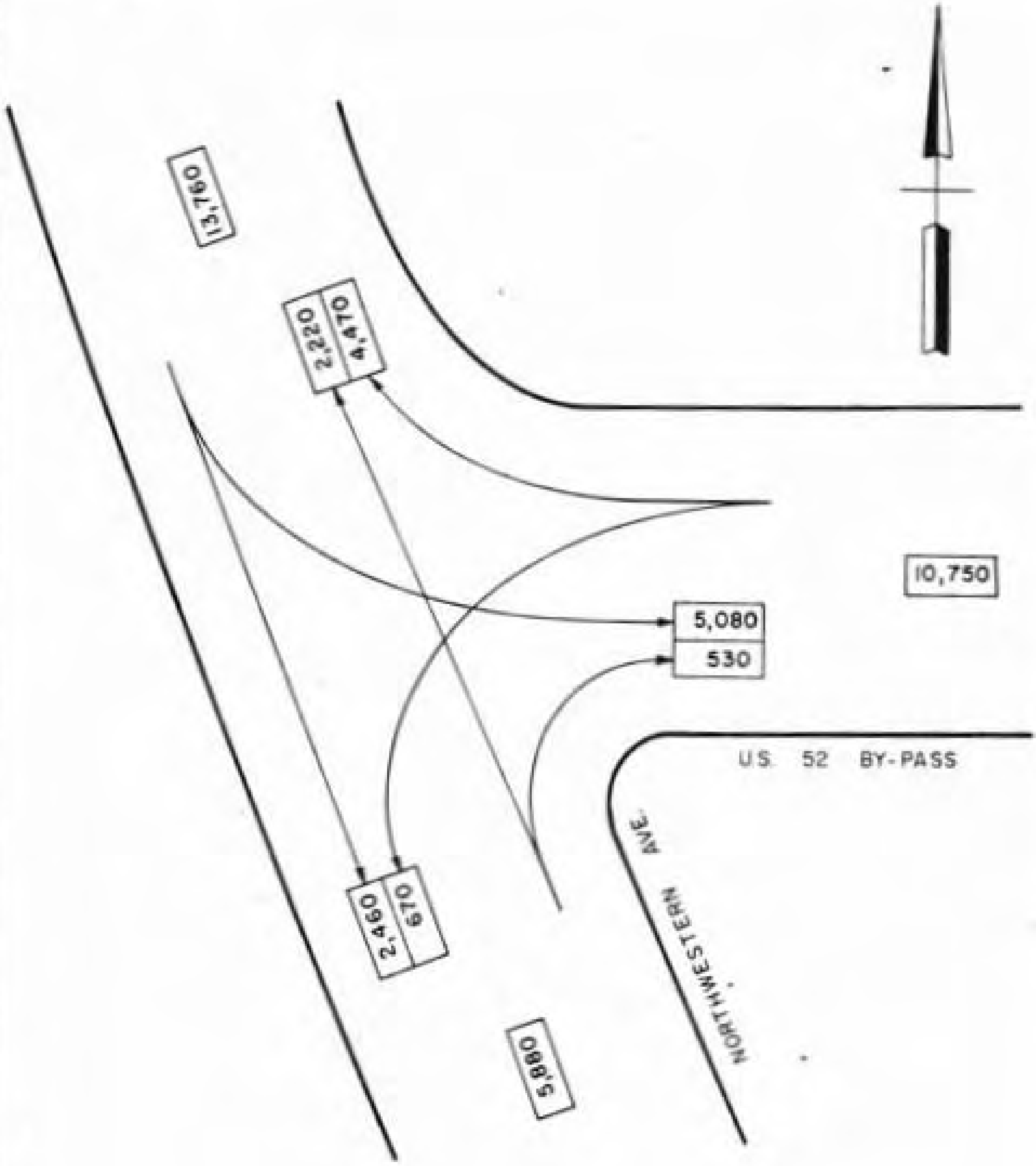


FIGURE A1 (a) 1964 ADT VOLUMES AND TURNING MOVEMENTS AT U.S. 52 BY-PASS AND NORTHWESTERN AVE.

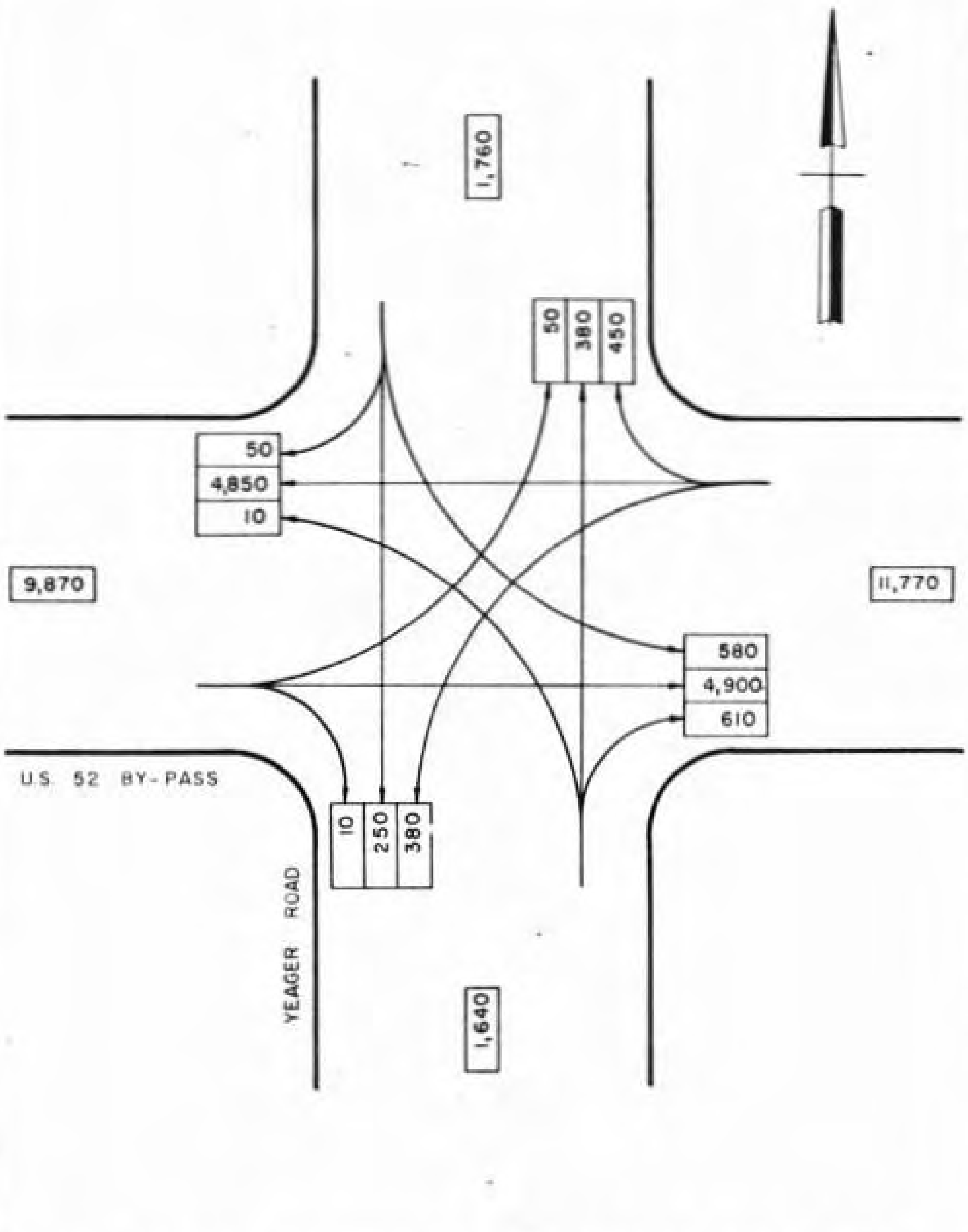


FIGURE A1 (b) 1964 ADT VOLUMES AND TURNING MOVEMENTS AT U.S. 52 BY-PASS AND YEAGER ROAD.

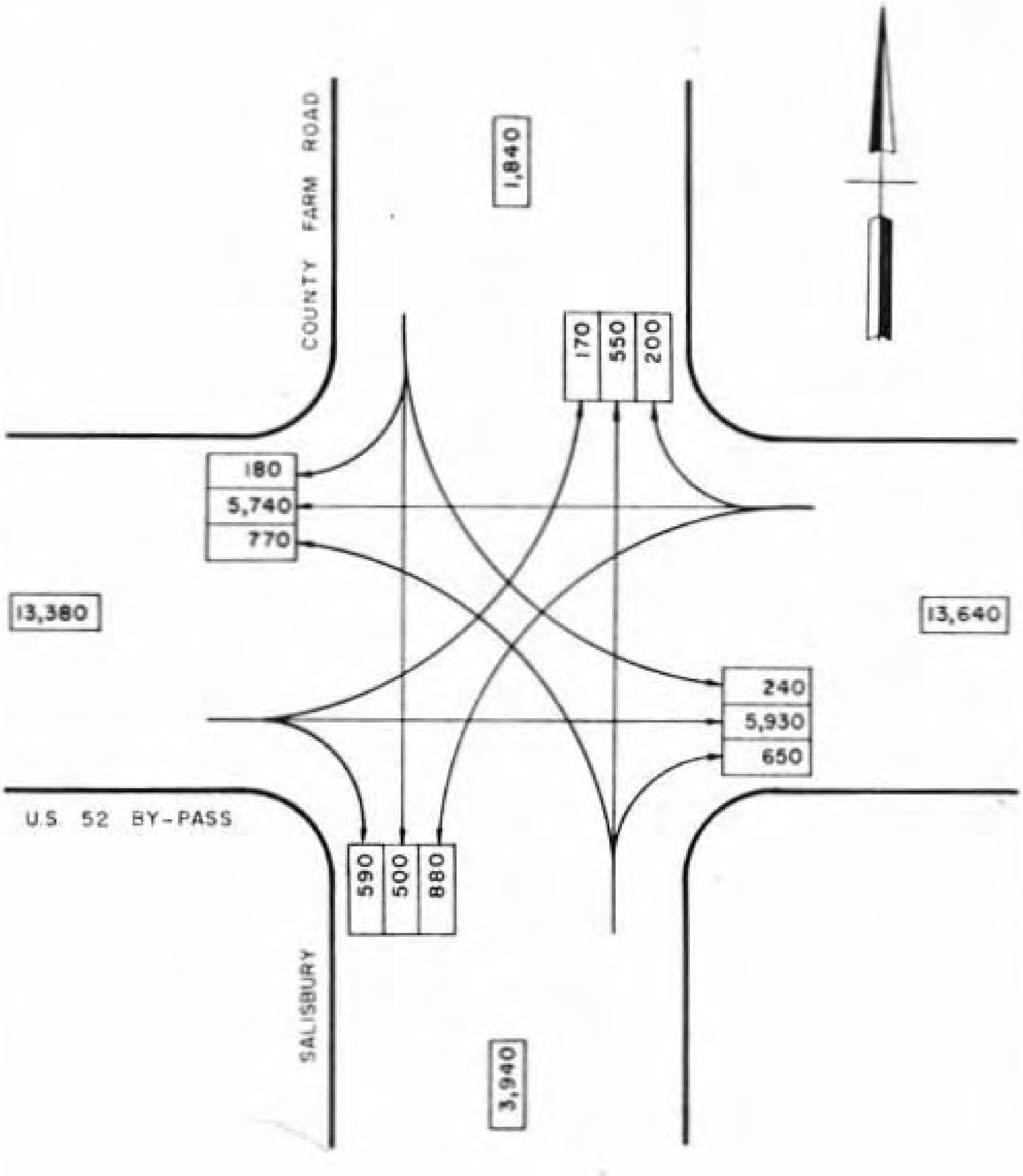


FIGURE A1(c) 1964 ADT VOLUMES AND TURNING MOVEMENTS AT U.S. 52 BY-PASS AND SALISBURY.

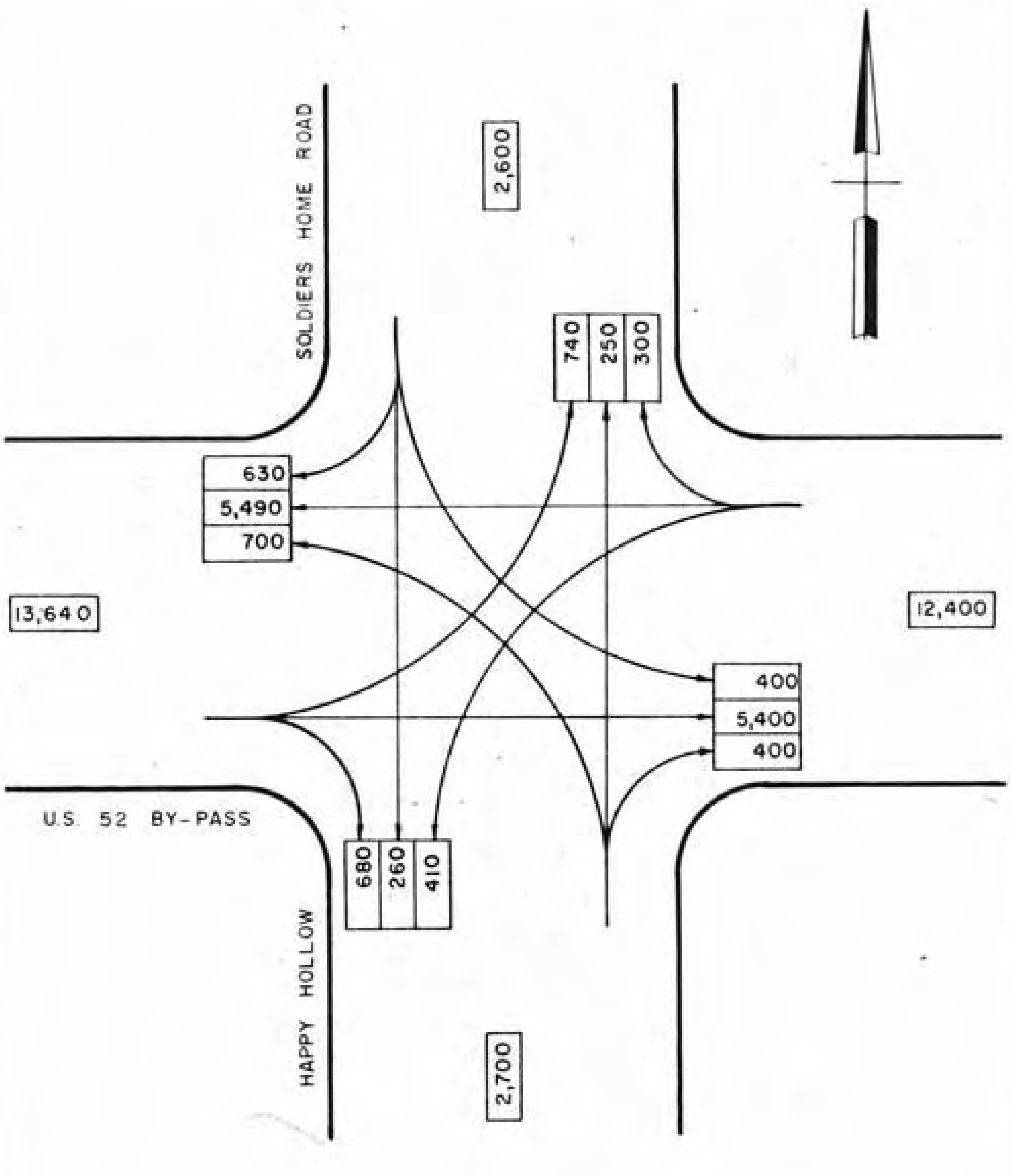


FIGURE A1(d) 1964 ADT VOLUMES AND TURNING MOVEMENTS AT U.S. 52 BY-PASS AND HAPPY HOLLOW.

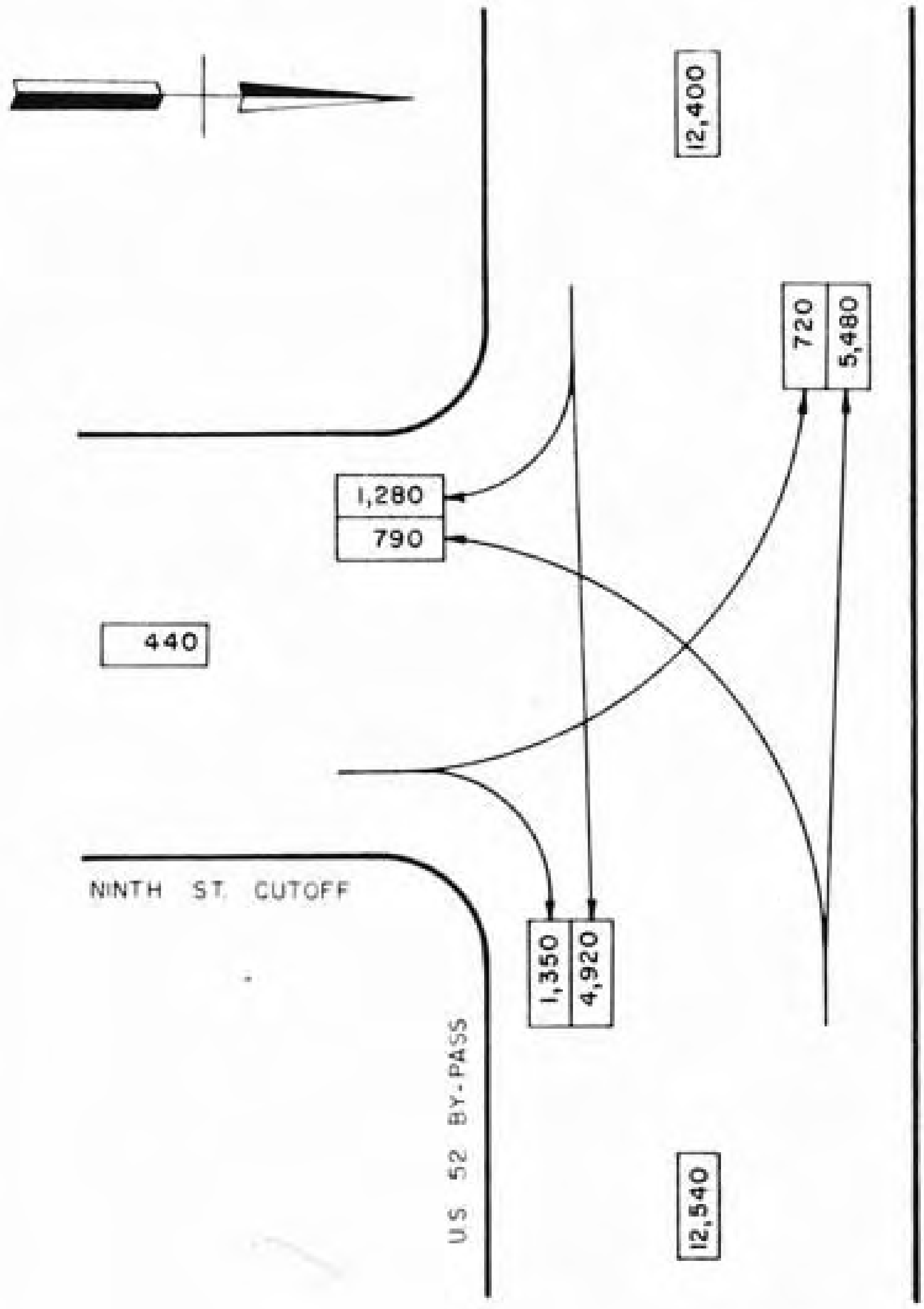


FIGURE A1(e) 1964 ADT VOLUMES AND TURNING MOVEMENTS AT U.S. 52 BY-PASS AND NINTH ST. CUTOFF.

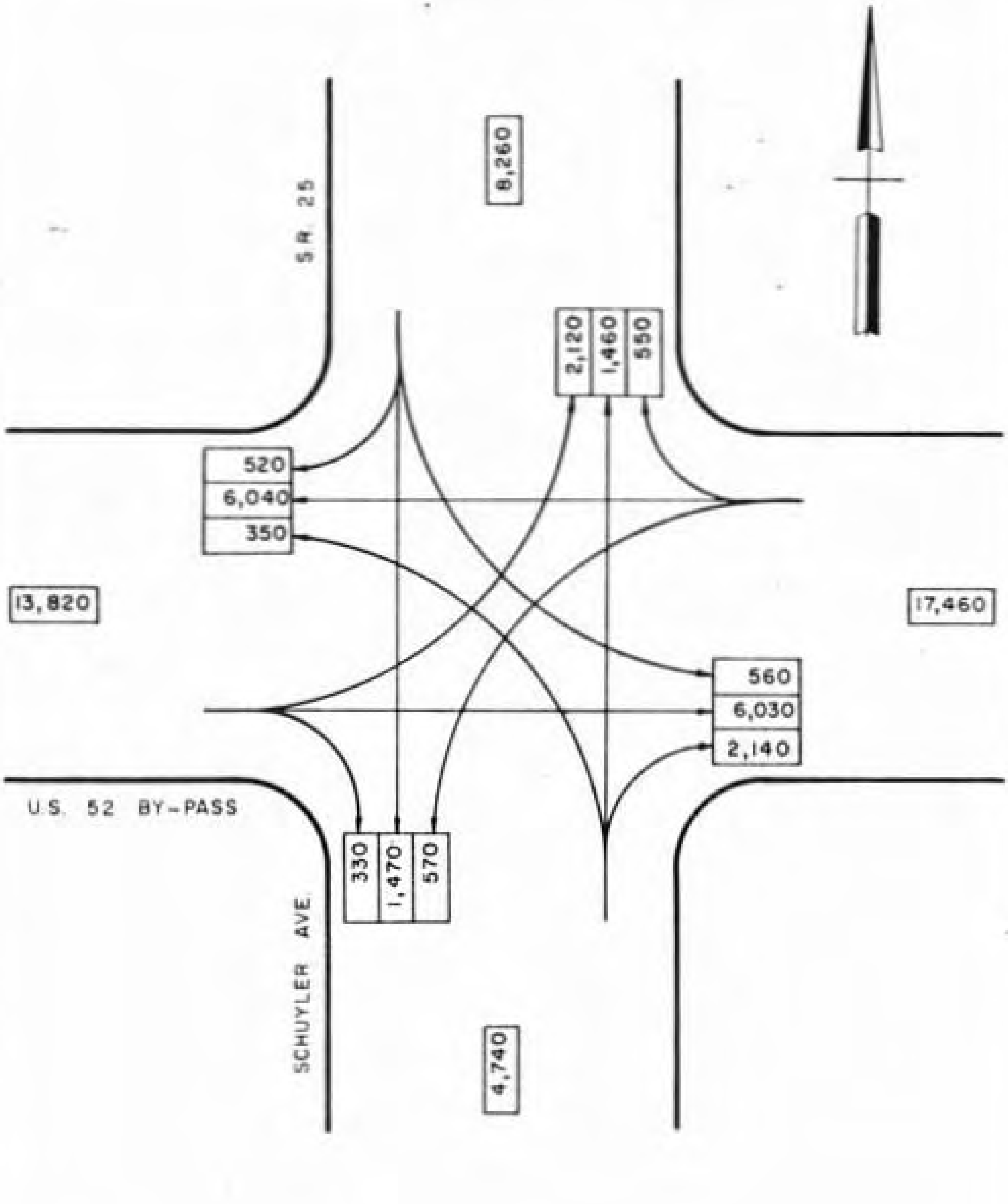


FIGURE A1(f) 1964 ADT VOLUMES AND TURNING MOVEMENTS AT U.S. 52 BY-PASS AND S.R. 25.

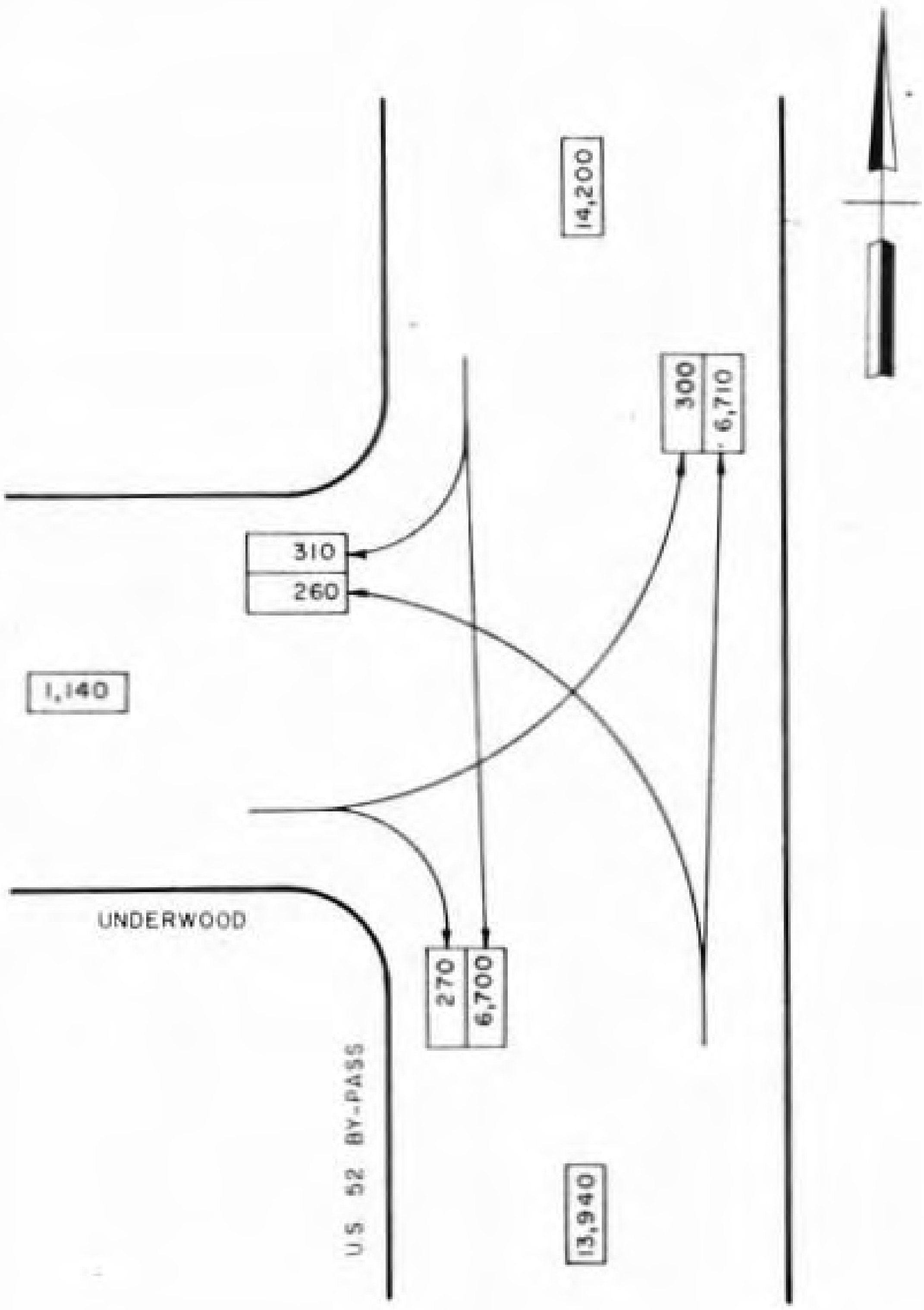


FIGURE AI(g) 1964 ADT VOLUMES AND TURNING MOVEMENTS AT U.S. 52 BY-PASS AND UNDERWOOD.

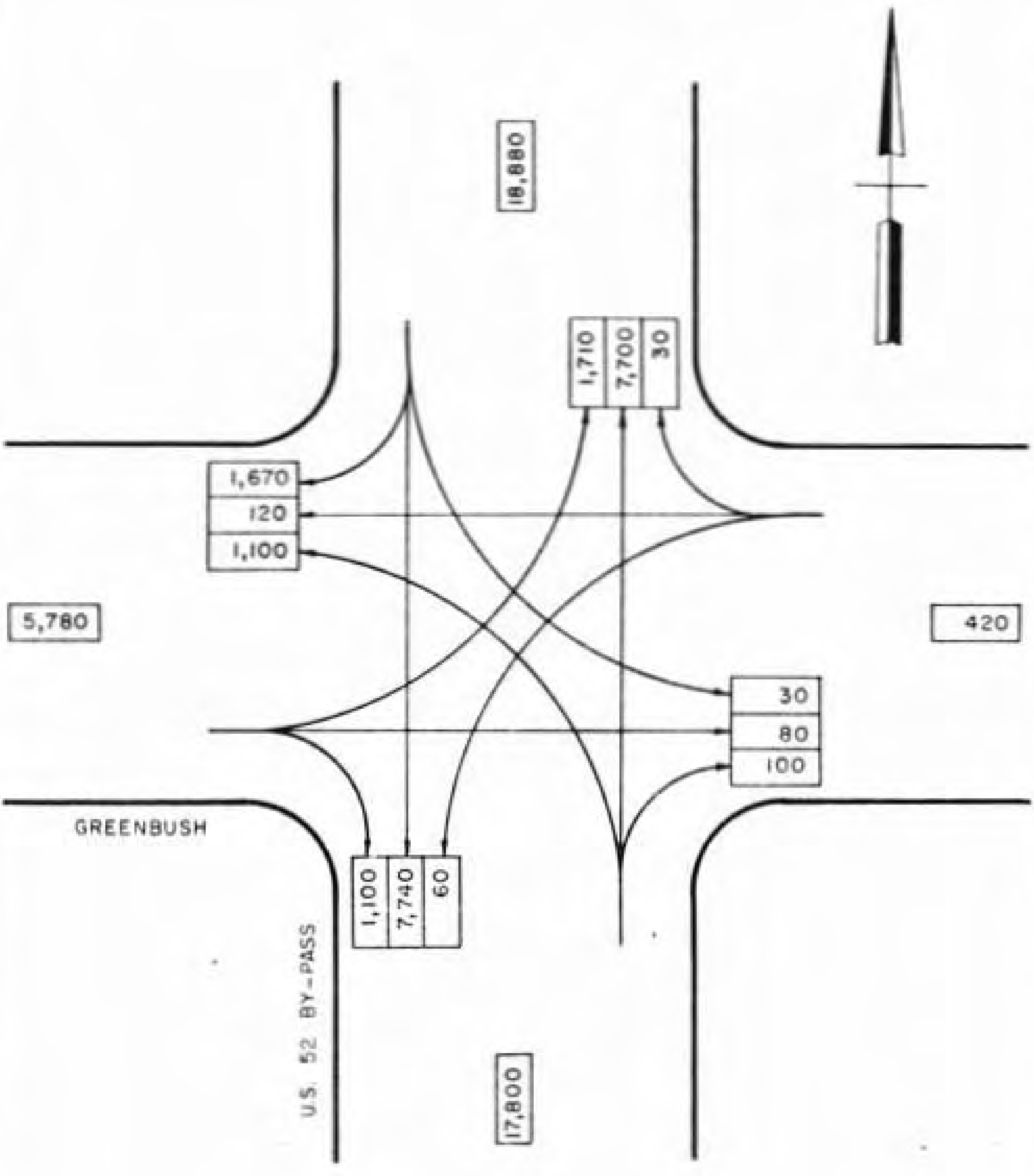


FIGURE A1(h) 1964 ADT VOLUMES AND TURNING MOVEMENTS AT U.S. 52 BY-PASS AND GREENBUSH.

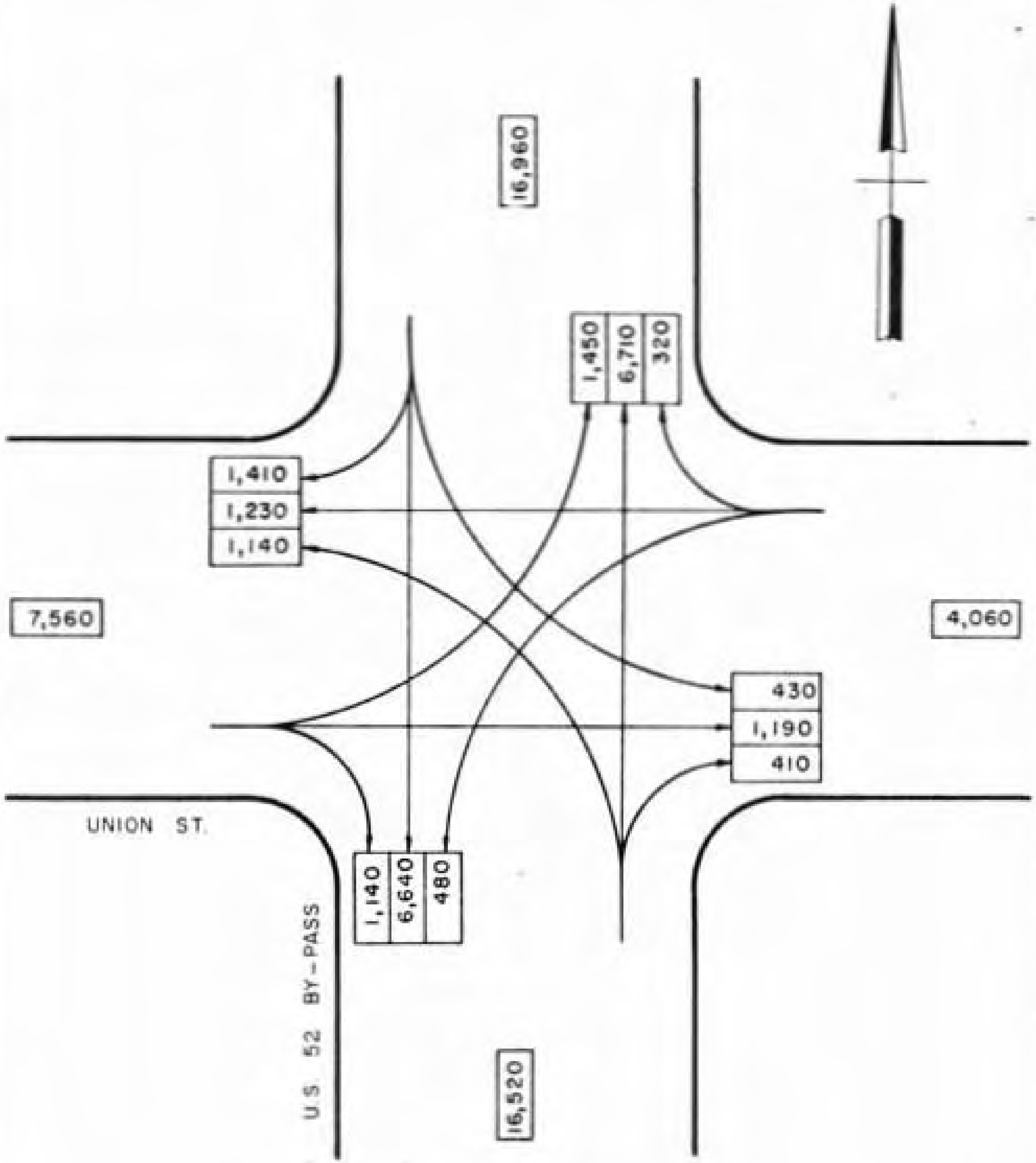


FIGURE AI(j) 1964 ADT VOLUMES AND TURNING MOVEMENTS AT U.S. 52 BY-PASS AND UNION ST..

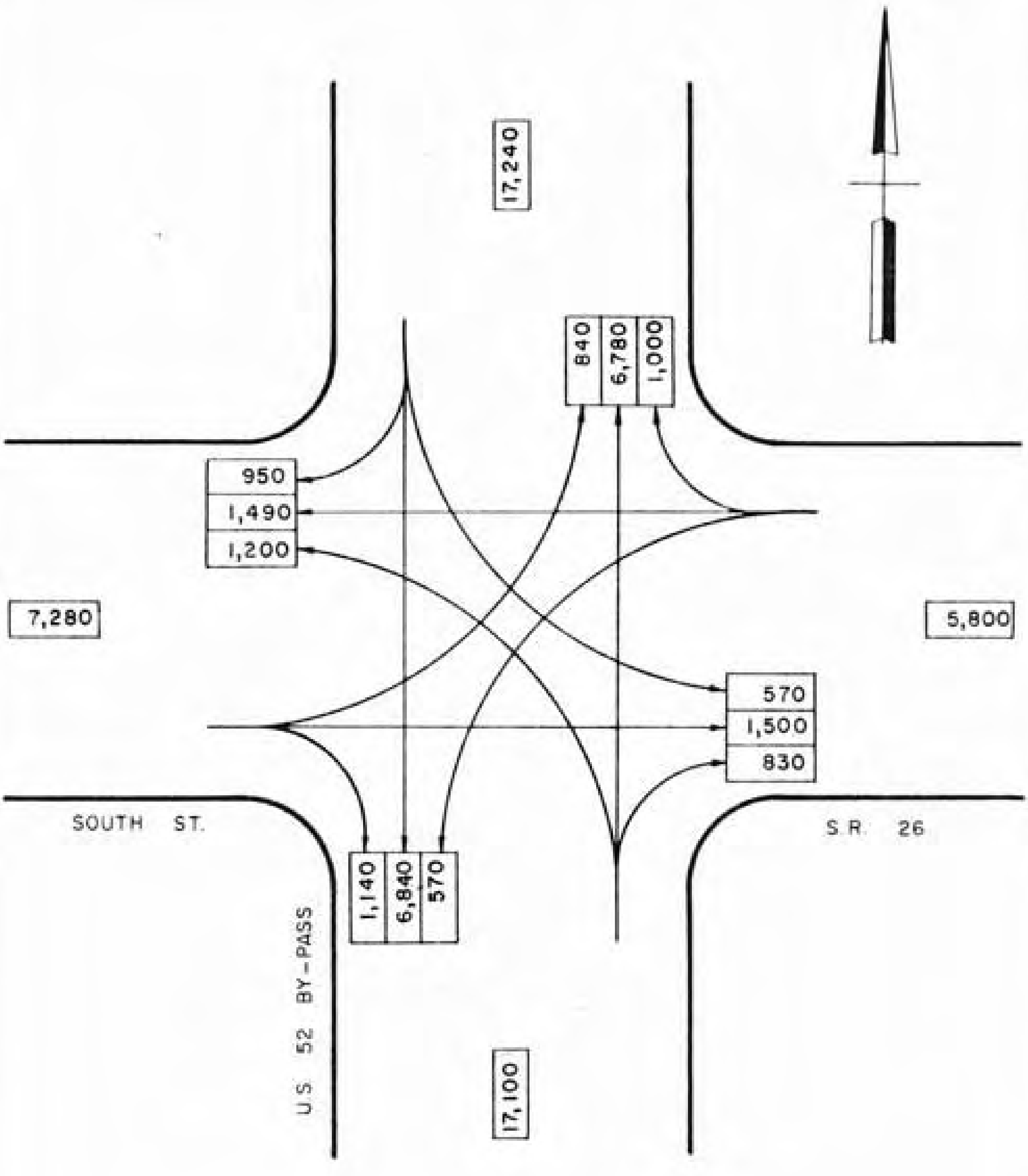


FIGURE A1(k) 1964 ADT VOLUMES AND TURNING MOVEMENTS AT U.S. 52 BY-PASS AND S.R. 26.

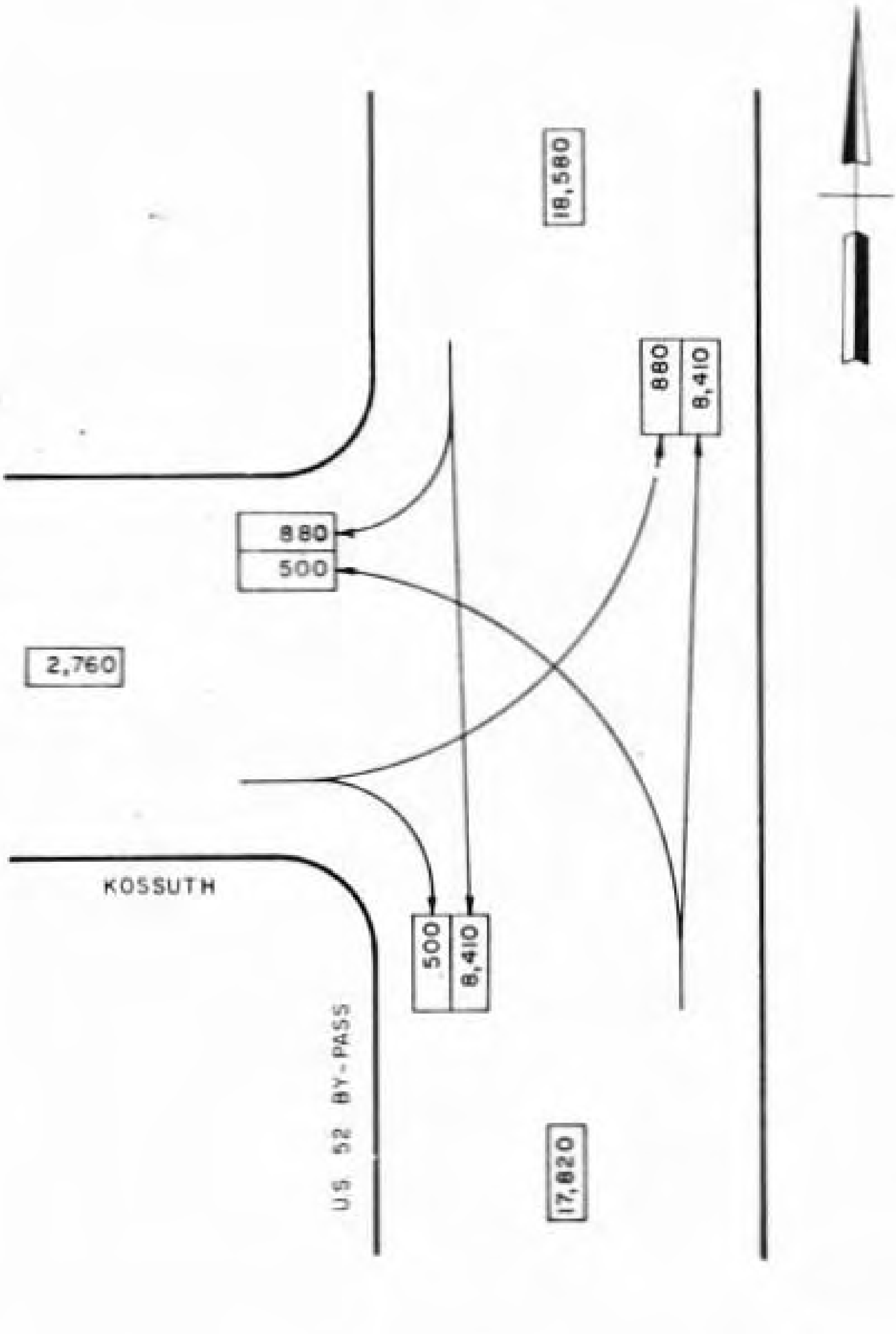


FIGURE A1 (1) 1964 ADT VOLUMES AND TURNING MOVEMENTS AT U.S. 52 BY-PASS AND KOSSUTH.

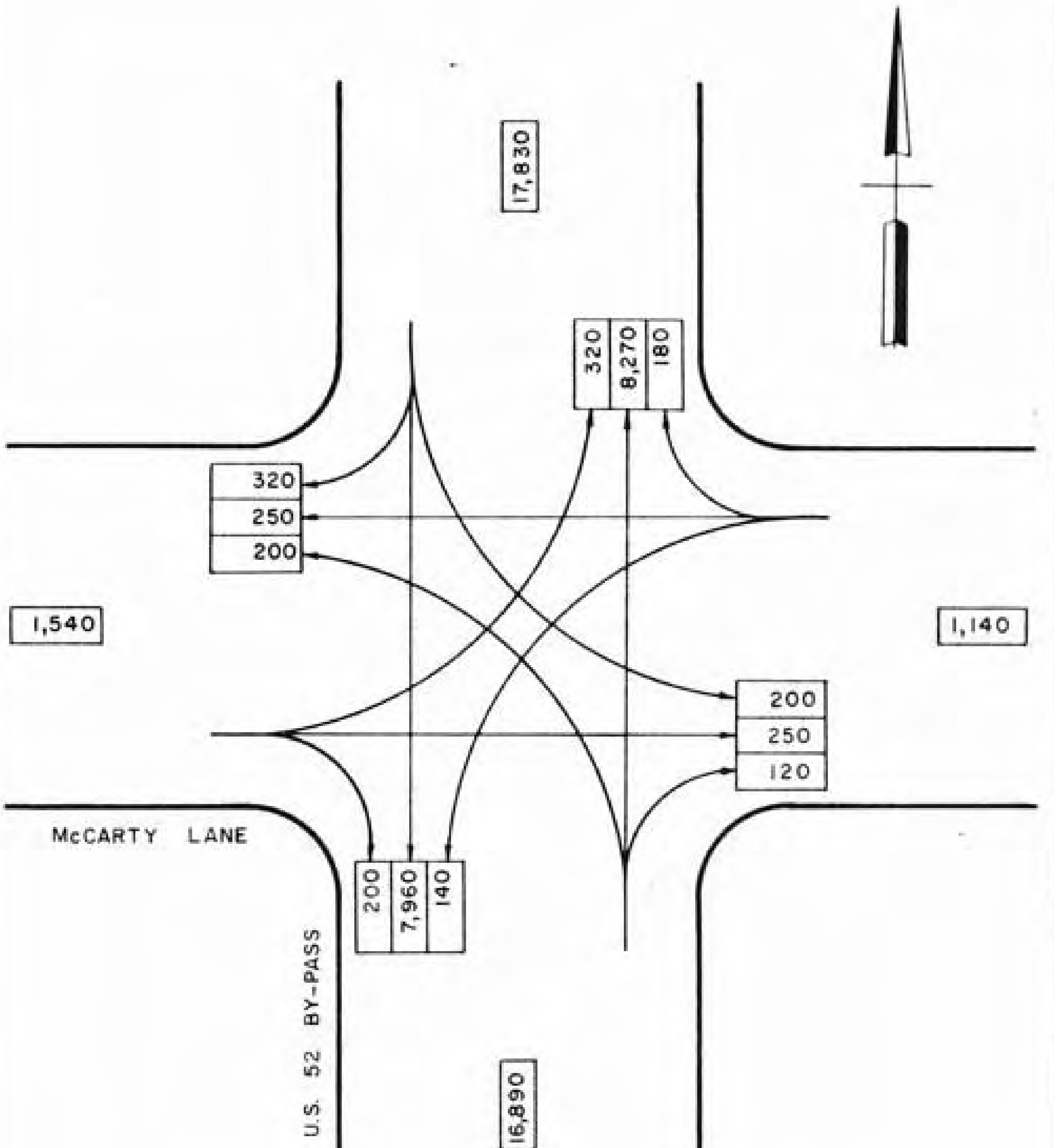


FIGURE A1(m) 1964 ADT VOLUMES AND TURNING MOVEMENTS AT U.S. 52 BY-PASS AND McCARTY LANE.

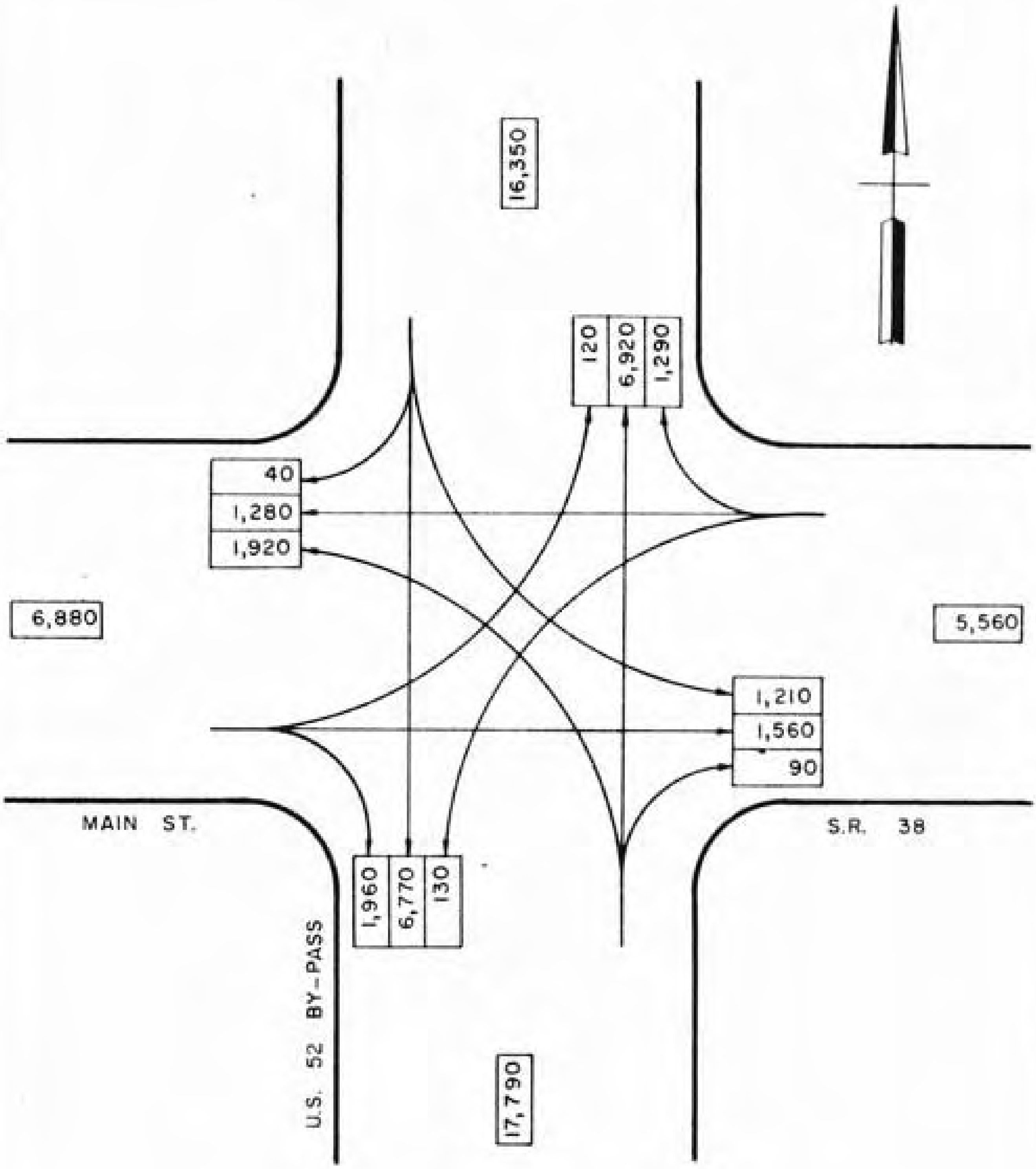


FIGURE A1 (n) 1964 ADT VOLUMES AND TURNING MOVEMENTS AT U.S. 52 BY-PASS AND S.R. 38.

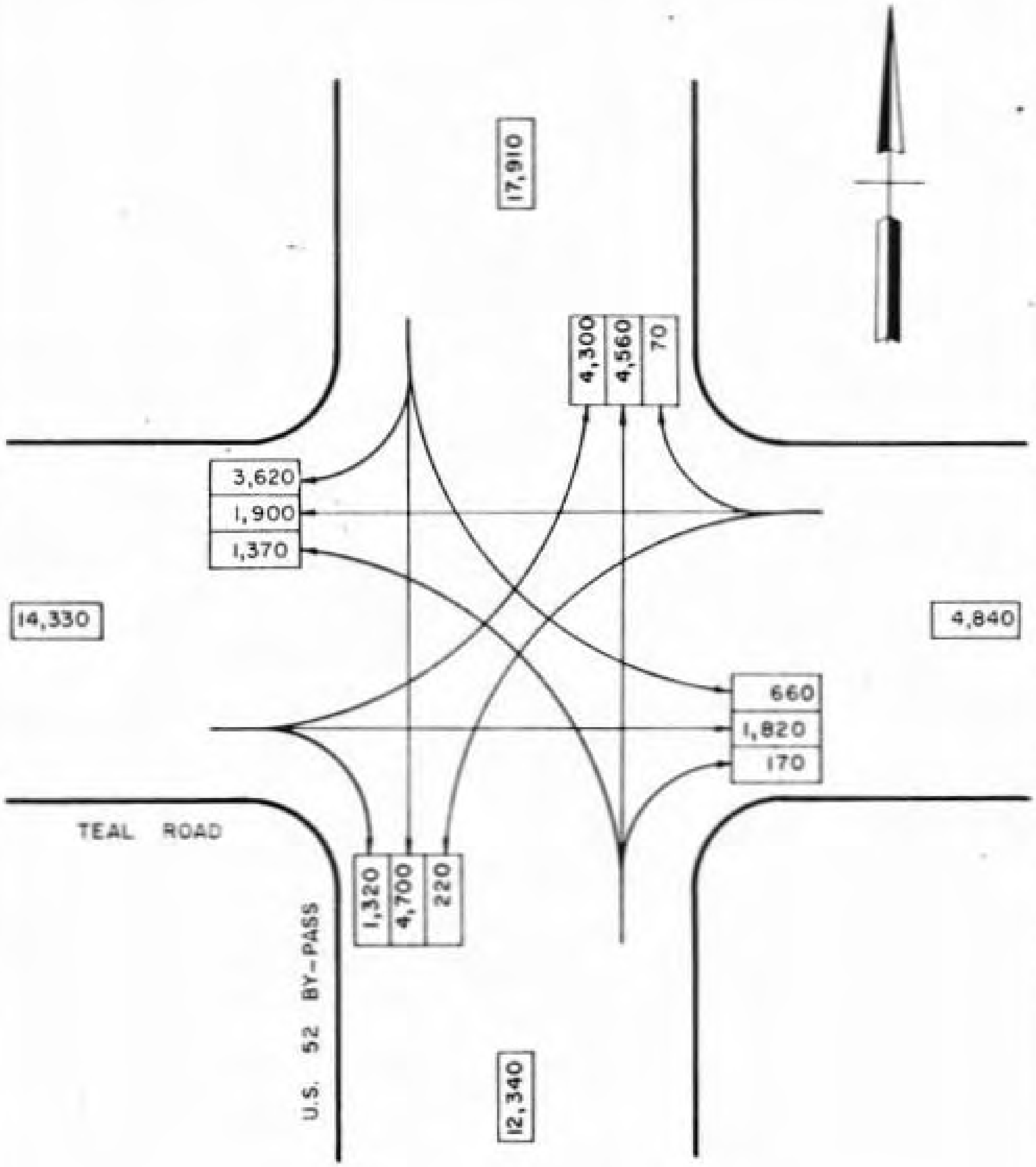


FIGURE A1(o) 1964 ADT VOLUMES AND TURNING MOVEMENTS AT U.S. 52 BY-PASS AND TEAL ROAD.

NUMBER OF VEHICLES
CONTROL NO. 1
TWO DIRECTIONS

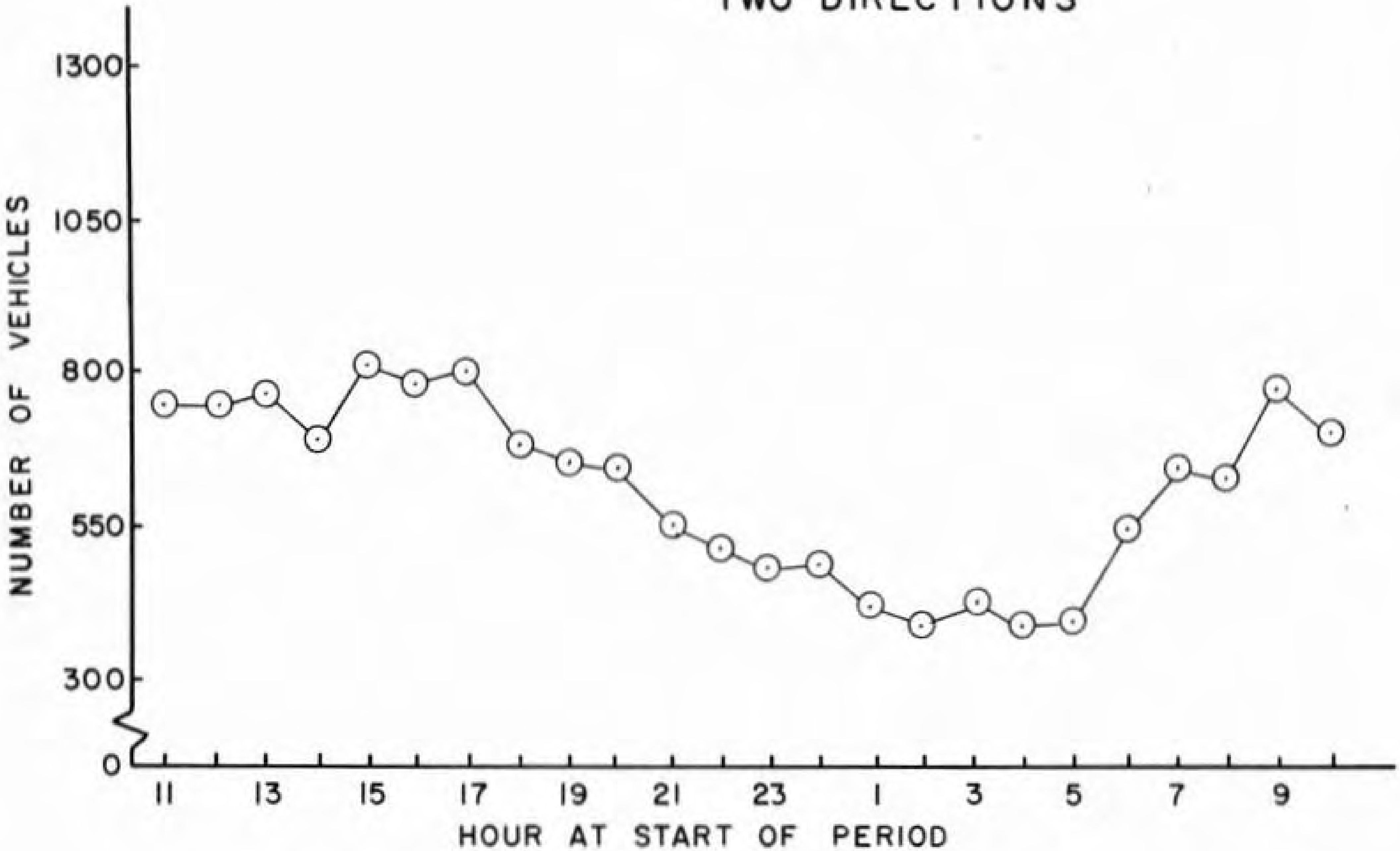


FIGURE A2(1)

NUMBER OF VEHICLES
CONTROL NO. 5
TWO DIRECTIONS

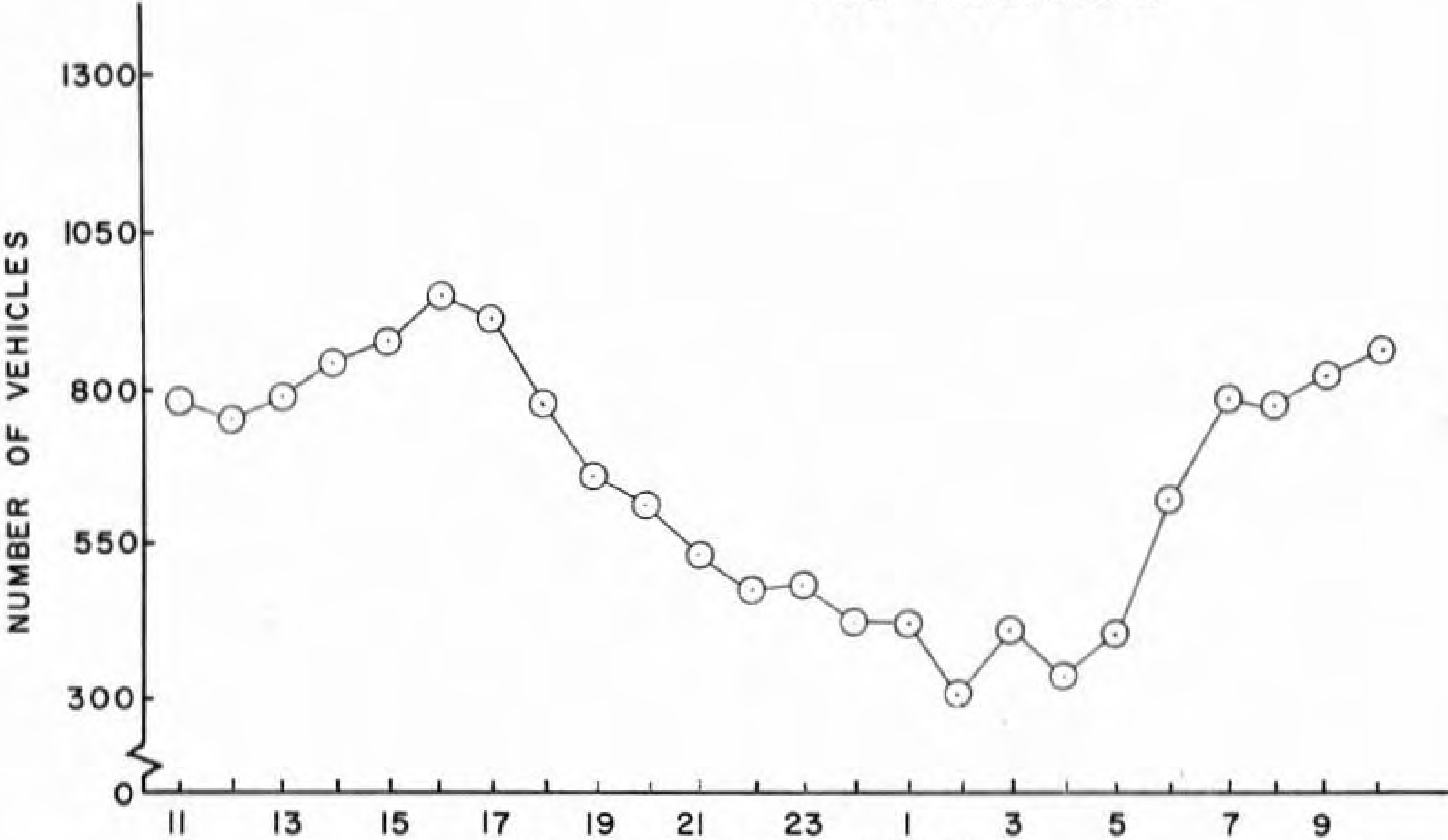


FIGURE A2(2)

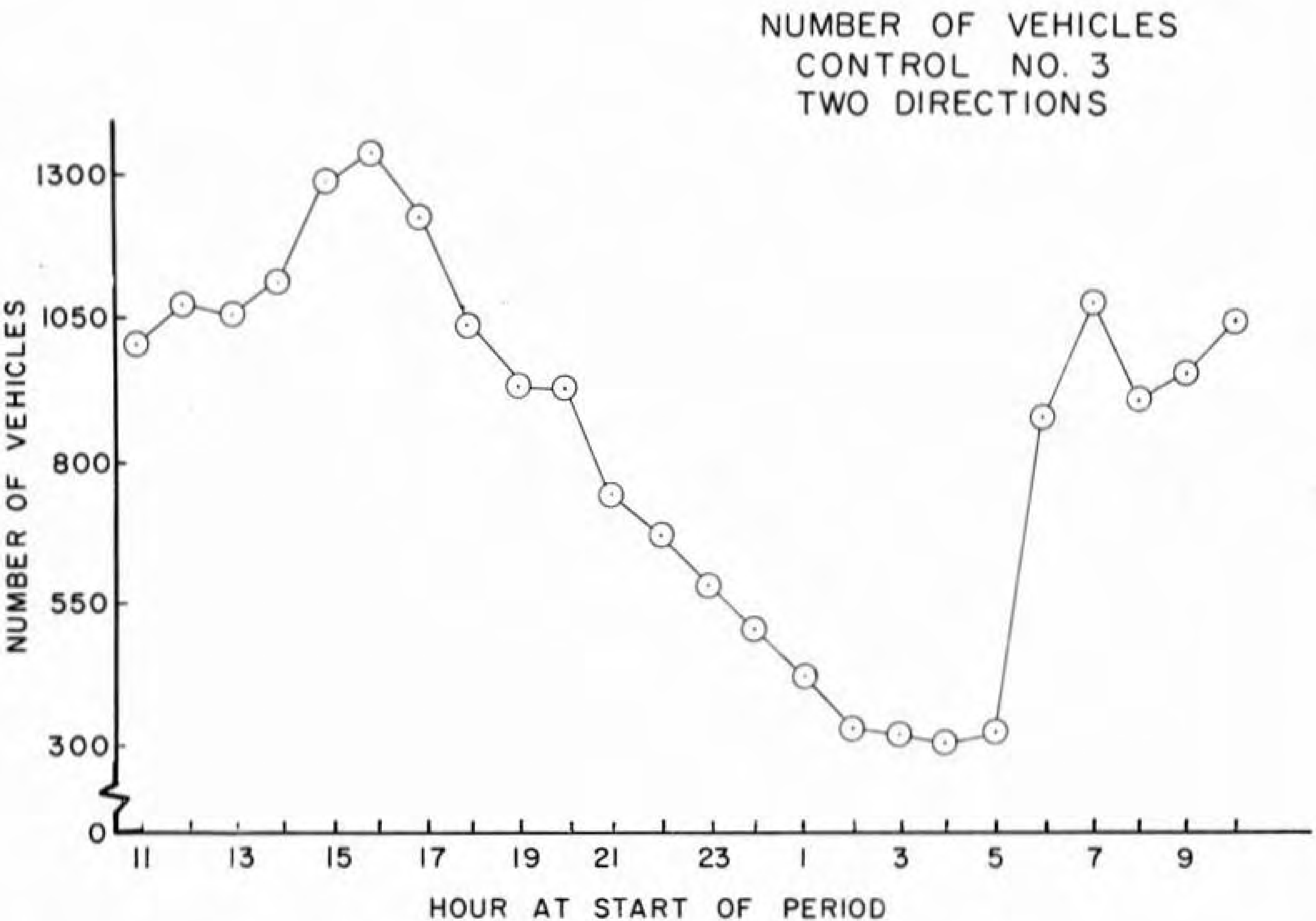

NUMBER OF VEHICLES
CONTROL NO. 3
TWO DIRECTIONS
NUMBER OF VEHICLES
1300
1050
800
550
300
0
11
13
15
17
19
21
23
1
3
5
7
9
HOUR AT START OF PERIOD

FIGURE A2(3)

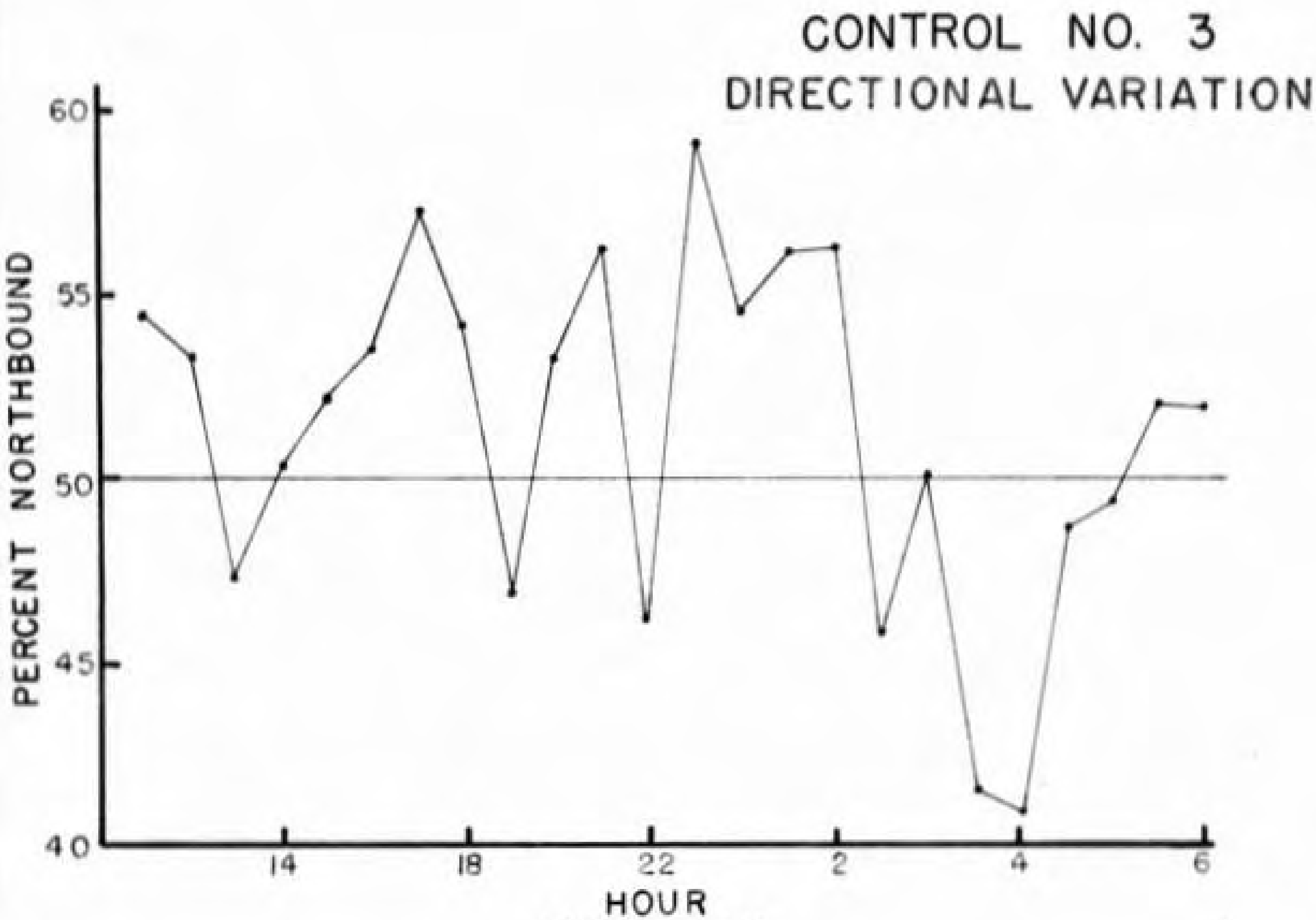

CONTROL NO. 3
DIRECTIONAL VARIATION
PERCENT NORTHBOUND
60
55
50
45
40
14
18
22
2
4
6
HOUR

FIGURE A3

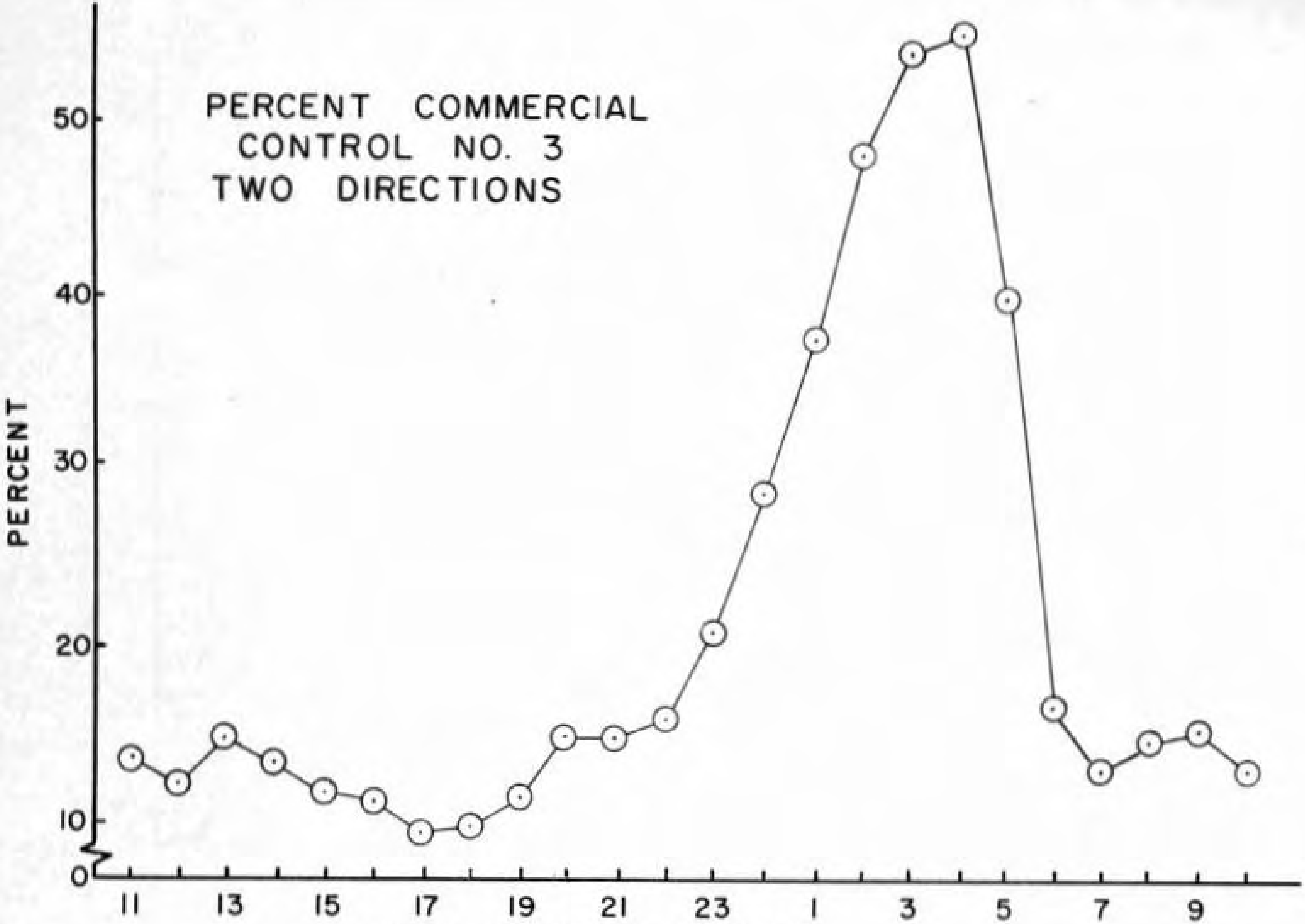

PERCENT COMMERCIAL
CONTROL NO. 3
TWO DIRECTIONS
PERCENT
50
40
30
20
10
0
11
13
15
17
19
21
23
1
3
5
7
9
HOUR AT START OF PERIOD

FIGURE A4

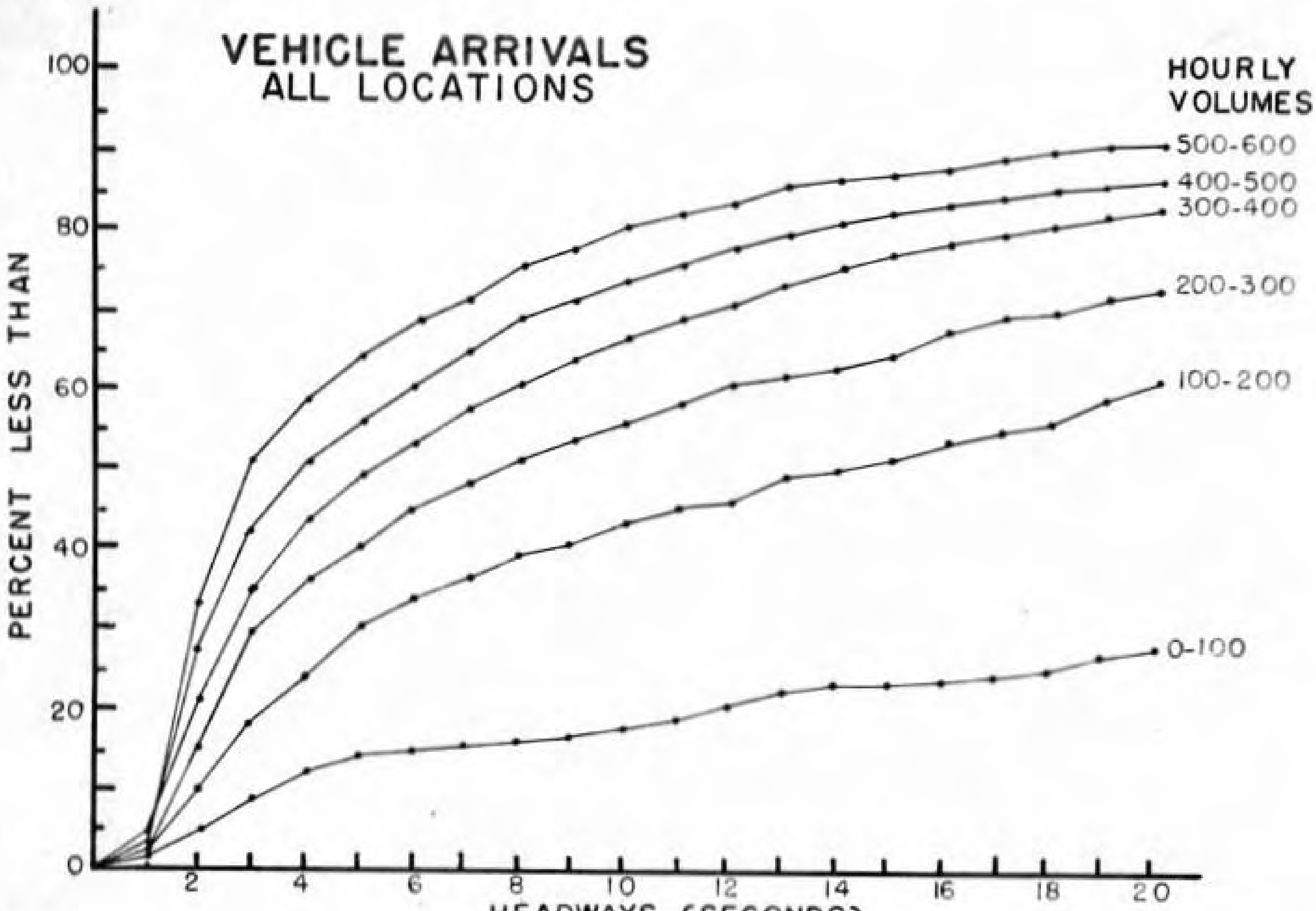

VEHICLE ARRIVALS
ALL LOCATIONS
HOURLY
VOLUMES
500-600
400-500
300-400
200-300
100-200
0-100
PERCENT LESS THAN
100
80
60
40
20
0
2
4
6
8
10
12
14
16
18
20
HEADWAYS (SECONDS)

FIGURE A5

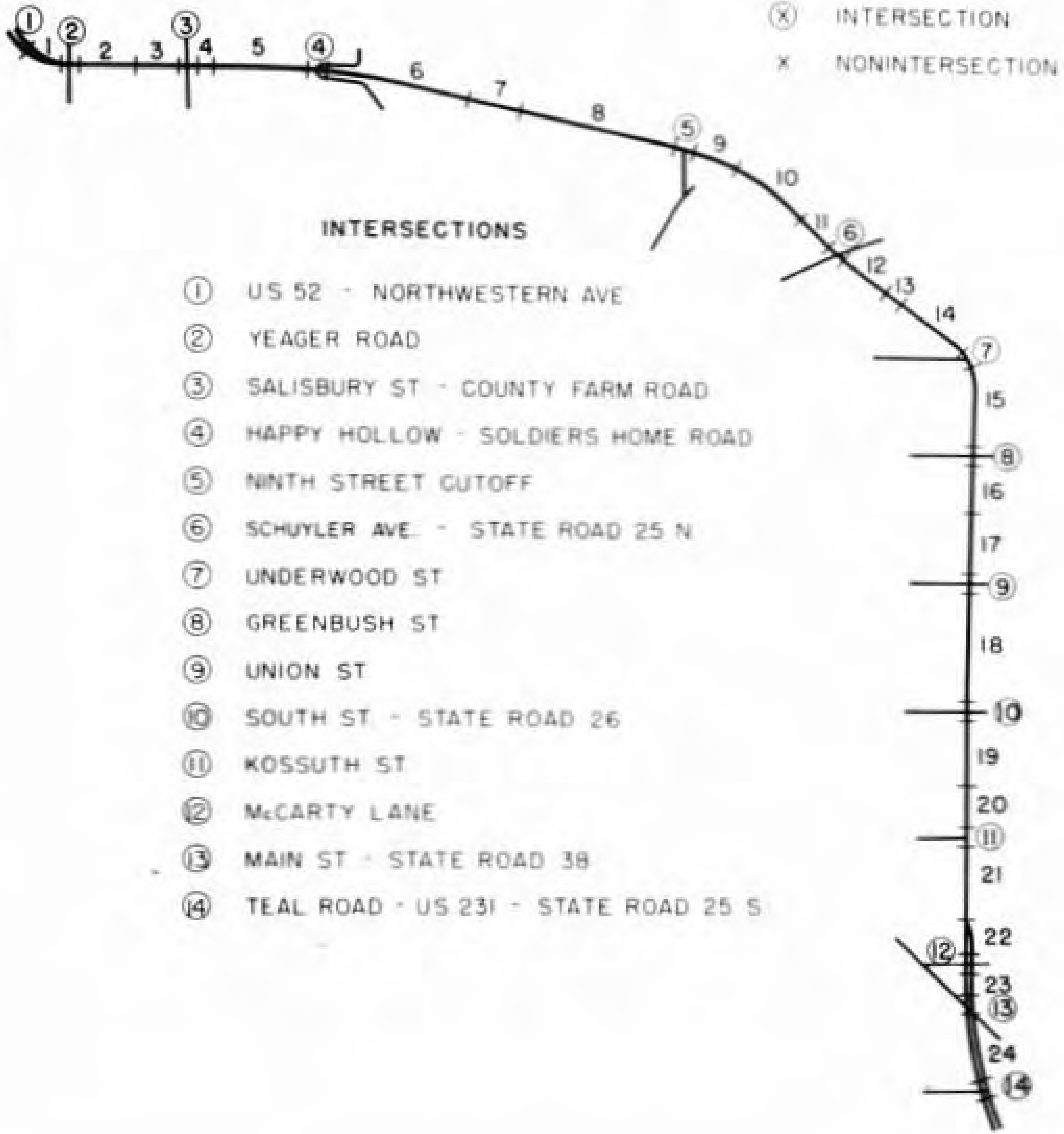


FIGURE A6 U.S. 52 BY-PASS STUDY SECTIONS
ACCIDENT ANALYSIS

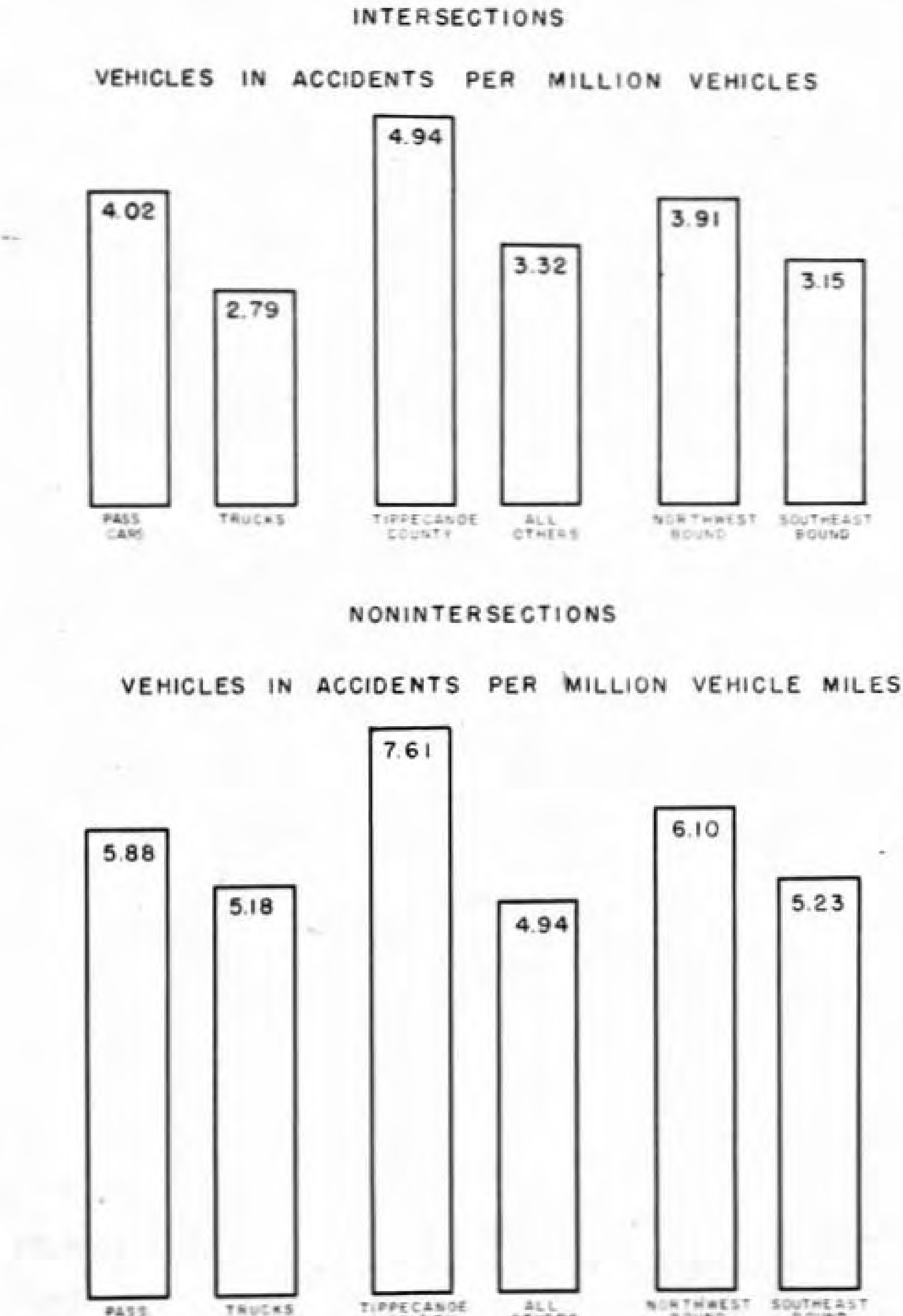
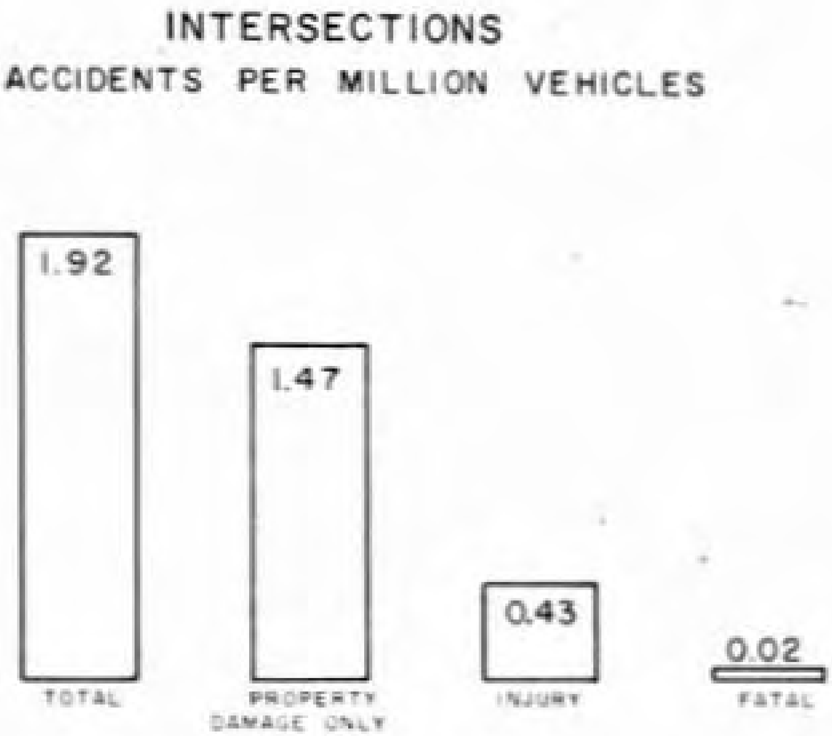


FIGURE A7(I) INVOLVEMENT RATES FOR VEHICLES BY TYPE, REGISTRATION AND DIRECTION FOR 1961, 1962 AND 1963.



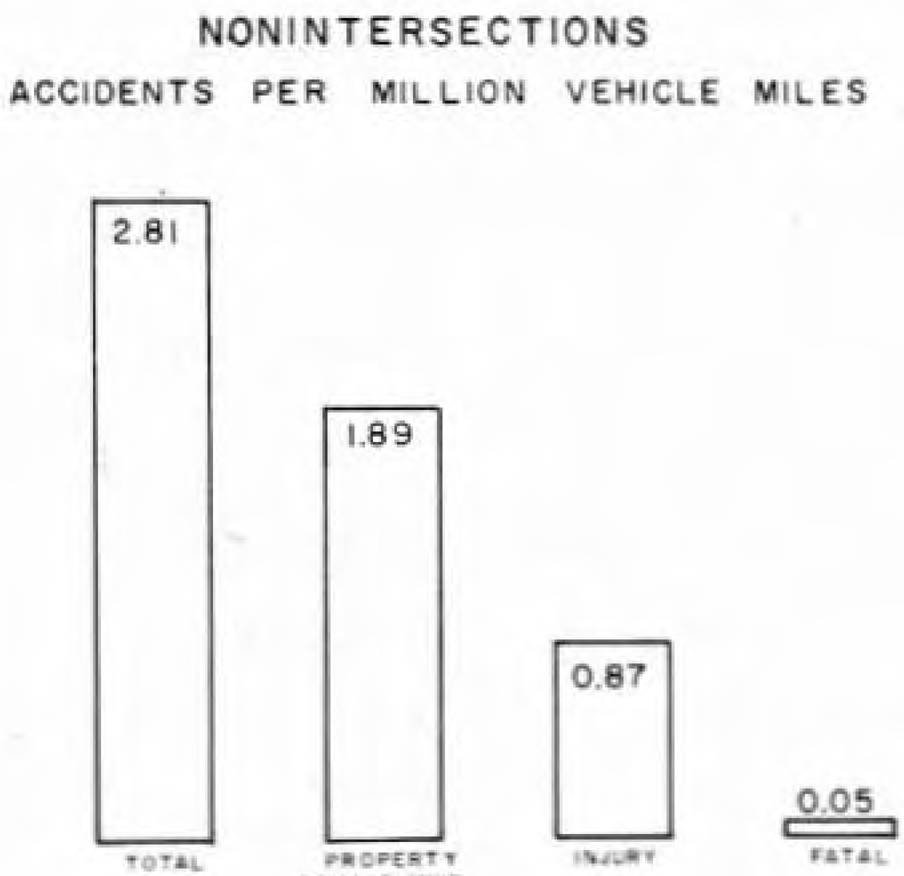
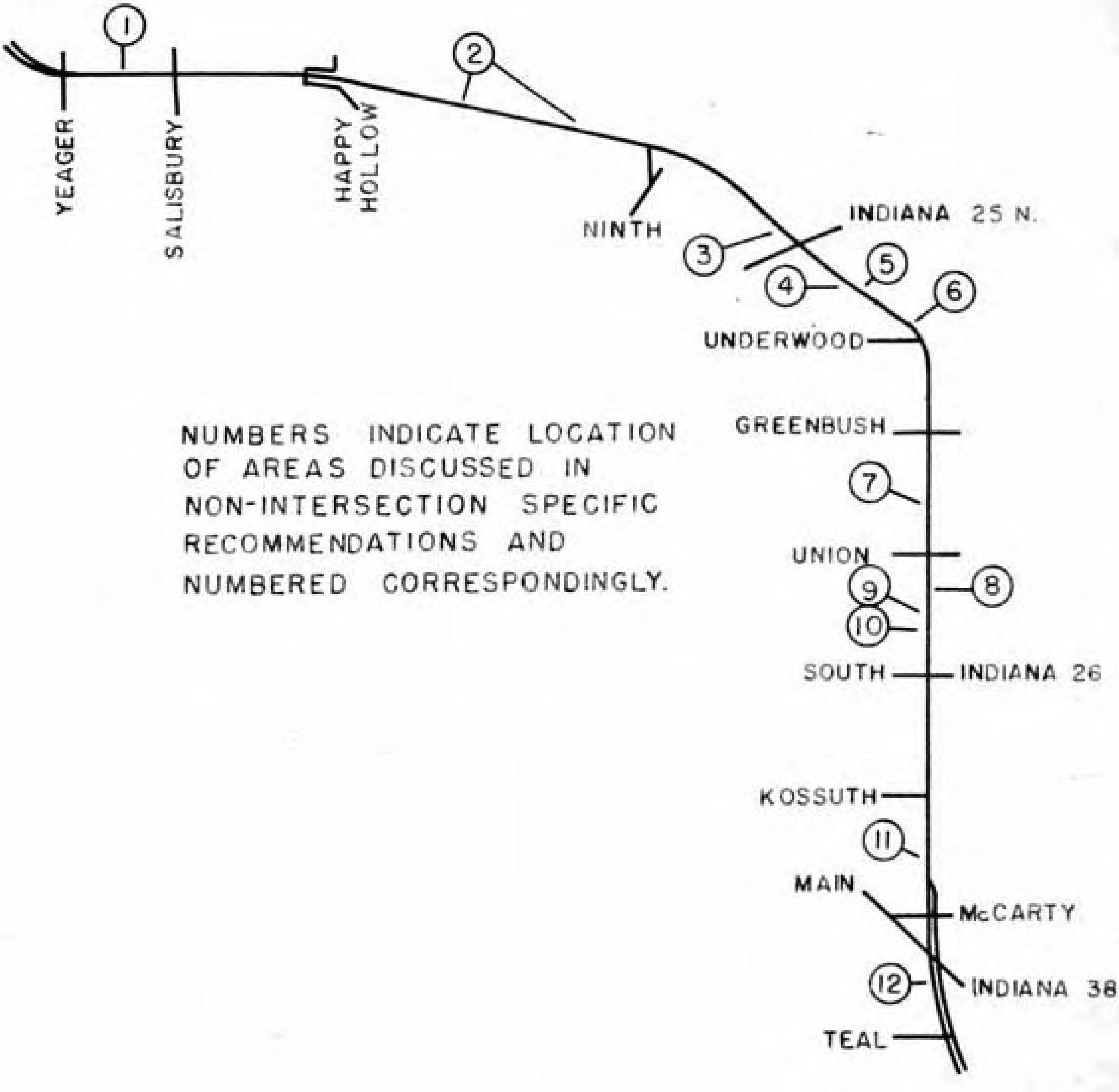


FIGURE A7(2) AVERAGE ANNUAL ACCIDENT RATES BY DEGREE OF SEVERITY FOR 1961, 1962 AND 1963.



NUMBERS INDICATE LOCATION OF AREAS DISCUSSED IN NON-INTERSECTION SPECIFIC RECOMMENDATIONS AND NUMBERED CORRESPONDINGLY.

FIGURE A8

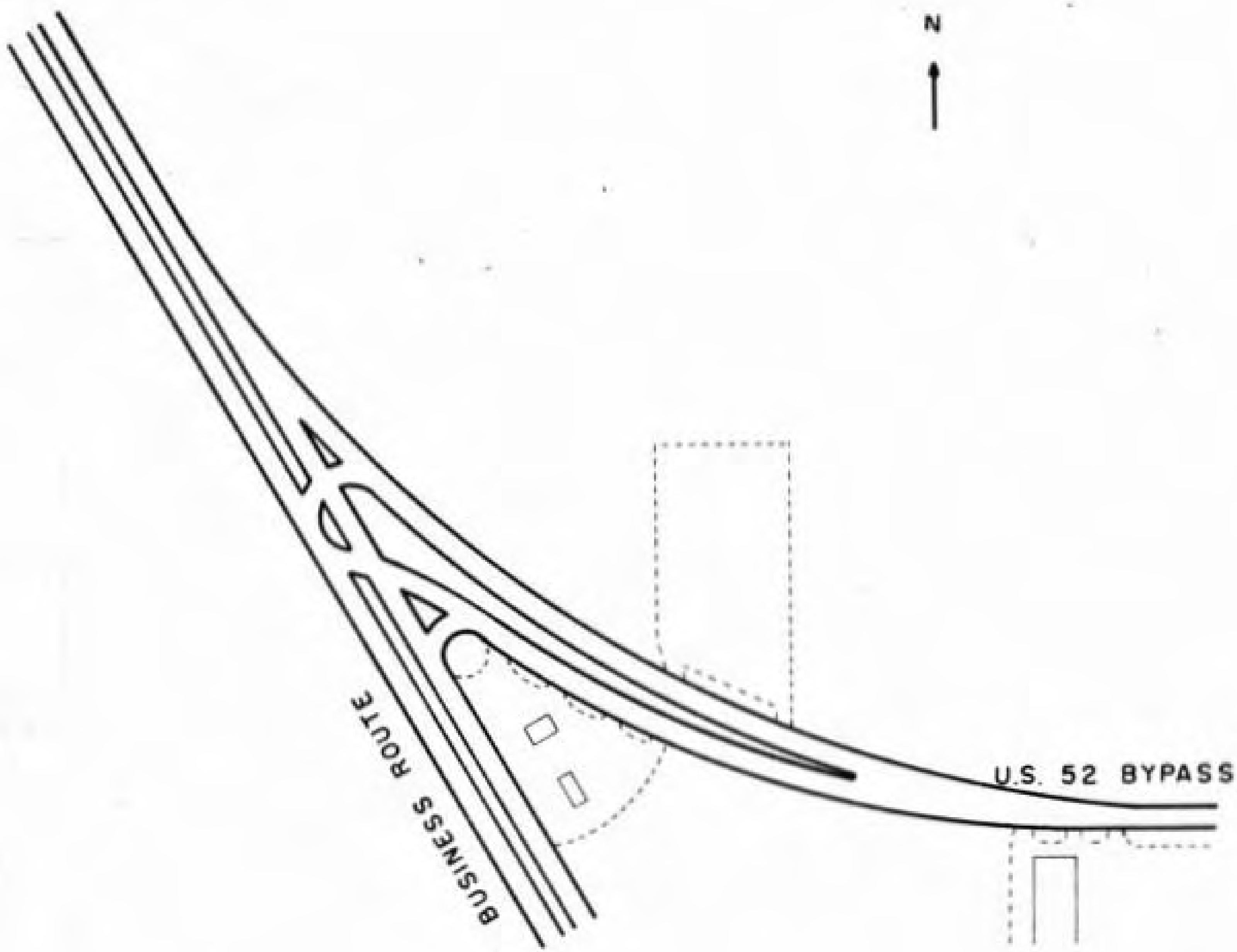


FIGURE A9(1)

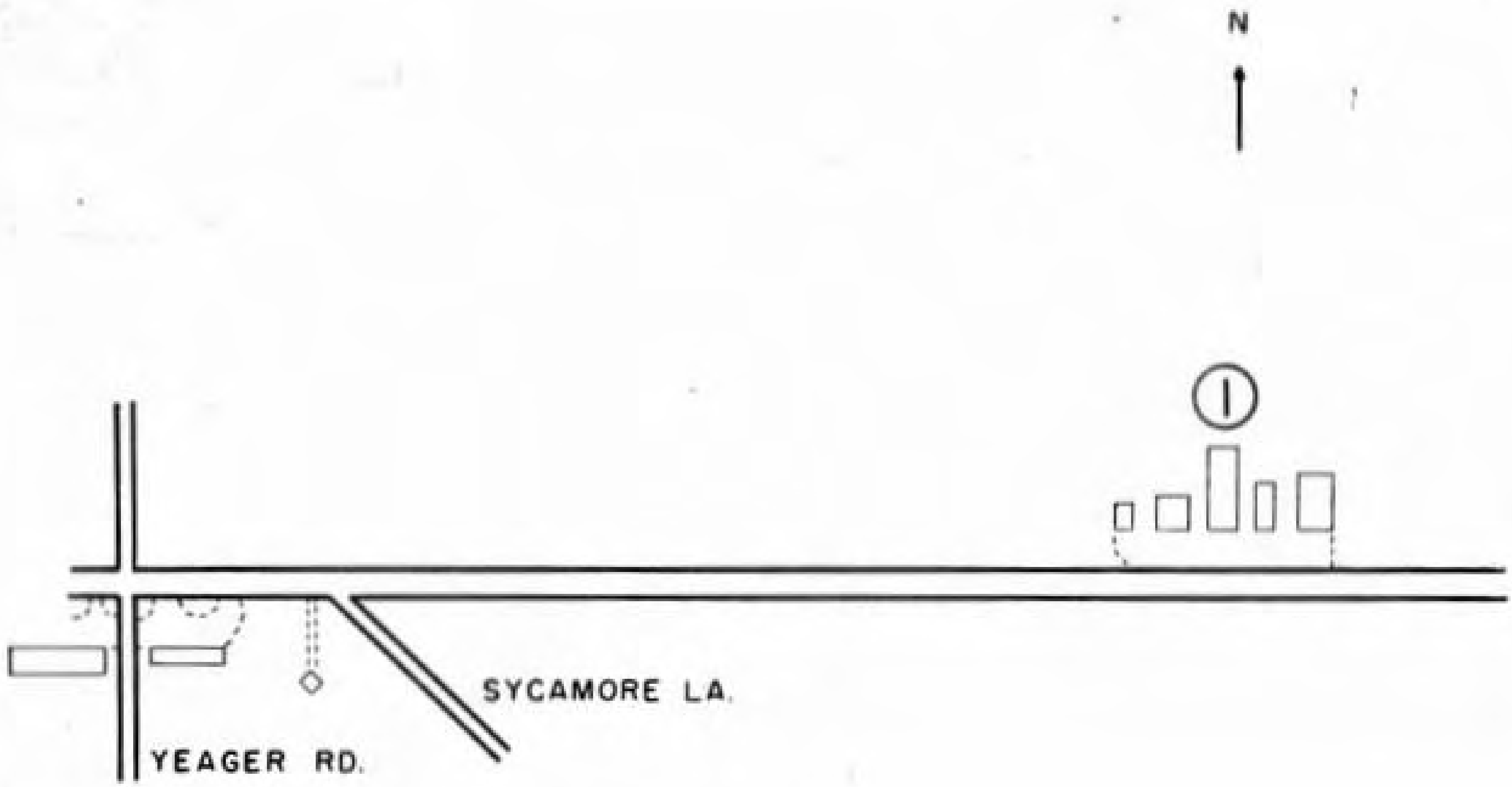


FIGURE A9(2)

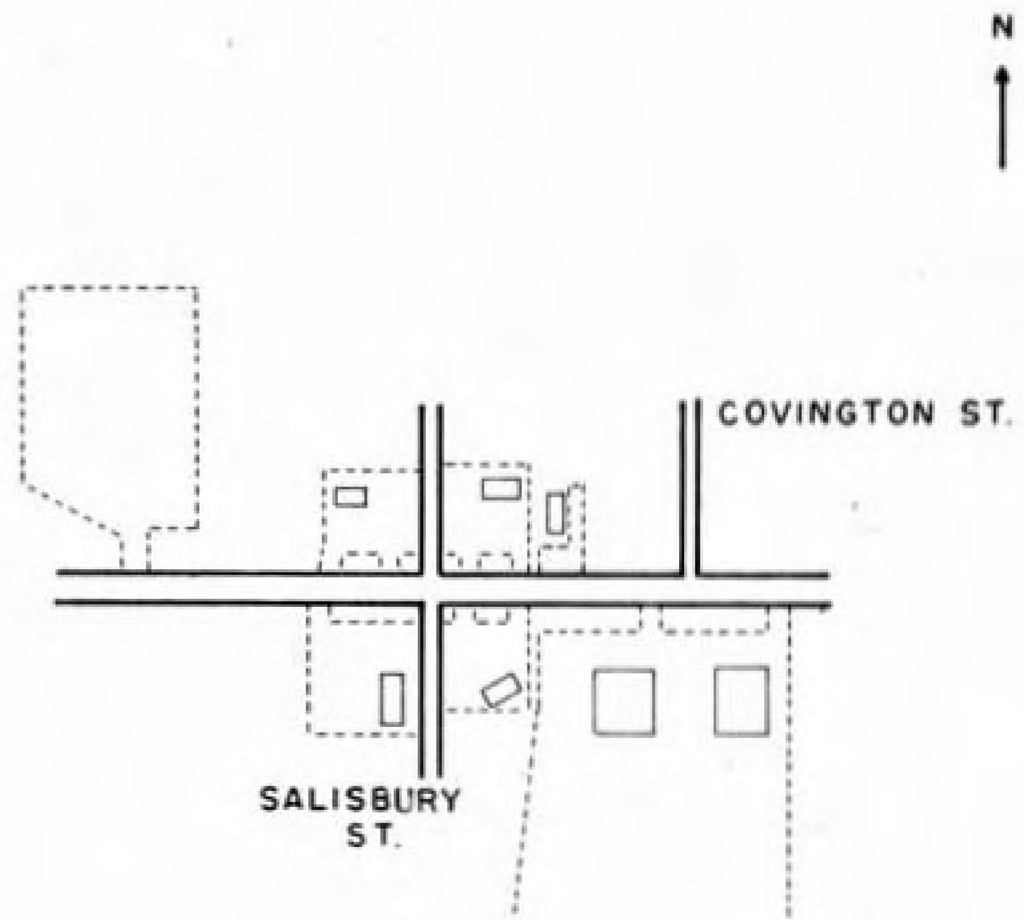


FIGURE A9(3)

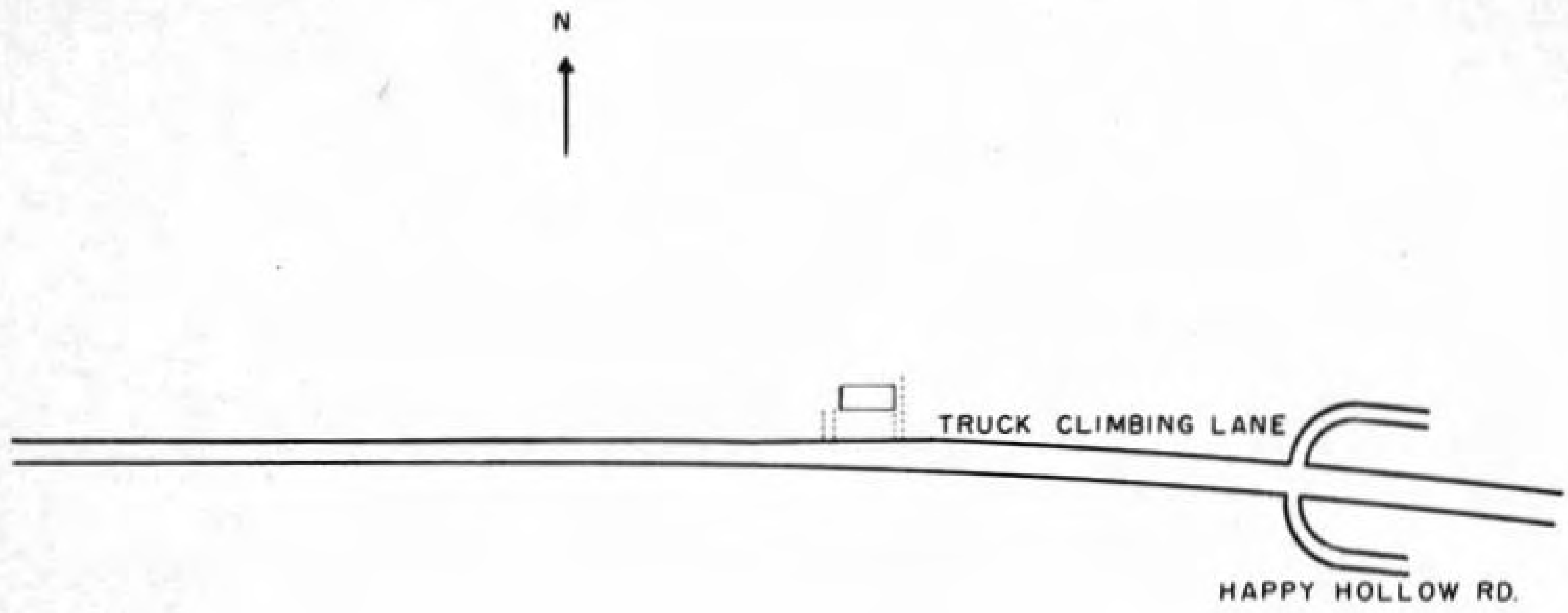


FIGURE A9(4)

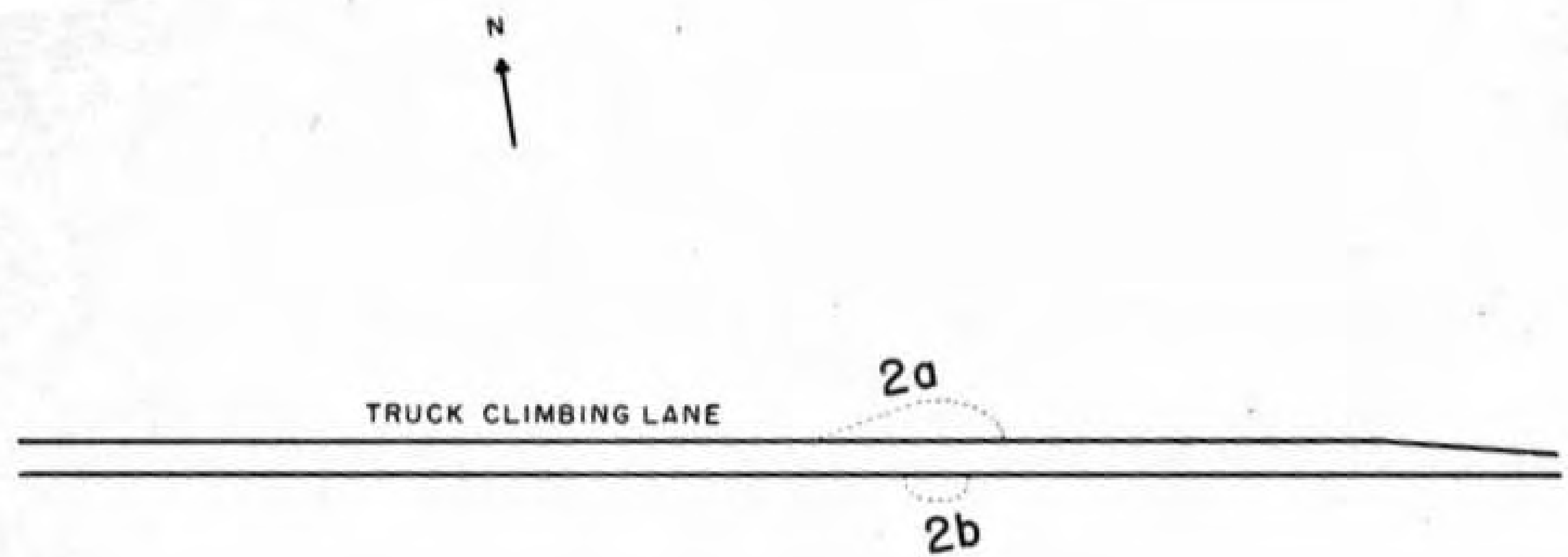


FIGURE A9(5)

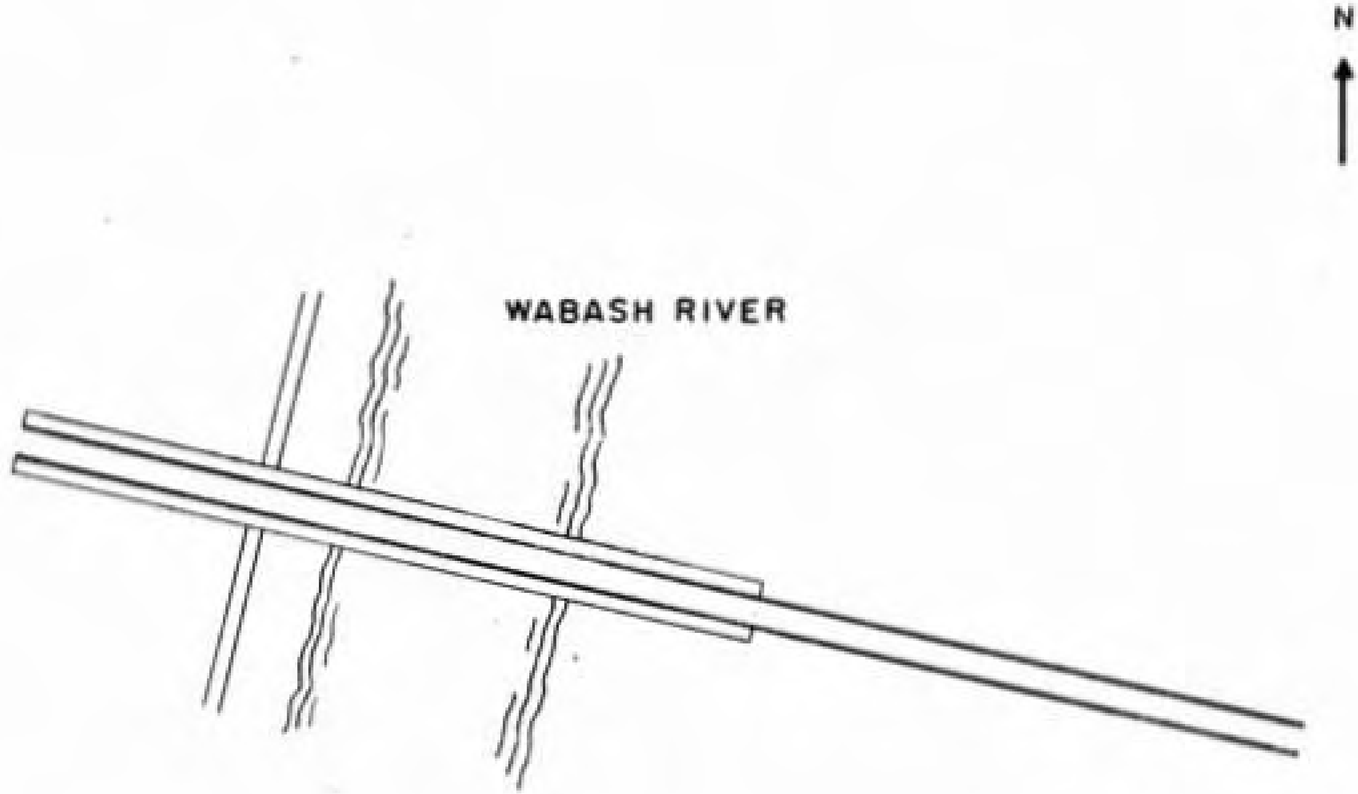


FIGURE A9(6)

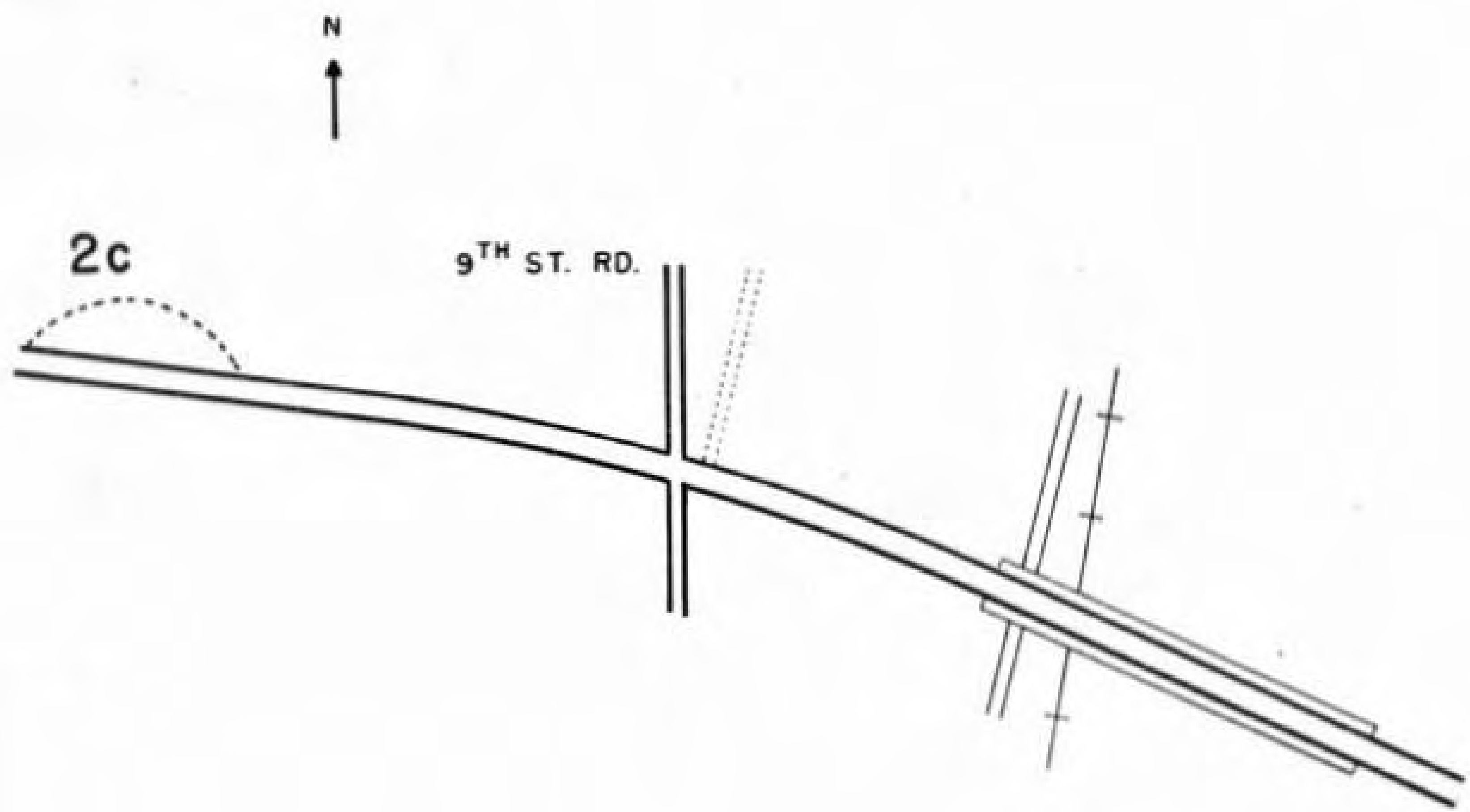


FIGURE A9(7)

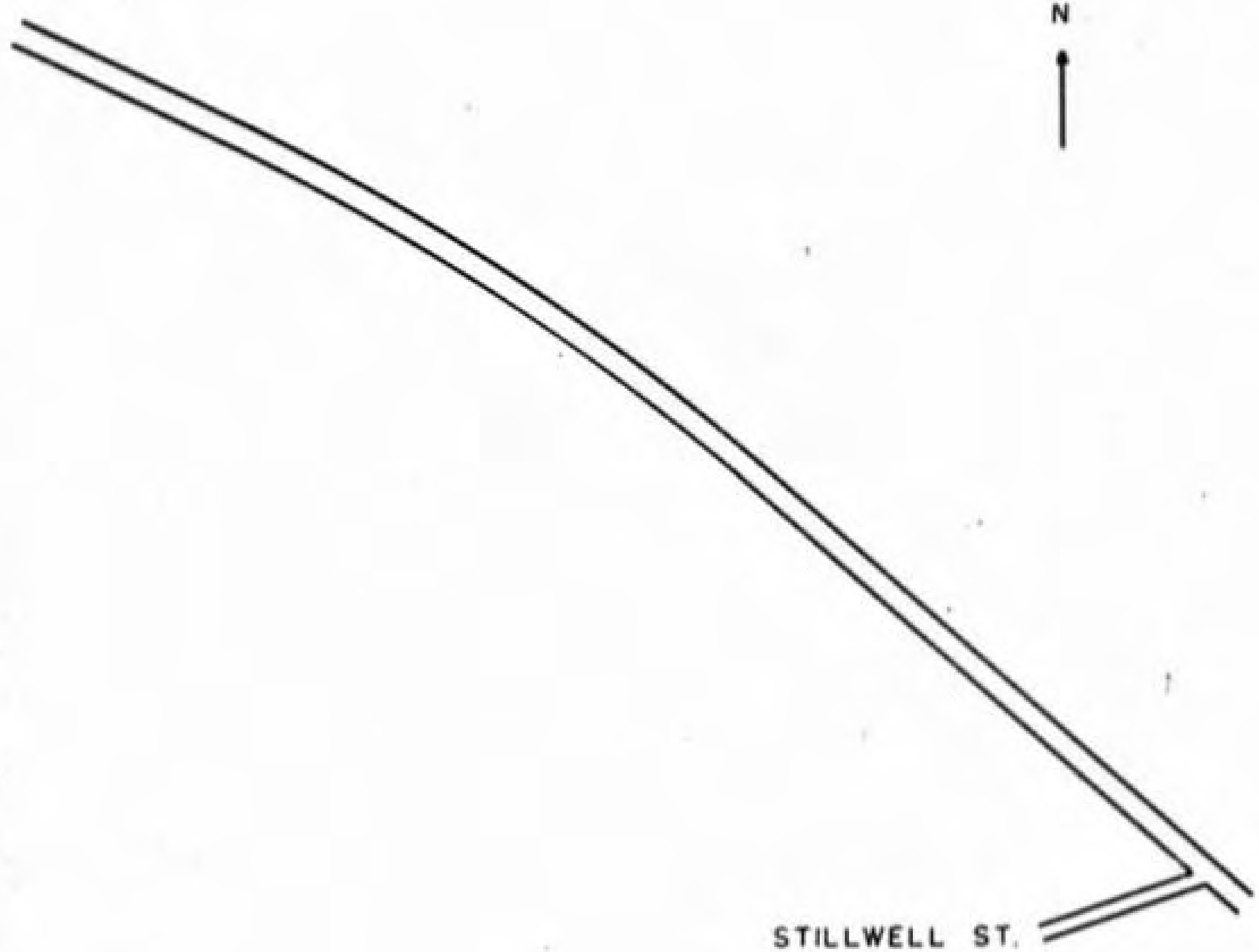


FIGURE A9(8)

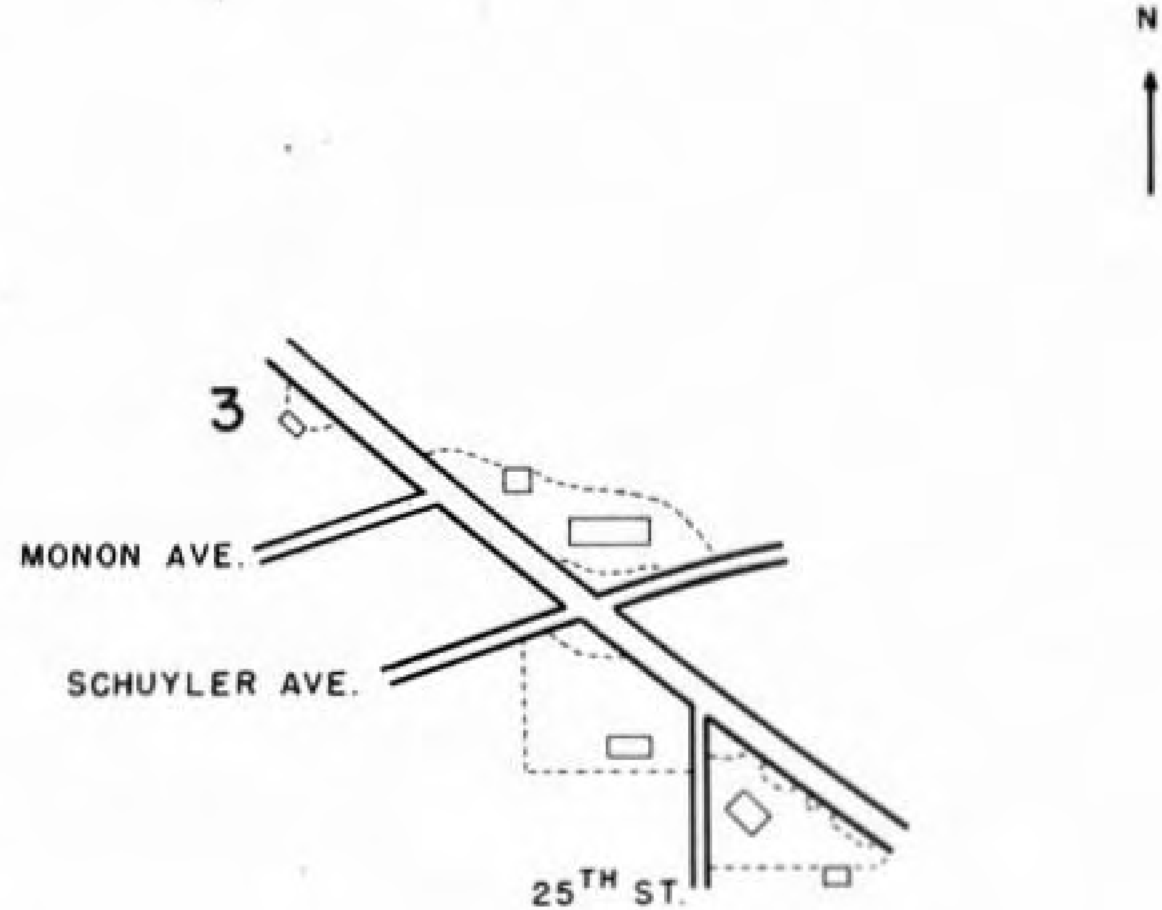


FIGURE A9(9)

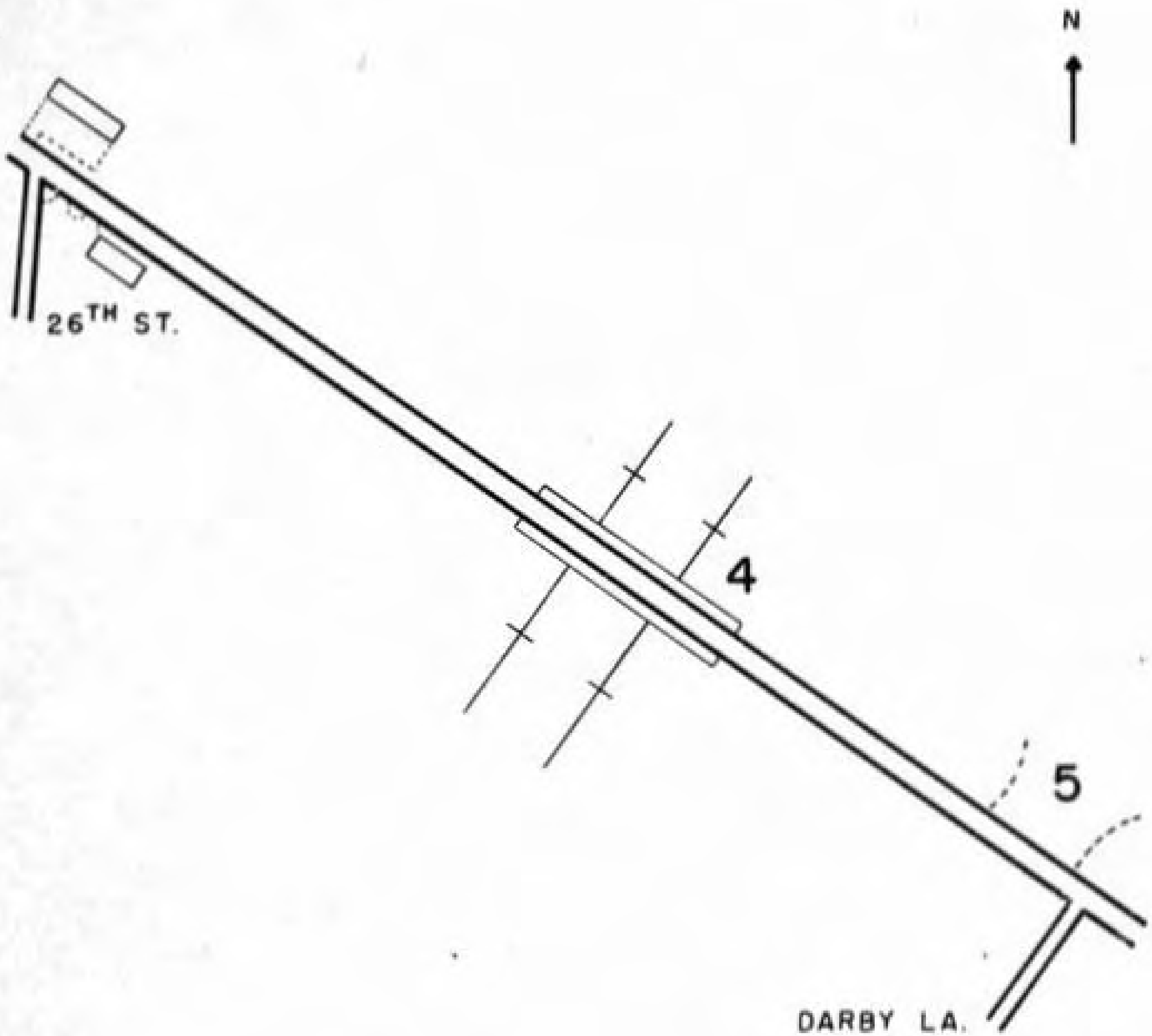


FIGURE A9(10)

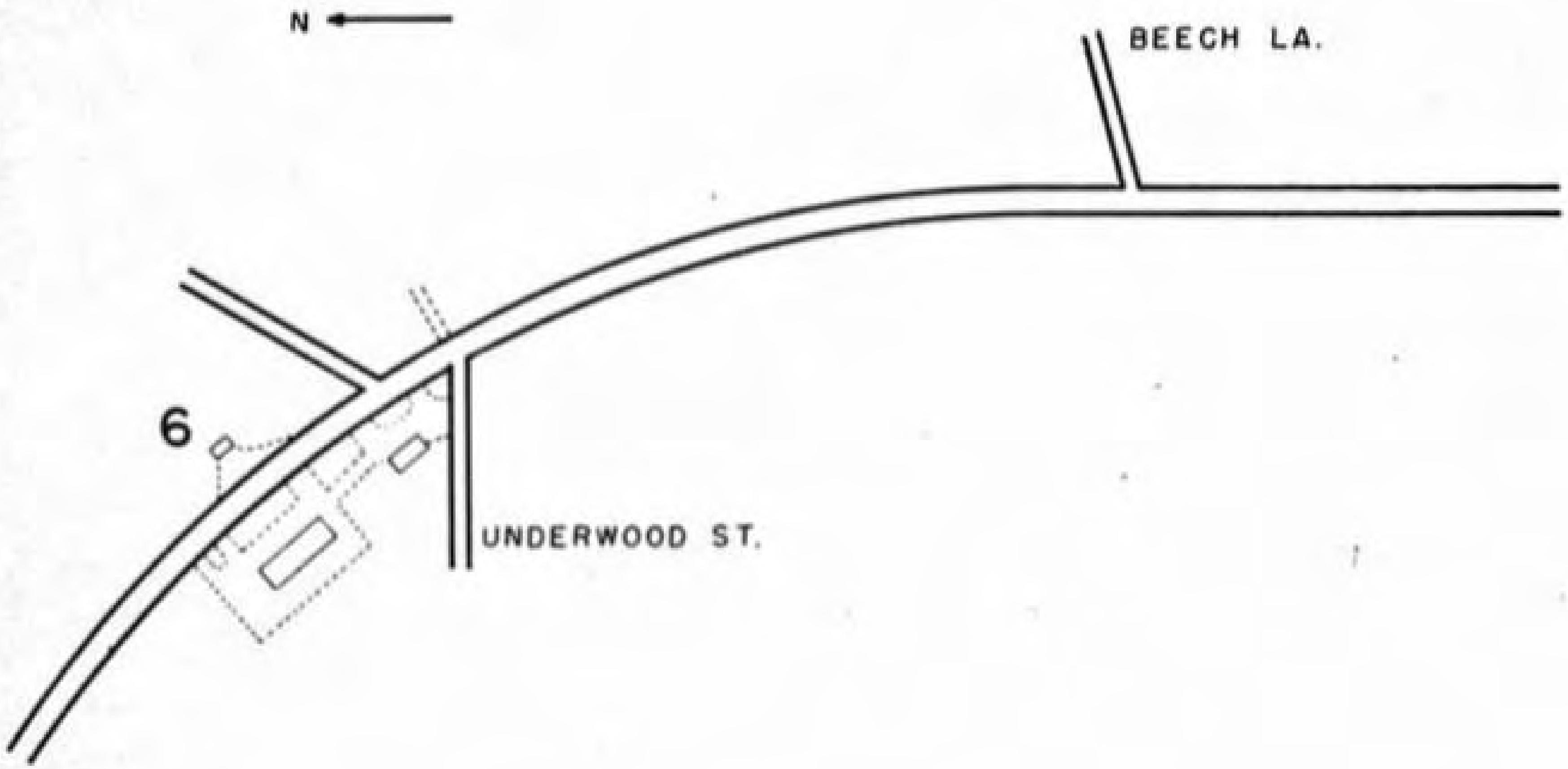


FIGURE A9(II)

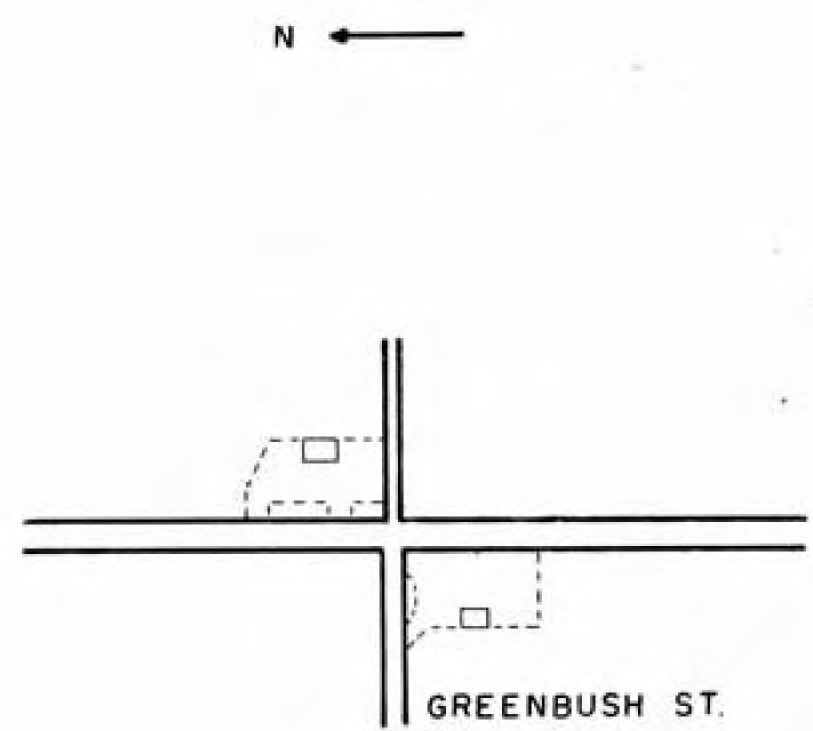


FIGURE A9(12)

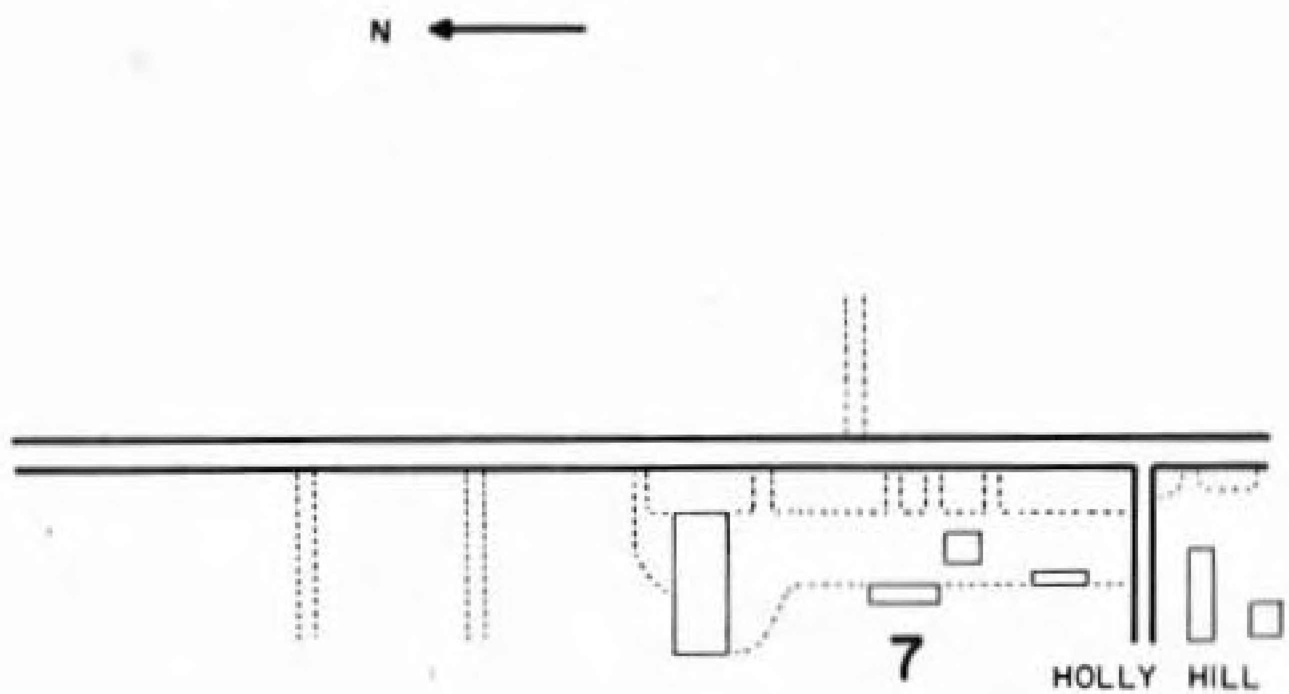


FIGURE A9(13)

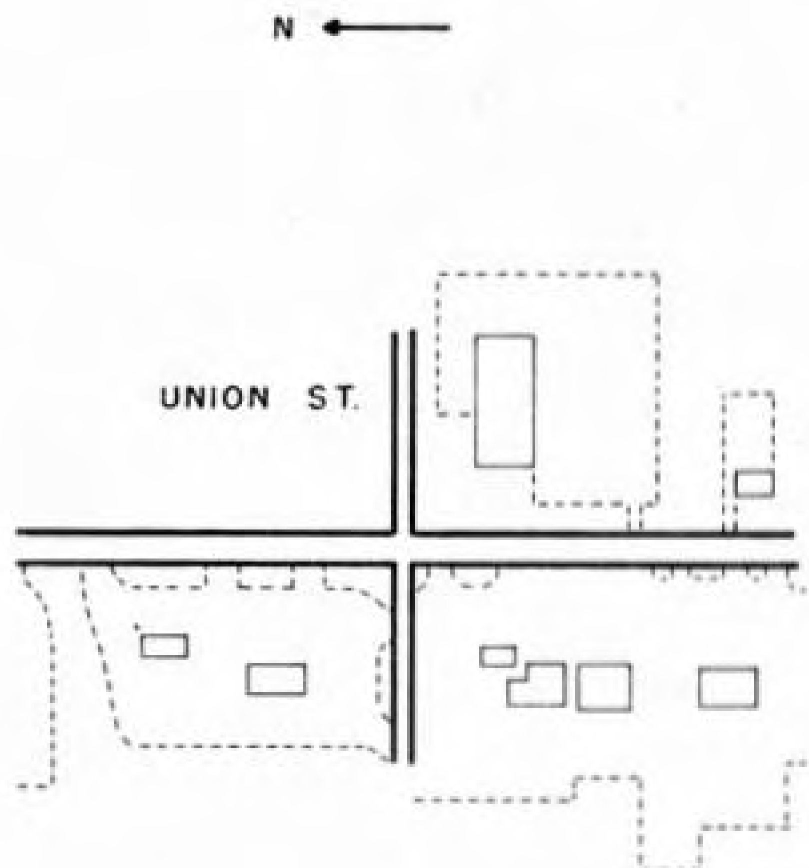


FIGURE A9(14)

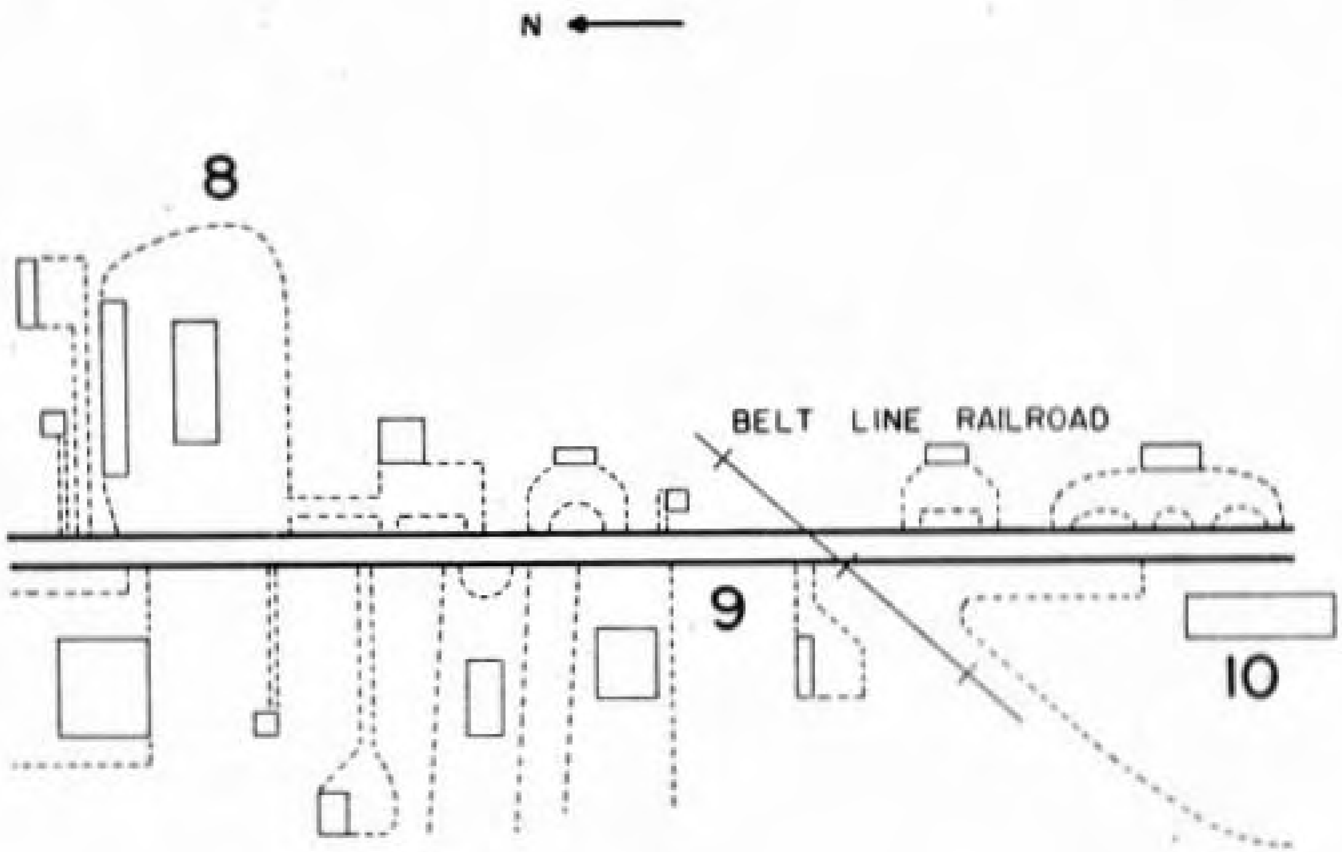


FIGURE A9(15)

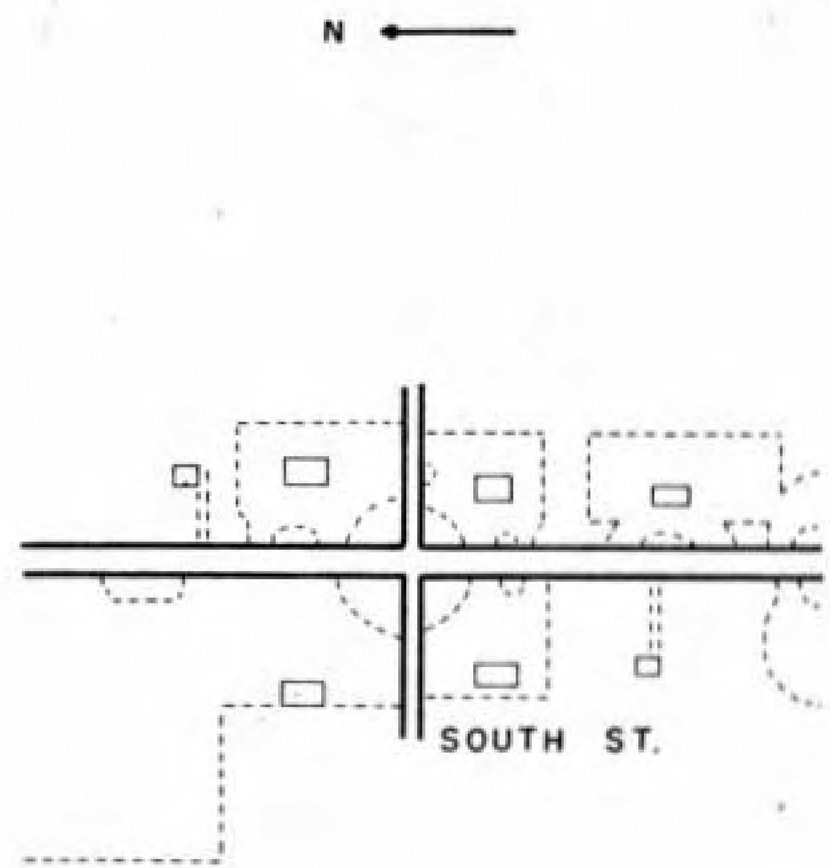


FIGURE A9(16)

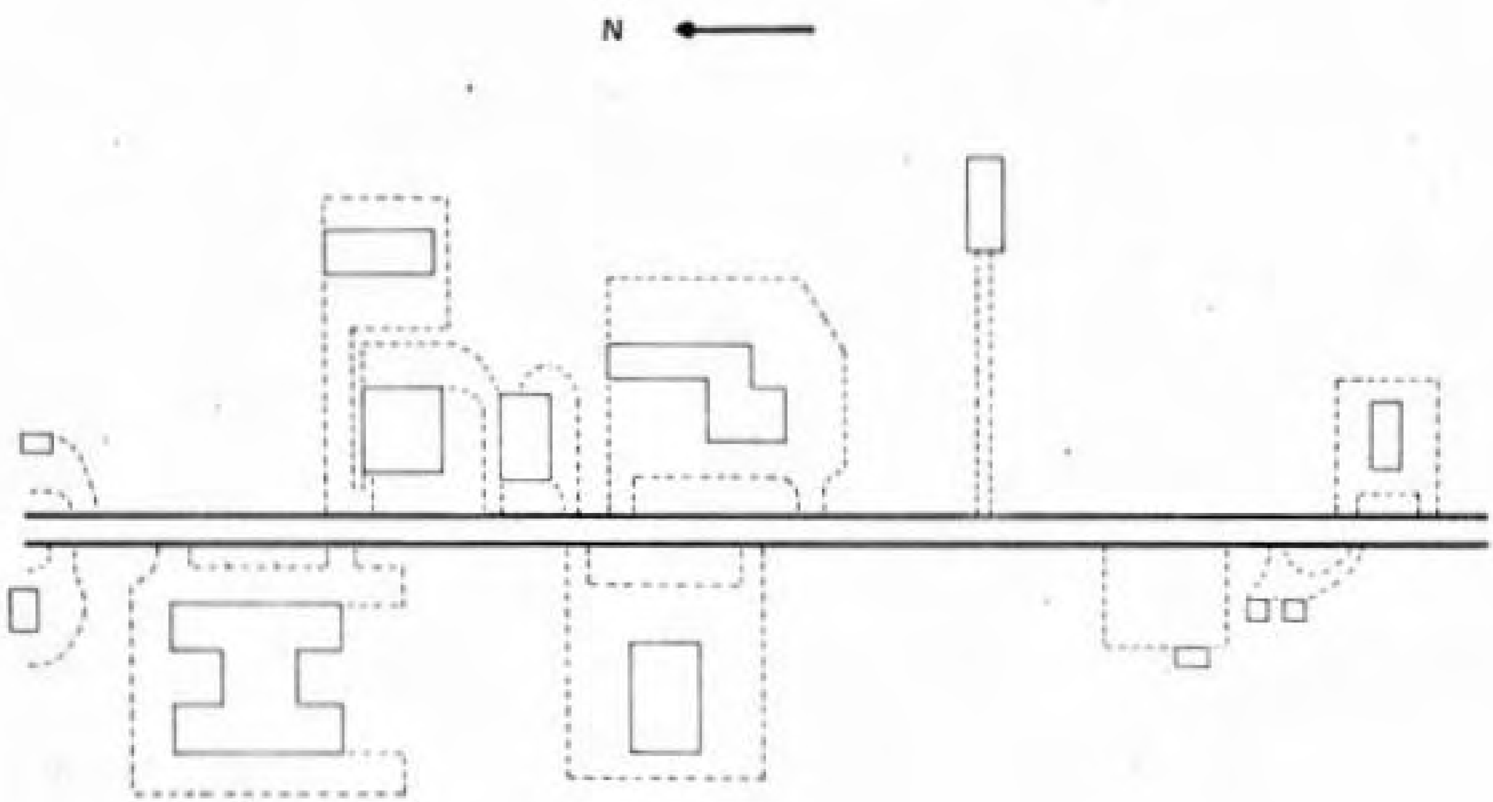


FIGURE A9(17)

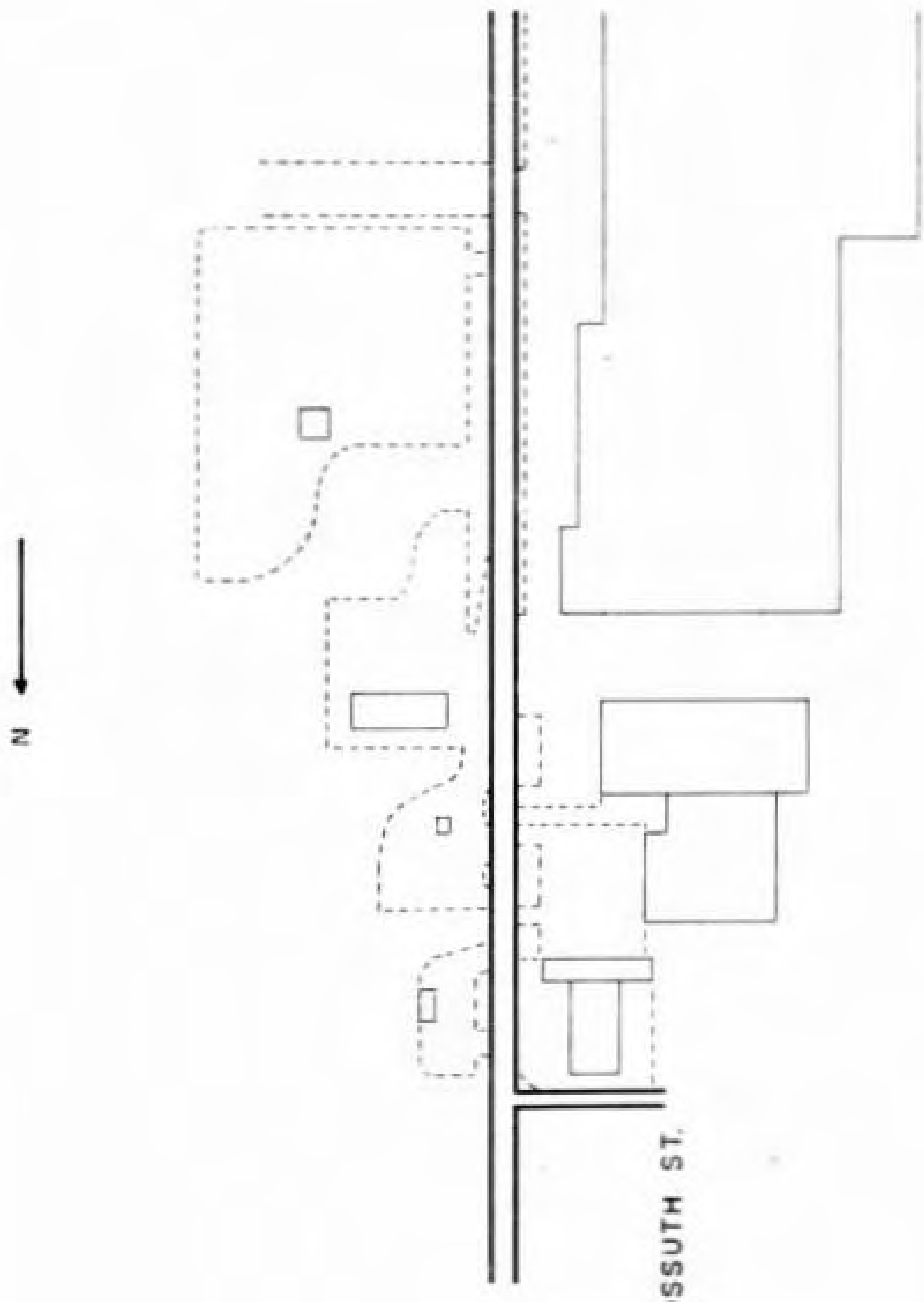


FIGURE A9(18)

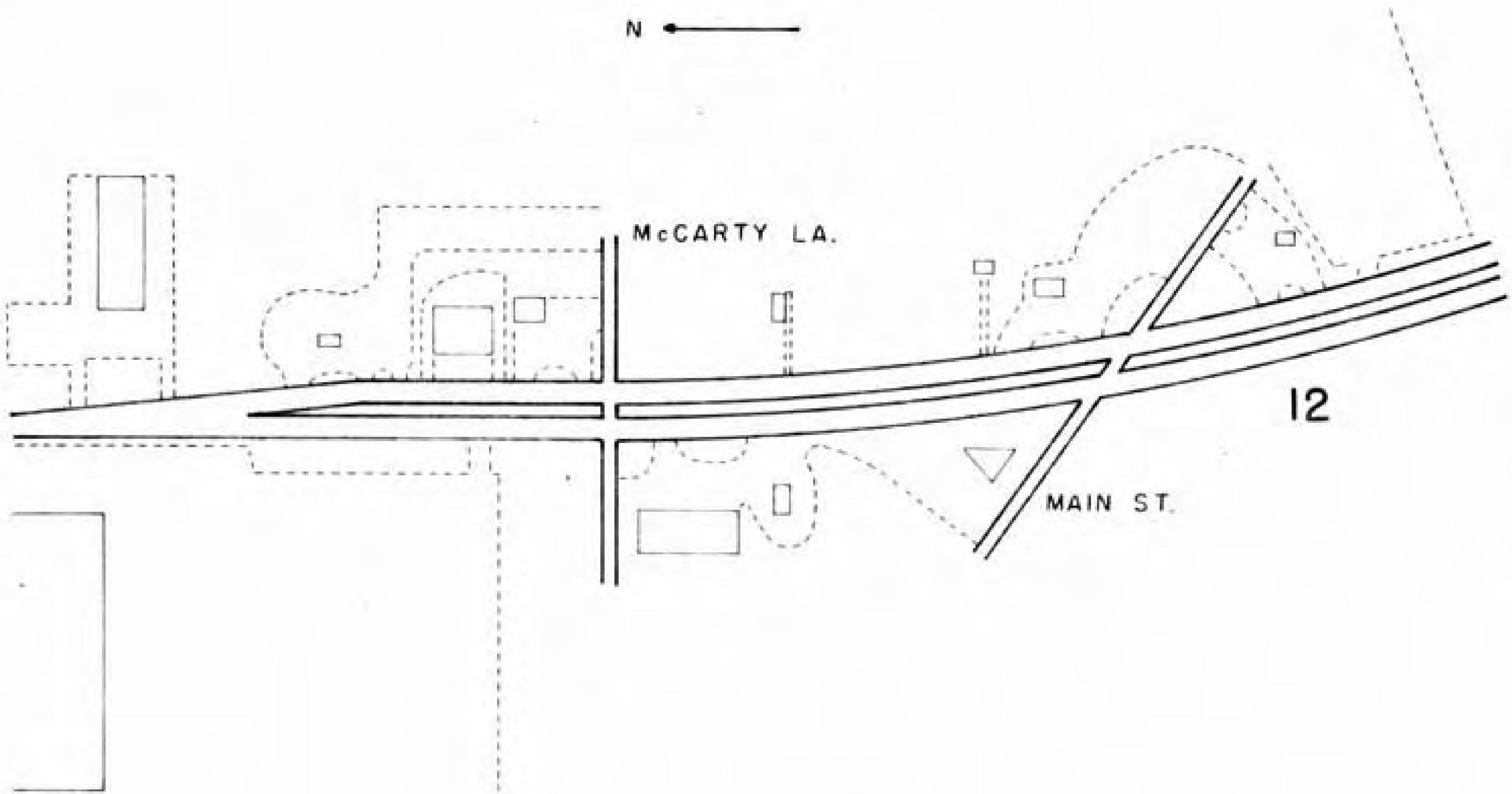


FIGURE A9(19)

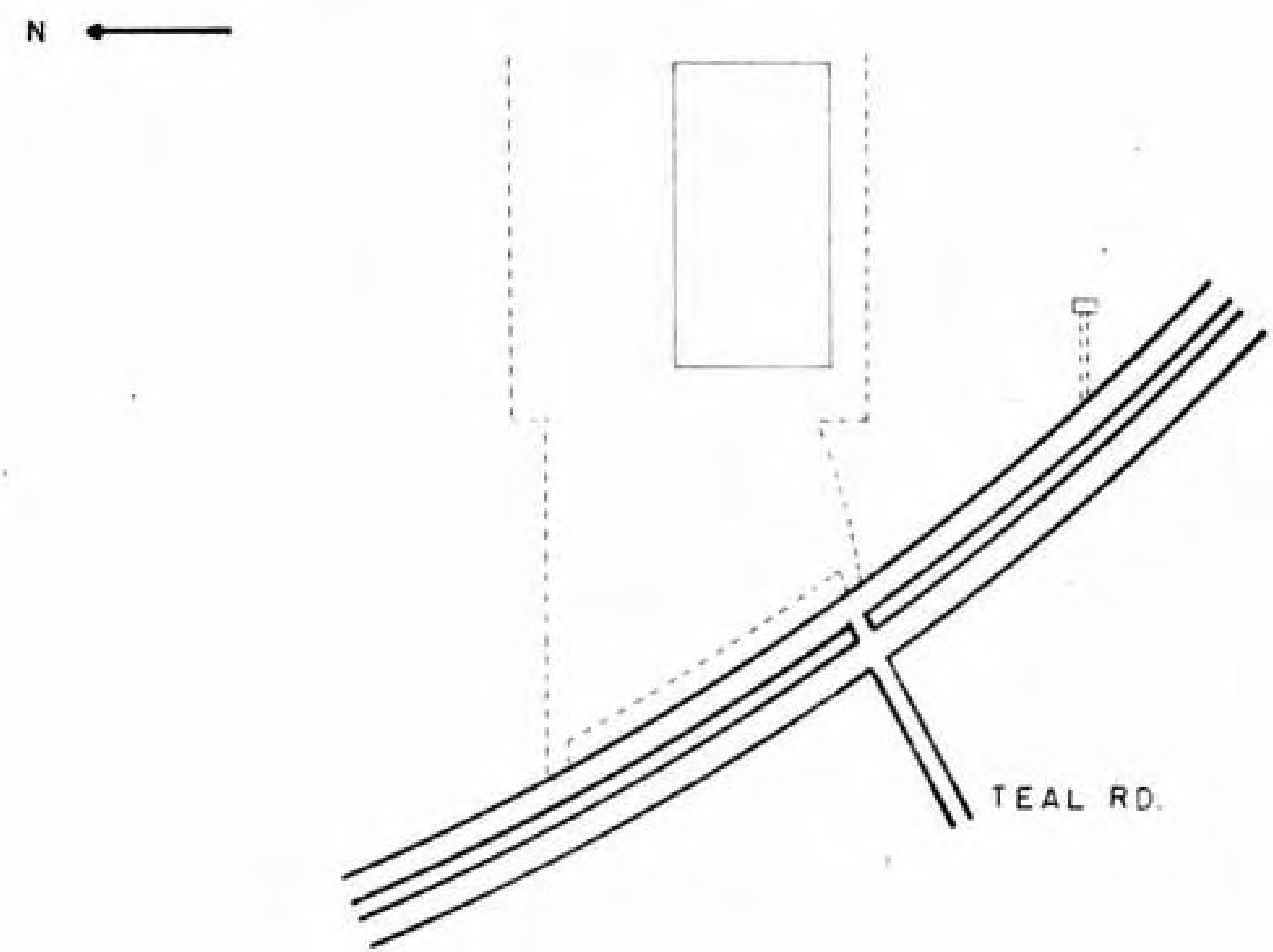


FIGURE A9(20)

CROSSING LOCATIONS

TABLE A1 (1)

Station	Name	Angle	Side
22+03	Yeager Road	90	R,L
24+84	Sycamore Lane	138	R
46+53	Salisbury	90	R,L
48+89	Covington St.	90	L
73+00	Happy Hollow Road	90	R,L
104+26	Overpass SR 43	90	
104+99	WE River Bridge		
114+87	EE River Bridge		
147+92	9th St. Cut-off Road		
153+35	Overpass 9th St. Road	88°	
154+65	Overpass Monon RR	106°	
175+33	Hall Street	68°	R
178+69	Stillwell Street	68°	R
182+30	Monon Avenue	38	R
184+85	Schuyler Avenue	58	R,L
186+59	25th Street	120	R
190+31	26th Street	120	R
199+75	Overpass Wabash RR	90	
201+41	Overpass Laf. Union Ry. Co.	47°	
209+35	Darby Lane	90	R
219+50	Underwood Street	63	R
229+74	Beech Drive	105	L
236+87	Greenbush Street	90	R,L
256+43	Holly Hill Drive	90	R
263+30	Union Street	90	R,L
234+04	Lafayette Belt RR	139	R,L
244+98	SR 26	90	R,L
271+76	Kossuth Street	90	R
285+00	Begin Four Lane		
298+64	McCarty Lane	90	R,L
307+05	Main Street	40	R,L
324+55	Teal Road	100	R

HORIZONTAL CURVATURE

TABLE A1 (2)

Southbound Starting Station	Southbound Degree	Southbound Length
0+00	---	1119
11+19	50.4	119
12+38	---	58
12+96	51.2	71
13+67	---	2
13+69	4.0	200
15+69	---	10
15+79	5.0	531
21+10	---	134
22+44	---	---

Northbound Starting Station	Northbound Degree	Northbound Length
0+00	---	705
7+05	---	6
7+11	4.0	1452
21+63	---	---

Southbound and Northbound

Starting Station	Degree	Length
21+70	---	3929
60+99	0.5	1647
77+46	---	6372
141+18	2.0	894
150+12	---	1152
161+62	2.0	850
170+12	---	859
178+71	1.0	931
188+02	---	2230
210+32	3.0	1807
223+39	---	3384
258+30	2.0	1000
223+29	---	10672
285+00	Begin dual lane transition	

Southbound Starting Station	Southbound Degree	Southbound Length
285+00	---	1397
298+97	9.0	712
305+81	---	400
309+81	1.0	1474
324+55	1.0	1400
338+55	end project	

Northbound Starting Station	Northbound Degree	Northbound Length
285+00	1.0	550
290+50	1.0	550
296+00	---	58
296+58	0.5	690
303+48	---	698
310+46	1.0	2803
338+49	end project	

VERTICAL CURVATURE

TABLE A1 (3)

Southbound			Northbound		
Starting Station	Grade	Length	Starting Station	Grade	Length
0+00	+0.26	1164*	0+00	+0.26	725
13+20	V.C.	40	7+25	V.C.	150
13+60	+0.33	55	8+75	+0.13	175
14+15	Transition	157	10+50	V.C.	300
15+72	+0.72		13+50	+0.72	700
22+79	V.C.	300*	22+56	V.C.	300*
23+50	+0.40		23+50	+0.40	
Two Lane Section					
23+50	+0.40	100	69+50	V.C.	300
24+50	V.C.	300	72+50	+0.60	50
27+50	+0.27	400	73+00	V.C.	600
31+50	V.C.	300	79+00	-6.00	1765
34+50	0	900	96+65	V.C.	400
43+50	V.C.	300	100+65	-2.50	1615
46+50	-0.51	400	116+80	V.C.	300
50+50	V.C.	300	119+80	0	1595
53+50	-0.10	550	135+75	V.C.	300
59+00	V.C.	300	138+75	+1.35	575
62+00	-1.17	300	144+50	V.C.	300
65+00	V.C.	300	147+50	+3.18	375
68+00	0	150	151+25	V.C.	650
157+75	-4.00	475	243+00	+1.22	250
162+50	V.C.	400	245+50	V.C.	300
166+50	0	400	248+50	-1.40	50
170+50	+6.00	375	249+00	V.C.	300
174+25	V.C.	550	252+00	-0.20	650
179+75	+0.12	525	258+50	V.C.	300
185+00	V.C.	300	261+50	V.C.	300
188+00	-0.33	233	264+50	+1.73	250
190+33	V.C.	300	267+00	V.C.	302*
193+33	+4.00	300	225+00	+0.15	550
196+33	V.C.	700	230+50	V.C.	300
203+33	-4.00	287	233+50	0	100
206+20	V.C.	300	234+50	V.C.	300
209+20	+0.75	430	237+50	-0.24	600
213+50	V.C.	300	243+50	V.C.	300
216+50	+1.00	325	246+50	-0.44	1700
219+75	V.C.	300	263+50	V.C.	300
222+75	+4.06	375	266+50	-0.04	300
226+50	V.C.	350	267+50	V.C.	300
230+00	-0.10	325	270+50	+0.30	400
233+25	V.C.	300	274+50	V.C.	300
236+25	+5.27	200	277+50	-0.52	600
238+18	V.C.	550*	283+50	V.C.	300
239+75	-0.80	25	286+50	-0.15	1100
240+00	V.C.	300	297+50	V.C.	300

* Station Equation Included

TABLE A1 (3)

VERTICAL CURVATURE

Southbound

Starting Station	Grade	Length
300+50	-0.19	150
302+00	-0.20	100
303+00	V.C.	400
307+00	V.C.	400
311+00	-0.20	
329+50	end project	

TABLE A1 (4)

PAVEMENT WIDTH

Northbound

Station	Width
23+00	11' Width
65+60	Begin taper from 11 ' to 22'
68+70	22' Width
101+90	Begin taper from 22' to 11'
104+99	11' Width
143+42	Begin taper from 11' to 21'
145+92	21' Width
150+29	Begin taper from 21' to 11'
151+05	11' Width
178+15	End 11' Start 21' Width
192+20	End 21' Width Start 11'
221+77	End 11' Start 21' Width
230+14	End 21' Start 11' Width
238+77	End 11' Start 21' Width
239+56	Line "B" = 235+63.4 Line "C"
238+62	End 21' Begin 11' Width
262+43	End 11' Begin 21' Width
264+80	End 21' Begin 11' Width
268+30	Line "C" = 223+28.7 Line "A"
243+83	End 11' Width Begin 21'
246+83	End 21' Begin 11' Width
270+71	End 11' Begin taper from 11' to 21'
271+67	21' Width
272+58	End 21' Begin taper from 21' to 11'
273+39	11' Width
290+03	End 11' Begin taper from 11' to 22'
294+98	22' Width
309+81	PR = 309+80.9
330	22' Width

TABLE A1 (4)

PAVEMENT WIDTH

Southbound

Station	Width
23+00	11' Width
68+20	Begin taper from 11' to 21'
69+20	21' Width
73+00	End 21' Width Start 11'
145+42	Begin taper from 11' to 21'
145+92	21' Width
147+92	End 21' Width Start 22'
148+19	End 22' Start taper from 22' to 11'
148+71	11' Width
178+25	End 11' Width Start 21'
188+70	End 21' Width Start 11'
22+20	End 11' Start taper from 11' to 21'
227+80	21' Width
239+56	Line "E" = 235+63.4 Line "C"
239+12	End 21' Width Begin 11'
260+71	End 11' Width Begin 21'
268+30	Line "C" = 223+28.7 Line "A"
225+43	End 21' Start 11' Width
242+19	End 11' Width Begin 21'
247+63	End 21' Begin 11' Width
269+62	End 11' Begin taper from 11' to 20'
270+42	20' Width
271+47	End 20' Begin 11' Width
285+00	Begin taper from 11' to 20'
290+03	22' Width
309+81	PR = POC 309+80.9
330	22' Width

TABLE A1 (5)

SHOULDER WIDTH

Northbound

Station	Width
0+00	10' Width
73+00	End 10' Width Start 3' Width
104+99	End 3' Width Start Bridge
114+87	End Bridge Start 6'
137+40	End 6' Width Start 20'
143+50	End 20' Start 10'
150+30	End 10' Start 7'
15+05	End 7' Start taper to 3'
154+49	End taper Start 3' (Bridge)
159+06	End 3' Start taper from 3' to 6'
160+72	End taper Start 6'
175+09	End 6' Start 10'
178+82	End 10' Width Start Rest Area 25' Radius
181+45	End Rest Area Start 10' Width
192+71	End 10' Start 7'
198+87	End 7' Start 0' (Bridge)
200+70	End Bridge Start 7'
20+45	End 7' Start 8'
207+85	End 8' Start 30'
208+90	End 30' Start 18'
216+91	End 18' Start 10'
219+50	End 10' Width Start 20'
229+74	End 20' Start 12'
239+56	Line "E" = 235+63.4 Line "C"
236+88	End 12' Start 30'
253+54	End 30' Start 10'
268+30	Line "C" = 223+28.7 Line "A"
244+99	End 10' Start 12'

TABLE A1 (5)

SHOULDER WIDTH

Southbound

Station	Width
0+00	10' Width
86+00	End 10' Width Start 7' Width
104+99	End 7' Width Start Bridge
114+87	End Bridge Start 6' Width
145+15	End 6' Width Start 10'
150+30	End 10' Width Start 7'
153+32	End 7' Start taper to 3'
15+49	End taper Start 3' (Bridge)
159+06	End 3' Width Start 5'
161+54	End 5' Start 10'
179+35	End 10' Start 5'
184+85	End 5' Start 10'
192+71	End 10' Start 7'
198+87	End 7' Start 0' (Bridge)
200+70	End Bridge Start 7'
20+45	End 7' Start 8'
209+33	End 8' Start 14'
213+57	End 14' Start 10'
219+50	End 10' Width Start 20'
223+99	End 20' Start 12'
239+56	Line "E" = 235+63.4 Line "C"
227+20	End 12' Start 3'
236+88	End 3' Start 10'
268+30	Line "C" = 223+28.7 Line "A"
244+99	End 10' Start 12'

TABLE A2

DRIVEWAY SUMMARY

RIGHT SIDE (SOUTHBOUND)

Business Number	Station	Functional Classification	Width (Ft.)	Estimated Generation
1	15+90	Service Station	32,29	110
2	17+72	Service Station	29,31	90
3	20+77	Motel	33,32	30
4	22+78	Restaurant-Motel	27,24	50
5	23+05	Service Station	30,32	70
6	24+78	Private Residence	10	5
7	44+92	Restaurant	34	110
8	47+47	Service Station	37,33	100
9	49+21	Restaurant, Drive-in	31	330
10	51+16	Shopping Center	33	1100
11	186+16	Service Station	53	250
12	188+10	Restaurant, Drive-in	27,23	200
13	189+34	Service Station	30,32	70
14	191+17	Restaurant-Motel	37,14	190
15	214+22	Motel	37	170
	215+15	Restaurant	38,40	210
16	218+09	Service Station	42,44	90
17	238+19	Service Station	41,41	120
18	247+23	Cemetery	20,20	20
19	250+57	Office Building	20,36	130
20	252+34	Auto Sales, Power Station	15	40
21	253+92	Auto Sales	20	40
22	254+39	Auto Sales	24	90
23	255+06	Residential Access	24	150
24	257+30	Carwash	23	90
25	258+09	Truck Terminal	37	20
26	259+27	Roadside Stand	36	40
27	261+42	Service Station	43,39	70
28	264+16	Service Station	31,31	90
29	265+81	Restaurant	52,53,52	220
30	267+25	Restaurant, Drive-in	41,39	370
31	224+29	Commercial Building	30,30	270
32	226+87	Private Residence	15	5
33	228+08	Commercial	26	30
34	229+49	Commercial	35,47	50
35	231+36	Commercial	100	60
36	233+58	Motel	59	30
37	238+12	County Highway Garage	271	60
38	241+67	Commercial	40,35	30
39	243+54	Service Station	44,42	40

TABLE A2 (cont'd)

Business Number	Station	Functional Classification	Width (Ft.)	Estimated Generation
40	246+18	Service Station	41	90
41	248+01	Private Residence	25	5
42	250+32	Drive-in Restaurant	33,33	240
43	253+00	Restaurant-Motel	32,32	470
44	258+32	Auto Sales, Service	28,33	260
45	264+90	Auto Sales	30,35	50
46	266+80	Commercial	20,20	15
47	272+53	Vacant	160	---
48	275+06	Industrial	22,20	20
49	276+95	Industrial	12,62	40
50	281+78	Industrial	61,46,36	190
51	300+33	Commercial	36,110	20
52	301+57	Garage	40	40
53	304+51	Service Station	140	50

LEFT SIDE
(NORTHBOUND)

Business Number	Station	Functional Classification	Width (Ft.)	Estimated Generation
1	15+44	Commercial	21	20
2	17+05	Trailer Residential	20	190
3	37+31	Commercial Miscellaneous	296	110
4	42+60	Trailer Residential	37	210
5	45+54	Service Station	38,33	80
6	47+50	Service Station	37,33	100
7	48+57	Commercial	30	15
8	147+10	Private Residence	15	5
9	148+26	Industrial	27	240
10	183+02	Restaurant-Service Station	230	190
11	190+26	Industrial	26	20
12	208+45	Railroad Yard	200	60
13	217+95	Commercial	---	10
14	229+74	Residential Access	30	300
15	235+58	Service Station	41,53	50
16	253+54	Industrial	32	80

TABLE A2 (cont'd)

17	266+33	Garage	17	50
18	267+43	Office	19	15
19	224+27	Private Residence	15	5
20	225+64	Commercial	95,143	150
21	228+87	Commercial	31,26	170
22	230+87	Service Station	40,39	140
23	231+93	Industrial	18	10
24	235+63	Service Station	35,41	120
25	234+16	Commercial	20,31,21	80
26	242+47	Private Residence	13	5
27	243+54	Service Station, Restaurant	45,38	150
28	246+08	Service Station	29,26	110
29	248+15	Service Station, Industrial	39,35	240
30	250+28	Service Station	42,48	90
31	254+13	Industrial	32	90
32	256+75	Commercial	25,18	30
33	259+00	Commercial	30,24	150
34	262+09	Industrial	22	150
35	267+67	Drive-in Restaurant	40,37	110
36	273+18	Service Station	37,30	60
37	274+85	Auto Sales	63	50
38	277+25	Commercial	20	30
39	277+78	Commercial	75,76	50
40	284+49	Commercial	26	110
41	284+99	Parking Lot	46	50
42	290+22	Commercial	28,26	40
43	294+20	Restaurant	38,31	170
44	296+18	Industrial	13,36	60
45	297+68	Service Station-Restaurant	40,42	120
46	301+89	Private Resdience	14	5
47	305+02	Commercial	10	10
48	305+79	Service Station	49,40	60
49	310+19	Service Station	49,29	110
50	311+50	Commercial	28	20
51	324+55	Commercial	50	300

SURVEY DATA
SPEED-DELAY STUDY
Average Travel Speed (mph)

Section	SE Flow Overall Speed	SE Flow Running Speed	NW Flow Overall Speed	NW Flow Running Speed	Combined Flows Overall Speed	Combined Flows Running Speed
Northwestern*	26.8	29.5	42.4	42.4	34.6	36.0
Salisbury	30.1	31.9	29.3	32.2	29.7	32.1
Schuyler	21.7	26.4	24.1	28.2	22.9	27.3
Greenbush	19.9	25.3	27.4	30.0	23.7	27.7
Union	23.6	25.9	24.8	27.8	24.2	26.9
South	19.7	23.5	21.1	25.7	20.4	24.6
Main*	35.0	38.0	32.0	35.7	33.5	36.9
Teal*	29.2	32.9	24.6	31.9	26.7	32.4

Average Stopped Times (sec)

Section	SE Flow Average Stopped Time per Run, sec	SE Flow Average Length of Stop, sec	SE Flow Percent of Runs when Stops Occurr	NW Flow Average Stopped Time per Run, sec	NW Flow Average Length of Stop, sec	NW Flow Percent of Runs when Stops Occurr
Northwestern*	5.3	5.3	100.0	---	---	---
Salisbury	3.7	12.4	30.0	4.1	15.3	27.5
Schuyler	10.0	16.6	60.0	8.1	15.0	52.5
Greenbush	12.1	18.7	65.0	4.2	10.5	40.0
Union	4.8	11.4	42.5	5.7	12.8	45.0
South	9.2	17.5	52.5	8.6	16.5	55.0
Main*	5.3	16.4	32.5	8.0	16.3	60.0
Teal*	8.8	17.6	50.0	15.8	19.6	72.5

Average Delay per Vehicle (sec)

Section	SE Flow Calculated	SE Flow Theoretical	NW Flow Calculated	NW Flow Theoretical
Salisbury	7.0	6.4	7.4	7.9
Schuyler	11.0	15.7	15.1	12.9
Greenbush	15.5	16.4	8.3	8.5
Union	8.3	7.9	10.6	8.9
South	113.5	14.2	13.0	12.7

*Not included in the multivariate analysis

Table A3

SPEED - DELAY STUDY

Contributions of Principal Factors to Variance of Travel Speed

Non-Interrupted Flow

Factor	Percent of Total Variance	Cum. Percent of Total Variance
Commercial Development	20.01	20.01
Horizontal Resistance	17.52	37.53
Evening Shopping Travel	10.16	47.69
Flat Topography	6.69	54.38
Time Variations	5.48	59.86
Urban Development	4.94	64.80
Driver Distractions	4.22	69.02
Time Variations	3.96	72.98
Outbound Traffic	3.46	76.44
Day-of-week Variation	3.17	79.61
Rural Development	2.99	82.60
Stream Friction	2.94	85.54

Interrupted Flow

Factor	Percent of Total Variance	Cum. Percent of Total Variance
High volume on major street	18.57	18.57
Non-peak period	14.85	33.42
Flat topography	14.17	47.59
Commercial development	9.50	57.09
Low-minor street traffic	7.86	64.95
Concentrated turning movements	6.27	71.22
Time variations	5.06	76.28
Vertical resistance	4.76	81.04
Long-distance travel	3.67	84.71
Day-of-week variations	2.90	87.61

Table A4(1)

MULTIPLE LINEAR REGRESSION AND CORRELATION RESULTS
INTERRUPTED FLOW

Factor	Correlation Coefficients With Travel Speed	Delay
High major street volume	-0.0278	-0.0646
Non-peak period	+0.2022 *	-0.1455 *
Flat topography	+0.1604 *	-0.1778 *
Commercial development	-0.0703	+0.0470
Low-minor street volume	+0.2626 *	-0.2044 *
Heavy turning movements	-0.0154	+0.0399
Time variations	+0.0137	+0.0120
Adverse verticle alinement	-0.0540	+0.0224
Through traffic	-0.0413	+0.0164
Day-of-week variations	+0.0567	-0.0636

* Significant at the 5 percent level

Dependent variable: Travel Speed
Intercept= 28.59 mph
Multiple correlation coefficient= 0.368
Standard error of estimate= 9.53 mph

Variable	Net Regression Coefficient	Standard Error
Avg. Approach Grade	-0.4165	0.3235
Signal Cycle Length	-0.2118	0.0587
Approaching Volume	-0.0120	0.0280
Total Intersection Volume	-0.0170	0.0104
Greentime Ratio	+25.4800	7.4789

Table A4(2)

TABLE A4 (3)

MULTIPLE LINEAR REGRESSION AND CORRELATION ANALYSIS OF TRAVEL SPEED, UNINTERRUPTED FLOW

Factor	Correlation Coefficient
Commercial development	-0.5507 *
Horizontal resistance	-0.0525
Evening shopping travel	-0.0923
Flat topography	+0.0049
Time variations	-0.0659
Urban development	-0.1874 *
Driver distractions	+0.0956
Time variations	-0.0920
Outbound traffic	+0.0535
Day-of-week variations	+0.0289
Rural development	+0.1744 *
Stream friction	-0.2674 *
Day-of-week variations	-0.0400

* Significant at the 5 percent level

Dependent variable: Travel Speed
Intercept = 68.60 mph
Multiple correlation coefficient = 0.704
Standard error of estimate = 6.55 mph

Variable	Net Regression Coefficient	Standard Error
Cross Streets	-0.4541	0.1214
Commercial Establishments	-0.1775	0.0211
No Passing Zone	-0.1007	0.0135
Practical Capacity	-0.0150	0.0022
Total Volume	-0.0301	0.0044

TABLE A5(1)

RANKING OF INTERSECTIONS BY ANNUAL NUMBER OF ACCIDENTS AND ANNUAL NUMBER OF ACCIDENTS PER MILLION VEHICLES.

Rank	Intersection	No. of Accidents	Intersection	Accident Rate
1	Teal Road	27.3	Teal Road	3.33
2	State Road 26	27.0	State Road 26	2.85
3	Union	20.3	State Road 25	2.59
4	State Road 38	20.3	Greenbush	2.47
5	State Road 25	20.0	Union	2.39
6	Greenbush	18.0	State Road 38	2.36
7	Happy Hollow	10.3	Northwestern	1.73
8	Northwestern	8.7	Happy Hollow	1.69
9	Ninth St. Cutoff	8.3	Ninth St. Cutoff	1.53
10	Salisbury	8.0	Salisbury	1.38
11	McCarty	5.3	McCarty	.78
12	Kossuth	5.0	Underwood	.73
13	Underwood	4.7	Kossuth	.73
14	Yeager	1.7	Yeager	.33

TABLE A5(2)

RANKING OF INTERSECTIONS BY COSTS OF ACCIDENTS

Rank	Intersection	Cost (Dollars)	Intersection	Cost per MV (Dollars)	Intersection	Cost of Index of Hazard
1	Teal Road	26,367	Teal Road	3,429	Teal Road	127.3
2	Greenbush	13,673	Northwestern	2,160	Salisbury	91.8
3	Union	13,013	Greenbush	1,987	Happy Hollow	66.0
4	State Road 25	12,930	State Road 25	1,757	State Road 38	49.0
5	State Road 26	12,283	Union	1,623	State Road 25	33.9
6	Northwestern	10,760	State Road 26	1,383	Union	28.2
7	State Road 38	9,303	Happy Hollow	1,368	State Road 26	23.5
8	Happy Hollow	7,987	Salisbury	1,261	Yeager	14.8
9	Salisbury	6,770	State Road 38	1,147	Greenbush	9.4
10	Underwood	4,813	Ninth St. Cutoff	878	Underwood	6.1
11	Ninth St. Cutoff	4,647	Underwood	794	Northwestern	5.4
12	McCarty	4,320	McCarty	670	McCarty	3.2
13	Kossuth	3,003	Kossuth	461	Ninth St. Cutoff	3.2
14	Yeager	423	Yeager	91	Kossuth	1.5

TABLE A6(1)

RANKING OF SECTIONS BY AVERAGE ANNUAL NUMBER OF ACCIDENTS AND SEVERAL MEASURES OF EXPOSURE

Rank	Sect.	No. of Acc.	Sect.	Acc. / Mile	Sect.	Acc. / 10,000 veh.	Sect.	Acc. / MVM
1	18	15.0	19	49.9	18	8.46	4	9.30
2	19	13.3	21	35.6	19	7.13	19	6.70
3	21	10.3	18	34.9	21	6.16	21	5.46
4	17	6.3	17	28.7	6	3.90	18	5.01
5	14	5.3	14	23.3	17	3.72	17	4.36
6	12	5.0	12	18.3	8	3.66	14	3.88
7	6	4.7	23	16.3	14	3.44	7	3.60
8	15	4.3	7	16.0	12	3.23	12	3.07
9	8	4.0	4	13.5	10	2.81	23	2.48
10	10	3.7	15	13.2	15	2.60	9	2.45
11	7	3.0	13	13.2	7	2.51	13	2.21
12	4	2.7	9	12.4	4	1.99	10	2.14
13	9	2.3	22	11.4	9	1.78	15	2.09
14	5	2.0	10	10.8	5	1.49	6	1.83
15	16	1.7	11	8.9	22	0.99	1	1.81
16	22	1.7	16	8.3	16	0.98	22	1.77
17	20	1.3	20	8.1	1	0.97	11	1.66
18	23	1.3	6	8.1	3	0.89	8	1.56
19	1	1.0	1	7.1	23	0.79	3	1.37
20	3	1.0	8	6.9	11	0.77	16	1.25
21	11	1.0	3	5.9	20	0.71	20	1.14
22	13	1.0	5	5.4	13	0.65	5	1.06
23	24	0.7	24	1.9	24	0.39	24	0.39
24	2	0.3	2	1.5	2	0.30	2	0.38

TABLE A6(2)

RANKING OF SECTIONS BY A MEASURE OF HAZARD AND
SEVERAL MEASURES OF AVERAGE ANNUAL COSTS OF ACCIDENTS

Rank	Sect.	Hazard (100)	Sect.	Cost (Dollars)	Sect.	Cost/MVM (Dollars)	Sect.	Cost/Hazard (1000)
1	4	141	19	12,723	4	12,679	4	199
2	19	102	18	10,332	19	6,531	19	98
3	21	84	21	7,300	17	4,441	17	67
4	18	76	15	6,407	21	3,883	15	61
5	23	76	17	6,373	14	3,877	14	59
6	17	67	14	5,323	7	3,747	21	58
7	14	59	6	5,253	18	3,513	7	57
8	7	55	8	5,203	15	3,139	18	53
9	12	47	4	3,753	11	2,268	6	47
10	6	42	12	3,280	6	2,049	22	39
11	15	42	7	3,110	12	2,033	11	35
12	22	41	10	2,460	8	2,021	8	31
13	9	37	5	2,073	1	1,881	12	31
14	13	34	9	1,870	13	1,758	9	29
15	10	33	11	1,363	10	1,427	1	27
16	1	28	20	1,246	23	1,291	13	27
17	11	25	1	1,063	9	1,085	10	25
18	8	24	16	860	5	1,078	5	17
19	20	22	13	786	20	1,047	20	16
20	3	21	23	683	16	656	23	12
21	16	19	22	487	22	523	16	10
22	5	16	24	466	3	520	3	8
23	24	12	3	400	24	266	24	8
24	2	6	2	43	2	49	2	1

TABLE A7

TYPES OF ACCIDENTS ON THE MOST HAZARDOUS NONINTERSECTION STUDY SECTIONS

	Section Number											
	4	7	10	12	14	15	17	18	19	21	Total	% of these acc.
Accident Rate	9.30	3.60	2.14	3.07	3.88	2.09	4.36	5.01	6.60	5.46	4.29	--
No. of Acc.	8	9	11	15	16	13	19	45	40	31	207	--
Injuries	7	6	3	5	10	12	14	18	28	12	115	--
Pavement wet or icy	4	6	6	6	5	6	3	12	16	18	82	40
Type I	0	0	1	1	0	2	6	15	9	2	36	18
Type II	7	1	2	5	8	7	8	23	26	21	108	52
Type III	1	3	4	3	7	1	2	2	3	1	27	13
Type IV	0	5	4	6	1	3	3	5	2	7	36	17
7 - 8 AM 2 - 8 PM	6	4	3	6	12	6	14	31	25	19	126	61
Night	1	3	7	6	1	0	1	4	4	6	33	16

TABLE A8
INTERSECTIONS
CAPACITIES AND VOLUMES

NO.	APPR.*	NAME	CAPACITY	PEAK HOUR VOLUME	VOL/CAP
001	N	Northwestern Ave.	1720	460	0.26
	S		820	390	0.48
	W		820	410	0.50
102	N	Yeager Rd.	440	430	0.98
	S		440	450	1.02
	E		130	240	1.85
	W		130	90	0.69
103	N	Salisbury St.	570	630	1.11
	S		550	440	0.80
	E		260	60	0.23
	W		300	250	0.83
104	N	Happy Hollow Rd.	370	690	1.86
	S		370	390	0.80
	E		100	90	0.90
	W		100	200	2.00
201	N	Ninth St.	280	430	1.54
	S		280	430	1.54
	W		220	240	1.09
202	N	Schuyler-Indiana 25	420	530	1.26
	S		460	520	1.13
	E		340	250	0.74
	W		410	250	0.61
301	N	Underwood St.	410	490	1.20
	S		410	480	1.17
	W		550	70	0.13
302	N	Greenbush St.	570	570	1.00
	S		630	730	1.16
	E		200	20	0.10
	W		210	220	1.05

*Approaches are named relative to the direction of Bypass Traffic.

TABLE A8

Continued

NO.	APPR.	NAME	CAPACITY	PEAK HOUR VOLUME	VOL/CAP
303	N	Union St.	560	540	0.96
	S		550	710	1.29
	E		200	190	0.95
	W		280	400	1.43
304	N	South St.-Indiana 26	570	840	1.47
	S		560	980	1.75
	E		200	270	1.35
	W		220	490	2.23
401	N	Kossuth St.	550	770	1.40
	S		550	720	1.31
	W		220	550	2.50
403	N	McCarty Lane	1650	680	0.41
	S		1650	710	0.43
	E		450	430	0.96
	W		450	230	0.51
404	N	Main St.-Indiana 38	1000	680	0.68
	S		1070	710	0.66
	E		220	180	0.82
	W		240	400	1.67
405	N	Teal Rd.-Indiana 25	1090	820	0.75
	S	US 231	790	430	0.54
	E		280	90	0.32
	W		210	410	1.95

TABLE A9

NON-INTERSECTION AREAS
VOLUMES AND CAPACITIES

NO.*	LENGTH	CAPACITY**	AADT	PEAK HOUR VOLUME	VOL/CAP
1	747	1750	10310	710	0.41
2	1130	1750	10850	750	0.43
3	897	1750	11390	790	0.45
4	300	1750	13640	940	0.54
5	1944	1290	13640	940	0.73
6	3041	1650	12400	860	0.52
7	987	1210	12400	860	0.71
8	3060	1320	12400	860	0.65
9	993	910	12540	860	0.95
10	1797	940	12540	860	0.91
11	592	990	13820	950	0.96
12	1464	1650	17460	1200	0.73
13	400	1150	14810	1020	0.89
14	1229	1750	14200	980	0.56
15	1733	1540	16410	1130	0.73
16	1063	2170	17800	1230	0.57
17	1167	2190	16960	1170	0.53
18	2268	2190	16880	1160	0.53
19	1410	2190	17100	1180	0.54
20	865	2190	18580	1280	0.58
21	1529	2190	17680	1220	0.56
22	729	2190	17690	1220	0.56
23	431	3300	16620	1150	0.17
24	1388	3300	17850	1230	0.19

*Sections are traffic oriented.
**Two Direction Capacity.

TABLE A10
TRAFFIC SIGNAL CYCLES*

LOCATION	APPR.	GREEN EXIST.	GREEN RECOM.	GREEN L.T.	RECOM** TOTAL CYCLE
SCHUYLER (S.R.25N.)	BYPASS	26	25	--	48
	CROSS	27	15	--	
GREENBUSH	BYPASS	35	35	--	60
	CROSS	17	17	--	
UNION	BYPASS	35	35	--	60
	CROSS	17	17	--	
SOUTH (S.R.26)	BYPASS	48	35	--	60
	CROSS	21	17	--	
MAIN (S.R.38)	BYPASS	32	25	10	60
	CROSS	13	17	--	
TEAL (S.R.25S.)	BYPASS	21	25	10	63
	CROSS	16	10	10(+T.)	

*Existing semiactuated signal at Salisbury should be retained in status quo although fixed time signal is warranted.

**Total cycle includes 3 seconds yellow and 1 second all-red at each phase change.

VEHICLE CLASSIFICATION

Location	Direction	Expanded Parameters % Commercial	Axle/Vehicle Ratio
North, No. 1 Oct. 1965	Northbound	22.7	2.468
	Southbound	21.0	2.440
	Total	21.9	2.454
No. 2 Oct. 1965	Northbound	18.2	2.340
	Southbound	15.9	2.317
	Total	16.9	2.328
No. 3 Nov. 1965	Northbound	20.5	2.347
	Southbound	19.0	2.360
	Total	19.8	2.353
No. 3 Feb. 1966	Northbound	23.2	2.374
	Southbound	21.0	2.218
	Total	22.1	2.296
No. 3 June 1965 (24 hrs.)	Northbound	17.4	2.315
	Southbound	19.4	2.361
	Total	18.4	2.337
No. 4 Oct. 1965	Northbound	19.8	2.322
	Southbound	15.0	2.296
	Total	17.3	2.308
South, No. 5 Dec. 1965 (A.M.)	Northbound	23.4	2.375
	Southbound	26.1	2.446
	Total	24.8	2.410
South, No. 5 Dec. 1965 (P.M.)	Northbound	25.4	2.435
	Southbound	21.3	2.401
	Total	23.2	2.425

TABLE A 11