

John M. Laughlin

**A STUDY OF HIGHWAY TRANSPORTATION
IN INDIANA**

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Research
Project**

**PURDUE UNIVERSITY
LAFAYETTE INDIANA**

by

**Transportation
Research
Staff**



~~FINAL REPORT~~

A STUDY OF HIGHWAY TRANSPORTATION
IN INDIANA

by

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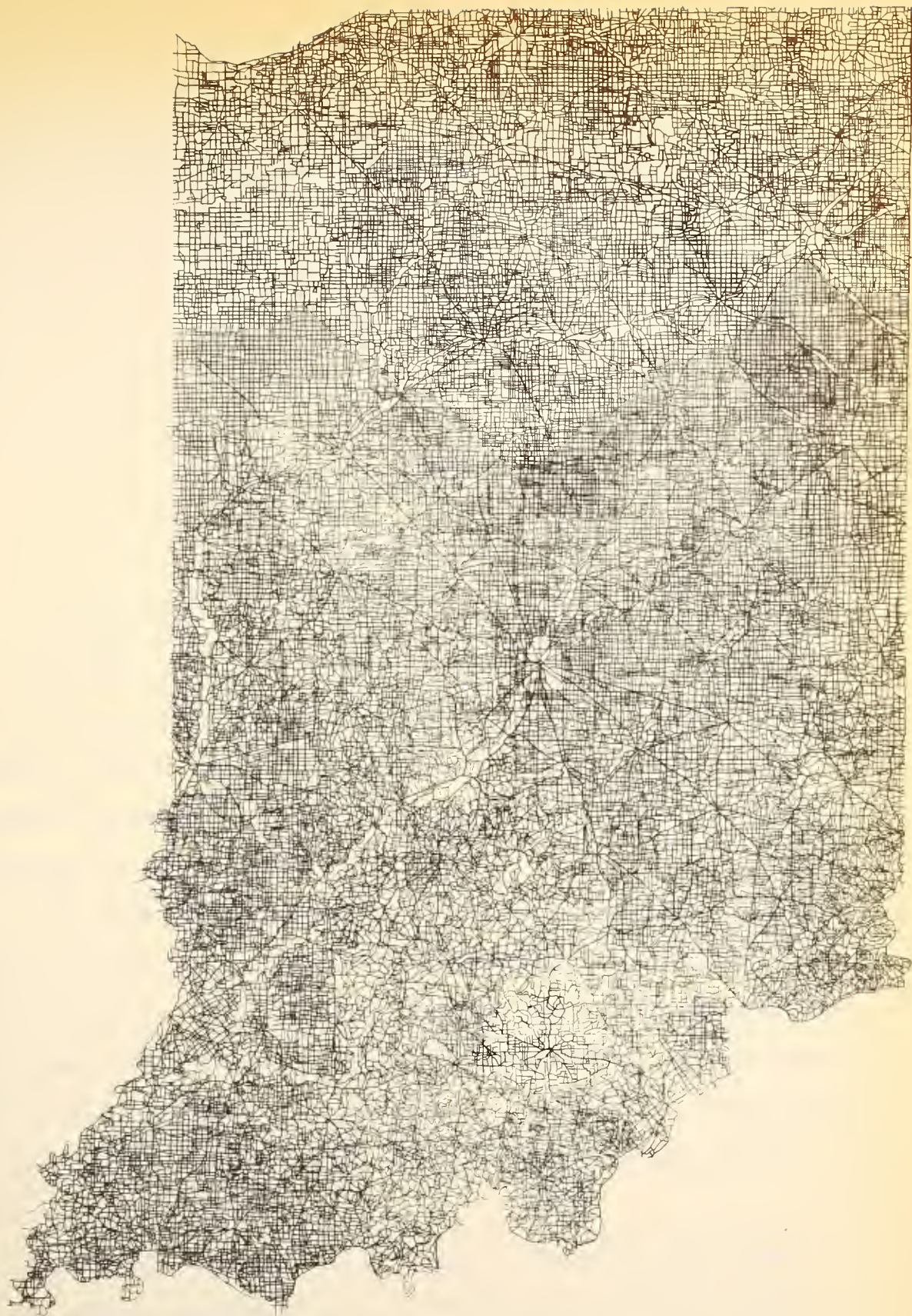
The advice and counsel of the members of the Advisory Board of the Joint Highway Research Project and especially that of Mr. C. E. Vogelgesang, Chairman, and Prof. K. B. Woods, Vice-Chairman and Director, is acknowledged.

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INDIANA'S HIGHWAY PROBLEM

FIGURE 1

A STUDY OF HIGHWAY TRANSPORTATION IN INDIANA

SUMMARY AND FINDINGS

Introduction

Although large expenditures have been made by the state and local government of Indiana to improve highways for motor vehicle travel, highway improvement has failed to keep pace with traffic demands. Moreover, there is the dismal prospect that without effective remedial measures, inadequacies relative to traffic demands will continue to increase while highway travel doubles by 1975.

This engineering study reveals the extent and difficulty of the highway problems of Indiana. More than one-fourth of the road and street mileage is deficient and now requires resurfacing, reconstruction, or entirely new construction to be adequate for traffic. An estimated expenditure of \$5.2 billion is necessary to correct present (1957) and future deficiencies and to provide for maintenance and administration during a 15-year program.

Development or improvement of adequate road and street systems, however, cannot be achieved by rule of thumb or by piece-meal legislation. They are engineering processes and their accomplishment requires

ARTICLE

REVIEW

THE STATE OF THE WORLD'S FORESTS: A REPORT BY THE

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effective and continuous long-range planning. Such planning and operation must be based on firm, consistent decisions of concern to transportation policy, administration, engineering, and finance.

Economic Services

The growth of the highway system has been intimately related to the social and economic progress of the state. Transportation is recognized as a major economic force and Indiana's progress can be measured in terms of the development of methods used to carry goods and people from place to place. In the past there has been a need for the extensive growth of the railroads in the state, water transportation remains of importance to certain geographical areas, and the use of air and pipeline transportation is increasing rapidly. But highways, in addition to being essential to motor transport in their own right, perform the essential service of linking all other means of transportation together.

It is difficult to measure the influence of highway transportation upon state and national economy, but great benefits accrue to agriculture, commerce, industry, education, and the national defense. The importance of highways to Indiana is represented by the many vehicle registrations, 1.5 million passenger cars and over 300,000 trucks in Indiana in 1955. Excluding farm trucking, about 325,000 persons were employed in highway transportation industries in Indiana in that year (55).* In 49 percent of the state's towns and villages, highways are reported to provide the only available freight transportation (55). It was also found by one investigator that every one of the 899 post offices in the state use some highway transportation and 550 depend upon highway transportation for service (55).

* Numbers in parenthesis refer to bibliography.

Agriculture depends greatly on highway transportation - one-fourth of all trucks registered in the state are farm trucks. Livestock marketing accounted for over one-third of the total farm income in the state during 1955 and nearly all livestock was shipped by truck in that year to the four major markets of Evansville, Fort Wayne, Indianapolis, and Muncie (55).

The highways integrate water, rail, pipe, and air transport into a transportation system and are necessary in the economic life of the society. City streets are crowded with the traffic that is essential to urban life, and local roads reach into the most remote and inaccessible corners of the state. Most families, regardless of social status or income, have an automobile.

The growth of suburban residential areas and the movement of industry away from urban centers has been made possible by the motor vehicle. Travel for recreational purposes has been made comfortable and inviting. The public welfare has benefited from rapid and efficient movement of professional and community services of doctors, fire fighters, mail carriers, ambulances, and school buses. But most important are the countless services rendered to industry and agriculture by the motor vehicle using the Indiana highway systems.

Highway Travel

A study of travel trends is a vital step in determining highway inadequacies and in developing practical long-range programs. Because funds for highway improvement represent a long term capital investment including many years of service, any highway improvement must be concerned with future demands.

The factors of population growth, vehicle ownership, and fuel consumption are an indication of the volume of traffic for any given period. By studying these variables, it is possible to make a reasonably accurate projection of traffic volume. Such projections or estimates, if soundly made, show how much traffic may be expected in future years, and the highways and streets which will be required to serve and accommodate the traffic.

The 1950 census reported nearly four million persons in this state, and it is estimated that the population will approach six million in 1975. Although motor vehicle registrations in Indiana decreased during the depression and World War II, they increased from 875,000 in 1930 to nearly 1,800,000 in 1955. The per capita ownership of the motor vehicles changed from 3.7 persons per vehicle in 1935 to 2.25 persons per vehicle in 1955 and it is expected to approach 1.35 persons per vehicle by 1975. Estimates based on analysis of motor vehicle use and fuel data indicate that the average vehicle traveled about 10,000 miles in 1955 (32). Average annual travel appears to be leveling off at about this mileage. Conservative projections of these basic factors of traffic generation indicate that in 1975 highway traffic in Indiana will be approximately double that of 1955.

Highway Classification

The purpose of long-range highway planning is to develop roads and streets which supply the amount and type of service demanded from each facility. Thus, it is necessary to group highways into systems with all highways in a system performing similar services, to assign

responsibility for their improvement to the unit of government most concerned, and to develop an overall financing plan fitted to the requirements of each system. When state, county, and city highway administrators are responsible for construction and maintenance of excessive mileages of highways inappropriately assigned to them, efficiency in management and fund expenditure is difficult to maintain.

One of the most basic steps in the proper and efficient administration of the highway systems is adequate classification. In Indiana, many of the county and city highways require classification and the state highway systems would benefit from a reclassification.

Standards

In this study some sub-standard construction was found on all road and street systems. In some cases, deficiencies in structural design contributed significantly to the rapid deterioration or obsolescence of pavements and bridges. In others the lack of control of access was of major importance. Highways cannot be changed as readily as automobiles by changing models. They must be constructed to standards which are adequate for the present and future demands of traffic.

Highway Operations

The efficiency of operation of many miles of highway could be increased through effective use of traffic engineering procedures.

One-way operation and removal of parking will increase the capacity of many city streets. Progressive timing of signals may permit free-flowing and unimpeded movement of traffic. Furthermore, the development of new highways requires the coordination of planning and design with operational characteristics and requirements.

Safety

In 1955, highway traffic accidents in Indiana claimed the lives of 1,145 persons - 258 in urban areas and 887 in rural areas (42). In addition, over 37,000 persons were injured (42). The total economic loss for these accidents including the loss of wages, medical expenses, cost of insurance, and property damage exceeded \$140 million (42). The traffic fatality rate in Indiana was 6.0 deaths per 100 million vehicle miles as compared to a national figure of 6.4 (42).

Elimination of the inadequate elements on the highways of Indiana will reduce accidents. Some estimates indicate that 40 percent of all accidents could be eliminated if the highway systems were improved to modern design concepts. Control of access on the Interstate and Primary State Highways will account for most of this reduction, for indiscriminate roadside development has caused many sections of highway to develop high accident rates.

The highway safety problem is indeed difficult. No one solution for it can be obtained, and man, with his human limitations, will always have accidents. Much can be done, however, to prevent many from occurring through adequate engineering, education, and enforcement.

Needed Highway Improvements

State System

With the notable exception of the toll road, Indiana has very few miles on the 1,100-mile Interstate System which meet modern minimum design standards. Nearly 936 miles of this system must be

newly constructed or reconstructed. Many of the four-lane divided highways on this system must be relocated or rebuilt, primarily because of lack of controlled access. All two-lane highways on this system must be rebuilt and many of them relocated for economic reasons. The initial construction costs for the Interstate System will require an expenditure of \$783 million in rural areas and \$274 million in urban areas. The freeway system in Indianapolis alone will use over one-half of the total urban expenditures for the Interstate System in Indiana.

More than 2,800 miles of the rural Primary and Secondary Systems are also in need of improvement. About 200 miles of improvements are required because of inadequate capacity and an additional 2,400 miles because of structural deficiencies. Nearly 1,300 structures should be replaced or widened. Over 450 miles of new four-lane divided highways are now required on the Primary System. The total estimated cost to eliminate present deficiencies is \$472 million. The cost of reconstruction of highways and structures is nearly 85 percent of the total and the remaining 15 percent of the cost is for widening and resurfacing. The cost of new structures is 28 percent of the total cost of eliminating all present inadequacies on the Primary and Secondary System.

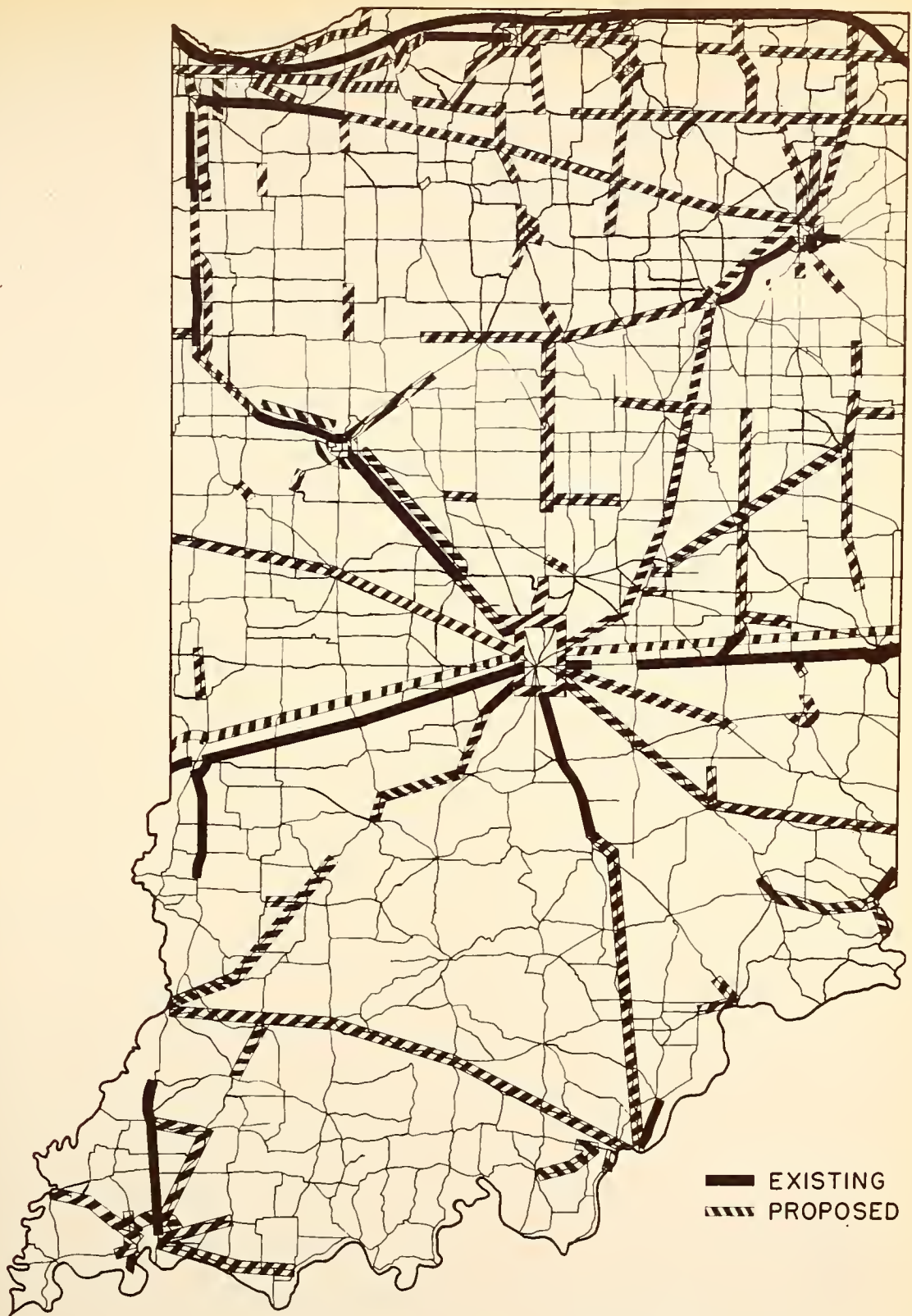
Over 150 miles of bypasses around large and small communities should be built now, and freeway systems are required in the large cities of the state. The total cost of the immediately needed improvements on the State Urban System is \$202 million. The cost of providing off-street parking lots and parking garages has not been included in this estimate. The parking problem, however, must be considered with

the highway problem if an adequate and lasting solution is to be attained.

The improvements required on the state systems during the next fifteen years will be of considerable magnitude. Over 6,100 miles of the rural Primary and Secondary Highways will become inadequate - 600 miles will be caused by lack of capacity, 5,000 miles by structural deficiencies, and 500 miles by a combination of capacity and structural deficiencies. It will be necessary to rebuild over 1,000 bridges. Nearly 1,150 miles of four-lane divided highway are required and 1,400 miles of two-lane highway must be rebuilt. Almost 3,600 miles of widening and resurfacing will be needed. The total cost of this work including the required structures is \$848 million, of which 77 percent of the cost is for reconstruction and 23 percent for resurfacing and widening.

On the State Urban System many additional miles of bypasses will be required in the next 15 years and most of this improvement should be four-lane divided construction. However, the most complex problems will remain on the routes that pass directly through the cities. On a mileage basis at least 40 percent of future urban deficiencies will be caused by inadequate capacity, and about 49 percent by structural inadequacies. It is estimated that \$272 million will be required to eliminate the urban deficiencies on state routes which will accrue in the next fifteen years.

In addition to the construction already discussed, it will be necessary to provide additional funds to adequately maintain the entire System. Although the System will be continually improved, the



EXISTING & PROPOSED
4 LANE DIVIDED HIGHWAYS

FIGURE 2

maintenance costs will remain almost constant. Improved highways have lower maintenance costs for the same traffic volume, but this reduction is offset by the higher total cost resulting from a greater number of miles of four-lane divided pavement and increased traffic. It is estimated that on the State Primary, Secondary, and Urban Systems \$354 million should be spent for maintenance, including administration, in the next 15 years.

County Road System

The counties greatest problems are on the Primary and Secondary Systems. In this study, nearly 21,000 miles were estimated to be in these Systems and the remaining 55,500 in the Local Service System.

In order to eliminate the present deficiencies and those that will accrue in the next 15 years, construction expenditures of \$372 million on the Primary and Secondary Systems and \$161 million on the Local Service System are required. An additional \$458 million is required for maintenance on all systems.

City Streets

It was necessary to estimate the mileages of streets in the various classifications in many cities where defined classified systems did not exist. A total of 2,600 miles were classified as city arterials, and 8,600 miles as residential streets in this study. During the next 15 years, nearly 1,000 miles of the arterial system and over 5,100 miles of the residential street system must be reconstructed or resurfaced. This will cost nearly \$237 million for construction on the arterial street system and \$207 million on the

residential streets. Nearly \$206 million will be required for maintenance of both systems.

Program

A period of 15 years was selected in this study as the optimum time required to eliminate all highway deficiencies in Indiana. The annual average cost for a 15-year program to bring all of the highways and streets of Indiana to adequacy is estimated to be:

Interstate System	\$ 85 million
State Primary, Secondary, and Urban Systems	\$156 million
All county roads	\$ 66 million
All city streets (except state urban highways)	\$ 43 million
	<hr/>
Total average annual cost for 15 years	\$350 million

Finance

The ability of Indiana to bring its highways to an adequate status is dependent upon the money available. Funds are available from three sources - the Motor Vehicle Highway Account, which derives its monies from motor fuel taxes and license and registration fees; local monies derived from property taxation; and Federal Aid (75).

Highway funds are spent for three essential highway functions- construction, maintenance, and administration. Expenditures for the state systems have been primarily for construction, and the expenditures for county roads and city streets have been primarily for maintenance.

Since 1939 costs of highway work have risen because of economic conditions. According to the highway construction cost index developed by the Bureau of Public Roads and published periodically in numerous technical magazines, the 1955 highway dollar purchased only 79 percent as much as in 1946 and only about half as much as it did in 1932.

Other conditions of major importance affect the cost of highway construction. Standards of highway construction have risen, and it is probable that they will continue to rise. Protection of the highway investment through adequate limited access will have a pronounced influence on preventing functional obsolescence and is economically sound but it will also increase the initial cost.

The general trend in highway finance is for the highway user, through vehicle and motor fuel taxes, to provide increasing amounts of revenue for highway construction and maintenance. In 1955 and excluding Federal Aid, the highway user provided nearly 86 percent of the monies available for use in highway construction and maintenance programs in Indiana (64).

The passage of the Federal Aid Act of 1956 and the increase in state motor fuel taxes early in 1957 will result in more dollars for highway construction and maintenance in Indiana. The projection of all highway revenues, to be expected from fiscal policies in effect in 1957, however, indicates that sufficient funds will not be available to eliminate all of the inadequacies of the highways of Indiana within 15-years.

RECOMMENDATIONS

As a result of this study of the highways of Indiana, the following recommendations relative to the highways in Indiana are made:

1. State, county and city highways should be classified on a functional basis. Initial classification will be necessary for most city and county highways inasmuch as most of these jurisdictions have never completely grouped their highways into systems. In most jurisdictions where all highways have been classified, a reclassification is necessary. The end result should be an integrated network of state, county, and city highways. Desirable mileage limitations should be established for major classifications and authorization to change the classification of a road as conditions warrant should be based on established criteria.
2. Minimum design standards for new highway facilities should be adopted by all governmental units responsible for highway construction. They should be based on the best engineering practice with a consideration of economics and be compatible with the traffic and safety requirements of each highway system.
3. The present limited access law should be applied vigorously where applicable to protect major state highways from the strangulation of uncontrolled roadside development.

4. The highway planning and traffic engineering activities of the State Highway Department should be integrated and expanded.
5. A program for developing effective city-county-state relations should be encouraged to facilitate the planning, construction, and operation of all highways in Indiana.
6. Most of the cities of Indiana should secure relief from many of their traffic problems through the application of the principles of traffic engineering. Additional qualified personnel and adequate budgets are required in this area. The smaller cities should investigate the possibility of securing the part-time services of an experienced traffic engineer to assist them.
7. The services of engineering personnel are badly needed in the counties to plan, construct, operate, and maintain their highway systems. Especially needed for county roads is adequate route marking and the better use of traffic signs and markings to improve service and safety.
8. The aggressive highway safety education program in Indiana should be continued and expanded to include more emphasis on the local level. Driver education programs should be expanded to include all high schools.

9. Many cities should study their traffic laws and bring them into agreement with the Model Traffic ordinances and state regulations.

10. Each county and city should initiate and maintain an accident record system according to uniform procedures. These records should then be analyzed and used to develop a local accident reduction program.

11. Each governmental unit in Indiana should prepare a long-range plan for highway modernization. The program should utilize a sound method for establishing priorities of construction.

12. A fiscal policy that will provide adequate funds to successfully complete the authorized long-range plan should be studied and agreed to by each governmental unit.

13. An inventory of highway conditions should be maintained in a current status by the State Highway Department and the counties and cities of Indiana.

INTRODUCTION

Background Information

The way of life in America has been changed significantly by the development of the automobile and by the improvement of the road and street systems. The nation, as well as every state, city, and village, has felt the impact of highway transportation. Fifty years ago horse-drawn vehicles were symbols of highway transportation, and community life was centered around the general store, the church, and the little red school house. Each community, in a sense, was separate and isolated from its neighbor.

Fifty years ago highway motor vehicles were a curiosity and a luxury, and the roads often were impassable. In 1906 Indiana had about one motor vehicle for every 1000 residents while in 1956 this ratio had increased to nearly one vehicle for every two residents. Indiana had only a few miles of all-weather roads in 1906. By 1956 over 90 percent of the road mileage was in this classification, but a large percentage of this mileage was inadequate for present and future traffic (36).

The inadequacy of the Indiana Highway System today is the result of four basic factors: 1) increased acceptance and use of the motor vehicle; 2) higher standards of highway construction required for the present motor vehicle; 3) failure to provide the necessary funds for construction, reconstruction, and maintenance; and 4) the decreased purchasing power of the dollar. World War II contributed significantly to the present inadequacies by interrupting the production of better roads. Construction and maintenance during the War met minimum needs

or was deferred altogether. Since the War, Indiana has not been able to meet the increasing demand for adequate highways. This delay has produced a backlog of deficiencies which can only be corrected by an extensive highway construction program during the next several years.

This study was initiated in late 1954 as a cooperative activity between the Joint Highway Research Project of Purdue University and the State Highway Department of Indiana.

Inventory data for the entire state administered system was collected by the Highway Department early in 1955 as a project of the Highway Planning Survey. Each of the six State Highway districts assumed responsibility for the collection of data in their respective areas.

Research information from the Highway Research Board, the Bureau of Public Roads, the American Association of State Highway Officials, and the Automotive Safety Foundation contributed to the study. The tabulation, review, and analysis of the information collected from the several sources, as well as the preparation of this report, were performed by research engineers and other personnel of the Joint Highway Research Project, Engineering Experiment Station, Purdue University.

Certain preliminary results of this study were released in late 1956 to the Indiana Highway Study Commission of the Indiana Legislature as information for the 1957 Indiana General Assembly.

Scope of Study

The engineering analysis for this study included several phases and is outlined as follows:

1. A historical review of highway transportation in Indiana was made. It included studies of road and street development and of the financial and economic progress of the highway system.
2. A study was made of travel trends, road use, and service of the various systems of highway in Indiana. Population and motor vehicle registration growth were studied along with increases in motor fuel consumption, and estimates of future travel were made.
3. Tolerable and design standards were developed and used to measure the adequacy of existing facilities and to determine cost data. A study was also made to determine the adequacy and cost of maintenance.
4. A survey of current traffic engineering practices was made in several areas of Indiana to determine their effectiveness and adaptation to present facilities.
5. A study of highway safety and the causes of accidents was made to determine their relationships to highway deficiencies.
6. An appraisal of the various highway systems of the state was made to determine the cost to correct existing and future deficiencies. Program costs were determined for a 15-year period on the state, county, and city systems.

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Fiscal Study

A comprehensive fiscal study is not included in this report; however, a finance study is necessary to adequately complete a report of present and future highway construction and maintenance needs. The finance study should, in general, be made independently of the physical needs study. It should, however, use facts obtained from the study of highway needs to determine total fiscal requirements.

Chapter I

ECONOMIC SERVICES

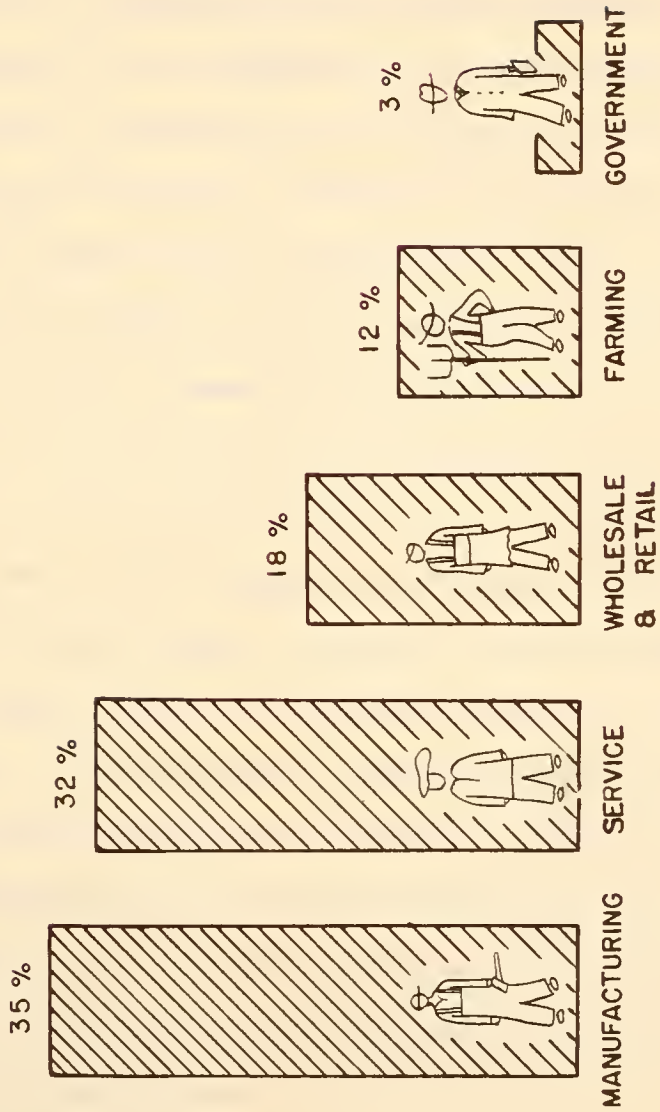
Basic Reasons for Motor Vehicle Transportation

For Indiana to develop in an orderly manner as a significant commercial, agricultural, and industrial state, an adequate and efficient system of transportation must be available. This system must provide for movement of goods and persons and for integration of all communities with the economy. The role of transportation has been so obvious in the creation of Indiana's wealth that its importance has been overlooked. For any community to progress beyond a subsistence economy, effective transportation is essential. For example, if a farmer or manufacturer were unable to send his products to market for consumption by others, there would be little reason for producing more than could be consumed in the local community. Low-cost, mass production techniques would not be important if products and services were not available to the millions of people desiring them; furthermore, decentralization of industry would be difficult and improbable. Transportation makes possible the interchange of goods and services, opens markets to the Indiana producer in broad areas, makes products from distant locations available to the Indiana consumer, and has a significant effect on employment.

The influence of highways on the economic life of the people, and the dependence of farmers, businessmen, and laborers in every corner of the state upon the motor vehicle in their daily activities is certainly an important factor. Furthermore, the economic life of our nation is rapidly becoming dependent on the motor vehicle.

Indiana has always required transportation for commerce, agriculture, and industry and for the daily desire of people to communicate.

INDIANA
EMPLOYMENT PERCENTAGES
BY OCCUPATION



SOURCE: REFERENCE NO. 70

FIGURE 3

In the early years of the nation and Indiana, transportation was primarily over routes that were nothing more than Indian trails. In the early 1800's the construction of the National Road (U. S. 40 today) and canals across the state added to the transportation system. Later the railroad replaced the use of the roads and canals except for local transportation. Highways were not of major importance again until the development of the automobile in the early 1900's.

Since 1900 the role of highways in our economy has grown consistently because the highly flexible, convenient, and adaptable service was furnished by motor vehicle transportation. Most of the early motor vehicles were passenger cars which were soon to replace the horse and buggy in everyday communication among people. As motor vehicles grew in number and importance, use broadened and special types were developed to serve specific purposes. New fields of service such as motor bus and motor truck transportation developed. Since 1920 the growth of the motor truck has been very rapid. The early trucks were of single-unit design, usually on hard-rubber tires, and the payload carried was small. In recent years the number of heavy trailer combinations and the weight per unit have increased at a rapid rate. Furthermore, the ton-miles of cargo carried by them has increased. Today, highway transportation is a great industry carrying nearly one-fifth of the ton-miles of intercity freight and about nine-tenths of the intercity passenger transportation (5)*.

A recent survey made in Indianapolis indicated that approximately 70 percent of the freight moved in and out of that city by highway transportation (55). Furthermore, it is estimated that approximately 90 percent of all intercity passenger transportation to and from

* Numbers in parentheses refer to bibliography.



Many commercial vehicle types operate on Indiana highways.

Figure 4



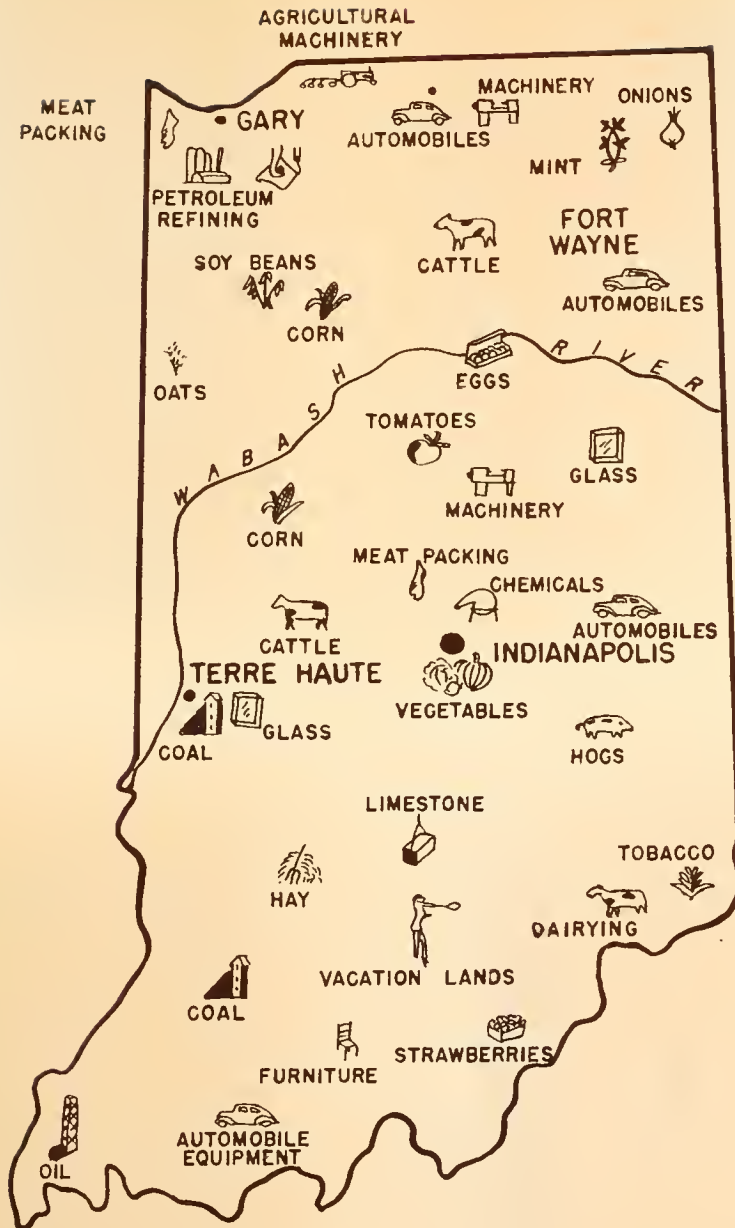
Indianapolis was by private auto and bus, with 85 percent of the total by private auto.

Economic Impact of Motor Vehicle Use

Highways produce great benefits to agriculture, industry, education, and national defense. It is very difficult, however, to measure the exact influence of highway transportation on the state and national economy. Many observations show the striking changes which the transporting of persons and goods has produced on our everyday living habits. The accompanying map of Indiana illustrates some of the products and commodities produced in different areas of the state. As can be readily noted, Indiana produces many varied and valuable products of agriculture and industry, and all are available to every citizen of the state because of effective highway transportation.

Indiana is known as "The Crossroads of America," and the motto is very appropriate. The state's strategic location on national north-south and east-west routes requires that its highways be adequate for Indiana's benefit and for the benefit of the entire mid-west and nation. The Great Lakes on the north, the mountainous regions on the south, the large centers of population on the east, and the vast agricultural areas of the west cause much of the cross-country traffic to be channeled through Indiana. During the summer of 1956, a survey indicated that over 40 percent of the passenger cars on the state's primary rural highways were non-Indiana vehicles (51).

Importance of highways to Hoosiers is also shown by the fact that in 1955 there were approximately 1.5 million passenger cars and 300,000



LOCATION OF LEADING PRODUCTS & INDUSTRIES
IN INDIANA

SOURCE: REFERENCE NO. 21

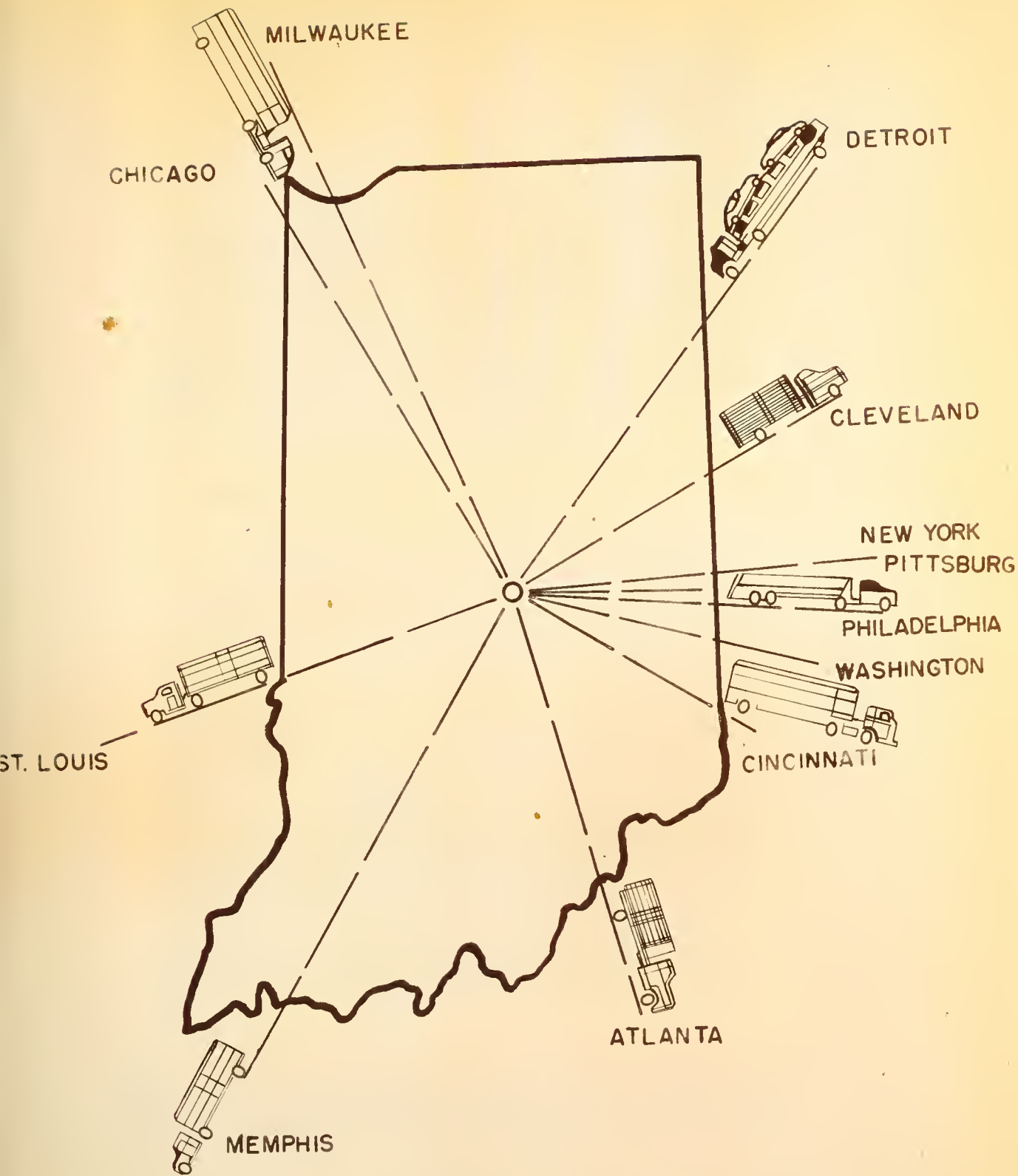
FIGURE 5



Steel, gasoline, or ice cream; no matter what the commodity may be, it is often shipped by truck.

Figure 6





INDIANA IS KNOWN AS THE CROSSROADS OF AMERICA

FIGURE 7



There are more than twice as many trucks in use in Indiana today as there were in 1940. Truck-trailer combinations haul 75% of the ton-miles of all trucks.

Figure 8

trucks registered in Indiana (70). Excluding drivers of farm trucks, there were about 325,000 people employed in highway transportation industries (55). Furthermore, the trucking industry was responsible for about one out of every six paychecks. In about one-half of the state's towns and villages, highways provide the only means of freight transportation used. It was also found that all of the 899 postoffices in Indiana use highway transportation and over 500 of them are serviced only by highways (55).

Agriculture

Indiana is an important agricultural state. About 85 percent of the land area is used for farming and over 20 percent of the population of Indiana lives on farms. Since more than one-fourth of all trucks registered in the state are farm-trucks, it can be readily seen that farmers rely heavily upon highway transportation for the movement of supplies and products from farm to market (21).

Indiana is among the four leading corn producing states of the country, and has a yield per acre about 40 percent higher than the national average. Although this crop grows all over the state, it grows best in the central region. Wheat is the second most important crop in terms of acreage with hay and oats ranking next. These crops are used mainly for feed and a large portion of them are shipped over the highways to market in many of the larger cities of the state and the nation.

Fruits and vegetables are also extensively grown. About one-tenth of the tomatoes grown in the United States comes from the fields of Indiana. Large crops of potatoes are grown in the drained lowlands

of northern Indiana. The rich muck soil of that region often produces over 600 bushels of potatoes per acre. Other crops of that area are onions, peas, cabbage, and celery. In 1955, trucks hauled about 94 percent of all fresh fruits and vegetables that moved out of Indiana (55).

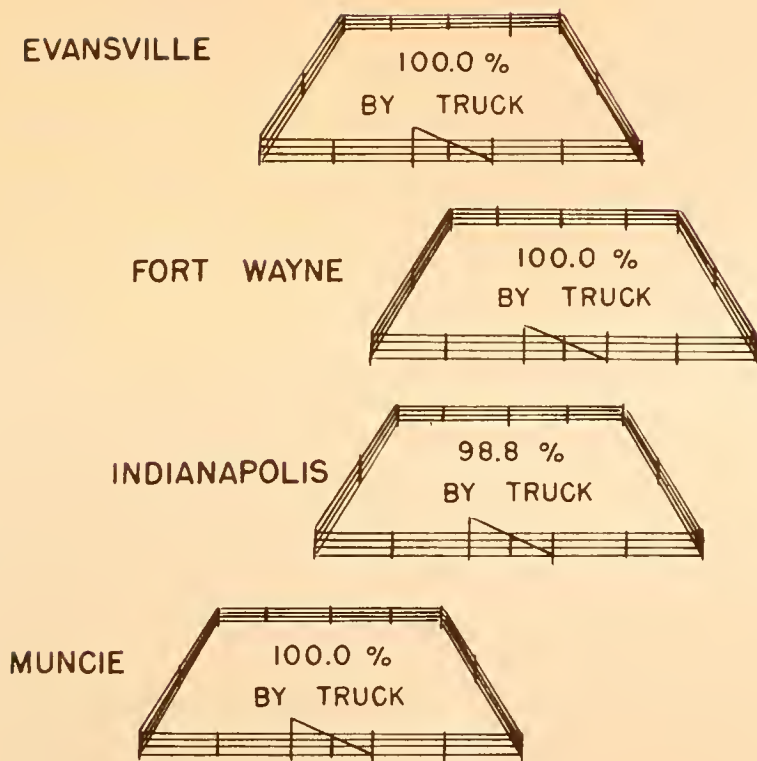
Livestock marketing produced well over one-third of the total farm income in the state during 1955 with hogs ranking first in production and cattle second. Every year thousands of calves are snipped from western and southern states to be fattened on Indiana farms - a difficult feat to accomplish without truck transportation.

In 1955 almost 100 percent of all livestock shipped to the four major markets of Evansville, Fort Wayne, Indianapolis, and Muncie was by truck (55). There is also an ever increasing demand for trucks to ship livestock to markets outside of Indiana and to ship dairy products within and out of the state.

Industry

For more than 30 years manufacturing in the United States has been decentralizing. Although each factory is normally not self sufficient, the requirements of industry have been accomplished by new techniques of mass production and transportation. This industrial reliance upon many separate organizations for supply can be readily illustrated by the manufacture of automobiles. A single automotive company may depend upon many plants to supply it with parts and materials. To keep its supply lines running continuously with maximum economy, highway transportation is an absolute necessity.

Although Indiana is primarily known as an agricultural state, its industries have national prominence. Probably the most important in the state today is the production of steel, in which Indiana ranks fourth



IN 1955 ALMOST 100 PERCENT OF ALL LIVESTOCK SHIPPED TO INDIANA'S FOUR MAJOR LIVESTOCK MARKETS MOVED BY TRUCK

FIGURE 9

in the nation. This industry is centered in the Calumet region, with the world's largest steel plant in the Gary area (21). In nearby Whiting is located one of the world's largest oil refineries where crude oil is transformed into various refined petroleum products, which are often shipped by truck to various areas of the mid-west (21).

Although not widely publicized, Indiana ranks second among all states in automotive products manufacturing (21). Factories in such cities as Indianapolis, South Bend, Anderson, Muncie, and Evansville produce automotive parts and tools and airplane engines and parts. Surveys made at factories in each of these cities indicated that over 90 percent of the goods entering and leaving were carried by highway transportation (55). Many of the state's other industries such as the manufacture of machinery, furniture, pharmaceuticals, and pottery are also dependent upon highway transportation for their existence.

Education, Safety, Defense, and Recreation

The benefits derived from highway transportation are so vast and varied that they are beyond objective measure. In addition to the uses made of the highway system in Indiana's industrial and agricultural and agricultural economy, a great amount of travel is for education.

Because of the school bus, there is no longer a need for the old-fashioned, one-room school house. Today, many of these schools of the past have been consolidated into fewer and better institutions that are capable of giving children the proper education needed to prepare them for the world of tomorrow. The extent of the Hoosier's reliance upon highway transportation for education is illustrated by the fact that in 1953 there were 6,248 school buses registered in Indiana (38).

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In addition to the highway's contribution to industry and agriculture, a great amount of travel is for recreation and education.

Figure 10



Highways are indispensable during local emergencies for the movement of police and fire fighting equipment.

Figure 11



High standards of sanitation would be almost impossible to maintain without street and highway networks.

Figure 12

On a national basis it has been estimated that approximately 25 percent of the public school students are carried by this form of transportation (38).

During local emergencies the highways are of paramount importance. Their function in expediting the movement of police, fire-fighting equipment, and other community services is invaluable. When speaking of emergencies, one must consider them on a national as well as local level. National defense cannot be maintained without adequate highway facilities. The federal and state governments have realized this dependence and have designated a large mileage of integrated highways to be used for defense in case of enemy attack.

The convenience of highway transportation for recreational purposes cannot be overlooked. Approximately 70 percent of the trips exceeding 100 miles in length made in the United States in 1955 were by automobile (38). Many of these were for vacations and have caused our highways to be crowded with vacationing tourists, especially during the summer months. On a nationwide basis, it has been found that nearly 85 percent of all vacations by families are by private car (38).

Highway Transportation and Cities

Many cities, towns, and villages in Indiana are completely dependent on buses and trucks for transportation communication with the rest of the State. Within cities, particularly larger ones, dependence on the motor vehicle for transportation is increasing. This increase is directly attributable to the advantages afforded by motor vehicles and the desire of people to use them. It is no longer necessary for people to live within walking distance of their jobs or the downtown shopping districts. Many do not live near routes of mass transportation service.

These conditions are responsible in turn for certain urban travel trends which have been evident for the past 20 years and which continue to gain momentum. Among these are the location of residential developments and industrial plants in the suburban areas, the establishment of shopping centers in outlying locations, and the growing congestion of street traffic in the central business districts. These trends are making it increasingly desirable to live in the suburbs where the environment is more conducive to a healthful and relaxed way of life. People are no longer willing to sacrifice comfort and privacy for the convenience of being located near the congested business district or the place they work. The automobile and the modern highway make these destinations accessible from distant locations.

If Indiana's economy is to keep pace with the desires and energies of its progressive population, highway transportation, properly integrated with other modes of transportation, is necessary. Highways, however, can only provide adequate transportation when they are in adequate quantity and condition.



Often a vacation cottage-on-wheels, the house trailer usually serves as a year-around home, especially in fast-growing communities.

Figure 13



Downtown congestion and lack of parking facilities have made drive-in enterprises and suburban shopping centers very desirable.

Figure 14

[Redacted text block]

[Redacted text block]

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With the trend toward decentralization of industry, most industrial workers go to and from the job in their cars.

Figure 15

Chapter II

HIGHWAY TRAVEL

History of Road Building

An absolutely essential step in determining highway construction and maintenance needs and developing adequate long-range plans is the study and analysis of highway travel trends. Present and past conditions must be used, in most cases, as a basis for the prediction of future conditions. An analysis of the many factors which affect the movement of highway traffic was performed in this study. Such factors as the development of the road system, characteristics of highway travel, population growth, motor vehicle registration, and motor vehicle fuel consumption, have a direct relationship to the complex highway problem facing Indiana today:

Although roads were developed slowly, they were recognized early as a necessity in community life. Many of the pioneer families of Indiana established homesteads in the triangular pocket of southwestern Indiana, an area bounded by the Wabash and Ohio Rivers. Immediately these pioneers began cutting crude roads from their homesteads to the river landings in order to move their supplies to water transportation. Flatboats were waiting to transport the settlers' produce on the Ohio and Mississippi to ready markets at New Orleans.

As early as 1806 Congress enacted legislation authorizing the building of a highway from Cumberland, Maryland, westward to Illinois (45). The route through Indiana was from Richmond via Indianapolis to Terre Haute. Meanwhile Indiana was engaged in an ambitious program of "Internal Improvements", estimated to cost, when finished, more than ten million dollars (13). Construction was started on a state road from Madison to Indianapolis, and thence to Lake Michigan (13).

In addition to building roads, the program of "Internal Improvements" called for the construction of a system of canals to provide cheap water transportation for farm crops and for the products of mines and factories of the state. The Central Canal, started in 1832, was intended to connect the Wabash-Erie Canal with Indianapolis and Evansville. Feeder roads were built to the barge landings along the canals, opening up the farming regions and further increasing the population and wealth of the state. Later when railroads came, the slow moving canal boats could not compete favorably with this mode of overland transportation, and most canals were abandoned. Local roads became more useful than ever with the coming of the railroads. Then, as now, a large part of all the freight carried by the railroads had to be collected and distributed by vehicles using the highways.

With the development of the automobile, good roads became more important to the transport-conscious people of Indiana. Smoother and better roads were required than those that had been adequate for horse-drawn vehicles. Township and county roads were graded and resurfaced with gravel or crushed stone. Many miles of city streets were paved.

Motor traffic in Indiana and the nation had reached such proportion by 1917 that the financial burden and responsibility of building and maintaining a connected system of intercity main highways was too much for local townships and county governments to bear. It was in 1916 that the Congress of the United States, recognizing a national responsibility for roads, enacted the first Federal Aid Highway Act, which allocated funds to each state contingent on their administration by a recognized State Highway Department (13).

Development of Road Building Agencies

Indiana quickly responded to the demands of the people for better highways. Action by the General Assemblies of 1917 and 1919 resulted in the creation of a State Highway Commission. The Highway Commission, in its formulative period of 1919 and 1920, was given the task, with the co-operation of the Federal Government, to provide in the shortest period of time a system of highways that would connect county seats and other cities of 5000 people or more (13). State funds and federal grants-in-aid provided for the improvement of this system. In 1923 the motor fuel tax was enacted - the initiation of the trend in Indiana that the highways should be supported by the users (13).

Since its inception the Highway Commission has built thousands of miles of roadways. The existing State Rural System is comprised of 10,600 miles of bituminous and portland cement concrete pavements and 65 miles of gravel or crushed stone surfaces.

There are now approximately 76,000 miles of local rural roads which are the responsibility of the counties (52). Over 15,500 miles have dustless surfaces; 50,500 miles of this system have gravel or stone surfaces; and 10,000 miles have unimproved surfaces (52). In 1955 about 8,500 miles of the total mileage (11,200 miles) in the city street system were paved (40). Nearly 2,000 miles have gravel or crushed stone surfaces and 700 miles have earth or unimproved surfaces (40).

Characteristics of Highway Travel

The traffic on Indiana's roadways includes many types of vehicles. At any given time these vehicles are making trips to particular destinations from various origins for specific purposes. The routes of these

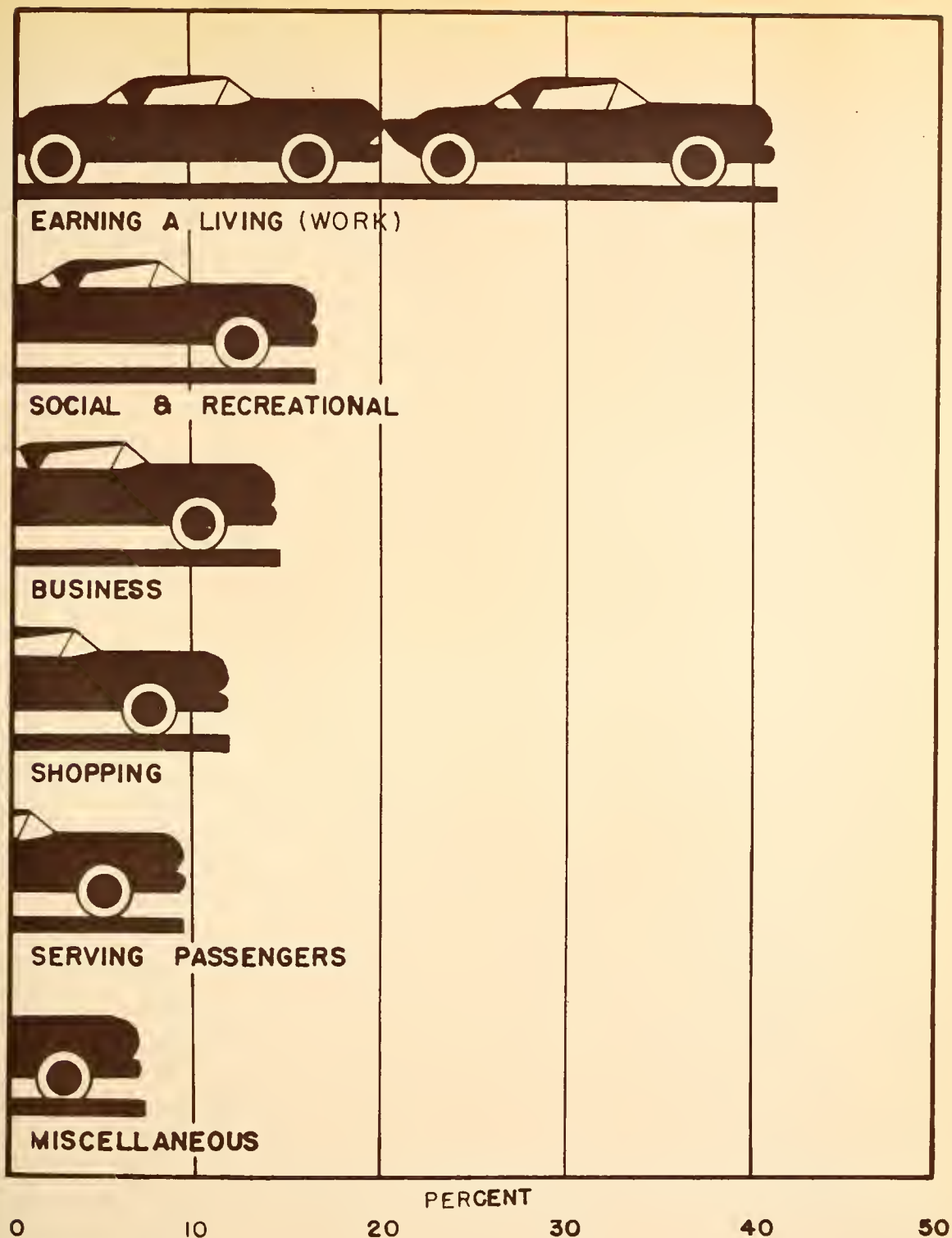
trips often utilize roads of several different classifications and types. The resulting distribution of travel produces traffic streams which vary in volume and composition at different times and on different sections of highways and systems of highways. All these characteristics, together with the rate of traffic increase, are factors in determining present and future inadequacies.

The reasons why people make trips indicate why they own motor cars and what they expect of their highways. They are indices of the services which the highways should be designed to deliver. The results of studies by various highway agencies show that almost three-fourths of all automobile trips are for essential purposes. About one-fourth of the total number of trips are for social, recreational, and miscellaneous purposes (71).

Motor vehicle trips are usually short. It has been determined by the U. S. Bureau of Public Roads that on a national basis, the average length of all vehicle trips is about eight miles. More than half the trips are under five miles and only about one percent are over 100 miles long (20). Time is an important factor in determining people's travel habits. Concentration of travel depends on the season, the month, the day of the week, and the hour of the day.

Because of weather, vacations, and recreational activities, volume is highest in Indiana during the warmer months, April to October. August is the month of peak seasonal traffic volume while January is the low volume month.

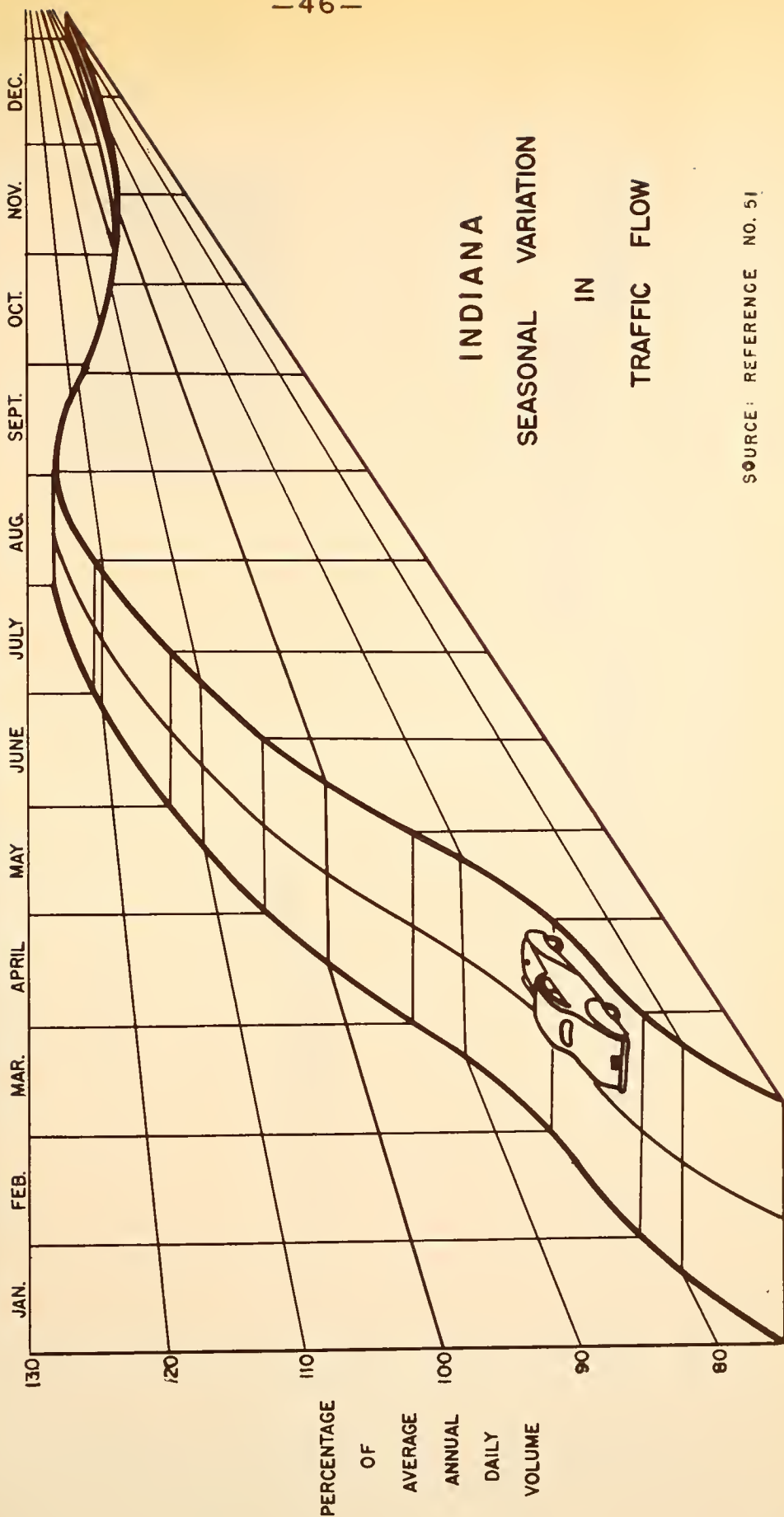
On the basis of days of the week, Saturday is the highest traffic day on all three types of highways considered - state roads, county roads, and city streets. Travel on Sunday is close behind on both state and county roads but is far below the weekday average on city streets



SOURCE: REFERENCE NO. 71

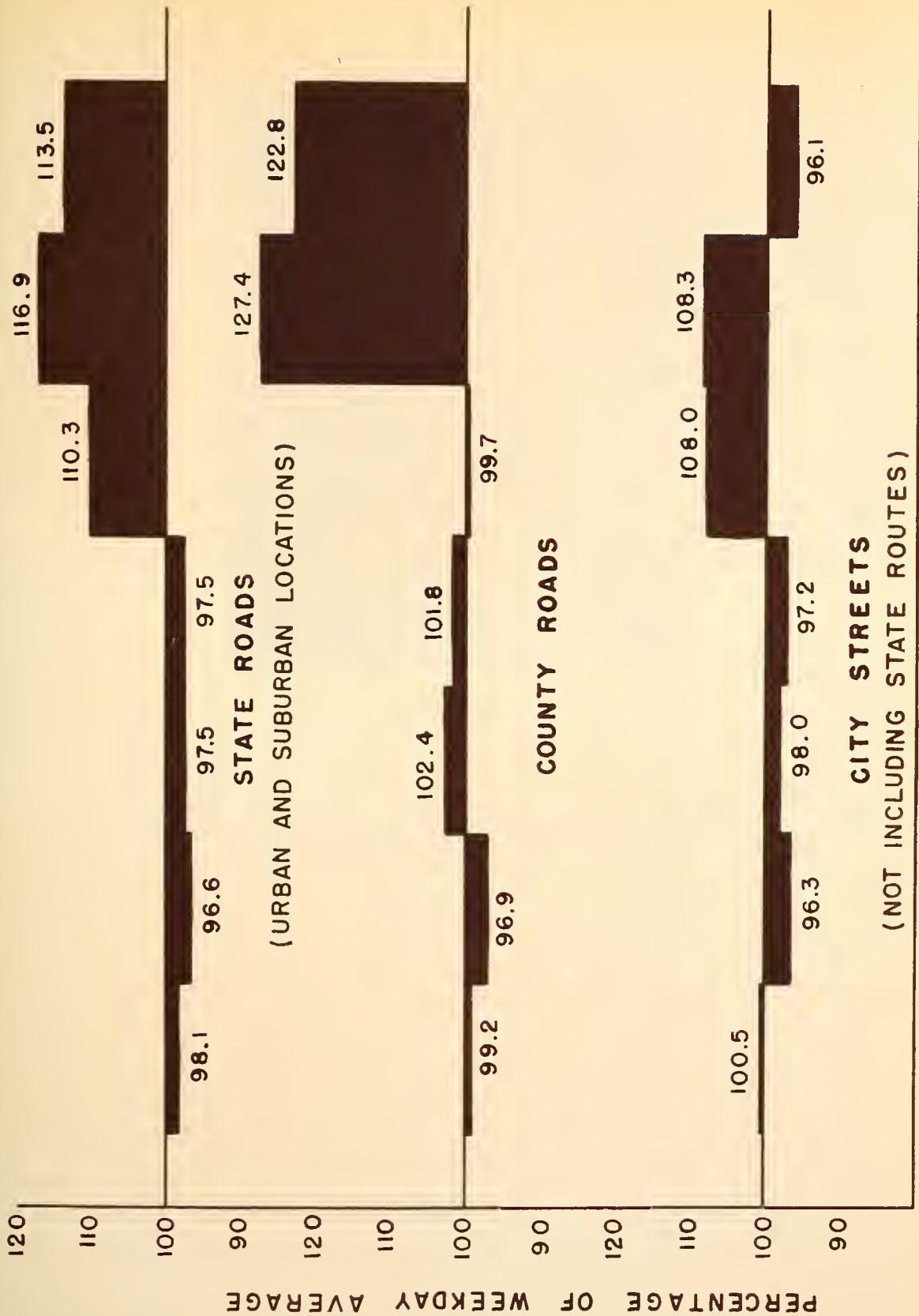
HOW PASSENGER CARS ARE USED

FIGURE 16



SOURCE: REFERENCE NO. 51

FIGURE 17

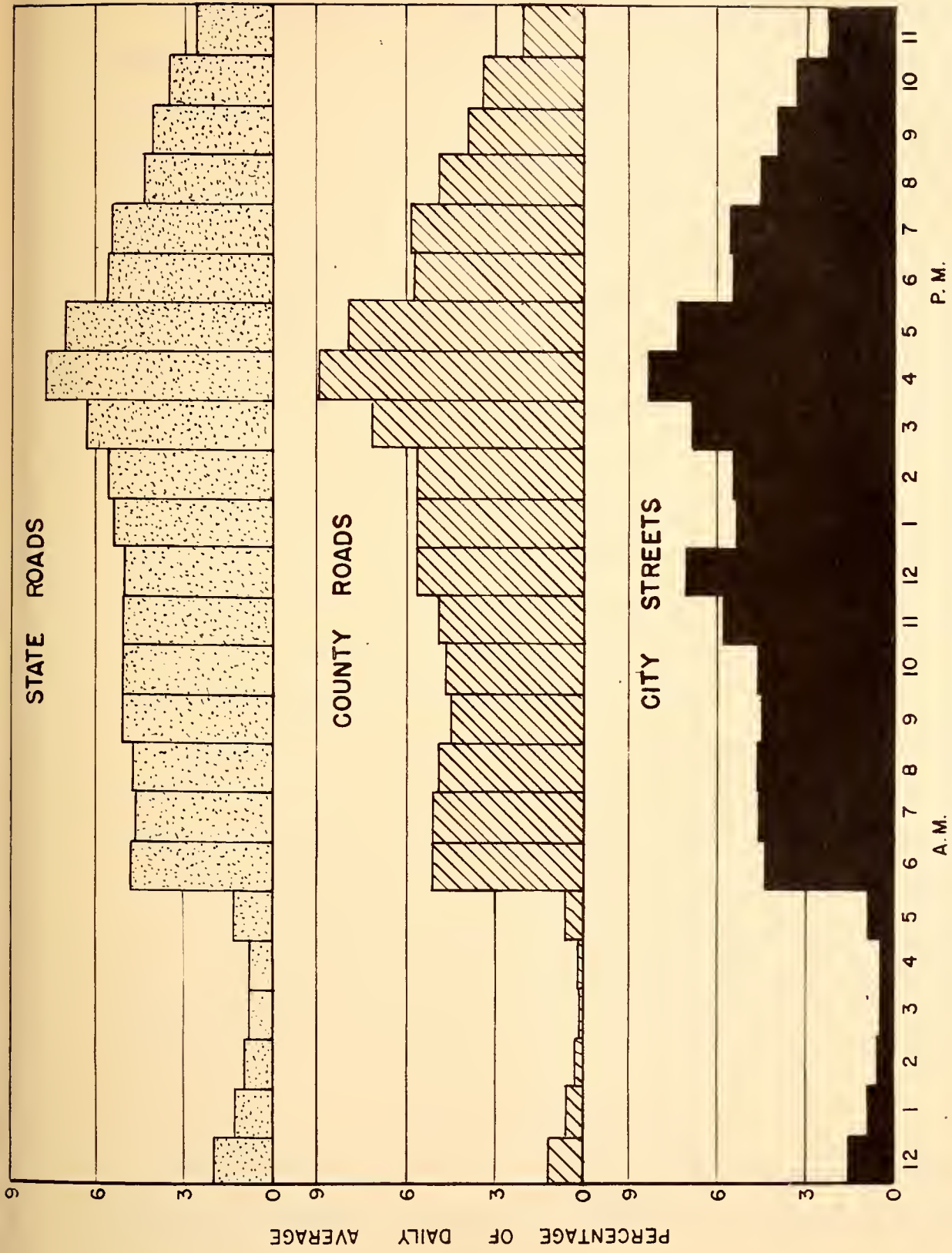


INDIANA
DAILY VARIATIONS IN TRAFFIC FLOW
FIGURE 18



In urban areas peak traffic volume is reached during the 4 to 6 P.M. homeward bound rush hour.

Figure 19



INDIANA
HOURLY VARIATIONS IN TRAFFIC FLOW

FIGURE 20

SOURCE: REFERENCE NO. 51

where Friday is the second highest.

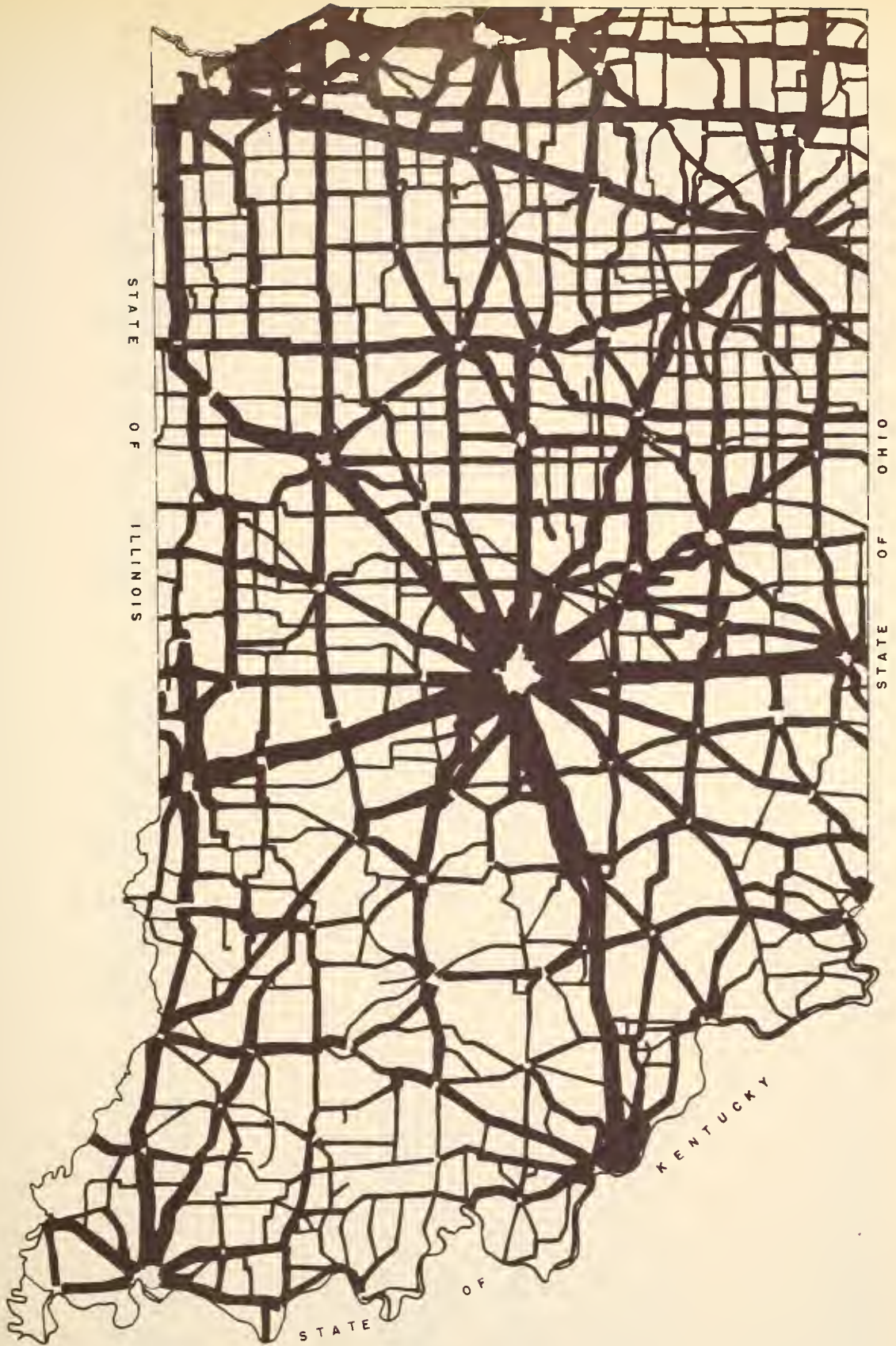
Hourly variations in traffic volumes during the day are much more pronounced than daily or seasonal variations. On city streets less than one-fifth of the total daily travel moves during the ten-hour period between 9 p.m. and 7 a.m. The highest volumes are from 4 p.m. to 6 p.m. when most people are returning home from work (51). During that period traffic is as much as 68 percent above the average hourly volume and 16 times higher than the minimum early morning hour volume (51). Information regarding variations of traffic volume caused by these and other factors is vitally important in determining the expected traffic loads on all classes of highway.

Indiana's roads and streets form a connected system which provides routes to all parts of the state and adjoining states. Travel between the different origins and destinations produces various amounts of traffic on the several classes of roadway into which the system is divided, and in the several geographical areas of the state.

A very large proportion of the rural travel is carried by a comparatively small part of Indiana's rural road mileage. The state-maintained rural and urban highway system of 10,600 miles, representing 11 percent of the State's total road mileage, carries about 67.5 percent of the total travel in the State. Only 17.5 percent of the total travel occurs on the County Road System of 76,000 miles, which represents approximately 71 percent of the total mileage (40).

Present and Future Travel

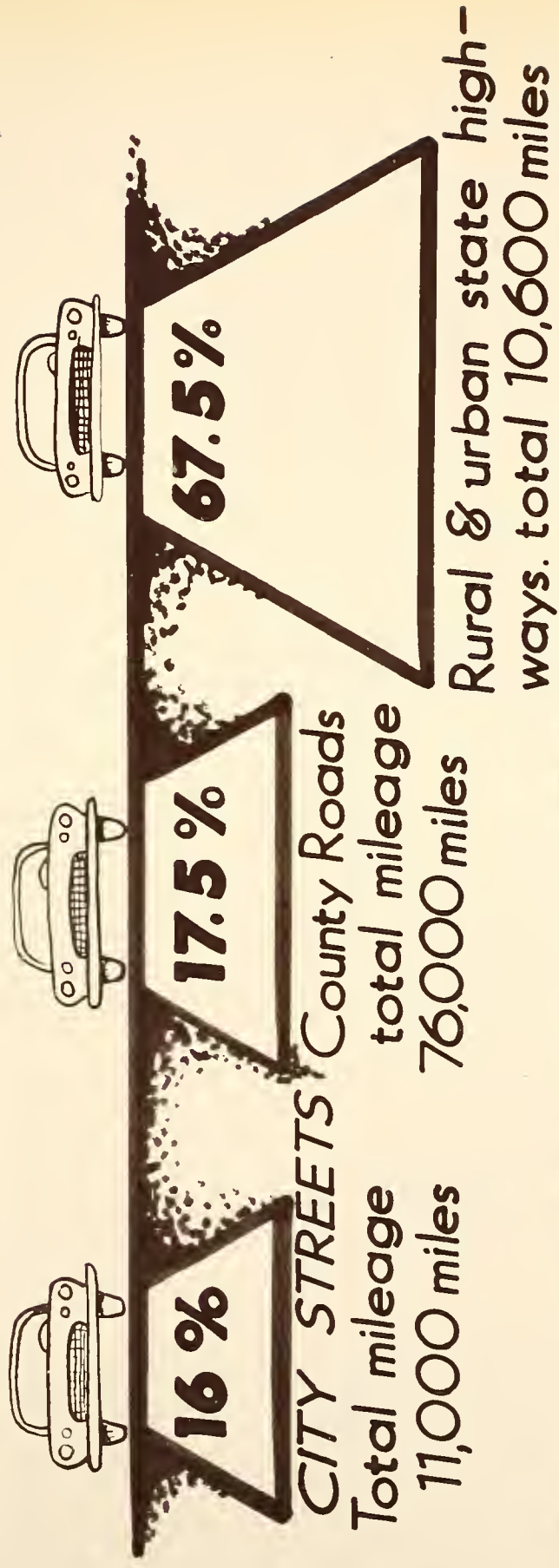
The magnitude of the total traffic movement in Indiana is determined by three factors: population, density of motor vehicle ownership,



FLOW OF TRAFFIC ON
STATE HIGHWAY SYSTEM.

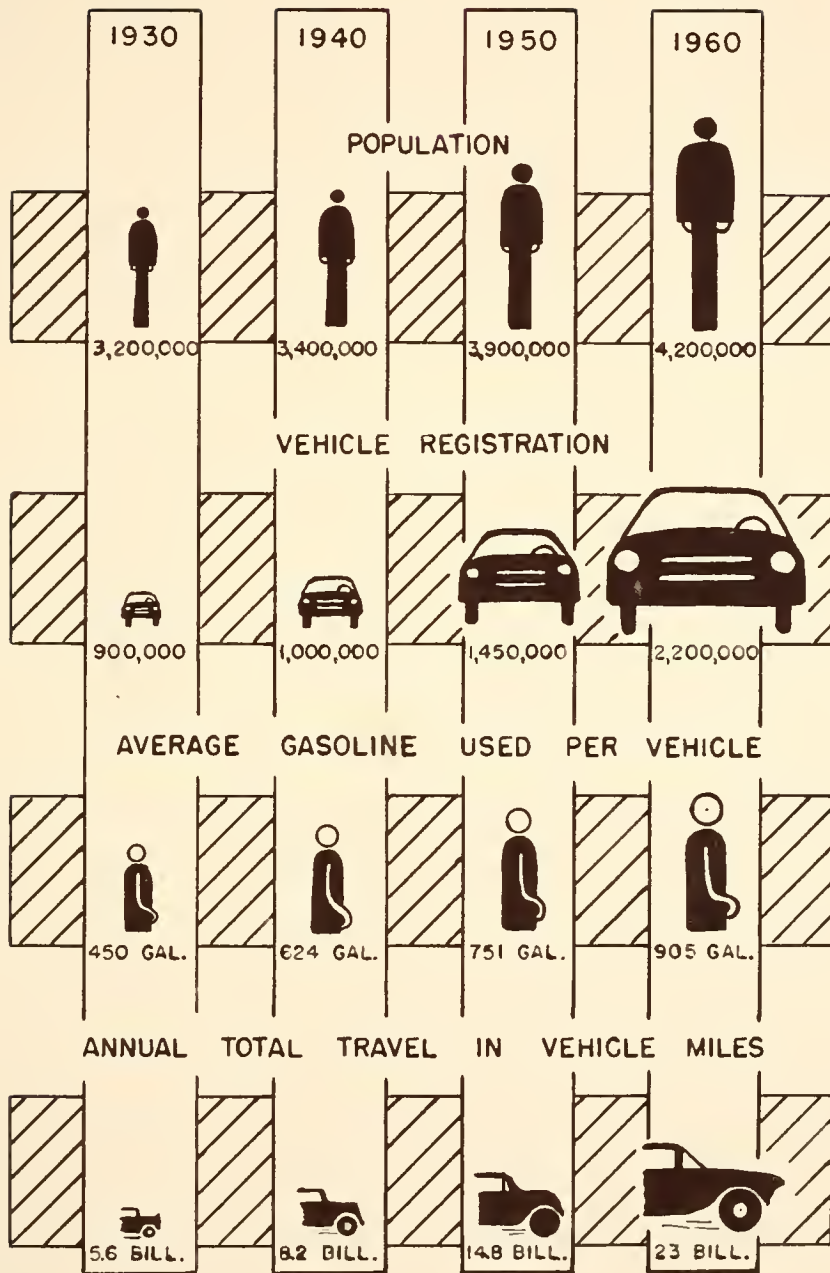
FIGURE 21

WHERE TRAVEL OCCURS



PERCENTAGES OF TOTAL IND. TRAVEL

FIGURE 22



GROWTH OF FACTORS AFFECTING TRAVEL ON INDIANA'S HIGHWAYS

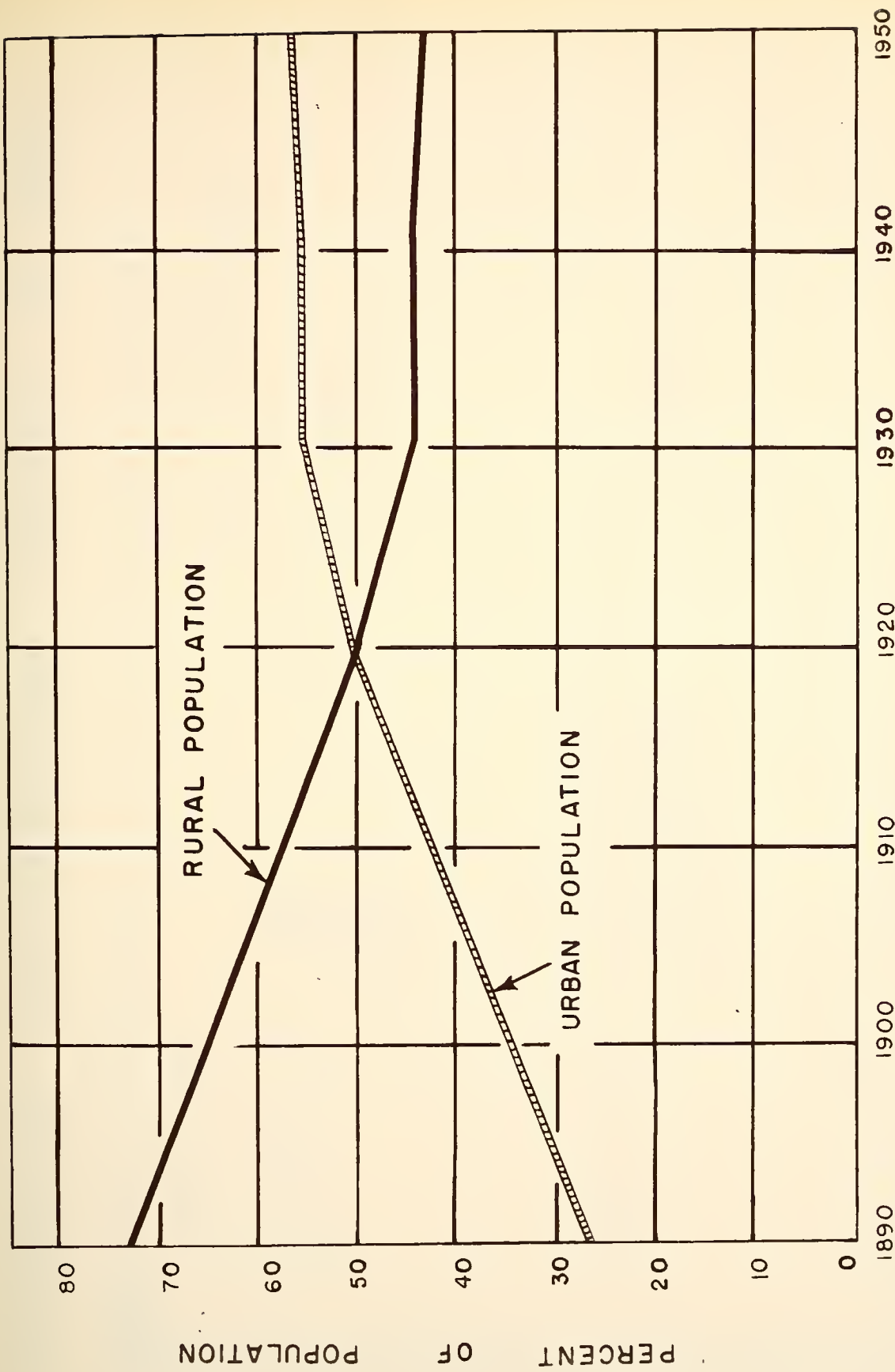
FIGURE 23

and miles driven annually by the average vehicle. As a group, these factors can be used to estimate the total volume of state-wide traffic for any given period.

Analyses of past and present variations in these basic factors reveal trends which can be projected into the future. Such projections or estimates, if soundly made, show how much traffic may be expected in future years, and what highways and streets will be required to serve and accommodate this traffic. For highways, due to the life of highway surfaces, estimates for 20 to 25 years in the future are of particular value.

The 1950 census counted 3,934,224 persons in the state, and it is estimated that the 1975 population will be between 5,200,000 and 5,900,000. Since 1900 the population of the United States has nearly doubled. The population of Indiana has grown somewhat slower, but it is reasonable to assume that the rates of increase of population for Indiana and the United States will have the same general trend during the projected period to 1975. The greatest increase has been in urban areas. Indiana, today, has more than twice as many people as a comparable average area of the United States, but only about 87 percent as many as the East North Central area of the United States (70).

For several reasons- among them the lack of good roads - the ownership of automobiles started rather slowly in Indiana. However, by 1930 the boom of the 20's had increased the number of motor vehicles owned in the state to 875,000. Although there were decreases during the depression and World War II, the upward trend continued and by 1955 Indiana registration was about 1,800,000 vehicles. The number of persons per motor vehicle has been reduced from about 3.7 in 1935 to 2.25 in 1955. For the latter year the comparable ratio in the United States was 2.8.



POPULATION TREND IN INDIANA
FIGURE 24

VEHICLE OWNERSHIP TREND IN IND.

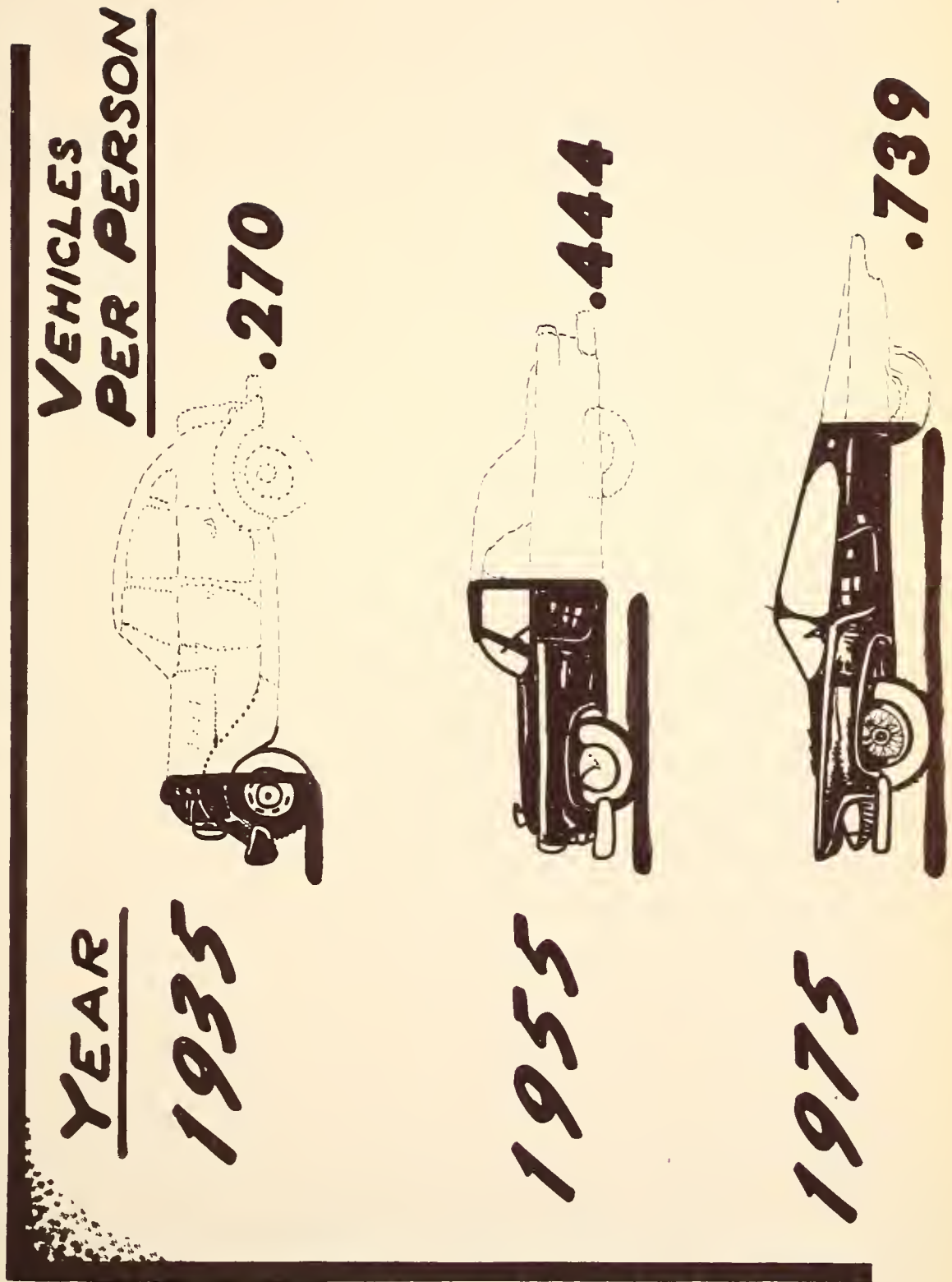


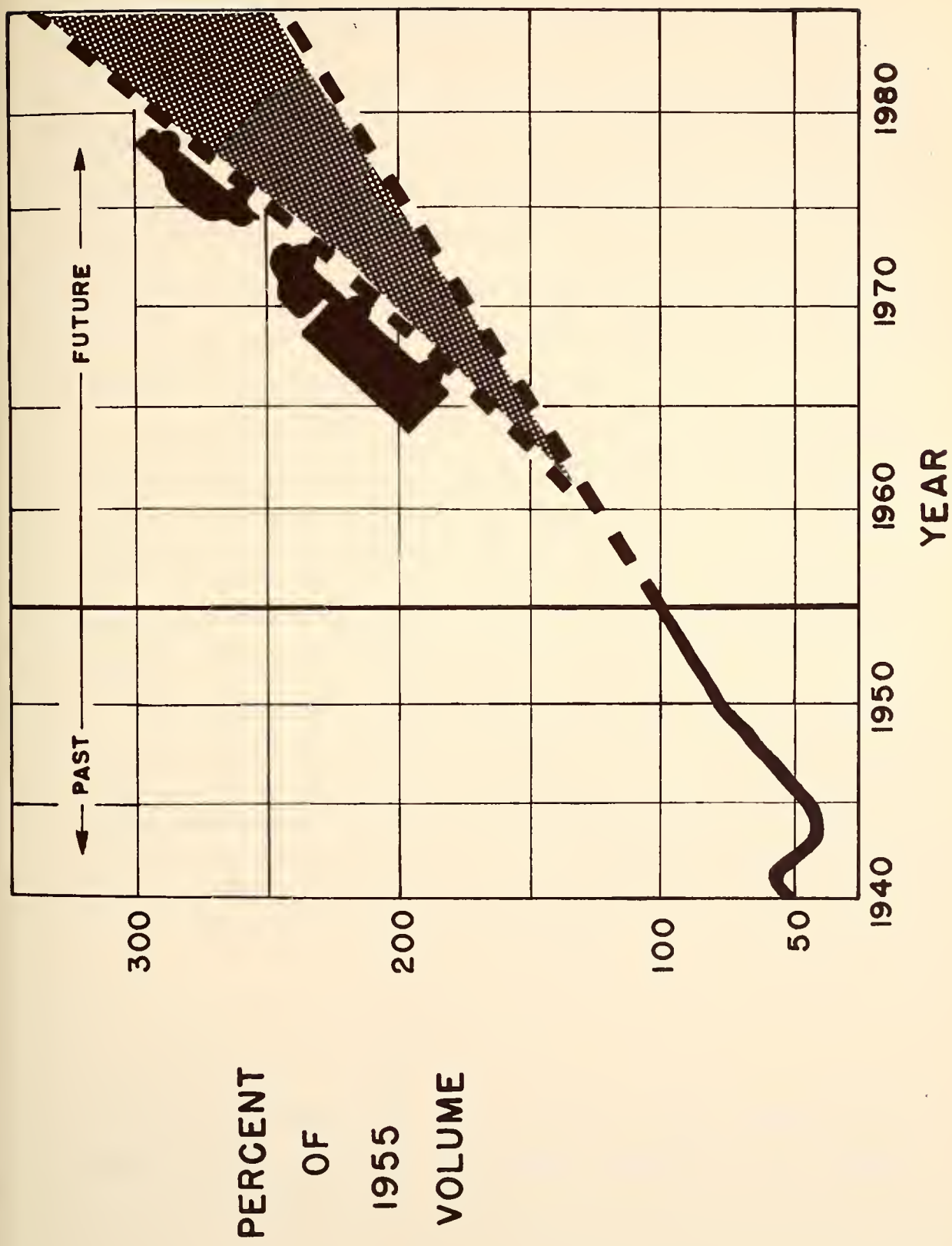
FIGURE 25

In view of the economic progress of Indiana and its people, and on the basis that highways and streets will be further improved, it is predicted that motor vehicle ownership will continue to increase at an accelerating rate for the next 20 years. It is estimated, therefore, that by 1975 the ratio of vehicle ownership will be nearly 1.35 persons per vehicle. This estimate of ownership density indicates that there will be approximately 3,380,000 motor vehicles registered in the state in 1975 or almost double the 1955 total.

The average individual vehicle operator has driven his car or truck an increasing distance each year. Estimates based on analyses of motor vehicle use data and on the motor fuel used annually for highway travel indicate that the average distance traveled by all vehicles was about 10,000 miles in 1955 (20). The data of the last few years indicate, however, that this figure is now nearly constant. The average travel for truck and trailer combinations, however, is increasing. This increasing travel by heavy vehicles is important because the size, weight, and operating characteristics of these units create special traffic conditions and design requirements.

In this study an estimate of traffic was made from 1955 to 1975 for the State Highway System. It was derived from the projection of growth trends as determined from the records of the permanent counting stations in Indiana and is indicated by the lower curve on the accompanying traffic growth chart (74). A projection derived from the three basic factors of traffic generation, - population, vehicle registration, and fuel consumption - gives the upper curve on the traffic growth chart. For the purpose of this study, the lower curve will represent the average growth and the upper will represent the upper limit of growth.

Computations of the projected values for the lower curve indicate that in 1975 total highway traffic in Indiana will be approximately double that of 1955. This estimate foreshadows a tremendous expansion of the traffic load which the highways and streets of Indiana will be required to carry in the years ahead.



GROWTH OF TRAFFIC

FIGURE 26

Chapter III

HIGHWAY CLASSIFICATION

Classification and Its Purposes

Highway classification is of basic importance in the proper development of Indiana's roads and streets. Classification is the process of grouping roads and streets according to the desires and requirements of traffic. Such systematic grouping is essential in dealing with problems of jurisdiction; fiscal responsibility; and the development of construction, and maintenance standards to permit uniform and economical development of an efficient highway system.

Orderly classification of highways results in economic benefits to the highway user. The development of highway classifications, however, is faced with serious problems and handicaps. In many cases highway administrators are not aware of the need of classification, and in many other cases proper classification is hindered by political pressures and lack of understanding and information.

Several factors affecting travel characteristics were previously discussed which cause different patterns of road and street usage. In general various traffic conditions generate different, well-defined patterns of travel which usually can be classified into four groups (59):

- 1) Interstate interest
- 2) State-wide interest
- 3) Community interest
- 4) Local interest

Each group demands a special type of service from the highway because traffic requires that different demands be fulfilled in each case.

Interstate highways must provide an integrated system of roads over the entire United States, because they must provide service of interest to the entire nation as well as to the individual states. Such a system of highways must also provide for special services during national emergencies.

Highways of state-wide interest provide facilities for travel between various areas of the state (59). In many respects the travel requirements on this type of highway will be similar to those on the interstate system. It is rather difficult to make a definite distinction between these two highway types because they provide a similar quality of service. More mileage of such highways will be required than for interstate travel, however, and there is lesser need for integration into a national network.

Highways of community interest are those facilities which handle trips from one part of a community to another part of the same community (59). It includes commuter travel from large cities to rural areas, travel from farm to market and travel from farm to farm in different areas of a community. A community is usually limited to a definite area about the size of a county.

Roads and streets of local interest provide access to land. In the rural area the local system provides access to farms; while in an urban area, it provides access to residential, commercial, or industrial property.

In addition to the primary travel function of the various types of highway, the highway also provides other services (59). For example, a highway of state interest may also provide service to local and community travel. In the cities much of the community travel is

carried on state highway extensions which pass through them.

Highways of community interest also carry much local traffic.

However, each of the basic types of highway described carries traffic which is predominately one of the types of travel. How a highway is predominately used is usually the basic factor in determining highway classification (59). Traffic volume, in itself, is not necessarily a determining factor; however, the volume of traffic and other factors give additional information concerning the predominant use of the highway.

The organization of highways into systems is a relatively simple matter after the classification procedure has been completed. These systems can be assigned fiscal support from the city, county, or state jurisdictional unit depending upon the predominance of traffic interest. Each agency is best suited to handle its own particular financing problems because it best understands the problems and their solution. Standards of design, however, should be selected for each class of highway so as to assure uniform standards of service for all parts of a state.

Existing Systems in Indiana

The more than 98,000 miles of roads and streets in Indiana are divided into three administrative systems - state, county, and city - created by legislative action. There is, however, a sizeable degree of overlapping of functional uses of the highways in these systems, especially on the State Highway System.

State Highways

The legislative power that resulted in the Highway Act of 1919 established the legal framework for the State Highway System. By 1920

nearly 3200 miles of this system had been established (13).

The mileage steadily increased until 1940 and has been on a gradual increase since, amounting to only a few miles each year, since that time. Today the State Highway System is over 10,600 miles in length.

Most of the rapid increase in state highway mileage was caused by the logical demands of greater quantities of traffic wishing to travel more conveniently to different areas of the state. Many miles of the state system are now urban extensions passing through cities, and many by-passes have been constructed around cities in the past 30 years. Many miles were also added because counties desired to be relieved of a road which was a maintenance burden or desired a higher type facility without direct expense to the county. Over the years many miles of highway have been added to the state system which, from a functional standpoint, should not be there. It has been estimated that perhaps as many as 1,000 miles of highway are not required on the present state system; most of these roads primarily carry community-interest traffic.

The Federal Aid Highway Act of 1944 provided for the establishment of an Interstate System of Highways which would connect major centers of population and establish a strategic network of highways for national defense. In 1955 the urban extensions of this system were established, thus completing the network. Indiana is responsible for the construction of 1100 miles of Interstate Highway including urban construction in Indianapolis and the Calumet area.

Federal statutes since 1916 have contributed to the establishment of a rural State Primary and a State Secondary System, along with the urban extensions to these highways throughout the state. The State

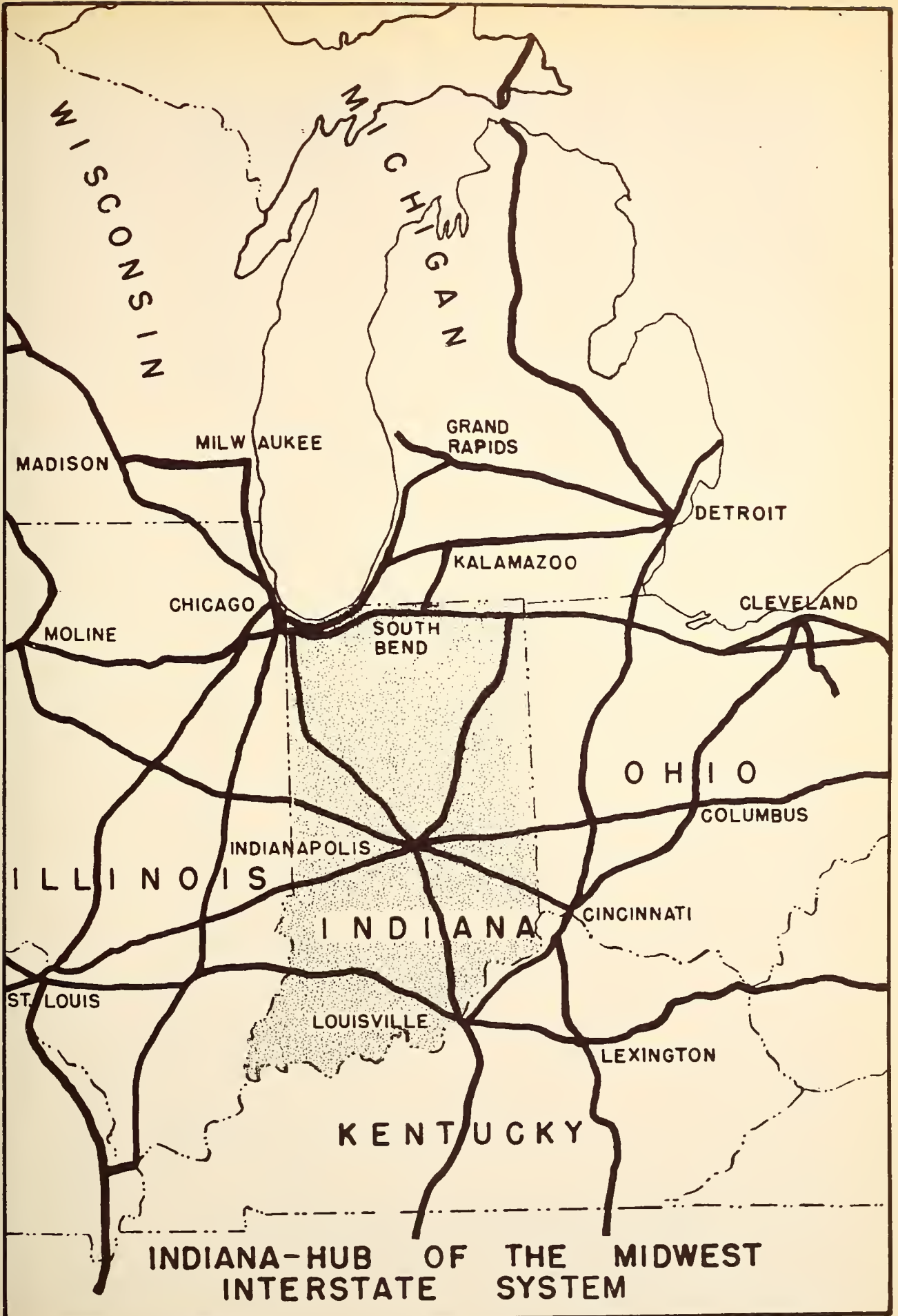
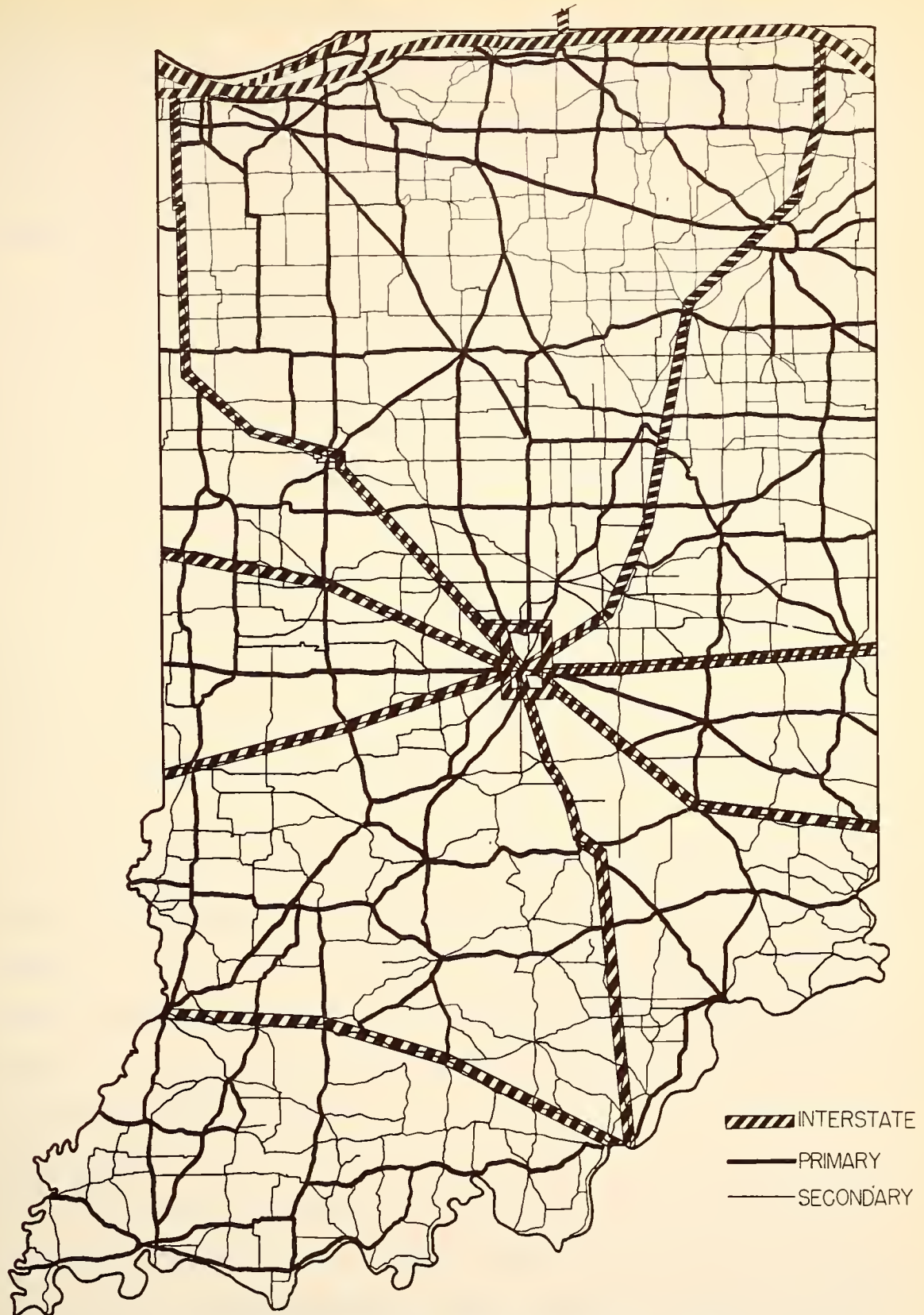


FIGURE 27



INTERSTATE, PRIMARY, AND
SECONDARY SYSTEMS

Primary System* consists of 3600 miles of the more important rural highway routes in the state and the State Secondary System consists of 5400 miles of the less important rural state highways. Urban extensions to the rural systems amount to about 500 miles.

County Roads

In general, no attempt has been made by the counties in Indiana, except Allen, Dubois, and Jay Counties, to classify their roads in terms of functional importance. The 1955 study in Allen County, conducted by the Joint Highway Research Project (7), classified county roads into primary, secondary, and local road systems. This study was performed to outline the procedures so that other counties could solve their road classification problem on an objective and scientific basis.

Very few miles of the 76,400 miles on the county systems carry traffic in excess of 1,000 vehicles per day. Most mileage carries less than 25 vehicles per day. Many of the highly traveled roads carrying local traffic were incorporated into the state system during the 1920's and 30's.

Some of the more important county highways have been eligible for Federal Aid Secondary Funds since 1944. Over 10,000 miles of county highways are presently in the Federal Aid Secondary System. However, other than this classification, the counties have not developed and followed a suitable highway classification program. The urgent need for classification is obvious.

City Streets

There are over 11,200 miles of streets in the incorporated cities and towns of Indiana (52). In smaller cities, most of the important city streets from the standpoint of usage have been classified functionally because they comprise the urban extensions of the State Highway

* Primary highways in this study do not include the mileage on the Interstate System.

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RECEIVED
DATE: 10/15/2001
BY: J. SMITH
FROM: DR. J. SMITH
SUBJECT: [Illegible]

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System. Of course, many of the important streets in larger cities are also on the State System. However, many of the streets in larger cities which carry substantial amounts of traffic are not on the State System.

Several of the cities in Indiana have done an excellent job of classifying their streets. Some have adopted the findings of city planners in the establishment of major thoroughfare routes. However, many cities have done little in organizing their street systems in a logical and orderly manner in accordance with their functional use.

Many streets, especially in larger cities, carry traffic volumes which are nearly equal to the traffic carried on the urban-state highway extensions. These streets also must carry heavily loaded vehicles and other special vehicles necessary for proper service to the population of the city. On the other hand, many streets are used primarily for land-service functions to serve those people in the homes which abut the street. Some streets also have small businesses and industry abutting them in addition to residential properties.

How Classification Can be Done

Although the present State Highway System is classified, there are many shortcomings in the present System. The System has expanded without adequate control and now requires a thorough review. Some roads now on the State System should be returned to county jurisdiction because they predominately serve community-interest traffic. Perhaps other roads currently under county jurisdiction should be in the State System. In recent years scientific methods, which do a better job of highway classification, have been developed by highway engineers and administrators.

Classification of county roads and city streets is more difficult

because of the absence of basic data. The problem is further complicated by the failure of the counties and cities of Indiana to adopt uniform criteria for classification. Each county and city, however, has specific problems and desires which do not completely conform to an established set of rules for classification.

Criteria for Classification of State System

There are many criteria which are helpful in making a classification study. These criteria are used to evaluate the predominant interest or use of a highway. It is easy to identify the predominant use when it is entirely devoted to one function and carries only one type of traffic. However, it is difficult to determine the predominant use when the highway carries traffic with various levels of interest.

The Interstate Highway System has been classified and designated by the various states and approved by the Bureau of Public Roads. With slight adjustment, criteria used for the selection of the Interstate Highway System can also be used for the State System. A highway system of state-wide interest should do the following (59).

- 1) Connect all major population, trade, and industrial centers;
- 2) Connect major highways of adjacent states and form an integrated system within the state;
- 3) Connect all seats of county government;
- 4) Provide access to major recreational areas, including state and national parks;
- 5) Provide access to major state institutions;
- 6) Provide access to major terminals of other transportation facilities;
- 7) Have a volume of traffic on each highway that is sufficient to

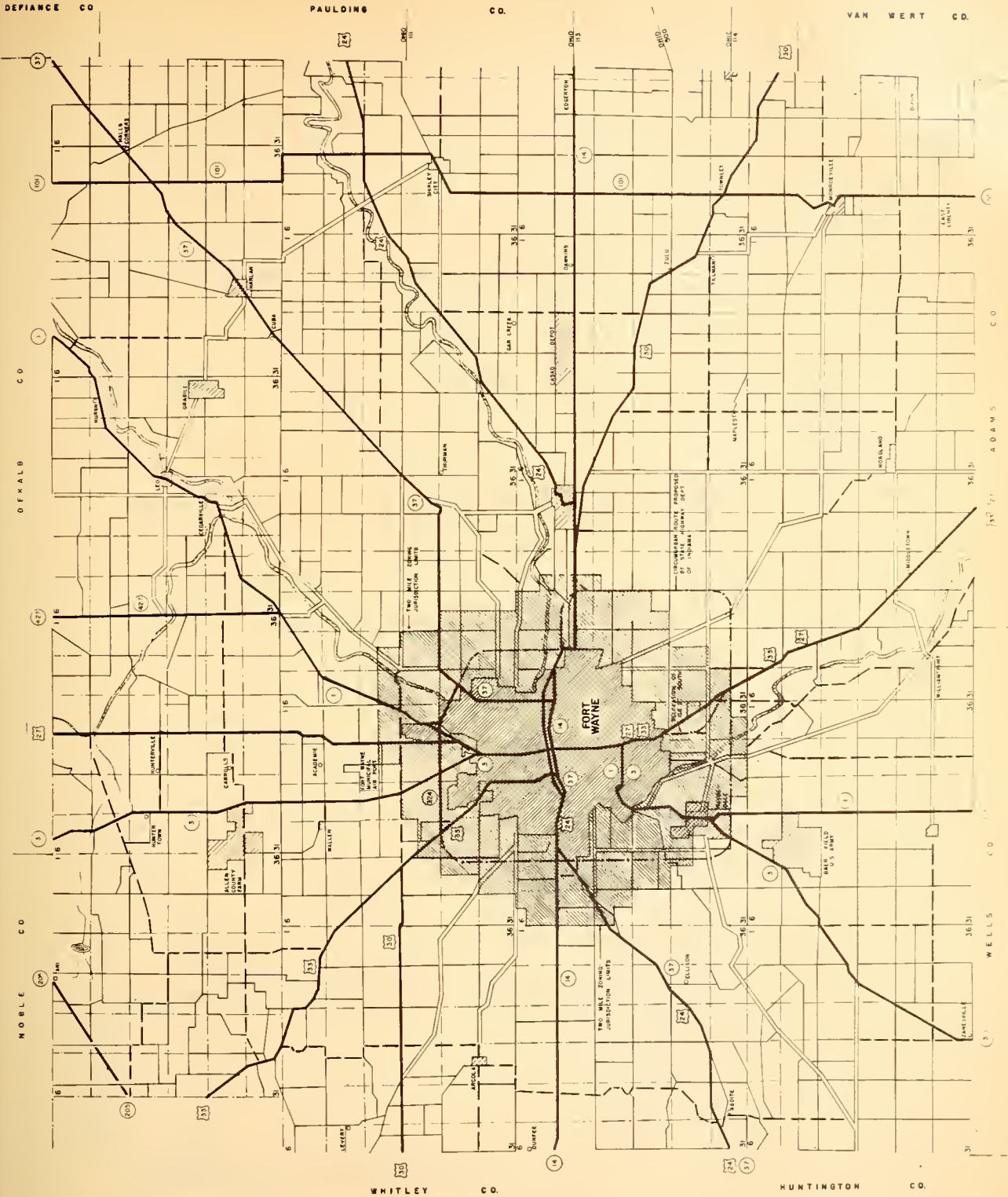
economically justify the inclusion of the highway within the system;

- 8) Include only those urban routes which carry traffic from rural state highways into and through cities, and those required to circulate traffic of state-wide interest.

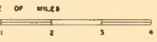
The highway should follow the most economical and feasible route between cities or other areas of attraction in the rural areas. In urban areas the highway should be integrated with other state highways to provide continuity of travel. Bypass routes should serve as alternate routes for traffic desiring to bypass the heart of the city. Often circumferential routes are needed to collect and distribute traffic on state routes around the city. In some cases alternate or parallel routes should be added to the system to provide additional capacity to serve the overflow of traffic.

Although routes that are established in a highway system generally serve the same traffic functionally for an indefinite period of time, it is necessary to reclassify some highways as conditions change. Economic expansion of agriculture and industry, migration of population, construction of new transportation facilities, and many other factors contribute to the need for such reclassification.

The State Highway System should be divided into several classes to further define the function of its various roads. The State Primary System should include long distance routes connecting every part of the state by direct lines of travel and should connect major centers of population and various regional areas of the state. A primary route also feeds traffic to the Interstate System.



- ROAD CLASSIFICATION LEGEND**
- STATE & FEDERAL ROADS
 - COUNTY PRIMARY ROADS
 - COUNTY SECONDARY ROADS
 - COUNTY LOCAL ROADS



- GENERAL LEGEND**
- CITIES & INCORPORATED TOWNS
 - OTHER TOWNS & VILLAGES
 - SECTION LINES
 - MAJOR STREAMS
 - PERENNIAL STREAMS
 - CORNER & BOUNDARY TOWNSHIP CORNERS

COUNTY ROAD CLASSIFICATION MAP
ALLEN COUNTY
INDIANA

PREPARED BY
JOINT HIGHWAY RESEARCH PROJECT
PURDUE UNIVERSITY

1954

FIGURE 29

SOURCE: REFERENCE NO. 7

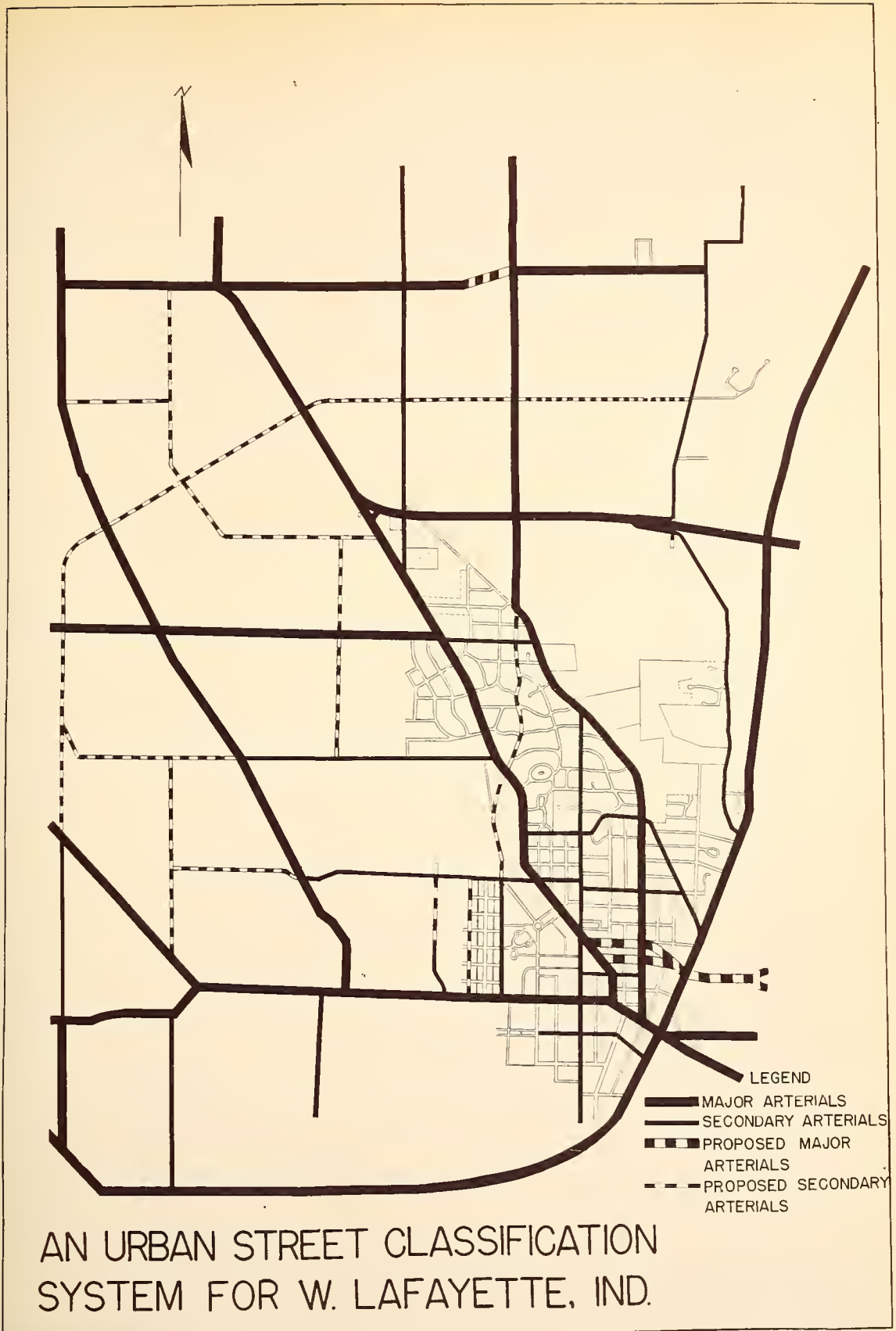


FIGURE 30

- 12 -

The State Secondary System should feed traffic to the Primary and Interstate Systems and should connect smaller population centers, public institutions, state parks, and recreational areas. This System also should be used to integrate and connect systems of higher classification. In some cases "stub" secondary highways should be permitted if they provide access to state parks and institutions.

The Urban State Highway System should form the third division of the State System. In all cases these urban extensions should be part of the city arterial system but should be classified as part of the State System because their predominant use is of state-wide interest.

County Highways

Criteria for the selection of the various classes of county highways can be developed from the criteria for a State Highway System. The scope of these criteria must be reduced to county highway purposes but the general procedure for classification is the same. Essentially county roads should be divided into three general classes: Primary, Secondary, and Local Service (7).

The Primary System should be the most important routes in the County System. Local industry, milk distributors, school buses, postal service, and other services utilize these highways to a great extent. These routes usually carry high volume county traffic of community interest and usually serve as the main farm-to-market highways.

The Secondary System should act as feeder roads to the primary routes. These roads will also serve the counties as milk, school bus, and postal routes. They will usually carry relatively less traffic volume than the Primary System.

The Local Service System should serve primarily local property

owners by providing them convenient access to their property. Traffic volume on these roads is small and in many cases will be only a few cars per day. These roads include the greatest number of miles of roads and streets in Indiana, but provide the least usage from the standpoint of the number of vehicle miles traveled.

City Streets

It is very difficult to devise general principles for the classification of city streets because many complex problems are involved. Each locality often has specific problems which must be solved. However, some of the broad aspects of classification are discussed in the following paragraphs.

The municipal streets have been classified into two general systems for this study, arterial and residential. In practice the arterial system is subdivided into two groups - the Primary Arterial and the Secondary Arterial. Generally, the arterial system connects focal points of interest within a city and provides for movement of traffic to and from different areas of the city and across the city. The residential or local streets primarily provide access to abutting property owners and serve as feeders to the arterial streets.

Results of Classification Study

Table 1 shows the results of a study of the actual mileage in each classification of the state systems and the estimated mileage in each classification of the county and city systems.

Conclusions

All of the roads and streets of Indiana need to be classified on a functional basis. This is especially needed for the county and city

highways. One of the basic steps in the proper and efficient administration of the highway system is adequate classification. Some of the obvious advantages are as follows:

- 1) Classification determines a foundation for the establishment of long-range fiscal policy;
- 2) Classification establishes a basis for efficient management and intergovernmental coordination;
- 3) Highways are integrated into a complete system and are also grouped with those highways which should be under the same jurisdiction because of the type and demands of highway service;
- 4) Equitable distribution of highway costs, according to the service rendered is provided;
- 5) All highways requiring the same level of technical competence for design and construction are grouped together;
- 6) Assignment of responsibility on various classes of roads to the most appropriate agency is made on a sound basis.

Table 1

Classified Mileage on State, County, and City Systems

<u>State System</u>	<u>Existing Mileage</u>
Interstate System	
1. Rural	785
2. Urban	<u>315</u>
Total	1,100
Rural Primary	3,600
Rural ₂ Secondary ¹	5,400
Urban ²	<u>500</u>
Total	9,500
 <u>County System</u>	
Primary	9,750
Secondary	11,150
Local	<u>55,500</u>
Total	76,400
 <u>City System</u>	
Arterial	2,620
Residential Streets	<u>8,580</u>
Total	<u>11,200</u>
 TOTAL IN INDIANA HIGHWAY SYSTEM	 98,200

1. Non-Federal Aid highways (130 miles) on the State System have been included in this classification.
2. Urban highways consist of routes through cities having greater than 3,500 population and bypasses around these cities.

Recommendation

1. State, county, and city highways should be classified on a functional basis. Adequate classification may require initial classification or reclassification of highways. The end result, however, should be an integrated network of state, county, and city highways. Desirable mileage limitations should be established for the higher classifications and authorization to change the classification of a road as conditions warrant should be based on established criteria.

Chapter IV

STANDARDS

How Standards Were Determined

The highways of Indiana have developed through improved concepts of construction, reconstruction, and maintenance. Traffic volume, vehicle size and weight, vehicle speeds, and vehicle design have also changed and the standards of construction and maintenance have been improved to meet the new and varying demands of traffic. A basic requirement for meeting present and future demands for highways in Indiana is the establishment of minimum standards of design for the various classes of highways. These must include geometric and structural features that are economical and adequate for present and future traffic demands.

Fundamentally, highway standards depend upon the level of service that traffic requires. The determination of the level of the standards to be used requires the development of criteria by which the traffic demand can be measured. Engineers from universities, the Bureau of Public Roads, the American Association of State Highway Officials, Highway Research Board, the National Committee on Urban Transportation, and county and municipal organizations have developed these criteria so that the best methods and practices for achieving economy, usefulness, and longevity in highway improvements and maintenance are obtained. Research and practice in highway departments and private industry and the experience of highway engineers have determined the standards that have been used in this study.

Standards for rural roads of various classes are firmly established on a national basis. Only recently, however, have urban standards become of concern. The National Committee on Urban Transportation, which



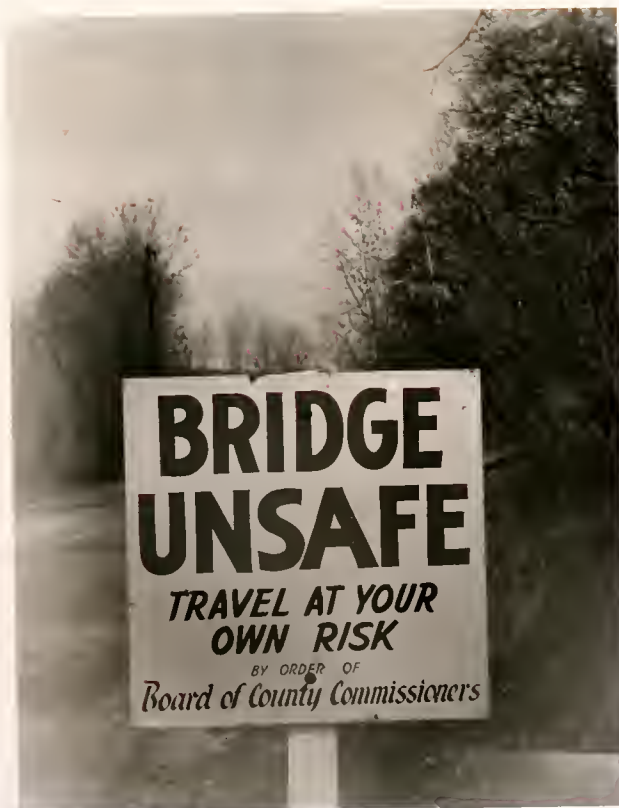
Obsolete pavements and bridges such as these must be replaced by modern facilities meeting new construction standards.

Figure 31



Lives are endangered and arterial traffic service is heavily penalized when movement is restricted to one lane and loads are limited.

Figure 32





Adequate design standards for streets, highways, and bridges are a primary necessity if capacity is to be increased and accidents reduced.

Figure 30

was recently organized and is composed of engineers in private, state and national agencies, is developing urban standards. In the determination of standards for design of streets in this study, the best available information from various engineering agencies was used.

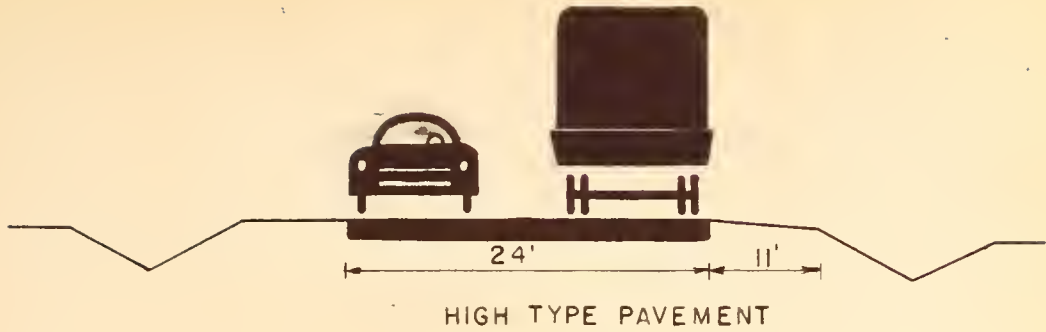
Standards for a given class of road may change from year to year. As the demands of traffic changes, so does the quality of standards. Changes in motor vehicle characteristics and operation, availability of funds, and the supply of raw materials for highway construction and maintenance have profound influence on highway design standards.

The State Highway Department of Indiana generally follows nationally recognized standards for design, construction, and maintenance. In some cases, the standards of Indiana exceed minimum national requirements.

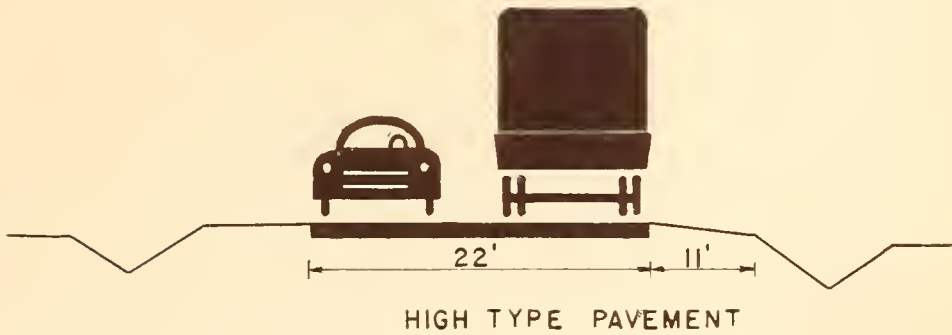
Many of the larger cities of Indiana have established standards for construction and design, but there is a lack of uniformity from one city to another. In some cities, many arterial streets become obsolete prematurely because they were built to low geometric and structural standards. Maintenance and repair costs on these streets are often excessively high and the apparent savings in initial construction costs are lost.

Design standards used by the counties of Indiana are not uniform and, in some cases, counties have not been consistent in their use when they professed to use them. In fact, some counties do not have formalized road construction standards. Inadequate bridges, improper widths of pavement and shoulders, inadequate right-of-way and inadequate drainage are some of the major deficiencies of highways in counties and cities.

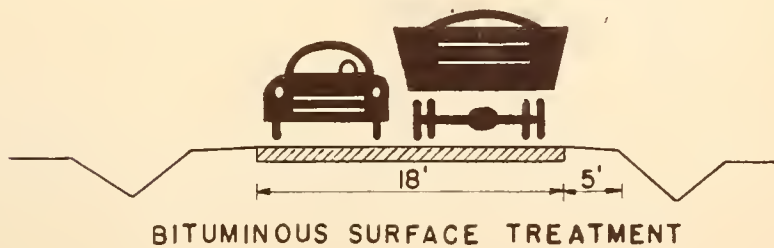
PRIMARY STATE HIGHWAYS



SECONDARY STATE HIGHWAYS



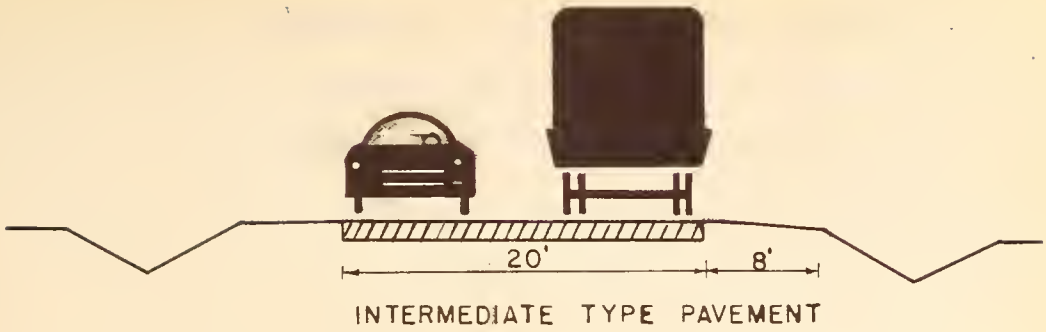
COUNTY PRIMARY ROADS



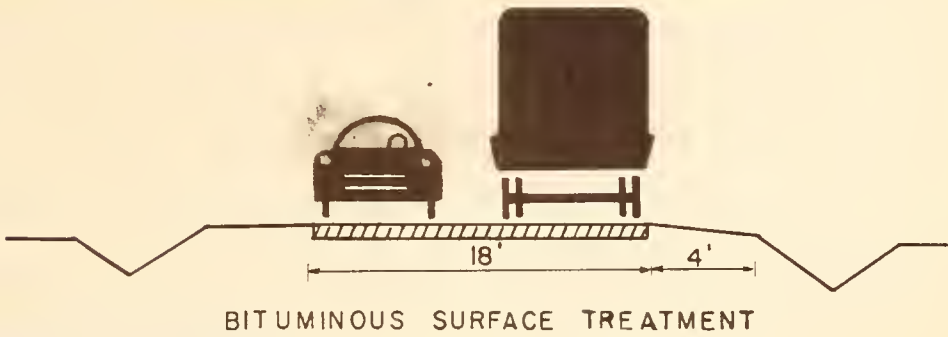
STANDARDS FOR NEW CONSTRUCTION

FIGURE 34

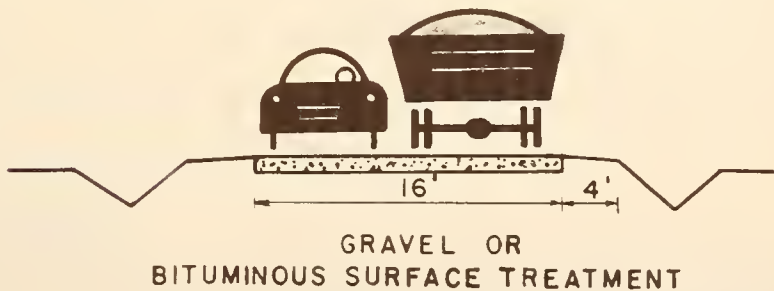
PRIMARY STATE HIGHWAYS



SECONDARY STATE HIGHWAYS



COUNTY PRIMARY ROADS



TOLERABLE STANDARDS

FIGURE 35

Study Standards

Two sets of standards were used in appraising the need for highway and bridge improvements in Indiana. One set indicated the geometric and structural features required for new construction. The second set describes conditions on present roads and streets which were considered to meet the minimum requirements for tolerable traffic service. Any highway which did not meet these minimum standards was considered intolerable and was deemed to be in immediate need of improvement.

Both sets of standards for the State System were developed by the study staff in cooperation with the State Highway Department of Indiana. Standards for use in evaluating county systems were developed by the staff of the study - and from the literature. Criteria to evaluate city streets were developed, although with difficulty because of the local nature of many of the problems involved in such a determination.

New Construction Standards

Standards required for new construction conform to the latest highway and street design recommended by the American Association of State Highway Officials (60 and 61). It was anticipated that construction practices and material specifications would be in accordance with present methods. The effect of topography and soils of Indiana was considered in the determination of standards and the total construction costs in the various areas in the state.

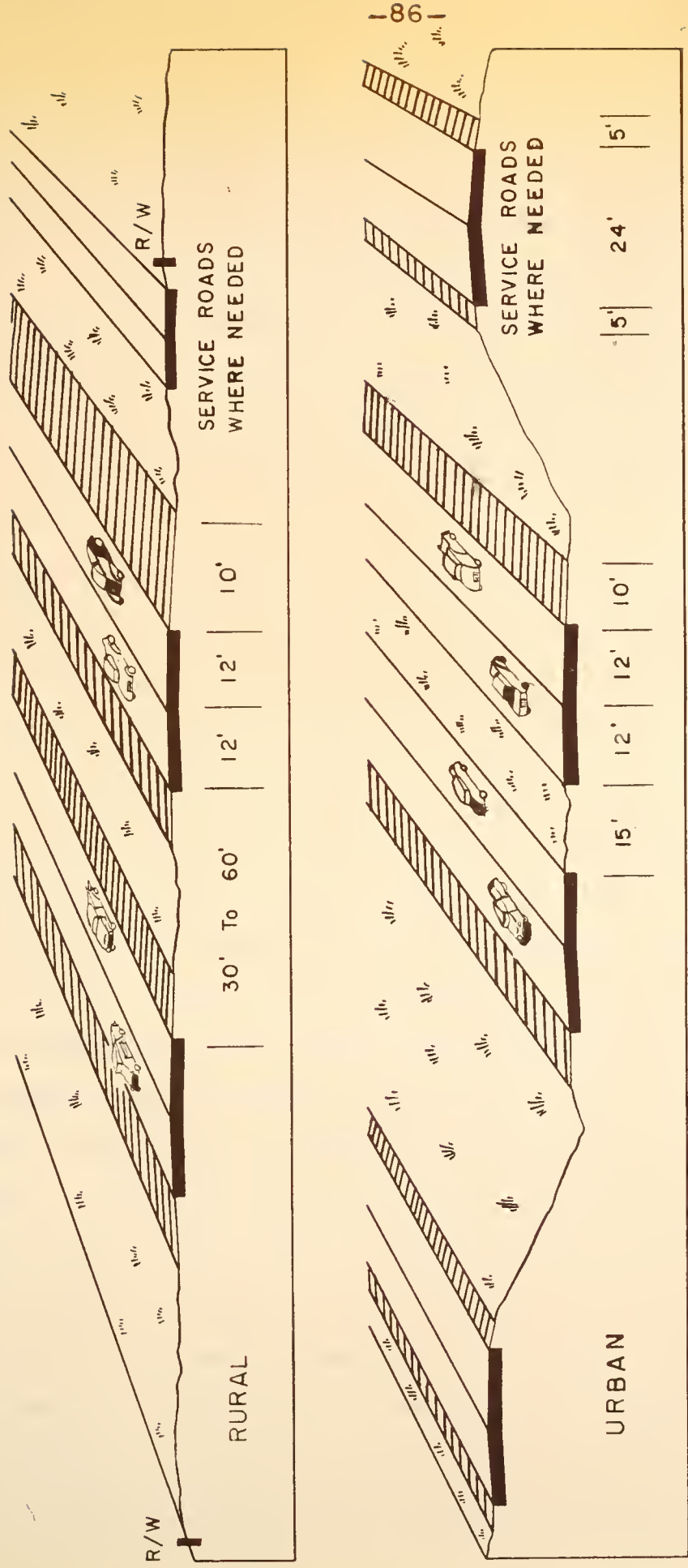
Rural State Highways

Tables 55, 51, and 38 show some of the essential features of new construction that were considered for rural state highways.

Control of access, 2-lane versus 4-lane roads, grade separations for

Table 2
Typical Construction Standards
for
Rural Interstate Highways

<u>Element</u>	<u>Topography (Flat, Rolling, Hilly)</u>	
Design Speed	70 MPH	
Operating Speed	50 to 55 MPH	
Stopping Slight Distance	725 Feet	
Maximum Curvature	2° 30'	
Maximum Grade	3%	
Number of Lanes	4-Lane Divided	(6-Lane Divided)
Design Hour Volume	2500	(3800)
1975 Average Daily Traffic	Up to 20,000	(20,000 to 30,000)
Average Right-of-Way	300 Feet	(325)



INTERSTATE HIGHWAY STANDARDS

FIGURE 36

highways and railroads, and other features were considered in addition to the information indicated in the tables. The State System was divided into various classifications - Interstate, Primary, Secondary and Urban - and minimum design standards were established for each class.

New construction standards for the Primary System are quite similar to the standards for the Interstate System. The standards for the State Secondary System are much lower because the importance of these highways from the standpoint of traffic carried is less than on the Primary and Interstate highways.

The ability of highways to carry large volumes of traffic is controlled by several factors. The number of traffic lanes, grades, slight distances, percentage of trucks, operating speeds, and roadway clearances are some of the more important elements which affect capacity. All state highways were investigated in terms of the ability to carry traffic volumes. Some 2-lane roads can carry as many as 5,000 vehicles per day, but usually roads carrying this much traffic require 4-lane divided construction. Some 2-lane highways cannot carry, because of a number of reducing factors, as many as 3,000 vehicles per day. The criteria used in these investigations were developed from information contained in the Highway Capacity Manual published by the Bureau of Public Roads (27).

One of the major design features on the Interstate System is the requirement for complete control of access. In all cases intersections at grade with side roads and private driveways are not permitted. In this study, control of access on the Primary System has also been anticipated, but the control was not considered to be as rigid as the Interstate System. Some grade intersections with side roads were permitted. Private driveway access was limited to present farm houses and private dwellings but additional access was not permitted. On the Secondary

Table 3
Typical Construction Standards
for
Rural Primary Highways

<u>Element</u>	<u>Topography (Flat, Rolling, Hilly)</u>
Design Speed	60 - 70 MPH
Operating Speed	40 - 55 MPH
Stopping Sight Distance	475 Ft. to 725 Ft.
Maximum Curvature	2° 30' - 4°
Maximum Grade	3% - 5%
Number of Lanes	2 or 4-Lane Divided
1975 Average Daily Traffic	Below 5,000, (2-Lane); Above 5,000, (4-Lane Divided)
Minimum Right of Way	100 Ft., (2-Lane); 175 Ft., (4-Lane Divided)

System, access to the highway was in general considered uncontrolled; however, some access control will be necessary in those areas where extensive roadside development is anticipated.

While Indiana has a limited access law, full use of the law has not been made, and acceptance of this law by the general public has not been complete (2 and 3). The large investment required to build needed facilities emphasizes the need of protecting the use of new highways by controlling access. Uncontrolled building on land adjacent to heavily traveled highways results in congestion, delay, and accidents. Ultimately, these roads become nothing but streets with ribbon business development on each side. It is the responsibility of the people of Indiana and highway engineers and administrators to see that control of access is adequately carried out and enforced.

The minimum standards for width of bridges on the state systems vary depending upon the length of the structure. The width for short spans is the roadway width (shoulder to shoulder width) minus 5 feet. For longer spans the width is the pavement width, plus 6 feet, for the rural systems. All bridges are designed for a load designation of H20 - S16.

County Roads

Because the traffic volumes carried on county highways are substantially lower than the traffic on the state systems, the required standards for new construction on County roads are not as high as for the state systems. The more important design features for the county are shown in Table 4.

In this study, these standards were used as a general guide for



The combination of a narrow bridge and careless driving resulted in this tragedy on State Route 13 west of Delphi.

Figure 37

Table 4

Typical Construction Standards for County Highways

<u>Item</u>	Estimated 1975 Average Daily Traffic Volume				
	0-50	50-100	100-400	400-1000	1000-Over
Pavement Type	Low	Low	Inter- mediate	Inter- mediate	Inter- mediate
Pavement Width	18'	18'	18'	20'	22'
Shoulder Width	4'	4'	5'	6'	8'
Horizontal Alignment	9°-18°	9°-18°	8°-16°	7°-14°	6°-8°
Grade	7-10%	7-10%	5-10%	5-9%	6-7%
Bridge Widths	24'	24'	24'	28'	Roadway-5'

proper construction. Many other elements which are not indicated in Table 4 were considered in determining the types of construction required. Only limited construction should be done on roads carrying less than 50 vehicles per day because most of these highways can be kept in adequate condition by proper maintenance. County roads often have adequate surfaces because road materials are readily available in Indiana but have serious deficiencies in pavement width, drainage, and alignment. Design standards for county roads carrying more than 1,000 vehicles per day are similar to the minimum standards for secondary state highways.

City Streets

Minimum requirements for newly constructed streets should not be less than an intermediate type pavement with curb and gutter and proper drainage and this construction should be the responsibility of the land developer.

Many factors in a city's development have an influence on street widths. Among them are requirements for parking, existing right-of-way widths, and the location of industry, shopping, and residential areas. The cost of urban construction is especially difficult to determine because existing right-of-way widths, sidewalks, and driveways influence these costs. In this study where right-of-way was restricted, improvement was in general confined to the use of the present right-of-way. Problems of this nature are common on overloaded city arterial streets. Large cities in particular, have many miles of arterial streets which are now carrying traffic to the limit of their capacity. In most cases other parallel streets in the city must be developed to carry these overloads and ease the congestion problem.

Tolerable Standards

Tolerable standards for the state systems were developed by engineers from the Joint Highway Research Project and the State Highway Department of Indiana. These standards were liberally applied to sections of highway and in many cases were only used as guides to good judgment.

Facts used with respect to highway conditions in capacity computations for highways with tolerable conditions were different than those used to calculate capacities for roads built to minimum design standards. In general, lower operating speeds, steeper grades, more curving horizontal alignment, and less commercial traffic exist and the present capacity was determined for these conditions.

Considerable study was necessary to develop tolerable standards for county highways. Each county has special problems of finance, topography, and available materials which affect demands of traffic service. Table 5 shows some of the more important criteria that were developed to determine tolerable roads and bridges on the County Primary, Secondary, and Local Systems.

A minimum traffic volume of 200 vehicles per day was required for a bituminous surface. In general, all county roads on the Local System were considered tolerable if surfaced with a material which permits adequate service during all seasons of the year. A few local roads were considered tolerable although they did not have all-weather surfaces.

County bridges were required to be in fair condition and at least 18 feet in width on the Primary and Secondary Systems. Safe load designation H-10 was required.

Table 5

Tolerable Standards
For
County Highways

<u>Item</u>	1955 Average Daily Traffic Volume			
	50*-100	100-400	400-1000	1000 and Over
Surface Type	Gravel	Gravel or Bituminous	Bituminous	Intermediate or High Type
Surface Width	16'	16'	18'	20'
Shoulder Width	4'	4'	4'	5'
Horizontal Alignment	18-36°	14-25°	12-18°	8-10°
Gradient	10-12%	7-12%	6-10%	6-8%
<u>Bridges</u>				
Loading	H-10	H-10	H-10	H-15
Width	18'	18'	22'	22'

* Tolerable standards were not developed for roads carrying less than 50 vehicles per day because they are not applicable.

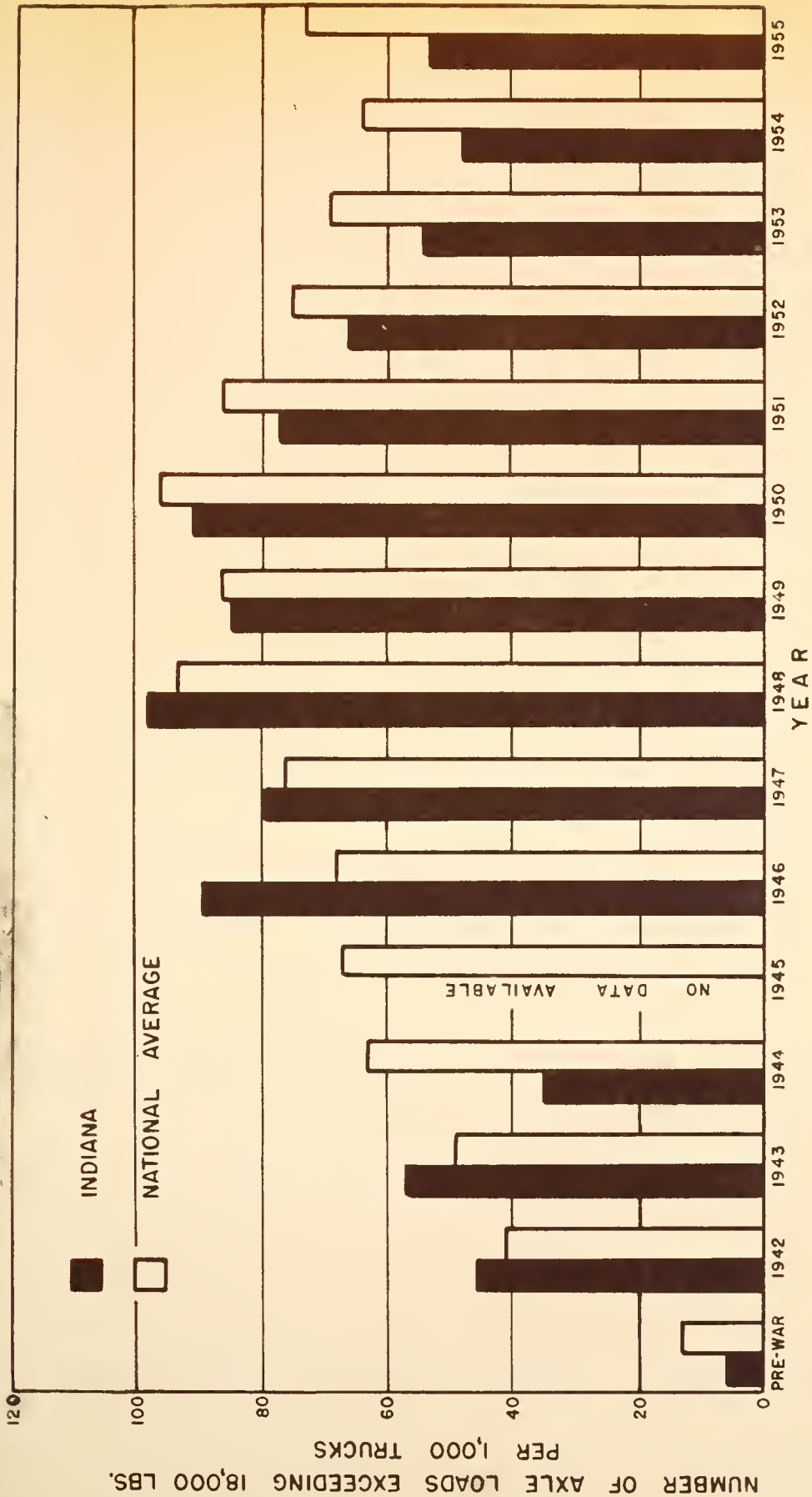
In this study the arterial streets of cities were required to carry traffic without exceeding practical capacity. If additional capacity could be obtained by the removal of parking or by the use of effective traffic operational procedures, these measures were utilized before reconstruction or widening the street was necessary. The pavement was required to be in adequate structural condition with curbs and gutters, sidewalks where needed, and proper storm sewer drainage. Formal tolerable standards, other than general conditions outlined, were not determined because it was not possible to define standards that would apply to each city.

Because tolerable standards for residential streets are a matter of local concern, these standards were also not formally developed. The requirements for these streets were computed by a process of estimation of overall needs on the total residential street mileage of the state.

Sizes and Weights of Vehicles

Highway design standards have changed because vehicles of ever-increasing weight and size use the road. The most noticeable and important changes have been caused by heavy, truck-trailer combinations traveling upon the state systems. Prior to World War II there were 5 axles per 1,000 trucks exceeding 18,000 pounds traveling the highways in Indiana but by 1955 this number had increased to 54 per 1,000 -- a ten-fold increase in 14 years. The total number of repetitions of these heavy loads has also increased because of the increased use of the heavy truck (20, 46).

The maximum allowable single axle load of 18,000 pounds in Indiana



COMPARISON OF NUMBER OF AXLE LOADS EXCEEDING 18,000 POUNDS
IN INDIANA TO THE NATIONAL AVERAGE

SOURCE: REFERENCES NO. 20 & NO 46

FIGURE 38

conforms to national standards as recommended by the American Association of State Highway Officials. Indiana law permits certain highways to be designated as heavy duty highways where the legal axle limit is 22,400 pounds. Tandem axle loads are limited to 32,000 pounds per axle, except on designated heavy-duty highways where 36,000 pounds is the maximum legal load (69).

The maximum legal gross load in Indiana is 72,000 pounds which approximates the maximum loads recommended by the AASHO (69). However, total gross load is not directly related to axle spacings or total length of truck unit. The AASHO standard reduces allowable gross loads depending upon the length of wheel bases. This requirement prevents heavy concentration of loads within a short distance. More recently constructed bridges and roads in Indiana can support the increased loads that have occurred in the past few years; however, many of earlier origin are not capable of bearing such weights. Certain heavy duty highways may adequately support a 22,400 pound axle load without causing structural damage but data are not available to substantiate this point. Performance under ever-increasing heavy truck traffic will give an answer to this question.

Regulation of Size and Weight

Because pavements and bridges are designed under specific standards, it is necessary that the revisions in these standards be carefully controlled to prevent indiscriminant changes which would result in premature functional and structural obsolescence of pavements and bridges already constructed. This is one reason why weight and size limitations on a vehicle must be kept reasonably constant, and that increases be

made only after careful considerations of the economic factors involved. Table 6 gives a comparison of the legal vehicle limitations in Indiana with those recommended by the American Association of State Highway Officials.

Recommendations

The design and characteristics of the vehicle changes quite rapidly; however, highways cannot be economically changed as readily as the vehicle. Highways, therefore, must be constructed to minimum standards which anticipate future demands of traffic. By this method the most efficient and economical use of the highway plant can be accomplished. Standards of construction, however, need periodic review and possible revision to keep pace with changing demands and needs of traffic.

It is necessary that the state, county, and city jurisdictions cooperate in the development and adoption of minimum standards for the construction of their highways and streets. These standards should be based on the best engineering practice with a consideration of economics and be compatible with the traffic and safety requirement of each highway system.

It is recommended that the present limited access law be wisely used to protect the major state highways from the strangulation of uncontrolled roadside development. In order to insure the safe and economical movement of large volumes of traffic, limited access controls must be applied vigorously where they are applicable.

Table 6

Size and Weight Limitations of Motor Vehicles (69)

<u>Item</u>	<u>Legal (Indiana)</u>	<u>Recommended by A.A.S.H.C.</u>
Width (inches)	96	96
Height (feet)	13.5	12.5
Length (feet)		
Single Unit Trucks	36*	35
Tractor and Semi-Trailer	50	50
Any Combination	50	60
Axle Load (pounds)		
Single Axle	18,000 **	18,000
Tandem Axle	32,000 ***	32,000
Maximum Gross Weight (pounds)	72,000	71,900

* Buses allowed 40 feet

** On designated heavy duty highways 22,400 lbs.

*** On designated heavy duty highways 36,000 lbs.



The control of size and weight of vehicles is essential to protect the ever-increasing highway investment. One method of control is the roadside weighing station.

Figure 39

Chapter V

HIGHWAY OPERATIONS

General Background

The field of highway traffic operations is a relatively new branch of highway engineering. Not many years ago the motto of the day was, "Get the highway out of the mud." This concept has been changed by appreciable achievement of that goal and the rapid growth of traffic in recent years. The motto today is "Get the highway out of the muddle." This dilemma has not been caused by poor construction or maintenance practices, but by increased volumes of traffic - traffic which has outgrown old and established street and road systems and results in congestion and delay to vehicles and in numerous accidents.

In order to efficiently utilize the older highways and to obtain maximum benefits from the new facilities, the art and science of traffic engineering can be used to great advantage. By increasing the effectiveness of traffic operations through traffic engineering, immediate benefits in improved efficiency and safety of traffic can be obtained.

The motorist in traveling over rural highways expects to move at a reasonable speed and with confidence that marking and signing will give him guidance to his destination. In urban areas the motorist wants to drive without unnecessary delay caused by inefficient movement of vehicles. He also wants to find a convenient place to park within a reasonable distance of his point of destination and desires clear, concise signs to guide him through urban areas to provide safe arrival at his destination.

State Highway System

Responsibility for traffic operations on the rural and urban state systems is primarily vested in the Traffic Bureau under the Construction



Overhead signs, which can be seen from a distance, are effective aids to drivers who are not familiar with a city.

Figure 40 .

and Maintenance Divisions of the State Highway Department. The Metropolitan Area Traffic Survey and the Highway Planning Survey Sections also perform some traffic engineering functions, mainly in the areas of data collection and traffic planning. Informal working relationships and cooperation between these sections are maintained.

Deficiencies in Traffic Control

In general, standards for traffic control devices in Indiana are comparable to national standards and to practices in other states (47). However, there is need for correcting many deficiencies in the application of these traffic control devices. Location of signs can be improved, especially those pertaining to route markings and directions of travel. In many cases old signs do not conform to national standards and should be replaced as rapidly as possible. More extensive use of reflectorized and overhead directional signs and of larger and legible signs should also be investigated.

Traffic signal timing on state highways is often not coordinated with other traffic signals in many cities. As a result signals are operating independently of one another and promote undue congestion and delay.

Model Traffic Organization

Because of the heavy volume of traffic carried by the state systems, it is essential that traffic operation functions be organized so that maximum efficiency of operation can be accomplished. It is, therefore, desirable to integrate essential traffic engineering functions to permit operations and planning to be performed most efficiently.



When out-of-town drivers are bewildered by a maze of route markers and signs such as these, hazards are increased and traffic movement becomes disorganized.

Figure 41

The following functions are essential:

1. Traffic Operations Functions.

- a. Issuance of revisions to State Manual on Uniform Traffic Control Devices.
- b. Supervision of installation and maintenance of traffic control devices.
- c. Speed zoning and parking control along state highways.
- d. Accident analyses and study of high-accident locations.
- e. Traffic studies for determining proper location of intersection controls, and other control devices.
- f. Study of urban sections of state highways, and traffic problems on related city streets.
- g. Aid and advice on traffic problems to cities and counties which do not have traffic engineers.
- h. Redesign of intersections, including channelization and illumination.

2. Traffic Planning Functions.

- a. Periodic collection of data on highways and bridges, traffic volumes, speeds, and truck weights.
- b. Assembly of traffic data for proposed projects, with predictions for the future.
- c. Economic feasibility studies of alternates, and related studies for route selections.
- d. Periodic analyses of highway needs, sufficiency ratings, and programming studies.
- e. Origin-Destination and other studies for locating routes in metropolitan areas.
- f. Other studies included in the scope of the state-wide highway planning survey.

3. Traffic Design Functions.

- a. Review and advise on design standards from standpoint of traffic service.
- b. Review preliminary geometric design features of proposed projects, in cooperation with the design engineers.

- c. Review preliminary highway plans and advise on signal design and other control devices for new projects.
- d. Review permits and plans for roadside entrances.

Standards of performance for the above functions should be established by The State Highway Department. The engineer in charge of traffic in each highway district should receive guidance from a central office. It would be his responsibility, however, to see that the traffic and planning operations in his district agree with the standards determined by headquarters.

Future Requirements

To develop a proper program of effective traffic operation and planning, it is necessary to increase engineering personnel in this area over those presently available. Not only are additional personnel required to carry the spivaling load of operational functions, but also additional personnel are required for a greatly needed and expanded activity in effective planning.

State-City Relationships

The State Highway Department of Indiana has full authority over traffic control devices on urban extensions of the State Highway System. As a result, cities have not indiscriminately installed traffic signals as often happens when such control is divided between city and state authorities. The state also has control over speed zones established through various municipalities on highways on the Urban State System.

In some cities, the state routes ramble through the city over circuitous routes which pass through congested business districts. Relocation of these routes to provide direct travel and by-pass the

business district would alleviate congestion and delay.

Traffic problems on the state systems especially in urban areas, should be investigated rapidly to provide efficient traffic movement. The application of improved traffic control methods and techniques to many trouble spots is necessary, but existing inadequate control often remains until the situation becomes intolerable. Improved cooperation with and assistance to the cities in the form of integration of the state systems in the cities with the total city street system must be developed if traffic is to flow efficiently, freely, and safely.

Traffic Engineering in Cities

One of the most important services that can be rendered by a city is the provision of efficient and economical highway transportation for its inhabitants. History has shown that cities grow and prosper if adequate transportation is provided to permit the flow of people and goods. Furthermore, the greatest traffic problems are in urban areas. Therefore, traffic planning and operation of the street system on a safe and efficient basis should be established as a major function of good city government.

Inefficient usage can impair the traffic carrying ability of a highway or street. In this study, a street was not listed as having inadequate capacity if the capacity requirements could be met by eliminating parking, establishing one-way operations, abolishing turning movements, or by similar traffic engineering measures. It is sound administration to make maximum use of present facilities before construction measures are considered.

Only a few of Indiana's largest cities have traffic engineers. However, many other cities in the state have traffic problems which warrant

the full-time services of a traffic engineer. Many smaller cities do not need the services of a full-time engineer, but could use one on a part-time basis. It is estimated that there should be the equivalent of at least two full-time traffic engineers for each 100,000 people in a city. This estimate of the proper number of engineers indicates that many more professionally trained personnel are needed in the cities of Indiana.

The traffic engineering division in a city should be placed in an engineering department or organized as a separate department of city government. In many cities, traffic engineering duties are the responsibility of a traffic officer who is usually a member of the local police force. In most of the small cities such an arrangement may be adequate, but the assistance of state traffic engineering departments or other competent traffic engineering consultants should be obtained for the solution of many problems.

More effective application of fundamental traffic engineering principles and practices is urgently needed in Indiana cities. Work beyond maintaining and operating traffic control devices is needed. Some of the necessary traffic engineering functions of an effective traffic engineering department of a city are as follows:

1. Conduct traffic surveys and engineering investigations of traffic conditions and make recommendations for improvements or changes in present streets.
2. Conduct long-range studies to determine overall transportation needs of the city.
3. Determine the type and location of traffic control devices, including the maintenance of signs, signals, pavement markings,

- and other necessary controls.
4. Establish traffic rules and regulations subject to the approval of the city council. Included are parking regulations, turning controls, one-way streets, arterial streets, traffic signal timing, pavement markings, loading zones, and other operational procedures necessary for safe and efficient travel. Transit routes and unloading and loading zones should also be subject to the traffic engineer's authority, especially as they affect the selection of one-way streets.
 5. Determine present and future needs for off-street parking facilities and review and approve such plans for design and location.
 6. Review of other miscellaneous activities which would affect traffic operations such as driveways, parking lots, subdivision layout, and shopping center location.

Traffic Engineering in Counties

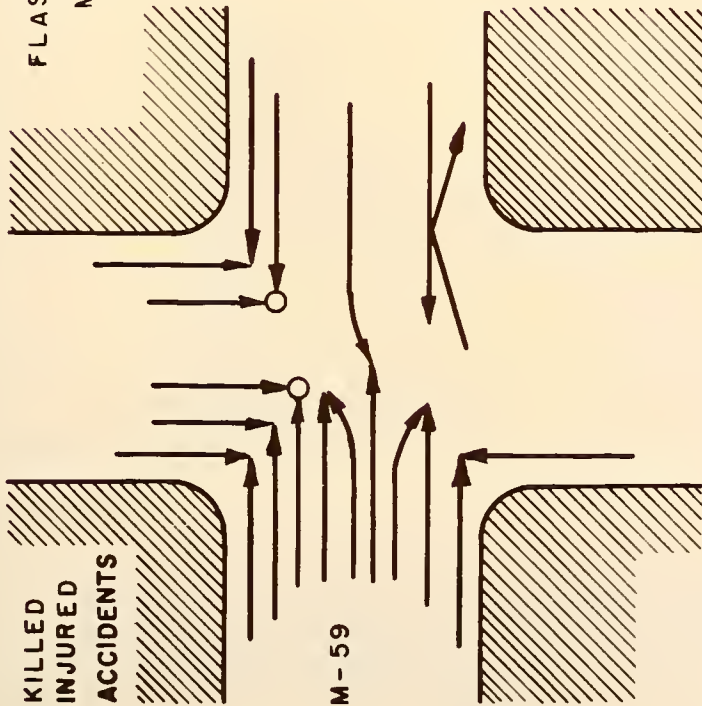
Although the county highway systems do not carry the heavy concentration of traffic that is found on the state and city systems, many operational procedures can be adopted which will expedite the movement of traffic and provide for safer and more efficient travel. One of the primary needs of the counties is a uniform road marking and identification system. At present only a few counties in the state have established such an identification system.

Adequate marking of no-passing zones and centerline locations on the paved County Primary and Secondary Systems is badly needed. Signing is usually not adequate and often does not conform to accepted standards.

TWO YEARS BEFORE

MARCH 17, 1948 THRU MARCH 16, 1950

0 KILLED
4 INJURED
12 ACCIDENTS

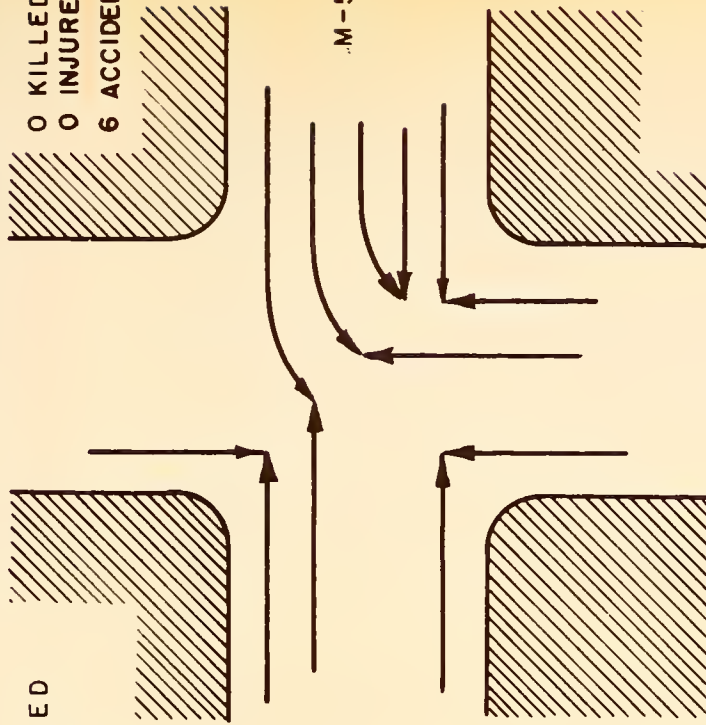


FLASHER INSTALLED
MARCH 17, 1950

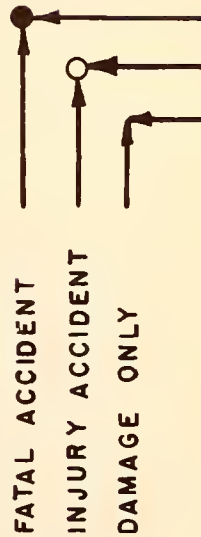
TWO YEARS AFTER

MARCH 18, 1950 THRU MARCH 17, 1952

0 KILLED
0 INJURED
6 ACCIDENTS



SEVERITY



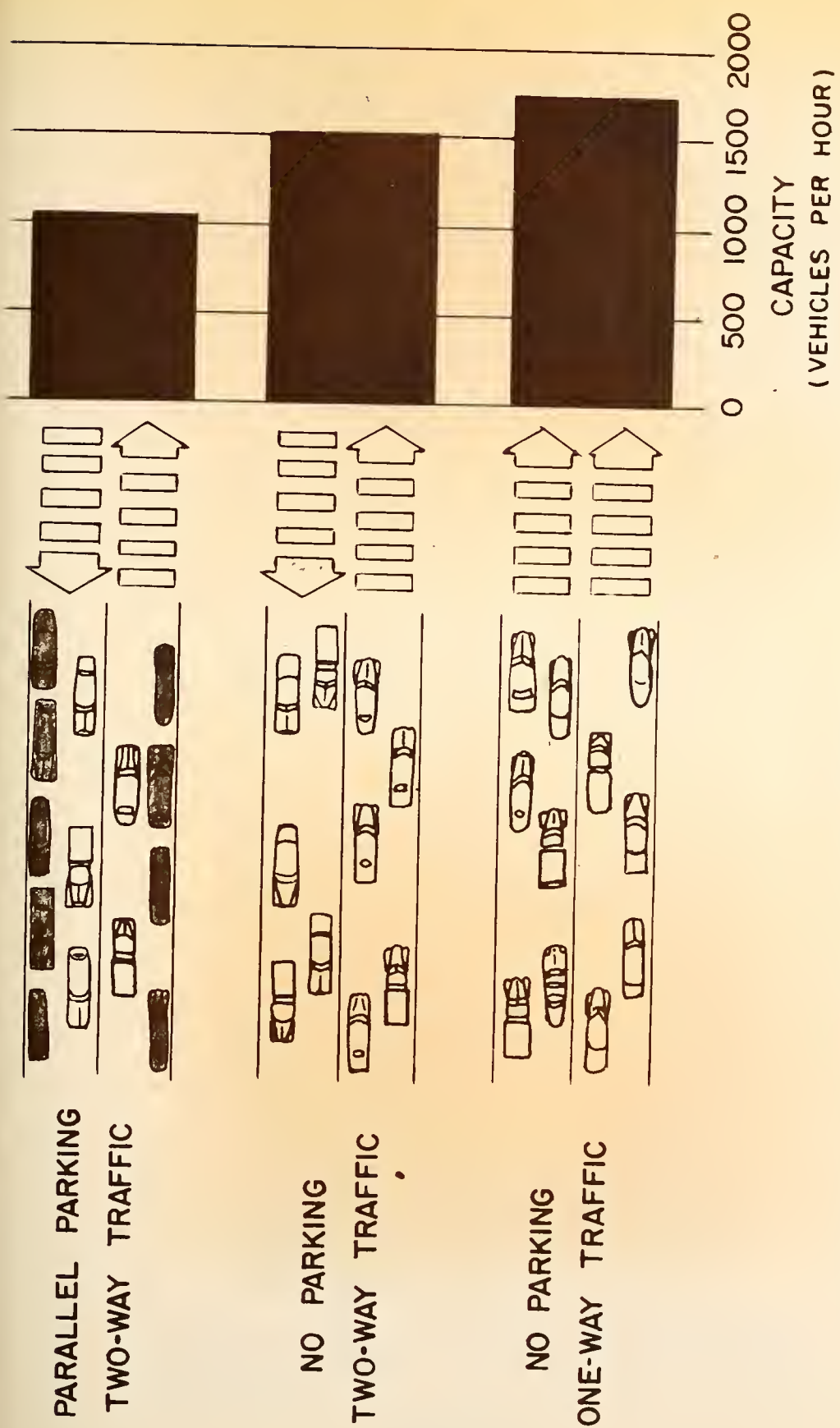
APPLICATIONS OF TRAFFIC ENGINEERING IN A COMMUNITY CAN
REDUCE ACCIDENTS AS SHOWN IN THIS COLLISION DIAGRAM

FIGURE 42



Relatively inexpensive improvements, such as properly located traffic lane markings, signs, and signals, are products of sound Traffic Engineering.

Figure 43



TRAFFIC CONTROL CAN INCREASE STREET CAPACITY
 (CAPACITIES INDICATED ARE FOR A TYPICAL STREET WITH ITS EXISTING CONDITIONS)



Properly marked, one-way streets may lessen the problems of traffic congestion and delay in busy urban areas.

Figure 45

In the proper development of traffic operations, the advice and counsel of a traffic engineer should be wisely used and standards of the State Highway Department of Indiana should be followed.

Recommendations

State Highway Department

The highway planning and traffic engineering activities of the State Highway Department should be integrated and expanded. An adequate budget should be established for this activity.

Marking and signing methods can be improved, especially in the use of reflectorization and in the rapid replacement of signs which do not meet accepted standards. Signing in urban areas should be improved to provide better route markings through cities. Traffic signal control and timing and the establishment of direct routes by-passing business districts should be investigated. Better working relationships should be established with the cities and counties by the state.

Cities

The larger cities in Indiana can relieve their traffic problems through the application of the principles of traffic engineering. Additional qualified personnel and adequate budgets are required in this area. The smaller cities should investigate the possibility of securing the part-time services of an experienced traffic engineer. Good city-county-state cooperation between the highway departments can contribute greatly to the solution of this problem.

Counties

The counties should establish uniform road identification programs. Marking and signing on the County Primary and Secondary Systems

should be improved. Many miles of heavily traveled County Primary highways badly need marking for centerline and no-passing zones and proper signing. Good county-city-state cooperation between the highway departments is essential.

Chapter VI

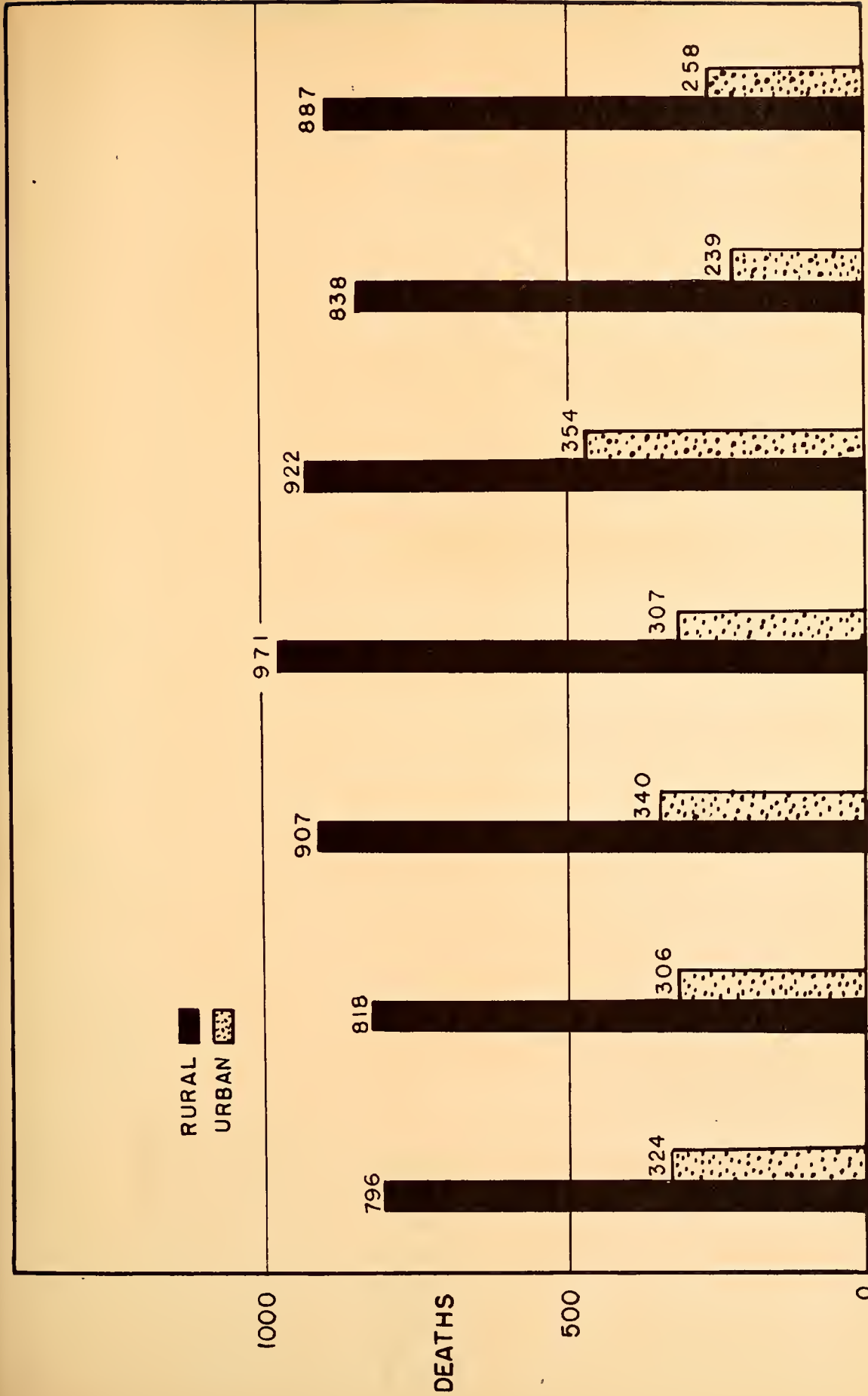
SAFETY

Highway Accidents in Indiana

The causes and prevention of accidents are the concern of every inhabitant of the state. Traffic accidents and their effects have been experienced by nearly every family and are the concern of many departments of government. In fact, it is one of the principal concerns of highway and street departments, for these agencies are responsible for the safe and efficient use of highway facilities. In most cases safety is built into new construction by use of improved standards for many highway features such as width of pavement, curvature, superelevation, and grades. Proper signs and markings also improve the safety conditions on the highways.

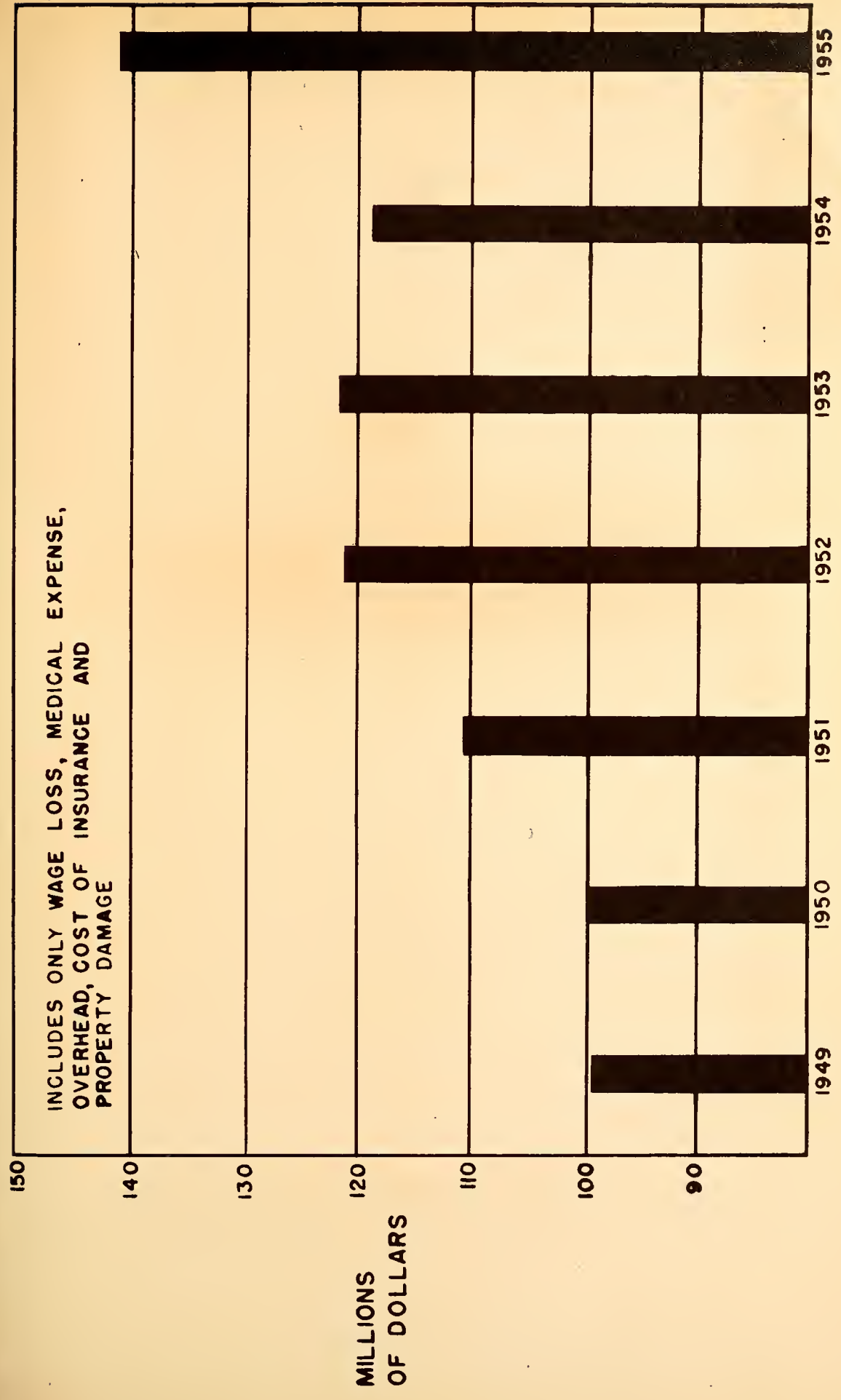
Other safety activities including the keeping of accident records, traffic law enforcement, driver licensing, driver control and training programs, public education, and safety organization are the responsibility of governmental units. Each agency concerned with promoting highway safety is important. Improved highway safety will only result from the combined activities of three programs in which many agencies have a part. These programs are Engineering, Education, and Enforcement--the three E's of highway safety. These programs must be supplemented by effective legislation action.

In 1955, 1,145 persons were killed in traffic accidents on the roads and streets of Indiana--258 in urban areas and 887 in rural areas (42). In addition, over 37,000 persons were injured, many severely. The total economic loss for these accidents including the loss of wages,



SOURCE: REFERENCE NO. 42

INDIANA
RURAL AND URBAN TRAFFIC DEATHS
FIGURE 46



COSTS DUE TO TRAFFIC ACCIDENTS
IN INDIANA
FIGURE 47

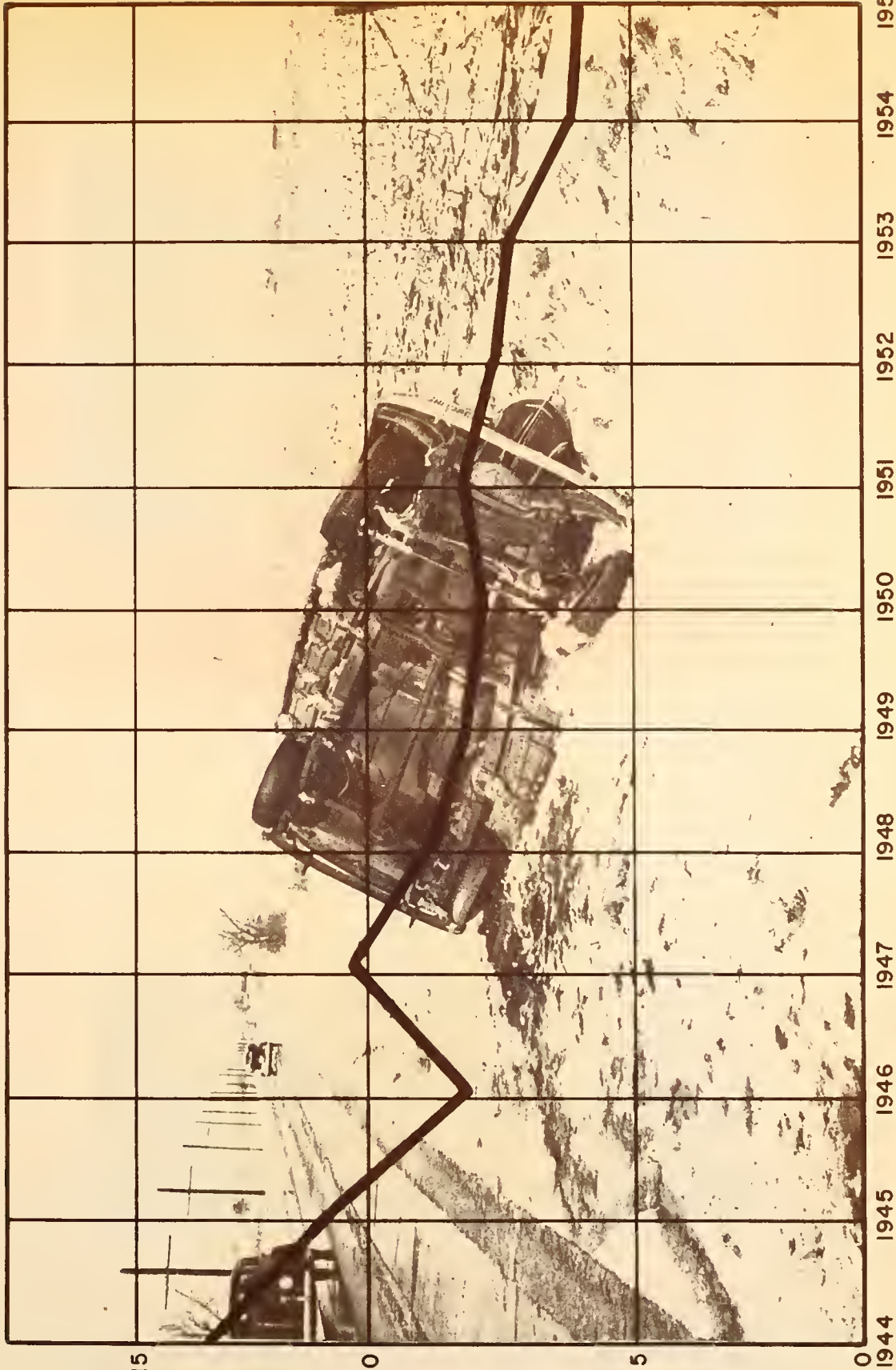
medical expenses, overhead, cost of insurance, and property damage exceeded \$140 million (42). The traffic fatality rate for 1955 in Indiana was 6.00 deaths per 100 million vehicle miles while the national figure was 6.4 (42).

The death rate for Indiana has been decreasing during the past ten years but the total number of fatalities remained nearly constant. The active programs in Indiana in the three E's of traffic safety are apparently improving the highway accident dilemma; however, a large amount of work remains to be done to further improve this situation. The time has not come when it is possible to say "the job is done." Ever increasing vigilance is still needed.

Engineering

Adequate highways are safer highways, and there is much evidence to prove this statement. Many things can be done to provide adequate highways through planning of future projects and effective operation of existing facilities through traffic engineering. Highway inadequacy and highway safety are closely related and elimination of deficiencies will do much to reduce accidents. It has been estimated that the proposed interstate System will reduce accident fatalities by 3500 lives annually in the United States and will result in an annual economic savings of \$350 million (62).

Modernization of inadequate highways can result in lower accident rates on all systems of highways. In a recent study conducted in Connecticut estimates were made of the accidents that would have occurred had the highways been constructed to modern design standards for the traffic which they carried. In all cases the total estimated reduction



NUMBER OF FATALITIES PER HUNDRED MILLION MILES OF VEHICLE TRAVEL

YEAR

INDIANA MILEAGE DEATH RATE

FIGURE 48

SOURCE: REFERENCE NO. 42



Huge economic losses, deaths, injuries, inconveniences, and frequent delays in movement of cargo are the prices paid for accidents.

Figure 49



Inadequate sight distance and alignment typical of earlier construction practices restrict free and safe movement of vehicles.

Figure 50



Two serious accident sources are railroad crossings at grade and many access points.

Figure 51

of traffic accidents ranged from 20 percent for a non-controlled access facility to almost 60 percent for a controlled access highway on the state highway system. An overall reduction of 43 percent of all accidents was estimated for the rural and urban system. A similar reduction in accidents can be expected on highways in Indiana if they are made adequate for traffic (49).

Recent studies indicate that control of access has a definite influence upon accidents. The total accident rate for a non-controlled access facility is usually several times as high as accident rates on controlled access highways. Fatality rates on four-lane divided highways with no control of access have been found to be four times greater than fatality rates on highways with full control of access (8). As expected, a substantial reduction of right angle collisions occurs on controlled access highways because of the elimination of roadside conflict caused by grade intersections and private driveways (48). Of course, the reduction in accident rates cannot be totally attributed to controlled access, but certainly the separation of highway and railroad intersections and elimination of private driveways have considerable effect.

Highways with full control of access have many benefits in addition to accident reduction. Travel speeds are higher and greater fuel economy is attained in urban areas where congestion and delay are the greatest (8). Their construction in an urban area also causes a reduction in accidents on other city streets because traffic is diverted from these streets to the freeway.

All highways cannot and need not be constructed to freeway standards. Operational procedures such as proper marking and signing,

channelization, and signal installation are a few of the techniques that can also be used to reduce accidents. In urban areas, almost 50 percent of all traffic accidents occur at intersections (1). Study and treatment of such high accident locations can help materially in reducing the intersection accident rate.

Education

Increasing Action Program Needed

The seriousness of the traffic safety problem is recognized by various organizations and interest groups through their participation in highway safety programs. On the national level the President's Highway Safety Conference and the National Safety Council and in Indiana the Governor's Traffic Safety Committee, the State Police Department, and the State Highway Department are among the many organizations working to improve highway safety.

The importance of local interest in traffic safety is evident since most accidents occur within a short distance of the home (42). Accident statistics for Indiana in 1955 showed that 73 percent of all collisions and 65 percent of fatal collisions occurred within 25 miles of the residence of the people involved. Only 14 percent of all collisions and 19 percent of fatal collisions involved people with an out-of-state residence.

Traffic safety is a community problem, and the effectiveness of its solution depends upon community action. Several cities of the nation have developed successful plans for community action. Experience of these communities has established a successful pattern for development of a traffic safety plan. A group of interested public officials

and community leaders usually initiate interest in a traffic safety program. A staff of professional people is also obtained to promote traffic safety. In the larger cities all of these activities are also the responsibility of the Traffic Director of the Department of Traffic Engineering. In the small cities without a traffic engineer, such activities are usually the responsibility of the Traffic Officer. Central guidance of safety activities of the various municipalities are often provided by establishing a general administrator to coordinate and integrate the program on a statewide basis.

A complete traffic survey and analysis is an important part of a successful program of safety. In conjunction with the analysis of traffic movement, many studies and activities may be included. Among them are:

1. The locations and types of traffic accidents;
2. The conformity of local traffic signs and signals with national and state standards;
3. The conformity of local traffic ordinances with the Model Traffic Ordinance (53);
4. The scope of the traffic safety program in city schools;
5. The need for establishing a public relations unit.

Education is such an important part of any successful traffic safety program that all public information media - radio, television, newspapers, and advertising - should be used. The educational program should be initiated before attempting to solve the immediate safety programs and before any traffic analysis is made. Public support is absolutely essential for the initial success and, more important, the future success of such a program. Active community interest in traffic safety is absolutely essential and must be maintained for a successful program to survive.



Many Indiana high schools and colleges offer courses in driver education, but only a small number of schools offer programs which approach the standards recommended by the National Education Association.

Figure 52

Driver Education

An analysis, of the results of driver training programs, indicates that adequate driver education courses reduce traffic accidents at least 50 percent. Nationwide, at least 6,000 high schools are now offering effective courses in driver education, including behind-the-wheel practice driving (44). In 1955, driver education, including practice driving, was offered in 452 high schools of Indiana (44). However, only a small number of these high schools offered programs which approached the standards recommended by the National Educational Association. About 44 percent of the high schools did not offer driver education in any form (44).

The total yearly cost of an adequate high school driver training program in Indiana is estimated at \$1,500,000. Compared to the total economic loss resulting from accidents each year, the cost of a driver education program is a small investment. The required money, however, poses a serious budget requirement for school authorities. It is believed by many people that these funds should be secured from highway user sources instead of general school funds and plans have been advanced whereby this money could be raised from traffic fines or driver license fees.

Enforcement

Engineering and education, however, are not enough to reduce accidents. Adequate laws and enforcement are necessary to produce an effective traffic safety program. Numerous local cases show how effective enforcement reduces accidents and undoubtedly enforcement has contributed to the state and national trend of a lowering fatality rate. Good and uniform laws are absolutely essential for the advancement of



To be most effective, good traffic operations must be supported by good law enforcement. The first truck in the left lane is double parked, eliminating one lane of traffic and causing congestion and possible accidents.

Figure 53

safe and efficient highway transportation. Accident records, driver licensing, high school driver training, police and court activities, and inter-governmental cooperation should be included.

In general, the laws of Indiana covering rules of the road are in reasonable conformity with the rules of the road of the Uniform Vehicle Code. For example, the State Highway Department designates roadways under its authority as "one-way" and designates "no-passing" zones. In general, it exercises authority over traffic control on urban extensions of state highways.

Many communities in the state, however, have not adopted traffic laws which conform to the Model Traffic Ordinance (53). Each city should investigate its present traffic laws and make those revisions which are necessary and consistent with state laws. The best way to get the job done is by informed community action. Adequate and uniform laws throughout the cities of the state would be an effective step in the direction of improved traffic safety.

Accident Records

For many years Indiana has had a compulsory accident reporting law. This law has done much to provide adequate accident records. Information for more effective enforcement activities and also necessary data for proper traffic engineering measures have been obtained from these records. An accident spot map is produced each year by the State Highway Department for the rural state systems from information obtained from these reports. Locations of fatal and personal property or injury accidents are shown. Intersections with poor accident experience are shown and appropriate corrective measures can be made.



Inadequate highways take a severe toll in lives lost and property destroyed.

Figure 54

The use of accident records in enforcement and engineering varies from city to city. Some cities effectively utilize accident reports in the development of spot maps to determine locations where enforcement or traffic engineering procedures are required. Others have ignored the use of such valuable information and have little knowledge of their accident problem or its solution.

Accident information on the county highway systems is very poor and county highway departments have done little to utilize available accident information. Fatal accidents are reported but many personal property accidents are never reported. Evidence indicates that the death rate is higher on this system than on rural state highways although speeds and exposure to accidents are lower.

Summary

The elimination of inadequacies on highways in Indiana will reduce accidents. Some estimates indicate that 40 percent of all accidents could be avoided if the highway systems are improved to modern design standards (49). Control of access on the Interstate and Primary State Highways will be the greatest contributor to a lower accident rate (48). Uncontrolled roadside development has undoubtedly caused many sections of highway to have high accident rates.

A well-informed public can alleviate the increase in accidents and the resulting deaths and economic losses. A clearly defined program should be established in each city and county so that information on traffic safety is made available to all news media. Through coordinated planning and an efficient cooperative program on the state and local level, action can be materially increased.

The benefits of an adequate driver training program have been proved in many states. Over one-third of a million students were enrolled in high school driver training courses throughout the nation in 1954 (44). However, this figure represents only a small portion of the potential drivers in the high school age group. Driver education programs should be established in more high schools and adequate funds should be provided to meet the needs of this program.

An adequate enforcement program is also essential to a successful highway safety program. Uniform laws are essential to effective enforcement and most cities need to revise their traffic laws to conform with the Model Traffic Ordinance (53). Good accident records are necessary in an effective safety program and when used in conjunction with traffic engineering procedures will reduce accidents. Most counties and cities have not attempted to keep and utilize accident records.

The highway safety problem is indeed difficult. No one solution can be obtained, and man, with his human limitations, will always have accidents. Much can be done, however, to prevent many of them from occurring through adequate engineering, education, and enforcement.

Chapter VII

HIGHWAY NEEDS

State Highway Appraisal

A mile by mile inventory of the State Highway System was performed in the winter and spring of 1955. Such information as type and condition of road surface; type, condition, and thickness of pavement; type of soil; age of pavement; sight distance; and degree of curvature for each section of highway was determined. Complete information on bridges and railroad crossings was also compiled. This voluminous mass of data was punched on IBM cards to permit rapid and accurate tabulation and computation. Such information as highway capacity, accident rates, traffic and structural characteristics, and remaining surface life was determined.

All the important geometric and structural elements of the highway were then analyzed in relation to the present and future traffic demands. The inadequate elements for each section were determined by comparing the present highway with the tolerable and design standards for the class of highway of which the section was a part. The sum of the needed improvements for all sections of highway, both urban and rural, represents the "total needs" for the State Primary, Secondary, and Urban Systems. The requirements of the Interstate System, however, were determined by using data from a detailed analysis made by the State Highway Department. Complete information, a portion of which is shown on Figure 55, was tabulated concerning the geometric and structural characteristics of each section, including adequacy of protection at railroad crossings and bridge information.

HIGHWAY INFORMATION

ROUTE NUMBER	MAINTENANCE SECTION LETTER	SUBSECTION NUMBER	HIGHWAY DISTRICT NUMBER	SUBSECTION LENGTH (MILES)	PAVEMENT WIDTH (FEET)	ACCIDENT RATE (NO. ACCIDENTS PER 100,000 VEHICLE MILES)	CAPACITY (VEHICLES PER DAY)	1955 TRAFFIC (VEHICLES PER DAY)	SOIL TYPE	SURFACE TYPE	RIGID OR FLEXIBLE PAVEMENT	SURFACE THICKNESS (INCHES)	TOTAL THICKNESS OF BASE (INCHES)	YEAR OF MAJOR CONSTRUCTION	YEAR OF SURFACE CONSTRUCTION	SURFACE CONDITION	SHOULDER WIDTH (FEET)	CURVE	GRADE	RIGHT-OF-WAY (FEET)	TOPOGRAPHY	YEAR CONSTRUCTION BEGAN	TYPIC OF CONSTRUCTION NECESSARY
US 41	K-1	1	CRAWFORDSVILLE	2.5	25	181	1,500	15,200	SAND	ASPHALT	FLEXIBLE	2.5	5	UNKNOWN	1940	MEDIUM (50)	7	NONE	0-3%	70	FLAT	1955	4-LANE DIVIDED HIGHWAY LIMITED ACCESS
US 41	K-2	1	CRAWFORDSVILLE	0.5	24	181	6,500	12,400	SAND	ASPHALT	FLEXIBLE	2.5	9	1924	1940	MEDIUM (60)	7	SOME CURVES	0-3%	70	FLAT	1955	4-LANE DIVIDED HIGHWAY LIMITED ACCESS
US 41	K-2	2	CRAWFORDSVILLE	5.3	23	181	4,300	7,500	SAND	CONCRETE	RIGID	9-7-9	UNKNOWN	1919	1924	MEDIUM (50)	7	NONE	0-3%	70	FLAT	1955	4-LANE DIVIDED HIGHWAY LIMITED ACCESS
SR 45	H	1	CRAWFORDSVILLE	3.9	20	216	3,500	2,400	ALLUVIUM	CONCRETE	RIGID	9-7-9	UNKNOWN	1917	1931	CRITICAL (over 30%)	11	SOME CURVES	3-6%	60	ROLLING	1956	WIDEN 4 RESURFACE TO 24'
SR 45	H	2	CRAWFORDSVILLE	7.1	20	216	4,000	2,400	ALLUVIUM	CONCRETE	RIGID	9-7-9	UNKNOWN	1917	1931	CRITICAL (over 30%)	11	SOME CURVES	0-3%	60	ROLLING	1956	WIDEN 4 RESURFACE TO 24'

COST INFORMATION

RAILROAD CROSSING INFORMATION

BRIDGE INFORMATION

BRIDGE NUMBER	TYPE OF STRUCTURE	LOC OR SERVICE	CLEAR WIDTH (FEET)	LENGTH (FEET)	NUMBER OF SPANS	POSTED LOADING (TONS)	VERTICAL CLEARANCE ABOVE HIGHWAY (FEET)	VERTICAL CLEARANCE OVER HIGHWAY (FEET)	YEAR STRUCTURE NEEDED	RAILROAD NAME	1955 TRAFFIC - NUMBER OF TRAINS	TYPE OF PROTECTION	YEAR SEPARATION NEEDED	HIGHWAY CONSTRUCTION COSTS	BRIDGE CONSTRUCTION COSTS	RAILROAD SEPARATION COSTS	RIGHT-OF-WAY COSTS	RAILROAD PROTECTION COSTS	TOTAL CONSTRUCTION COSTS	MAINTENANCE COSTS	ADMINISTRATION COSTS
UNKNOWN	REINFORCED CONCRETE ARCH	STREAM CROSSING	36	105	1	20	UNKNOWN	14	1955	CHICAGO, MILWAUKEE, ST PAUL & PACIFIC	60,800 15,200	SIGNALS	1955	\$600,000	\$113,000	\$232,000	\$125,000		\$1,134,000	\$2,600 PER MILE OF CONSTRUCTION PER YEAR	
GATZ-14	REINFORCED CONCRETE ARCH	STREAM CROSSING	24	159	3	20	4	20	1955					\$120,000	\$176,000		\$25,000		\$321,000	\$2,600 PER MILE OF CONSTRUCTION PER YEAR	
41-K-568A	REINFORCED CONCRETE ARCH	STREAM CROSSING	53	67	1	20	6	22	1955					\$1,270,000	\$87,000	\$265,000	\$265,000		\$1,622,000	\$2,600 PER MILE OF CONSTRUCTION PER YEAR	
														\$140,000					\$140,000	\$500 PER MILE OF CONSTRUCTION PER YEAR	
109	STEEL TRUSS	STREAM CROSSING	24	84	1	25	4	12	1956	PENNSYLVANIA	4,800	SIGNALS	1956	\$314,000	\$150,000		\$2,000		\$468,000	\$500 PER MILE OF CONSTRUCTION PER YEAR	
1089	REIN. CON. ARCH	STREAM CROSSING	24	40	1	25	5	10	1956												
281-A	REIN. CON. GIBBER	STREAM CROSSING	28	24	1	25	4	10	1956												

FIGURE 55

County Highway and City Street Appraisal

The requirements of counties and cities for road and street improvements were also determined. Time and financial requirements made it impossible, however to make detailed inventory of the 87,600 miles of county roads and city streets. Furthermore, inadequate records of construction and maintenance and the failure of counties and cities to provide long-range planning made impossible a completely objective appraisal of the deficiencies.

In order to obtain an estimate of county road inadequacies, data from two Indiana counties were used as a sample. In these counties, detailed information on road and bridge conditions was evaluated, and the needs were determined. A study of the requirements for improvement of county roads in adjoining states as reported in their recent needs studies also provided supplemental information helpful in making an estimate of the county highway picture.

The demand for city street improvements falls into two categories - those on streets that are urban extensions of the State Highway System and those on streets that are the complete responsibility of the cities. The needed improvements for the urban extensions were determined as part of the state highway study. These improvements constitute a large portion of the state highway requirements because most of the costly construction is in urban areas. Many miles of expressways are needed in Indianapolis, Fort Wayne, South Bend, and other metropolitan areas of the state.

The evaluation of other city streets was done by studying the network of streets in representative cities of several population classes.

The percentage of street mileage in each of these cities that should be classified as arterial and local access streets was determined. The cost per mile of improving the streets of a typical city to adequate condition and of providing any additional capacity necessary was determined from studies of such improvements made by engineering organizations for a few cities, from estimates made by several city engineering departments, and from estimates made by state highway needs studies in nearby states.

The estimates for needed highway improvements for counties and cities were based on evidence that is not as complete as the information for state highways. It was not possible to obtain good information from counties and cities for this study and it will not be possible until better data are developed by the counties and cities. The highway needs of counties and cities, however, are reported on the basis of a projection and/or expansion of the best information available.

Cost Estimates

On the state highway systems, estimates were computed on the basis of unit prices for grading and drainage, surface and base, structures, and right-of-way. In most of the city street and county highway estimates, the costs for various types of improvements were computed on the basis of average unit cost per mile.

All costs were based on the 1955 price levels for construction and maintenance. Bid prices for 1955 contracts on the State Highway System were obtained from the Indiana State Highway Department. Estimates of costs for county and city construction and maintenance were obtained from a study of costs of improvements in counties and cities. In some

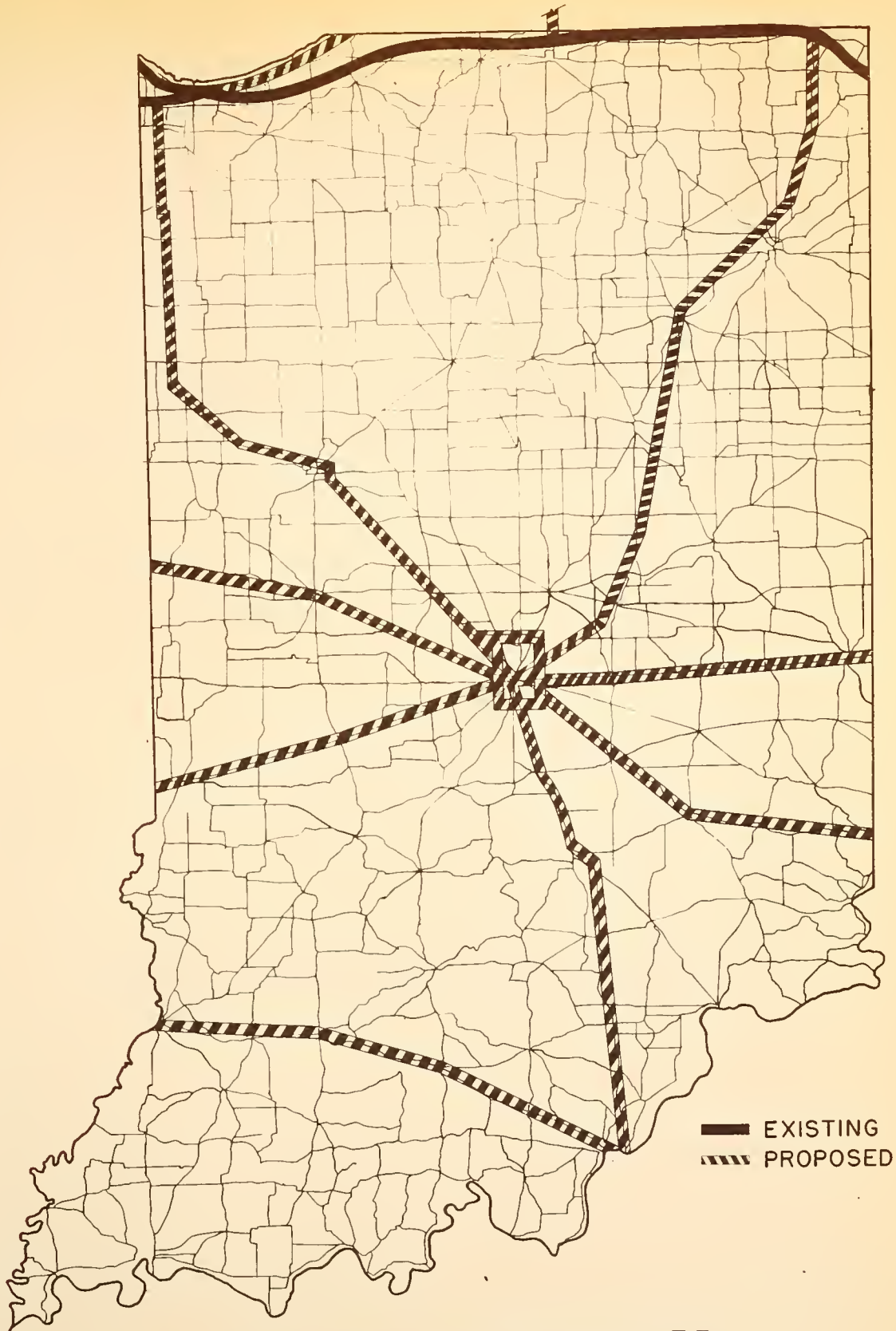
cases the cost studied were not for 1955 but were adjusted to the 1955 level. In all such cases, the Bureau of Public Roads cost index was used to adjust these costs. An adjustment in the yearly needs for the future was not made because fluctuations in the level of costs cannot be determined with accuracy.

Needed Improvements for the State Highway System

Although only a small percentage of the presently deficient mileage in Indiana is on the rural state highways and their urban extensions, correction of the deficiencies on the state systems requires 75 percent of the money needed to eliminate all present deficiencies. Furthermore, the elimination of present inadequacies on the Interstate System requires 61 percent of the total funds needed for the state systems and 46 percent of the total funds needed for all systems. The high cost of eliminating inadequate highway elements on the state systems is because of the high concentration of traffic on these systems and the resulting high construction costs, especially on the urban sections.

Interstate System

With the notable exception of the toll road and a few miles of public highways in the Calumet area, Indiana has very few miles of highway which meet the design standards required for the 1,100-mile Interstate System. This System, therefore, must be essentially "built from scratch". It will be necessary to relocate or reconstruct nearly every mile of the two-lane and four-lane divided highways that presently are designated as the Interstate System. Most four-lane divided highways on this System must be reconstructed because some geometric elements



EXISTING & PROPOSED
INTERSTATE HIGHWAYS

FIGURE 56

TABLE 7

Interstate System Mileages and Costs

Mileage Meeting Design Standards

<u>Location</u>	<u>Cost-Millions</u>		<u>Number of Miles</u>
	<u>Rural</u>	<u>Urban</u>	
Indiana Toll Road	--	--	156
Tri-State Expressway	--	--	<u>8</u>
			164

Mileage Not Meeting Design Standards

Remainder of System	<u>\$783</u>	<u>\$274</u>	<u>936</u>
Total	\$783 *	\$274 *	1,100

* Revised costs as determined by Section 108(d) Study conducted by State Highway Department of Indiana.

are not adequate and none of this mileage has completely controlled access. Table 7 presents the mileage which meets design standards, and the cost of the presently needed improvements on the remainder of the System.

There are 150 miles of urban and 786 miles of rural mileage not meeting design standards, and the urban mileage accounts for 26 percent of the Interstate System construction cost. The proposed expressway system in Indianapolis will cost over \$150 million.

Rural Primary and Secondary Highways

Table 8 lists presently needed improvements on the rural State Primary and Secondary Highway Systems. The costs are also very high, but are less than the rural Interstate System on a cost per mile basis.

Type of Deficiency and Work Required

The deficiencies which make the state highways intolerable have been classified as capacity, structural, and a combination of capacity and structural. Table 9 shows the type and extent of some of the current deficiencies. Many deficiencies on the Primary System are caused by inadequate capacity or structural inadequacy while those on the Secondary System are, as a general rule, structural deficiencies. One of the notable features shown by these data is the poor structural condition of the state systems. It can be observed that many miles of highway built in the early 1930's now need resurfacing or reconstruction and that many structures, built during this era, are now functionally obsolete.

The cost per mile of correcting capacity deficiencies is several times the cost per mile of correcting structural deficiencies because

TABLE 8

Present Deficiencies and Costs of Improvements
on Rural State Highways *

<u>Item</u>	<u>State Primary</u>	<u>State Secondary</u>	<u>Total</u>
Total Miles in System	3,600	5,400	9,000
Miles Deficient	1,057	1,775	2,832
Percent Deficient	29	32	31
Deficient Structures (No.)	526	752	1,278
Estimated Cost (Millions)			
Roads	\$192	\$146	\$338
Structures	<u>62</u>	<u>72</u>	<u>134</u>
Total	254	218	472

* Does not include Interstate System

TABLE 9

Types of Present Deficiencies on
Rural State Highways *

<u>Type of Deficiency</u>	<u>Miles</u>	<u>Percent</u>
Capacity	212	7
Structural	2,349	83
Capacity and Structural	<u>271</u>	<u>10</u>
Total	2,832	100

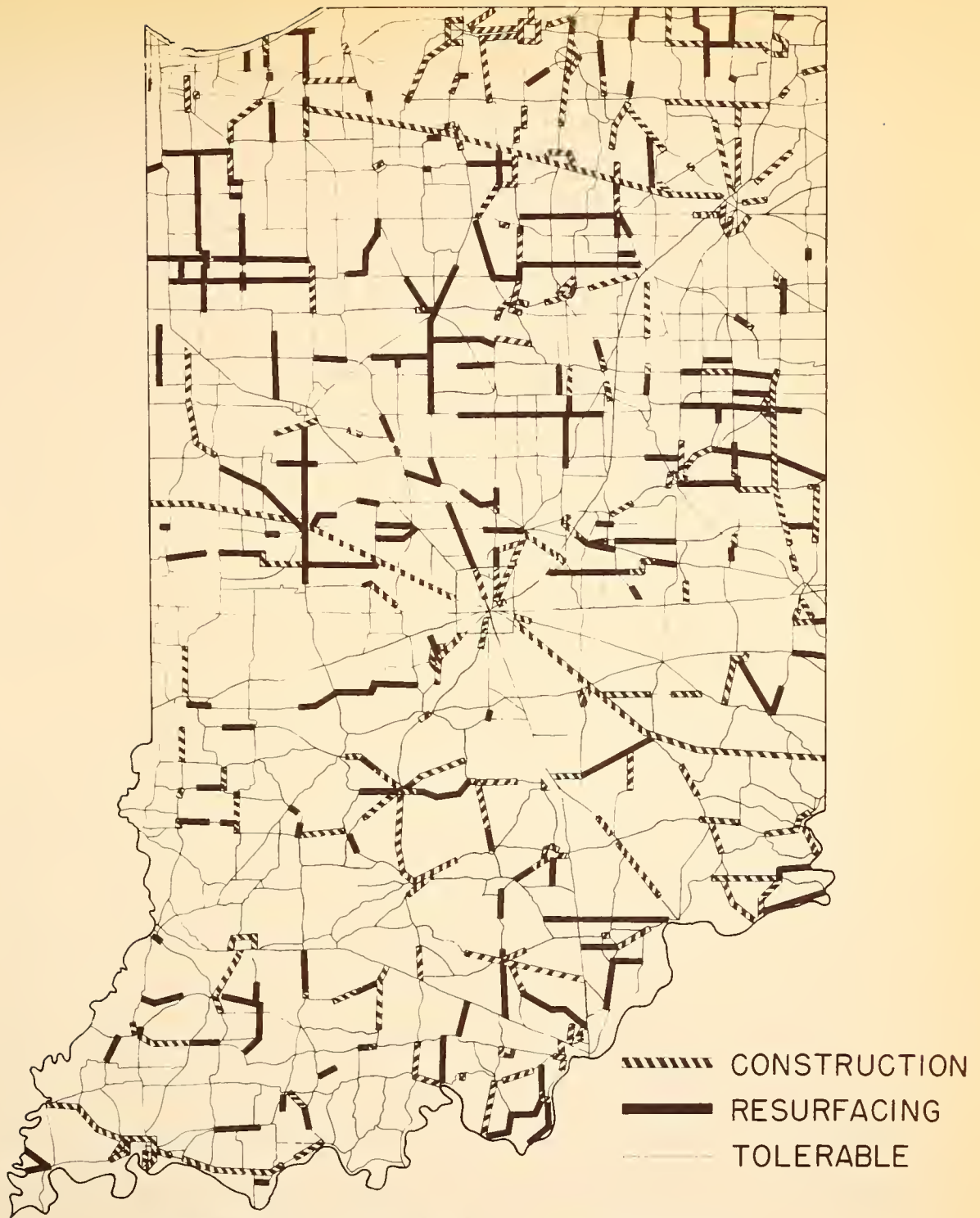
* Does not include Interstate System

TABLE 10

Types of Present Construction Needed and Costs on
Rural State Highways *

<u>Type of Improvement</u>	<u>Miles</u>	<u>Cost - \$ Millions</u>	<u>Percent of Total Cost</u>
Resurfacing	26	2	1
Widening and Resurfacing	1,391	64	14
Reconstruction	1,351	259	54
Relocation	64	14	3
Structures (Number 1278)	_____	<u>133</u>	<u>28</u>
Total	2,832	472	100

* Does not include Interstate System



IMMEDIATE NEEDS ON THE PRIMARY AND SECONDARY STATE SYSTEM

FIGURE 57

many of the capacity deficiencies require expensive four-lane divided construction. Many of the structural deficiencies of the pavement, on the other hand, can be corrected by a new surface and base or by resurfacing.

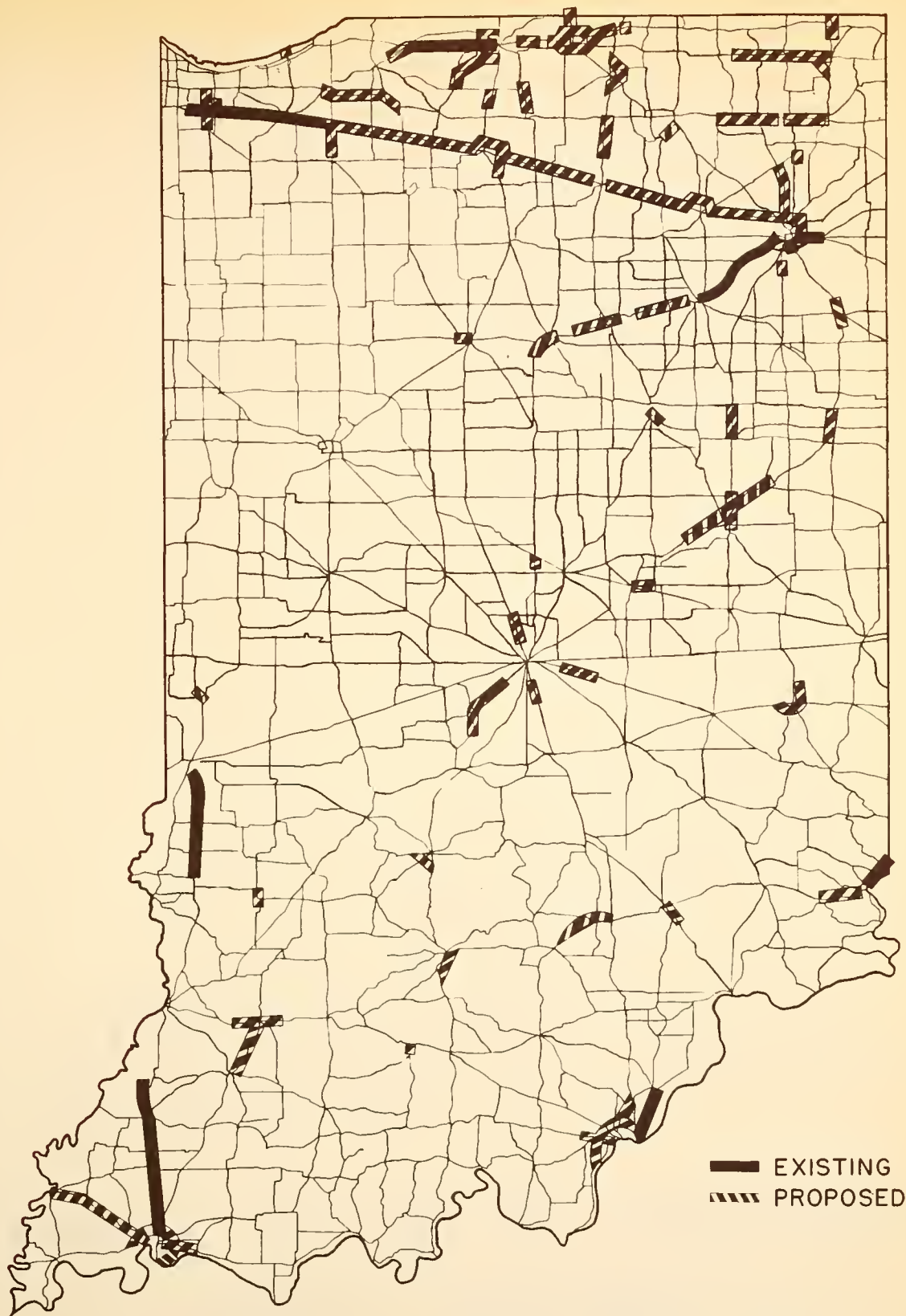
The types of construction to remedy these deficiencies are given in Table 10. Reconstruction contemplates using at least part of the old roadbed for the improved road. In some cases, however, highway cannot be located on the old alignment because controlled access is required. Figures 58 and 59 indicate the existing needed improvements on the rural Primary and Secondary Systems. Of the 2,832 miles needing improvements, nearly 450 miles require four-lane divided construction.

Deficiencies in 15 years

The immediate correction of existing deficiencies on the rural state systems is impossible; perhaps 10, 15, or 20 years are required, depending upon the economy, fiscal policy, and the availability of manpower. During this period of delay, additional roads and structures will become deficient, and these inadequacies must be corrected as they accrue if the entire system is to be adequate at the end of the program period. Figure 59 shows the location of these additional needs that will accrue over a period of 15 years and Table 11 indicates the type of needed improvements that will accrue. Table 12 shows how the needed improvements which accrue during the 15-year period are to be corrected.

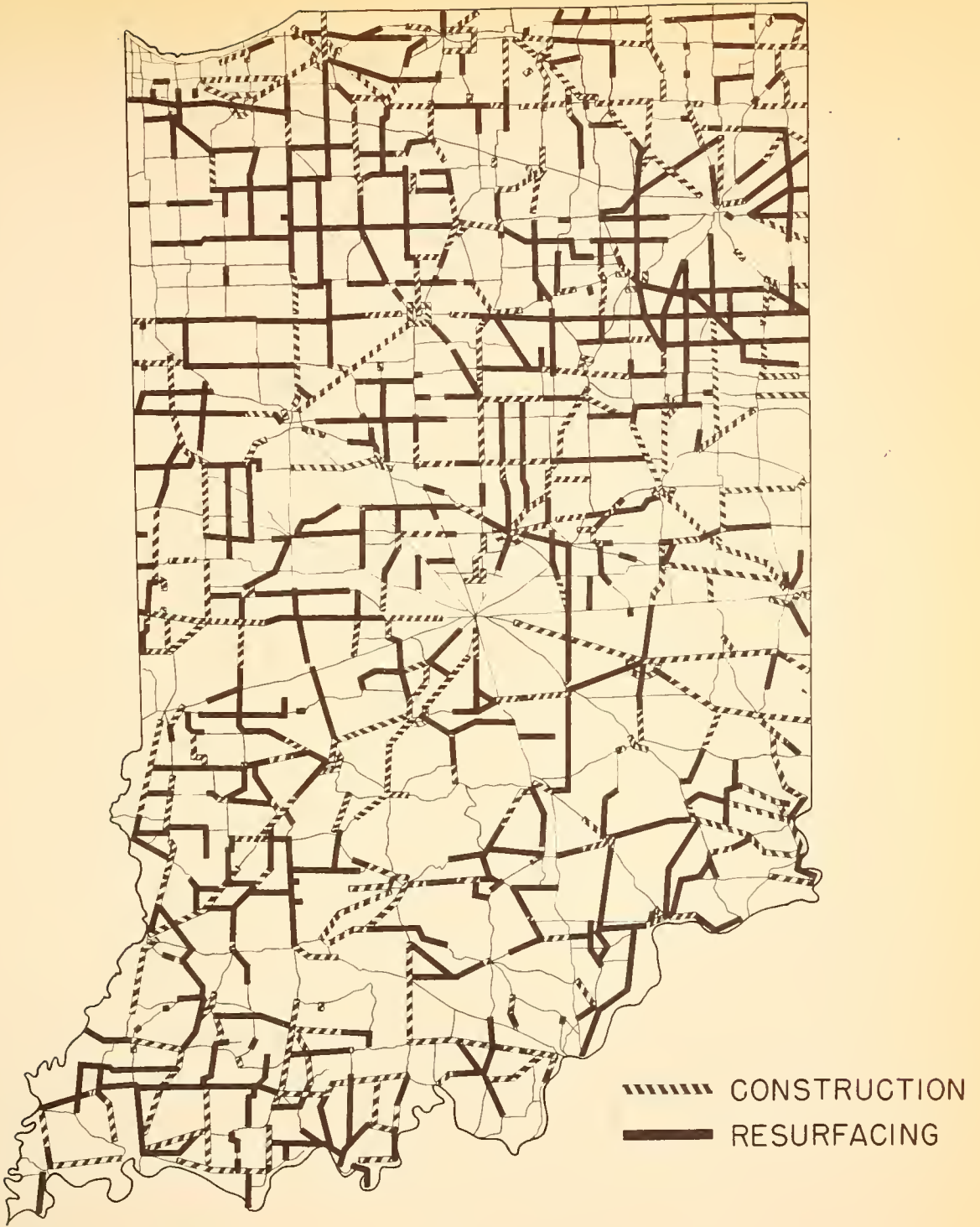
Urban State Highways

The solution to problems of highway transportation in urban areas must be bold and decisive. Problems in these areas are critical;



4 LANE DIVIDED HIGHWAYS NEEDED NOW
FOR PRIMARY AND SECONDARY SYSTEM

FIGURE 58



FUTURE NEEDS ON THE INDIANA STATE SYSTEM

FIGURE 59

TABLE 11

Future Deficiencies on Rural State Highways
for a 15-Year Program *

<u>Type of Deficiency</u>	<u>Miles</u>	<u>Percent</u>
Capacity	604	10
Structural	4,965	81
Capacity and Structural	<u>542</u>	<u>9</u>
Total	6,111	100

* Does not include Interstate System

TABLE 12

Types of Future Construction Needed and Costs on
Rural State Highways for a 15-year Program *

<u>Type of Improvement</u>	<u>Miles</u>	<u>Cost - \$ Millions</u>
Widening and Resurfacing	3,600	198
Reconstruction - Two Lanes	1,379	240
Reconstruction - Four Lanes	1,132	292
Structures (Number 1023)	-----	<u>118</u>
Total	6,111	848

* Does not include Interstate System

congestion and delay are clogging the lifelines of each large city in the state. The urban transportation problem is not confined to the urban extensions of the state systems in large cities; it also concerns urban extensions and bypasses in other communities. For this study, many of the state routes passing through communities having less than 5,000 population have been classified as urban routes.

Over 150 miles of bypasses now needed require multi-lane divided construction. The most critical urban problems, however, are in the large metropolitan areas. The work necessary to eliminate those deficiencies is important because these streets serve the heaviest traffic volumes, and the construction costs are extremely high. The dense development, the high costs of right-of-way, and the urgent need for extensive freeway construction result in average costs per mile which are many times higher than the cost per mile in rural areas.

Table 13 indicates the number of miles of urban construction that are presently needed and the cost of these improvements. The costs estimated in this table include the cost of freeway construction in several major cities. These projects have been proposed for several years and are urgently needed. The 150 miles of bypasses are required to relieve urban congestion and provide for the through movement of traffic.

Types of Deficiencies and Work Required

The types of deficiencies now present on the Urban State Highway System are shown in Table 14. Many miles of the structural inadequacy are pavements whose service life has been exceeded and are in need of reconstruction. Such items as narrow pavement, unrestricted parking, and heavy traffic volume are causing many capacity deficiencies.

TABLE 13

Present Deficiencies and Costs of Improvements
on Urban State Highways *

<u>Item</u>	<u>Total Miles</u>	<u>Miles Deficient or Needed</u>	<u>Number of Deficient or Needed Structures</u>	<u>Estimated Cost --- \$ Millions</u>	
				<u>Highway</u>	<u>Structures</u>
By passes	150	150	174	95	31
Other Urban State Highways:					
Cities: Popula- tion 0-3500	98	80	36	16	6
Cities: Popula- tion 3,500 - 500,000	<u>217</u>	<u>127</u>	<u>112</u>	<u>25</u>	<u>29</u>
Total	465	357	322	136	66

* Does not include Interstate System.

TABLE 11

Types of Present Deficiencies on Urban State Highways *

<u>Type of Deficiency</u>	<u>Miles</u>	<u>Percent of Deficient Mileage</u>
Capacity	172	48
Structural	139	39
Capacity and Structural	<u>46</u>	<u>13</u>
Total	357	100

* Does not include Interstate System.

TABLE 15

Types of Present Construction Needed and Costs on
Urban State Highways *

<u>Type of Improvement</u>	<u>Miles</u>	<u>Cost - \$ Millions</u>	<u>Percent of Total Cost</u>
Resurfacing	124	23	12
Reconstruction	21	6	3
New Construction	212	108	53
Structures (Number 322)	<u>—</u>	<u>65</u>	<u>32</u>
Total	357	202	100

* Does not include Interstate System

The financial demands shown in Table 15 do not include the cost of providing adequate off-street parking. Parking upon a city street is a privilege and all parking should be prohibited from those streets which do not have adequate capacity if parking is permitted. In other cases, capacity and traffic flow requirements may be obtained by using one-way streets. Improvement costs can be reduced by the use of such methods, and the needs shown below are based on the fullest use of such operational measures. The type of work necessary to correct the present deficiencies is also shown in Table 15.

Reconstruction, as used in Table 15, refers to work required to widen and resurface the existing pavement. In many cases, the old pavement cannot be salvaged for use as a base for the new pavement, but must be removed so that the widened street can fit into sidewalk grades and topography. Resurfacing refers to projects which can be completed by simply rehabilitating the facility and raising the elevation of manholes. New construction pertains to the complete rebuilding of a street, usually along new grade lines and new or partially new alignment.

Deficiencies Accruing in 15 Years

Table 16 shows the costs of the future improvements needed (within 15 years) for the Urban State Highways and also the kinds of deficiencies which will accrue. The data of present and future deficiencies indicate that about 40 percent of the total cost of urban highway improvements for a 15-year program will be eliminated with the correction of the present deficiencies. The types of improvement included for the future for a 15-year period are shown in Table 17.



New facilities, such as this cloverleaf intersection east of Indianapolis, must be designed to accommodate the traffic of the future as well as the present. Otherwise, as experience has demonstrated, traffic increases will render them obsolete years before they wear out.

Figure 50

TABLE 16

Future Deficiencies and Costs on Urban State Highways
for a 15-Year Program

<u>Type of Deficiency</u>	<u>Miles</u>	<u>Cost - \$ Million</u>	<u>Percent of Total Cost</u>
Capacity	270	151	56
Structural	330	88	32
Capacity and Structural	<u>70</u>	<u>33</u>	<u>12</u>
Total	670	272	100

TABLE 17

Types of Future Construction Needed and Costs on
Urban State Highways for a 15-Year Program

<u>Type of Improvement</u>	<u>Miles</u>	<u>Cost - \$ Millions</u>	<u>Percent of Total Cost</u>
Resurfacing	315	23	8
Reconstruction	102	19	7
New Construction	253	115	43
Structures	<u>---</u>	<u>115</u>	<u>42</u>
Total	670	272	100

* Does not include Interstate System

Municipal Streets

The improvements needed on city streets other than on urban extensions to state highways were also investigated. To obtain the total cost for eliminating all deficiencies in a given city, it is necessary to add the cost for needed municipal streets to the cost for the Urban State Highways in that city.

In many of the smaller cities the Urban State Highway extensions represent the only established systems of streets. Therefore, the arterial and access street mileages discussed here are those estimated during the course of the study by analyzing the street systems of many cities of Indiana.

The use of proper traffic engineering techniques was assumed in order to realize full and efficient utilization of the streets. In many cases on heavily traveled city arterials, it will be necessary to prohibit parking and to provide off-street parking to obtain the necessary traffic capacity.

Improvements Required on the Arterial Streets

Table 18 shows the deficient mileage of city arterial streets. The costs are based primarily on the monies required to eliminate deficiencies determined from engineering studies of various cities in Indiana and from the average urban inadequacies determined by needs studies in other states. Some of the deficiencies were caused by reasons other than inadequate capacity and poor structural condition. For example, some arterial streets do not have proper drainage, curbs and gutters, and/or sidewalks.

TABLE 18

Present Deficient Mileage and Costs on Arterial Streets *

Total Miles	2,624
Miles Deficient	656
Percent Deficient	26
Deficient Structures (Percent)	25
Estimated Cost - \$ Millions:	
Streets	115
Structures	<u>47</u>
Total	162

* Does not include Urban State Highways

TABLE 19

Types of Present Deficiencies on Arterial Streets *

<u>Type of Deficiency</u>	<u>Miles</u>	<u>Percent of Deficient Mileage</u>
Capacity	276	42
Structural	321	49
Capacity and Structural	<u>59</u>	<u>9</u>
Total	656	100

* Does not include Urban State Highways

TABLE 20

Types of Present Construction Needed and Costs on Arterial Streets *

<u>Type of Improvement</u>	<u>Miles</u>	<u>Cost in Millions</u>	<u>Percent Cost</u>
Resurfacing	466	2	1
Reconstruction and New Construction	190	113	70
Structures	<u>—</u>	<u>47</u>	<u>29</u>
Total	656	162	100

* Does not include Urban State Highways

Table 19 shows the approximate distribution of the types of present deficiencies. The types of improvement necessary to overcome these deficiencies and the cost of correcting them are shown in Table 20.

Future Deficiencies

The mileage of arterial streets which will probably become deficient within the next 15 years is shown in Table 21. The costs that are indicated include the cost of structures. Maximum use of operational improvements was assumed in prolonging the useful life of existing streets. Maximum salvage value of existing city streets was also assumed when these streets are to be improved. Table 22 gives a summary of the estimated work by type of improvement needed to eliminate the deficiency.

Residential Streets

Many miles of residential streets do not have curbs and gutters nor adequate drainage and sidewalks. However, in most cases, these deficiencies have not been considered as a direct highway need because the abutting property owners are usually responsible for the type of street in front of their homes. In addition, many cities require that the land developer build streets and sidewalks to at least minimum acceptable standards before selling lots to prospective home owners. Usually these city standards require streets with proper surface, curbs and gutters, sidewalks, and storm sewers. The costs presented here are those required to maintain and improve for the next 15 years residential streets that have been initially improved to acceptable standards by the property owners or the land developer.

Table 23 indicates the magnitude of some of the deficiencies that are present or that will accrue during the next 15 years. Cost of

TABLE 21

Types of Future Deficiencies and Costs on Arterial Streets *

<u>Type of Deficiency</u>	<u>Miles</u>	<u>Cost - \$ Millions</u>	<u>Percent of Total Cost</u>
Capacity	117	24	32
Structural	176	38	50
Capacity and Structural	<u>22</u>	<u>13</u>	<u>18</u>
Total	315	75	100

* Does not include Urban State Highways

TABLE 22

Types of Future Construction Needed on Arterial Streets *

<u>Type of Improvement</u>	<u>Number of Miles</u>
Resurfacing	154
Reconstruction and New Construction	<u>161</u>
Total	315

* Does not include Urban State Highways

TABLE 23

Present and Future Improvements and Costs
on Residential Streets

<u>Type of Improvement</u>	<u>Miles</u>	<u>Cost - \$ Millions</u>
Resurfacing	2,155	48
Reconstruction	<u>2,975</u>	<u>159</u>
Total	5,130	207

structures is included in the improvements indicated. The rate of improvement on residential streets will vary by community because these streets must be improved to a large extent by local funds, including property assessments and other local sources of revenue.

County Highways

All roads except state highways and city streets are under county jurisdiction in Indiana. Most of the counties, however, have not established a system of classifying their highways. Therefore, in this study, county highways have been classified into three groups - Primary, Secondary, and Local Service - and they are treated in this report as established systems (7).

The greatest need for improvement on county highways is on the Primary and Secondary Systems; these highways carry the largest volumes of traffic. Although a great proportion of the county road mileage has all-weather surfaces, many of the structures on these systems are inadequate for modern traffic. They are neither wide enough nor strong enough. A great many structural and functional deficiencies also exist on these county roads.

In Table 24, the mileage and cost of the work required to eliminate the present deficiencies and those expected within the next 15 years are shown for the county Primary and Secondary Systems.

Highways in the Local Service System are mainly concerned with providing adequate transportation for people who abut the highway. In most cases, all that is required to eliminate deficiencies is to improve

TABLE 24

Present and Future Improvements and Costs
on County Primary and Secondary Systems

<u>Type of Improvement</u>	<u>Miles</u>	<u>Cost - \$ Millions</u>	<u>Percent of Total Cost</u>
Resurfacing	9,971	121	32
Reconstruction	13,862	240	64
New Construction	<u>477</u>	<u>11</u>	<u>4</u>
Total	24,320	372	100

and properly maintain the existing roadway and replace the inadequate structures.

Very little major road construction was contemplated on the local road system. Those counties containing growing urban areas should require that the new roads in suburbs be developed to adequate standards by the land developer. These improvements are not included in total construction costs for local roads since they are primarily a responsibility of individual property owners or land developers. Some construction, however, is anticipated on this system. It will be the type of construction that is required to keep the present system serviceable for the small volume of traffic that uses these roads. The cost of the present and future work required on the Local Service System is indicated in Table 25.

TABLE 25

Present and Future Improvements and Costs
on County Local Service Systems

<u>Type of Improvement</u>	<u>Cost - \$ Millions</u>	<u>Percent of Total Cost</u>
Resurfacing	71	44
Reconstruction	87	54
New Construction	<u>3</u>	<u>2</u>
Total	161	100

Chapter VIII

PROGRAM

Selection of a Program

The present highway needs represent deficiencies which should have been corrected in earlier years; however, for various reasons they were not corrected. The magnitude of the needed improvements is so great that it is both physically and financially impossible to correct them within a few years. They must be scheduled over a longer period that is consistent with an acceptable financial policy and with the availability of engineering and construction manpower.

A program period of 15 years was selected as the optimum period and probably represents the minimum time in which a program of this magnitude could be completed efficiently and economically considering the financial and manpower requirements. The Federal Aid Highway Act of 1956 also requires construction of the Interstate System within 15 years, giving additional emphasis to the choice of a 15-year program.

The average annual expenditures necessary to eliminate all highway inadequacies in a shorter program period would be greater and perhaps beyond the revenue capacity of Indiana. The shorter the program period, the greater the benefits to the highway user in the form of efficient operation of his automobile, time savings, reduced accidents, and other benefits. On the other hand, a longer program period results in a smaller annual expenditure over the program period. No matter what program period - 10, 15, or 20 years - is used, the total expenditures on highway improvement and maintenance for a 30-year period will be approximately the same (25). This fact indicates that from a long range viewpoint a

10-year program would not cost more than a 20-year program and would yield additional benefits to the highway user.

Types of Needed Improvements

The following improvements were considered in the development of the costs for a 15-year program in this study:

1. Immediate Improvements Needed - The present deficiencies.
2. Future Requirements - The roads that are now adequate but that will wear out within the program period, and need replacement.
3. Replacements Needed - Improvements necessary before expected life is attained.
4. Stop-gap Requirements - Improvements of a temporary nature to presently inadequate roads to make them useable until inadequacies can be eliminated.
5. Maintenance - The preservation of the investment, operational costs, and highway housekeeping.
6. Administration - Engineering supervision and business management.

Immediate Improvements Needed

The immediate improvements refers to the amount of money needed to improve all inadequate highways, bridges, and railroad crossings to tolerable or design standards. This term refers explicitly to those inadequacies of the highway systems of Indiana that have accumulated because of the ever-increasing gap between an adequate and an inadequate highway system.

Future Requirements

Although 70 percent of the mileage on all systems is inadequate now, many miles of presently adequate highways will become deficient before completion of the 15-year program. Roads wear out or become inadequate, in a capacity sense, due to the increasing volumes of traffic. The accrual of these deficiencies during the program period represents a large portion of the total cost.

Replacements Needed

Replacements are results of inadequacies which develop on improved sections of highway before they are anticipated. For example, although the average service life of a structure is 50 years, a few structures will be adequate for only 10 years while others may be adequate for 75 years. A new bridge could be destroyed by a flood, or a relatively new section of highway may need more traffic lanes because of an unexpected increase of vehicular travel, perhaps caused by the construction of an industry along the new highway. The number and cost of such improvements, which will become inadequate within the program period, have been determined by probability computations. Over a short period of time replacement costs for a highway system are small, but they increase progressively as the program period is increased. The replacement costs for the 15-year program for the state highway systems are shown in Table 26.

Stop-Gap Requirements

At an accelerated rate of construction, it will be necessary to delay many improvement projects for several years because there is a

TABLE 26

Stop-gap and Replacement Costs for State Highway Systems -
15-Year Program

<u>Interstate System</u>	<u>Cost</u>
Replacement	\$ 19,004,000
Stop-gap	95,130,000
 <u>Rural Primary and Secondary and Urban</u>	
Replacement	\$ 33,210,000
Stop-gap	159,880,000

tremendous backlog of required improvements. Some of these delayed improvements will require temporary construction to permit traffic to safely use the highway. This additional construction is called the stop-gap requirements. The cost of these improvements was found to be approximately nine percent of the total construction costs on the state highway systems, the city arterial systems, and the county highway systems for the 15-year program. Stop-gap costs for residential streets and Local Services roads were not considered because improvement projects on these systems could be postponed without undue hardship to the relatively few highway users. Table 26 indicates the stop-gap costs on the state highway systems for the 15-year program.

Maintenance

Effective maintenance of highway facilities is essential so that uninterrupted traffic service can be provided. Analysis of cost records of highway maintenance is difficult because these are numerous maintenance functions and many of these functions are not clearly separated from construction activities. Maintenance costs, as used in this report for state, county, and city highway systems, do not include the cost of betterments, such as the cost of construction of low-type surfaces and other items which are capital improvements.

State Highway Maintenance

Roadway and structure maintenance on the rural state highways should be improved. At present funds for proper maintenance of many miles of highway are dispersed in order to spread available funds over the state systems.

Maintenance cost records of the State Highway Department served as a base for estimating the cost of adequate maintenance on the present and future systems. Maintenance costs on the future system will increase because many miles of four-lane divided highway and high-type, two-lane highway will be constructed. The average maintenance costs for various classifications are shown in Table 27.

County Road Maintenance

Cost information in the counties of Indiana is inadequate. However, costs for adequate maintenance were determined on the basis of average costs for labor, materials, and operating expenses. A summary of maintenance costs used in this study is shown in Table 28. Included in these estimates are sufficient funds for replacement of gravel, and patching and sealing of bituminous pavements.

City Street Maintenance

City street cost records like county highway cost records, are not adequate for estimating maintenance costs. The few records kept by certain cities vary considerably and the absence of a uniform method accounting makes it difficult to assign equitable costs. Unit costs for maintenance were determined, however, from available information for arterial and local access street systems and are shown in Table 29.

Administration

Administrative and overhead costs were included in the amounts for maintenance. Among the administrative costs are charges for rent

TABLE 27

Estimated Annual Costs Per Mile
for Adequate State Highway Maintenance

<u>System</u>	<u>Surface Type</u>			
	<u>High</u>		<u>Intermediate</u>	<u>Low</u>
	<u>Multiple Lane</u>	<u>Two-Lane</u>		
<u>Interstate</u>				
Rural	\$3500	--		
Urban	4500	--		
<u>Primary</u>				
Rural	2200	\$1500	\$1700	\$2000
<u>Secondary</u>				
Rural	2200	1400	1600	1500
<u>Urban</u>	3000	3000	2500	3000



Included in maintenance is the constant renewal of pavement, markings and other operational aid.

Figure 61

TABLE 28

Estimated Annual Costs Per Mile
For Adequate County Highway Maintenance

<u>County System</u>	<u>Dollars</u>
Primary	850
Secondary	500
Local Service:	
Improved	275
Unimproved	50

TABLE 29

Estimated Annual Costs Per Mile
For Adequate City Street Maintenance

<u>System</u>	<u>Dollars</u>
Arterial	2300
Residential Streets	1060

and upkeep of highway offices; salaries for administrative staffs, clerks, and typists; costs of plans and blueprint reproduction; and office supplies.

The Program

The program for this study is presented in the form of average annual costs and total costs for a 15-year program. Programs for other periods of time were considered but will not be presented for reasons already explained. The program presented shows the distribution of costs according to the classification of the state, county, and city highway systems.

Because of the large backlog of needed improvements, a large portion of the program time will be spent in correcting these deficiencies. Any future inadequacies which develop during this time, of course, must be delayed until the backlog of deficiencies are corrected. It may also be desirable to select different programs for different systems, such as an accelerated program on the major systems. However, worthy of consideration is the fact that longer program periods on any system postpone for many years improvements badly needed now.

State Highway Program

The annual program costs for the rural and urban state highways are summarized in Table 30. In this and the following tables, costs of stop-gaps and replacements are included in the cost of future improvements. Administrative costs are included in the maintenance costs. In the program outlined, 48 percent of the total cost is required to correct existing deficiencies, 39 percent is to provide for needs that will accrue within 15 years, and 13 percent is for maintenance.

TABLE 30

Cost of a 15-Year Program on the State Highway Systems

<u>Types of Highway</u>	<u>Total Cost</u>	<u>Average Annual Cost</u>
<u>Rural Interstate Highways*</u>		
Existing Needs	\$ 783,293,000	\$ 52,219,000
Future Needs	55,380,000	3,692,000
Maintenance Needs	<u>72,676,000</u>	<u>4,845,000</u>
Sub Total (Rural Interstate)	\$ 911,349,000	\$ 60,756,000
<u>Urban Interstate Highways *</u>		
Existing Needs	\$ 274,483,000	\$ 18,299,000
Future Needs	58,754,000	3,917,000
Maintenance Needs	<u>26,570,000</u>	<u>1,771,000</u>
Sub Total (Urban Interstate)	\$ 359,807,000	\$ 23,987,000
Total Interstate (Rural and Urban)	\$1,271,156,000	\$ 84,743,000
<u>Rural State Highways (Primary and Secondary)</u>		
Existing Needs	\$ 471,888,000	\$ 31,459,000
Future Needs	984,991,000	65,666,000
Maintenance Needs	<u>289,706,000</u>	<u>19,314,000</u>
Sub Total (Rural State Primary and Secondary)	\$1,746,585,000	\$ 116,439,000
<u>Urban State Highways</u>		
Existing Needs	\$ 201,642,000	\$ 13,443,000
Future Needs	327,736,000	21,849,000
Maintenance Needs	<u>64,882,000</u>	<u>4,325,000</u>
Sub Total (Urban)	\$ 594,267,000	\$ 39,617,000
Total (Rural Primary and Secondary Urban)	\$2,340,852,000	\$ 156,056,000
Total Interstate and State Highway (Rural and Urban)	\$3,612,008,000	\$ 240,799,000

* Costs revised to values obtained from Section 108(d) Study conducted by SHDI.

County Road Program

Improvement and maintenance of the 76,000 miles of county highways to acceptable standards will cost \$66 million per year for 15 years. Needs, of course, are not uniformly distributed throughout the state. Heavily populated counties with extensive road mileages near urban areas have greater needs than those counties of a predominately rural nature. Table 31 summarizes the costs of a 15-year improvement program on the county systems.

Of the total cost for the 15-year program, 54 percent is for construction and 46 percent is for maintenance. When compared with the State Highway System costs, the percentage required for maintenance is much higher on the county system. This is true because most of the mileage on the county system has an unstabilized surface and requires proper periodic maintenance to be kept in an adequate condition.

City Street Program

Based on the arterial system selected for those cities which did not have classified street systems and also on the classified street systems in existence in a few of the larger cities, the costs for a 15-year street improvement program shown in Table 32 were obtained. Many of the costs for arterial streets in cities are State Highway System costs and are not included in this table. In some cases, portions of the State Highway System should be removed from the smaller cities by means of adequate bypasses and the present streets should become the responsibility of the cities involved.

TABLE 31

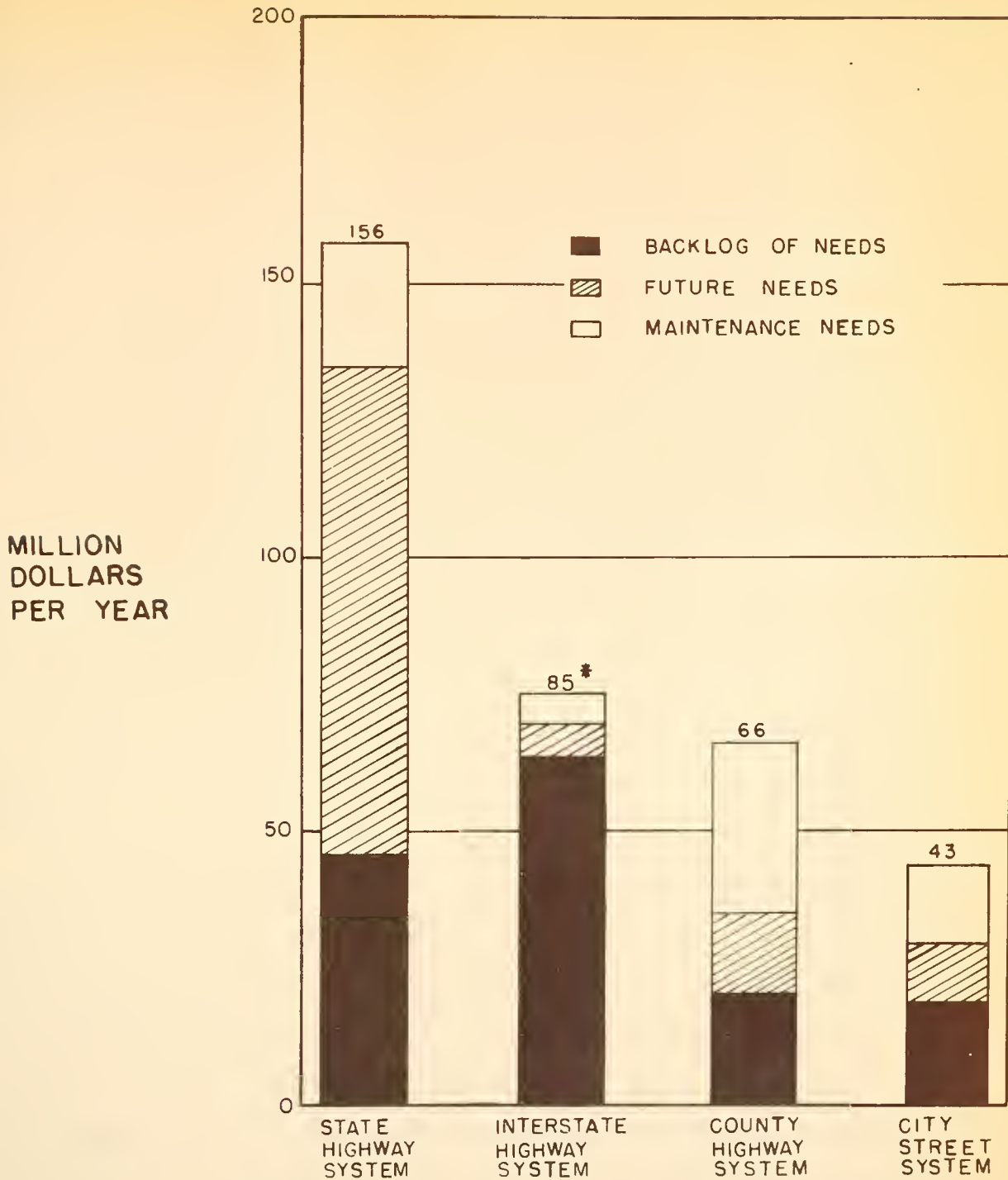
Cost of a 15-Year Program on the County Highway Systems

<u>Type of Highway</u>	<u>Total Cost</u>	<u>Average Annual Cost</u>
<u>Primary and Secondary Systems</u>		
Existing Needs	\$ 193,222,000	\$ 12,882,000
Future Needs	178,298,000	11,886,000
Maintenance Needs	<u>234,990,000</u>	<u>15,666,000</u>
Sub Total (Primary and Secondary)	\$ 606,510,000	\$ 40,434,000
<u>Local Service System</u>		
Existing Needs	\$ 105,001,000	\$ 7,000,000
Future Needs	56,493,000	3,766,000
Maintenance Needs	<u>222,786,000</u>	<u>14,852,000</u>
Sub Total (Local Service Roads)	\$ 384,280,000	\$ 25,618,000
Total	\$ 990,790,000	\$ 66,052,000

TABLE 32

Cost of a 15-Year Program on the City Street Systems

<u>Type of Highway</u>	<u>Total Cost</u>	<u>Average Annual Cost</u>
<u>Arterial Streets</u>		
Existing Needs	\$161,820,000	\$ 10,788,000
Future Needs	75,045,000	5,003,000
Maintenance Needs	<u>89,760,000</u>	<u>5,984,000</u>
Sub Total (Arterial Streets)	\$326,625,000	\$ 21,775,000
<u>Residential Streets</u>		
Existing Needs	\$109,740,000	\$ 7,316,000
Future Needs	97,080,000	6,472,000
Maintenance Needs	<u>116,490,000</u>	<u>7,766,000</u>
Sub Total (Residential Streets)	\$323,310,000	\$ 21,554,000
Total (Arterial and Residential)	\$649,935,000	\$ 43,329,000



ANNUAL AVERAGE COST FOR 15 YEAR PROGRAM

* CORRECTED TO COSTS OBTAINED FROM SECTION 108(d) STUDY

FIGURE 62

Results of a 15-Year Program

State Systems

It was assumed in this study that the deficiencies of each highway system (state, county, and city) would be corrected to a level that would give adequate service, considering the classification of each road or street and the amount of traffic which uses it, by the end of a 15-year improvement program. The status of the Interstate System would be as shown in Table 33.

It should be noted that on the rural system many miles of four-lane divided highways are necessary to complete this program. All rural mileage of the Interstate System must be at least 4-lane divided construction and limited access. For economic reasons it will be necessary to rebuild this entire system except those parts included in the Indiana Toll Road and the existing portion of the Tri-State Expressway.

The change in status on the rural Primary and Secondary Highway Systems for a 15-year program is given in Table 34. The degree of improvement on this system is obvious. The number of miles of paved two-lane highways will be decreased from 85 percent to 72 percent of the mileage in the two systems, and the number of miles of four-lane divided highways will be increased from 4 percent to 18 percent. Because much of the rural motor vehicle travel will occur on these systems, benefits to highway users will be great.

It is estimated that the number of miles of bypasses around urban areas will be increased by over 200 miles. Many miles of Urban State Highway extensions will also be widened, resurfaced, or rebuilt. The larger urban areas throughout the state will have freeway systems

TABLE 33

Present and Future Status of the Interstate System

<u>Type of Facility</u>	<u>Present Status</u>		<u>Status at the End of 15 Years</u>	
	<u>Miles</u>	<u>Percent of Total Miles</u>	<u>Miles</u>	<u>Percent of Total Miles</u>
<u>Urban Streets</u>				
Cities over 5000	66	6.3	0	0
Cities under 5000	30	2.8	0	0
Bypasses	5	0.5	60	6
Expressways	8	0.8	90	8
<u>Rural</u>				
Paved Two-Lane	700	66.6	0	0
Paved Four-Lane	<u>242</u>	<u>23.0</u>	<u>950</u>	<u>86</u>
Total	1,051	100.0	1,100	100

TABLE 34

Present and Future Status of the State
Rural Primary and Secondary Systems

<u>Type of Facility</u>	<u>Present Status</u>		<u>Status at End of 15-Year Program</u>	
	<u>Miles</u>	<u>Percent of Total Miles</u>	<u>Miles</u>	<u>Percent of Total Miles</u>
Gravel	65	1	0	0
Intermediate Pavement	935	10	935	10
Paved Two-Lane	7,810	85	6,965	72
Paved Four-Lane	<u>390</u>	<u>4</u>	<u>1,700</u>	<u>18</u>
Total	9,200	100	9,600	100

which will carry heavy traffic to the heart of the city safely, quickly, and economically. The greatest noticeable change in the highway system, in fact, will probably take place in these large metropolitan areas. People in these areas will observe the benefits of an adequate highway as they drive to work, shop, attend church, and perform other daily activities which require the use of motor vehicle transportation.

County Highway System

A great portion of the Primary and Secondary Systems in the counties must be resurfaced or reconstructed during the 15-year program. These systems will feel the greatest effects of the improvement program in the county. In general, many existing county highways have geometric design features that are adequate or that can be made adequate with a minimum of construction; the reason for most reconstruction or new construction on these roads is usually insufficient bases or surfaces. Many of the existing gravel roads which will carry over 200 vehicles per day must have an intermediate type pavement and, of course, some of the more heavily traveled roads must have high-type pavements.

Another major problem on the county Primary and Secondary Systems is the replacement of many inadequate bridges with structures that are capable of carrying heavy modern loadings and which have sufficient length and width to provide adequate waterway openings and safe, unobstructed vehicular passage. In some cases, these bridges can be widened to adequate standards by using less expensive construction than would be required for complete replacement.

The Local Service System will remain essentially as it is today except for replacement of inadequate structures and rebuilding of inadequate roads. Most of the money that will be spent on this system



Bottlenecks causing lengthy delays must be eliminated or by passed.

Figure 63

will be used for adequate maintenance. In general, the lowest surface type should be gravel, crushed stone, or some stabilized road surface. In counties in which large urban areas are located, the problem of the Local Service System will be complicated by the continual expansion of the city suburbs into the rural areas. These new highways will provide an additional maintenance and cost problem to the counties.

City Street System

The large cities of the state are faced with a serious problem in the elimination of present and future deficiencies within the next 15 years. Freeway and major thoroughfare construction is necessary on some city arterials in addition to the proposed for the State Highway System. A 1954 comprehensive traffic survey report for the city of Indianapolis outlines an extensive improvement program on the arterial system of the city which would greatly benefit the highway user. This program would be accomplished by providing streets of adequate width and surface for the movement of traffic with a minimum of delay. In the smaller cities much of the city arterial system is provided by the State System. For this reason the smaller cities do not have the serious problems that are found in large cities. However, these cities do have problems on their arterials, and a large amount of improvement is still necessary.

Because the initial construction of new residential streets is the responsibility of the land developer, the construction standards for these streets depend upon local laws and regulations concerning platting and city planning. In many cities these standards are adequate and enforced. When the improvement program ends, these new streets and all

existing streets should have adequate surfaces, curbs and gutters, sidewalks, and drainage. These streets will then provide adequate service for residential traffic and also contribute to a well-developed neighborhood that a wholesome society needs.

The parking problem in most cities is becoming more serious each year and there is little indication of any relief unless bold and decisive action is taken. Although parking improvements have not been included in this report, adequate, off-street parking garages and lots should be constructed in the next 15 years to more fully solve the highway transportation problem. Terminal parking facilities must be developed at the same rate or perhaps even faster than highway improvements. The urban transportation problem will be only partially solved if the problem of adequate parking is ignored or a half-hearted solution is attempted.

Priorities

The amount and cost of the work required on the roads and streets of Indiana make it imperative that priorities of improvement be determined and followed in the development of highway facilities. This tool of planning will insure that the most urgent and important work will be completed as rapidly as possible and will place the entire program on a logical and systematic basis.

The fact that roads and streets are classified into different systems places highways on some degree of priority. In most instances a highway on the Interstate System would have more urgent need of improvement than a county road. Each system, however, includes many miles of deficient highway for which a detailed method is needed to determine



Adequate off-street parking facilities are needed to help solve the highway transportation problem.

Figure 64

the priority of individual projects.

Controls on the classification of highway systems are usually the result of legislative action. However, the development of annual project priorities is the direct concern of the highway administration in each jurisdiction. Therefore, with proper classification of the road system, each jurisdiction should establish its own project priorities by developing a logical evaluation system for improvement.

Project priorities can be developed by measuring the service a highway performs and the adequacy of the highway to provide that service. Generally service is measured on the state system by comparing traffic volume and capacity. On the county systems, service is measured by existence of mail, milk, and other service routes, as well as traffic volume. Adequacy of the highway to serve traffic is generally measured by the relative condition of pavement; shoulders; drainage; and geometric design features such as pavement width, shoulder width, restricted sight distance, and horizontal and vertical alignment. Accident experience has also been used to measure adequacy of service.

Priorities can be determined by these yardsticks, but other criteria should also be used. It is desirable that highways be improved in an orderly manner so a whole route or section of a route is uniformly improved. It would be unwise for safety reasons to retain a few miles of two-lane highway between sections of four-lane divided highways. In addition, federal aid apportionments to each highway system must be considered. Technical difficulties in the preparation of surveys and plans, the procurement of right-of-way, the awarding of contracts, and unforeseeable emergencies such as floods, may influence priority rating programs. In the development of annual programs, all of these

factors must be considered and weighed with sound judgment by administrators to avoid pitfalls and impossible situations.

Sufficiency Ratings

Sufficiency rating procedures have been developed in recent years to assist in the determination of construction priorities (37). They have proved to be a valuable tool in selecting projects for annual programs. In these procedures, each section of highway is compared with accepted ideal standards of service, safety, and structural condition. Any condition which does not meet these ideal standards is given a rating which is a percentage of the ideal rating; the worse the condition the lower the rating. Annual review and revision of these ratings and the selection of those projects with the lowest ratings keeps the program geared to the most urgently needed improvements.

The State Highway Department of Indiana has not adopted a sufficiency rating procedure. If a logical programming method is to be established, a sufficiency rating procedure or other effective method must be adopted. Such procedures should also be used for county highways and municipal streets. The results would be as valuable to local administrators as to state administrators.

Chapter IX

FINANCE

Early Highway Financing

The development of highways from the time of Indiana's statehood in 1816 is intimately related to finance. Highway finance has progressed from the period of "payment in kind" in the early 19th century, when every physically capable male was expected to work as much as ten days on the road, to the present when highway revenues are collected from various sources (13).

The following discussion will not recommend a particular method of highway finance or form of allocation of the cost to the highway user and non-user. It will point out several sources of highway revenue that have been used in the past and those that are now being used.

In 1792 the Government of the Northwest Territory authorized the annual appointment of responsible individuals to supervise road work in each township. Under the system established, every physically capable male citizen over 15 years of age was required to work ten days per year without pay on the roads in his township. In 1799 a township road tax, to be assessed persons who did not perform actual work on the road, was authorized. These practices continued for more than a century.

A requirement of the Federal Government, when Indiana became a state, provided that five percent of the net proceeds from the sale of public lands in Indiana should be reserved for the construction of roads and canals. Three-fifths of these reserved funds were given to the new state government for expenditures on projects within Indiana while the remaining two-fifths were used by the Federal Government for the construction of the National Road (now U. S. 40). Money received from the

"three percent fund" for many years constituted the only aid to the counties and townships for road construction and maintenance.

From statehood to about 1850, the Indiana Legislature used a "special act" to finance the construction of highways. A State Commissioner was appointed to distribute the "three percent fund" to the counties, and on several occasions the Legislature made grants from this fund for the improvement of specific roads.

In 1835, the Internal Improvement Act provided money, obtained principally by borrowing, for the construction of canals and highways. This venture in bond financing did not prove financially successful and the state became burdened with a debt which could not be paid.

As a result of these financial failures, the state constitution provided, when revised in 1851, that no law shall authorize a debt to be contracted on behalf of the state except in extremely limited conditions. This "pay-as-you-go" policy has governed the method of financing the highways of Indiana to the present time.

Growth of Modern Highway Financing

The development of the motor vehicle caused great changes in highway financing. Prior to the development of the motor vehicle, highway funds came from local property taxation. As the motor vehicle grew in importance, the major source of highway funds shifted from a tax on property to a tax on the highway user. Property taxation remains an important source of highway revenue to cities, but its importance to counties as a source of highway revenue has diminished greatly in recent years. Funds from the property tax have not been used on the state systems since 1825. In recent years motor fuel taxes and registration fees have supplied most of the highway funds. Federal aid

has also had significant influence on highway finance and may have profound influence in the future.

Registration Fees and Motor Fuel Taxes

The State of Indiana entered the motor vehicle tax field in 1905 with the passage of its first motor vehicle licensing act. The act provided for a fee of one dollar to be paid to the General Fund of the State Treasury by the owner of each motor vehicle, regardless of size or type. The act also required Indiana's first official license plate, a circular disk two inches in diameter.

In 1913 a graduated system of taxation based on vehicle horsepower was adopted. The fee ranged from two dollars to twenty dollars annually for each vehicle. Because a state highway system in Indiana was not established at that time, the entire revenue, less the cost of supplies, operation, and administration, was apportioned to the counties. With the exception of registration fees for trucks, these fees remained the same until 1923.

In 1923 the graduated system of motor vehicle fees was changed to include the gross weight and horsepower of the vehicle. The year 1923 also saw the enactment of the state's first motor fuel tax, which provided for a tax of two cents on each gallon of gasoline. A substantial portion of the funds derived from this tax is allocated to the State Highway Department, which had been established in 1919. In 1925 the motor fuel tax was increased to three cents per gallon. One-third of the revenue derived from this tax was allocated to counties and cities, and two-thirds to the State Highway Commission. The motor fuel tax was increased to four cents per gallon in 1929. Three-fourths of the revenue derived from this tax was allocated to the State Highway

Commission and the remainder to counties and cities. The allocation formula was changed in 1932 and the counties and cities received a much larger share of the highway user imposts received by the State.

In March, 1957, the motor fuel tax was raised from four to six cents a gallon. The registration fees, however, were not increased. Essentially, vehicle registration fees have remained constant since 1922 with only minor changes in fees for heavy vehicles.

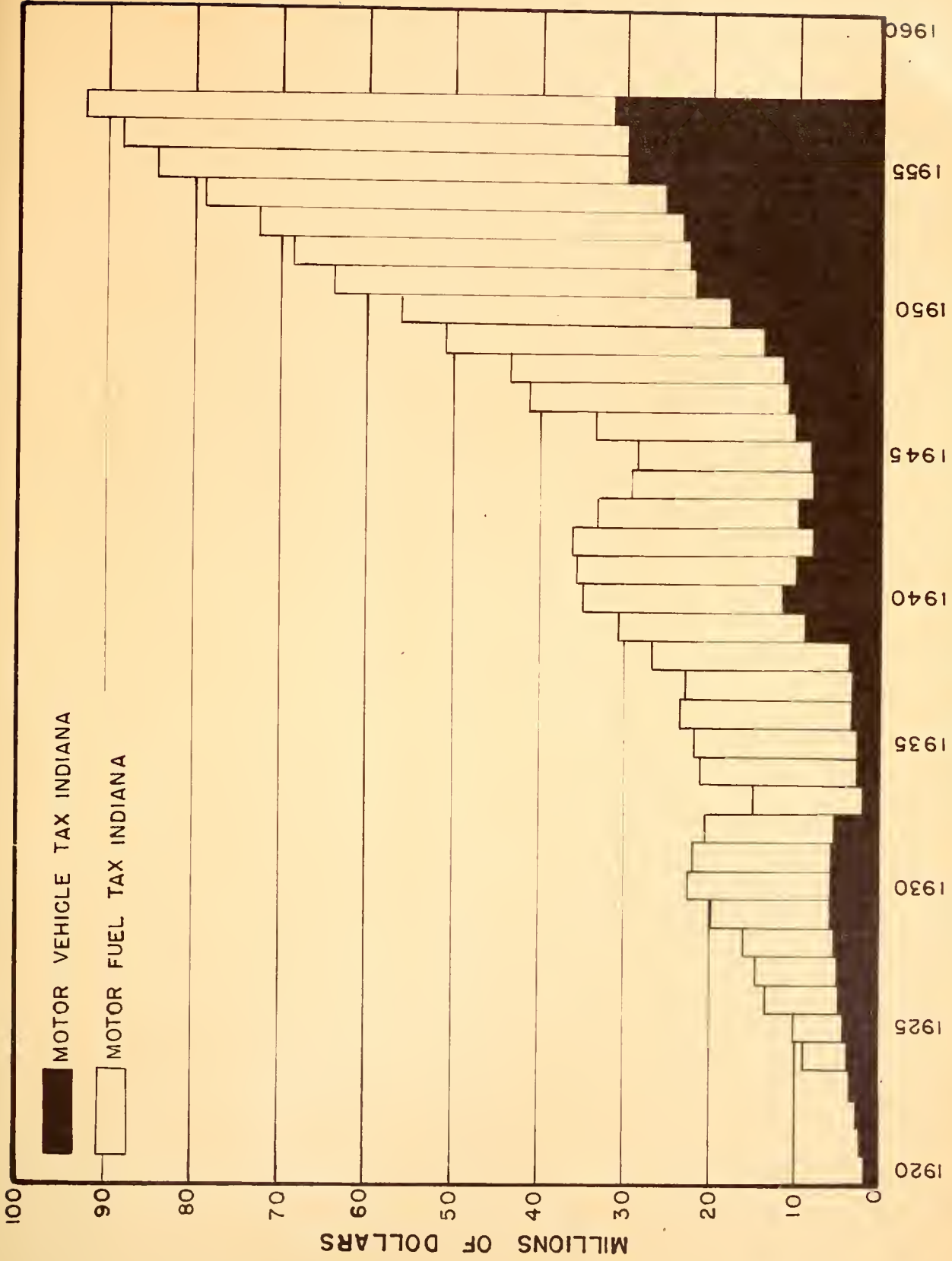
Motor vehicle registration fees and motor fuel taxes are now the major sources of highway revenue. During the years 1955 to 1956, Indiana received almost \$90 million in license and registration fees while motor fuel taxes provided over \$637 million.

Federal Aid

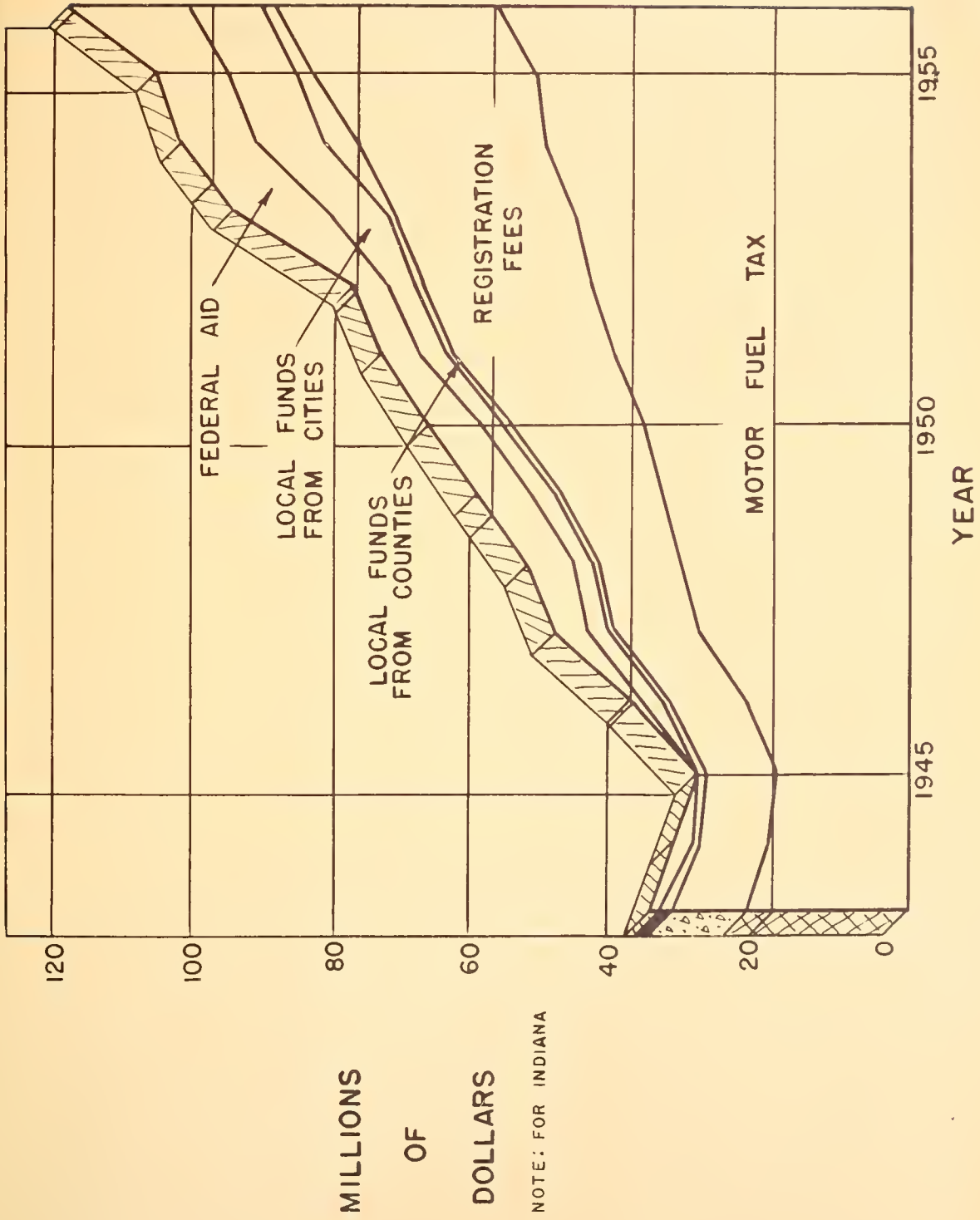
In 1916 the United States Congress passed the first federal aid act for highways. This legislation apportioned a total of \$75 million to the states for a five-year program. A steady increase in the federal aid highway programs has occurred with large increases in appropriations. Under provisions of the 1956 Act, about \$200 million was authorized for Indiana until the fiscal year ending June 30, 1959.

From 1917 to 1946, Indiana received \$139 million from the Federal Government for highway construction. For the ten years following 1946, federal funds were about 30 percent of the total funds spent on highway construction in Indiana.

A careful examination of the records reveals that Indiana has never lost federal aid funds for highway purposes because of the inability to match federal funds with state funds. However, in recent years the rate of obligating such funds has not kept pace with the rate



REVENUES FROM MAJOR HIGHWAY USER TAXES
INDIANA
FIGURE 65
SOURCE: REFERENCE NO. 64



MAJOR SOURCES OF HIGHWAY REVENUE

FIGURE 66

SOURCE: REFERENCE NOS. 33, 34, 36

at which federal funds are available. State matching funds simply were not adequate to meet the growing federal aid money. Loss of federal funds has not occurred, however, because of the two-year grace period provided by law. The recent increase in state motor fuel taxes from four to six cents a gallon will help provide sufficient revenues to meet federal funds.

Traditionally, federal funds have been allocated on a 50-50 matching basis with state revenues on approved highway construction projects. However, the formula for apportioning the total amount of federal funds approved has been greatly changed by the Federal Highway Act of 1956. One of the main features of the 1956 legislation provided for a 15-year program for the completion of the Interstate System. The construction costs for the mileage on this program in Indiana must be matched on the basis of 90 percent federal funds and 10 percent state funds. As an example of the magnitude of this program, Indiana had available over \$41 million in federal funds for the fiscal year, 1957-58, for use on this system.

Federal funds are still apportioned to the Primary, Secondary, and Urban Systems on the traditional 50-50 matching basis. It was anticipated for this study that the federal apportionment for construction of these highways will be increased slightly from year to year to \$24 million annually for these systems in Indiana. On the basis of present federal policies, it was estimated that for the 15 years, beginning with 1956, approximately 1613 million will be appropriated for the Interstate System and \$450 million for other systems--a total of \$2063 million in federal funds.

Property Taxation

The importance of property taxation as a source of highway revenue has declined during the past 30 years. In 1955 only seven percent of the total county revenues for highways came from property taxation or other local sources, and most of these funds were derived from a cumulative bridge levy. All funds for county highway construction and maintenance came from the Motor Vehicle Highway Account.

Property taxation and special assessments have always been an important source of revenues for the cities. In 1955 nearly 44 percent of the total street funds was obtained from these sources and the remaining amount was derived from the Motor Vehicle Highway Account.

Funds from property taxation have not been used on the state systems since 1925. All of the state revenues presently used on these systems are obtained from the Motor Vehicle Highway Account.

Motor Vehicle Highway Account

In 1937 the State Legislature established the "Motor Vehicle Highway Account" as a fund of the State. Receipts from registration fees, motor fuel taxes and funds from miscellaneous sources are credited to this account. Funds from this account are distributed by the State Auditor to the cities and counties and to the State Highway Department. The distribution of these funds has been changed by the State Legislature in the years 1941, 1943, 1947, and finally in 1949. At the present time, the net amount of this fund, after deduction of administrative costs and appropriations for the Division of Public Safety and for the State Police Department, is distributed as follows:

Incorporated Cities	15 percent
Counties	32 percent
State Highway Department	53 percent

For the fiscal year ending June 30, 1955, the cities received \$12.7 million, the counties \$27.1 million and the State Highway Department \$44.9 million from this Account.

Funds Distributed in 1955

State

The total funds available for highway purposes on the state systems are derived from monies distributed from the Motor Vehicle Highway Account and federal aid. Federal aid fund allocation is divided between the Interstate, Primary, Secondary, and Urban systems. The total made available in 1955 to the state systems from the Motor Vehicle Highway Account and federal aid was \$56 million (64).

Counties

County highway funds are derived mainly from the Motor Vehicle Highway Account. Since 1944, federal aid funds have also been made available to counties for use on approved Federal Aid Secondary Highways. In 1955 funds from local sources -property tax levy for use only on bridges- amounted to less than 10 percent of the total revenue for highway construction and maintenance. Total funds made available in 1955 from all sources amounted to \$30.7 million (33).

Cities

The principal source of revenue for the city street system is the distribution from the Motor Vehicle Highway Account. Local sources of revenue, however, are responsible for an appreciable portion of funds for the city streets. Local funds in 1955 amounted to approximately \$10 million, and the funds derived from the Motor Vehicle Highway Account

for that year were \$12.7 million. Funds from all sources for city street construction and maintenance were approximately \$24 million (34).

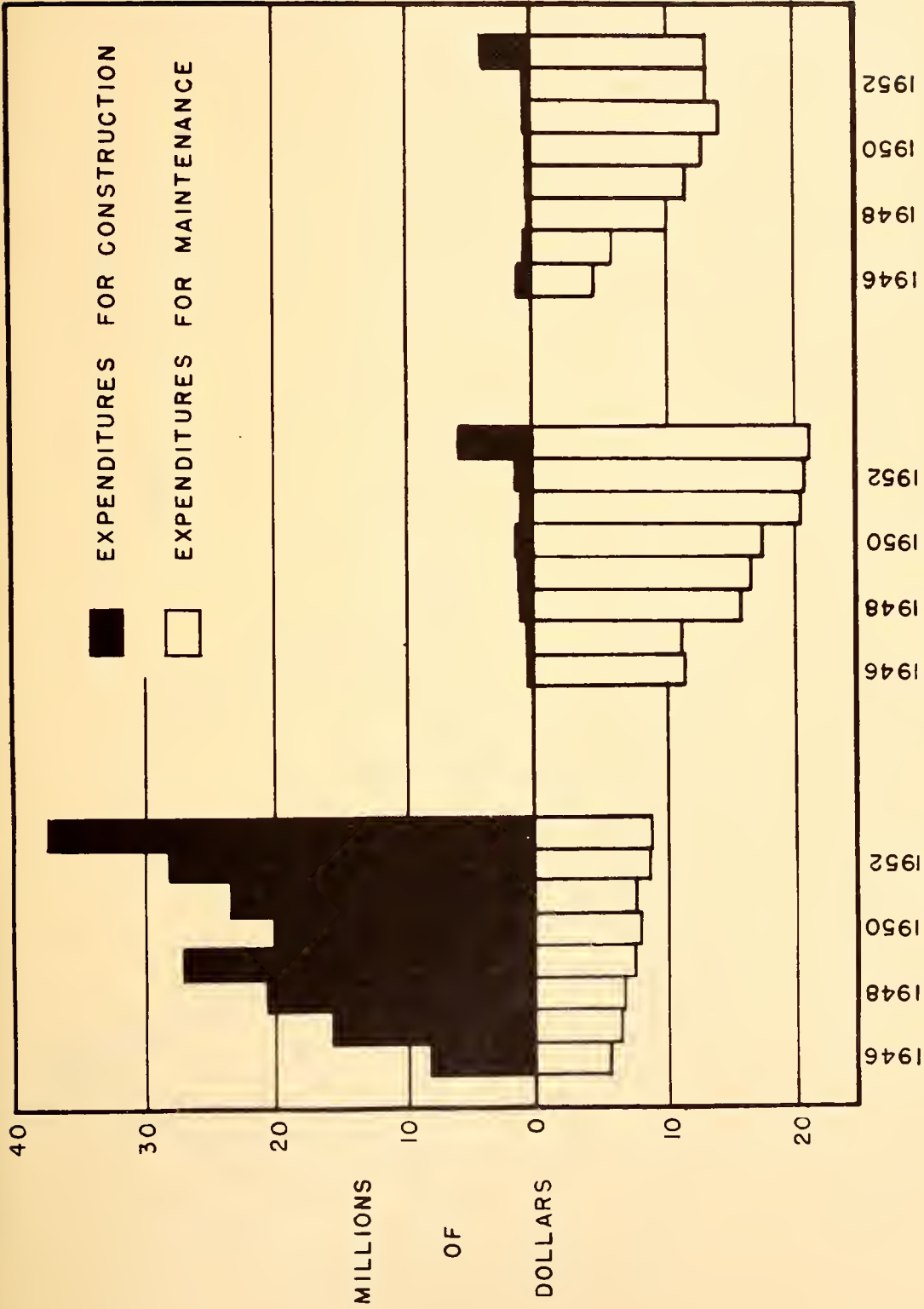
Expenditure of Highway Funds

Highway funds are spent for three highway functions--construction, maintenance, and administration. The distribution of funds for these highway functions vary between highway agencies. Difference in traffic, the extent and condition of the highway network, and the past and present funds available result in widely different expenditures on the various highway systems.

The accompanying chart indicates the construction and maintenance expenditures for 1946-1953 on the state, county, and city systems (75). Administration expenditures are included in the construction and maintenance costs. Expenditures for the state systems are primarily for construction, and expenditures for county roads and city streets are primarily for maintenance. It is a fact, however, that some of the costs that were classified as maintenance were construction, because past accounting methods have included some construction expenditures with maintenance costs.

Other Factors in Highway Finance

Highways are constructed, maintained, and administered by using equipment, labor and materials and are affected by inflation of costs. Since 1939 costs of highway work have risen steadily because of economic conditions during the war and post-war era. According to a highway construction cost index developed by the Bureau of Public Roads, the highway dollar in 1955 purchased only 79 percent as much as it did in 1946 and only about half as much as it did in 1932.

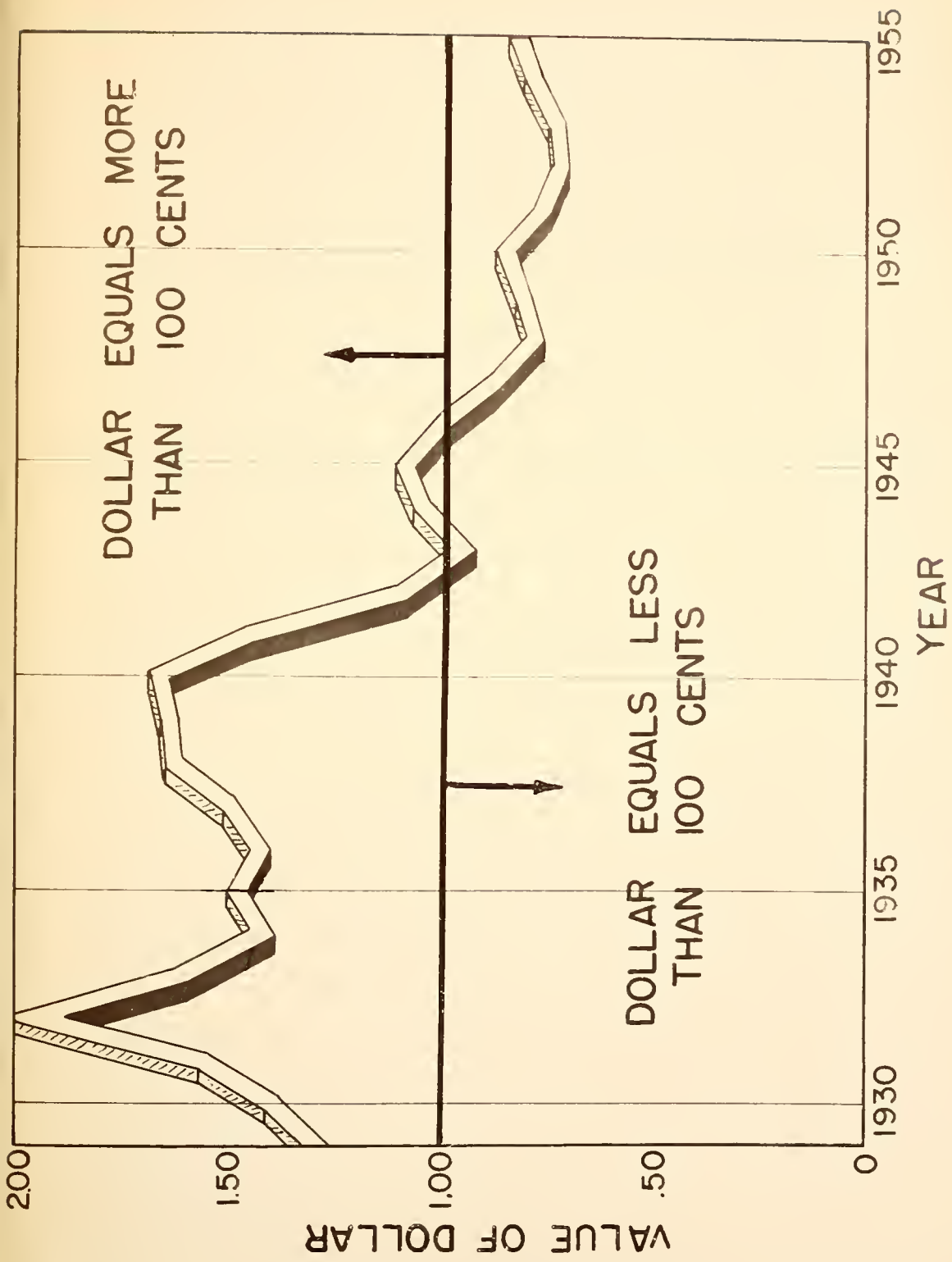


STATE HIGHWAYS COUNTY ROADS CITY STREETS

CONSTRUCTION AND MAINTENANCE EXPENDITURES FOR INDIANA'S HIGHWAYS

FIGURE 67

SOURCE: REFERENCE NO. 75



PURCHASING POWER OF THE HIGHWAY
CONSTRUCTION DOLLAR
FIGURE 68

Other conditions of major importance affect the cost of highway construction. Standards of highway construction have continually increased, and it is possible that they will increase in the future. Certainly the availability of funds will greatly influence the rate of structural obsolescence of the highway. Protection of the highway investment through adequate limited access laws will also have a pronounced influence on preventing functional obsolescence. All of these items have an effect on the ultimate highway cost.

Adequacy of Our Present Fiscal Program

The passage of the Federal Aid Highway Act of 1956 and the increase in state motor fuel taxes early in 1957 will result in more dollars for highway construction and maintenance in Indiana. The projection of the revenues from local sources, the Motor Vehicle Highway Account, and estimated income from federal aid will not, however, yield sufficient funds in the next 15 years to eliminate all of the highway deficiencies.

Conclusion

The highway fiscal policies used in Indiana are the results of experience and attitudes that developed in expanding the state from a frontier wilderness to an industrial and agricultural center of the midwest. The trend in highway finance is that the highway user, through vehicle and motor fuel taxes, is providing increasing revenue for highways. In 1955 the highway user provided nearly 86 percent of the total highway funds, excluding Federal Aid, available for highway improvement in the state.

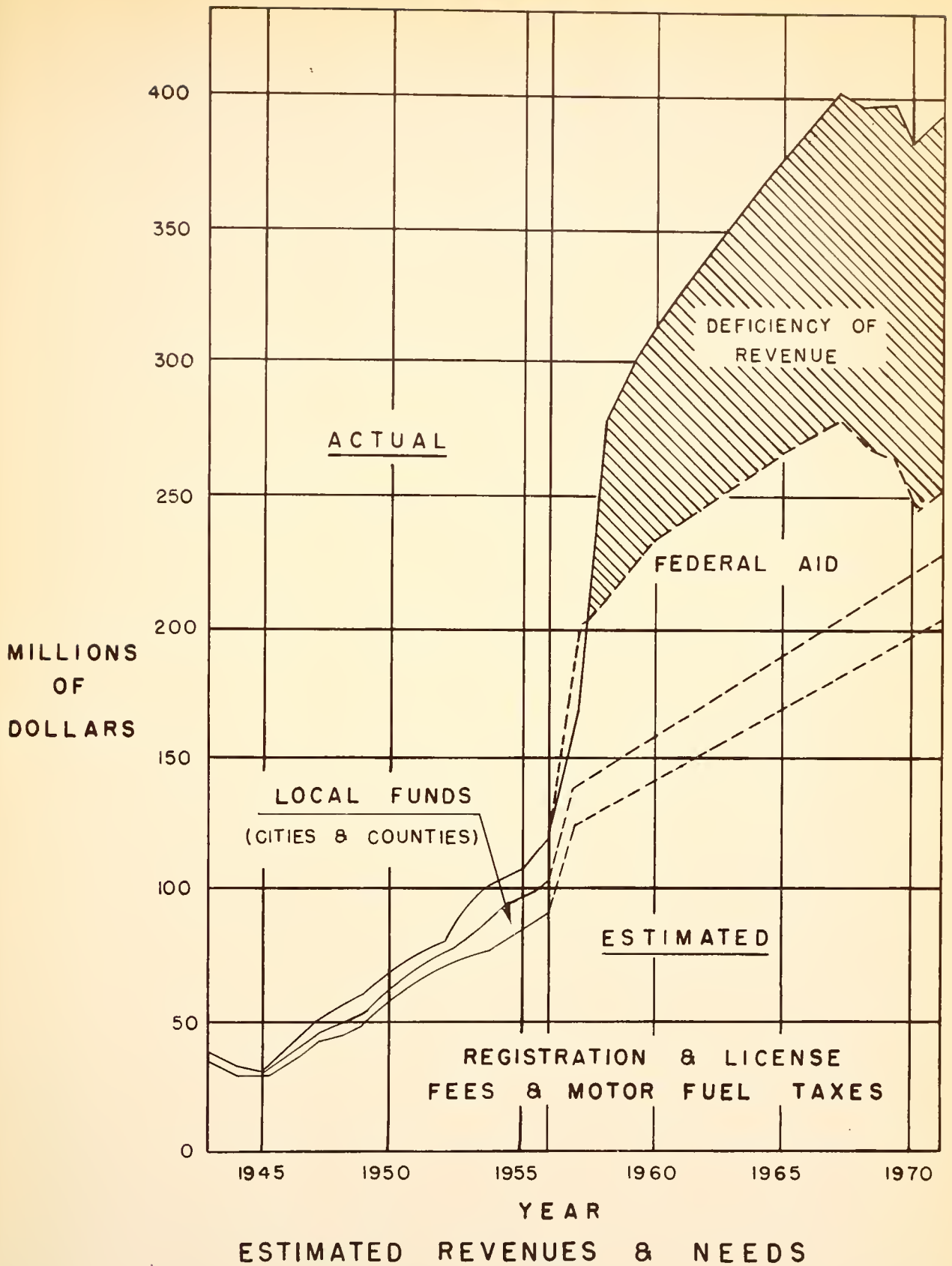


FIGURE 69

Although Congress has increased Federal Aid to Indiana and the General Assembly has increased motor fuel taxes, money to eliminate all deficiencies within 15 years will not be available under the fiscal policies.

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