STUDY DESIGN FOR COLUMBUS, INDIANA, MAJOR
THOROUGHFARE AND PLAN DEVELOPMENT STUDY

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BY

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JHRP

JOINT HIGHWAY RESEARCH PROJECT
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PLAN DEVELOPMENT STUDY

File: 3-7-4

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Interim Report
STUDY DESIGN FOR COLUMBUS, INDIANA, MAJOR THOROUGHFARE AND
PLAN DEVELOPMENT STUDY

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The opinions, findings and conclusions expressed in this
publication are those of the authors and not necessarily
those of the Federal Highway Administration.

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INTRODUCTION

It is anticipated that the City of Columbus and the Indiana State Highway Commission will undertake development of a major thoroughfare plan for Columbus, Indiana utilizing the simplified procedures developed by the Joint Highway Research Project at Purdue University and will utilize said organization as consultants in this undertaking.

The study is being undertaken to provide proper direction and planning for highway and street projects in the area on a cooperative basis to ensure provision of a future transportation system that will efficiently and effectively serve the area.

It is intended that this document, the Study Design for the Columbus Major Thoroughfare and Plan Development Study, delineate the methods and scope of work to be accomplished and the cost of same.

The study will produce the following data:

1. Inventory of dwelling units by corridor and by sub-zones
2. Inventory of total employees and retail employees by corridor and by sub-zone
3. Physical street inventory, including widths, parking restrictions and number of driving lanes
4. Summary of the capacity of the existing system by street section
5. Inventory of traffic control devices, including signals and timing, stop signs, etc.
6. Locations of major traffic generators
7. Recommended Major Thoroughfare Plan for 1990

DEFINITION OF TERMS

To adequately discuss the proposed procedure and preclude misunderstandings some possible confusing terms will be herein defined:

Major Thoroughfare - Thoroughfare System - Those streets that compose a network of the present or proposed routes used or designated to serve the majority of traffic within the city.

Central Business District - The major business district of a city sometimes called the downtown area plus immediate surrounding area.

Study - The overall planning program defined within this Manual.

Job - A unit of work from the entire study that has been defined to subdivide the total work into units indicating the work necessary for completion.

End Product - The material result of work performed for a specific job.

Study Area - The specific geographical area designated for the purpose of the study in order to delimit the area shown in Figure 1B.

Project Flow Chart - A diagram indicating all job activities and the general order of work progression.

Detailed Work Program - An identification of all jobs with subdivision of job work items for a particular study with a description of the purpose of the job, the end product (s) of the job, and the method to be used in performing the job. The Flow Chart indicates the interrelationship of all jobs, work items, and job activities. Agency

responsibilities are not designated; however, a budget cost estimate is provided by job.

Study Design - A document prepared prior to initiating the study to describe in detail the procedures to be used for the specific jobs.

Report - A formal document published to provide a permanent record of the study procedures, analyses, conclusions, and recommendations.

Target or Design Year - The selected future year for which forecasts and projections will be prepared in order to develop plans for long-range needs. The design year typically is 20 to 25 years in the future, and for the Columbus area a date of 1990 has been selected to meet this criterion and to fall on a census year.

THE MAJOR THOROUGHFARE PLANNING STUDY

The purpose of the major thoroughfare planning study is to provide for planning and development of an arterial street and highway network in Columbus, Indiana adequate to provide for the anticipated future needs.

The study outlined herein provides for inventory of the existing facilities and conditions, analysis of data, forecasts to the target year of traffic demands and development of a plan to meet the future needs. The plan will be prepared in a reproducible form.

Study Area

The study area for Columbus, Indiana is shown on Figure 1B. This delimits the area for detailed collection of employment, dwelling units and other data. Population information will be obtained from U.S. Bureau of Census reports and other sources listed under Previous Studies and Reports.

The area includes that portion expected to be developed by the target year (1990). This area is compatible with past planning efforts and can utilize information therefrom to the maximum (available reports listed at end of chapter).

The outer limits of the designated area take into consideration the location of Indiana State Highway Commission traffic counting stations.

FIGURE 1 . GEOGRAPHIC LOCATION & STUDY AREA LIMITS — COLUMBUS

Study Summary

The Columbus Major Thoroughfare and Plan Development Study will be a cooperative project involving the Indiana State Highway Commission, the City of Columbus and will utilize the Joint Highway Research Project of Purdue University as engineering - planning consultants. It is intended that partial financing will be from the Federal Highway Administration. The scope of the study will include the data collection and analysis necessary to develop a major thoroughfare plan for Columbus, Indiana, using the recently developed procedures outlined in the Joint Highway Research Project Report entitled "A Simplified Procedure for Major Thoroughfare Planning in Small Urban Areas."

The study will include the following:

1. Population study - Existing population data, 1970 U.S. Census combined with available economic data, will be used to forecast 1990 population. Intermediate forecasts at five year intervals will also be provided.
2. Using the existing land use inventory (current to June 1971) as a base, forecasted land use to the target year of 1990 will be made. Incremental forecasts at five year intervals will be provided.
3. An inventory of the existing transportation system will be completed using existing data where possible. The inventory will include accidents, present volume counts, travel times and capacity analysis.
4. Present and future traffic volumes will be developed using the simplified procedures developed by Joint Highway Research Project, calibrating by checks of the modeled volumes from an earlier year versus existing volumes and then future volumes on the major thoroughfare system will be forecasted to 1990

with five year incremental figures.

5. Parking controls on the thoroughfare system will be inventoried with recommendations for the future.
6. Traffic control will be reviewed with the explicit purpose of recommending traffic engineering type changes that will immediately, with minor cost, improve traffic flow and increase the capacity of the systems. These recommendations will be also considered in the formulation of the thoroughfare plan for the target year.
7. An inventory and review of laws and ordinances pertaining to transportation and development will be made.
8. A review of expenditures of public funds, city, county, state and/or federal, for transportation and related improvements in the area will be made. This historic pattern of disbursement of funds over a five to ten year period will be made to permit an evaluation of possible future expenditures. The ultimate purpose is to evaluate the financial feasibility of the recommended future improvements in the Major Thoroughfare Plan.
9. The intangibles that are of utmost concern to all, the social and community value factors, will be continually appraised during this study, at all times looking to the community leaders for guidance and direction ensuring compatability of the developed plan with the community goals and objectives.
10. Comparison of forecasted future traffic volumes to the calculated capacities for the system will identify the segments of the system that will require upgrading in the future. Recommendations will separately consider these segments with specific recommendations and through the media of

the intermediate five year forecasts will establish a priority ranking for the recommended improvements.

1970 will be the base year for data collection, with the actual forecast from 1970 to 1990. This will permit using 1970 Census data.

The continuing phase of the planning process, so important in any size study, will develop naturally in Columbus due to the nature of the simplified procedure for major thoroughfare planning, which requires input from the local people to permit its proper use and enhance its acceptability as a feasible procedure. Five year, or for that matter any required interim checks in the future will become a part of the routine of the city organization instead of becoming a special event. This is due to the simplicity of the procedure and due to the intimate knowledge gained through the duration of the initial study.

The final report "Major Thoroughfare Plan for Columbus, Indiana for 1990" will be prepared in reproducible form with final determination of the necessary copies to be made near the end of the study period. Interim reports will not be planned but could possibly be added at a later date if considered necessary.

The final report will include tabulations of existing data and forecasts. The final recommended major thoroughfare system with specific improvements tabulated by priority ranking, anticipated relative date of inclusion in the capital program, and estimated cost.

Previous Studies and Reports

Publications available in the Columbus City Engineer's Office or Office of Director of Planning.

1. Barton-Aschman Associates, Inc., Columbus Central Area Traffic Volumes, December 1970.

2. Barton-Aschman Associates, Inc., A Suggested Circulation Plan and Illustrative Parking Program (for Columbus CBD), January 1969.
3. Chastain, T. H., Columbus Transportation, Unpublished Report, Joint Highway Research Project, Purdue University, January 1972.
4. Columbus Area Chamber of Commerce, Industrial Directory.
5. Columbus Plan Commission, Columbus Master Plan, 1949.
6. Columbus Plan Commission, Columbus Master Plan, 1951.
7. Columbus Plan Commission, Comprehensive Plan - 1985, 1967.
8. Columbus Plan Commission, Proposed General Plan, 1966.
9. Columbus Plan Commission, Thoroughfare Plan - Ordinance, January 1968.
10. Columbus Plan Commission, Zoning Ordinance, 1971.
11. Columbus Plan Commission, Annual Reports, 1968, 1969, 1970.
12. DeLeuw, Cather & Company, Arterial Street Plan, (Columbus, Indiana), 1963.
13. DeLeuw, Cather & Company, Parking Needs and Feasibility Study; Bartholomew County Hospital, January 1966.
14. Hammer, Greene, Siler Associates, The Housing Crisis in Bartholomew County, Indiana, 1970.
15. Indiana Traffic Safety Survey Team, Traffic Safety Survey; City of Columbus, 1958.
16. 1960 Census, Population and Housing Characteristics, Columbus - Bartholomew County, Indiana.
17. 1970 Census, First Count Data, Bartholomew County, Indiana.

The Study Budget and Time Schedule

A detailed estimate of the man-days and costs that will be required to perform the work required in Columbus, Indiana to complete a major thoroughfare and plan development study has been prepared.

To permit placing all jobs in proper perspective and to evaluate the overall project in terms of critical jobs and their completion times, a Flow Chart and Time and Cost Estimate was prepared entering all the major job headings and assigning estimated time requirements to each job. Figure 1B and Table 1B presents this information.

Each of the jobs included in the program are completely outlined in the following pages. The total estimated cost is \$15,389.00. The detailed cost breakdown is shown in Table 1B.

Detailed Program

The Columbus, Indiana major thoroughfare plan and development study consists of ten major areas as follows:

1. Population
2. Land use
3. Physical inventory of existing transportation system
4. Present and future traffic volumes
5. Parking
6. Traffic control features
7. Laws and ordinances pertaining to transportation
8. Financial resources
9. Social and community value factors
10. Development of major thoroughfare plan

The report outlining and presenting the plan developed as a part of this study will be completed concurrently with

the above listed studies and will not require a separate job heading. Additional supporting items, subsidiary to the above named, are included as steps in the process and are indicated on the Flow Chart.

FIGURE 2 . PROJECT FLOWCHART - COLUMBUS THOROUGHFARE STUDY

Table 1 Time and Cost Estimates

Activity Description	Estimated Time Man Days	Estimated Cost Dollars
Study Design	0	0
Inventory of Map and Photos	5	250.00
Population Study:		
Inventory and Collection Data	2	100.00
Review and Summation by zones	2	100.00
Forecast by zones	5	250.00
Land Use:		
Inventory of Data	2	200.00
Update	5	250.00
Forecast by Zones	15	750.00
Transportation Facilities Inventory:		
Street Classification	-	
Physical Street Inventory	10	500.00
Determine Existing Street Volumes	15	750.00
Travel Time	10	500.00
Travel Patterns and Forecasts	15	750.00
Accident Study	5	250.00
Transit Service Inventory	5	250.00
Capacity Determination	10	500.00
Parking Inventory	5	250.00
Inventory of Traffic Control Devices	10	500.00
Inventory of Law and Ordinances	0.5	25.00
Review of Law and Ordinances	2	100.00
Inventory of Financial Resources	5	250.00
Review and Forecast of Financial Resources	10	500.00
Corridor Identification	10	500.00
Review of Social and Community Value Factors	0	
Development of Major Thoroughfare Plan:		
Determination of System Deficiencies	-	
Development of Alternative Plans	-	
Evaluation of Alternative Plans	-	
Selection of major thoroughfare plan	-	
Estimating Costs and Establishing Construction Priorities	-	
Preparation of Final Report	-	
	60	3,000.00
Estimated Total - Man Days	208	\$ 10,525.00
Supervision - Man Days	52	3,465.00
		\$ 13,990.00
Vehicle and Misc. 10%		1,399.00
		\$ 15,389.00

Estimated Costs Assume \$12,000 year for Staff and \$16,000 year for Supervisor.

JOB DESCRIPTIONS

To provide a sound basis for forecasting future traffic volumes in Columbus, Indiana two points in time, 1960 and 1970, will be used for a data base.

Using the volumes existing at the earlier time and applying growth factors, based on the increase in dwelling units, total employment and retail employment by corridor from that year to the existing year, to the earlier traffic volumes, a method of calibration is established. Comparison of these "forecasted" volumes to the actual volumes will confirm the corridor identification and limits. This procedure will allow the planner to identify any discrepancies in the delineation of the corridors and allow refinements of the boundaries to reflect local factors that are not in keeping with the normal patterns.

This same calibration or fitting procedure for the period 1960 to 1970 will also permit accurate checks on the simplified procedures for forecasting external traffic volumes described herein, dictating the use of the more sophisticated regression models if the checks so indicate.

Note: For most of the specific job tasks listed in the following pages a special manual outlining a procedure has been prepared by the National Committee on Urban Transportation. These manuals were prepared in the late 1950's; however, they are still good references. Where newer references are also available they will be specifically referenced in the job description. The titles of the manuals are as follows:

National Committee on Urban Transportation, Better Transportation for your City, Public Administration Service, Vermont Printing Company, 1958.

National Committee on Urban Transportation, Procedure Manuals, Public Administration Service, Cushing-Malloy, Inc., 1958.

Procedure Manual

"Conducting A Comprehensive Parking Study"

"Conducting A Limited Parking Study"

"Conducting A Home Interview Origin-Destination Survey"

"Cost Accounting for Streets and Highways"

"Determining Travel Time"

"Financial Records and Reports"

"Improving Transportation Administration"

"Inventory of the Physical Street System"

"Maintaining Accident Records"

"Measuring Traffic Volumes"

"Measuring Transit Service"

"Modernizing Laws and Ordinances"

"Origin-Destination and Land Use"

"Recommended Standards, Warrants, and Objectives for Transit"

"Services and Facilities"

"Standards for Street Facilities and Services"

Inventory of Maps and Photos

Aerial photography for 1960 and 1970 should be ordered initially. These are available from the Photogrammetry Section of the Indiana State Highway Commission, Statehouse, Indianapolis, Indiana. The scale of the negative allows photographic enlargements to a scale of 1" to 400'. 1969 photographs are to be substituted for 1970. This is not considered to be a significant variation. If later aerial photography is available at the initiation of the study the data base years may be changed to that year.

Topographic maps are available from the City Engineer's Office in Columbus, Indiana.

Employment data (Indiana Employment Securities Division) can be obtained for 1960 and 1970 through the Urban Planning Division of the Indiana State Highway Commission.

Copies of the reference reports listed in the list of Previous Studies and Reports are available at either the Columbus City Engineer's Office or the Office of Director of Planning.

Additional data sources will be referenced in the individual job descriptions and any additional reference sources should be checked initially by the study personnel.

Maps indicating the location of all overhead and underground utilities should be obtained initially from either the city or the utility companies.

The specific job identification on the Flow Chart is "Inventory of Maps and Photos". The estimated time necessary to complete the job is five man-days.

Population Employment Economics

The objective of the job is to estimate the 1990 Columbus, Indiana population and its distribution. The 1970 U.S. Census, combined with available economic data, other forecasts, etc., will be used to forecast the 1990 population. Intermediate population estimates at five year increments will also be determined.

Information contained in the numerous reports listed under Previous Studies and Reports and, in addition, recent information compiled by Indiana University for the Indiana Department of Commerce, Division of Planning, will be relied on extensively for the projections.

The distribution of the forecasted population throughout the study area will be accomplished with the guidance of personnel in the city administration and will be reflective of past projected growth trends.

The ultimate use of the information will be as an input to future traffic volume estimation for Columbus.

The population forecasts for Columbus will be made using the ratio method. The detail of breakdown or distribution will be by corridor.

Employment forecast and distribution will be a part of this study. Employment forecasts for the Columbus economic region were made as a part of the study completed by Indiana University for the Indiana Department of Commerce, Division of Planning. These forecasts will provide total future employment information for Columbus but will require distribution to corridors for traffic forecasting. The forecasted land use pattern will serve as the basis for the employment forecast, using the existing ratio of employees per land use unit for each classification as the basis for allocation of future employment to the various corridors. Chapin's Urban Land Use Planning book provides

a good reference and discusses population and employment studies on page 158 through 221.

The specific jobs and estimated time for this phase of the study is as follows:

1. The inventory and collection of available reference material, including all previous studies, should be completed initially. Two man-days are estimated for this job.
2. A review of previous studies should be completed, checking the forecasts where possible by comparing two points in time with the known population (1970 Census). Two man-days are estimated for this job.
3. A forecast of the population and employment for the Columbus study area should be completed relying primarily on work done by others. This will be an adjustment of previous work rather than a new forecast. Five man-days are estimated for this job.

Land Use

Land use plays a decisive part in any major thoroughfare study. The growth of an urban area and the use of the land interacting with the transportation facilities provides the impetus for continued directed growth. An existing land use inventory is necessary to locate residential areas, major traffic generators, etc. The current land use map maintained by the Columbus Director of Planning will be used as the base for this study and updated as necessary. The number of land use classifications used will coincide with the present city procedure. The standard SIC code will be followed for the land use inventory and forecast.

The 1990 land use forecast, with intermediate five year forecasts, is the ultimate objective of this job. This will locate the future residences and future employment to provide input to the traffic models for the major thoroughfare planning study.

Past studies will be reviewed and used to assist in the forecasting. The current zoning ordinances will establish the policy framework for guiding the future growth location in the forecasts. A recommended reference for the procedure is Chapin, F. Stuart, Urban Land Use Planning, University of Illinois Press, Urbana, Illinois, 1965, pp. 355 - 487.

Aerial photographs will be used for updating the land use inventory and for forecasting. Where necessary, on the ground checks will be made to supplement aerial photograph information, such as to determine the number of units in multi-family dwellings and to determine the classification for commercial establishments. The detail of breakdown will be by corridor.

The estimated time for this task is as follows:

1. Inventory and collection of existing information is estimated to take two man-days.
2. Review and updating of the land use inventory is estimated to take five man-days to complete.
3. Forecasting and distribution of future land use for the study area is estimated to require three man-weeks. The land use forecast will be accomplished concurrently with the population and employment forecasts and distribution.

Transportation System Inventory

This phase of the study will be subdivided into several sections discussed separately as follows:

1. Street classifications
2. Physical inventory of thoroughfares
3. Traffic volumes
4. Travel time
5. Traffic patterns and traffic forecasts
6. Accident study
7. Bus transit
8. Capacity determination
9. Parking
10. Inventory of traffic control devices
11. Calculation of street capacities

The information collected in the physical inventory will be used in the overall study as follows:

1. To determine capacities of the arterial system
2. To evaluate the overall level of service and system efficiency
3. To assist in location and quantification of problem areas
4. To provide basic information, right-of-way widths, etc., necessary for development of alternate plans

Street Classification

The arterial street system presently included as a part of the existing Columbus Master Plan will be accepted for use in the major thoroughfare study.

This job is considered an integral part of the physical inventory phase and was not assigned an estimated time.

Physical Inventory of Thoroughfares

A complete physical inventory of the present major thoroughfare system is an integral part of this study. The existing width and condition of the streets, right-of-way widths, number and width of lanes, whether curbed or not curbed, and the existing parking and traffic control devices will be obtained. The major portion of this information is available from existing reports or City Engineer records. The aerial photographs can be used for determining the street widths, number of lanes, existence of curbs, and right-of-way widths. A Gurley Rapid Comparator may be used to accurately measure street widths, etc., from the aerial photography.

Previous studies may be used for a source of information, using records of projects completed subsequent to the source document to update where necessary.

The condition of the streets should also be determined. This portion of the job task will require a windshield survey and should be completed concurrently with the traffic control device inventory.

National Committee on Urban Transportation Procedure Manual 5A discusses this phase of a study.

The estimated time required for this job is ten man-days.

Traffic Volumes

The existing traffic volumes will be obtained at all arterial streets or highway cordon crossings and at the central area screenline crossings. Volumes on the arterials at the approximate mid-point between the central area and the outer cordon will also be obtained. The majority of this information is available in the City Engineer's Office in Columbus and from Mr. Frank Howard, Indiana State Highway Commission, Indianapolis, Indiana for 1970. If a later year is used for the study other sources of data may be required. Missing counts may necessitate use of pneumatic tube recorders by study personnel. Counts should be taken on Monday through Friday, for a forty-eight hour period, when schools are in session. If there is any unusual event that would affect the normality of the counts they should not be taken during that period. An example would be a holiday, a major strike, etc.

The existing volumes will be utilized for comparison to the computed capacities for thoroughfare system to determine the available excess capacity, and to check street useage.

National Committee on Urban Transportation Procedure Manual 3A describes procedure for measuring traffic volumes.

The estimated time required for this phase of the study is three man-weeks. This time estimate is based on the assumption that 1970 volumes counts by the ISHC will be utilized with the actual forecast period being from 1970 to 1990.

Travel Time

Travel times during peak periods (7:00 - 9:00 A.M. and 4:00 - 6:00 P.M.) in the peak direction are to be obtained to provide a means of evaluating the existing level of service and efficiency.

Major thoroughfares providing central area access from all directions should be studied to provide an isochronal map of the study area. It is not considered necessary to include every street. One street per corridor is considered satisfactory.

The procedure for making travel time studies are described in National Committee on Urban Transportation Procedure Manual 3B.

The estimated time for this job is two man-weeks.

Travel Patterns and Traffic Forecasts

Using the simplified procedures developed by the Joint Highway Research Project at Purdue University, future traffic volumes will be forecasted for the major thoroughfares in Columbus. The traffic volumes existing on each major thoroughfare will be divided into two components, one representing the external traffic and one representing the internal traffic. Forecasts will be made for each component separately and then summed for the design volumes. The forecasted volumes will be determined by application of growth factors, based on the increase in dwelling units, total employees and retail employees, from the base year to the target year, in each corridor and applied to the internal traffic component. The growth factors will be developed as follows:

A. Internal Traffic:

1. The total dwelling units existing and forecasted for each corridor and for the entire study area are to be determined.
2. The total number of employees and number of retail employees (those employed in businesses with a SIC classification code between 5250 and 5460 or 5540 to 5990) are to be determined for each corridor and for the entire area for the base year and target year. The four digit code is used to correspond to the information available from the Indiana Employment Security Division; however, for forecasting the code will be summarized into one digit classification.
3. The percentage of the total trips to be represented by each parameter will be the same

as used in Lafayette. This is fifty percent for dwelling units, thirty-five percent for total employees and fifteen percent for retail employees.

4. A trip generation rate is calculated as follows:

$$\frac{\text{(Percent of trips represented by parameter)}}{\text{Total units of parameter in study area}}$$

Example: Assume there are ten thousand dwelling units, five thousand total employees and one thousand retail employees in an area in the base year.

$$\text{For dwelling units: } \frac{.50}{10,000} = 5.0 \times 10^{-5}$$

$$\text{For total employees: } \frac{.35}{5,000} = 7.0 \times 10^{-5}$$

$$\text{For retail employees: } \frac{.15}{1,000} = 15.0 \times 10^{-5}$$

For further calculations the 10^{-5} may be discarded.

5. A total trip generation rate is calculated for each corridor for the base year and the target year as follows:

Example: Assume one thousand dwelling units in corridor in base year, one thousand two hundred dwelling units in corridor in target year; five hundred total employees in corridor in base year and seven hundred in corridor in target year; one hundred retail employees in corridor in base year and one hundred-twenty retail employees in corridor in target year. Calculation of growth factor:

Base Year

$$1,000 \text{ dwelling units} \times 5.0 = 5,000$$

$$500 \text{ total employees} \times 7.0 = 3,500$$

$$100 \text{ retail employees} \times 15.0 = 1,500$$

$$\underline{10,000}$$

Target Year

1,200 dwelling units X 5.0	=	6,000
700 total employees X 7.0	=	4,900
120 retail employees X 15.0	=	<u>1,800</u>
		12,700

The growth factor for the corridor is the total for the target year divided by the total for the base year.

$$\text{Example: Growth Factor} = \frac{12,700}{10,000} = 1.27$$

6. The growth factor is applied to the existing internal traffic volume in the corridor near the screenline adjacent to the central area to determine the forecasted volume for that point for the target year. The same procedure should be followed for a point in the corridor near the midpoint between the central area and the external cordon or outside boundary of the study area. The same growth is applied to the existing traffic volume, because the existing traffic volume represents total vehicle movement and is not directional.
7. The same procedure should be followed for a circumferential route after determination of the corridor boundaries for the route. These corridors will naturally overlap the radial corridors. This does not affect the procedure and valid results will be obtained.

The calibration of the procedure to fit local conditions is discussed in the corridor identification section. This calibration will require developing growth factors for the period from 1960 to 1970. Applying these growth factors in the 1960 traffic volumes will provide the necessary check on the corridor delineation. The final step in the forecasting technique is to forecast dwelling

units, total employment and retail employment for each corridor to the target year, 1990, by five year steps. Computation and application of the growth factors to 1970 traffic volumes give the design traffic volumes for each interim period.

B.External

External traffic volumes will be expanded separately from internal traffic volumes and the two forecasts combined for the total volume to be used for design. The following procedure will be used to determine the external-external trips, those passing through the area, and the external-internal trips, those with origins or destinations in the area, crossing at each external station on a major thoroughfare in a corridor.

The total number of vehicles presently crossing the external cordon on a major thoroughfare in an average twenty-four hour period will be determined using automatic traffic recording devices such as the pneumatic tube counters. The percent that the volumes at each cordon location represent of the total volume of such crossings is determined.

An external growth factor developed by dividing the total vehicle registration for 1970 by the total vehicle registration for 1960 for Bartholomew County is applied to the total external traffic volumes for 1960 and the result compared to existing 1970 volumes. If the comparison substantiates that the accuracy of the procedure is satisfactory an external growth factor for the period 1970 - 1990 is developed by forecasting county vehicle registration based on the historical trend.

The required accuracy will be determined by review of the forecasted 1990 volume at the central area screenline. If the error in the forecasted volume at the screenline is sufficient to require a design change then an alternate forecast procedure should be used (regression model).

The total external-external traffic volume as determined for the study area by a regression model. The regression model is as follows:

$$Y = 4.28 + 0.035(X1) + 0.066(X2) - 0.064(X3)$$

Where:

Y = The total external-external cordon crossings for the city.

X1= Population of cities larger than subject city within 25 miles radius of center of city, expressed in thousands.

X2= County population density, expressed as persons per square mile.

X3= Population of cities smaller than subject city within 25 mile radius of center of city, expressed in thousands.

This volume is distributed among the cordon stations using the same percentage ratio for each station as exists. Subtracting this from the total external volume determined above gives the external-internal component.

The next step is to determine the percentage of the external-internal traffic destined to the central area. This is calculated by setting the ratio of the employment in the central area to the total study area employment equal to the ratio of the external-internal traffic destined to the Central Area to the total external-internal traffic and solving for the external-internal traffic destined to the central area.

An Example follows:

Assume: External cordon station with ten percent of total external traffic crossing at that point; total external-internal traffic for the study area is ten thousand external crossings; central area total employment is five thousand with total study area employment ten thousand. To find the component of the external-internal traffic crossing the central area screenline, compute as follows:

10 percent of 10,000=1,000 external-internal trips crossing at the external cordon station.

$$\frac{5,000}{10,000} = \frac{X}{1,000} ; \quad \begin{array}{l} X = 500 \text{ external-internal trips} \\ \text{crossing the central area} \\ \text{screenline.} \end{array}$$

A sample calculation of the forecasted volume on a major thoroughfare (corridor) at the central area cordon is as follows:

Example: Existing observed total traffic volume at the central area screenline is ten thousand vehicles per day. External-external volume at the external station on the corridor is one thousand vehicles per day.

1. Utilizing the above procedure for determining the external-internal component to the central area, the figure is determined to be five hundred vehicles per day. The external-external volume is added to the above to give the total traffic to be expanded using the external growth factor. This gives a total of fifteen hundred vehicles per day.
2. 10,000 - 1,500 leaves 8,500 vehicles per day as the internal-internal traffic to be expanded using the corridor growth factor.

A sample calculation sheet from the West Lafayette - Lafayette area procedure check is included (Table 2B) for informational purposes.

This job is estimated to require three man-weeks.

Table 2 Radial Corridors - Lafayette - Near Central Area

Corridor	Streets	1952 Volume	Internal		External		Estimated 1970 Volume	Actual 1970 Volume	Corridor Error
			Volume	Growth Factor	Volume	Growth Factor			
1	Wabash	3,530	3,530	2.14	-	-	7,554	6,000	
	Third & Fourth	8,740	5,440	2.14	3,300	1.9	17,911	18,400	
		<u>12,270</u>					<u>25,465</u>	<u>24,400</u>	1,065
2	Ninth	3,760	3,760	2.48	-	-	9,325	10,100	- 775
3	Eighteenth	2,850	2,850	3.53	-	-	10,060	11,100	-1,040
4	Main	7,690	5,690	1.97	2,000	1.9	15,010	10,500	4,510
5	South	7,370	5,870	1.93	1,500	1.9	14,180	12,000	2,180
6	Union	3,630	3,630	3.90	-	-	14,156	10,500	
	Elmwood	1,660	1,660	3.90	-	-	6,474	12,000	
		<u>5,290</u>					<u>20,630</u>	<u>22,500</u>	-1,870
7	Eighteenth	2,950	2,450	1.11	500	1.9	3,670	6,800	
	Fourteenth	6,950	5,450	1.11	1,500	1.9	8,900	5,500	
		<u>9,900</u>					<u>12,570</u>	<u>12,300</u>	270
8	Ninth	3,010	2,710	1.54	300	1.9	4,745	7,000	
	Canal	3,650	2,950	1.54	700	1.9	5,875	9,000	
		<u>6,660</u>					<u>10,620</u>	<u>16,000</u>	-5,380
9	SR 43 N	3,190	730	9.63	2,460	1.9	11,703	9,400	
	Robinson	1,820	1,820	9.63	-	-	17,526	3,920	
	Salisbury	1,240	1,240	9.63	-	-	11,941	7,550	
		<u>6,250</u>					<u>41,170</u>	<u>20,870</u>	20,300
10	Salisbury	1,240	1,240	8.58	-	-	10,640	7,550	
	Grant	1,580	1,580	8.58	-	-	13,555	6,500	
		<u>2,820</u>					<u>24,195</u>	<u>14,050</u>	
								3,900 Robinson	
								<u>17,950</u>	6,245
12	Northwestern	5,500	2,300	7.27	3,200	1.6	21,840	14,500	7,340
13	State	10,000	8,500	3.18	1,500	1.9	29,880	18,500	
	Stadium	5,580	5,580	3.18	-	-	17,744	10,500	
		<u>15,580</u>					<u>47,624</u>	<u>29,000</u>	
						Wood, Harrison, Williams		9,500	
								<u>38,500</u>	9,124

Average Existing Volume Per Corridor = 16,352

Average Estimated Volume Per Corridor = 21,050

Difference = 4,698

Error Per Street = 2,800

Note: Removal of West Lafayette Corridors 9, 10, 12 Reduced Corridor Error to 2,450 A. D. T. and
per Street Error to 1,700 A. D. T.

Accident Study

The objective of an accident study as a part of major thoroughfare planning study is to assist in locating deficiencies in the system and to provide another parameter for evaluating the overall efficiency of the system. A three to five year historical record of the number of accidents by location should be made. Locations with high numbers of accidents year after year should be evaluated individually to determine the cause. The accident rate, relating the number of accidents to the traffic volume, should be determined to place the accident data on a comparable basis throughout the study. The procedure in the manual prepared by the National Committee on Urban Transportation, entitled "Maintaining Accident Records", should be followed in data collection and interpretation.

The time required for this phase of the study is five man-days.

Bus Transit

The manual prepared by the National Committee on Urban Transportation should be used as general guide for this job although the study requirements will be substantially reduced. The bus schedules, routes and coverage should be determined with specific attention to the areas served or not served. The existing equipment and condition, number of bus passengers per day per route should be determined.

The existing service should be compared to the recommended level of service in the above named guide. General information concerning the people served should be noted, including approximate age groups, occupations, etc., if possible.

For a major thoroughfare study the information on existing bus service is utilized in determining if a drastic change in the operating procedure would adversely affect the proposed thoroughfare system.

The time required for this job is estimated to be five man-days.

Capacity Determination

In major thoroughfare planning a critical requirement is that a means of determining the traffic carrying capabilities of a particular thoroughfare be available. This information compared to the forecasted traffic volume for that thoroughfare then provides a gauge or measure of the need for new facilities or improvements. The 1965 Highway Capacity Manual will be used for capacity calculations with the various data collected under the physical inventory phase for input. Both a generalized approach, using service volume ranges for four lane, four lane with left turn lanes, and six lane thoroughfares, and a detailed intersection by intersection capacity review will be completed, comparing the two methods.

The estimated time required for this job is two man-weeks.

Parking

The parking control existing on major thoroughfares outside the central area should be determined and indicated on a base map. Truck loading zones, with the hours of permitted use, should also be noted.

The central area parking has been the subject of several recent reports noted in the list of Previous Studies and Reports. It is not considered necessary to re-evaluate the central area at this time due to the above studies and the major redevelopment presently underway in the area.

The parking restrictions on streets can be determined partially from the aerial photographs; however, a windshield survey with a driver and a recorder actually driving each thoroughfare is recommended for this study and is the basis of time and cost estimates.

The estimated time for this job is one man-week.

Inventory of Traffic Control Devices

Information required to prepare a map indicating the traffic control devices at the major thoroughfare intersections on the system should be collected. This will include whether there is two-way or four-way stop control or traffic signals at this intersection. If traffic signals are present, information on the type, fixed time or actuated, should be noted with the signal timing.

A windshield survey will be utilized to collect this information where necessary. The City Engineer's Office and previous reports will provide a large portion of the information.

The estimated time for this job is two man-weeks.

Laws and Ordinances

In any transportation study recognition should be given to the community controls that have been imposed by the community leaders to ensure that development of the area will precede along avenues and in a manner that will be in the best interest of the people.

Any major thoroughfare study and resulting plan must be compatible with the local zoning ordinances, subdivision regulations and any other local ordinances affecting major thoroughfare location and/or design. The existing master plan for Columbus is the datum from which transportation and major thoroughfare planning must work. A review of the above will be made by study personnel to ensure observance during development of the major thoroughfare plan.

The time required to complete this phase of the study is estimated as follows:

1. Inventory and collection of available information
0.5 man-days.
2. Review of information and comparison to recommended
minimums - two man-days.

Financial Resources

To propose a system that is not within the financial reach of a community would be futile and would automatically preclude any implementation of the recommendations no matter how worthwhile. A five year study of expenditures by the city of Columbus, Bartholomew County and the Indiana State Highway Commission for the study area should be made. This will entail a year by year tabulation and summary. The tax base and bonded indebtedness should also be determined.

Using the historical trend, determining the percentage of expenditures for transportation and related facilities, it will then be possible to forecast expenditures to 1990 by five year increments. In the analysis of the city, state, and county expenditures a trend analysis type of forecast, based on the historical trend established over the past five to ten years should be made.

This procedure will establish a financial constraint for the recommendations in the major thoroughfare plan. The assumption is made that expenditures for transportation will remain stable percentagewise over the forecast period unless the future city administration and taxpayers see a need to finance new facilities by sale of bonds. This type development can not be anticipated or forecasted.

Capital improvement programs and tax information are available from the City of Columbus and the information on state and county expenditures may be obtained from those agencies.

The estimated time to complete this study phase is as follows:

1. Inventory and collection of available information is estimated to require five man-days.
2. A complete review of the information, historic trends, tax base, etc., is estimated to require five man-days.

3. A forecast of funds that will be avail ... for the forecast period is estimated to require five man-days.

Corridor and External Cordon Identification

The identification of traffic corridors is an integral and basic part of the simplified procedure for major thoroughfare planning herein described. The procedure for establishment of the corridors requires data collection for two points in time to permit calibration or fitting to local conditions. The time span for this "calibration" should be approximately five to ten years with the date of the study then being used to provide the base year information for future forecasts. For Columbus 1960 and 1970 are recommended because aerial photographs are available for both years. Traffic volume counts are also available for these periods from the Indiana State Highway Commission.

The information needed for corridor identification is as follows:

1. A street classification map indicating the major thoroughfares
2. Traffic flow map prepared using current volumes on all major thoroughfares
3. Existing land use map

The above information for Columbus is available from the sources listed in the list of Previous Studies and Reports except for the current volume map.

The procedure for corridor identification begins by evenly dividing the distance between radial thoroughfares. If a physical barrier better establishes the dividing line, or some aspect of a particular thoroughfare gives it a higher attractiveness than the adjacent facility, then the line would be moved further toward the adjacent thoroughfare. The "divide" is similar to the divide between drainage areas, with this divide representing the point where vehicles move in opposite directions to reach a

thoroughfare destined to the central area.

Circumferential corridors would be reviewed similarly. The corridor boundary would be at the point between the route and a similar alternate route, probably through the central area, where traffic would be attracted to the route to travel across town. Equal time instead of equal distance will probably control this line.

The external cordon line should be located at a point that includes all urban development within the study area for the present and forecast period.

The data collection for the parameters for calculation of corridor growth factors is then completed by corridors for the two times being used. In Columbus this will be 1960 and 1970. The growth factors computed are applied to the 1960 corridor traffic volumes and then compared to the existing volumes. Minor adjustment in corridor boundaries will probably be necessary to provide an adequate comparison of volumes. It should be remembered that the procedure is designed to provide data sufficiently accurate for design, but not absolutely precise.

The estimated time required for this job is two man-weeks.

Social and Community Value Factors

The study must consider at all times the factors that make the community a good place to live. The relative values the residents place on parks, open space, recreational facilities in relation to transportation must be constantly considered. In the development of alternate plans and the selection of the final recommended major thoroughfare plan care must be exercised to prevent disruption of neighborhoods, cutting through school districts, parks, etc., with proposed new facilities. The aesthetics of the proposed new facilities must also be a consideration.

This phase of the study will not be separable but will be continually an integral part of other jobs and is not assigned an estimated time.

An environmental impact statement will be an output from this study indicating therein the effects the proposed system will have on the environment of Columbus. This will provide necessary information to support requests for federal funds for any project in the area.

Development of Major Thoroughfare Plan

Creation of a realistic major thoroughfare plan, tailored to fit the community is more of an art than an exact science. The collection and evaluation of the basic data is necessary to define the location and extent of the problems. Consideration of available techniques for solving the problems are then evaluated individually and/or collectively with due consideration to the constraints of financial, legal, engineering, and social and community value factors. This in essence outlines the process.

The procedure is briefly outlined in technical terms below.

By applying the computed growth factors for the period 1960 to date of study to the available base year (1960) traffic volumes, values are obtained to compare to the existing volumes. Corridor boundaries may require adjusting to provide accurate checks. This is the calibration phase of the procedure. The next step is the application of the forecasted corridor growth factors to the study year traffic volumes. This provides the design volumes for the target year.

Preparation of a target year traffic flow map, indicating the forecasted volumes by band width is prepared. Comparing the study year capacity with the forecasted volume map provides a method of locating deficient system sections.

Individual sections where capacity deficiencies exist are studied individually to determine if remedial measures, such as parking restrictions, minor widening, addition of lanes (Ref. Highway Research Board Special Report 93, Improved Street Utilization Through Traffic Engineering, May 1967.) can increase the available capacity to meet the future demand. If this is not possible, the study personnel should review alternate ways of providing the

required relief in the following order:

1. Addition of parallel streets to the throughfare system by additional marking, signing, traffic control devices, etc.
2. Create one-way pair of streets
3. New facility on new location

Where two or more of the above will solve the problem at approximately equal expense, both actual and social, both should be presented to the administration as alternate solutions with the advantages and disadvantages listed.

Finally, incremental traffic volume forecasts for five year periods should be made for the area and, based on the relative demand versus supply at the various deficiency points, priorities for scheduling of improvements are to be established. Dates or responsible agencies for construction will not be established by the report, only the relative order of priorities. The determination of the exact timing and the governmental agency responsibility is considered a policy matter to be resolved on the administrative level.

For this study phase it is recommended that use be made of both Joint Highway Research Project and Indiana State Highway Commission expertise in addition to that available at the local level to provide a broad prospective. This type procedure should provide for evaluation of all alternatives from many different viewpoints thereby precluding oversights in any area.

There have been articles and publications directed to presenting procedures to evaluate alternate major thoroughfare plans. Each presentation is of necessity based on the author's considered opinion especially with respect to the weights given each item. The economic factors are always important. The level of service provided by each alternate is also a prime factor. These two items are quantifiable, therefore easily compared. The effect on the amenities of

the community can not be easily quantified. At this point in the analysis the community leaders must assist in the analysis and by the knowledge of the community and people, assist in the evaluation of the qualitative factors thus arriving at a decision reflecting the best interests of the community from all viewpoints.

The above discussion actually encompasses four separate tasks as follows:

1. Determination of system deficiencies
2. Development of alternate plans
3. Evaluation of alternate plans
4. Selection of the major thoroughfare plan estimating of costs and establishment of construction priorities for the recommended additions and improvements

The jobs will be concurrently in progress with considerable overlap therefore the estimated time for the combination is given as three man-months.

Final Report

The major thoroughfare plan for Columbus, Indiana, developed as described herein will be produced as a end product to the study. Basic data collected, with sufficient figures and tables to adequately depict the entire procedure with forecasts, plan schedules, etc. , will be included.

The number of report copies will be an item to be considered early in the study.