FINAL REPORT

PROJECT E-900-800

VEHICULAR TRAFFIC CONTROL STUDY
CITY OF ATLANTA

E. T. Hungerford

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Rich Electronic Computer Center
Engineering Experiment Station
GEORGIA INSTITUTE OF TECHNOLOGY
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I. INTRODUCTION

A. General

1. The control of pedestrian and vehicular traffic within a metropolitan area is a complex problem. When public transportation facilities and commercial traffic movements are superimposed on the same area, the need becomes critical for an efficient control of all traffic. Such a situation has existed in the City of Atlanta for a number of years. This is, perhaps, an obvious statement, at least to the public user, whether he commutes by public or private means of transportation or whether he utilizes the street system in the course of business.

2. Although the control problems of traffic and transportation are complex, the current state-of-the-art is sufficient to "solve" the problems both from a technical and from a political viewpoint. What is required, at least for the City of Atlanta, is a positive and coordinated effort to implement on-the-street traffic controls together with adequate law enforcement of these controls. This can be accomplished for Atlanta. Immediate implementation of several existent proposals could be accomplished within the operating budget. Others can be initiated and completed in the near future as funds become available. In particular, as the driving public begins to experience the advantages of smooth traffic flow, public interest and support will be forthcoming. This fact has been demonstrated quite well in Baltimore, Maryland[1] and in New York City.[2] In New York City, for instance, despite the rather diversified interests of the driving public (private and commercial), the support and "feedback" to the Commissioner of Traffic and Transportation has been surprisingly favorable.

3. Currently, there are many studies underway which are concerned with the control of traffic in Metropolitan Atlanta. The details of some of these studies are known, as well as the sincere efforts of their proponents. However, some immediate on-the-street implementations are needed for relief of some of the major traffic "bottlenecks." It is maintained that immediate relief can be given, and in some instances it could be accomplished without large capital outlay.

B. Scope and Purpose

1. This report is the result of interest and effort expended by personnel of the Georgia Institute of Technology. Funding for this work was obtained through internal research funds from the Engineering Experiment Station of Georgia Tech. This study contract is designated as E-900-800; it is of short duration (3 months); and it represents a relatively small expenditure of funds.

2. The viewpoints and opinions of many agencies, both public and private, have been considered. However, no particular emphasis has been given to any single agency's views. Rather, it is intended to present the pertinent aspects of several existent proposals, together with other observations and results obtained during the present study.

3. The purpose of this report may be categorized in six major areas:

a. Brief study of northwest, north, and northeast Atlanta traffic needs.

b. Somewhat detailed proposals for possible immediate solutions to several traffic "bottlenecks."

c. Survey of some future proposals as they relate to current proposals.

d. Review and study of some existent systems for the control of vehicular traffic.

e. Proposal for an automated traffic control system for the City of Atlanta.

f. Proposals for future contractual work by the Georgia Institute of Technology for the City of Atlanta. Included also are any other interested departments of planning for the City or for the State of Georgia, or any private consultant firms involved in environmental and/or transportation studies for the area.

4. It should be emphasized that the technical capabilities of personnel employed at Georgia Tech, as well as the facilities available, offer a significant source for information and problem-solving capability in any field. In particular, a knowledgeable engineering approach generally enables an efficient solution to be obtained. The esthetics of the impact on the environment for proposed solutions are also considered.

C. Organization

1. This report is organized in eight chapters as follows:

a. Chapter I contains a general introduction of the report.

b. Chapter II briefly discusses the current problem areas. Some vehicular traffic problems for the central business district (CBD), including the general flow of traffic for the northwest, north and northeast areas, are discussed. In addition, some suggestions are presented which can be implemented immediately, without major reconstruction or capital outlay.

c. Chapter III briefly discusses some of the known proposals for future work, construction of connectors, freeways, rapid transit, etc. Opinions are given with respect to the compatibility of these future proposals and the current proposals of this report.

d. Chapter IV briefly reviews several means for controlling traffic in a metropolitan area. The traffic control systems are discussed with respect to their use and impact on the Atlanta environment. A proposed approach to an automated system for the City of Atlanta is given.

e. Chapter V reviews some areas where further work should be accomplished.

f. The Summary is contained in Chapter VI.

g. The References are in Chapter VII.

h. A glossary of terms is given in Chapter VIII.

i. There are four Appendices. Included are some detailed discussions for proposed traffic routings on surface streets, the Peachtree Corridor, some suggested treatments of several particularly congested intersections, and some brief details on a proposed automated system.

II. CURRENT STATUS AND PROPOSALS

A. Problem Identification

1. There are at least three criteria which are basic for an efficient traffic control system in any metropolitan environment:

a. An organizational hierarchy with sufficient political and legal power to implement a system and its procedures.

b. A coordinated control plan or philosophy which is compatible with present traffic and transportation needs as well as future predictions.

c. A technical system which utilizes the appropriate hardware for implementation of the traffic control system on-the-street.

2. These criteria have been effectively documented in the course of this study as to their basic importance. References 1 through 11 list the cities contacted with respect to current traffic and transportation philosophies as well as the implemented systems. In particular, considerable study effort was devoted to the cities of New York, N. Y., Baltimore, Md., and Charleston, S. C. In addition to discussions with the traffic commissioners, some of the streets were driven in both private and commercial vehicles, and opinions on traffic flow were obtained from taxicab drivers, several inner-city commercial transportation drivers, and transit company officials.

3. It was the unanimous opinion of the commissioners mentioned above that the criteria listed are basic; indeed, they were considered to be mandatory by the commissioners. In addition, the order of priority in the listing was deemed correct.

B. The Principal Problem

1. The principal problem existent in Atlanta with respect to traffic control is the lack of an autonomous department headed by a Commissioner of Traffic and Transportation. The importance of the need for this office cannot be overemphasized. Without such an office, the attainment of significant changes to the current system is very difficult and generally requires great expenditures of time and effort.

2. It is understood that a part of the election platform of the Mayor of Atlanta included concern for "solving" traffic problems in the City. The Mayor's office has been contacted on this matter in the course of this study.[12] Although a personal appointment with the Mayor was not granted, the following information was obtained from the Mayor's office.

a. It is desired to remove the Traffic Engineer for the City of Atlanta from aldermanic control.

b. The operating charter for any city (under Georgia State law) will not allow a city to establish autonomous departments under mayoral control. (However, it is further understood that this aspect of the law has not been tested and is currently subject to several different interpretations.)

c. Because of charter limitations, it was stated that the Mayor plans to submit a proposal (related to the above) to the Atlanta Board of Aldermen, via the subcommittee on Traffic, Transit and Parking. It is understood that approval and recommendation of this subcommittee is necessary before any proposal can be successfully submitted to the State Legislature.

d. The proposal from the Mayor must then be presented and become acceptable to a majority of the local state representatives before it can be actually submitted to the State Legislature for vote and approval and/or charter modification.

e. It was stated that such a proposal is planned for possible submission in the fall of 1970 to the State Legislature for consideration in the January 1971 session. This, of course, assumes the prior approval under items c and d above.

3. The Chairman of the subcommittee on Traffic, Transit, and Parking has also been contacted[13] in the course of this study. Mr. Mitchell stated that he was generally in favor of such a proposal, subject, of course, to the details of the proposal.

4. Because of the principal importance of the establishment of an autonomous Department for Traffic and Transportation in the City of Atlanta, it is strongly recommended that all appropriate action be taken to insure this accomplishment. Unfortunately, even if State action is favorable in 1971, approximately one year (from the present date) would be a minimum requirement for the actual implementation of such an office. Hopefully, some effective measures of a temporary nature can be undertaken by the City, so that much needed and immediate relief can be given in several critical areas.

5. The remaining paragraphs of this section are devoted to some observed experiences which have been evidenced in other cities with autonomous Departments of Traffic and Transportation. Specific examples are given for the Cities of New York, Baltimore, and Charleston, although many other accomplishments have been obtained by these and other cities, and are a matter of record.

6. Initially, there seems to occur much "static" with respect to the establishment of an autonomous office for the control of traffic and transportation. Apparently, many individual agencies are concerned that their "fair share" of representation will not be adequate. For the three cities

mentioned, these agencies include the various merchant associations, trucking associations, the local transit company (in one instance), and the local ward representatives. It is encouraging to report that these "fears" apparently have been removed in almost all cases. Some of the reasons for this are reviewed below.

7. The individual traffic commissioners do not appear to suffer from a "Czar" complex. Rather, they appear as quite knowledgeable men, with only a sincere desire that the best interests of their cities be served. In discussions with the respective Commissioners, specific conflicts of interest were mentioned. However, in all cases it was stated that differences were resolved to the satisfaction of both City needs and private interests. In some cases, two to three month trials were established. For instance, one-way street systems, dedicated bus lanes, and various turning movements were tested. Subsequently, evaluations were made jointly by the Office of the Commissioner and the interested parties. This is a <u>positive</u> approach, and it stands favorably in contradistinction to other oft-used approaches of "wait-and-see" or lengthy study evaluations. It is quite significant to note that the former, positive approach (used in the three cities mentioned) has established a surprisingly good rapport between the several Commissioners and various other interested agencies in the cities. Several specific instances are cited as follows:

a. The Baltimore Transit Company was somewhat apprehensive concerning the major implementation of one-way street systems in the city prior to 1963. Nevertheless, the company did not oppose the changes. The documented results are interesting. Revenue began to increase <u>immediately</u> and continued to do so until 1968, when a crippling strike occurred, according to the statement of a company vice president.[14] Trip time decreased significantly (up to 30% on some routes), and the number of riders increased steadily. Objections were received from some riders who were required to walk several extra blocks (because of a one-way street situation). However, it was noted that other riders found the new routes sufficiently more convenient, such that they began utilizing the services. Thus, some inconvenience occurred to some riders in that they could not obtain A.M. and P.M. bus service on the same street; however, a larger number of riders apparently found convenient servicing at least once a day as a result of the new routes. These observations warrant equal applications in the City of Atlanta.

b. Bus lanes were also implemented in Baltimore, and some remain. However, the usefulness of this concept in Baltimore has been partially negated by lack of enforcement, according to remarks by the Transit Company[14] and the Traffic Commissioner.[1] On the other hand, in the City of New York, bus lanes and one-way street systems have enabled a flow of upwards to 200 buses per hour, on a given one-way street,[2] according to the Commissioner. Enforcement of rules such as no standing or stopping on the side of a one-way street used for bus loading has also helped significantly.

c. A request for a change in traffic flow (involving a new traffic light and lane changes) was submitted to one of the traffic commissioners by a local ward representative. The written request was quite interesting, and included some revealing comments by the ward representative. For instance, the representative commented that he had dutifully submitted the request of his constituent; however, he also stated that he was equally pleased to "dump the monkey" on the Commissioner's back and be relieved of the responsibility.

Thus, the responsibility for solution of traffic "bottlenecks" and a more efficient traffic distribution does (and should) rest on one person, the Commissioner. In the three cities mentioned, this aspect of responsibility has apprently contributed significantly to the rapport between the respective commissioner's offices and the public.

d. Two or three taxi drivers and commercial truck drivers were contacted in the three cities also. Without exception, they expressed a respect for the traffic commissioner's efforts. In particular, they felt that they could "complain" about a local problem and obtain a useful response from the commissioner's office. This rapport was rather surprising, particularly in New York City, with the rather widely diversified interests of the different drivers.

e. In some instances, there was adamant objection from various merchant associations with respect to the initial implementation of one-way street systems. Some of these objections were investigated for the City of Baltimore. However, it was immediately apparent that in all but two cases, the affected merchants were very pleased with the results. For instance, sales tax receipts were used to document any significant changes in income. Generally, the results showed either stable or increased incomes. This circumstance appears quite reasonable: A similar situation occurred in Houston, Texas a number of years ago. (This author was resident in Houston at the time.) One-way street systems were imposed over the objections of some local merchant associations. However, after several months of operation, it became apparent that merchants were "delighted" with the results. Where almost impossible traffic congestion occurred on the previous two-way street systems in Houston, traffic was enabled to flow on the one-way systems.

Previously, a given shopper might spend fifteen minutes in the down-town area getting to a store or a parking lot, because of the congestion. On the other hand, with the one-way street system, shoppers found relatively easy access to the store fronts for discharging passengers or easy access to parking lots. As a consequence, store shopping increased in the central business district. These observations are also in accord with some of those given by the Georgia State Highway Department.[15]

f. For the two cases mentioned above where merchants' objections remained after implementation of the one-way street systems in Baltimore, one case was changed back to a two-way street system; sales tax receipts indicated a legitimate hardship. In the other case, shoppers (primarily bus passengers) were shopping at other stores more convenient to the bus route, and no change was made.

8. Hopefully, the above examples will establish the esthetic desirability for an autonomous Commissioner of Traffic and Transportation for the City of Atlanta. In addition, there are many technical reasons for the desirability of such an office. It should be obvious that only technically trained personnel are competent for establishing efficient traffic flow patterns. It is most inefficient for other agencies (public or private) to maintain "effective veto" powers on the implementation of traffic control systems. On the other hand, advice and counsel should be made available. In the three cities mentioned, the Traffic Commissioners are responsible to the Mayor only; advice, counsel, and recommendations are made by the respective city councils or appropriate subcommittees.

9. A primary usefulness of an autonomous traffic commissioner's office is the capability for <u>immediate</u> implementation of needed traffic controls,

changes to existent systems, etc. The responsibility for establishing the appropriate and desirable changes for traffic control, of course, must rest on the traffic commissioner.

C. Other Problems

1. A second problem relates to an overall traffic control plan for the metropolitan area. It is believed that the current one-way street system in Atlanta represents significant progress towards the establishment of an overall plan. However, the present system needs to be expanded such that maximum flow rates into and out of the Cordon Area[16] (downtown business district) can be accommodated. This is needed particularly during the peak traffic periods.

2. The attainment of an efficient traffic control plan for a metropolitan area the size of Atlanta is not an easy task. Further, a given plan, once implemented, needs to be tested and modified as situations demand. However, skeletal plans can be studied, and reasonable predictions with respect to traffic flow characteristics can be made. Again, several basic criteria exist:

a. Generally, predominant and major flow patterns exist in an area. The overall traffic flow plan should accommodate these predominant flows and enable a maximum amount of influx and outflux to the Central Business District (CBD) in a minimum amount of time.

b. Without the consideration of new construction, the desired flow plan must be adapted to the existent street system.

c. In the selection of a plan, distinct consideration should be given to implementing the maximum number of through-lanes, compatible with street capacities.

d. Traffic signal operation (adjustment and timing) must be adequate to permit maximum traffic flow, at least for peak period demands. Thus, minimum consideration should be given to opposing traffic flow. (An example for opposing traffic flow in the Peachtree Corridor is given in Appendix B, Section B, paragraphs 8 and 9.)

3. These criteria are, perhaps, obvious. In any case, they have been utilized as a basis for development of the proposed traffic flow plan. The type of plan is dictated to a large extent by the vehicle volume and density patterns during peak periods (item 2a above). For Atlanta, updated Screen Line figures[17] on peak traffic volumes are indicated as follows:

a. The northern screen line sector (Howell Mill Road to Monroe Drive) handles 33% of the total screen line peak A.M. and P.M. volumes.

b. The eastern screen line sector (Ponce de Leon Avenue to Ormewood) handles 24% of the total peak volumes.

c. The southern screen line sector (East Confederate to Lawton Street) handles 25% of the total peak volumes.

d. The western screen line sector (Gordon Road to West Marietta) handles 18% of the total peak volumes.

4. For the above listed traffic volume percentages, the expressways accommodate the following relative percentages:

a. I75-85 (North Expressway) handles 15% of the volume for the northern screen line sector.

b. I20 (East Expressway) handles 39% of the volume for the eastern screen line sector.

c. I75-85 (South Expressway) handles 49% of the volume for the southern screen line sector.

d. I20 (West Expressway) handles 33% of the volume for the western screen line sector.

5. The above percentage figures include the fact that the northern sector currently requires servicing for approximately 4000 more vehicles per hour (peak periods) than the eastern and southern sectors, and approximately 7000 more vehicles per hour (peak periods) than the western sector. This fact, in itself, does not necessarily mean that more arterials or connectors should be built for servicing of the northern sector only. Rather, it means that a larger number of vehicles must currently be accommodated into and out of the CBD for the northern sector. If existent expressways and surface street configurations are not sufficient, then <u>first priority</u> should be given to this area for new construction. Existent or potential traffic "bottle-necks" must also be considered.

6. An appropriate traffic flow plan must be adapted to the existent street configuration, if immediate relief of the traffic congestion is to be accomplished (item 2b above). If possible, the plan should be compatible with predicted future needs and future construction. On the other hand, the particular plan chosen should provide the most useful configuration possible which will satisfy immediate needs. That is, the plan should not be penalized in adaptability, just to become more compatible at a later time with future construction. This is particularly true when the implementation of new construction is 2 years or more into the future. It is believed that this latter point is most important as it relates to the Atlanta environment, where many proposals exist for future construction.

7. As regards a useful traffic flow plan for the Atlanta area, specific consideration should and can be given to the utilization of maximum numbers of through-lanes, both on surface arteries and on the downtown interval of I75-85 (item 2c above).

8. There are several different approaches for obtaining solutions for these traffic problems:

a. New freeways, connectors, and surface streets can be constructed. New construction will certainly be necessary; however, this alternative does not offer an immediate solution. Indeed, must of the proposed future construction will not be completed for two to five years with 10 or more years being predicted[18] in some cases.

b. During the peak periods, major arteries can be closed to opposing traffic. Essentially, this means that main arteries are to be made one-way for A.M. traffic and the opposite-way for P.M. traffic. This practice has been implemented successfully in Washington, D. C., for instance. However, due to the geographical nature of the major arterial system in the Atlanta area, this alternative does not appear to be desirable. Also, it is probable that this alternative would not be acceptable to the driving public, because there are too many areas which are accessible only by means of a single street connecting to an artery. Therefore, excessive travel would be necessary to gain access to these particular streets.

c. A third alternative consists of a judicious arrangement of one-way surface streets, together with controlled or reversible lanes on certain arteries, and a judicious arrangement of thru-traffic lanes which can alleviate the necessity for lane changing or squeezing.

9. Because of the immediate relief needed in many areas of Atlanta, the third alternative has been adapted as the major emphasis of this report. Further, because of the short time available for this study, it has been impossible to consider, in detail, the vehicular driving needs for all areas in the City. Therefore, most of the detailed efforts have been restricted to the northern sector of the city.

10. The criteria discussed in paragraph 2 above and the alternative approach mentioned in paragraph 8c above have been applied. The suggested traffic flow plan for the metropolitan area is discussed in Appendix A. The plan is essentially a skeletal plan with a few necessary details. Hopefully, the details are sufficient to indicate the potentialities and working features of the plan. Details on the Peachtree Road Corridor are discussed in Appendix B, and several particular "bottleneck" intersections are discussed in Appendix C.

11. Some of the principal features of the traffic flow plan are summarized in the following section. However, it is recommended that careful perusal be given to the contents of all of the above mentioned Appendices, so that the suggestions can be more fully understood. Further, it is pleaded that the reader will not "form mental blocks" when any particular detail does not fit his idea of an appropriate solution. The reason for this plea results from observations and contacts made in the course of this study. For instance, it has been noticed that good ideas and worthwhile proposals have been submitted by several different agencies, both public and private. However, it has also been noticed that the best parts of some proposals apparently have not received their just merit. Often, it seems that if any one detail is objectionable, the total idea is rejected. Finally, it is noted that some of the results indicated in this report are similar in part to other current proposals, submitted by other agencies. Although all results given have been obtained from independent research effort, it is encouraging to observe that the different individual efforts have led to similar results in several instances.

D. Proposed Solutions

1. A suggested traffic flow plan is shown in Figure 1. One-way streets are indicated by one-way arrows; streets with reversible lanes are indicated by bi-directional arrows; existent two-way streets and arteries (with no suggested changes) have no arrow indicators. Peachtree Street, Edgewood Avenue, and Decatur Streets are indicated with two opposing one-way arrows. The bold-faced one-way arrow is intended to represent the principal one-way direction; the opposing arrow indicates a single bus lane (see Appendix B, Section C, paragraphs 5 and 6).

2. In the northern sector of the City (from Howell Mill Road to Briarcliff Road), there are 10 lanes currently available to the City for A.M. or P.M. peak traffic needs (exclusive of expressways). One lane is available on Howell Mill, North Highland, and Briarcliff Roads; two lanes are available on Piedmont Avenue and Northside Drive (the center lane being reversible on Northside Drive); three lanes are available on Peachtree Road. The number of these lanes can be increased by 50% to 15 lanes with the installation of the following reversible lanes:

a. The present widths of Howell Mill, North Highland and Briarcliff Roads will accommodate 3 lanes of traffic (10 to 12 foot lanes). Therefore, these streets can be made effective arteries by the installation of a reversible center lane. The success of such an implementation can be adjudged by the similar installation which exists on Northside Drive, between the Northwest Expressway and Northside Parkway. (Incidentally, the safety hazard for a reversible lane on the three streets mentioned above should not be as great as that on Northside Drive. This is because of the street geometries, cross streets, traffic lights, etc., which presently exist on

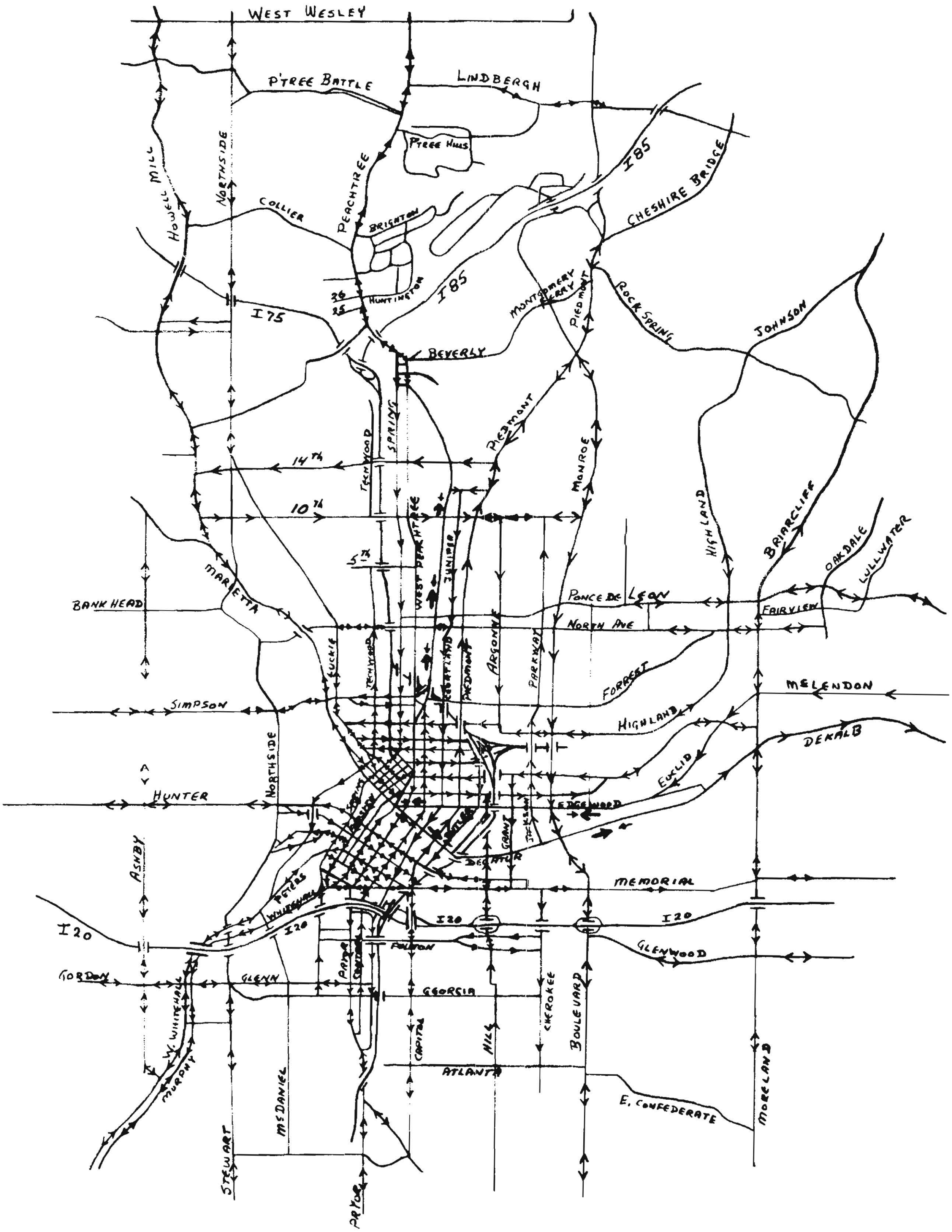

Figure 1. Overall Traffic Flow Plan.

these streets. Thus, excessive speeds on these streets are not as easily attained as, for instance, along the straight reversible stretch of approximately 2.4 miles on Northside Drive).

b. On Piedmont Avenue the street width will accommodate 5 lanes between the Cheshire Bridge and Montgomery Ferry Road intersections. To the south, the street width varies such that only 4 lanes can be accommodated in particular areas (without street widening). The implementation of reversible lanes on Piedmont Avenue (from 12th Street to the Cheshire Bridge intersection) would effectively provide an extra lane for peak period traffic needs. Thus, 5 lanes should be established between Cheshire Bridge and Montgomery Ferry with the center lane reversible; the two center lanes should be made reversible from Montgomery Ferry to 12th Street. In the latter instance, a single lane would be provided for opposing traffic in this interval during peak periods. However, the peak period traffic volumes appear to be less than 400 vehicles per hour for opposing traffic. Thus, a single lane should be quite adequate during the peak periods for opposing traffic in this interval.

c. On Peachtree Road there are effectively six lanes of two-way traffic from West Paces Ferry Road (Buckhead area) to Peachtree and West Peachtree Streets (Pershing Point area). If the two center lanes are made reversible, four one-way lanes can be provided for peak period demands. It is strongly recommended that these reversible lanes be implemented from Pershing Point northward to the Buckhead area; at the minimum, they should be extended to the Peachtree Battle Avenue intersection.

3. The available 10 lanes in the northern sector currently handle approximately 9065 vehicles/hr during peak periods. This value is obtained

from the average total peak period volume (exclusive of expressway traffic) for the northern Screen Line sector (7987 vehicles/hr) and from the current peak volume for North Highland (539 vehicles/hr), plus a similar estimated peak volume for Briarcliff Road. With adequately timed traffic signals and restricted turning movements during peak periods, it is estimated that the present 10 lanes could accommodate a maximum of 12,870 vehicles/hr for 30 mph platoon flow. (The particular volume rate of 1287 vehicles/hr/lane which has been used is discussed in Appendix A.) With the additional 5 lanes of traffic (provided by the suggested reversible lanes), a maximum of approximately 19,305 vehicles/hr could be accommodated. (These volume rates can be adjusted for turning movements as discussed in Appendix B.)

4. For the eastern sector of the City (east of Moreland Avenue) there appear to be four major surface arteries: Ponce de Leon Avenue (4 lanes); McLendon Avenue (2 lanes); DeKalb Avenue (3 lanes); and Memorial Drive (2 lanes). For current peak periods, these arteries appear to support 6 lanes of traffic; i.e., 2 lanes on Ponce de Leon Avenue, 1 lane on McLendon Avenue, 2 lanes on Dekalb Avenue, and 1 lane on Memorial Drive.

a. The two center lanes on Ponce de Leon Avenue should be made reversible from Moreland Avenue eastward to Scott. Thus, 3 one-way lanes could be provided for the peak A.M. and P.M. periods. The single remaining lane for opposing traffic will accommodate the opposing peak period traffic volumes, which appear to be considerable less than 400 vehicles/hr.

b. McLendon and Dekalb Avenues are suggested as a one-way street system. Thus, McLendon-Euclid-Edgewood could be made effectively one-way west and Decatur-Dekalb could be made effectively one-way east. (The utilization of an effectively one-way street is discussed in Appendix B, Section C, paragraphs 5 and 6.)

c. The width of Memorial Drive should enable 3 traffic lanes to be supported. Therefore, the center lane should be utilized as a reversible lane.

d. The above suggested implementations for the proposed traffic flow plan will provide 2 additional lanes of traffic for the A.M. or P.M. peak periods. In addition, considerably improved traffic flow rates should be realized on the suggested one-way street system. Also, it is noted that adequate numbers of interconnecting streets exist between the suggested one-way streets such that circulating traffic will not be impeded.

5. For the southeastern, southern and southwestern sectors of the City, there appear to be seven major surface arteries: Glenwood Avenue (4 lanes); Moreland Avenue (4 lanes); Boulevard (4 lanes); Capitol Avenue (4 lanes); Pryor Street (4 lanes); Stewart Avenue (4 lanes); and Lee-West Whitehall (5 lanes). As has been mentioned previously, most of the study effort of this report has been devoted to the northern sector and the Peachtree Corridor. Therefore, detailed knowledge for this southern sector is lacking. Nevertheless, it would appear that at least seven additional lanes could be obtained by the use of reversible lanes on the above mentioned arteries during the peak periods. Seven lanes of traffic on arteries which can support platoon flow represents an additional capacity of 9009 vehicles/hr, at an average speed of 30 mph with an available green time of 65%. (See Appendix A, Section A.)

6. For the western sector of the City, there appear to be five major surface arteries: Gordon Street (4 lanes); Hunter Street (4 lanes); Simpson Road (4 lanes); Bankhead Highway (4 lanes); and Marietta Street (4 lanes). The utilization of reversible lanes on these streets (excluding the Bankhead Highway) could provide an additional four lanes of traffic for the A.M. and P.M. peak periods.

7. In the vicinity of the CBD area, the proposed traffic flow plan suggests several major changes. Principally, these changes amount to the implementation of one-way street systems: Spring Street and Techwood Drive; Forsyth and Whitehall Streets; Houston-Irwin Streets and Auburn Avenue. In addition, Trinity and Butler Streets have been added as one-way streets to the present one-way grid system. Adjacent to the CBD area, some of the other suggested one-way systems are listed as follows: Cherokee Avenue and Hill Street; Bell and Grant Streets; Boulevard-Monroe and Jackson-Parkway Streets. A significantly improved utilization of the Murphy-Whitehall artery (to the southwest) is also proposed. The reasons for the various suggestions are discussed in Appendices A and B.

8. The significant gains which can be realized from the suggested traffic flow plan are summarized as follows. (The details may be documented in the Appendices.)

a. Table I lists the principal surface arteries which are considered for traffic flow into and out of the city. There are 26 arteries listed. The number of currently available lanes are listed also for the outlying areas of these arteries. (For instance, the available lanes on Ponce de Leon Avenue are considered east of Moreland Avenue.) The number of lanes resulting from the proposed traffic flow plan are also indicated for A.M. and P.M. peak periods. Except for Spring, Peachtree, McLendon and DeKalb, all of the increases in the numbers of available lanes occur as a result of reversible lanes. Thus, 20 additional lanes could be provided for the A.M. peak period and 16 lanes could be provided for the P.M. peak period.

b. If it is assumed that platoon flow can be established on the outlying intervals at, say, 20 mph with 65% of green time, the currently available

	Current		Proposed	
	A.M.	P.M.	A.M.	P.M.
Howell Mill	1	1	2	2
Northside	2	2	2	2
Spring	2	2	4	0
West Peachtree	2	3	3	3
Peachtree	2	2	0	3
Piedmont	2	2	3	3
Monroe	2	2	3	3
N. Highland	1	1	2	2
Briarcliff	1	1	2	2
Ponce de Leon	2	2	3	3
McLendon	1	1	3	0
DeKalb	2	2	0	3
Memoranl	2	2	3	3
Glenwood	2	2	3	3
Moreland	2	2	3	3
Boulevard	2	2	3	3
Capitol	2	3	3	3
Pryor	2	2	3	3
Stewart	2	2	3	3
Murphy-Whitehall	1	1	2	2
Lee-Whitehall	2	3	3	3
Gordon	2	2	3	3
Hunter	2	2	3	3
Simpson	2	2	3	3
Bankhead	2	2	2	2
Marietta	2	2	3	3
	47	50	67	66

Available and Proposed Traffic Lanes

Major Arterials

TABLE I

lanes should accommodate a maximum of approximately 53,768 vehicles/hr for the A.M. peak period and 57,200 vehicles/hr for the P.M. peak period. The proposed plan should accommodate a maximum of approximately 76,648 vehicles/hr for the A.M. peak period and 75,504 vehicles/hr for the P.M. peak period.

c. If left turn movements were considered and were assumed to reduce the affected lane average speed to 10 mph, essentially 26 lanes would be affected both for the currently available lanes and for the proposed lanes. Thus, for the currently available lanes, approximately 46,072 vehicles/hr and 49,504 vehicles/hr could be accommodated, respectively, for the A.M. and P.M. peak periods. For the proposed lanes, approximately 68,952 vehicles/hr and 57,808 vehicles/hr could be accommodated, respectively, for the A.M. and P.M. peak periods.

d. Table II lists the principal surface streets adjacent to the CBD area which are considered for traffic flow into and out of the area. A net gain of 9 lanes for the A.M. peak period and 4 lanes for the P.M. peak period is indicated.

9. The values listed above in 8b and 8c and the additional lanes listed above in 8a and 8d are intended to indicate the potentials which might be accomplished. It is realized that many other factors need to be considered; in particular, a time-space diagram needs to be established for the entire area, and the equipment for implementing the appropriate traffic light controls must be installed. However, the arguments presented do indicate rather wide discrepancies between current traffic volumes (with the associated stop-and-go traffic) and possible traffic volumes (with a predicted smooth traffic flow). For instance, the current peak volume rate (A.M. or P.M.) for total traffic into or out of the Screen Line boundary (exclusive of expressway

	Current		Proposed	
	A.M.	P.M.	A.M.	P.M.
Marietta	2	2	3	3
Luckie	2	2	3	3
Techwood	2	2	0	4
Williams	2	2	2	2
Spring	2	2	4	0
Peachtree	3	2	3	3
Ivy	0	4	0	4
Courtland	4	0	4	0
Piedmont	0	4	0	4
Butler	2	2	4	0
Baker	4	0	4	0
Cain	4	0	4	0
Houston	2	2	4	0
Auburn	2	2	0	4
Edgewood	2	2	4	0
Decatur	2	2	0	4
Hunter	2	2	3	3
Memorial	2	2	3	3
Capitol	2	3	3	3
Washington	0	4	0	4
Central	4	0	4	0
Pryor	0	4	0	4
Spring	2	2	2	2
Whitehall	2	2	3	3
Peters	2	3	3	3
Mitchell	4	0	4	0
Hunter	0	4	0	4
	55	56	64	60

Available and Proposed Traffic Lanes
Adjacent to CBD

TABLE II

traffic) is approximately 26,790 vehicles/hr. (This value is based on a summation of the values obtained by taking 10% of the daily volumes for all streets crossing the screen Line boundary.[17]) The predicted values, utilizing the suggested reversible lanes, indicate a potential for improved volume rates which is a factor of 2 to 2.5 greater than current volume rates.

III. FUTURE STATUS AND PROPOSALS

A. Time Prior to 1972

1. All of the proposals for imminent construction of new freeways, connectors, surface streets and/or intersection modifications are not known. Therefore, the observations and comments in this chapter are limited to this extent.

2. Although many of the current traffic congestion problems can be alleviated (as suggested in the previous chapter and in the appendices), it is obvious that the ultimate transportation needs in metropolitan Atlanta can only be satisfied through new construction and implementation of new systems. Surface streets, connectors, and freeways as well as some form of rapid, public transportation must be considered.

3. For the immediate future, some relatively minor construction can be accomplished. For instance, it is understood that a current proposal exists for the extension of Forrest Avenue across Peachtree Street to make connection with Alexander Street on the west side of West Peachtree Street. However, unless it is also planned, simultaneously, to widen Alexander Street westward to McAfee Street, a potential "bottle neck" will exist on Alexander Street. This results since Alexander Street currently cannot support 4 lanes of smooth-flowing, through-lane traffic. In addition, Alexander Street would be utilized as two-way, which is considered undesirable. An alternative choice is recommended for consideration:

a. Connect Forrest Avenue through Peachtree to both Alexander and Peachtree Place. Right-of-way from Porter Place could be utilized.

b. Westbound traffic from Forrest Avenue could be supported on Alexander Street and eastbound traffic could be supported on Peachtree Place to Forrest Avenue.

c. Through-lanes should be provided from the North Avenue-Forrest Avenue intersection (on the east side) through, at least, to the Simpson Street-Ashby Street intersection (on the west side). This would provide a much-needed east-west connector through the northern business district.

4. It is also suggested that Piedmont Avenue be widened from 12th Street northward to Montgomery Ferry Road. According to measurements, most of this interval on Piedmont Avenue will currently support 5 lanes of traffic (10 ft. lanes). Relatively minor widening in the remaining intervals would allow 5 continuous lanes to the Cheshire Bridge intersection. Thus, with the center lane reversible, 3 through-lanes could be provided on this artery for both AM and PM peak periods, with 2 lanes being provided for opposing traffic.

5. A very minor widening of Northside Drive under the Seaboard Coast Line Railroad (SCL) bridge (immediately south of Holmes Road intersection) is discussed in Appendix C. If this were accomplished, three one-way lanes could be utilized for peak period AM or PM traffic on Northside Drive from Bishop Street to I75. In addition, if the reversible lanes south of the Southern Railroad overpass are implemented as suggested in the Appendix, three one-way lanes could be provided from 14th Street to I75. Currently, the Southern Railway overpass on Northside Drive (immediately north of the 14th Street intersection) will support only 4 lanes of traffic. Therefore, it is also recommended that the bridge structural support on the west side of Northside Drive be rebuilt to permit 5 traffic lanes. This is discussed

in Appendix C. With minor widening of Northside Drive from the overpass to Bishop Street, 5 through-lanes of traffic could then be supported from the 14th Street intersection northward to I75. Vehicle capacity and volume rates in this interval would be increased considerably; the current bottle neck for AM and PM peak traffic would also be eliminated.

6. On Peachtree Road, the present seven lanes (which exist between Deering Road and the northbound ramps for I85) should be extended southward to the Spring Street intersection. This can be accomplished by minor widening of Peachtree Road and is compatible with the proposed reversible lanes on Peachtree Road. Implementation would permit both four lane through-traffic as well as left-turn movements in this area, even during the peak periods. Details are discussed in Appendix C.

7. There exists an appreciable need for allowed cross-flow and/or east-west traffic in the area bounded by Peachtree and Piedmont Roads between Lindbergh Drive and I85. Bridge construction across the creek between Palisades Road and Armour Drive would provide an adequate interconnect. In addition, bridge construction across Peachtree Creek and the SCL Railroad between Brighton Road and Virginia Place would provide another interconnect. This is discussed in Appendix C. If these connectors were constructed, circulating traffic should be reduced on Peachtree Road (at Brookwood), on I85 (between Peachtree Road and Piedmont Road), and on Piedmont Road. Additionally, cross-flow traffic for Peachtree Battle Avenue, Collier Road, and Deering Road could access Piedmont Road (and areas to the northeast) without traveling through the Peachtree Road-Brookwood interchange area.

8. Finally, throughout the city there are numerous intersections where through-traffic could be accelerated significantly by reconstruction of the right-turn traffic lanes. This is particularly true on all arterials. For instance, in many areas sufficient widths exist on city right-of-ways to increase the turning radius for right-turns, which exit from the artery. Such construction can significantly accelerate traffic flow in all lanes on the affected artery. Also, it is realized that separate right-of-way would need to be purchased in many other instances. Nevertheless, it is believed that careful consideration should be given to such construction, particularly at critical or crowded intersections.

B. Time Subsequent to 1972

1. As previously mentioned, all proposals for future construction are not known. With respect to proposed freeways and connectors, the status report[18] from the Atlanta Chamber of Commerce and discussions with Central Atlanta Progress, Inc.[19] represent the principal sources. Proposed Freeway systems from the status report[18] are reproduced in Figure 2.

2. There exists an appreciable need for a connector from Peachtree Road (immediately north of the Peachtree-West Peachtree intersection at Pershing Point) across I85 and northward. It is understood that a proposal for this connector has been made; the connector is to extend northward across I85 and generally along the Southern Railroad to connect with Piedmont Road at the extension of Marian Road. This is shown in Figure 3. It is believed that such a connector should have a principal priority in new construction. There are at least two reasons:

a. The connector can probably be accomplished more rapidly and for fewer dollars than other freeways and/or connectors;

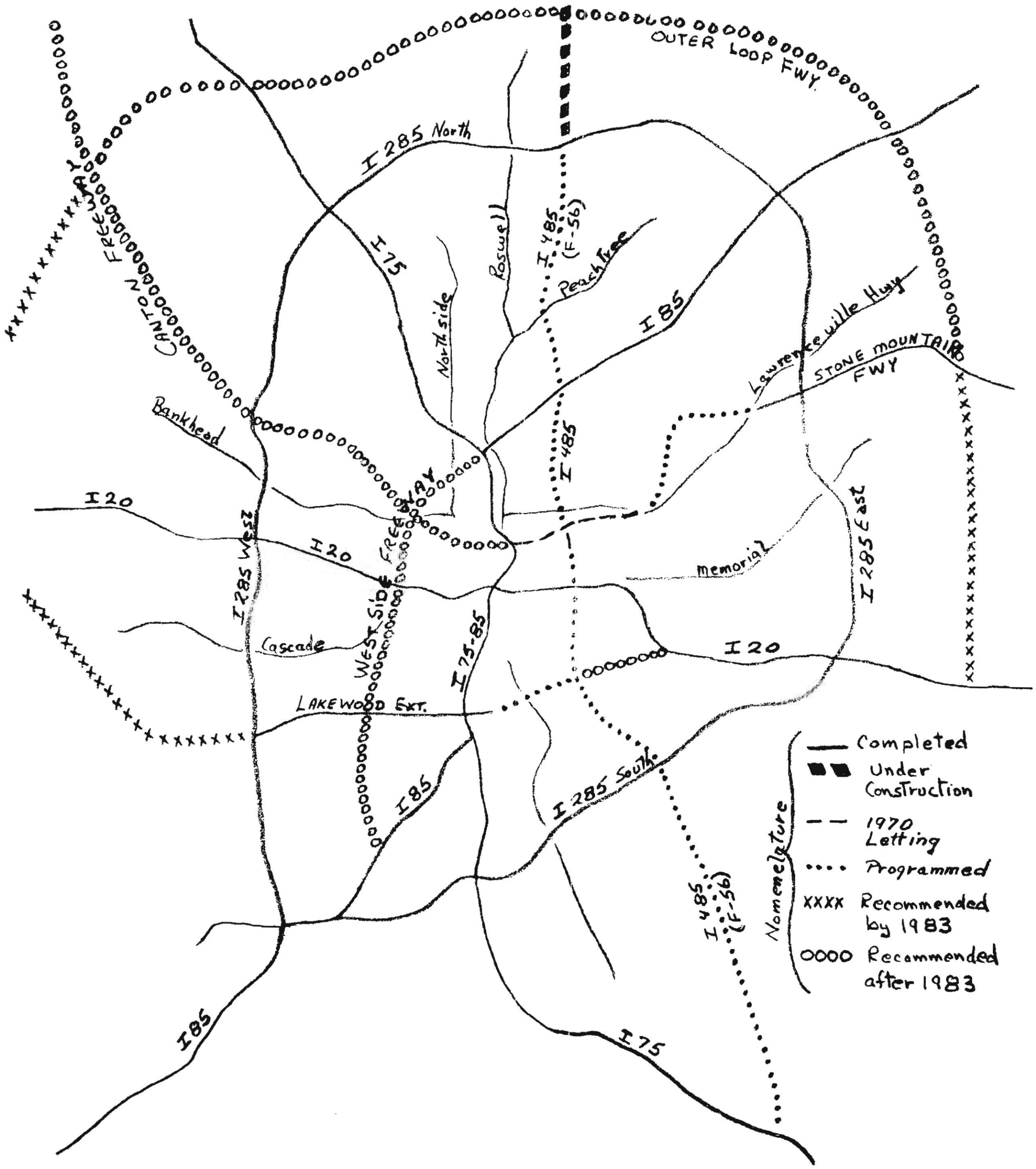

Figure 2. Existent Freeway Proposals.

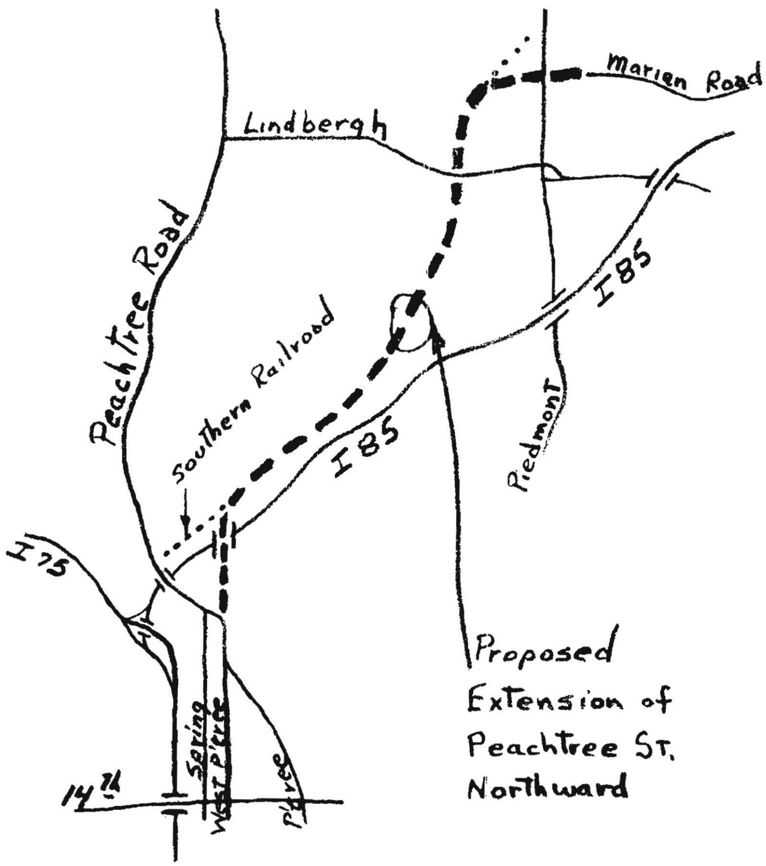

Figure 3. Proposed Northward Extension of Peachtree Street.

b. The connector should reduce by a significant amount the volume demands on Peachtree Road (north of Pershing Point) and on Piedmont Road (north of 14th Street). With implementation of such a connector, the volume demands on Spring Street, Peachtree and West Peachtree (south of Pershing Point) would probably increase. However, the suggested changes for these streets (discussed in Appendices A and B) would accommodate the increased demands without serious effects on traffic flow.

3. For the proposed connector (paragraph 2 above), a possible interchange is suggested with I85 and is discussed in Appendix C.

4. In addition to the proposals mentioned in the Status Report[18], it is believed that several other proposals are of considerable merit:

a. It is understood[19] that a west-side connector has been proposed to replace the West Side Freeway of the Status Report (see Figure 2). This west-side connector would extend from the I75-85 interchange westward along the Southern Railroad to the vicinity of the Northside Drive-14th Street intersection, and generally southward (east of Northside Drive) across Marietta Street, North Avenue, along Gray and Haynes Streets to an interchange with I20 in the area of Whitehall, Stewart and Northside Drive.

b. Another connector is proposed along Northside Drive from I75 to interchange with the proposed west-side connector (item a above) in the vicinity of the Northside Drive-14th Street intersection.

c. Finally, it is understood that an east-west connector (perhaps tunneled) is proposed from the current I485 and I75-85 interchange to extend westward (along Baker and/or Harris Streets) to the proposed westside connector (item a above).

d. The proposals mentioned in items a, b, and c above are depicted in Figure 4.

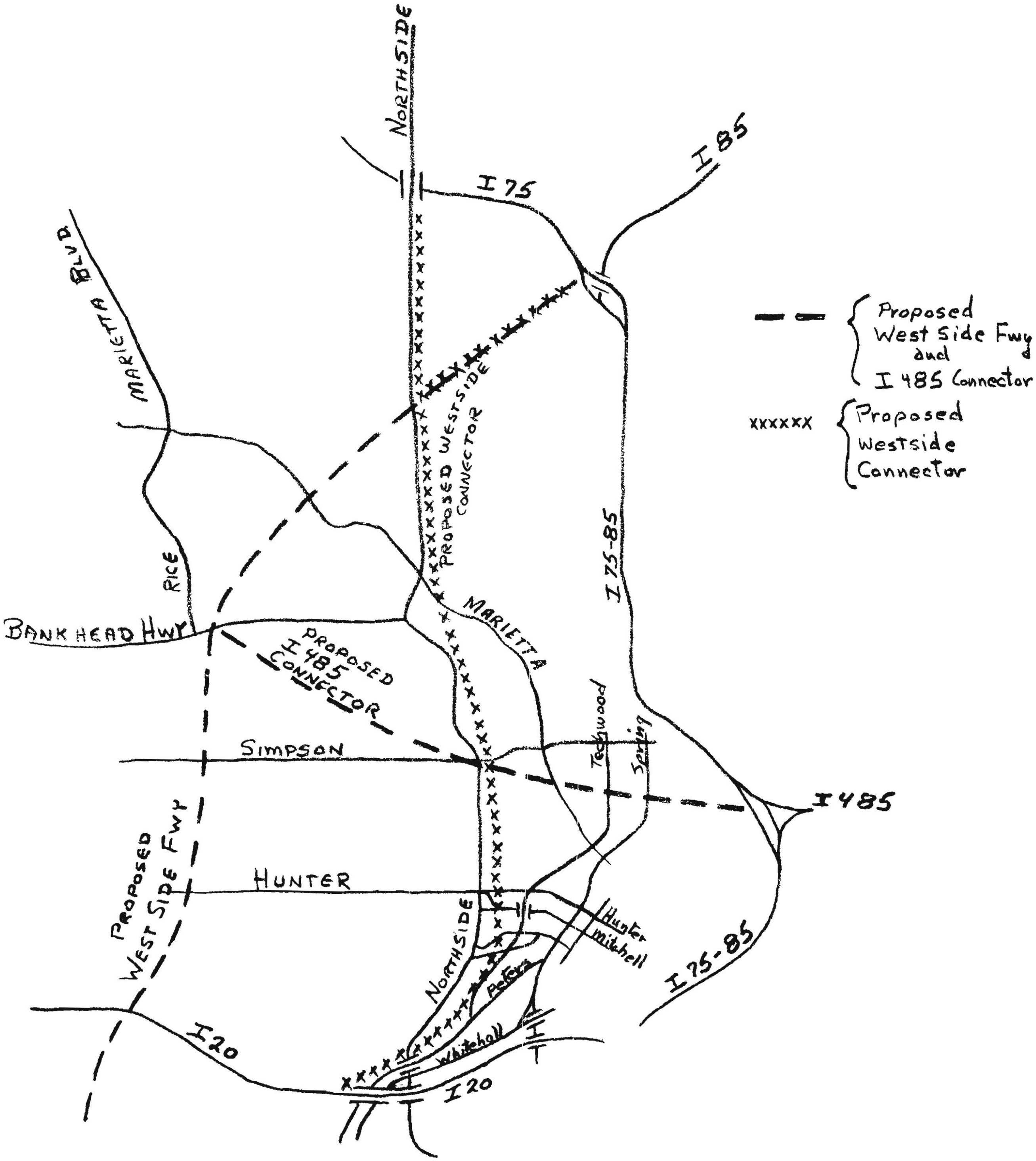

Figure 4. Proposed Connectors on the West Side.

5. Considerable discussion has been given in Appendix A on proposed construction on Techwood Drive. It has been proposed to utilize Techwood Drive as a major north-south artery; thus, Spring Street and Techwood Drive could be utilized as a very high capacity one-way street system. It is believed that this utilization is of principal importance. Several problems with this construction on Techwood Drive have been discussed in Appendix A. They are summarized here:

a. It is assumed that Techwood Drive can be extended northward from 16th Street to connect with Deering Road and Peachtree Road. For instance, an elevated surface could be constructed over the Atlantic Steel property and over I75.

b. The principal deterrent, however, appears to occur in the interval between 10th Street and North Avenue. This interval intersects the Georgia Tech Campus and divides major housing facilities from classrooms and other activities. As discussed in the Appendix, it is completely undesirable to implement a major surface artery through the Georgia Tech Campus.

c. The possibility of connecting Techwood to Williams Street does not appear to offer a satisfactory solution because there is not sufficient space available to support three or four lanes of traffic.

d. There exists the possibility of tunneling on Techwood Drive from 10th Street to North Avenue. This interval currently does not carry large volumes of traffic, so that construction work would not impede north-south traffic flow. The street could be "cut-out and covered", such that a major through street (tunnel) would be provided, together with the present surface facility. Several features should be mentioned:

(1) It is believed that it would not be necessary to construct an interchange between the southern end of the Techwood tunnel and North Avenue. Thus, North Avenue east-west traffic would overpass the tunnel traffic on Techwood Drive. This appears reasonable since the tunnel would service through traffic from Peachtree Road (and northward) to the downtown area, south of North Avenue.

(2) There presently exists ample space for surface connectors between the surface street at Techwood Drive and North Avenue. Thus, to the south of North Avenue, there is sufficient width for accommodating surface street connectors (on each side of the tunnel access) to the North Avenue-Techwood Drive intersection.

(3) There presently exists ample space for surface connectors between the surface street of Techwood Drive and 10th Street, thus, to the south of 10th Street, there is sufficient width for accommodating surface street connectors (on each side of the tunnel access) to the Techwood Drive-10th Street intersection.

(4) Widening of Deering Road from Peachtree Road to the proposed connection with Techwood Drive would be advisable to accommodate an anticipated large volume demand.

e. The relative costs of any one of the proposed Freeway systems versus the suggested Techwood Drive construction is not presently known. However, it would appear that the tunneling costs (cut and cover) and the extension costs (north of 16th Street) would be very much less than any of the Freeway proposals. This conclusion appears reasonable for the following reasons:

(1) There would be a relatively smaller amount of construction effort involved. Only four lanes of tunneling would be necessary on Techwood Drive. Also, the tunnel (cut and cover) distance is only 0.7 miles. The elevated extension (from 16th Street) is only 0.5 miles.

(2) With modern construction methods, the tunneled interval could be completed in an estimated three months time with, perhaps, four months for the elevated interval.

6. The priorities for future freeway and/or connector construction should be reviewed. It is believed that the following list places the proposals in their proper order, according to present needs:

a. The connector from Peachtree Road (Pershing Point area) northward to the Marian-Piedmont Road intersection (paragraph 2 above).

b. The Techwood Drive tunneling and extension to Deering Road and Peachtree Road (paragraph 5 above).

c. The westside connector (paragraphs 4a and 4b above).

d. I485 from the current I485 and I75-85 interchange northward to I285 North. (This freeway is also labeled as the northern end of F-56 in the Status Report[18].)

e. Stone Mountain Freeway to I485 (Status Report[18]).

f. Completion of the east-west connector in the downtown area (paragraph 4c above).

g. Lakewood Extension both east and west, or F-56 completion (from I485 southward to I75), dependent on the times for acquisition of right-of-ways.

h. Other proposals such as the Outer Loop Freeway and the Canton and Northwest Freeways.

7. The westside connector (paragraphs 4a and 4b) is to be preferred over the Westside Freeway[18] for the following reasons:

a. The proposed westside connector can be utilized to excellent advantage for access into the CBD for all traffic in the northern, western and southwestern areas of the city. Admittedly, similar traffic could be handled by the proposed Westside Freeway, except that access to the CBD would currently be available only by means of Simpson and Hunter Streets. Thus, it would appear that new construction of other feeder streets would be necessary to adequately access the CBD. On the other hand, it appears that the proposed route of the westside connector would have a more ready access to the CBD by means of a number of already existent feeder streets. Correspondingly, costs should be less for the westside connector. A lower cost might be further argumented by the proposed route of the westside connector, since it appears that the route mainly follows existent railroad lines. Finally, there may exist a worthwhile esthetic advantage to the westside connector, since a minimum amount of residential area would be affected.

C. Impact on Current Systems

1. A brief study of the future proposals (preceeding sections of this chapter) and of the current proposals (given in Chapter II) does not indicate any significant conflicts. That is, all current proposals appear to be compatible with future proposals.

2. It should be noted, however, that the current proposals remain necessary and desirable for immediate implementation. These suggested changes are needed for current traffic and transportation needs. Also,

these needs will continue to exist after the future proposals are implemented. Thus, an implementation of both the current and future proposals is believed to be necessary in order to satisfy the ultimate traffic and transportation requirements of the city.

3. One of the largest impacts (in dollar magnitude) appears to be the Marta proposal for rapid transit[20]. It is understood that a new proposal will be submitted, perhaps, in the fall of 1971. Estimated cost for implementation of the new proposal is approximately 1 billion dollars. It is understood that approximately 23% of this cost must be supplied by local tax payers, presumeably, the property owners. It has been estimated that the additional property tax on a residence which is currently assessed at $8,000 would be approximately $38.50 per year.

4. The following items are given as approximate information which has been obtained relative to the rapid transit proposal[20].

a. Essentially, four initial routes will be proposed. A "central" station will be located immediately south of the Marietta and Broad Street intersection:

(1) The route eastward would generally follow the Georgia Railroad to the City of Decatur, to Avondale Estates, and eastward to I285 East.

(2) The route southward would generally follow the A&WP Railroad to the Atlanta Airport, and southeast to Forrest Park.

(3) The route westward would parallel Hunter Street (several blocks to the north) to the SCL Railroad, and westward to I285 West.

(4) The route northward would essentially follow Broad Street, Peachtree Street and West Peachtree Street underground to the Pershing Point

area; then, it would overpass I85 to the SOU Railroad, and extend northward along the railroad to the vicinity of the proposed I485 freeway. The route would then split, one branch continuing parallel to the railroad to Doraville, the second branch following I485 northward to I285 North.

b. It has been estimated[20] that approximately 200,000 people-trips per day would be serviced by 1983.

5. Because of the large estimated cost of the Marta proposal for rapid transit, it would appear reasonable that the details of other alternatives should also be submitted to the public for careful perusal. For instance, the costs of a Monorail System along the same routes should be significantly smaller. Although the number of people carried per trip would be less (because of the smaller sized vehicles), more frequent schedules could still satisfy the volume needs and, perhaps, provide a more convenient service. With respect to Monorail usage down the Peachtree Street corridor, it might not be unreasonable to sacrifice one of the 5 traffic lanes for right-of-way needs. (This would be true, particularly, with the implementation of an efficient plan for the movement of surface traffic and transportation).

6. Albeit other alternatives for rapid transit might be less grandiose, still they might suffice as quite adequate means for rapid public transportation. At the same time, their costs might be significantly less, thereby enabling an easier public approval. This is particularly true for the average property owner, whose resources for paying more property taxes are about exhausted.

IV. TRAFFIC CONTROL SYSTEMS

A. General

1. The implementation of an autonomous office of traffic and transportation and the selection of an efficient traffic control plan are prerequisites to on-the-street control systems. However, the best of plans and philosophies can fail without proper system implementation and operation.

2. Fortunately, the state-of-the-art for traffic control systems is sufficiently developed such that most current needs can be satisfied. Individual equipment as well as systems equipment can be purchased for accomplishing almost any desired need. For the specific control of traffic flow, there appear to be four general areas of system applications:

   a. Local Control

   b. Master Control

   c. Automated Control

   d. Hybrid Control

3. These traffic control systems are reviewed briefly in the following Sections B, C, D, and E.

B. Local Control

1. This type of system allocates the function of traffic control (distribution and flow) to the local controller at the local intersection. An overwhelming number of the signalized intersections throughout the United States are of this type. This statement is true also for the City of Atlanta.

2. Local control methods and equipment cannot provide adequate means for an efficient traffic control system. This is generally true for all large metropolitan areas; it is particularly true along any artery (with many intersections) which supports in excess of 500 vehicles/hr/lane. Although it is, perhaps, obvious that local control methods are undesirable, the local controller, itself, is the basic mechanism for turning traffic light indicators on and off. Since some kind of local controller is basic to any traffic control system, the general characteristics of local controllers are usually reflected in the more complex systems. Therefore, some of the principal features of local controllers are discussed in this section.

3. A dial controller is an example of a local controller which has been available for a number of years. Probably, most of the local controllers in service are of this kind. The principal mechanisms for a single dial controller consist of a synchronous driver motor, a timing dial, and a solenoid-operated drum, which contains cams for actuating contact switches for the various light indicators at an intersection.

4. The operation of a dial controller is simple. The synchronous motor operates from 60 cycle line power and furnishes the basic timing mechanism. It drives the timing dial through a set of timing gears. The timing dial may have mechanical slots which allow for convenient insertion of control keys. These control keys close various contacts as the timer dial rotates. The contacts actuate the drum solenoid through internal circuitry. The solenoid, as it is actuated, steps the drum around sequentially. The drum contains cams which actuate the signal contacts to the various traffic light indicators.

5. At any given time, a single dial controller can be utilized to provide only one pre-selected cycle time, one cycle split, and one off-set timing (see Glossary for term definitions). Nominally, the pre-selected cycle time can be varied from approximately 30 seconds to 130 seconds by the insertion of the appropriate timing gear. One of three different off-sets is usually available, and 4 to 16 different intervals may be established within a timing cycle.

6. Multi-dial local controllers are generally more flexible and can provide more traffic control functions. For instance, a three dial controller may be pre-selected for three different cycle splits (one for each dial) and three different off-sets (one of three choices for each dial). Some models provide motors and circuitry for three different cycle times (one for each timer dial). Thus, three different patterns may be established (for a 3-dial local controller operation) for use at different times of the day or night. Some units also provide for automatic flashing at a pre-selected time (for light traffic demands). For instance, the main street may have a flashing caution (yellow) indicator, and the side street might have a flashing stop (red) indicator.

7. More complex local controllers can also be actuated by local pedestrian or vehicular traffic. This is accomplished by walk buttons (for pedestrians) and by various types of detectors (for vehicles). A semi-actuated local controller has vehicle detectors on the side street. Dependent on interval circuitry adjustments in the local controller, side street demands can be accommodated during the allowed interval (when the main street can be stopped); however, the time of the side-street green

can be allowed to vary (up to a pre-determined maximum time), dependent on side-street demands. Thus, a maximum amount of green time can be provided for the main street. (This feature can be quite useful, and it can also be utilized in interconnected local controller systems.)

8. Fully-actuated local controllers can permit control of all traffic on all streets at a given intersection. This kind of control utilizes vehicle detectors on all streets at the intersection; it may also utilize volume and/or density computers. In the latter case, the green-time is based on the proportional traffic demands from the different streets at the intersection. As such, the function of the local controller approaches that of a master controller, although only one intersection may be controlled.

9. More recently, local controllers have been constructed from solid state devices. These controllers utilize transistors, integrated circuits, electronic switches, and generally have no moving parts which would require maintenance. Several different manufactured types have been under test for some time.[1] It appears that the new units are quite reliable and stable; they do not require frequent adjustment or maintenance.

10. In principle, synchronization of the local controller is maintained by the device itself. In dial units, if the drum and timer dial get out-of-step, internal circuitry effectively causes a stepping of the drum to a pre-determined position; the timer dial is then allowed to "catch up," and synchronization is restored. A synchronization "check" between drum and dial is performed once each cycle by the internal circuitry. Nevertheless, poor maintenance, mechanical wear, or momentary power line surges can cause a dial type local controller to gradually fall out-of-step with respect to a

previously set time pattern. Therefore, the establishment of smooth traffic flow (for instance, on an artery) by the use of non-interconnected local controllers is believed to be virtually impossible. Thus, if the correct timing pattern were initially established, it is maintained that the pattern can be destroyed (or become ineffective) in a few days of operation for any one of the above mentioned reasons.

11. Many examples of improper timing exist at various non-interconnected intersections throughout the City of Atlanta. Also, considerable documentation exists on the undesirable characteristics of local control methods based on past studies in the cities of Baltimore[1] and New York.[2]

C. Master Control

1. In this report, the term "master control" refers to an installation which utilizes a master controller for directing the operations of all interconnected local controllers in the master area. As such, the master controller assembly usually will incorporate analog computers of various types for selection and use of a particular traffic pattern. Other systems, for instance, those utilizing digital computers, are not to be included in this master control category.

2. A master control system can be simple or complex in configuration. The degree of complexity will depend on the number of intersections controlled (via the local controllers) and on the various control functions to be implemented. In its simplest form, a master control could consist of a single "local" controller which is connected to the traffic light indicators of two adjacent intersections. Thus, the timing intervals for the traffic indicators at both intersections would be simultaneous and identical.

3. Generally, a master control system is utilized with a number of different intersections. A geographical, master control area is first established. Within this area, the traffic demands and traffic flow should be similar for the same periods of the day. The local controllers at all intersections (to be controlled in the area) are connected to the master controller facility. (Usually, the individual local controllers are interconnected in series, similar to the branches of a tree; the trunk is then connected to the master controller.) Some installations require 14 wires in the interconnecting cables.

4. Dependent on the sophistication of the master controller facility as well as that of the local controllers, several different traffic control functions may be accomplished.

a. For the simpler systems, the master controller may utilize the basic cycle times established by the local controllers. For instance, in a system with 3-dial local controllers, the master controller may call for any one of the three cycle times available in the local controllers. Synchronization is provided from the master controller via the cable interconnects. The three available cycle times must have been pre-selected (by the appropriate timing gear insertions) in each of the interconnected local controllers. Each of the three different cycle splits, available in each local controller, are associated with the particular cycle time and timer dial selected by the master controller. The different available off-set times in the local controllers can often be utilized with any one of the cycle times, and will depend on that which is called for by the master controller.

b. In some master control installations, the local controllers which can be vehicle or pedestrian actuated are allowed a degree of autonomous control. For instance, side-street access can be allowed without explicit instructions from the master controller. However, such side-street access is "regulated" as follows. Minimum green times and off-sets are established by the master controller instructions; during the remaining times (within the specified cycle time) the local controller may be allowed to vary the cycle spit to accommodate side street traffic demands.

c. More sophisticated master controllers utilize analog computers and traffic sampling detectors to establish current vehicle volumes and/or densities. From these calculated data (based on sampling inputs), a particular traffic pattern is called for and implemented by the various local controllers. This is a traffic adjusted system. The local controllers usually function as remotely controlled "slave" switches, although a "local" function such as that described in item b above may still be allowed.

5. For the more complex master control installations, it is seen that all three basic kinds of traffic control may be allowed, i.e., pre-timed, vehicle actuated, and/or traffic adjusted. However, it should be emphasized that in a master controller installation, all interconnected local controllers in the master area must function on one given cycle time, one pre-selected cycle split (which occurrs at each local controller), and one pre-selected off-set, at any given time. If the traffic pattern needs to be changed in any part of the area, all local-controllers in the entire area must be changed accordingly. This lack of flexibility can cause problems in large cities where appreciable cross-flows from one master control area to another must be accommodated.[1,2]

6. Perhaps, the largest master control installation is found in the City of Baltimore.[1] Currently, Baltimore has seven master controllers, which control intersections in seven different areas of the city. All master controllers and analog computers are housed in a central facility. Although different equipments have been developed for satisfying the various manufacturers' versions of a master control installation, the approaches are somewhat similar. Therefore, the installation for the City of Baltimore will be described as representative of a complex master control.

a. Vehicle detectors are judiciously placed on different arteries within a master control area. These detectors consist of different types of sampling detectors which are capable of measuring vehicle presence (stopped or moving) as well as vehicle speed. The raw data from these detectors is connected directly to the appropriate master controller computers.

b. The vehicle counts are input to a cycle computer.[21] These counts can be continually "measured" and the volume rate computed, based on the number of vehicles detected and on the time spacing between successive vehicle detections. A single cycle computer is utilized for traffic measurements for one direction on a street (or artery); a second cycle computer is necessary for traffic measurements for the opposite direction on the same street. There are six different cycle times available, each cycle time being determined by a pre-selected threshold value of volume counts. Thus, each cycle computer (one for each of the two directions) will select one of the six cycle times, determined by its own computed volume count level.

c. The system selector accepts inputs from the two cycle computers and compares the requested cycle times. The larger cycle time is selected for use. Dependent on the difference in the two cycle time requests, one of five different off-set times will be chosen by the system selector. The five off-set times are pre-selected and relate to the five kinds of traffic demands as follows: (1) light traffic, inbound; (2) light traffic, outbound; (3) average traffic; (4) heavy traffic, inbound; and (5) heavy traffic, outbound. Various alternatives are available under light and heavy traffic demands with regard to the local controller responses. For instance, some (pre-selected) local controllers may be "released" from master control under light traffic conditions.

d. The different cycle splits must be pre-determined and manually selected in the various local controllers. Each cycle split in a local controller can be associated with one or more of the off-set times; however, the particular association desired must be pre-determined and manually selected by switch in the various local controllers.

e. As mentioned previously, there are six different cycle times available. The actual values of the cycle times are pre-determined by controls on the cycle generator. Thus, the cycle time being called for by the system selector is generated by the cycle generator. The appropriate electrical signal is then supplied to the local controllers via interconnect cable, and the background cycle is established. Perhaps it should be mentioned that the same cycle time is normally used for all interconnected local controllers at any given time. Usually, this is necessary in coordinated systems for efficient traffic handling.[22] Also, a longer cycle time is usually necessary in order to handle large traffic volumes. Longer cycle times enable longer main street green (MSG) times and, correspondingly, larger volume rates can be accommodated.

f. Each master control assembly usually contains a system supervisor. This circuit essentially performs a monitoring function on all of the master controller circuits. If certain malfunctions occur, all interconnected local controllers will be released from master control.

g. Other auxiliary computers are also utilized. For instance, it is noted that the volume computers (item b above) are effective and diagnostic only for free-flowing traffic conditions. When stoppage occurrs, misleading information can result. (This has been discussed in more detail in Appendix B, Section B, paragraph 3.) Density computers are useful in such circumstances. In order that density can be evaluated correctly, individual vehicle detection (vehicle counts) and individual vehicle speed data need to be measured. For any given manufactured system, it should be determined that the selected analog computer system does, indeed, compute traffic density in the correct manner, and that the system utilizes the resultant density information appropriately.

7. In the course of this study, it has been stated by several traffic engineers (as well as several manufacturers) that master controller installations are always synchronized. This means that the local controllers must always remain appropriately synchronized because of the interconnections to the master controller. In principle, the statement is true; in practice, errors do occur.[1,2] Two documented instances are discussed:

a. The Traffic Commissioners' Office for the City of Baltimore supports an excellent maintenance program which is accomplished by experienced electronic and instrument engineers. Frequent and periodic checks are made on all local controllers in the seven master areas. When malfunctioning equipment is found, it is returned to the maintenance laboratory for repair. In spite of these precautions, the local controllers in current usage continue to ignore some of the commands from the master controllers. Often, such malfunctions are intermittent and quite random. Consequently, such errors are hard to detect. It is for this reason of randomness that many engineers assume a proper functioning of an operating local controller in a master control installation, according to statements made by both Traffic Commissioners in Baltimore[1] and New York.[2] Thus, a given local controller may function correctly for several hours before an intermittent error occurs; unless the appropriate recording equipment has been used, the fact that an error has occurred may not be detected. However, on-the-street detection is evident, according to the Commissioner,[1] and is evidenced when bottle-necks occur where smooth traffic flow is predicted.

b. Recently, an automated system was installed in the City of New York.[2] (Details are given in the following section.) In the process of implementing the system, it became apparent that the system was ineffective. It happened that too many local controllers were not responding to computer commands, and these local controllers were automatically "released" from computer control. The remaining "on-line" controllers were too few in number for an effective utilization of the system. In this case, considerable documentation existed, since a print out is furnished for each malfunction. It has been stated by some that these errors in the New York installation were caused by poor communication links (from the computer to the local controllers). However, the Commissioner,[2] himself, stated that this is not the case. The affected controllers were replaced with new units, and the automated installation is now operable.

8. The point to be made in the above examples is that malfunctions do occur frequently enough for traffic flow to be seriously impeded. The advantage of the automated installation over the master control installation for these examples is simply that documentation of the malfunctions, their frequency of occurrence, etc., is obtained more easily. It should be noted that the local controllers in these examples were of the electromechanical type. Malfunctions were attributed principally to the physical wear of integral parts, although some adjustment errors were noted.

9. Finally, it is noted that the City of Baltimore is proceeding as rapidly as possible to implement an automated traffic control system. The reasons given by the Traffic Commissioner[1] will serve as a summarized list of the undesirable characteristics of master control installations. Lack of sufficient flexibility is the principal reason. There are several different problem areas:

a. Current analog devices operate on a percentage basis. Cycle splits and off-sets are based on a pre-selected percentage of the total cycle time. If the cycle time is changed, the percentages do not change, but the real times for different phases within a cycle will change, as well as off-set times. This will result in speed changes on-the-street. In many instances, a constant speed is desired, and appropriate changes in cycle splits and off-sets cannot be accomplished without manually changing the specified percentages.

b. A given master controller operates interconnected local controllers in a given master control area. Coordination of cross-traffic flow from one control area to an adjacent control area can cause problems, particularly if the established traffic patterns in each area are very different.

c. Within a given master control area, some sub-parts of the area may differ significantly in their traffic flow patterns at different times of the day. However, only one traffic pattern can be "in force" throughout the area at any given time.

d. It may be desirable to change cycle splits and off-sets at different times for several different local controllers within a master control area. This cannot be accomplished in a master control installation by automatic or remote means. For instance, three different cycle splits are available, nominally, at the local controller. However, a given cycle time (called for by the master controller) will automatically establish one of the three pre-selected cycle splits. A particular cycle split cannot be changed automatically without changing to another cycle time, which may not be possible, or desirable, because of other traffic demands in the master control area.

e. It is not possible to quickly establish that a given local controller is malfunctioning or producing intermittent responses.

D. Automated Control

1. In this report, an automated traffic control system refers to an installation which utilizes a digital computer. Thus, analog computers (used in master control systems) are excluded from the automated control category.

2. In current automated systems,[2,4,5] all local controllers and all detection devices are individually connected to the computer facility. In general, the actual computer machine connections are accomplished by means of "buffering" circuits (or multiplexing circuits). Thus, incoming data signals are transformed into appropriate signals for the particular computer in use; similarly, the computer output signal commands are transformed into appropriate electrical signals for the local controller.

3. The communication links from the computer facility to each of the local controllers and detectors are usually provided by leased telephone lines or by city-installed lines. The large number of required links is, perhaps, one of the greatest deterrents to current automated system usage. The initial installation of these lines can be very costly in large metropolitan areas. For instance, two local controllers positioned at a distance of 5 miles from the computer facility currently will require 10 miles of connector cable (one 5 mile length for each controller). On the other hand, in a master control system, where the two local controllers are an interconnected part of the same system, only 5 miles of connector cable would be required. However, it should be remembered that upwards to 14 wires may be necessary in the connector cable for the master control system; 2 to 5 wires are required in the connector cable for current automated control systems. (For more details on a proposed communication system for the City of Atlanta, see Section G of this chapter.)

4. Generally, the digital computing facility of a traffic control installation has the following characteristics.

a. A principal feature is the large number of computations which can be accomplished in a very short period of time. These include the usual arithmetic operations of addition, subtraction, multiplication and division. They also include timing, data scanning, data storage and retrieval, data manipulations, changes, etc. These computations or functions may be accomplished in the order of a few millionths of a second.

b. A second feature relates to the relatively large memories of computing facilities. Generally thousands (and sometimes millions) of bits of information can be stored, accessed for use, re-stored, changed, updated, etc.

c. These two basic features (items a and b above) enable computers to analyze large amounts of data and generate "solutions" in short periods of time. Such a computer device has immediate applications in the field of traffic control.

d. A computer and its peripheral equipments are labeled or represented by the term "hardware." The various instructions by which the computer performs its operations are labeled as software. Thus, a computer facility is programmed by its software packages to perform the various and desired functions.

e. A computing facility may be utilized in real time or in delayed time. As a real time device, the full capacity of the computer facility is dedicated to generating control functions in real time for some operating process. As a delayed time device, input programs (problems) are serviced (solved) according to some predetermined priority, and answers are provided at a later time. As a real time device, the computer may be a part of an operational loop. In this latter capacity, the computer can be utilized to significant advantage for the automated control of traffic. This is particularly true for large and complex metropolitan areas.

f. A computer program (software) involves a systematic procedure which is generally comprised of a sequence of steps or instructions. Computer programs vary in accordance with their purpose and use:

(1) Executive programs represent the general methodology which the machine utilizes to perform various functions. Such software is generally supplied by the manufacturer and is resident in the machine at all times. This means that the executive program essentially can be considered as a part of an operating computer.

(2) Stored programs can represent a rather large category. However, this kind of program generally represents the special instructions which are followed in order to perform specific tasks. Dependent on the frequency of their usage in a computing facility, stored programs may be effectively resident in the machine at all times, or they may be added in (loaded) as they are needed. For a real time operation, the software package for traffic control would represent a stored program which would probably be resident at all times in a traffic-control computer installation. A traffic control program would represent all of the particular instructions for handling all data inputs, for analyzing the data, for appropriate storage, for appropriate computations, for generating appropriate outputs, and for channeling these outputs to the appropriate output circuits.

(3) Other programs may be represented by smaller special purpose programs such as the various traffic patterns which are to be implemented by the local controllers; also, emergency vehicle interrupt programs and

computational programs for time-space diagrams may be used. Generally, this type of program can be varied and/or changed by a competent traffic engineer. On the other hand, the stored traffic control program represents a very complex set of interrelated instructions and should be changed only by competent system programmers.

g. All of the various types of programs listed above in f will require storage space in the computer memory. Therefore, dependent on the type and size of computer facility available, the number of functions which can be handled is limited. Also, it is to be remembered that space must be saved in the memory to accommodate the data inputs and some data storage. In the IBM 1800 system for traffic control,[23] approximately 6750 to 9250 words are required to accommodate the traffic control program. Each local controller requires a twelve-word table and each detector requires a twelve-word table. The maximum allowed number of combined controllers and detectors is approximately 800, and a maximum of either 500 controllers or 500 detectors is allowed. In addition, space is provided for 500 background traffic patterns. These patterns contain the various cycle times, cycle splits, and off-set times which can be implemented by the various local controllers. Similar characteristics are available in the Sperry Rand STR 1000 and 2000 systems.[24] However, Sperry Rand also claims to have a virtual memory facility in its computer. This means essentially that the active core memory of the computer is not limited. Thus, if auxiliary storage is available in the computer facility, blocks of stored information will be automatically moved into and out of active core memory, as they are needed. This operation is a function of the executive program; it can facilitate other stored program usage to a tremendous extent, and it should materially increase the effective, usable memory of the computer facility.

5. An automated control system may be utilized in a manner which is somewhat similar to that of a master control system, except that greater flexibility is available in the automated system. Within the total traffic area to be controlled, various traffic sampling detectors must be judiciously located; proper locations will insure that the sampling vehicle data are representative of current traffic flows in the sampled areas. These data are used to compute volumes, volume rates, and densities. These computed results are then utilized to select one of the 500 traffic patterns (in the IBM system) for implementation by a predetermined group of local controllers. (The particular group of controllers can be changed or rearranged with other groups by appropriate manual inputs to the keyboard of the computer console.) Essentially at the same time, other data from other sampling areas are being used to control other groups of controllers. At any time desired, any particular controller can be changed with respect to its own cycle time, cycle split, and off-set by appropriate input on the computer keyboard.

6. A local controller can also be made responsive to the local demands of traffic on the streets at the intersection, via the vehicle detectors located at (or near) the intersettion. (This corresponds to the degree of autonomous control allowed certain local controllers at critical intersections in the master control system.) For the IBM system, this local intersection control is handled by a so-called microloop control algorithm.[23] This is simply a sub-program (subroutine) which overrides the main traffic control program and allows variation of cycle length, cycle split, and off-set at the particular local controller. These variations may be manually input at the keyboard or they may be furnished automatically by the program based on traffic demands. The individual controller can also be maintained in synchronism

with the other adjacent controllers, as specified by the traffic engineer. The maximum number of intersections which can be controlled by microloop is 160 for the IBM 1800 system.[23] (It is noted that one traffic engineer stated that the microloop software was not operative. However, a statement to the opposite effect was made by IBM personnel.[23] It is known that some problems exist in the IBM software packages for the New York installation.[2] However, at the present time, the question on the microloop software remains unresolved.)

7. In the computer control of a single controller, the following functions are performed.

a. A "hold-on-line" signal activates the controller for computer control.

b. Each step (phase) of a controller is accomplished by electrical signal. Thus, the computer has a table of timings for each controller: the computer checks once each second to ascertain whether a controller must be advanced.

c. The main street green time is monitored twice per cycle to ascertain whether the green traffic light indicator circuit has been actuated "on" at the proper time and "off" at the proper time.

d. Other functions such as all red, or flashing, can be generated and controlled as well as pedestrian indicators.

e. When a traffic light is brought under computer control, appropriate "phasing in" is accomplished.

f. When a controller fails to respond to commands, the controller is "released" from computer control. However, the computer will attempt to "pick up" a "released" controller and bring it back into synchronization with the rest of the system. This may be attempted several times. Suitable alarms (audible and visual) are activated when controllers malfunction.

8. Automated systems can also accommodate rather elaborate emergency vehicle controls. For instance, if particular arterial routes are utilized or if a particular area is affected, emergency vehicle indications can be implemented automatically at the affected intersections. The City of Chrrleston utilizes an emergency area control: the traffic lights at the intersections in the area give a rapid flashing of red on one street and green on the other street, dependent on the emergency vehicle route.

9. The largest automated installation is found in the City of New York.[2] Currently, there is one IBM 1800 system in operation, which controls about 500 intersections. Communication links are provided by leased, signal-grade telephone lines. The initial telephone line installation costs were approximately $550 per intersection. (The quality of these lines is less than voice-grade but adequate for handling the detector data and the command data for the controllers.) A second 1800 system is currently being installed, and three more 1800 systems are in order. It is understood that all five 1800 systems will be in operation by 1971. Currently, there are approximately 9000 traffic lights in the City, and ultimately, 7000 will be computerized. An IBM 360/50 computer will be utilized to monitor and/or control the 1800 systems.

E. Hybrid Control

1. Hybrid Control involves some combination of master and automated controls. The only known installation of this type is found in the City of Charleston.[3] The system is currently being implemented and utilizes the master controller concept, together with a small monitoring computer facility.[3,25,26]

2. The metropolitan area of Charleston has been divided into two master control areas. One master controller assembly is utilized for each area. In the initial installation, there are a total of 90 local controllers for both areas; also, there are a total of 83 vehicle loop detectors. Vehicle sampling data are obtained from 23 of these loop detectors. The remaining 60 detectors provide vehicle counts, which are utilized for surveillance purposes as well as data for system checks and performance evaluations.

3. The computer facility utilizes a Digital Equipment Corporation (DEC) PDP 8/L computer with a machine core storage capacity of four thousand (4K) words. Auxiliary storage is provided by a DEC DF-32 disk pack drive unit which has a 32K word storage capacity.

4. Communication links are provided by city-installed lines. The master controller connections are accomplished by means of 14 wire interconnect cables. In addition, 2 wire connections are provided from the central facility to each individual controller and each individual detector. The maximum distance for any one cable is approximately 3 miles.

5. For the routine control of traffic, the system performs in a manner similar to that described in Section C above for a master control installation. Generally, the same flexibility limitations are present in the Charleston installation as were mentioned previously for master controllers. However, there are several important exceptions:

a. All of the local controllers in the hybrid installation are new solid state devices. This feature should eliminate the potential for many of the malfunctions (synchronization, lack of response, etc.) listed previously for master control installations.

b. Each local controller is connected directly to the computer. This permits the local controller responses to each of the master controller commands to be monitored. As in an automated installation, if a local controller does not respond correctly, it is "released" from master control automatically. In addition, it is understood that two attempts will be made by the computer to bring such a controller back into the system. Audible and visual alarms, as well as permanent record print out, are implemented in such instances.

c. Each loop detector is monitored for zero and/or excessive counts. This provides a check on detector performance. In addition, each detector function can be changed. This novel accomplishment is made possible by a "plug-in" matrix board located in the central facility. For instance, some particular detectors may be used for vehicle counting, while other particular detectors may be used for vehicle speed; the count detectors are routed (via the plug-in matrix board) to a computer circuit, while the speed detectors are routed (via the plug-in matrix board) to another computer circuit. By changing the plug-ins on the matrix board, a given detector usage can be changed, say, from a count detector to a speed detector, and the particular detector changed may be routed to a different computer. Of course, the basic data output from the detector which is buried in the street does not change. However, the detector function can be effectively and very conveniently changed.

6. Visual display boards are currently utilized in all automated or semi-automated (hybrid) systems. Essentially, a display board is a street map of the area. Controlled intersections may be indicated by small red, green, and yellow lamps which are connected to operate simultaneously with local traffic lights at the intersection. In addition, some systems,[24] provide rather novel detector indications, which are positioned on the display board and are respresentative of the local detectors on the street. In principle, at least, it is possible to study an operating display board and "follow" traffic flow. In practice, particular usefulness results in the ability to detect traffic bottlenecks (from the detector lamps and the local intersection lamps). Perhaps what is more important is the ability to detect a potential bottleneck as traffic build-up occurs. In a fully automated system, such situations can be handled by an immediate and real-time change in the operations of the affected local controllers. In the Charleston installation (or in a master control system), if the system is performing properly, the heavy traffic pattern has already been implemented. The only means for changing the system is by manually establishing some other heavy traffic pattern for the total area; this cannot be accomplished in real time.

7. The Charleston installation also has five closed-circuit TV systems for traffic surveillance in critical areas. The TV cameras are remotely controllable, being adjustable in elevation angle as well as azimuth (approximately 360°).

8. The total system cost is approximately \$500,000 and includes all equipment (new, solid state controllers, detectors, TV circuits, master controller assemblies, computer, etc.). The installation costs (detectors, and communication lines, cabling installation, etc.) are not included.

F. Brief Systems Comparison

1. There are definite advantages to each of the systems which have been discussed. The master control system is perhaps the least expensive in implementation. The current hybrid system in Charleston is the next most expensive, and the current automated systems[2,4,5] are the most expensive.

2. There are several master control systems currently operating in the City of Atlanta. However, the only one of any size (and sophistication) is that for the Peachtree Road corridor, northward from the Brookwood area. Some improvement along this corridor could be realized by the additional reversible lanes, restriction of left turn movements, and one-way street systems discussed in Appendices A and B. However, it should be apparent to anyone who drives the area that the present master control installation is completely inadequate for handling the traffic demands, particularly during the peak periods. Observations are summarized as follows:

a. To some extent, the inadequacy is documented by the current volume rate measurements versus those which are predicted. During peak hours significant stoppage (and waiting) is experienced at relatively low volume rates ($\sim$ 433 vehicles/hr/lane). The system appears to be either adjusted incorrectly, or malfunctions are occurring at the local controllers.

b. At the "tail end" of a peak period (when traffic remains heavy but is flowing without excessive waiting), the heavy traffic pattern should still be in force. Nevertheless, considerable stoppage still occurs, often at the rate of every third or fourth traffic light. In addition, a driver may establish himself within platoon flow during this period; however, he can experience the frequency of stoppages mentioned above.

3. The observations mentioned in paragraph 2 above are intended to exemplify some of the problems in a master control installation. Integration (synchronization) with other intersections (off of Peachtree Road) which carry traffic to and across Peachtree Road is almost impossible in the present system.

4. For these reasons and because of the various characteristics mentioned for the different systems in the previous sections, further considerations are limited to the hybrid and automated systems. There appears to be considerable appeal among traffic engineers for the hybrid system. A principal feature of this system is its smaller cost. The second principal attraction appears to be esthetic in nature; it relates to the hybrid system utilization of the master control approach. This approach is familiar to most traffic engineers and, thereby, carries considerable "weight" in that new, unfamiliar, and untried approaches are not utilized. Also, the opinion has been expressed that the hybrid approach is simpler, and the traffic engineer will not be "at the mercy" of a computer technician or programmer. It is true that current installations which utilize computers are also employing computer personnel. However, these negative opinions seem unjustified and are certainly not evidenced by the Commissioners in New York, Baltimore, or Charleston.

5. General cost figures are difficult to obtain from manufacturers because of the varying circumstances and characteristics for different installations. Nevertheless, the following cost estimates have been obtained:

a. For the hybrid installation in Charleston, it is understood that the major automated systems bid was approximately \$150,000 more than that for the system being installed. In addition, it is understood that the automated system bid did not include the cost of new controllers. From these figures, it would appear that an automated system cost is approximately 50% to 60% greater than the corresponding hybrid system. (This is true at least for the Charleston environment.)

b. An IBM 1800 system with 8K memory is estimated at \$200,000 for an installation controlling approximately 150 intersections with 85 detectors. Approximately \$20,000 should be added for the 16K memory system. These costs do not include local intersection equipment, local controllers, detectors, cabling, labor, etc.

c. The Sperry Rand SRT 1000 system is estimated at approximately \$400,000 for an installation controlling approximately 100 intersections with a "reasonable" number of detectors. This sytem appears to be more elaborate and somewhat more flexible than the IBM system. It is understood that some other equipment costs are included. The SRT 2000 system appears to be the most elegant system available. The cost estimate for a similar number of intersections is \$900,000. However, it is understood that this cost includes all equipment, including communications gear, but does not include labor for detector installations or for communication lines installation.

6. As has been mentioned, the hybrid system utilizes the master control approach. As such, the flexibility of the system is limited. Only six different cycle lengths, five off-sets and three cycle splits can be accomplished. The various possible cycle lengths, splits, and off-sets must

be previously selected. Then, at any given time of operation, only one cycle time is allowed in a master control area, as well as one pre-determined cycle split and off-set at each controller. These parameters represent one given traffic pattern. At another time, the master controller can implement a different cycle time, cycle split, and off-set up to the maximum numbers listed above. However, any desired changes from the pre-selected values of these parameters must be accomplished manually, by adjustment of the operating controls on the master controller assembly as well as by manual adjustments at the various local controllers (in the case of cycle split and off-set changes).

7. For smaller metropolitan areas, a hybrid system which utilizes a master control approach is apparently satisfactory. There exists sufficient flexibility in the master control system for efficient control of traffic flow. This does not appear to be the case for larger and more complex metropolitan areas. Many evaluation studies were performed for the City of New York. The conclusions led unequivocally to some type of automated system. Similar results have been obtained for the City of Baltimore. Although the final decisions have not been made, some type of automated system will be implemented.[1]

8. Metropolitan Atlanta is comparable in size to Baltimore. Based on 10% of the average daily volumes, the peak period traffic demands are approximately 50,000 and 65,000 vehicle/hr for Atlanta and Baltimore, respectively. The street systems are somewhat similar, except that Baltimore has a significantly larger number of radial arteries and a much more systematic grid system of surface streets. These latter characteristics for the Baltimore environment should emphasize the fact that a satisfactory traffic control

system for Atlanta, necessarily, will be more complex than that for Baltimore. This results because of the greater street complexity in Atlanta and does not relate to the size or capacity of a control system.

9. A thorough traffic study and a traffic control systems evaluation has been performed for the city of Baltimore.[27] It is significant to note that the conclusions reached in this report lead unequivocally to an automated system (just as for New York City). A principal point of emphasis is that an automated system is not limited to any extent by hardware; rather, the system is completely controlled by software, i.e., the changeable computer programs. For an expanding and growing metropolitan area such as Atlanta, this point is most important. It is virtually impossible to implement the master control approach and at the same time "keep-pace" with the changing traffic demands in a growing metropolitan area. This has been exemplified in the history of master controller usage in the City of Baltimore. For this city, a very well maintained system of master controllers (seven different systems) has been built up over the years; however, the present systems are not sufficiently flexible to meet the growing traffic demands. Also, it should be mentioned that the present Baltimore system possesses essentially the same flexibility as that available in the newer, hybrid system in Charleston. (Considerably more traffic information is available from the Charleston installation, but there is essentially no increase in the flexibility available for basic traffic control.)

10. Although present automated systems "control" traffic flow by pre-determined traffic patterns similar to the master controller, there is a much greater choice available for these traffic patterns. For instance, 500 different patterns may be input to the IBM 1800 system. It is also true that

these traffic patterns for current automated systems are usually input to the system; that is, the traffic patterns are developed by other means, space-time diagrams, etc., and the results are then input to the computer. However, the capability exists in automated systems for internal generation of these traffic patterns. Thus, a computer facility is adequate to accomplish desired needs. The principal problem relates to construction of the software (programs) for these needs. Through the use of new programs other important functions can also be made available. For instance, in completely saturated conditions (caused by excessive vehicle volumes, accidents, etc.) it should be possible to program a computer for a systematic "unblocking" of the area with respect to traffic movement. Thus, saturation will generally cause "spillback" across the upstream intersections. Normal traffic light operations will continue to "feed" the blockage, particularly from cross-street entry into downstream traffic. Also, as is well known, cross-street traffic can be blocked due to stopped vehicles in the intersection in the downstream flow of another street. This, in turn, will generate a bottleneck and "spillback" on the side-street at other intersections. Evidences of these kinds of stoppages can be found on many Atlanta streets during the peak periods. However, traffic lights can be controlled such that green time is given only when storage space exists in the downstream position for vehicles in this type of stop-and-go traffic flow. It is impossible to obtain such flexibility with present master control installations.

11. A very elaborate and thorough cost analyses study was also provided in the Baltimore study.[27] Ultimately, 1200 intersections will be controlled and about 1000 detectors will be utilized. Over a 10 year period, the <u>difference</u>

in costs is approximately 6.2 million dollars between an automated system (installed and operating with a large general purpose computer, new controllers, etc.) and the present system (up-dated with some new and necessary equipments). The proposed automated system is very elaborate and extremely versatile. In addition to the real time operation, many other delayed time operations can be accommodated.

12. The projected 10 year cost for the proposed Baltimore automated system is approximately 13.3 million dollars. A surprisingly large benefit/cost ratio is also established from very conservative figures. Thus, a ratio of 13.9 is predicted; this represents a minimum return of \$13.90 for every dollar invested by the taxpayer. Because of the comparable sizes and traffic needs for Baltimore and Atlanta, similar results should be applicable to the Atlanta environment.

G. Recommended Control System for Atlanta

1. The various facts, cost figures, and characteristics given in the preceding sections indicate that an automated traffic control system should be untilized in large metropolitan areas. Therefore, it is strongly recommended that an automated system be implemented for traffic control in the City of Atlanta. Total costs are estimated at 6 to 10 million dollars for 1000 computerized intersections in the metropolitan area. (It should be noted that a cost in excess of 5 million dollars is estimated for a hybrid installation in the City; also, cabling costs would not be drastically reduced because of the required large number of wires for interconnected controllers in a master control installation together with the required individual cable connections to each controller and each detector.) A phased approach for the installation is desirable. Moreover, a phased approach may be manditory both with respect to available money and with respect to technical needs.

a. Computerized intersections could be installed, perhaps, in steps of 50 or 100 intersections, dependent on the geographical area requirements. Such a phased implementation procedure affords sufficient time for personnel training as well as for study of system effectiveness. The implementation and integration of successive groups of computerized intersections can also be greatly facilitated.

b. Initial cost figures are also reduced by such phased implementations. Thus, if 5 to 10 steps were to be accomplished, the costs would be approximately 1 to 2 million dollars per step.

c. If either the IBM or Sperry Rand systems were utilized, these systems can readily accommodate modular system implementations. This fact is useful and desirable. Thus, it is technically feasible to increase the capacity of an automated system, and it is also possible to increment the implementation costs. Either of the two mentioned systems should accommodate 500 intersections. Therefore, two automated systems would be anticipated for

1000 intersections. Based on the Sperry Rand SRT 2000 system estimates, approximately $900,000 would be required for each implementation step of 100 computerized intersections.

d. The average individual intersection costs for telephone line communications in the New York City installation were approximately $550 per intersection. Telephone rates and labor costs in Atlanta are less than those in New York City. Therefore, costs for a similar installation in Atlanta should be less. However, based on the $550 figure, telephone line installation in Atlanta would be approximately $550,000 for 1000 computerized intersections. These line installation costs have been included in the estimated costs of the total system.

2. It would appear that the costs in item 1d above can be reduced. Some study has been devoted to this aspect of automated traffic control systems. As a result, it appears that the number of communication lines presently required in a given installation can be reduced, perhaps significantly. This can be accomplished by placing more than one communication link on the same two-wire pair. Results are discussed briefly in Appendix D. The principal features are summarized as follows:

a. An individual sensor circuit is necessary for each controller. A simpler circuit is necessary for each detector. These circuits can be mounted in the local controller housing or in the detector box housing. Unit cost is estimated at $300 or less.

b. A single pair of wires (communication line) can accommodate from 32 to 64 different controllers and/or detectors. The particular number will depend on the number of different functions desired or required at each local controller. A two-wire cable equivalent to a telephone voice-grade line should be adequate. The cable can be connected to each controller and/or detector as these devices are encountered along a traffic control path, for instance, an artery. Grid networks can be serviced in a similar manner.

c. Sufficient information can be communicated such that all desired computer commands can be implemented uniquely at each individual controller. Moreover, the existent state of each controller or the vehicle count data at each detector can be conveyed uniquely to the computer facility.

d. Local controllers can be brought "on-line" or placed "off-line", and adequate information to this effect is provided. Incremental steps for "phasing in" a local controller can be accomplished by command signals at 2 second intervals.

e. Emergency vehicle controls can be accommodated at each local controller.

V. SUGGESTED FUTURE WORK

A. Traffic Flow Plans

1. The suggested traffic flow plan of this report should be reviewed by traffic engineering and planning personnel of the City. Further detailed work should be accomplished for the eastern, southern, and western areas of the City. Desirable modifications and changes should be integrated into a detailed traffic flow plan for the entire metropolitan area of the City.

2. Individual space-time diagrams should be developed for all major arteries, as well as for the two subareas of the CBD. These diagrams should then be integrated into an efficient master space-time table for the metropolitan area.

3. Interested personnel at Georgia Tech are available to complete these studies. If desired, more elegant computerized studies can be accomplished. Automated programs exist which will accommodate a variety of inputs such as vehicular sources and sinks and people-densities in business areas. However, for the outputs of such programs to be useful, careful analyses of all data inputs should be accomplished. (The acquisition of appropriate data for these programs can be rather time consuming.)

B. Implementations

1. The suggested implementations should be reviewed by traffic engineering and planning personnel of the City. Modifications and/or changes should be accomplished. Subsequently, the priorities for implementation of the master traffic flow plan should be established.

These should be influenced primarily by existent traffic patterns, peak period vehicle densities, bottlenecks, etc.

2. Interested personnel at Georgia Tech are available to aid in establishing these goals.

C. Automated Systems

1. A more detailed evaluation of an automated traffic control system for the City should be accomplished. Suggestions and working proposals should be initiated with interested computer manufacturers. Specific potentials of the automated systems should be evaluated. Needed system components should be determined. Incremental installation steps should be outlined, such that annual costs can be estimated and technical procedures can be determined.

2. Because of past experiences in automated system studies, personnel of the Rich Electronic Computer Center at Georgia Tech are particularly well qualified to perform the necessary evaluations mentioned above in paragraph 1. Suggestions and specific proposals can be prepared.

VI. SUMMARY

1. This study for vehicular traffic control in the City of Atlanta is sponsored by internal research funds from the Engineering Experiment Station of Georgia Tech. Five different areas of investigation are included together with the suggested solutions:

a. Identification of the principal traffic control problems in the City.

b. A suggested traffic flow plan for the metropolitan area of the City.

c. Possible treatments of some bottleneck areas in the City.

d. A brief review of the characteristics of various traffic control systems.

e. A proposed automated traffic control system for the City.

2. The principal traffic problems are identified and discussed in three categories:

a. The need for an autonomous Office of Traffic and Transportation for the City of Atlanta.

b. A need for an overall and efficient traffic flow plan.

c. A need for the proper means of implementing on-the-street improvements.

3. A skeletal plan for traffic flow in the metropolitan area of the City has been devised. Emphasis is given to the CBD area and to the northern sector of the City. Sufficient documentation is provided which indicates that significant improvements are possible in vehicle capacities and traffic flow rates. For instance, it appears possible to increase vehicular volume rates at least by a factor of two over current rates.

4. The study of various traffic control systems indicates that an automated (digital computer) traffic control system is needed for any large metropolitan area such as Atlanta. Comparisons are made between the automated system in New York, the master control system in Baltimore, and the hybrid system in Charleston. Results document the conclusions that the inherent flexibilities of an automated system are needed, particularly if an installed system is to keep pace with growing and changing vehicular traffic demands. Estimated costs are included also.

5. Finally, a communications system has been devised for the necessary communication links between the computer facility and all local controllers and detectors. It appears that the suggested communication system can save considerable costs over currently utilized methods. It is recommended that further detailed studies be accomplished.

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VIII. GLOSSARY

Algorithm: An algorithm is a specific set of instructions for a digital computer whereby specified data types are input and results (solutions or answers) are output, dependent on the instructions. An algorithm can also be considered as a specific digital computer program.

Controller: A device for controlling all traffic light indicators, usually at one intersection.

Cycle or Cycle Time: The time required for one complete sequence of all phases of signal indications.

Density-actuated Controller: A controller which has associated vehicle detectors and (usually) analog density computers such that traffic flow is automatically controlled by vehicle densities on the streets in the vicinity of a given intersection.

Fully-actuated Traffic Controller: A controller which is actuated by vehicle detectors on all streets at an intersection. Demands are usually satisfied, dependent on their times and frequencies of occurrence, with predetermined cycle splits within the controller mechanism.

Interconnected Controller: A local controller which is interconnected with other controllers (usually in a master control system). The traffic control functions of the various interconnected controllers can be coordinated.

Local Controller: A controller which controls traffic at a local intersection.

Loop Detector: A mutual inductance loop is buried in the pavement; the loop plus associated circuitry may be adjusted to measure the presence or the passage of a magnetic (metal) vehicle. If an average vehicle length is assumed, a loop detector may also be utilized to detect vehicle speed.

Master Controller: A master controller usually consists of an assembly of devices for measuring traffic flow in a given geographical area. The master controller then instructs the interconnected local controllers accordingly.

MSG: The abbreviation refers to main street green time, and, consequently, to side street red time.

MSR: The abbreviation refers to main street red time, and, consequently, to side street green time.

Offset: The number of seconds (or percentage of cycle time) that the start of the green time on a street is delayed, as referenced to the green time for an initial (or refrence) intersection. Offsets are utilized for establishing platoon flow of vehicular traffic on a given street.

Phase: A part or interval of the cycle time allocated to a specific traffic movement. Two or more phases may overlap, as for instance, in pedestrian movement on one street and vehicular movement on the cross street at a given intersection.

Platoon-flow: Unimpeded and continuous flow of a group of vehicles on a particular street. Platoon-flow is usually accomplished by proper offsets and cycle length for a series of interconnected controllers at a series of intersections along a street.

Pressure-sensitive Detector: A pressure-sensitive detector usually consists of a pressure "pad" imbedded in the street (and actuated by vehicle weight) or a pressure button (actuated by pedestrian).

Pre-timed (Fixed-time) Controller: A controller whose cycle time, cycle split, and offset is predetermined, usually by a self-contained and fixed programming means.

Progressive System: See Platoon-flow.

Radar Detector: A radar detector is a high frequency electromagnetic wave signaling device which "beams" radio energy, generally, from an overhead position in a traffic lane (or lanes). Vehicular presence, or passage, or speed can be detected by reflected echo from the vehicle.

Semi-actuated Traffic Controller: A controller which is actuated by side-street vehicle detectors; the MSR will occur on demand from the side-street, if the time of the demand is compatible with predetermined cycle splits within the controller mechanism.

Sonic Detector: A sonic detector is a high frequency sound signaling device which "beams" sonic energy from overhead or from the side of a traffic lane (or lanes). Vehicular presence or passage is detected by reflected echo from the vehicle.

Split: Cycle split relates to the absolute or percentage split in the cycle time, which is allocated to one street versus the second (or third, etc.) street at a given intersection.

Surface Street (or Artery): As utilized in this report, the term surface street (or artery) applies to any and all streets, other than expressways or freeways.

Time-Space Diagram: This diagram is a plot of cycle times versus intersection spacings along a given street or artery. The cycle times and cycle splits (MSG and MSR) are plotted as sloping lines; the slope represents the desired speed (time in seconds) for a vehicle to progress in one direction on a street from the first (initial) intersection to the last intersection. In establishing a given speed for vehicle travel in one direction, consideration must also be given to vehicle travel in the opposite direction along the same street.

Vehicle Detector: A device for detecting a vehicle. Detection may be related to a stopped vehicle or to a moving vehicle. Also, the vehicle speed may be detected. There are five basic kinds of detectors in current usage: the pressure-sensitive detector; the loop detector; the sonic detector; the radar detector; and others. The other kinds generally relate to infrared types or magnetic devices; these are not in wide usage, either due to costs, unproven results in use, or lack of stability.

APPENDIX A

PROPOSED TRAFFIC FLOW PLAN

A. General

1. This appendix contains a suggested traffic flow plan (one-way and two-way street plan) for the metropolitan area of Atlanta. The plan is skeletal, but sufficient details are given such that vehicle volume rates can be predicted for the principal arteries. Vehicle "sinks" and "sources" (such as parking lot locations) have not been detailed in this short study. However, sources and sinks tend to be represented in the vehicle volume counts at the various locations.

2. The peak period volume data (vehicles/hr) have been obtained by assuming values which are 10% of the daily (24 hour) volumes. Generally, this procedure yields approximate peak values, although such values may be high for heavily traveled arteries. This was done since the peak volume data for A.M. and P.M. traffic were not immediately available on all individual street systems. However, more exact volume data are not considered essential, since comparisons between street systems are relative. Therefore, the proposed systems will not be materially affected.

3. In some examples, specific volume rates are calculated. A minimum safe-distance separation between moving vehicles is assumed to be equal to one vehicle length for each 10 mph of vehicle speed. If the vehicle length (assumed to be 20 feet) is added to the separation distance, the minimum-safe individual vehicle queue length can be estimated. Thus, for an average speed of 30 mph (44 ft/sec), the estimated vehicle queue length equals 20 ft + (30/10) x 20 ft = 80 ft. Therefore, at 30 mph.

0.55 vehicles/sec (= 44(ft/sec)/80 (ft/vehicle)) will pass a given point on a traffic lane. This represents approximately 1980 vehicles per hour per lane at an average speed of 30 mph. Other values for different speeds are listed as follows:

a. At 10 mph, 1320 vehicles/hr/lane

b. At 20 mph, 1760 vehicles/hr/lane

c. At 30 mph, 1980 vehicles/hr/lane

d. At 40 mph, 2112 vehicles/hr/lane

e. At 50 mph, 2200 vehicles/hr/lane

4. The above listed values are assumed to represent maximum lane capacities per hour (or maximum flow rates) for expressway traffic at the given speeds. Of course, these values cannot be maintained if any slowdowns occur, for instance, as a result of turning movements for entrance or exit ramps. Further, these values cannot be maintained without constant speed and spacing. If the minimum safe distance separation (paragraph 3 above) is doubled, the following volume rates are obtained. The reduction in flow rates are about 40% to 45%:

a. At 10 mph, 880 vehicles/hr/lane

b. At 20 mph, 1056 vehicles/hr/lane

c. At 30 mph, 1131 vehicles/hr/lane

d. At 40 mph, 1173 vehicles/hr/lane

e. At 50 mph, 1200 vehicles/hr/lane

5. Also, it is evident that increased speeds will not increase the number of vehicles per hour in the same ratio. Thus, a factor of 2 increase in speed from 10 mph to 20 mph yields only a factor of 1.3 increase in the number of vehicles/hr. A factor of 2 increase in speed from 20 mph to 40 mph

yields only a factor of 1.2 increase in the number of vehicles/hr. Therefore, for a change in speed of ±10 mph at an average speed of 30 mph, the difference in volume rates is approximately 200 vehicles/hr/lane or less.

6. It may be interesting to note that the peak volume rates for I85 are approximately 2300 vehicles/hr/lane,[17] based on a value which is 10% of the daily volume. Thus, there appears to be a discrepancy between this value and any of the maximum values listed in paragraph 3 above. Two factors (which have not been considered previously) can explain this discrepancy. It is probable that a combination of both factors should be made:

a. A peak volume figure which is based on the value obtained by taking 10% of the daily (24 hour) volume is an invalid assumption for expressway traffic in Atlanta.

b. Sub-safe separation distances are being maintained. For instance, if an average speed of 20 mph is assumed, together with an unsafe separation distance of 26 feet (vehicle queue is 46 ft), then 2300 vehicles/hr/lane could be accommodated.

7. Since the volume rates listed in paragraph 3 above appear to be reasonable and are based on minimum safe assumptions, it is believed that such basic values should be utilized. It is noted that when the maximum volume rates are approached for the respective speeds, slow-down and/or stoppage is predicted. Thus, at a flowing rate of 30 mph, as the volume approaches 1980 vehicles/hr/lane (roughly one vehicle every two seconds per lane), a slow-down is predicted to occur. However, for the next lowest speed shown (20 mph), the volume rate is only 1760 vehicles/hr/lane. Therefore, stoppage is predicted. These figures indicate the principal importance of avoiding slow-downs on expressways. They also indicate clearly the reason for stoppages.

8. With respect to arterial traffic flow, the values given in paragraph 3 above should be modified. It is first assumed that smooth platoon flow is possible for the direction of major flow. This means that groups of vehicles can move unimpeded along an artery, with no stoppage due to traffic lights. For purposes of this report, it has been assumed that 65% of the total time is available as traffic light green time for arterial flow in a platoon system. The following volume rates are obtained by taking 65% of the values given in paragraph 3 above, and should be applicable to arterial platoon flow:

a. At 10 mph, 858 vehicles/hr/lane

b. At 20 mph, 1144 vehicles/hr/lane

c. At 30 mph, 1287 vehicles/hr/lane

d. At 40 mph, 1430 vehicles/hr/lane

9. The value chosen (65%) for available green time appears reasonable. In particular, a 70% value is sometimes used where the particular intersections along the artery involve only minor side-street access. For traffic flow in a grid network, where no particular directional preference is apparent, a 50% value may be more desirable. In the latter case, the values given in paragraph 3 above should be halved.

10. Finally, when platoon flow ceases, or slow-downs occur due to turning movements, or stoppages occur at given intersections, the values given in paragraph 8 above should be modified further. For instance, the listed values can be reduced by a factor of 1/4 to 1/2 (net flow would be 3/4 to 1/2 of that listed above). These factors can be derived from nominal acceleration rates for a group of stopped vehicles, each of which starts to move (similar to incremental rubber band stretching) and subsequently passes through a given intersection.

B. Central Business District

1. For purposes of discussion, the suggested traffic flow plan has been divided into parts, each part being discussed in the following sections. Although the individual parts must be viewed as they relate to the overall plan, discussions can be made more coherent by consideration of individual parts of the plan.

2. The business district is considered as the Cordon Area[16] and is shown in Figure A-1. Within the Cordon Area, there are two actual subareas, which are considered as the Central Business District (CBD) and which need particular examination. These are shown also in Figure A-1:

a. The southern subarea is considered as being bounded by Piedmont and Capitol Avenues, Memorial Drive, and Garnett, Spring, and Alabama Streets.

b. The northern subarea is considered as being bounded by Carnegie Way, and Peachtree, Marietta, and Spring Streets.

3. Within the Cordon Area there already exists a significant system of one-way streets. Although it might be desirable to change the functions of some of these one-way streets, their functions are controlled, principally, by expressway entrance and exit ramps. Therefore, no change in the present system of major one-way streets is contemplated or recommended. The current major one-way streets are indicated for the Cordon Area in Figure A-2. (Since it is assumed that these streets are familiar to the reader, they are not enumerated.)

4. Before discussion is made with respect to a proposed traffic flow plan several observations are made:

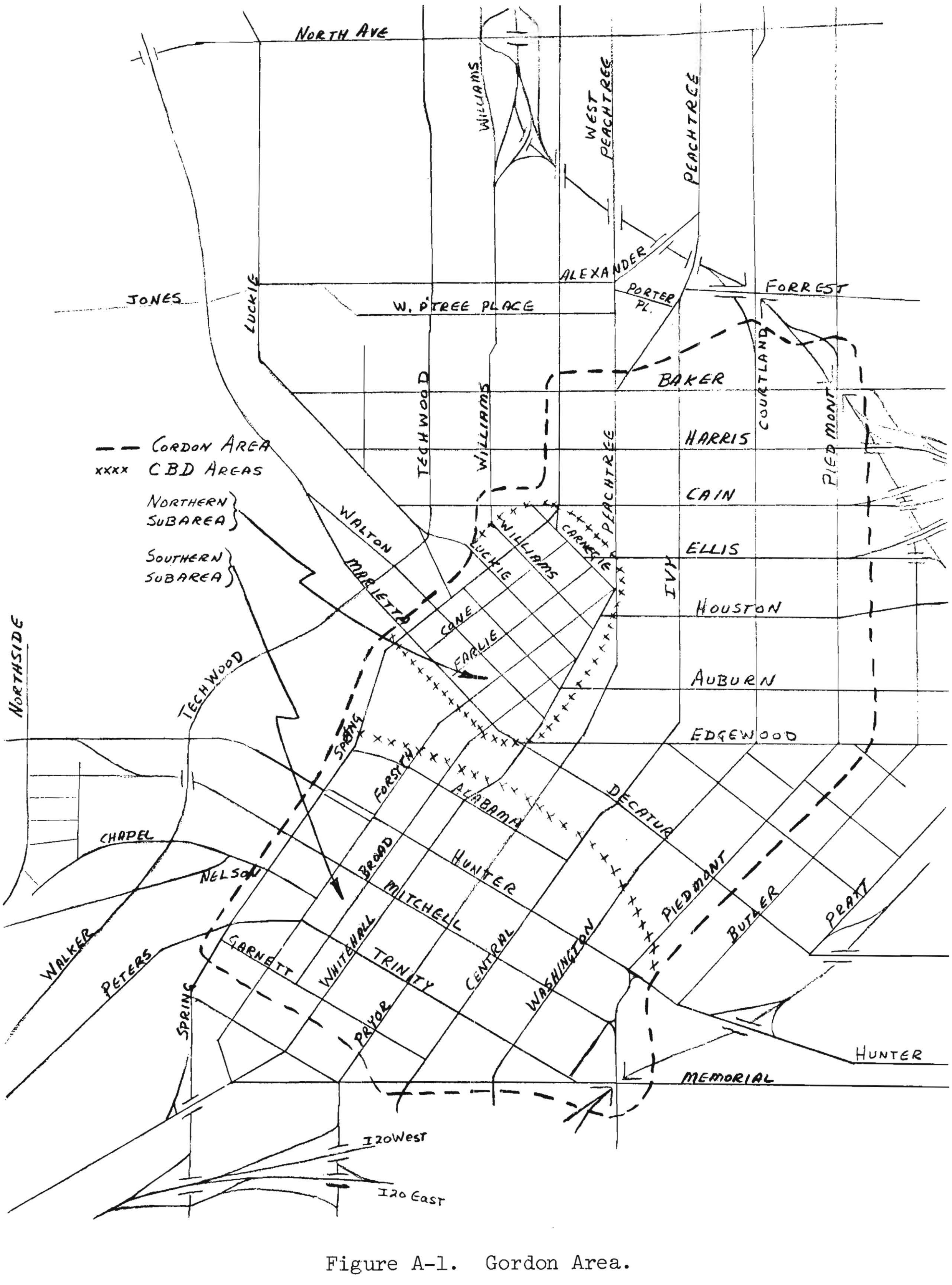

Figure A-1. Gordon Area.

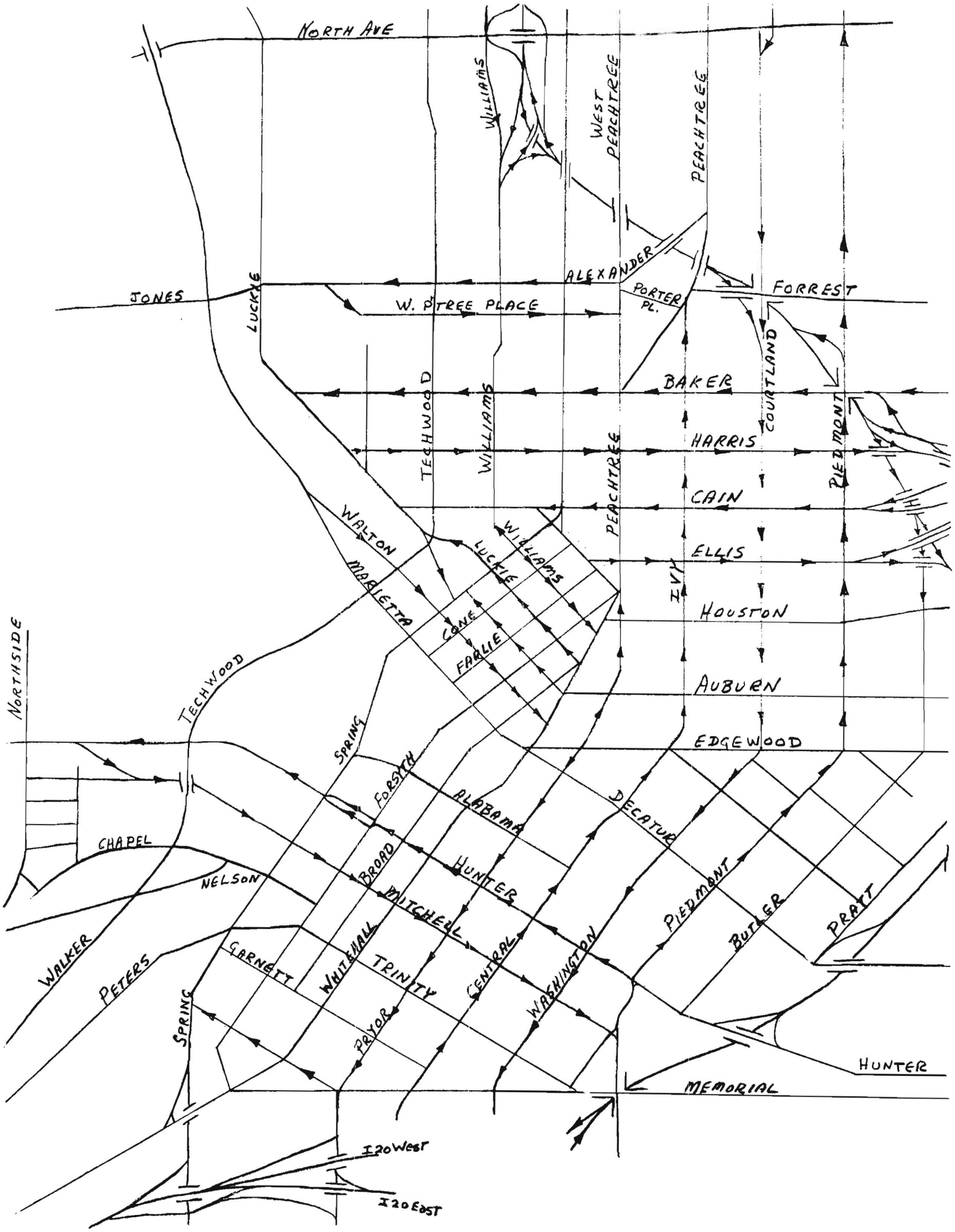

Figure A-2. Current One-way Street System.

a. Additional one-way street systems are needed in the CBD area if maximum flow rates are to be realized for peak period demands of traffic moving into and out of the area.

b. Other streets and arteries adjacent to the area should be adjusted as to their functions such that maximum flow rates can be maintained for the CBD area.

5. One of the principal problems evidenced in Atlanta (both within and external to the CBD area) is the absence of smooth traffic flow on two-way street systems. One has only to drive-the-streets in Atlanta (both during peak periods and during normal periods) to observe that major congestion exists on almost all heavily traveled two-way street systems which can accommodate only 4 lanes of traffic. On the other hand, heavy congestion on major one-way streets appears to exist only during peak periods, and this appears to occur principally at major traffic intersections. These observations lead one, intuitively, to the conclusion that one-way street systems are far superior to two-way street systems for moving traffic, particularly for streets with a capacity of 4 lanes or less. Additionally, documented flow rates[1,2] have been indicated which show increased flow rates by as much as a factor of 2 for a pair of one-way streets versus the same pair utilized as two-way streets.

6. Principally, because of the observations and reasons given above, one-way street systems are emphasized and utilized throughout this study effort, wherever possible. (Where a conflict of interest may exist, for example, with bus routes and services, other approaches are possible such as "effectively" one-way streets. See Appendix B, Section C, paragraphs 5 and 6.)

7. A suggested traffic flow plan is shown in Figure A-3 for the subareas mentioned in 2a and 2b above. All major one-way streets are indicated by directional arrows, whether they currently exist as one-way streets or whether they are suggested as one-way streets. Streets with reversible lanes are indicated by bidirectional arrows. Streets which have been made "effectively" one-way have opposing directional arrows, the bold-faced arrow indicating the one-way direction. Nominal two-way streets have no arrow indicators. The new or suggested one-way streets are listed as follows:

a. Southern subarea

(1) Forsyth Street

(2) Whitehall Street (north of Memorial Drive)

(3) Butler Street

(4) Trinity Street

(5) Garnett Street

(6) A reversible lane on Nelson Street (betwen Forsyth and Chapel Streets)

(7) Spring Street (north of Peters Street)

b. Northern subarea

(1) Forsyth Street

(2) Spring Street (south of Carnegie Way)

(3) Carnegie Way

(4) Peachtree Street (between Marietta and Luckie Streets)

(5) Cain Street (between Spring and Luckie Streets)

(6) Techwood Drive (This street is actually external to the subarea and is discussed in the following section.)

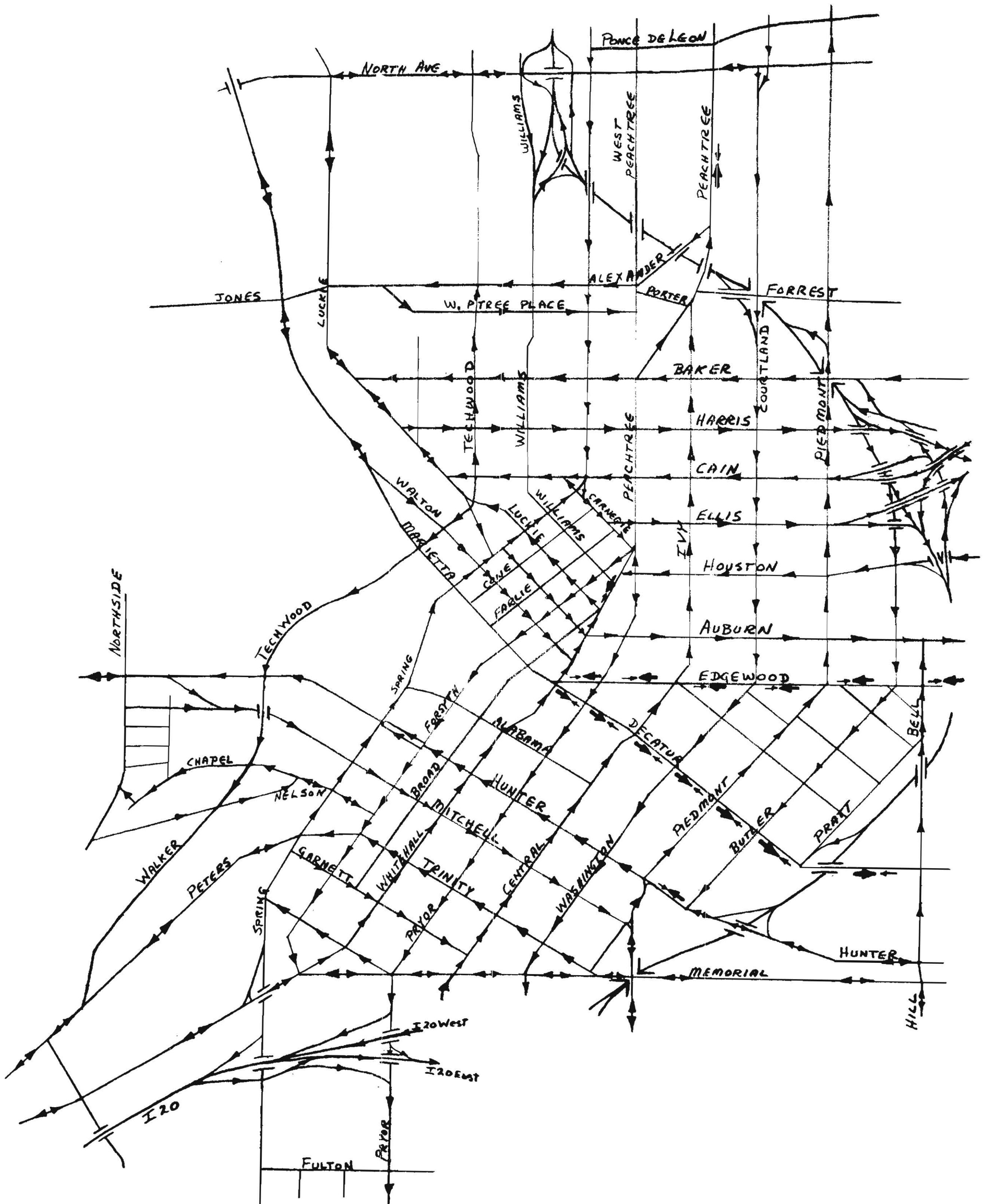

Figure A-3. Suggested Central Business District Traffic Flow Plan.

8. As presented, the plan offers the possibility for establishing maximum flow rates into and out of the two subareas, compatible with the overall flow plan. In addition, the suggested plan does not appear to impede circulating traffic flow in the area.

9. The reasons for the choice of the particular plan shown in Figure A-3 are discussed in the following paragraphs. The southern subarea is the first to be discussed. Perhaps, the most difficult (and controversial) choice in the plan relates to the treatment of Spring Street in this area. There are several possibilities:

a. Spring Street can remain unchanged. That is, two-way traffic can be accommodated from the southern terminal point northward.

b. Spring Street can be made one-way south in this area.

c. Spring Street can be made one-way north in this area.

d. Some combination of the above listed possibilities.

10. Item 9a above is not considered as being necessary or desirable. Two-lane traffic on Spring Street would continue to cause significant congestions along the entire route during peak traffic periods. Therefore, Spring Street should be utilized as a one-way street, if possible.

11. Item 9b is not considered as offering the most desirable solution, particularly if Spring Street is also to be made one-way south under I20 to the entrance and exit ramps for eastbound traffic on I20. Several reasons are given:

a. Rapid access to the southern subarea from the south and southwest can be accomplished from the Murphy-Whitehall artery, from the Lee-West Whitehall-Peters artery, and from the southern area between Stewart and Central Avenues (south of I20). If Spring Street is made one-way south to I20, several detrimental reroutings of traffic would be necessary.

(1) Northbound traffic from the Murphy-Whitehall artery would be forced to use Whitehall northbound, since there would be no convenient route northward on the west side of the area. (If Spring Street were one-way south in this area, the <u>only</u> access to the west side for northbound traffic in this area would be via McDaniel Street across a two-lane railroad bridge to Peters Street.) Again it is not considered necessary to establish these traffic routes.

(2) It might be argued that peak volume demands on the Murphy-Whitehall artery (approximately 300 vehicles/hr) are not sufficiently large to justify consideration given in (1) above. However, it will be demonstrated, subsequently, that the Murphy-Whitehall artery can be utilized to a much greater extent than present usage allows. Thus, it is anticipated that peak traffic volumes of upwards to 1600 vehicles/hr could be accommodated on this artery.

(3) Finally, northbound traffic from I20 or from the southern area between Stewart and Central Avenues would be forced either westward to McDaniel Street or eastward to Central Avenue. These streets are already congested with peak volume demands. Therefore, additional traffic volumes on these streets is undesirable, particularly if it is not necessary.

b. Because of the arguments given in a(1) through a(3) above, it is concluded that Spring Street should remain two-way at least from Peters Street southward. This results because this interval of Spring Street can serve an adequate function of handling medium values of peak volume demands, both for A.M. and for P.M. traffic. Perhaps more significant is the fact that all traffic handled in such a manner would be removed from the already congested surface streets and intersections along the Lee-West Whitehall-Peters artery and along the Pryor and Central arteries.

c. For the southern subarea, if Spring Street were made one-way south from Marietta Street to Peters Street, other traffic problems can arise:

(1) Northbound traffic from the Lee-West Whitehall-Peters artery would either have to use Walker Street-Techwood Drive or go eastward on Trinity Street and use Whitehall Street northbound. (Reasons for establishing Forsyth one-way south and Whitehall one-way north are given below in paragraph 13.) Northbound traffic from the Lee-West Whitehall-Peters artery could be readily accommodated via Walker Street-Techwood Drive. In fact, if this were the only problem, this northbound route would offer an excellent solution. Northbound traffic from the Lee-West Whitehall-Peters artery via Trinity Street and Whitehall Street is not considered advisable. This results because of the existent, high peak volume traffic on Whitehall from other streets. Hence, more traffic should not be added, if it is not necessary.

(2) For access to the northwest, northbound traffic from the southern subarea would be forced to use either Nelson or Hunter Streets for access to Techwood Drive. This requirement, perhaps, is not completely undesirable, although Hunter Street already carries a medium P.M. volume (~ 1074 vehicles/hr) for traffic to the west side.

(3) If Spring Street were one-way south in this interval, there would exist two adjacent, high capacity streets (Spring and Forsyth Streets), both of which are one-way in the same direction. Although this feature is not completely undesirable, it is not necessary. Additionally, circulating traffic in the southern subarea might be affected, since Broad Street would be the only available street for circulating traffic for the western part of this southern subarea.

12. Item 9c above is now considered. If Spring Street were made one-way north from Peters Street, all of the objections listed above in paragraphs 10 and 11 would either be removed or would not be applicable. Thus, it appears that if Spring Street is made one-way north for this interval, a satisfactory solution will be obtained for the southern subarea. However, it will probably be advisable to make Techwood Drive one-way south for a similar interval so that by-pass or access from the northwest is adequate. (Actually, the principal access to the southern subarea from the north and northwest is adequately provided by Forsyth Street, one-way south. Thus, Techwood Drive could function quite well as a southbound by-pass for the southern subarea. More discussion on this feature is given in the following section.)

13. The reason for making Forsyth Street one-way south and Whitehall Street one-way north (for the interval north of Memorial Drive) is rather simple. The intersections at the terminal points of these streets are such that if the opposite choice were made, significant intersection problems (conflicting traffic movements) would result. This is particularly true at the Carnegie Way-Forsyth Street-Peachtree Street intersection. If Forsyth Street were one-way north at this intersection, a three-phase traffic light would be required. Since the intersection carries large peak volumes, a three-phase light is completely undesirable, if it can be avoided. (A three-phase traffic light splits the available green time into three parts, as compared to two parts for a two-phase light.)

14. In the northern subarea, several possibilities again exist for the treatment of Spring Street.

a. Two-way traffic is possible. It is believed that this should be avoided, if possible; larger volume rates can be accommodated on one-way streets.

b. Spring Street may be continued one-way north from Marietta Street to Carnegie Way, or even further north.

c. Spring Street may be made one-way south to Marietta Street.

d. Some combination of the above possibilities.

15. Item 14a above is considered undesirable for the reasons given. Item 14b above is perhaps the best choice, if Spring Street is to be made one-way north for the previously mentioned interval south of Marietta Street (from Peters Street to Marietta Street). Also, item 14c above would probably not be acceptable in this situation, since four lanes of northbound traffic on Spring Street at the south side of the Marietta Street intersection would oppose four lanes of southbound traffic on Spring Street at the north side of the intersection.

16. Spring Street one-way northbound can be terminated conveniently at Carnegie Way, with little safety hazard. (Reasons for not continuing Spring Street one-way north are given in the following section.)

17. For the northern subarea, therefore, it is suggested that Spring Street be continued one-way north from Marietta Street to Carnegie Way. If the interval of Spring Street north of Carnegie Way is to be made one-way south (as shown in Figure A-3), then Carnegie Way should be made one-way east. Forsyth Street has already been discussed above in paragraph 13. As a continuation for Whitehall Street traffic, Peachtree Street should be made one-way north from Marietta Street to Luckie Street. It is suggested that Cone Street remain two-way for circulating traffic needs in this northern

subarea. Two-way use of Cone Street can be accomplished, since this street should not be subjected to excessively high peak volume demands. (However, it is possible that a large A.M. peak volume could result from southbound traffic from Spring Street terminating in the area. On the other hand, it could also happen that a large P.M. peak volume could result from exiting traffic to Ellis Street. If these peak volumes develop, then Cone Street should be implemented with the two center lanes being reversible. In this manner, three one-way traffic lanes could be supported for both the A.M. and P.M. peak periods.)

18. If the interval on Spring Street north of Carnegie Way is made one-way south, then a companion interval on Techwood Drive should be made one-way to the north. This one-way interval on Techwood Drive should initiate at the Cain Street intersection. Techwood Drive should remain two-way between Cain Street and Luckie Street to provide access for Cain Street traffic to Techwood Drive, southbound. Nassau Street should remain one-way east to Spring Street. Cain Street should be made one-way west in the interval from Spring Street to Luckie Street. Since there is adequate access to Williams Street northbound from Cain Street, the two lanes on Williams Street south of Cain Street should be made one-way south and east. This provides access from Williams Street to the northern subarea.

19. On Peachtree Street, between the Luckie and Forsyth Street intersections, three southbound lanes and one northbound lane could be provided. (The reasons for this choice as well as alternative treatments are discussed in Appendix B.) The single northbound lane is provided as an exclusive bus lane. Thus, northbound traffic on Whitehall-Peachtree is forced either westward on Luckie Street or eastward via Auburn Avenue to Ivy Street and, thence, northward. These features are compatible with the overall traffic flow plan.

20. As a summary for the CBD area, the traffic flow patterns into and out of the area are reviewed.

a. A.M. traffic (surface streets only)

(1) From the west, access is provided by Mitchell Street (4 lanes), and by Nelson Street (2 lanes, one of which is reversible) to Spring and Forsyth Streets.

(2) From the southwest, access is provided via Peters Street (3 lanes, one of which is reversible), and by the interval on Whitehall Street south of Memorial Drive (3 lanes, one of which is reversible).

(3) From the south, access is provided via Spring Street (2 lanes), by Central Avenue (4 lanes), and by Capitol Avenue (3 lanes, one of which is reversible).

(4) From the east, access is provided via Memorial Drive (3 lanes, one of which is reversible), by Hunter Street (3 lanes, one of which is reversible), by Edgewood Avenue (3 lanes), and by Houston Street (3 lanes at the Peachtree Street intersection).

(5) From the northeast and north, access is provided by Courtland Street (4 lanes), by Pryor Street (4 lanes), by Peachtree Street (3 lanes), and by Butler Street (4 lanes).

(6) From the northwest and north, access is provided by Spring Street (4 lanes), by Williams Street (2 lanes), by Luckie Street (3 lanes, one of which is reversible), and by Marietta Street (3 lanes, one of which is reversible).

b. P.M. traffic (surface streets only)

(1) To the west, access is provided via Hunter Street (4 lanes), and via Nelson-Chapel Streets (2 lanes, one of which is reversible).

(2) To the southwest, access is provided via Peters Street (3 lanes, one of which is reversible), and via the southern interval on Whitehall Street (3 lanes, one of which is reversible).

(3) To the south, access is provided via Spring Street (2 lanes), via Pryor Street (4 lanes), via Washington Street (4 lanes), and via Capitol Avenue (3 lanes, one of which is reversible.)

(4) To the east, access is provided via Memorial Drive (3 lanes, one of which is reversible), via Hunter Street (3 lanes, one of which is reversible), via Decatur Street (3 lanes), via Auburn Avenue (4 lanes), and via Ellis Street (4 lanes).

(5) To the northeast and north, access is provided via Piedmont Avenue (4 lanes), and via Ivy Street (4 lanes).

(6) To the northwest and north, access is provided via Williams Street (2 lanes), via Techwood Drive (4 lanes), via Luckie Street (3 lanes, one of which is reversible), and via Marietta Street (3 lanes, one of which is reversible).

21. Thus, there would be a total number of 60 lanes available for A.M. entrance traffic into the CBD. This is to be compared with 50 lanes, currently available. Also, there would be a total of 62 lanes available for P.M. exit traffic from the CBD. This is to be compared with 57 lanes, currently available. The net increases in available lanes result from reversible lanes on several of the main arteries, namely, Luckie, Marietta, Peters, and White-Hall Streets and Capitol Avenue and Memorial Drive. However, even if there were no net increase in the number of available lanes, the possibility for increased flow rates is quite significant as a result of the additional one-way streets.

22. Predicted volume rate figures for entrance or exit of the CBD area are also interesting. The volume rates given in the previous section A, paragraph 3, are utilized. These previously listed values are applicable to continuous expressway traffic. Therefore, some average available green time must be assumed to compute predicted flow rates on the surface streets. Since all directions are involved for traffic into and out of the CBD area, a 50% time factor might be suggested. Thus, it is assumed that vehicular flow is possible for 50% of the time. The predicted volume rates are listed as follows:

a. At 10 mph, 660 vehicles/hr/lane

b. At 20 mph, 880 vehicles/hr/lane

c. At 30 mph, 990 vehicles/hr/lane

23. For the peak periods (access to and from the CBD), these values suggest the following possible total volume rates.

a. A.M. traffic flow

(1) On the currently available 50 lanes, 33,000 vehicles/hr might be accommodated at a speed of 10 mph.

(2) As a result of the proposed plan, the available 60 lanes might accommodate 39,600 vehicles/hr at a speed of 10 mph.

(3) At speeds of 20 mph, the values in (1) and (2) above are increased to 44,000 vehicles/hr and 52,800 vehicles/hr, respectively.

b. P.M. traffic flow

(1) On the currently available 57 lanes, 37,620 vehicles/hr and 50,160 vehicles/hr might be accommodated at 10 mph and 20 mph, respectively.

(2) For the proposed plan, the available 62 lanes might accommodate 40,920 vehicles/hr and 54,560 vehicles/hr at 10 mph and 20 mph, respectively.

24. For the entire Cordon Area, the current total peak volume rate is approximately 22,656 vehicles/hr. This value also includes all expressway traffic which terminates (or originates) in the area; however, the above listed values in paragraph 23 include only the traffic into or out of the CBD area (which is considerably smaller than the Cordon Area. Therefore, the differences in the values are quite large. The currently available 50 lanes (for A.M. traffic) should support at least the minimum volume rate of 25,000 vehicle/hr. This value is obtained for stop-and-go traffic which attains only 10 mph after acceleration. (It is derived by taking 3/4 of the 10 mph volume rate for 50% green time. See paragraphs 10 and 22 above.) On the other hand, measured values for stop-and-go traffic which attains 30 mph after acceleration indicate an appropriate volume rate of 780 vehicles/hr/lane for 50% green time (see Appendix B, Section B, paragraph 8).

25. In order to account for the current volume rate into the CBD area (22,656 vehicles/hr), approximately 453 vehicles/hr/lane must be assumed for each of the 50 currently available lanes. This represents an average speed of only 5.2 mph, or (what is more probable) an effective green time of only 34%. A categorical statement can be made that these differences should be ignored and that the comparisons are not valid for unknown reasons. On the other hand, it is impossible to ignore the relative increases made possible by the additional lanes. The 10 additional lanes for the A.M. peak period could accommodate an additional 6600 vehicles/hr or 8800 vehicles/hr, respectively, for speeds of 10 mph or 20 mph, with 50% of green time. Similarly, the 5 additional lanes for the P.M. peak period could accommodate 3300 vehicles/hr, or 4400 vehicles/hr, respectively, for spreads of 10 mph or 20 mph.

26. Finally, it should be re-emphasized that the proposed plan should accommodate relatively smooth traffic flow as opposed to the present stop-wait-and then-go traffic. When the CBD traffic reaches an artery, platoon flow should be experienced and further stoppage would not be predicted.

C. Northern City Area

1. A suggested overall traffic flow plan is shown in Figure A-4. The Screen Line[17] is also indicated by a dashed line.

2. The treatment of Spring Street is presented first. As in the previous section, there are several possibilities for this treatment:

a. Spring Street may remain unchanged. That is, two-way traffic may be accommodated north of Cain Street. Again, this possibility is not deemed to be desirable or necessary. Since this is a four lane street, very significant increases in volume flow rates can be realized if the street is made one-way.

b. Spring Street can be continued one-way north from Cain Street. The terminal point could be established at North Avenue, 5th Street, 10th Street, 14th Street, or at the Peachtree Road intersection.

c. Similarly, Spring Street can be made one-way south from Peachtree Road to 14th Street, 10th Street, 5th Street, North Avenue, or to Cain Street.

d. Some combination of the above listed possibilities.

3. In order that the above possibilities may be evaluated, the traffic patterns and volumes on Peachtree Road in the Brookwood and Pershing Point areas need to be examined.

a. Because of the configuration of the present street system which currently exists in this area, Spring Street unquestionably should be made one-way south from the Peachtree Road intersection. (How far this should extend southward is not of concern at the moment.) Several principal problems exist in this area and

lanes as well as to the number of vehicles entering or leaving Peachtree Road.

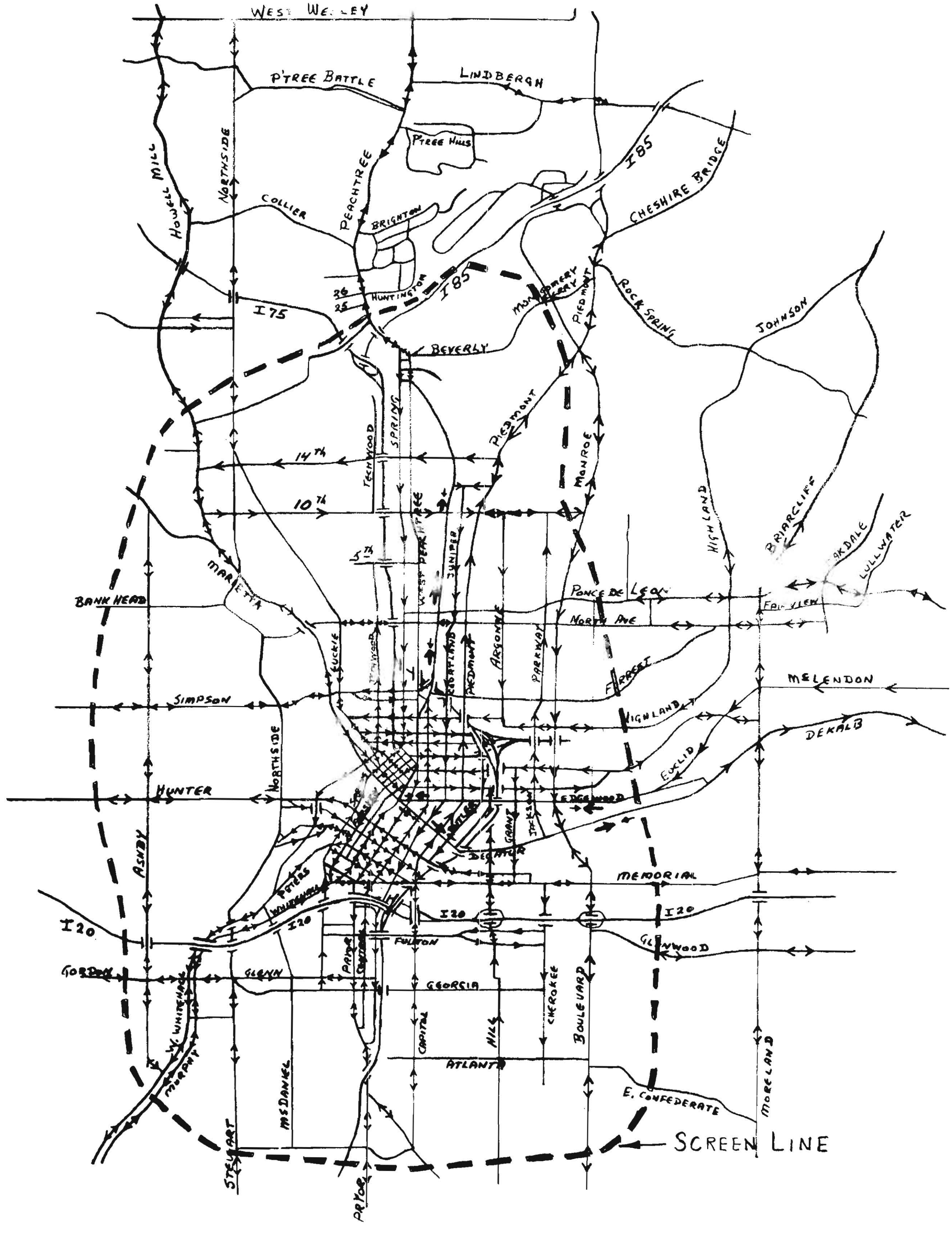

Figure A-4. Overall Traffic Flow Plan with Indicated Screen Line.

(1) The southbound peak A.M. traffic on Peachtree Road begins to experience stoppage at the Spring Street intersection. Traffic "backup" may extend northward as far as Peachtree Battle Avenue, and sometimes as far as Wesley Road. Current rates have been measured at approximately 2100 vehicles/hr[28] (700 vehicles/hr/lane). As is well known to anyone who drives this area during the peak periods, actual stoppage may occur before the above volume rate is reached. For instance, by actual measurement on northbound peak P.M. traffic,[29] stoppage occurred at approximately 1300 vehicles/hr or about 433 vehicles/hr/lane.

(2) One of the principal reasons for this stoppage (both in the A.M. and the P.M.) is the conflicting traffic movements at the Spring Street intersection with Peachtree Road. Other individuals have contended that stoppage occurs primarily as a result of heavy congestion (turning movements, etc.) from Deering Road north to Collier Road or to Peachtree Battle Avenue. However, it is demonstrated in Appendix B that this cannot be the principal cause, although it is certainly a prominent and contributing factor. Inadequate traffic light control is another prominent contributing factor.

(3) For A.M. traffic, continuous through-lanes with no unnecessary stoppages are needed. With the existent street arrangement, this can be provided by making Spring Street one-way south at the Peachtree Road intersection, and by providing four one-way lanes for through traffic on Peachtree Road. (As discussed in Appendix B, these four lanes can be provided by means of two reversible center lanes.)

(4) If Spring Street is made one-way south at Peachtree Road, at least two lanes of continuously moving traffic can be provided as an exit

from Peachtree Road to Spring Street, southbound, with no stoppage. Actually, if it is desired, three lanes could be provided during the peak A.M. period, by forcing both outside lanes on Peachtree Road (southbound) to exit at Spring Street. Thus, the third inner lane could either exit or continue on Peachtree Road. The fourth inner lane would be required to continue on Peachtree Road. Thus, it is argued that through traffic movement on Peachtree Road can be assured in spite of the congestion from Peachtree Battle Avenue southward. (See Appendix B for discussions and examples.)

(5) For P.M. traffic, 4 one-way lanes can be provided northbound on Peachtree Road from the Peachtree-West Peachtree intersection. There will be no unnecessary stoppage at Spring Street (if it is one-way south). Platoon flow can be established at the Peachtree Road-Peachtree Circle intersection. This is discussed in some detail in Appendix B.

(6) In addition, left-turn movements should be restricted for the peak P.M. traffic period on Peachtree Road between Deering and Collier Roads, as discussed in Appendix B. For instance, all of the residential areas to the west of Peachtree Road between these two streets can be readily accessed from Peachtree Road via either Deering or Collier Roads. Therefore, left-turn movements should be restricted to these two streets only in this area for the peak P.M. period.

b. It has been suggested[16,19,30] that the whole area needs rebuilding with respect to a more efficient interchange, particularly in the Brookwood area. This may ultimately be accomplished. However, implementation would occur at least 5 years into the future, and present needs should be satisfied.

c. It has been suggested[16] that Techwood Drive might be continued northward from 14th Street, perhaps, to connect with Peachtree Road via Deering Road. Subsequently, if Techwood could be connected southward from 10th Street to 5th Street, a major north-south artery could be created. Therefore, it has been argued that Techwood Drive should then be made one-way south and Spring Street should be made one-way north. The two streets would function as a one-way pair throughout the north-south area, perhaps to Peters and Walker Streets, at the southern terminal point. This proposal contains considerable merit. However, there are several conflicting problems.

(1) It is probable that Techwood Drive could be continued northward from 14th Street to Deering Road. However, it is not possible to extend Techwood Drive southward, as a main surface street artery, through the Georgia Tech campus. This possibility has been considered and discarded as being completely undesirable with respect to campus activities as well as with respect to circulating vehicle and pedestrian traffic in the campus area.[31]

(2) It would be possible to extend Techwood Drive southward as a major artery by tunneling from 10th Street south to North Avenue (approximately 0.7 miles). However, it is understood that this proposal has been discarded as being too expensive. Such a reason as being "too expensive" does not appear to be compatible with other existent proposals. For instance, it has been proposed to tunnel (approximately 1 mile) from the I485 and I75-85 interchange westward to connect with a new north-south freeway system to the west of Marietta Street.[19] This latter connector would be most useful, particularly when I485 and the Stone Mountain Freeway are completed. However, it is believed that this need is no greater than the proposed

tunneling on Techwood Drive. Certainly, the cost for tunneling on Techwood Drive would be significantly less.

(3) As an alternative to tunneling on Techwood Drive, it has been proposed (and accepted in content[31]) that Techwood Drive could be extended through the area of the O'Keefe High School Gymnasium southward to connect with Williams Street at Third Street. This would also require demolishing approximately one-third of two Georgia Tech dormitories immediately north of Third Street. At best, implementation of this proposal could provide only two lanes of traffic southbound on Williams Street. Actually, there currently exists space for three lanes (10 ft. width) on Williams Street southbound to Pine Street (by measurement). However, it is understood that an additional lane is to be added, ultimately, to I75-85 (both north and southbound). In the latter situation, there would remain only space for two lanes on Williams Street.

(4) With respect to immediate influence on the choice of a one-way direction for Spring Street, therefore, the proposal in (3) above is discarded for two reasons.

(a) Five or more years would be required to implement the proposal.

(b) The additional two southbound lanes would not accommodate sufficient traffic volumes to warrant the costs.

d. The proposed use of Techwood Drive (items c(1) and c(2) above) would provide an excellent solution for north-south traffic demands. However, the traffic movement on Peachtree Road should be examined carefully.

(1) If Techwood Drive were made one-way south (from Deering Road), then Spring Street should be made one-way north. However, this usage

of Spring Street can cause serious congestion at the intersection with Peachtree Road. Thus, the situation would be similar to that which currently exists at this intersection. Actually, the congestion would be compounded because four lanes of northbound traffic on Spring Street would be seeking exit onto Peachtree Road, instead of two lanes.

(2) For the peak P.M. period, traffic congestion occurs for the following reason. There are too many northbound lanes "dumping" into Peachtree Road in a very short distance of approximately 900 feet. Thus, Spring Street currently exits two northbound lanes of traffic; if Spring Street were one-way north, four lanes of northbound traffic would exit onto Peachtree Road. Approximately 900 feet to the south, three northbound lanes of traffic currently exit from Peachtree Street and another three lanes exit from West Peachtree Street. Even with the proposed 4 one-way lanes on Peachtree Road (for the P.M. peak period), it would be impossible to move this amount of entering traffic on Peachtree Road (from so many lanes in so short a distance), such that smooth traffic flow is established. This is the principal reason that a current "bottleneck" exists: eight lanes from three different streets exit onto three lanes on Peachtree Road within a distance of 900 feet.

(3) The only solution which appears to be compatible with both (1) and (2) above is stated as follows. If Techwood Drive were made one-way south, Spring Street should be made one-way north; then West Peachtree must be made effectively one-way south and Peachtree Street must be made effectively one-way north. Thus, eight lanes would exit (from Spring and Peachtree Streets) onto four lanes on Peachtree Road for the peak P.M. period.

However, these eight lanes occur on only <u>two</u> streets; this would enable a reasonable platoon flow to be established for northbound traffic on Peachtree Road. There would be no reason for a "bottleneck" in the area for either the peak A.M. or P.M. periods.

(4) The hypothetical solution proposed in (3) above appears to offer the most logical and efficient means of handling the north-south peak period traffic in this area. Unfortunately, Techwood Drive is not currently available as a through artery.

e. Because of the above arguments, it has been suggested that Spring Street be made one-way south from the Peachtree Road intersection. It is noted that the particular arguments presented in d(2) and d(3) above are applicable to the current situation which exists between the conflicting traffic demands for peak P.M. traffic on Spring, Peachtree, and West Peachtree Streets. As mentioned previously in a(5) above, platoon flow can be established for peak P.M. traffic from Peachtree and West Peachtree Streets. In the future, if Techwood Drive is connected as proposed in c(1) and c(2) above, one of two possibilities exists:

(1) Spring Street may be reversed and made one-way north.

(2) Spring Street may be left unchanged, i.e., one-way south, and Techwood Drive can be made one-way north.

f. It has been stated by others that the possibility of Techwood Drive being made one-way north to Peachtree Road (item e(2) above) would be completely unsatisfactory because of the conflicting traffic movements onto Peachtree Road. Actually, this opinion does not consider all of the facts. It is true that "cross traffic" would be generated from the vehicles on Techwood Drive which enter Peachtree Road northbound. However, if Techwood

Drive is made one-way south, then a similar situation for "cross traffic" is generated at the Spring Street-Peachtree Road intersection; thus, northbound vehicles on Spring Street which enter Peachtree Road, northbound, would generate "cross traffic." Therefore, it should make no difference which of the two streets is made one-way south. Actually, it would appear easier to establish platoon flow on Peachtree Road northbound for the peak P.M. period if Techwood Drive were made one-way north instead of one-way south. This results because the distance separation between Techwood Drive and Peachtree-West Peachtree Streets is considerably greater than the distance separation between Spring Street and Peachtree-West Peachtree Streets.

4. It is assumed that Spring Street should be made one-way south from Peachtree Road. However, this southbound traffic must be terminated in advance of the northbound traffic which exists on Spring Street, south of Carnegie Way. Since an adequate number of northbound lanes can be provided on West Peachtree and Peachtree Streets for the peak P.M. period, it is concluded that additional northbound lanes are not needed on Spring Street. Therefore, it is suggested that Spring Street be continued one-way south to Cain Street. This will provide much needed through lanes into the downtown area from the northside for the peak A.M. period. Other alternatives are available:

a. Spring Street (one-way south) could be terminated at 14th Street. However, this alternative does not afford any other route for ready access to the downtown area.

b. Spring Street (one-way south) could be terminated at 10th Street. Routing to the downtown area would be forced eastward onto West Peachtree Street. This is a possible solution. However, it is not recommended because it is not considered necessary to add this additional volume to West Peachtree Street. Also, the ultimate increase in traffic volume which would be generated on Peachtree Street, south of Baker Street, would be undesirable.

c. Spring Street (one-way south) could be terminated at 5th Street. Southbound traffic would be forced eastward to West Peachtree (which is undesirable) or forced westward to Techwood Drive. The latter possibility has been discussed.[31] However, it would only be satisfactory as a temporary route, since it would tend to make Techwood Drive a major artery through the Georgia Tech campus.

d. Spring Street (one-way south) could be terminated at North Avenue. Again, southbound traffic would be forced eastward to West Peachtree Street (which is undesirable) or forced westward to Techwood Drive. The latter possibility is acceptable with respect to use of Techwood Drive one-way southbound into the downtown area. However, North Avenue is a major east-west artery. Additionally, North Avenue needs to support at least three lanes of eastbound traffic in this area for the peak A.M. period. Currently, this would leave only one effective westbound lane from Spring Street to Techwood Drive, and this would create a serious "bottleneck" in this area. On the other hand, if North Avenue were widened to accommodate a total of six lanes (between Williams Street and Techwood Drive), three lanes of westbound traffic from Spring Street to Techwood Drive could be accommodated. (Actually, widening of Techwood Drive has been recommended for this area; see Appendix C.) The advisability of this latter approach remains in question, however. This is because North Avenue remains as a major east-west artery. Thus, it would be inefficient to utilize a part of North Avenue for "shuttle" traffic from Spring Street to Techwood Drive, if it is unnecessary. For instance, a significant left-turn movement would occur from North Avenue to Techwood Drive, southbound; this fact, coupled with a large volume of eastbound traffic on North Avenue, plus other traffic on Techwood Drive north of North Avenue, would necessitate a three-phase traffic light. This is not desirable for large traffic volumes, if it can be avoided.

e. Because of the reasons mentioned above in a through d, it is recommended that Spring Street be made one-way south, to extend from Peachtree Road to Carnegie Way.

5. It is assumed that the above arguments have adequately presented the reasons for the suggested treatment of Spring Street. With the disposal of this rather difficult choice, it becomes relatively easy to discuss the suggested treatments for the remaining streets in the northern area of the City. For this northside area, there currently exist six major surface arteries (excluding expressways). For either A.M. or P.M. periods the available lanes are listed as follows:

a. Howell Mill Road (1 lane)

b. Northside Drive (2 lanes, center lane reversible

c. Peachtree Road (3 lanes)

d. Piedmont Avenue (2 lanes)

e. North Highland (1 lane)

f. Briarcliff Road (1 lane)

6. It is interesting to note that one pair of these arteries could be utilized as a one-way street system. North Highland and Johnson Road could be made one-way, from the intersection of Johnson Road and Briarcliff Road, south to Ponce de Leon Avenue; correspondingly, Briarcliff could be made one-way north from Ponce de Leon Avenue to the intersection with Johnson Road. However, because of the street patterns as well as access problems to the various residential areas and shopping centers, this one-way street system has not been recommended.

7. The only remaining choice for these arteries is to increase the number of available lanes to the maximum extent possible for handling peak volume A.M. and P.M. traffic demands. This has been recommended for these streets:

a. Howell Mill Road has sufficient width (by measurement) to support three lanes of traffic. Therefore, three lanes should be established, the center lane being reversible for A.M. and P.M. peak periods. Some intersection lane markings in the area of Chattahoochee Avenue are discussed in Appendix C.

b. A reversible lane is already provided on Northside Drive from Arden Road to I75. However, a considerable improvement in traffic flow can be realized by further implementation of reversible lanes on Northside Drive, between I75 and the 14th Street intersection. The recommended treatment is discussed in Appendix C. The results are three-fold:

(1) A much needed additional lane (between I75 and 14th Street) is provided for peak volume traffic demands.

(2) The "bottle-neck" at the 14th Street intersection should be eliminated for peak periods.

(3) The current and rather awkward lane terminations on Northside Drive at the I75 entrance and exit ramps (on the northside of the overpass) are eliminated. Incidentally, the current safety hazard at these lane terminations would be eliminated also.

c. It is strongly recommended that Peachtree Road be provided with two reversible lanes from the Peachtree-West Peachtree Street intersection northward to the West Paces Ferry intersection in the Buckhead area. If this is not possible or desirable, these reversible lanes should be extended to Peachtree Battle Avenue at the very minimum. This is deemed necessary for several reasons:

(1) The high peak period volume demands, particularly south of the Peachtree Battle Avenue intersection.

(2) The necessary turning movements.

(3) The absolute need for maintaining a greater number of through-traffic lanes for peak period demands.

d. Piedmont Avenue has sufficient width to support 5 lanes of traffic from Cheshire Bridge to Montgomery Ferry Road. Southward to 12th Street, there are intervals which can currently support only 4 lanes of traffic. (Appropriate widening of these intervals has been recommended in Chapter III.) Nevertheless, for current needs it is recommended that the center two lanes be made reversible on Piedmont Avenue from 12th Street northward to Montgomery Ferry Road. Thereafter, the center lane should be made reversible to Cheshire Bridge. Thus, three continuous lanes of inbound or outbound traffic can be maintained. The single lane remaining for opposing traffic between 12th Street and Montgomery Ferry can adequately handle current peak period demands (both A.M. and P.M.).

e. At the Piedmont Road-Cheshire Bridge intersection it is noted that the third lane for southbound traffic on Piedmont Road terminates at Piedmont Circle. However, if the reversible lanes are implemented on Piedmont Avenue, three continuous southbound lanes on Piedmont Road can be maintained through the intersection. This is discussed in Appendix C.

f. It is also recommended that Monroe Drive be implemented with two reversible lanes between 10th Street and the Piedmont Avenue intersection. This can augment, considerably, the A.M. and P.M. peak traffic flows. Further, if Monroe Drive-Boulevard were made one-way south (as shown in Figure A-4) from 10th Street to Edgewood Avenue, a very significant and useful artery is established for inbound A.M. traffic from the northeast. The companion street northbound could be Jackson-Parkway.

g. Similarly, for P.M. peak traffic, three northbound lanes can be provided on Monroe Drive from 10th Street to the Piedmont Avenue intersection. Northbound traffic from the downtown area could utilize Jackson-Parkway and offset at 10th Street either to Piedmont Avenue or to Monroe Drive. Thus, the one-way pair of streets (Monroe-Boulevard and Jackson-Parkway) could establish a much needed major arterial pair for the northeast side, close-in to the downtown area. Adequate circulatory traffic between the pair of streets is currently provided.

h. North Highland has sufficient width to support three lanes. Therefore, it is recommended that three lanes be established, the center lane being reversible. The three lanes could be extended to Johnson Road and Northward on Briarcliff Road if desired. Thus, North Highland could become an effective artery (2 lanes, A.M. or P.M.) from the northeast area all the way to Baker Street, for inbound traffic, or from Parkway northbound for outbound traffic. (It is noted that the railroad bridge on Highland Avenue, four blocks west of the Randolph Street intersection, will support three lanes of traffic.)

i. Briarcliff Road has sufficient width to support three lanes of traffic. Therefore, it is recommended that three lanes be established, the center lane being reversible. Southward from Briarcliff Road, the two center lanes of Moreland Avenue can be made reversible to the McLendon Street intersection. Thus, Briarcliff Road could accommodate two lanes of one-way traffic to the Ponce de Leon Avenue intersection, either A.M. or P.M. Thereafter, Moreland Avenue could support three lanes of one-way traffic (A.M. or P.M.) all the way to the southeastern part of the city. Access to the CBD from Moreland and Ponce de Leon Avenues is discussed in the following section.

j. The interval on 10th Street between Piedmont Avenue and Monroe Drive may also need a reversible lane for accommodating peak A.M. and P.M. traffic. Three lanes could be utilized westbound in the A.M. and eastbound in the P.M.

k. The above suggestions will allow relatively continuous traffic flow for the entire northern region of the city. In no case is there a "squeeze" lane situation. Moreover, all volume rates to and from the downtown area can be supported. That is, there are no anticipated traffic "bottlenecks."

D. Eastern City Area

1. Currently there are only three major arteries east of Moreland Avenue:

a. Ponce de Leon Avenue (4 lanes).

b. DeKalb Avenue-Decatur Street (3 lanes).

c. Memorial Drive (2 lanes).

2. West of Moreland Avenue (and east of the downtown area), there are currently three additional major arteries:

a. North Avenue (3, 4, or 6 lanes, dependent on direction and location on the street).

b. Forrest Road-Forrest Avenue (4 lanes).

c. Edgewood Avenue (4 or 5 lanes, dependent on location).

d. Also, one to two additional lanes are provided on Ponce de Leon Avenue, dependent on location.

3. In order for the maximum number of through-lanes to be provided for the eastern area of the City, several changes are recommended. These have been shown in Figure A-4, and are discussed in the following paragraphs of this Section.

4. On Ponce de Leon Avenue, there are 7 lanes from Juniper Street to Ponce de Leon Place. Thereafter, 5 lanes are available eastward to Moreland Avenue. Thereafter, 4 lanes are available to Scott Street. The following treatment of Ponce de Leon Avenue is strongly recommended.

a. Ponce de Leon Avenue does not experience significant peak volumes for opposing traffic east of Moreland Avenue, either in the A.M. or the P.M. Therefore, it is suggested that two reversible lanes be established on Ponce de Leon Avenue from Moreland Avenue eastward to Scott. Thus, 3 one-way lanes would be available for peak A.M. or P.M. periods; the single remaining lane can accommodate the peak period volumes for opposing traffic.

b. Betweenn Ponce de Leon Place and Moreland Avenue, the center lane should be made reversible such that 3 one-way lanes are available for peak A.M. or P.M. periods.

c. From Juniper Street to Ponce de Leon Place, the center lane (7th lane) should be made reversible. Thus, 4 one-way lanes could be established for peak A.M. or P.M. periods. For P.M. travel, the eastbound center lane (4th lane) would be required to exit northward onto Ponce de Leon Place. The center lane (7th lane) in this interval is presently utilized for left-turn movements only. However, by appropriate traffic signal control during peak periods, this lane can also be utilized as a through-lane. This could be accomplished in a manner similar to that discussed for the Peachtree Corridor in Appendix B.

5. North Avenue, between Peachtree and Juniper Streets, currently supports only 5 lanes of traffic. Therefore, between these intersections, the center lane should be made reversible. This will allow three through lanes for peak periods from I75-85 eastward to the North Angier interesection (immediately east of the Southern Railroad underpass). Thereafter, a total of 4 lanes are available to Bonaventure Avenue, and a total of three lanes are available to Moreland Avenue. If the center lane is made reversible between Bonaventure and Moreland Avenues, and the two center lanes are made reversible from Bonaventure Avenue to North Angier, three continuous traffic lanes can be provided (for A.M. and P.M. peaks) from I75-85 to Bonaventure Avenue. For P.M. traffic, the center lane would be required to turn left northbound onto Bonaventure Avenue. Thereafter, two traffic lanes

could be provided (for A.M. and P.M. peaks) between Bonaventure and Moreland Avenues. If desired, three lanes could be continued on North Avenue to Oakdale Avenue (center lane reversible) with access northward onto Oakdale or via Fairview onto Lullwater.

6. The pair of streets, Edgewood Avenue and Decatur Street, need further discussion. These streets should be established as a one-way pair from Five Points to the City of Decatur, terminating at the Ridgecrest Road intersection. This can be accomplished as follows:

a. Decatur Street-DeKalb Avenue can be made one-way east from the Peachtree Street intersection (Five Points) to Ridgecrest Road.

b. McLendon Street-Euclid Avenue-Edgewood Avenue can be made one-way west from Ridgecrest Road to the Peachtree Street intersection.

c. Adequate connections for circulating traffic are currently provided.

d. At the very minimum, Edgewood Avenue and Decatur Street should be established as a one-way pair between Peachtree Street and Hurt Street.

e. Because of bus services and routes on Edgewood Avenue and Decatur Street, it may be desirable to establish bus lanes on the interval mentioned in d above. Thus, Edgewood could remain "effectively" one-way west, with a single eastbound bus lane. Similarly, Decatur Street could remain "effectively" one-way east, with a single westbound bus lane. Since bus traffic volumes are not excessive (even in peak periods), the intersection at Peachtree Street (Five Points) could be satisfactorily serviced by a two-phase traffic light. The only conflicting traffic movement would occur between bus traffic for the exclusive bus lanes; i.e., westbound on Decatur Street and eastbound on Edgewood Avenue. It is assumed that the affected bus drivers could handle their own situation; that is, eastbound busses on Marietta Street could access Edgewood Avenue as a left-turn movement from Marietta Street to Edgewood Avenue, i.e., across the westbound bus traffic on Decatur Street.

f. Memorial Drive should be provided with a reversible lane from the Whitehall Street intersection (in the southern subarea of the CBD) eastward, perhaps, to Candler Road.

g. The above suggestions will accommodate two additional traffic lanes (on Ponce de Leon Avenue and on Memorial Drive) east of Moreland Avenue. The traffic flow rates should be increased significantly, particularly on Ponce de Leon, and also because of the additional one-way street pair, McLendon-Euclid-Edgewood and Decatur-DeKalb.

h. West of Moreland Avenue (and east of the downtown area), the utilization of Houston-Irwin Streets and Auburn Avenue as a one-way pair will also facilitate increased peak period volume rates. In addition, it may be desirable to establish three lanes (center lane reversible) on Lake Avenue (at the eastern end of Irwin and Auburn Streets), and continue these lanes via Austin Avenue to Moreland Avenue. Thus, an additional lane of traffic could be provided for this area.

E. Southern City Area

1. Currently, there are six arteries available.

   a. Lee-West Whitehall Streets (4 to 5 lanes, dependent on location)

   b. Stewart Avenue (4 lanes)

   c. Pryor Street (4 lanes)

   d. Ridge Avenue (4 lanes)

   e. Boulevard (4 lanes)

   f. Moreland Avenue (4 lanes)

2. Close-in (from Georgia Avenue northward), the following arteries are currently available.

   a. West Whitehall (4 to 5 lanes, dependent on location)

   b. Murphy-Whitehall Streets (currently limited to 2 lanes on Murphy Street.

   c. Northside Drive from Stewart Avenue (6 lanes)

   d. McDaniel Street (4 lanes)

   e. Pryor Street (4 lanes)

   f. Central Avenue (4 lanes)

   g. Washington Street (4 lanes)

   h. Capitol Avenue (5 lanes)

   i. Hill Street (3 to 6 lanes, dependent on location)

   j. Cherokee Avenue (4 lanes)

   k. Boulevard (3 to 4 lanes, dependent on location)

   l. Moreland Avenue via East Confederate or Glenwood Avenue (4 lanes)

   m. Spring Street (4 lanes) is also accessible from Fulton Street.

3. The only possible new pair of one-way streets appears to be Cherokee Avenue and Hill Street. However, because of I20 entrance and exit ramps at Hill Street, Hill Street should remain two-way from Sydney Street north to Hunter Street. Nevertheless, Hill Street and Cherokee Avenue could serve effectively as a one-way street system between Memorial Drive and Atlanta Avenue.

a. On Hill Street between Memorial Drive and Hunter Street, six lanes of traffic are currently available. This provides adequate access for AM and PM peak volumes onto Hunter Street at this intersection. On Hill Street, south of Memorial Drive, there are effectively three lanes available. It is recommended that one lane southbound and two lanes northbound be established on Hill Street from Memorial Drive to Sydney (two lanes southbound would exist beneath the underpass for I20. It is recommended that Hill Street be made one-way north (3 lanes) from Atlanta Avenue to Sydney Street. North of Memorial Drive, Bell Street should be established one-way north to Auburn Avenue. The companion street which is Grant Street should be established one-way south, between Irwin Street and Memorial Drive.

b. Cherokee Avenue can be established one-way south (as a companion to Hill Street) between Memorial Drive and Atlanta Avenue.

4. Lee-West Whitehall Streets, Capitol Avenue, Boulevard, and Moreland Avenue should all be established with reversible lanes. Thus, three continonous lanes could be provided on all of these streets for the peak periods. In addition, Pryor Street (south of Georgia Avenue) and Ridge Avenue should probably be established with reversible lanes. Because of the short time available for the studies contained in this report, a detailed study has not been performed for the south side areas.

5. It is noted that Murphy Street and Whitehall Street can be utilized effectively as a medium volume artery at least to the Shelton Street intersection. The interval on Murphy Street from Whitehall to Shelton Street can support three traffic lanes. If this available width extends southward, then Murphy-Whitehall could be established as a significant artery for the southwest, perhaps, to the Fort McPherson area. In any case, three lanes can be established from the Shelton Street intersection northward to the Northside Drive intersection. If the center lane is made reversible, both on Murphy Street and on Whitehall Street (south of Memorial Drive), 2 one-way lanes for A.M. or P.M. peak traffic can be established for the entire length of the artery. Three one-way lanes can be established on Whitehall for A.M. or P.M. peak traffic, in the interval from Northside Drive to Memorial Drive.

6. A four lane intersection should be constructed between Pryor Street and Central Avenue either at Dodd, Hendrix, or Ormond Streets to facilitate easy access to Central Avenue for northbound traffic. Similarly, Pullman Street (extension of Washington Street, southbound) should be extended to Pryor Street with a four lane intersection, for easy exit southbound on Pryor Street.

7. Finally, it is noted that Hunter Street from the Hill Street intersection westward to the Butler Street intersection should have reversible lanes (center two lanes reversible). Thus, three continuous lanes can be accommodated for both peak periods. For A.M. traffic, this would be useful, since it would remove a significant volume of traffic from Memorial Drive, west of Hill Street. Similarly, for P.M. traffic, if the current two-way interval on Hunter Street between Capitol Avenue and Butler Street is maintained, eastbound P.M. traffic from Mitchell Street could be allowed access to three outbound (eastbound) lanes on Hunter Street, east of Butler Street.

8. It is suggested that Fulton Street, Georgia Avenue, and Pratt Street (by Grady Memorial Hospital) remain two-way for circulating traffic needs.

9. The above suggestions for the streets and arteries in the southern area of the city can provide six additional lanes for the peak periods, south of Georgia Avenue, and 5 additional lanes north of Georgia Avenue.

F. Western City Area

1. Currently, there are five arteries available.

    a. Marietta Street (4 lanes)

    b. Bankhead Highway (4 lanes)

    c. Simpson Road-Jones Avenue (4 lanes)

    d. Hunter Street (4 lanes)

    e. Gordon-Glenn Streets (4 lanes)

    f. A convenient by-pass on the west side is provided by Ashby Street.

2. It is recommended that all of these streets be equipped with reversible lanes, in order to provide the maximum number of available lanes for the peak periods. Dependent on A.M. and P.M. volume counts on Ashby Street (not available for this study), the reversible lane on Ashby Street could be utilized in one of four ways:

a. For the A.M. peak period, two one-way lanes southbound from Marietta Street to Hunter Street and two one-way lanes northbound from West Whitehall Street to Hunter Street could be established.

b. For the P.M. peak period, the inverse of item a above.

c. Two one-way lanes southbound could be established for the A.M. peak period, for the entire length of Ashby Street.

d. For the P.M. peak period, the inverse of item c above.

G. Review of Traffic Flow Plan

1. In the entire City area, 19 additional lanes can be provided for the peak periods. These additional lanes are made available by the use of reversible lanes and are summarized as follows (one additional lane for peak periods on each street): Howell Mill Road, Peachtree Road, Piedmont Avenue, North Highland, Briarcliff Road, Ponce de Leon Avenue, Memorial Drive, Glenwood Avenue, Moreland Avenue, Boulevard, Capitol Avenue, Pryor Street, Stewart Avenue, Murphy-Whitehall Street, Lee-West Whitehall Street, Gordon Street, Hunter Street, Simpson Road, and Marietta Street.

2. Including these additional lanes, there could exist as many as 62 lanes for peak period traffic to and from the outlying areas of the City. If it could be assumed that 30 mph platoon flow could be established (65% green time) for these outlying areas, the 19 additional lanes could increase the peak period vehicle capacity by 24,453 vehicles/hr. The total of 62 lanes could support a maximum of approximately 79,794 vehicles/hr. The current peak period volumes into and out of the Screen Line boundaries are approximately 47,876 vehicles/hr. This latter value includes approximately 21,086 vehicles/hr on the expressway system. Therefore, it would appear that the current surface street volume (26,790 vehicles/hr) could be increased by a factor of at least 2.9.

3. It appears, therefore, that a coordinated overall traffic flow plan can adequately accommodate the current peak period traffic demands in the City. Adequate traffic light adjustment and control is assumed.

H. Alternative Traffic Flow Plans

1. There are several different modifications which could be applied to the suggested traffic flow plan of Figure A-4. Generally speaking, however, there does not appear to be any other satisfactory approach which possesses any major differences with that which has been presented.

2. For the CBD area and the Peachtree Road corridor, however, several other possibilities should be mentioned.

a. The utilization of the one-way street pairs, West Peachtree-Peachtree Streets, and Spring Street-Techwood Drive (via tunneling under the Georgia Tech campus), has already been discussed above in Section B. If such a scheme were possible and were implemented, then the southern terminal points should be handled as follows.

(1) Techwood Drive should be made one-way south at least to Nelson Street, and perhaps, via Walker Street, to Peters Street.

(2) Spring Street should be made one-way north from Peters Street to Peachtree Road.

(3) West Peachtree Street should be made one-way south, and could be terminated, perhaps, at the Baker Street intersection; a reversible lane could then be utilized southward on Peachtree Street to the Luckie Street intersection.

(4) Peachtree Street should be made one-way north, and could be initiated at the Baker Street intersection.

(5) A northbound exclusive bus lane should be provided on Peachtree Street from Luckie Street to Baker Street.

b. Several different alternatives exist in the CBD area:

(1) In the suggested plan, if it is not desirable to maintain Spring Street one-way north from Marietta Street to Carnegie Way, an alternate street arrangement is shown in Figure A-5. The only significant change is that a single southbound lane has been provided on Spring Street in this interval. Perhaps, this could aid circulating traffic in the area. However, it will definitely impede the exiting P.M. traffic.

(2) In Figure A-6, the resultant street functions are indicated as a result of Spring Street being continued one-way south from Carnegie Way to the Peters Street intersection. As mentioned above in Section B, this is a possible solution. However, exiting traffic to the northwest (from the southern area of the CBD) would definitely be impeded. Hunter Street would offer the only high capacity exit, and additional traffic would be forced on to Broad Street and Whitehall Street to the Hunter Street intersections, for access to the northwest, via Techwood Drive.

(3) An additional minor modification might be desirable on Nassau Street, if (1) above were implemented. That is, a single southbound lane could be provided, together with two northbound lanes on Nassau Street. This would aid, somewhat, in exiting traffic from Spring Street, since there would now exist only 3 northbound lanes on Spring Street.

(4) Any changes on Carnegie Way to two-way traffic between Cone Street and Spring Street or Cain Street is not recommended. This is particularly true if Spring Street is one-way south to Cain Street. Thus, the four lanes of southbound traffic need ready access into the CBD area via the four lanes on Carnegie Way. Otherwise, a "bottleneck" will be generated

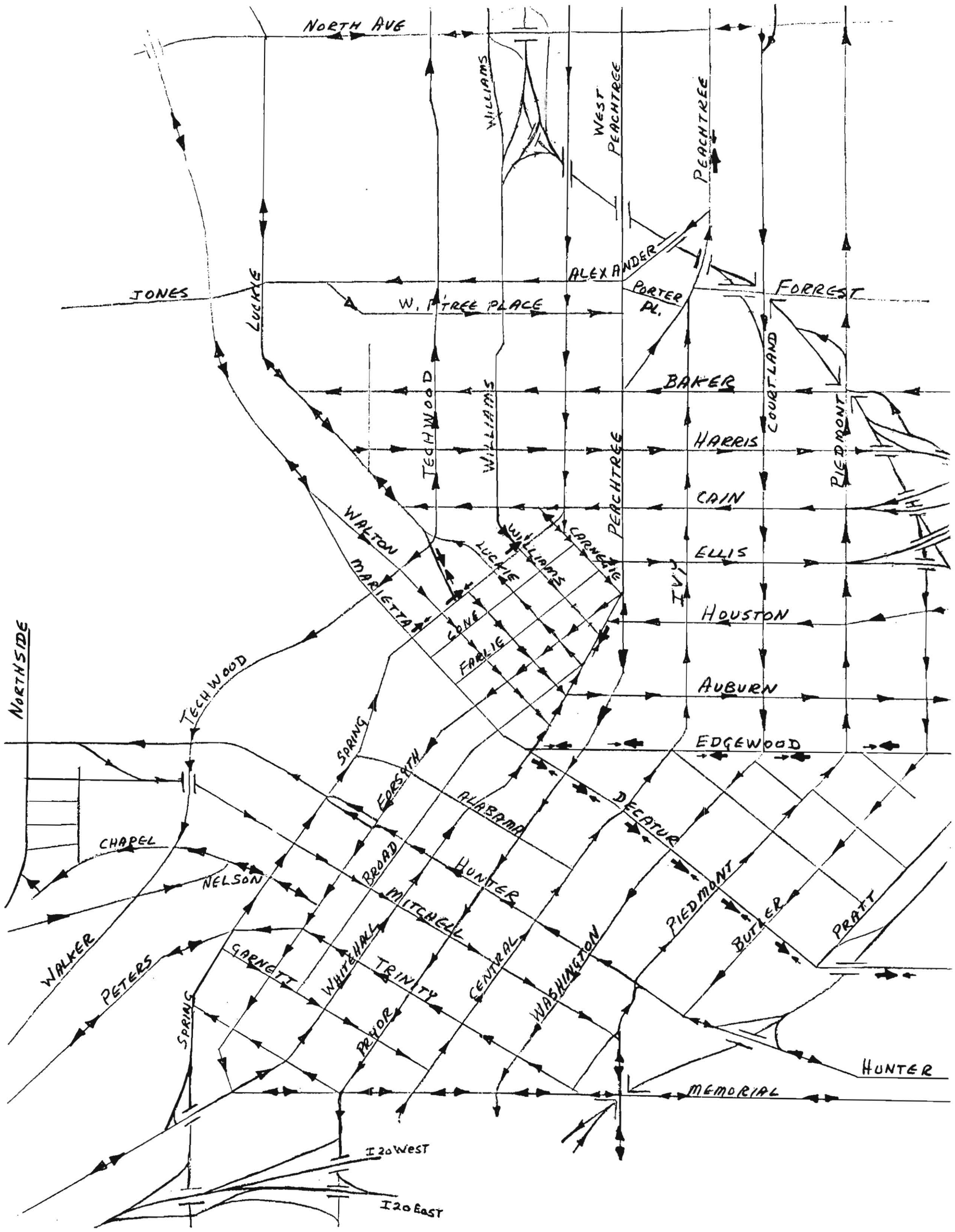

Figure A-5. Alternate Two-way Treatment on Spring Street.

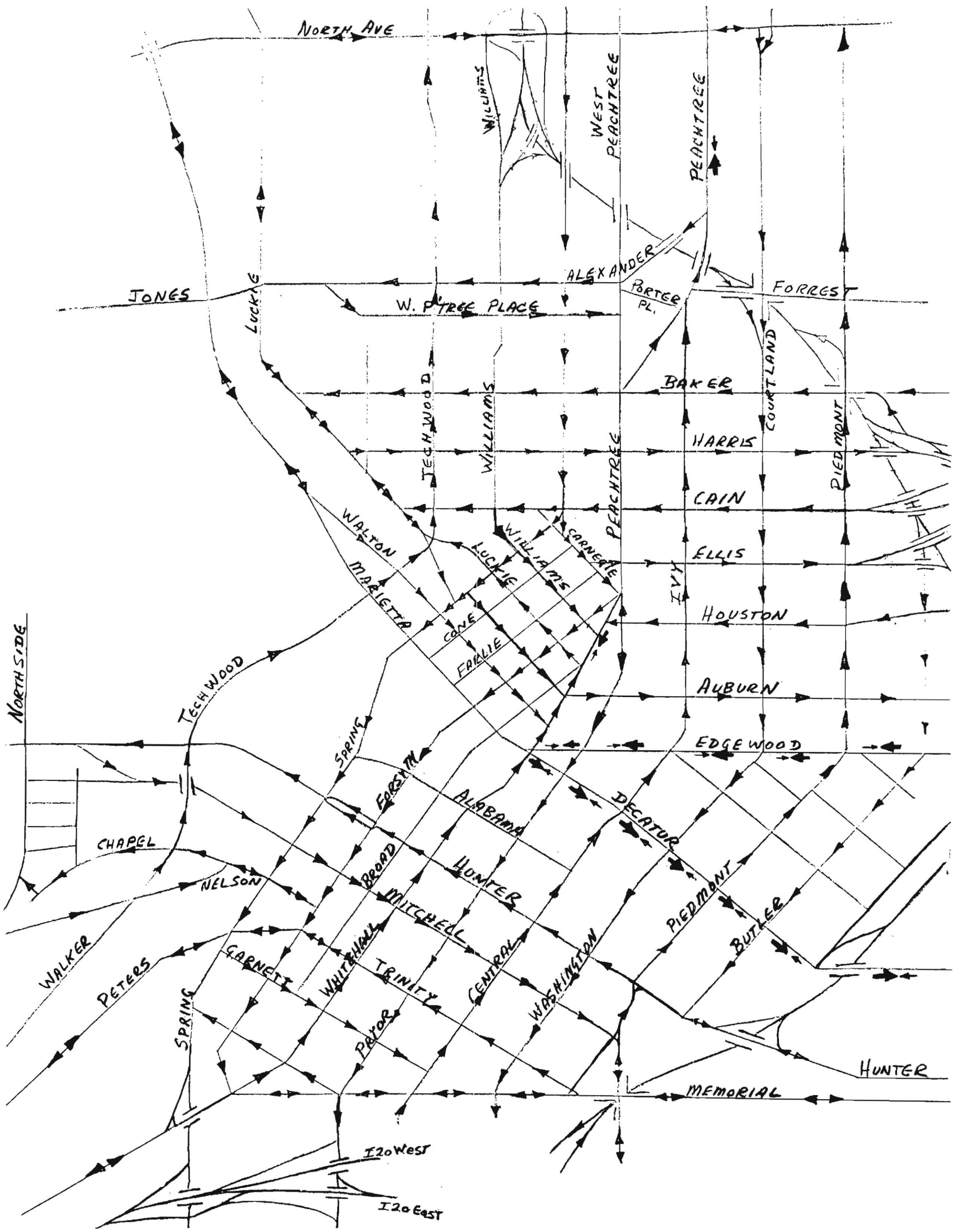

Figure A-6. Alternate One-way Treatment on Spring Street.

on Spring Street north of Cain Street. (Incidentally, there already exists a significant "bottleneck" at this point which occurs frequently throughout the working day. This occurs from southbound traffic on Spring Street desiring to make a left-turn movement onto Carnegie Way.)

APPENDIX B

PEACHTREE CORRIDOR PROPOSALS

A. General

1. Suggested changes and treatments of the Peachtree corridor are presented in this Appendix. Perhaps, the most congested area in the city occurrs along this corridor. The area is illustrated in Figure B-1, and is considered as extending from the Five Points area northward (approximately 6 miles) to the Buckhead area. There are two intervals of particular interest:

a. The northern interval from the Peachtree-West Peachtree intersection through the Brookwood area to Collier Road or to Peachtree Battle Avenue;

b. The southern interval from the Edgewood Avenue intersection to Baker Street or to 10th Street.

2. Currently, during the peak periods parts of these intervals are completely saturated with stop-and-go traffic. This results from several reasons.

a. The large volume demands for through-traffic;

b. The large number of business establishments located in these intervals;

c. The associated numerous turning movements;

d. An inadequate number of lanes for through-traffic and/or inadequate traffic light control.

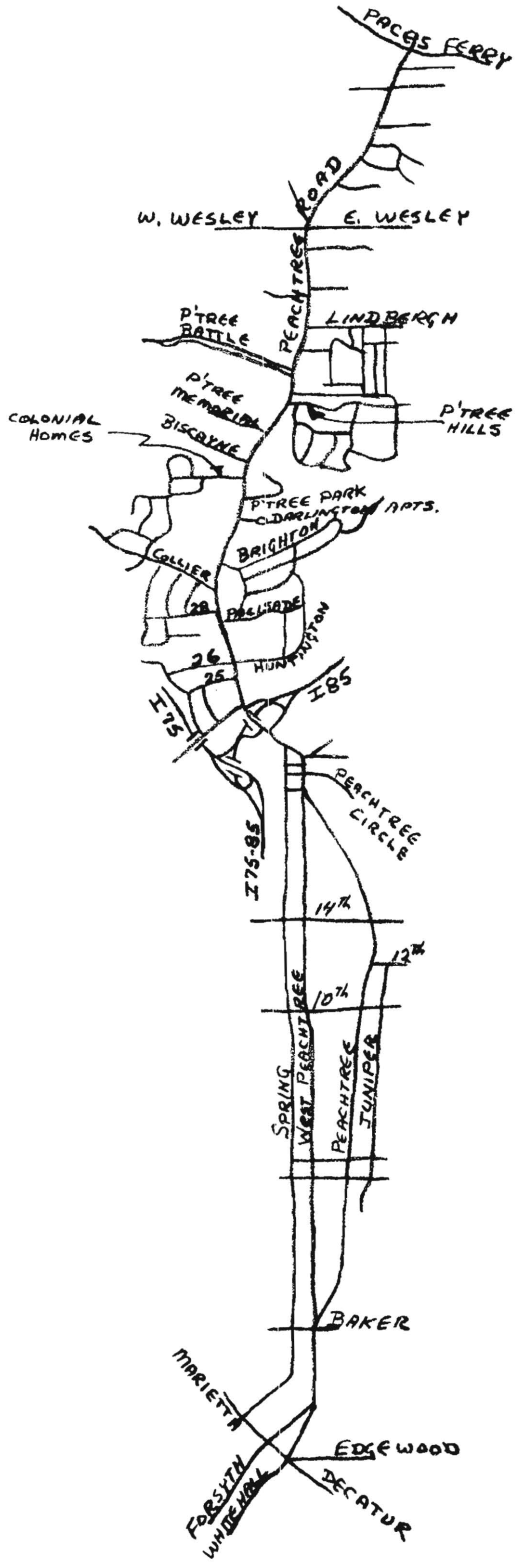

Figure B-1. Peachtree Corridor.

3. Without the construction of new freeways, connectors, etc., traffic flow along this corridor will remain a problem. However, it is believed that considerable relief can be given immediately. This is particularly true in the above mentioned intervals, where traffic "bottle necks" exist. This can be accomplished by the following means:

a. Implementation of one-way feeder streets, wherever possible;

b. Full utilization of reversible lanes;

c. Restriction of turning movements, particularly during peak periods.

4. Because of the length of the corridor, separate discussions are given in the following Sections for the two intervals mentioned above.

B. The Northern Interval

1. In the interval from Pershing Point to Buckhead, Peachtree Road currently supports six lanes of traffic. It is recommended that the two center lanes be made reversible for this entire interval. This will provide four one-way lanes of through-traffic for the peak A.M. and P.M. periods. At the very minimum, these reversible lanes should be established northward to Peachtree Battle Avenue. This results because of the high peak volume demands in this area as well as the large number of turning movements along the interval.

2. A suggested treatment for the Brookwood-Pershing Point area is shown in Figures B-2 and B-3 for the peak periods of A.M. and P.M. traffic, respectively. A suggested treatment for normal periods is shown in Figure B-4. The existent seven lanes (from Deering Road to the entrance and exit ramps for I85 North) have been maintained. (Subsequently, it is recommended that these seven lanes be extended southward, approximately 500 ft., to the

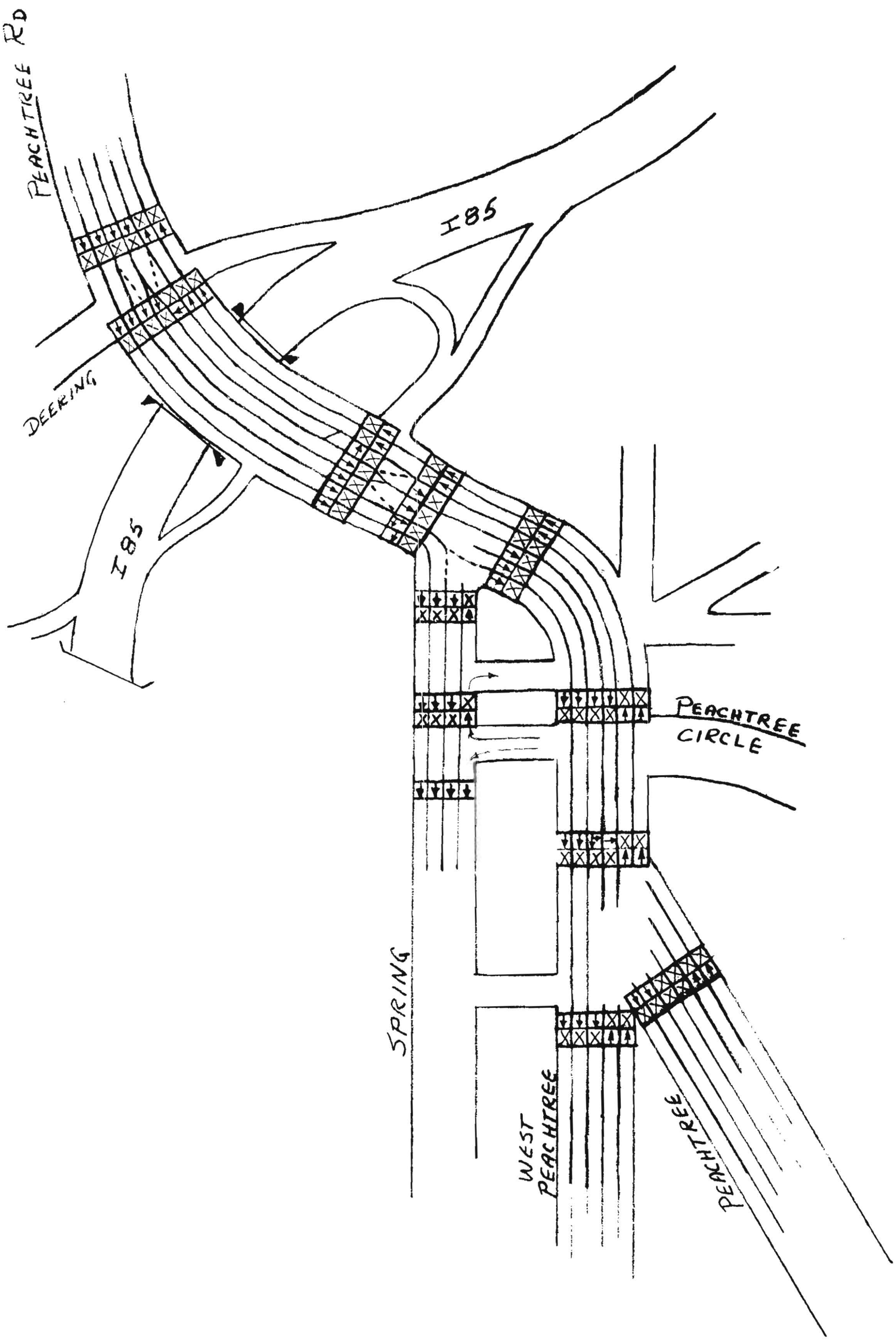

Figure B-2. Suggested Lane Control, Brookwood-Pershing Point Area, (Peak A.M. Period).

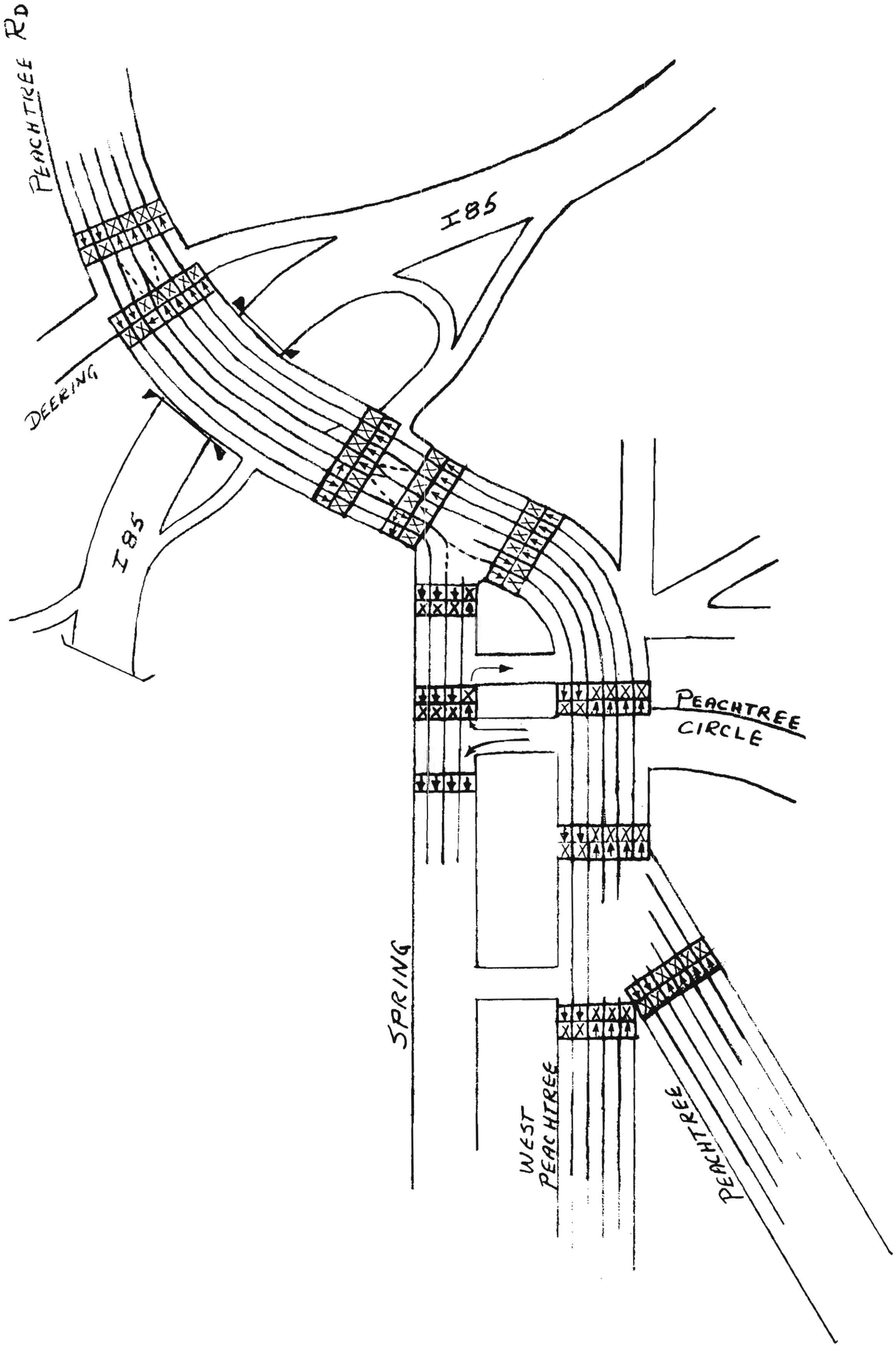

Figure B-3. Suggested Lane Control, Brookwood-Pershing Point Area, (Peak P.M. Period).

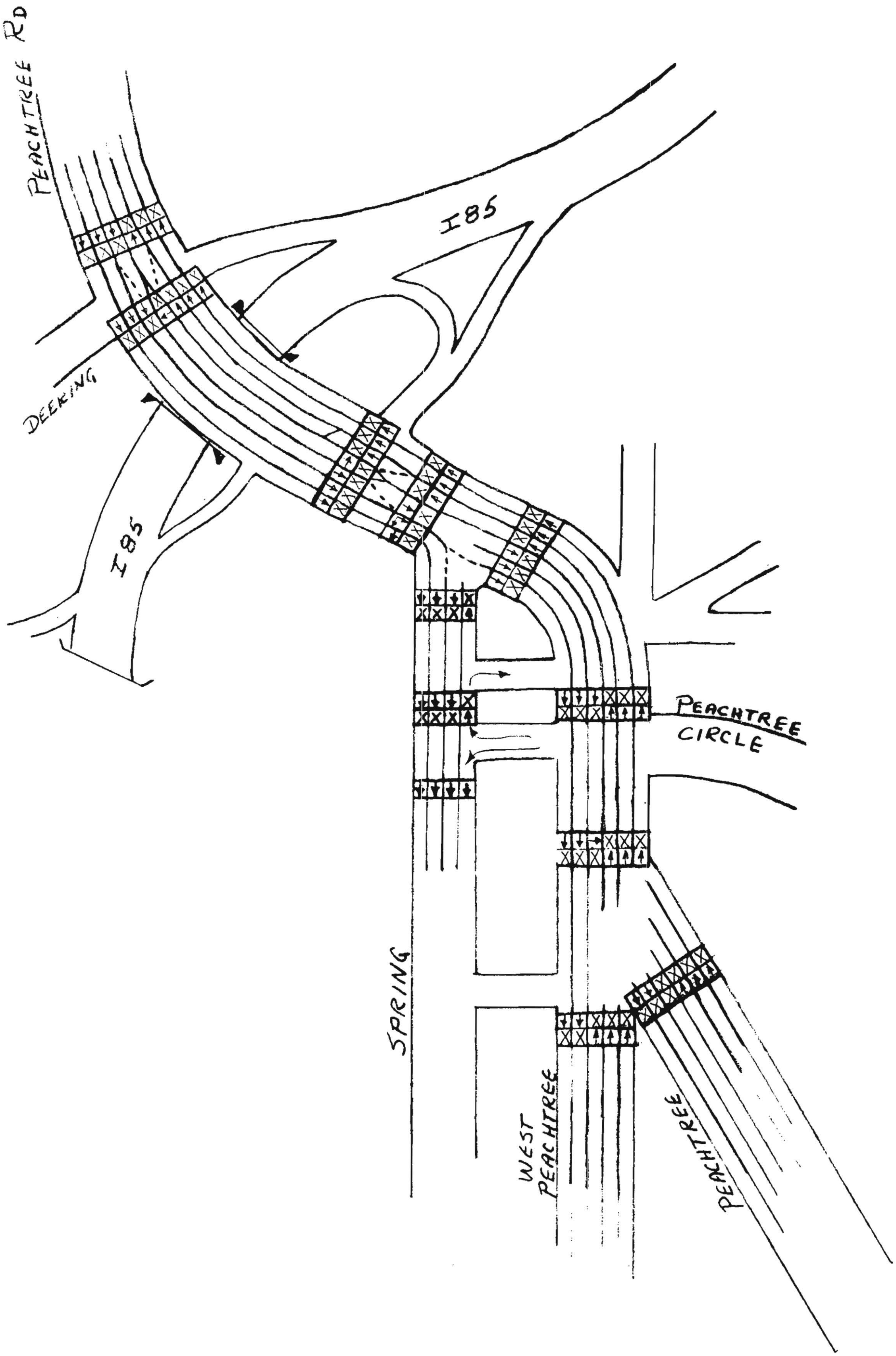

Figure B-4. Suggested Lane Control, Brookwood-Pershing Point Area, (Normal Periods).

Spring Street intersection.) In the interval of the present seven lanes, it is noted that four one-way lanes can be provided for peak traffic demands. For opposing traffic there are two one-way lanes; the third inner lane can be utilized for left-turn movements. These left-turn movements can be provided for both directions of traffic during peak periods.

3. It has been argued by some that, a total of two lanes for opposing traffic will not adequately service the volume demands during the peak periods along Peachtree Road. Past measurements have indicated volume ratios as high as 60/40 during peak periods. However, it must be remembered that the 40% figure represents opposing traffic volume rates obtained for flowing traffic (i.e., 30 mph), whereas the 60% figure represents volume rates obtained from stop-and-go traffic. For instance, for P.M. traffic, the actual demand (density) for northbound traffic is considerably greater than that for the opposing, southbound traffic. An example is given as follows:

a. Measured values[29] at the Spring Street intersection for northbound traffic on Peachtree Road indicate a total of approximately 2,150 vehicles/hr, on a Friday afternoon sampling of peak period traffic. Opposing traffic during the same interval was approximately 1,400 vehicles/hr. The northbound traffic was stop-wait-and-go, while the southbound traffic was flowing at approximately 30 mph during traffic light green time.

b. For the three available lanes for each traffic direction, approximately 717 vehicles/hr/lane are indicated for northbound traffic, and 476 vehicles/hr/lane are indicated for southbound traffic. The northbound value (717 vehicles/hr/lane) represents less than 10 mph average speed. Thus, if equal consideration (equal weighting) were given to both traffic directions one of two circumstances could result.

(1) Opposing traffic flow could be reduced to approximately 15 mph and restricted to two southbound lanes. With an assumed green time of 50%, this average speed would support approximately 770 vehicles/hr/lane or 1,540 vehicles/hr for both lanes. This value is greater than the current demand for 1,400 vehicles/hr for opposing traffic. (Actually, considerably greater speeds can be allowed for opposing traffic flow as indicated in paragraph 9 below.)

(2) The principal traffic flow can be increased both with respect to the number of available lanes and with respect to average speed. If four one-way lanes were assumed to be available for the peak P.M. period, and if platoon flow were established (30 mph with 65% green time), then 1,287 vehicles/hr/lane could be accomodated. This represents a total of 5,148 vehicles/hr. It also represents continuous traffic flow (no stoppage), while the current conditions cause much stop-and-go traffic. The total volume rate of 5,148 vehicles/hr is also a factor of 2.4 greater than the current rate of 2,150 vehicles/hr.

4. These arguments indicate two significant features:

a. Volume ratios (between the principal traffic flow direction and the opposing traffic flow direction) are not sufficient, in themselves, to establish traffic flow patterns, particularly when one direction has stopped vehicles.

b. It may be possible to establish adequate volume rates for opposing traffic by implementing platoon-flow for the principal traffic direction and accepting the resultant traffic flow for the opposing traffic. This amounts to ignoring the opposing traffic demands when establishing the time-space diagram. (Subsequently, of course, the results must be checked such that the opposing traffic demands can be satisfied at reasonable speeds.)

5. For the A.M. peak period, the flow pattern (Figure B-2) is discussed as follows:

a. Current peak volumes are approximately 2,379 vehicles/hr, if the value of 10% of the daily volume is utilized. Actual measurements[28] yield approximately 2,100 vehicles/hr.

b. If platoon flow were established (assuming Spring Street is one-way south), four lanes of traffic can be established from the northern extremity of reversible lanes (at least from Peachtree Battle Avenue) through the Peachtree-West Peachtree intersection. With platoon flow (assuming 65% green time at 20 mph), then 1,144 vehicles/hr/lane can be accomodated. This represents a total of 4,576 vehicles/hr. Additionally, it must be remembered that this volume rate permits smooth traffic flow, i.e., not stop-and-go traffic. This estimated rate is at least a factor of 2.1 greater than the current flow rate. At an assumed speed of 30 mph (platoon flow), a total of 5,148 vehicles/hr should be accommodated.

c. It may be argued that the volume rates given in b above cannot be maintained for all four lanes, for instance, because of turning movements in the interval. For southbound A.M. peak traffic, left-turn movements are not considered as significant in this interval. (The only major left-turn intersections appear to occur at Lindbergh Drive and, perhaps, at the entrance ramp to I85 North.) If the assumed speed of 20 mph is reduced to 10 mph for one lane (impeded due to right-turn movements), then a total volume rate of 4,290 vehicles/hr is predicted. This volume rate is still approximately a factor of 2 greater than the current rate.

d. Some impediment of opposing traffic on the two northbound lanes may be experienced in the 25th and 26th Street areas, because of the relatively large number of left-turn movements into private parking areas. This is discussed in more detail in paragraph 7 below. However, it is noted that left-turn movements for northbound A.M. traffic should be restricted to 25th Street, 26th Street, Deering Road and Collier Road. Actually, all adjacent residential areas (west of Peachtree Road) can be readily accessed from either Deering Road or Collier Road. The principal left turn movements for northbound A.M. traffic result because of needed access to the parking lots for business establishments on the west side of Peachtree Road in the 25th and 26th Street area.

e. With Spring Street one-way southbound, there will exist no stoppage at the Spring Street intersection. Traffic is permitted to flow smoothly onto Spring Street or to continue on Peachtree Road. If desired, three exit lanes onto Spring Street can be provided. Thus, during the A.M. peak period, both outside lanes could be required to exit on Spring Street; the third inner lane could either exit on Spring Street or continue on Peachtree Road; the fourth inner lane would be required to continue on Peachtree Road.

f. On Peachtree Road south of Spring Street, four lanes are provided to the West Peachtree-Peachtree Street intersection. These lanes can accommodate both of the southbound lanes on Peachtree Road (from the Spring Street intersection), as well as entering southbound traffic from Beverly Road or Peachtree Circle. At the West Peachtree-Peachtree intersection, the two curb lanes (southbound) would be required to continue southward on West Peachtree Street. The fourth, inner lane could be required to exit southbound on Peachtree Street. If a reversible lane is utilized on West Peachtree Street from this intersection southward to 10th Street, then the third inner lane (southbound on Peachtree Road) can either continue south on West Peachtree Street or exit onto Peachtree Street.

g. With respect to the desirability of a reversible lane on West Peachtree Street, the following comments are offered:

(1) West Peachtree Street currently supports six traffic lanes from the Baker Street intersection northward to the 10th Street intersection. Five lanes exist from 10th Street northward.

(2) Three one-way lanes (for either A.M. or P.M. peak period traffic) can be maintained on West Peachtree Street, if a reversible lane is utilized on West Peachtree Street between the Peachtree-West Peachtree Street intersection and the 10th Street intersection.

h. There are two southbound lanes suggested on Peachtree Street from the Peachtree-West Peachtree intersection to the 12th Street intersection. These two lanes would be required to exit at 12th Street, for private vehicles. That is, commuter traffic would be shuttled eastward (approximately 500 ft) to Juniper Street (one-way south). Bus traffic southbound on Peachtree Street would be allowed to continue on the single bus lane to Alexander Street. The remaining four lanes on Peachtree Street (north of 12th Street) are needed for northbound P.M. traffic.

6. For the P.M. peak period, the flow pattern (Figure B-3) is discussed as follows:

a. As mentioned previously, four one-way lanes could be established by means of two reversible lanes. Thus, the four northbound lanes could support a total peak volume demand of 4,576 to 5,148 vehicles/hr, dependent on the allowed speeds of 20 or 30 mph, respectively.

b. Northbound platoon flow can be initiated by an appropriate combination of two traffic lights, one at Peachtree Circle and one at the Peachtree-West Peachtree intersection.

(1) An example is shown in Figure B-5 for the P.M. peak period. In part (a) of the figure, opposing, southbound Peachtree Road traffic starts to flow; left-turn onto Peachtree Circle is allowed for 10 seconds as well as right-turn from Peachtree Circle to northbound Peachtree Road. At 10 seconds, northbound traffic on Peachtree Street is initiated at the Peachtree-West Peachtree intersection.

(2) In part (b) of Figure B-5, northbound traffic on Peachtree Road at Peachtree Circle is initiated at 15 seconds.

(3) In part (c) of Figure B-5, northbound traffic from Peachtree Street continues (for 35 seconds) until 45 seconds (at the Peachtree-West Peachtree intersection).

(4) In part (d) of Figure B-5, northbound traffic from West Peachtree is initiated at 45 seconds and continues (for 30 seconds) until 75 seconds.

(5) In part (e) of Figure B-5, northbound traffic on Peachtree Road at Peachtree Circle continues until 80 seconds. This partially empties the storage space between Peachtree Circle and the Peachtree-West Peachtree intersection.

(6) In part (f) of Figure B-5, Peachtree Circle traffic is permitted access to Spring Street (via Rhodes Center Street) or onto Peachtree Road (northbound or southbound) for 20 seconds until 100 seconds. Then the cycle repeats.

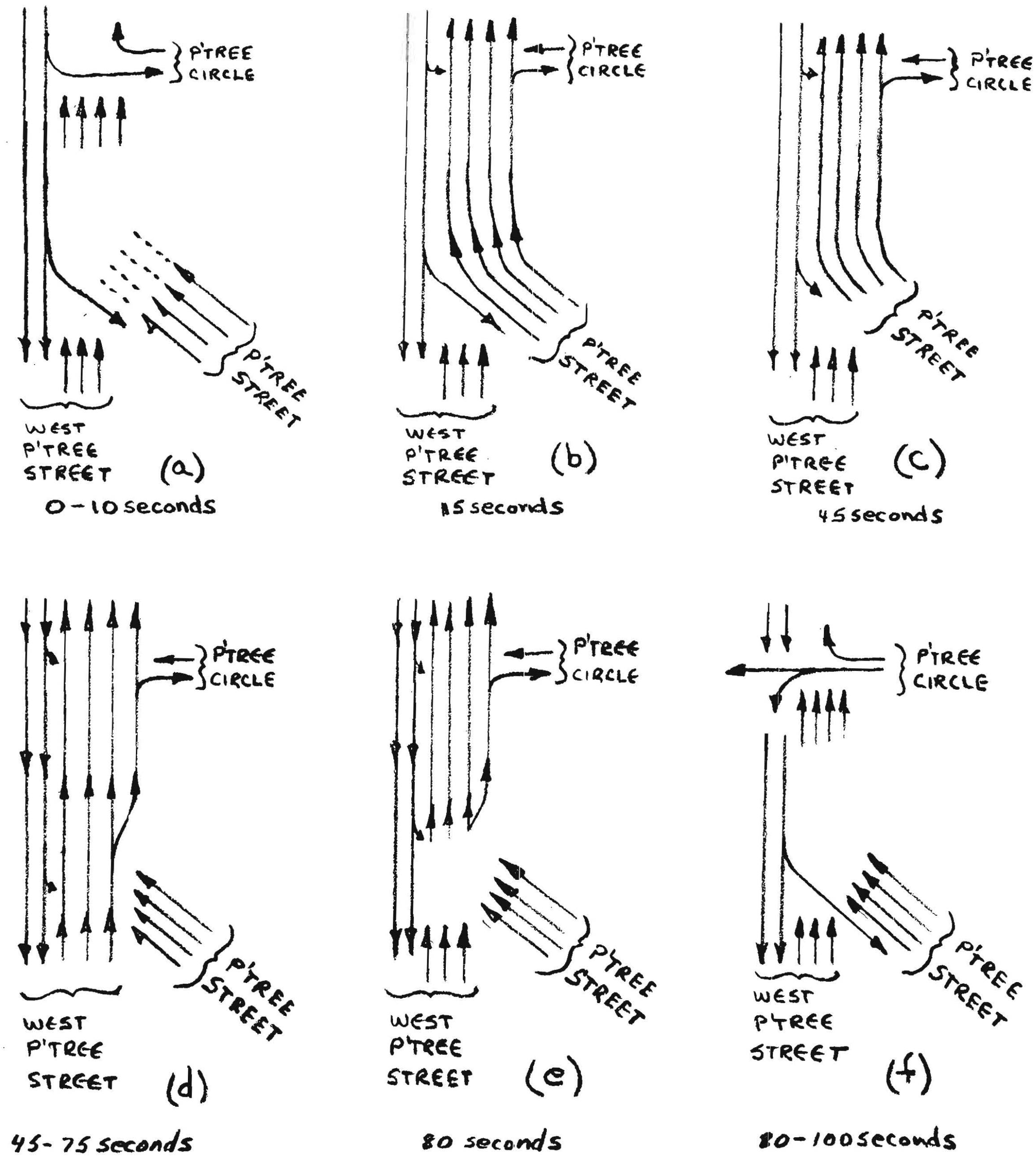

Figure B-5. Possible Traffic Light Pattern for Pershing Point Area.

c. The above described functions of the traffic lights at Peachtree Circle and Peachtree-West Peachtree Street establish a 65 second platoon flow for northbound traffic on Peachtree Road. Essentially, a 30 to 35 second "gap" is produced (dependent on the amount of northbound traffic entering at Peachtree Circle and at Beverly Road). Northbound traffic on Peachtree Street would experience a 60 second wait each 100 second cycle; West Peachtree Street would experience a 65 second wait each 100 second cycle. Of course, these waiting periods would not be necessary if platoon flow on Peachtree and West Peachtree Streets is established at some point south of the area. If desired, the waiting periods mentioned above could be reduced as follows:

(1) Green time for northbound Peachtree Street could be reduced from 35 to 25 seconds.

(2) Green time for northbound West Peachtree Street could be reduced from 30 seconds to 20 seconds.

(3) However, these green times ((1) and (2) above) will only accomodate approximately 3,168 vehicles/hr into platoon flow at 30 mph for northbound traffic on Peachtree Road. On the other hand, the recommended green times (mentioned in b above) will accommodate approximately 4,608 vehicles/hr at 30 mph.

(4) There are three reasons for the apparent differences in the volume rate of 5,148 vehicles/hr at 30 mph (mentioned above in a) and the volume rate of 4,608 vehicles/hr at 30 mph (mentioned above in (3)).

(a) Four lanes are being used on Peachtree Street (northbound), while only three lanes are being used on West Peachtree Street (northbound);

(b) The percentage of available green time is different in the two cases;

(c) The rate of 5,148 vehicles/hr is obtained from platoon flow where no stoppage is considered. The rate of 4,608 vehicles/hr is obtained from a stopped line of traffic, i.e., it is assumed that platoon flow has not yet been established. (A simple formula for obtaining the latter rate is discussed below in paragraph 8.)

7. A specific example will illustrate the possibilities for platoon flow in this area for peak period traffic. In Table I, the various intersections are listed with their approximate distance separations, from Peachtree Battle Avenue to Peachtree Circle. All streets in this area terminate on Peachtree Road, except the 26th-Huntington Street intersection which is treated as a cross street. Therefore, the street terminations are indicated as to whether entrance occurs from the east or from the west onto Peachtree Road. This feature allows consideration for the treatment of turning movements.

a. For A.M. peak traffic, a possible time-space diagram is shown in Figure B-6. A 100 second total cycle time is assumed. Main Street Green (MSG) for southbound traffic (platoon flow) is considered to be 70 seconds; therefore, the time allowed for each side-street entry is approximately 30 seconds.

b. For southbound traffic, a 30 mph speed is assumed. If no turning movements are considered, 1,386 vehicles/hr/lane can be accommodated. (This value is obtained by taking 70% of the value listed for 30 mph in Appendix A, Section A, paragraph 3.) For four lanes, a total of 5,544 vehicles/hr should be accommodated throughout the area. If right-turn

	Entrance to Peachtree from	SOUTHBOUND A.M. TRAFFIC Relative Distance between Streets (miles)	NORTHBOUND P.M. TRAFFIC Relative Distance between Streets (miles)
Peachtree Battle Avenue	west	0	.10
Peachtree Hills	east	.10	.15
Peachtree Memorial	west	.15	.15
Biscayne	west	.15	.05
Colonial Homes	west	.05	.10
Peachtree Park	east	.10	.10
Peachtree Valley	east	.10	.05
Darlington Apartments	east	.05	.11
Brighton	east	.11	.14
Collier	west	.14	.15
Palisades	east	.15	.15
26th Street (Huntington)	east-west	.15	.09
25th Street	east	.09	.12
Deering	east	.12	.30
Peachtree Circle	west	.30	0

Intersection Spacings on Peachtree Road,
Between Peachtree Battle Avenue and Peachtree Circle

TABLE B-1

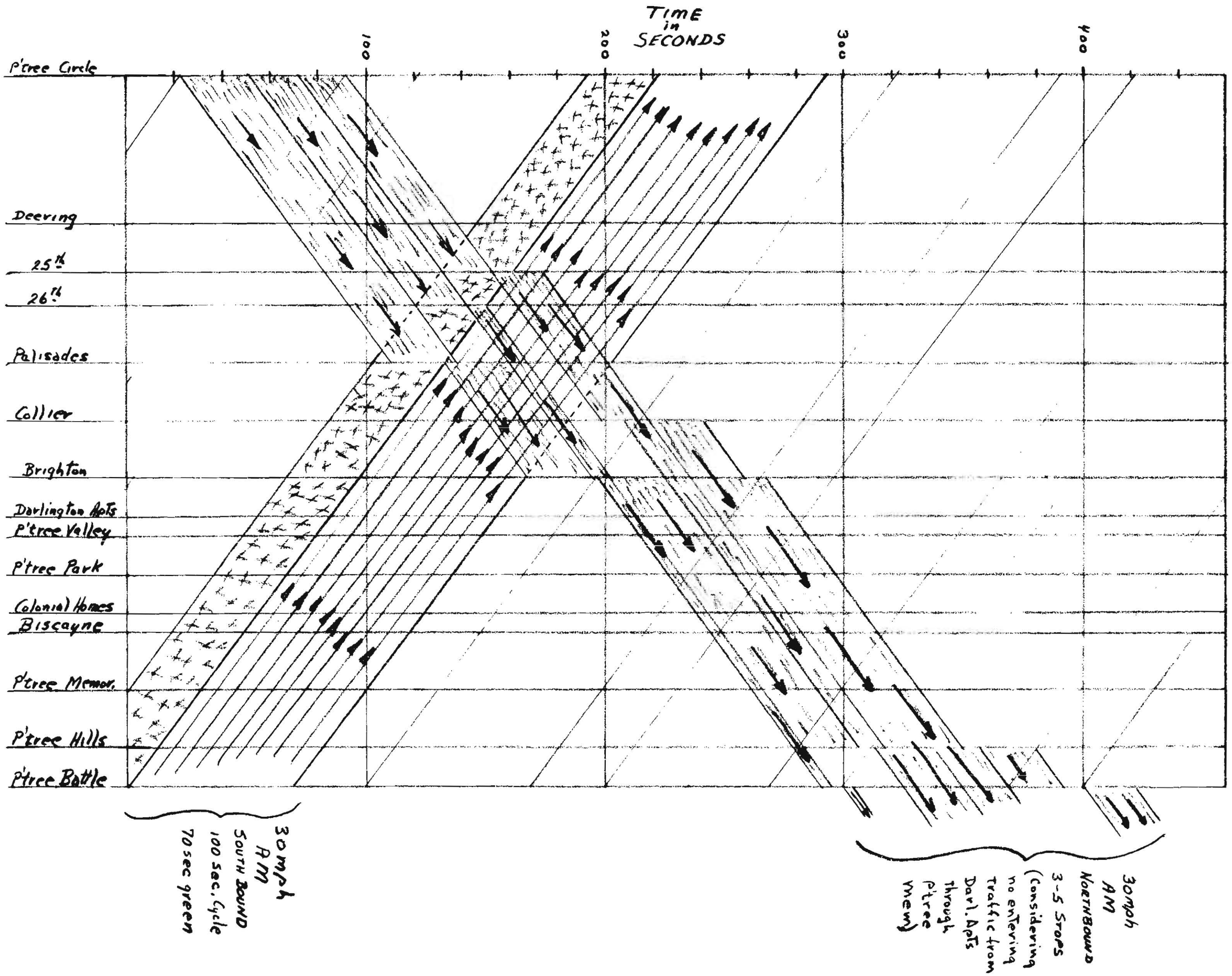

Figure B-6. A.M. Space-time Diagram for Peachtree Road Between Peachtree Battle Avenue and Peachtree Circle.

movements are considered, it is conservatively estimated that the curb lane would be slowed to an average speed of 15 mph. In this case, the four lanes should support a total of 4,851 vehicles/hr.

c. Northbound traffic, initiating at Peachtree Circle, (during the A.M. peak) will experience several stoppages as indicated in Figure B-6:

(1) For the traffic closest to the Peachtree Circle intersection, two to three stops are indicated through the area; i.e., at Palisades, Brighton and perhaps, Peachtree Hills.

(2) For traffic next in line at Peachtree Circle, three stops are indicated; i.e., at 26th Street, at Collier or Brighton, and at Peachtree Hills.

(3) For the traffic which is furthest back at Peachtree Circle, five stops may be encountered; i.e., at 25th Street, at Collier, at Brighton, at Peachtree Hills, and at Peachtree Battle Avenue.

(4) It is noted that 10 second lead times are provided to northbound A.M. traffic for left-turn movements at Deering Road, and at 25th and 26th Streets. This should also accommodate left-turn movements into the several private parking facilities in this area on the west side of Peachtree Road.

(5) Stoppages for northbound traffic at the Darlington Apartments, Peachtree Valley, Peachtree Park, Colonial Homes, Biscayne, and Peachtree Memorial have been ignored. It is known that some A.M. entrance demands will be made at these intersections. However, it is assumed that such demands will not occur every cycle. (However, see paragraph 8 below.)

(6) The minimum predicted times through the area for northbound A.M. traffic will vary from 278 seconds to 330 seconds, dependent on the stops and associated vehicle position in the initial group at Peachtree Circle. These times are equivalent, respectively, to 24.0 mph and 20.2 mph.

(7) The minimum predicted average speed of 20.2 mph (in (6) above) will accommodate approximately 1,246 vehicles/hr/lane. If a conservative estimate of 10 mph is assumed for the inner lane (due to left-turn movements) 924 vehicles/hr should be accommodated in this lane. For the two available northbound lanes, therefore, a total of 2,170 vehicles/hr should be accommodated. This latter value is in considerable excess of current demands.

(8) If stoppages did occur for northbound traffic at all of the intersections from the Darlington Apartments through to Peachtree Memorial, approximately 44 seconds of travel time would be added to the trip time. The minimum average speed through the area for northbound traffic would then be reduced to 17.8 mph. Even if this were the case, the predicted total is 2,143 vehicles/hr, which remains in considerable excess over current demands.

(9) Essentially the same results as given in (1) through (8) above could be accomplished by the following:

(a) An increase in assumed speed to 35 mph

(b) A reduction in total cycle time to 90 seconds

(c) A reduction in MSG to 60 seconds

8. Finally, it may be argued that the time-space diagram does not adequately represent stop-and-go traffic flow. For Figure B-6, this might result because the lines (or groups of lines) representing north-bound A.M. traffic (the broken-sloping lines to the right) all assume essentially instantaneous 30 mph speeds for all vehicles (in a stopped group) at the instance of acceleration. Therefore, it could be stated that the time-space diagram is somewhat inadequate for this type of representation. However, when acceleration times for a group of stopped vehicles is considered, the results are not significantly different than those listed above. When acceleration times are considered, the following listed items will summarize the results which are obtained:

a. It has been determined from measurements that vehicles (in a stopped lane of traffic) appear to obey the following emperical formula with respect to time required to reach the intersection:

$$T(\text{seconds}) = 3 + 2N$$

where T = the time in seconds required for the Nth vehicle in a stopped lane of traffic to accelerate to approximately 30 mph and reach the intersection; and where N = the number of the vehicle in a stopped line of vehicles. For the first vehicle at the intersection, N = 1.

b. The above formula is strictly emperical since many pertinent factors appear to be ignored. Nevertheless, the time values obtained by use of the formula appear to be generally applicable for values of N from 2 to 14. When two or more tractor trailer units occur in a stopped line, the predicted times should be increased by 4 to 8 seconds. On the other hand, when only automobiles are present in a stopped lane of traffic, the predicted times are sometimes reduced by several seconds.

c. For values of N greater than 14, other factors need to be considered. Relatively wide variations and scattered results were obtained in the measurements. These fluctuations appeared to result from slow-starts by some vehicles and from excessive spacings between other vehicles.

d. The above formula was utilized for predicting the actual numbers of vehicles which would be allowed through a given intersection in the various groups for northbound A.M. traffic (for the interval from Peachtree Circle to Peachtree Battle Avenue on Peachtree Road). In addition, all possible stops were considered in this interval when indicated on the space-time diagram. That is, possible stops at the Darlington Apartments, Peachtree Valley, Peachtree Park, Colonial Homes, Biscayne, Peachtree Memorial were considered. Thus, these stoppage considerations should produce a worst case condition. The number of predicted stops increased from the previous values of 3 to 5 to the values of 4 to 6, dependent on the relative position of a vehicle in a line of stopped vehicles. For northbound A.M. traffic, the minimum predicted average speed throughout the interval is 17.7 mph; the maximum predicted average speed is 21.6 mph. These predicted values are only about 10% less than those previously given. Thus, a minimum total of approximately 2,000 vehicles/hr is predicted for the two available northbound lanes for A.M. traffic. This value is still a factor of 1.4 greater than current measured demands.

e. Therefore, it is concluded that the usual time-space diagram yields adequate results even for stop-and-go traffic. Thus, the usual time-space diagram appears to predict average speeds which are 10% greater than actual speeds, for stop-and-go opposing traffic flows.

9. For P.M. peak traffic, a possible time-space diagram is shown in Figure B-7. A 100 second total cycle time is assumed. MSG for northbound traffic (platoon flow) is considered to be 70 seconds; therefore, access time for side-street entry is approximately 30 seconds. In addition, a 20 second time is allowed for exclusive left-turn movements at Deering and Collier Roads. Thus, at these intersections, the time for southbound P.M. traffic is reduced to 50 seconds.

a. There is a maximum of 3 to 4 stops predicted for southbound P.M. traffic, dependent on the relative position of a vehicle in a group which initiates at Peachtree Battle Avenue. This number of predicted stops assumes that there is no demand for entrance traffic at the Darlington Apartments, Peachtree Valley, Colonial Homes, Biscayne, or Peachtree Memorial.

b. The minimum predicted times through the area for southbound P.M. traffic will vary from 292 seconds to 346 seconds, dependent on the stops and associated vehicle position in the initial group at Peachtree Battle Avenue. These times are equivalent, respectively, to 22.8 mph and 19.2 mph.

c. The minimum predicted average speed of 19.2 mph (in b above) will accommodate approximately 1,186 vehicles/hr/lane through the area. For the available two lanes, this amounts to a total of 2,372 vehicles/hr. This latter volume rate is in considerable excess of current demands.

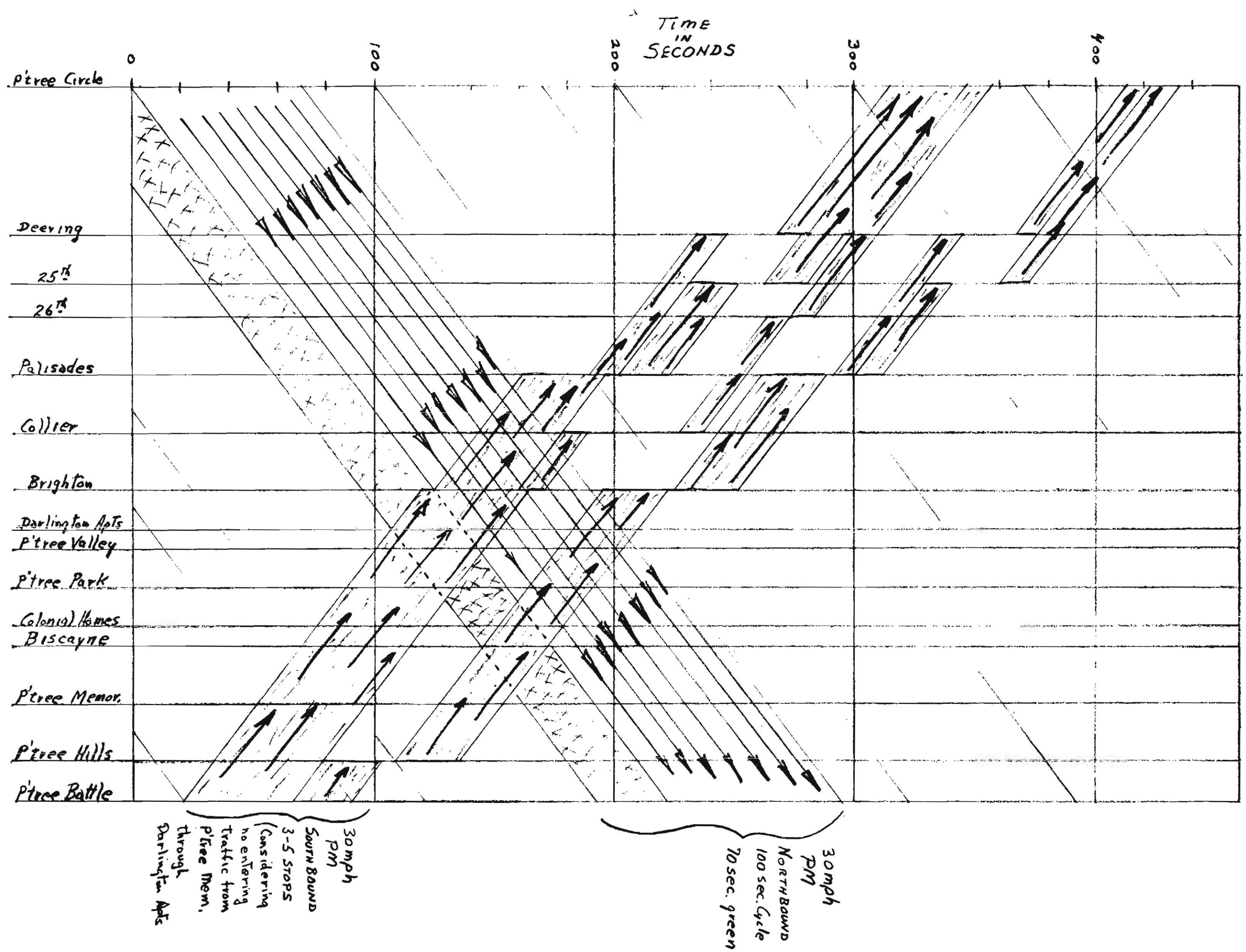

Figure B-7. P.M. Space-time Diagram for Peachtree Road Between Peachtree Battle Avenue and Peachtree Circle.

C. Downtown Area

1. Currently, there are two northbound lanes on Peachtree Street to Baker Street. Thereafter, there are effectively two through-lanes northbound to Pershing Point, although three lanes are provided north of 14th Street. Currently, there are also two lanes northbound on Spring Street and three lanes northbound on West Peachtree. The total number of through lanes for northbound P.M. traffic in this corridor from the CBD area can be established in several different ways.

a. From Ellis Street northward

(1) Two lanes on Spring Street

(2) Two lanes on Peachtree Street

(3) Four lanes on Ivy Street

(4) Items (1) through (3) above total to eight lanes

b. From Alexander Street northward

(1) Two lanes on Spring Street

(2) Three lanes on West Peachtree Street

(3) Two lanes on Peachtree Street

(4) Items (1) through (3) above total to seven lanes

c. From 14th Street northward

(1) Two lanes on Spring Street

(2) Three lanes on West Peachtree Street

(3) Three lanes on Peachtree Street

(4) Items (1) through (3) above total to eight lanes

2. From the items listed in 1 above, it is seen that seven through lanes are currently provided from the CBD area northward for P.M. traffic. (South of Baker Street here are eight lanes, and north of 14th Street there

are eight lanes.) In the proposed traffic flow plan (Figure 1 in the Text, Chapter II, Section D), there are six lanes available along this corridor south of Baker Street, for P.M. traffic: 4 lanes on Ivy Street and 2 lanes on Peachtree Street. The latter 2 lanes on Peachtree Street could be increased to 3 lanes by the use of permanent lane markings or by implementation of a reversible lane on Peachtree Street (south of Baker Street). North of Baker Street to 12th Street there are also six lanes proposed, i.e., 3 lanes on West Peachtree and 3 lanes on Peachtree Street. North of 12th Street there are seven lanes proposed, i.e., 3 on West Peachtree and 4 on Peachtree Street. If desired, 4 one-way northbound lanes could be provided on West Peachtree by the use of reversible lanes from Baker Street to the Peachtree-West Peachtree intersection.

3. The current peak period P.M. volume rates [16] indicated for Spring, West Peachtree and Peachtree Streets are listed as follows: Spring Street (944 vehicles/hr); West Peachtree Street (551 vehicles/hr); and Peachtree Ivy Streets (1447 vehicles/hr). The large increase for Peachtree-Ivy Streets is due to eastbound traffic which exits at Forrest, or North, or Ponce de Leon Avenues. Since northbound P.M. traffic on Peachtree Street in this area does not appear to flow any faster than that on Spring Street, the value for northbound P.M.traffic on Peachtree Street is assumed to be the same as that for Spring Street, i.e., 944 vehicles/hr. Thus, the total volume demand for northbound P.M. traffic in the corridor would be 2439 vehicles/hr. (This predicted volume is slightly larger than the Screen Line[17] value, which is 2253 vehicles/hr.) However, either of these volume demands can be satisfied readily by the proposed total of

6 lanes for northbound P.M. traffic on Peachtree and West Peachtree Streets. Actually, if the previously mentioned stoppage is assumed to occur at the Peachtree-West Peachtree intersection, a total rate of 4608 vehicles/hr is predicted. On the other hand, if platoon flow were established on both Peachtree and West Peachtree (south of the Peachtree-West Peachtree Street intersection), the 6 lanes should accommodate a total maximum of 7722 vehicles/hr at 30 mph with 65% green time assumed.

4. As has been mentioned, Peachtree Road can accommodate 4 one-way lanes for northbound P.M. traffic. Therefore, it is also possible to provide 4 lanes of northbound P.M. traffic on West Peachtree Street (instead of the proposed 3 lanes). This is particularly true if Spring Street is one-way south. Thus, for opposing southbound P.M. traffic, 4 lanes would be available on Spring Street, one lane would be available on West Peachtree to 10th Street, and two lanes would be available on Peachtree Street to 12th Street. If this scheme were implemented, there would exist, effectively, seven through-lanes for northbound P.M. traffic in the corridor. A total maximum of 9009 vehicles/hr could be accommodated at 30 mph with 65% green time assumed.

5. It may have been noticed that the proposed number of through-lanes on Peachtree Street is three, although the street currently supports four lanes from 12th Street to Ponce de Leon Avenue. It is most desirable that Peachtree Street be made one-way north from Baker Street to 12th Street. However, this proposal does not appear to be acceptable to the Atlanta Transit Company.[32] It is maintained that the utilization of bus services would be adversely affected. Thus, A.M. bus users would

have to walk to West Peachtree Street or to Juniper Street. The walk to West Peachtree Street (at 12th Street) represents approximately 1373 feet (0.26 miles); however, the walk to Juniper Street represents only one block. Therefore, it would appear that very adequate A.M. bus service could be provided for Peachtree Street users (between 12th Street and Baker Street) by a southbound A.M. route on Juniper Street.

6. The above objections [32] have been noted, however, and the proposed flow plan provides utilization of Peachtree Street as being "effectively" one-way north. Thus, a single southbound bus lane has been provided; the remaining three lanes are made one-way north. The single southbound bus lane would be required to shuttle westward to West Peachtree Street at Alexander Street. This suggested treatment also eliminates the need for a three-phase traffic light at the intersection of the Peachtrees with Baker Street.

7. A similar approach for effective one-way street usage has been suggested for Edgewood Avenue and Decatur Street. A single eastbound bus lane is utilized for Edgewood Avenue, which is effectively one-way west; also, a single westbound bus lane is utilized for Decatur Street, which is effectively one-way east.

8. The interval on Peachtree Street from Edgewood Avenue northbound to Baker Street is of particular interest. There currently exists a large peak period volume for P.M. traffic from the CBD area. Several treatments are possible.

a. In the proposed plan, northbound P.M. traffic, which originates south of Edgewood Avenue, is encouraged to utilize Spring, Marrietta, Luckie, or Techwood for access to the northwest. Also, easy access to Williams Street (and I75-85) is provided from Cain Street (one-way west to Luckie Street). For access to the north or northeast, traffic which originates south of Edgewood is encouraged to utilize Central-Ivy Streets or Piedmont Avenue, or Whitehall via Auburn Avenue to Ivy Street. In this manner, all of this northbound traffic can be eliminated from the northbound lanes of Peachtree Street (north of Luckie Street).

(1) Suggested lane markings on Peachtree Road between Edgewood Avenue and Carnegie Way are illustrated in Figure B-8.

(2) These lane markings indicate that Peachtree Street does not support northbound traffic in this interval. A single northbound bus lane has been provided from the Luckie-Broad Street intersection to the Carnegie Way intersection.

(3) The suggested traffic routing also allows A.M. entrance from Houston Street (3 lanes) directly into the CBD area.

(4) North of Carnegie Way, two or three northbound lanes could be supported on Peachtree Street to Baker Street. (Two lanes can be supported by permanent lane markings as is currently done; three lanes could be supported by use of a reversible lane.) In any case, northbound peak traffic could be supported on Peachtree Street, for instance, from left-turns from Ellis or Harris Streets, and also from right-turns from Cain and Baker Streets. The point to be made is that ample storage space would now exist on the northbound lanes of Peachtree Street (2 or 3 lanes), for this entering traffic. This is because other traffic (from the south) has been diverted eastward or westward from Peachtree Street.

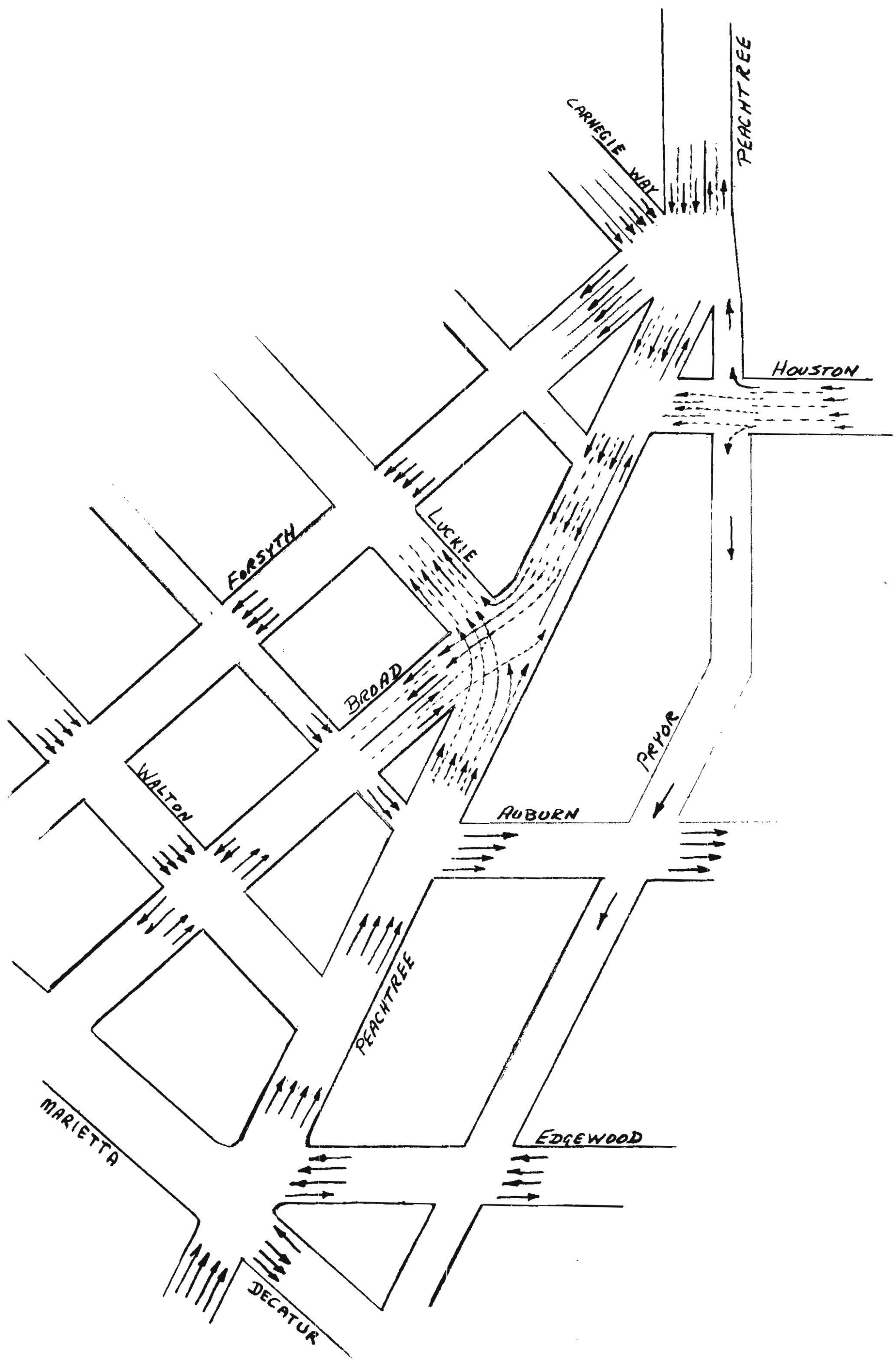

Figure B-8. Suggested Lane Control, Five Points Area.

(5) The three lanes which are currently available on West Peachtree (north of Baker Street) also could better accumulate northbound traffic from the adjacent areas as well as allow various turning movements without a detrimental effect on the northbound through-traffic. This is made possible because the "back log" of traffic from the south would not access this area.

(6) Appropriate timing of traffic signals in the whole region could permit a reasonable degree of platoon flow such that large volume rates could be supported.

b. It is also possible to maintain several northbound lanes on Peachtree Streets from Edgewood Avenue northward through the Carnegie Way intersection. However, if this were accomplished, at least 3 northbound lanes should be provided during the peak P.M. period. This would probably necessitate reversible lanes at least from the Luckie-Broad Street intersection northward to Baker Street. Reasons are summarized as follows:

(1) If the P.M. traffic which originates south of Edgewood Avenue is not forced eastward or westward from Peachtree Street, it will probably continue northward on Peachtree Street. This could result because it is simply more convenient for drivers, rather than shuttling westward or eastward to other streets.

(2) Through-traffic on Peachtree Street from the south would cause a "bottle neck" (or serious congestion) from Broad Street northward to Baker Street, particularly, if only 2 northbound lanes are provided.

(3) Therefore, if it is considered manditory to maintain through-lanes for northbound traffic on Peachtree Street in this interval, at least 3 one-way lanes should be provided. These lanes should be provided from the Luckie-Broad Street intersection northward to Baker Street.

(4) On Peachtree Street, south of the Luckie-Broad Street intersection, the four lanes should be maintained one-way north; the western lane would be required to exit westbound onto Luckie Street.

(5) The 3 remaining lanes on Peachtree Street in the interval from the Luckie-Broad Street intersection to Baker Street should be maintained by use of reversible lanes, since additional lanes would also be needed for the southbound A.M. peak period.

9. The treatment of Peachtree Street suggested in 8a above has been chosen for use in the suggested traffic flow plan. The principal reason is the avoidance of reversible lanes on this interval of Peachtree Street. However, the most efficient method for moving traffic in this area would utilize reversible lanes. As has been discussed, 3 one-way lanes could be supported for the peak A.M. traffic from Baker Street southward to Luckie Street. At this intersection, the curb lane would be required to right-turn onto Luckie Street, the remaining two lanes could continue southward on Broad Street (two-way). Four lanes would be supported for the peak P.M. traffic from Edgewood Avenue north to Luckie Street. At this intersection, the inner lane would be required to left-turn onto Luckie Street, the remaining three lanes could continue northward on Peachtree Street.

10. The Peachtree Road Corridor (north of Baker Street) can accommodate any of the generated traffic volumes which might occur from any of the above suggested treatments for Peachtree Street.

APPENDIX C

SUGGESTED TREATMENTS FOR SOME INTERSECTIONS AND STREET INTERVALS

A. General

1. Suggested treatments for several different "problem" intersections and several different street intervals are given in this appendix. Because of the short time of this study, the suggested treatments have been limited to the north side of the City. Several significant improvements are possible.

2. Some of the suggestions can be implemented immediately, that is, with little or no construction work. These are listed as follows and discussed in Section B.

   a. Piedmont-Road-Lindbergh Drive intersection.

   b. Piedmont Road-Cheshire Bridge intersection.

   c. Piedmont Road-Roswell Road intersection.

   d. The interval on Northside Drive from I75 to 14th Street.

   e. The interval on Howell Mill Road from Bellemeade to Chattahoochee Avenue.

3. Other suggested implementations will require major construction efforts. These are listed as follows and are discussed in Section C.

   a. Widening of North Avenue.

   b. Widening of the Southern Railroad overpass on Northside Drive.

   c. Widening of the SCL Railroad underpass on Howell Mill Road.

   d. Bridge connector between Palisades and Armour Drive.

   e. Bridge connector between Brighton Road and Virginia Place.

   f. Widening of Peachtree Road for approximately 500 feet to the Spring Street intersection.

g. Arterial connector northbound from Pershing Point across I85 via the Southern Railroad, to connect to Piedmont Road at Marian Road.

h. Suggested expressway modifications.

B. Near Future Implementations

1. Piedmont Road-Lindbergh Drive intersection

a. The suggested treatment for the Piedmont Road-Lindbergh Drive intersection is shown in Figure C-1. Current practice allows a P.M. left-turn movement from northbound traffic on Piedmont Road onto Lindbergh Drive westbound (at traffic light #2). This turning movement must accommodate a relatively large P.M. peak volume rate. Consequently, northbound P.M. traffic on Piedmont Road will "back-up" often for one-half mile southward in this inner lane. In addition to the stoppage produced in the left-turn lane, there results (effectively) only two through lanes which are northbound in this interval on Piedmont Road.

b. On the other hand, there is adequate space for an ample storage of left-turn vehicles within the off-set interval to the east of Piedmont Road. As indicated in Figure C-1, northbound traffic on Piedmont Road which desires exit to Lindbergh Drive, westbound, can be required to turn right (at traffic light #3) onto the extension of Lindbergh. Thence, a left-turn movement at traffic light #4 will circulate this traffic back northward and westward to the intersection in question (traffic light #2). In this manner, the present P.M. "bottleneck" at this intersection should be entirely eliminated.

c. It is noted that the present street widths at traffic light #4 are quite adequate for handling four to five lanes of traffic. However, traffic light #4 should probably be a three-phase light. This results because of an

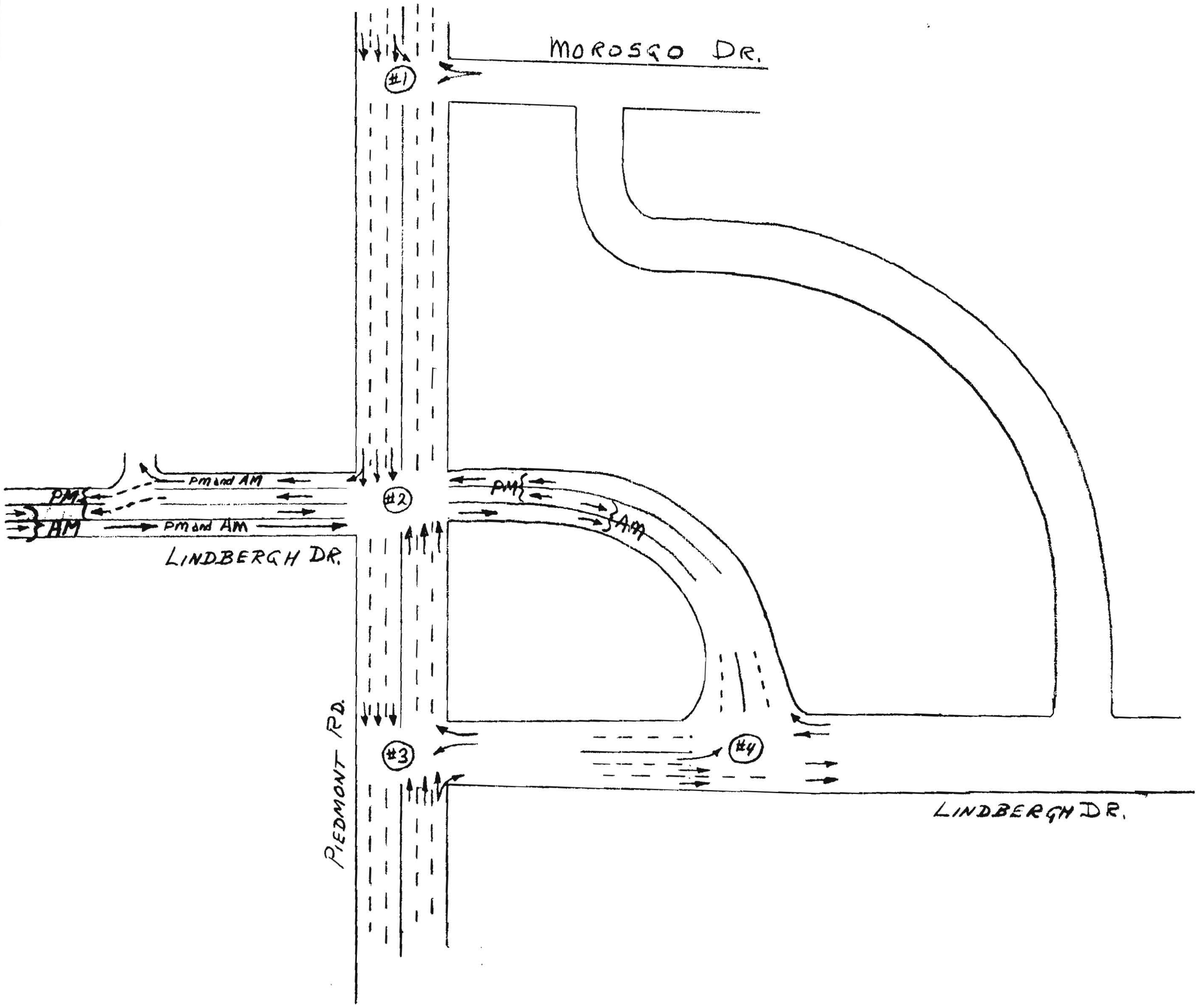

Figure C-1. Suggested Treatment for Lindbergh-Piedmont Intersection.

assumed relatively large volume of westbound traffic on Lindbergh which may desire entrance onto Piedmont Road, southbound, at traffic light #3. Otherwise, a two-phase light could probably accommodate this traffic with a sufficient lead time for this westbound traffic.

d. Also, it should be noted that Lindbergh Drive west of Piedmont Road can accommodate four lanes of traffic to the shopping center entrance and three lanes on further to the west. In addition, three lanes of traffic can be accommodated on Lindbergh Drive at traffic light #2, immediately east of this intersection (by measurement).

e. With the use of reversible lanes on Lindbergh Drive immediately west of the shopping center entrance and immediately east of the intersection at traffic light #2, two through-lanes can be provided for either A.M. or P.M. peak traffic demands.

f. For A.M. southbound traffic on Piedmont, left-turn movement for eastbound traffic onto Lindbergh Drive could be accomplished at Morosgo Drive (traffic light #1), at Lindbergh Drive (traffic light #2), or at the Lindbergh Drive extension (traffic light #3). However, it appears that a minimum stoppage of A.M. southbound traffic would occur if these left-turn movements were restricted to Morosgo Drive at traffic light #1. Northbound A.M. traffic demand on Piedmont Road at this intersection (traffic light #1) is small. Therefore, if desired, a three phase light (at traffic light #1) could be utilized for peak period A.M. traffic only. Thus, the full green time for southbound A.M. traffic could be used for through-southbound traffic and for left-turn traffic onto Morosgo Drive. This produces (effectively) three lanes of through-southbound traffic (for platoon flow), with some slow-down in the inner lane due to left-turn movements. The remaining cycle time at this intersection could be split (as required) between westbound Morosgo Drive traffic and northbound Piedmont Road traffic.

g. Implementation of these suggestions should allow three through lanes (effectively) for Piedmont Road in this interval, for either the peak A.M. or P.M. demands.

2. Piedmont Road-Cheshire Bridge intersection

a. It is believed that only a limited improvement is possible, without reconstruction of this intersection. Because of relatively high peak period demands on all three streets (Piedmont Circle, Piedmont Road, and Cheshire Bridge), it is apparent that a three phase light is needed. However, if a reversible lane is utilized on Piedmont Avenue, south of the intersection, a considerable improvement in flow rate can be realized, both for the A.M. and P.M. peak periods.

b. For the A.M. peak period, the two major traffic light phases are shown in Figure C-2. Phase #1 is indicated by solid-line arrows; phase #2 is indicated by dashed-line arrorws. The left-turn onto Piedmont Circle for northbound A.M. traffic on Piedmont can be provided by a leading left turn arrow. The split between the two major phases should be based on platoon flow on Piedmont Road (southbound) and on the relative southbound volume demands between Piedmont Road and Cheshire Bridge. The third phase (minor phase, not shown in Figure C-2) would permit exiting traffic to flow from Piedmont Circle.

c. For the P.M. peak period, the major traffic light phase is shown in Figure C-3. The time for this phase should be adjusted for adequate platoon flow for northbound P.M. traffic on Piedmont. The two

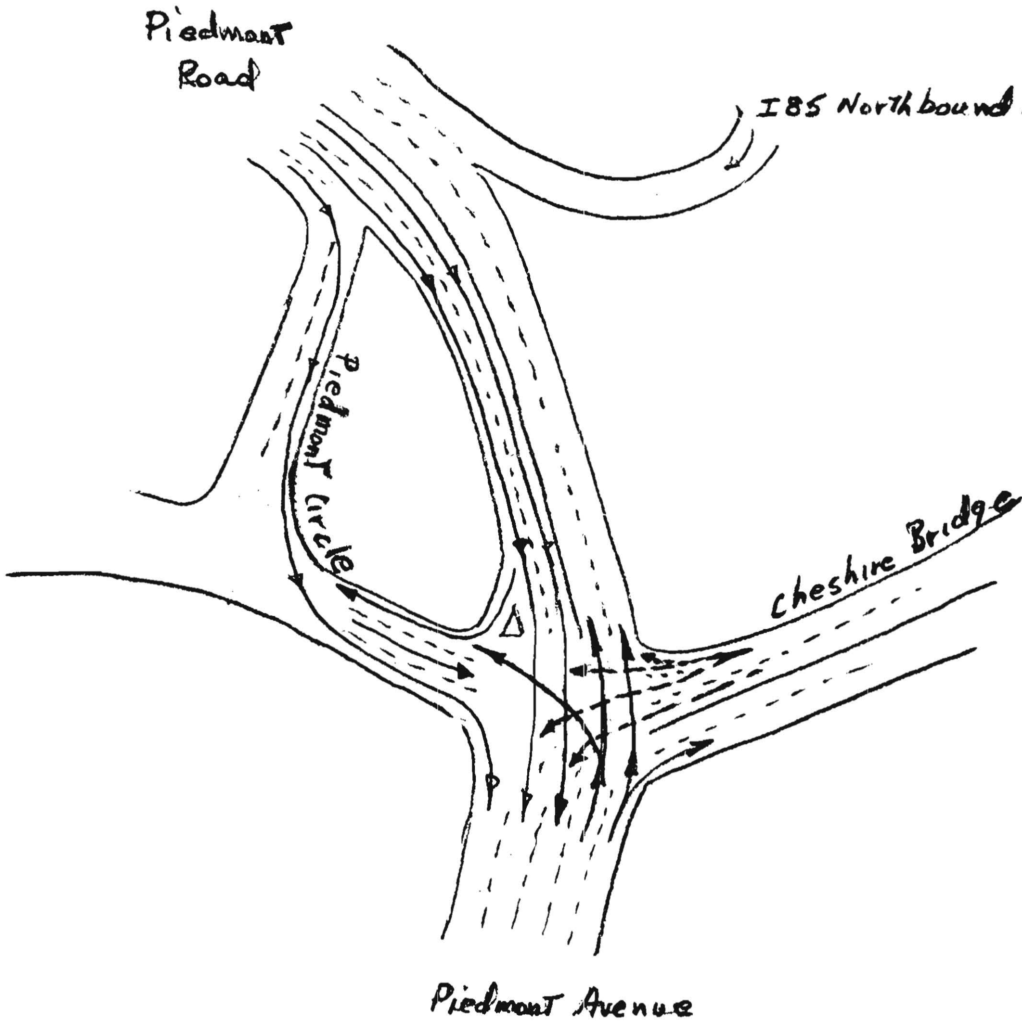

Figure C-2. Suggested Treatment for Piedmont-Cheshire Bridge Intersection, (Peak A.M. Period).

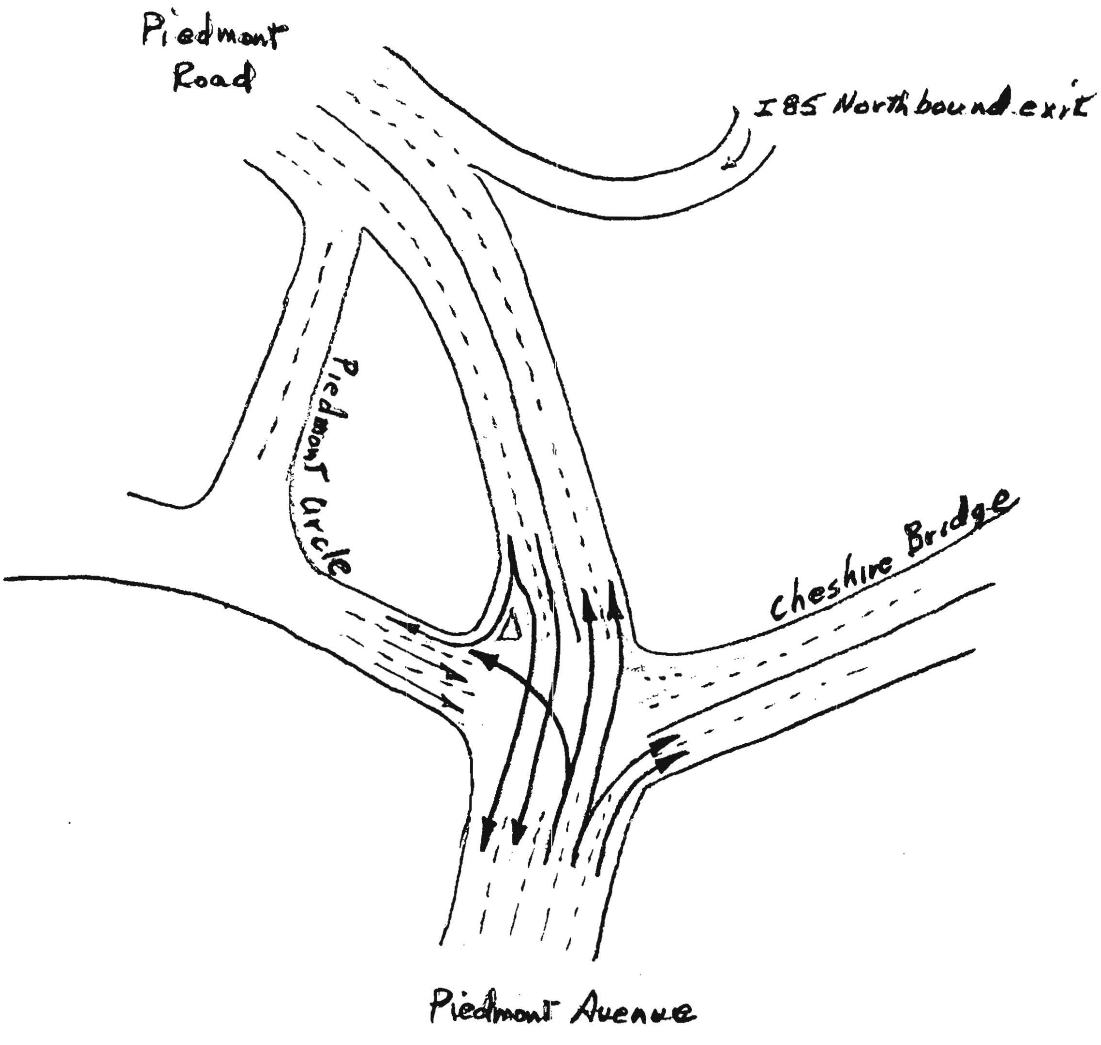

Figure C-3. Suggested Treatment for Piedmont-Cheshire Bridge Intersection, (Peak P.M. Period).

minor phases should be split. A leading left-turn arrow will allow exiting traffic onto Piedmont Circle, westbound. The two minor phases should be split between Piedmont Circle and Cheshire Bridge, dependent on relative volume demands for the opposing traffic.

d. It is noted that the outside (curb) lane for A.M. southbound Piedmont Road traffic terminates at Piedmont Circle. However, this third lane can be provided with through-lane movement via Piedmont Circle back to Piedmont Road at the Cheshire Bridge intersection. This is true if the reversible lane is implemented on Piedmont Avenue south of this intersection. Thus, if a traffic light is established at the intersection of Piedmont Circle and Monroe Drive, and if this traffic light is coordinated with the A.M. southbound phase of the traffic light on Piedmont Road (at the Piedmont Circle-Cheshire Bridge intersection), continuous 3 lane flow can be provided for southbound traffic on Piedmont Road through the intersection onto Piedmont Avenue southbound.

3. Piedmont Road - Roswell Road intersection

a. A suggested treatment for this intersection is shown in Figure C-4 through C-9. A reversible lane is to be utilized from the Habersham Road intersection on Roswell Raod at least to the northern part of the shopping center area. In Figure C-4, A.M. southbound traffic flow is depicted. The inner lane is required to exit southbound onto Piedmont Road; the middle lane may exit onto Piedmont or continue south on Roswell; the curb lane may exit on Blackland, Habersham, or continue south on Roswell.

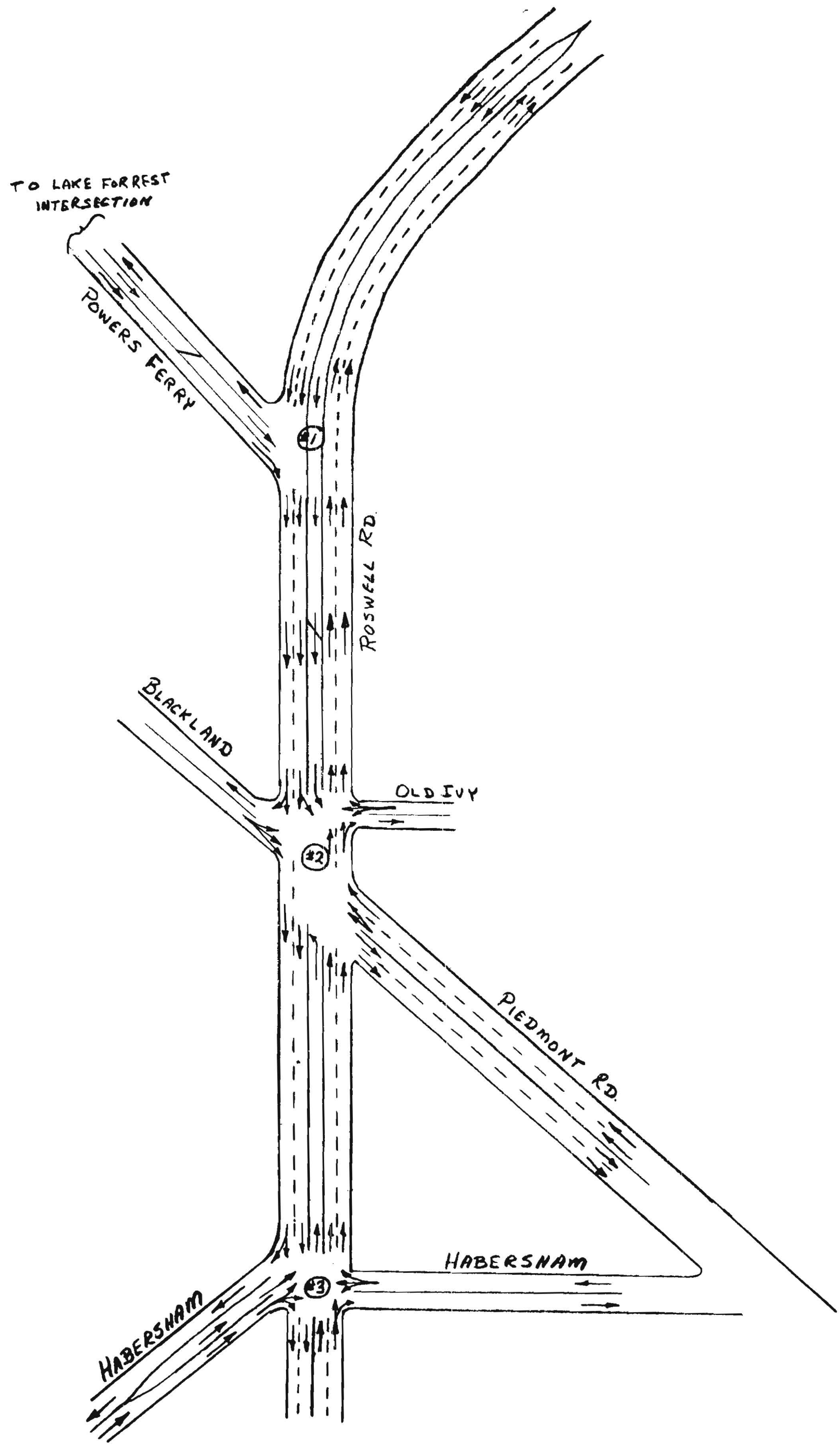

Figure C-4. Suggested Treatment for Roswell-Piedmont Intersection, (Peak A.M. Period).

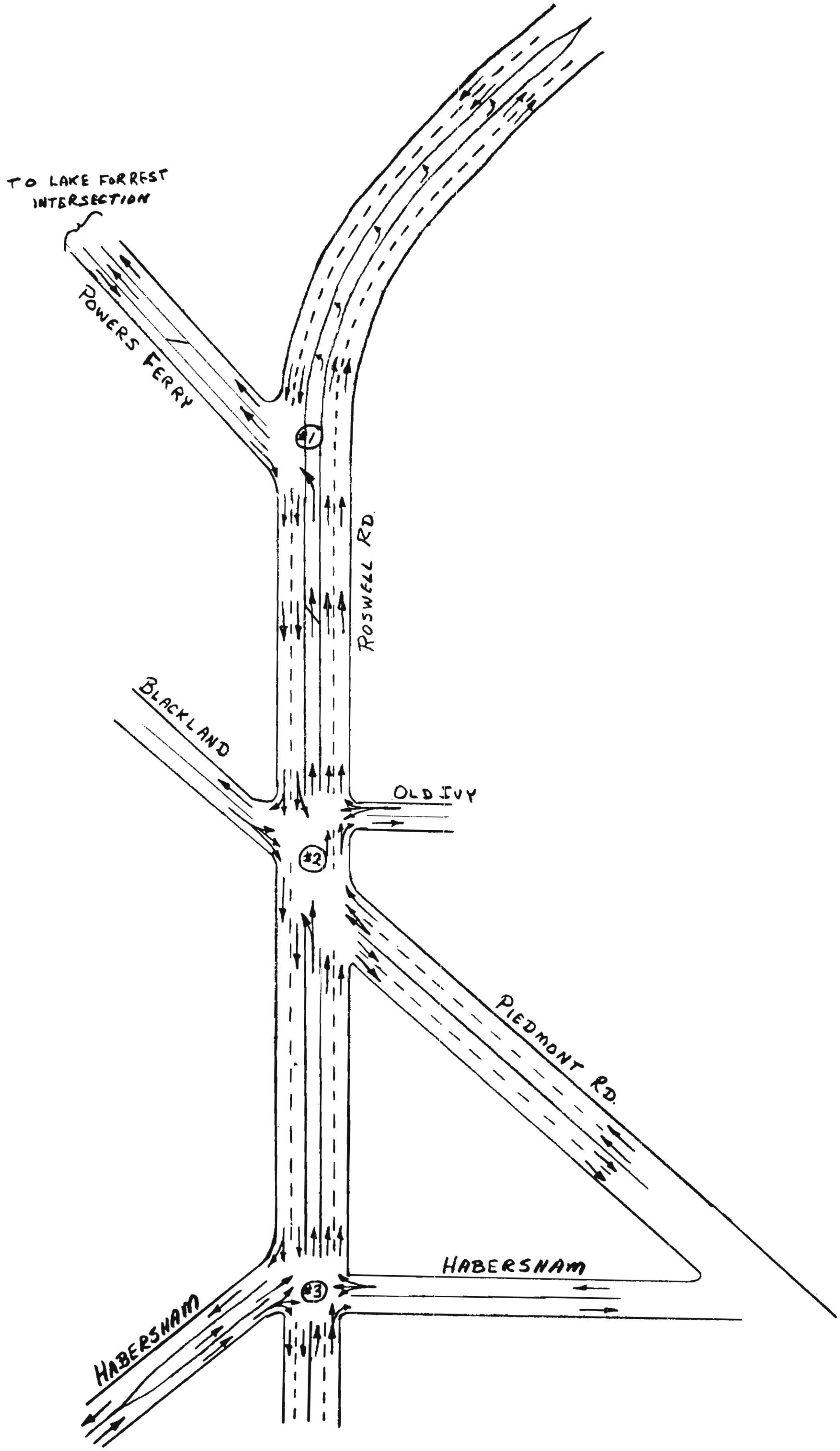

Figure C-5. Suggested Treatment for Roswell-Piedmont Intersection, (Peak P.M. Period).

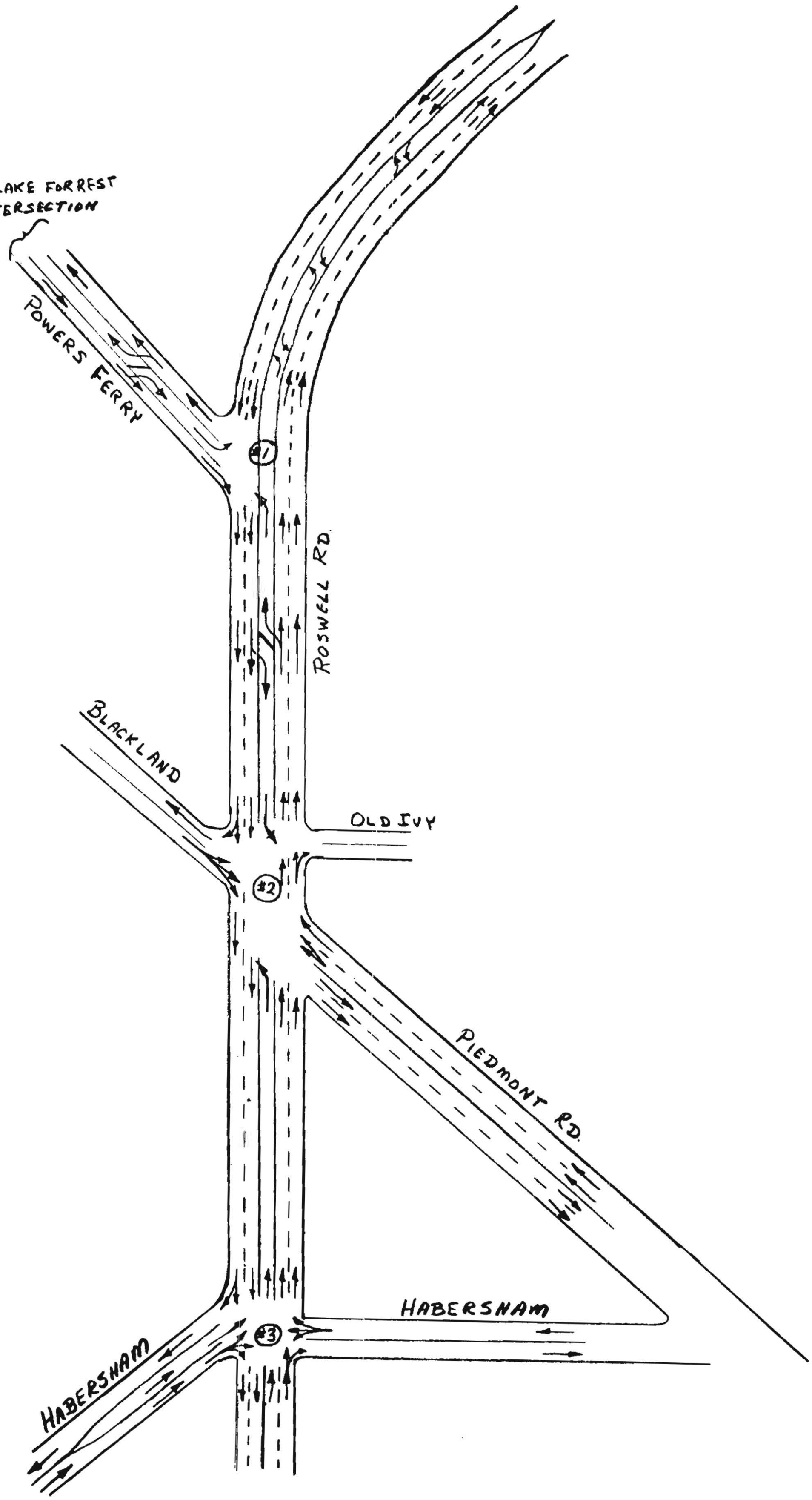

Figure C-6. Suggested Treatment for Roswell-Piedmont Intersection, (Normal Periods).

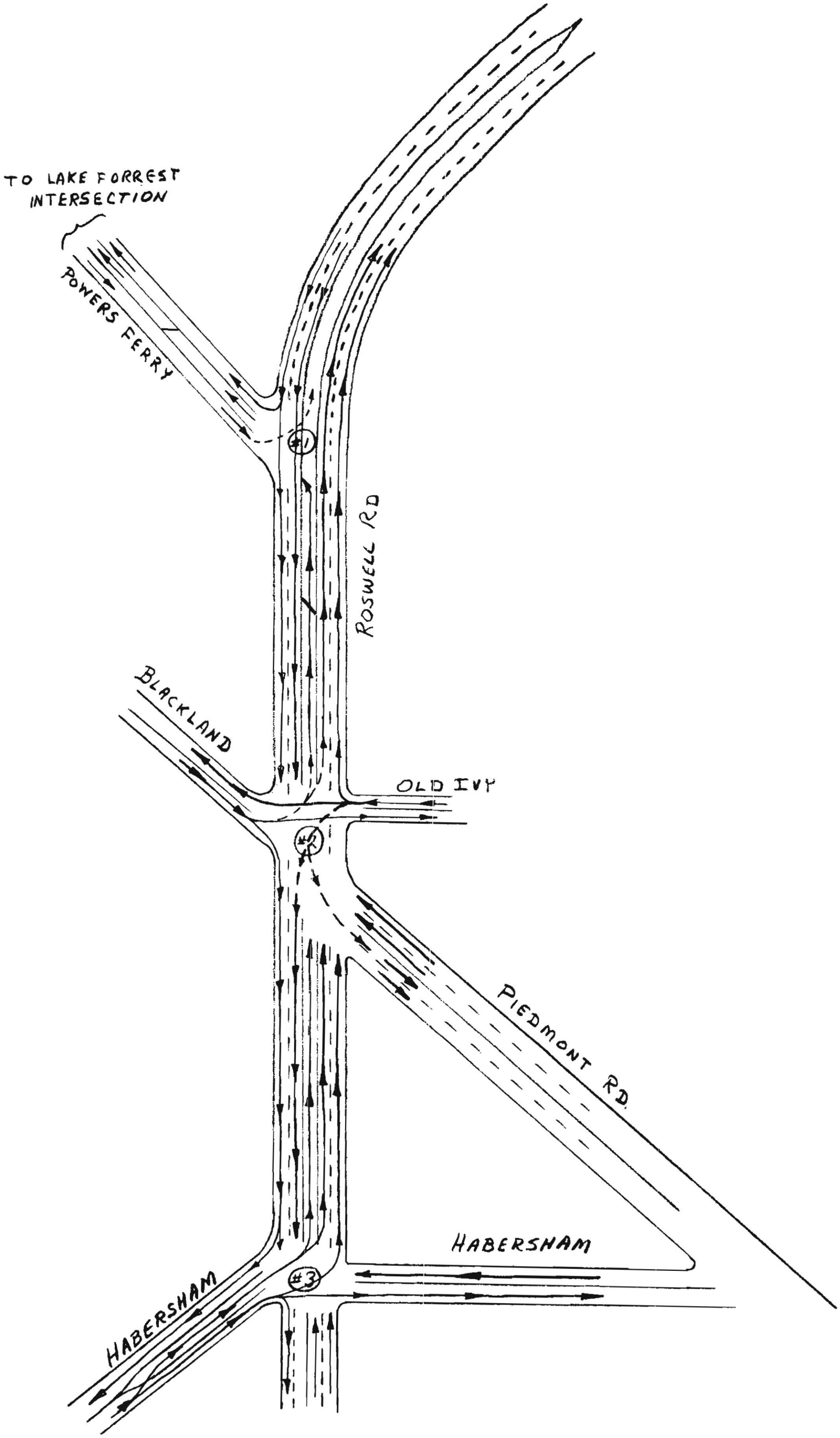

Figure C-7. Suggested Traffic Light Phases, Roswell-Piedmont Intersection (Phase I).

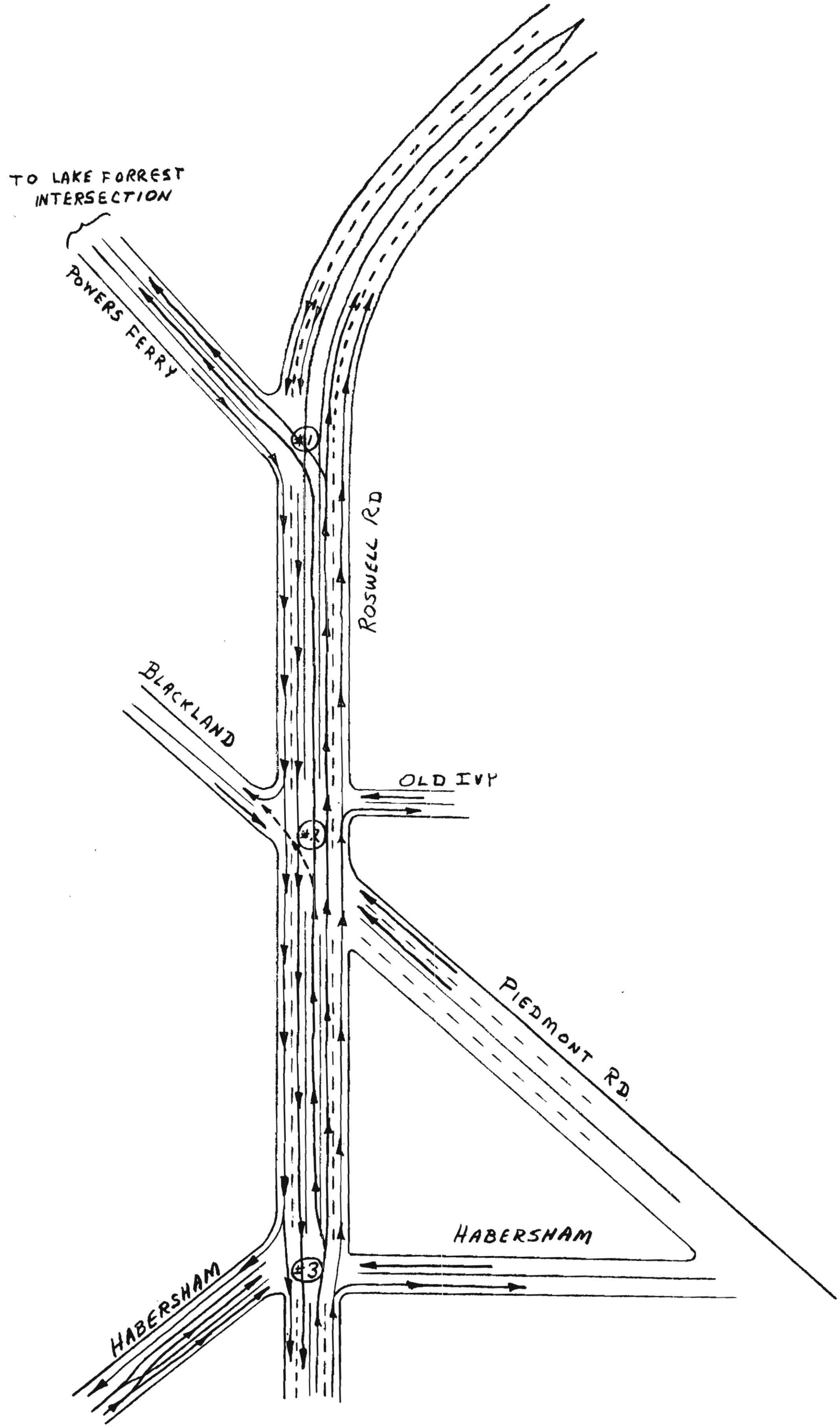

Figure C-8. Suggested Traffic Light Phases, Roswell-Piedmont Intersection (Phase II).

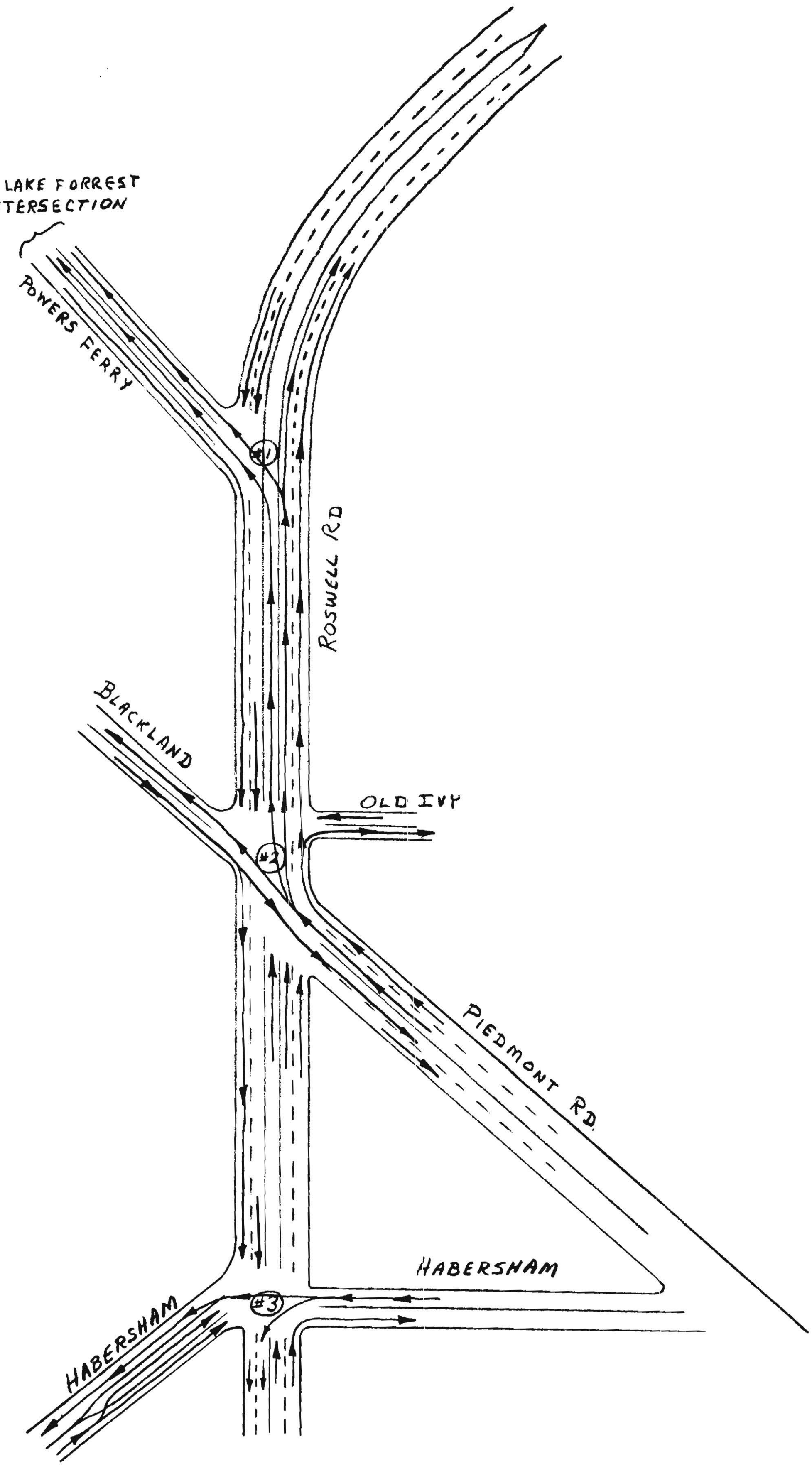

Figure C-9. Suggested Traffic Light Phases, Roswell-Piedmont Intersection (Phase III).

b. Southbound A.M. traffic from Powers Ferry Road can be "pumped" onto Roswell Road by appropriate utilization of the traffic lights #1 and #2. This can be accomplished in a manner similar to that described below in paragraph f for Habersham Road.

c. For northbound A.M. traffic on Roswell Road, three lanes are provided between Habersham and Piedmont Road. The inner lane is required to exit onto Blackland, westbound; the remaining two lanes are required to continue northward. Of these two remaining lanes, the inner lane may exit northbound onto Powers Ferry.

d. In Figure C-5, P.M. northbound traffic flow is depicted. Three northbound lanes are provided from Habersham to Powers Ferry Road. If a reversible lane is utilized on Powers Ferry between Roswell and the Putman-Lake Forrest intersection, then two through lanes can be provided (both A.M. and P.M.) for entering or exiting traffic on Powers Ferry Road.

e. In Figure C-6, normal usage of the interval on Roswell Road is depicted. This is similar to current usage.

f. In Figures C-7 through C-9, a possible traffic light sequence for P.M. traffic flow is indicated. Two-phase traffic lights are utilized. In Figure C-7, northbound traffic from Habersham is "loaded" onto Roswell Road between Habersham and Piedmont: i.e., between traffic lights #2 and #3. (This can be considered as a pumping action for northbound traffic from Habersham. It is assumed that this interval on Roswell Road has been vacated of any previous traffic by appropriate traffic light controls between traffic light #2 and #3.) Simultaneously, cross traffic between Blackland and Old Ivy Roads is accommodated at traffic light #2. Also, a leading left turn arrow for Powers Ferry will allow left turns onto Roswell Road, northbound.

f. In Figure C-8, northbound traffic on Roswell is released for northward flow onto Powers Ferry or on Roswell Road northbound. In Figure C-9, cross-traffic flow is depicted from Habersham westward, and from Piedmont Road westward or northward to Powers Ferry or Roswell Roads.

g. An 80 second cycle time can be utilized. For the P.M. peak period, northbound traffic on Roswell Road and on Piedmont Road can each obtain 30 seconds of green time. Based on stop-and-go acceleration times approximately 14 vehicles/lane can be accommodated on each cycle from each street. Thus, 28 vehicles from Piedmont Road and 28 vehicles from Roswell Road will be serviced once each cycle. This is equivalent to 1260 vehicles/hr/street. If the cycle time is increased to 100 seconds, and if 10 seconds of green time is added to each green time on Roswell Road and on Piedmont Road, then approximately 2016 vehicles/hr/street can be accommodated. Similar volume rates can be accommodated during the peak A.M. period.

4. Northside Drive

a. A suggested treatment for Northside Drive is shown in Figures C-10 through C-12, for the interval from I75 to 14th Street. This interval can currently support five lanes between I75 and the overpass for the Seaboard Coast Line Railroad (SCL). Southward from the SCL overpass, five lanes are possible, essentially, to Bishop Street. Southward from Bishop Street through the overpass for the SOU Railroad, four lanes are possible. Southward from the SOU overpass, five lanes are possible to the 14th Street intersection. Thereafter, Northside Drive provides six lanes of two-way traffic (three lanes in each direction).

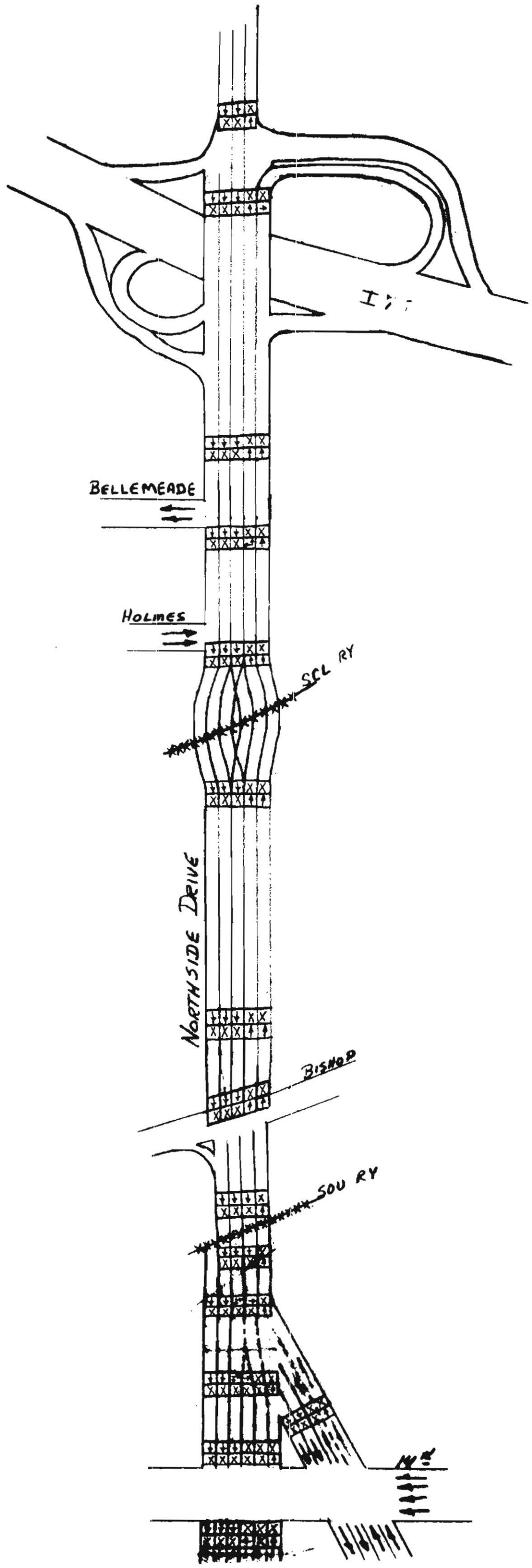

Figure C-10. Suggested Interval Treatment on Northside Drive, (Peak A.M. Period).

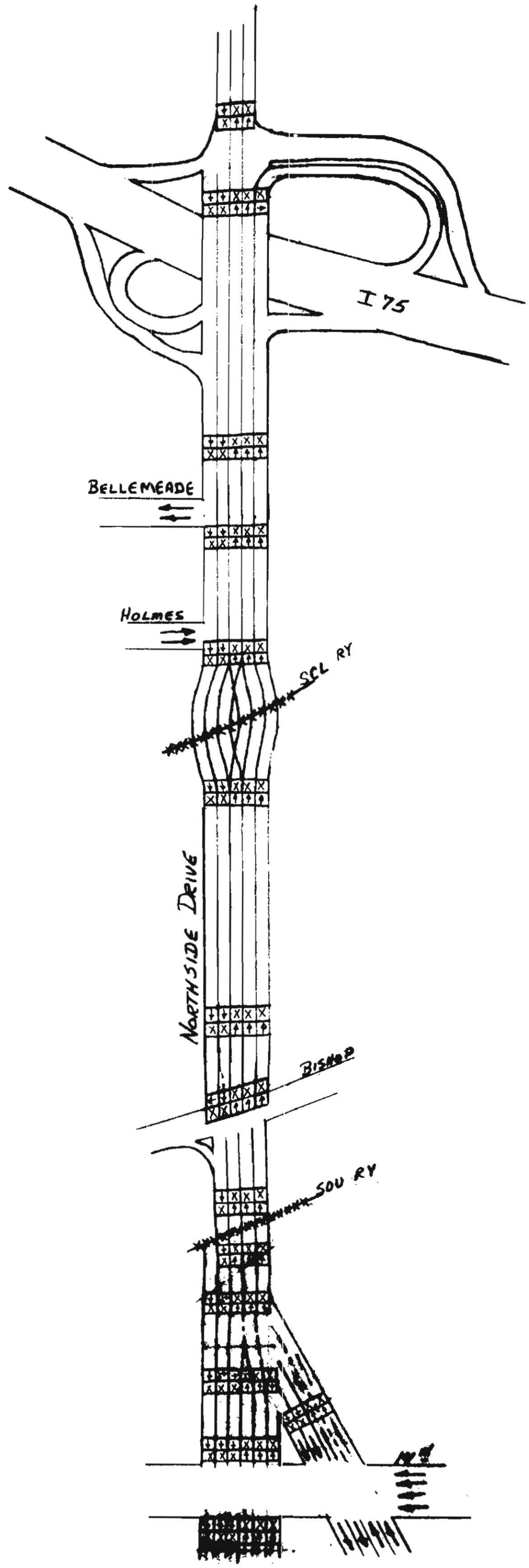

Figure C-11. Suggested Interval Treatment on Northside Drive, (Peak P.M. Period).

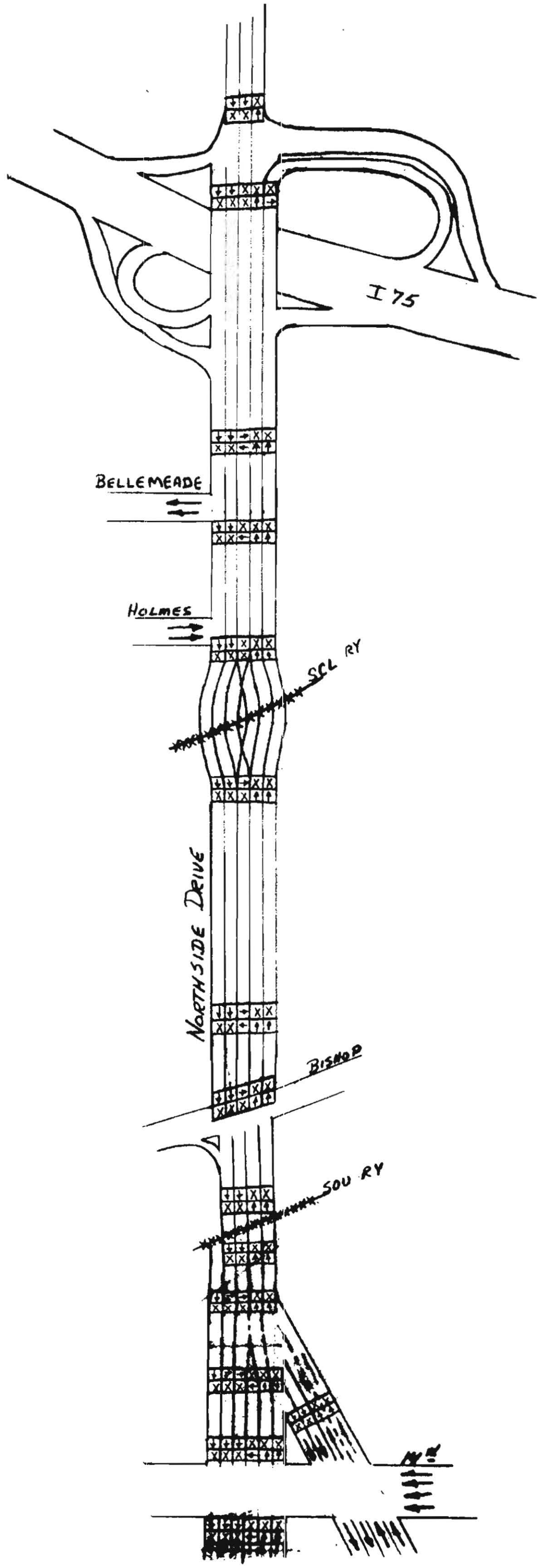

Figure C-12a. Suggested Interval Treatment on Northside Dirve, (Normal A.M. Period).

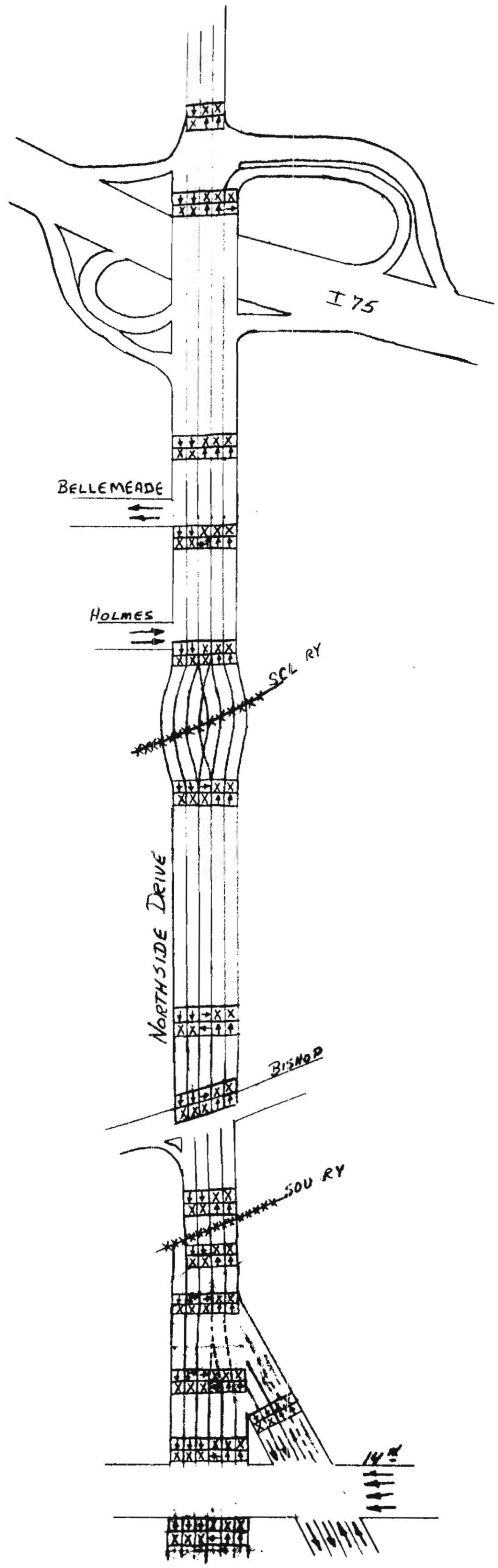

Figure 12b. Suggested Interval Treatment on Northside Drive, (Normal P.M. Period).

b. There currently exists a significant "bottleneck" in this interval both for A.M. and P.M. peak periods. With very minor reconstruction, five through lanes (center lane reversible) can be provided form I75 southward to Bishop Street. The reconstruction would amount to a very minor curb widening beneath the SCL overpass and a very minor widening of Northside Drive immediately north of Bishop Street, for approximately 200 feet.

(1) There presently exists 36' 10" between the structual supports on each side of the SCL overpass. The present distance between curbs is 26' 4". Therefore, the curb can be widened beneath the overpass to 30 ft. This amounts to a widening of each curb by 1' 10". There would remain ample protection space between each curb and the structual column supports, namely, 3' 5" between the curb and the structual columns.

(2) In this manner, three lanes can be provided beneath the overpass on each side as show in Figure C-10. A reversible lane would then allow three through-lanes from I75 to Bishop Street for both A.M. and P.M. peak periods.

c. In order to eliminate the peak period "bottleneck" in the vicinity of the 14th Street intersection, three through-lanes must also be provided from Bishop Street southward under the SOU railroad overpass to 14th Street. This can be accomplished by the use of two reversible lanes (i.e., the two center lanes). The remaining single lane for opposing traffic between Bishop Street and the Hemphill "Y" intersection can accommodate the current peak demands. Some stoppage of this opposing traffic is anticipated, but in no case will it be as drastic as the current stoppage for the principal peak period demands for the P.M. flow northward or the A.M. flow southward. In addition, a peak period time interval of only one hour to one and one-half hours could be utilized.

d. Additionally, the awkward lane change on Northside Drive at I75 would be eliminated. Of the five lanes provided south of I75, the center lane (reversible) would always "match" the corresponding center lane on Northside Drive, north of I75, with respect to traffic direction. Thus, no offset would be required for traffic moving through the area.

e. Finally, implementation of the above suggestions would provide the following:

(1) For A.M. peak period traffic (Figure C-10), three through-lanes would be provided on Northside Drive from I75 southward through the 14th Street intersection. The "extra" lane will accommodate an additional 1386 vehicles/hr (platoon flow at 30 mph with a cycle time of 100 seconds and a MSG equal to 70 seconds). Also, this extra lane would augment, considerably, the exiting A.M. traffic from I75 southbound.

(2) For P.M. peak period traffic (Figure C-11), three through-lanes would be provided for northbound traffic on Northside Drive through the 14th Street intersection and on northward to I75. At this intersection, the curb lane always would be required to exit onto I75 North. Since there is a significant volume of traffic (northbound on Northside Drive) which desires exit onto I75 North, the curb lane provides ample storage for these vehicles; the remaining two lanes would then exist

as through lanes, matching the two northbound lanes on Northside Drive, north of I75. Thus, P.M. traffic exiting onto I75 would not impede northbound traffic on Northside Drive, as it currently does.

(3) The traffic flow is indicated in Figure C-12(a) for the normal A.M. period and in Figure C-12(b) for the normal P.M. period. The center lane (south of the SCL Railroad overpass) is utilized as a dual left-turn and right-turn lane. North of the SCL Railroad overpass, the center lane would be utilized for left turns on to Bellemeade, because of the suggested one-way pair, Bellemeade and Holmes Road.

(4) If the traffic lights at the 14th Street and Bishop Street intersections are coordinated properly, a "pumping" action is also possible for northbound P.M. traffic from Hemphill and from 14th Streets. The major traffic demands occur from Northside Drive and from Hemphill Street. If the peak P.M. green time for Bishop Street is limited to 20 seconds (approximately 9 vehicles/lane/cycle), then smooth platoon flow can be accommodated on Northside Drive. Thus, a total cycle time of 100 seconds could allow 30 seconds MSG for Northside Drive, 30 seconds MSG for Hemphill Street, and 20 seconds for northbound traffic from 14th Street. With three lanes of northbound traffic available, these times would accommodate approximately the following vehicular volumes:

(a) 1512 vehicles/hr northbound from Northside Drive;

(b) 1008 vehicles/hr northbound from Hemphill;

(c) 648 vehicles/hr northbound from 14th Street;

(d) At the Bishop Street intersection, a total of approximately 4536 vehicles/hr could be accommodated. This assumes platoon flow at 30 mph for northbound traffic from Northside Drive and from Hemphill; the volume also assumes stoppage at Bishop Street for the northbound traffic from 14th Street. A volume rate of 2860 vehicles/hr can be accommodated on the two lanes of Northside Drive (north of I75), at 40 mph with 65% green time assumed for MSG at subsequent northern intersections.

5. Howell Mill Road

a. A suggested treatment for Howell Mill Road is shown in Figures C-13 through C-15 for the interval between White Street and Marietta Streets. This interval currently supports only one lane of through-traffic for each direction. However, the street width is quite adequate to support three lanes of traffic. Therefore, a reversible lane has been recommended.

b. The reversible lane should actually extend from the Marietta Street intersection northward at least to West Wesley. A possible flow plan for the A.M. peak period is shown in Figure C-13. Two through-lanes of southbound traffic can be accommodated. It is noted that the connector streets to Northside Drive, Holmes and Bellemeade, are shown as a one-way street pair. It is believed that this traffic flow plan will increase traffic flow in the area significantly.

c. A possible flow plan for the P.M. peak period is shown in Figure C-14. A normal flow plan is shown in Figure C-15. For the normal plan, the reversible lane is shown northbound. However, it should be utilized to favor the direction of the larger volume demand for work-day travel.

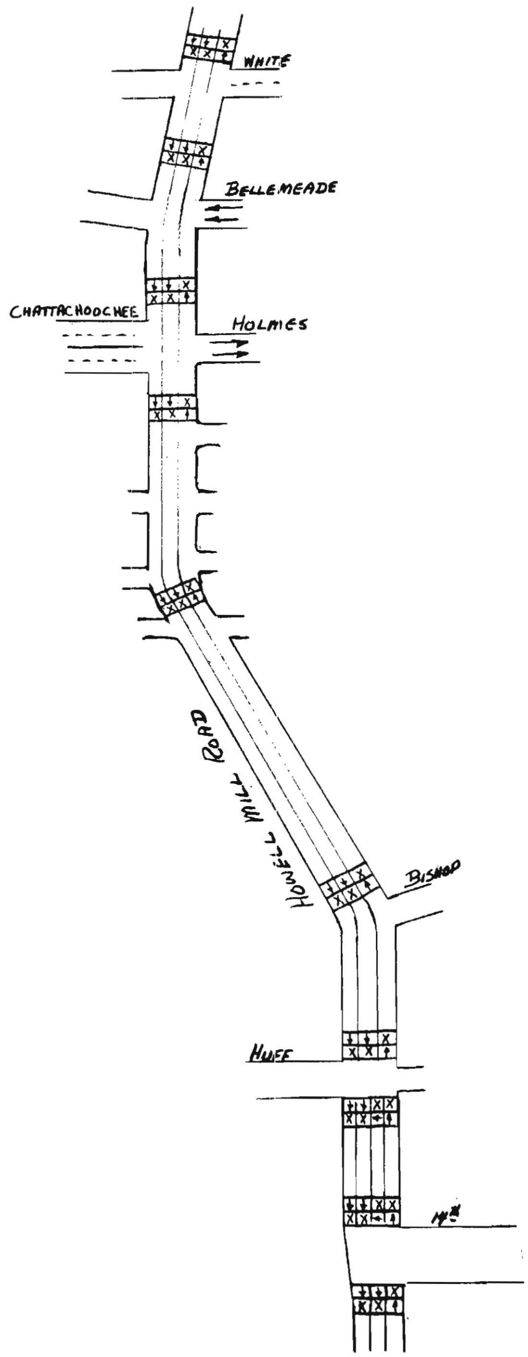

Figure C-13. Suggested Interval Treatment on Howell Mill Road, (Peak A.M. Period).

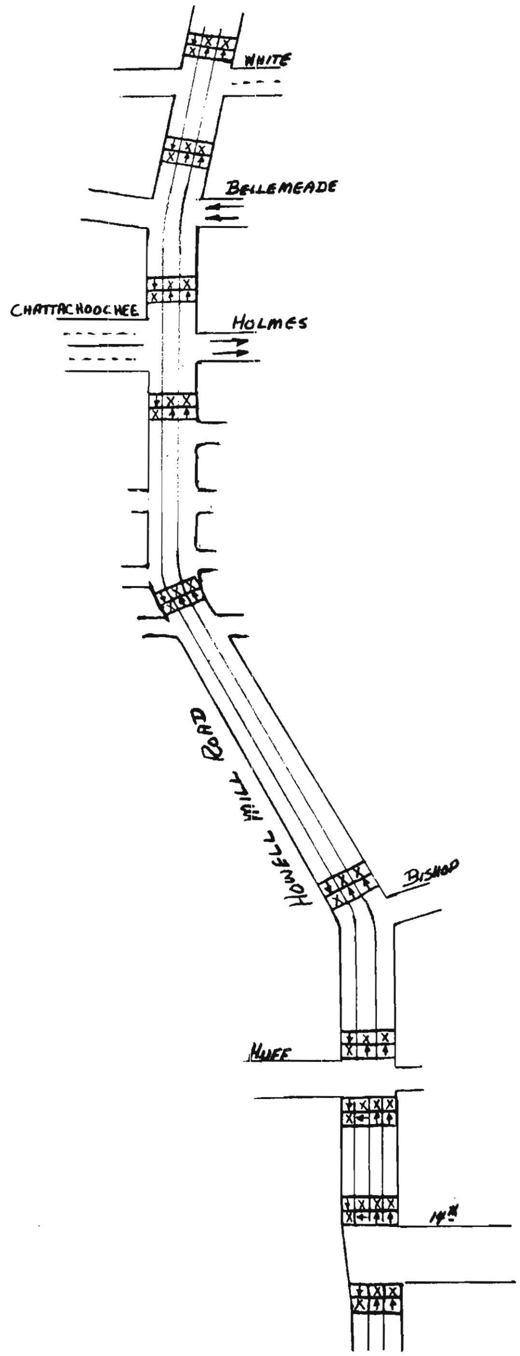

Figure C-14. Suggested Interval Treatment on Howell Mill Road, (Peak P.M. Period).

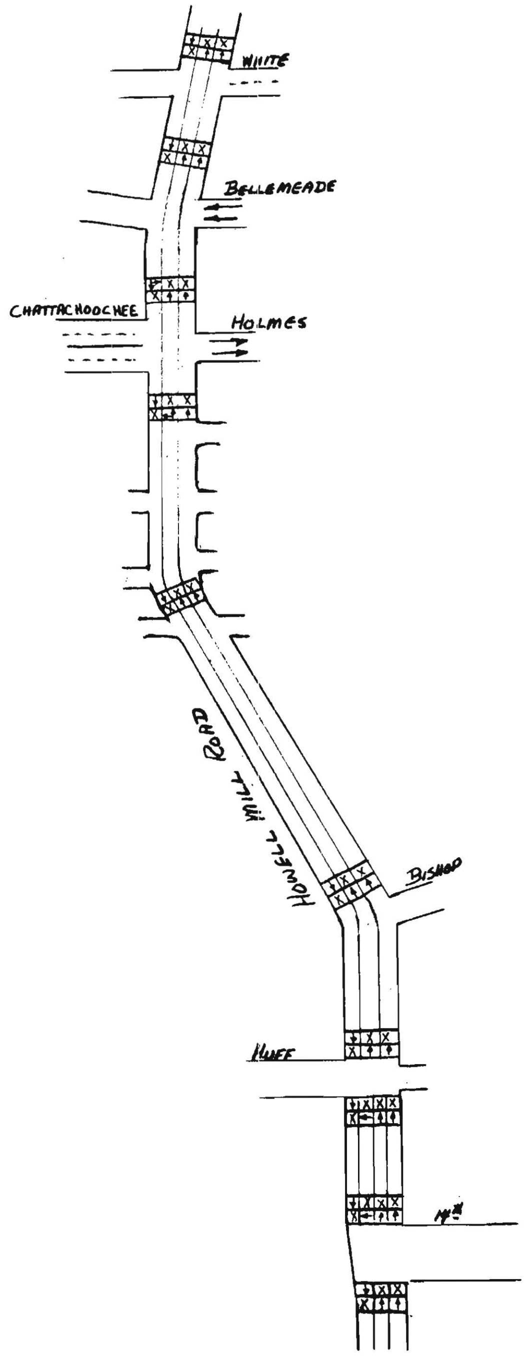

Figure C-15. Suggested Interval Treatment on Howell Mill Road, (Normal Periods).

C. Future Implementations

1. Widening of North Avenue

a. There is a considerable need for widening North Avenue between the Luckie Street intersection eastward to the Williams Street intersection. Currently, there are a total of four lanes in this interval. During Peak periods, including the noon hour, complete stoppage exists in this interval. North Avenue is the only existent east-west through artery in this section of the City. Relatively large volume demands exist not only in peak periods but throughout the work day.

b. The construction of two additional lanes from Williams Street westward to Techwood Drive can be accomplished with relative ease. The construction of two additional lanes from Techwood Drive westward to Luckie Street will require more planning, since some widening on both sides of North Avenue would be necessary. Some minor curvature of North Avenue and some small reduction in the existent sidewalk widths may be necessary. This has been discussed briefly with appropriate Georgia Tech personnel [31] and stands unofficially approved.

c. If the above implementation were accomplished, three through-lanes of east and westbound traffic can be accommodated on North Avenue from Luckie Street to Angier Avenue. (As has been mentioned, a reversible lane is also necessary on North Avenue between Peachtree and Juniper Streets in order that three lanes can be maintained for the peak A.M. or P.M. periods.

2. Northside Drive SOU Overpass

a. The vehicle capacity and volume rates on Northside Drive can be increased significantly in the interval from 14th Street to I75 by reconstruction of the SOU Railroad overpass. There currently exist five lanes on Northside Drive south of this overpass. Widening to five lanes on the north side of this overpass can be accomplished with relative ease to the current five lane juncture (approximately 200 feet north of the Bishop Street intersection).

b. Major reconstruction of the structural supports on the west side of the overpass will be necessary to accommodate 5 lanes beneath the overpass. This reconstruction is recommended.

3. Howell Mill Road SOU Bridge

a. The vehicle capacity and volume rates on Howell Mill Road can be increased significantly in the interval from Marietta Street northward to West Wesley Road by reconstruction of the SOU Railroad Bridge. This bridge will currently support three lanes of traffic. (Hence, the use of a reversible lane has been recommended on Howell Mill Road in the preceding Section.) This bridge could be widened to accommodate four lanes; then, with only minor widening (in intervals) along Howell Mill Road, four through lanes (10 foot width) could be utilized throughout the above mentioned interval.

b. This reconstruction is, therefore, recommended. Howell Mill Road would then be utilized as a major artery to the northwestern area of the City.

4. Bridge connector between Palisades Road and Armour Drive

a. A bridge could be constructed across the creek between Palisades Road and Armour Drive. Such a bridge would facilitate circulating traffic in this area. Thus, it would not be necessary for east or west bound (cross-town) traffic in the area to pass through the Brookwood area of Peachtree Road.

b. This construction is, therefore, recommended

5. Bridge connector between Brighton Road and Virginia Place

a. A bridge could be constructed across the creek and the SCL Railroad between Brighton Road and Virginia Place. Such a bridge should greatly facilitate cross-town traffic in the area. Thus, it would not be necessary for east or westbound traffic in the area to pass through either the Brookwood area of Peachtree Road or the Piedmont-Cheshire Bridge intersection. Cross-traffic from Collier Road towards the east and northeast would be facilitated also.

b. This construction is, therefore, recommended.

6. Widening of Peachtree Road

a. The seven lanes on Peachtree Road (between Deering Road and the I85 northbound ramps) should be extended to the Spring Street intersection. The extension length is approximately 500 feet. This extension would facilitate the full utilization of all seven lanes in this interval.

b. In Figures C-16 through C-18, the suggested lane markings are indicated, respectively, for the peak A.M. and P.M. periods and the normal period.

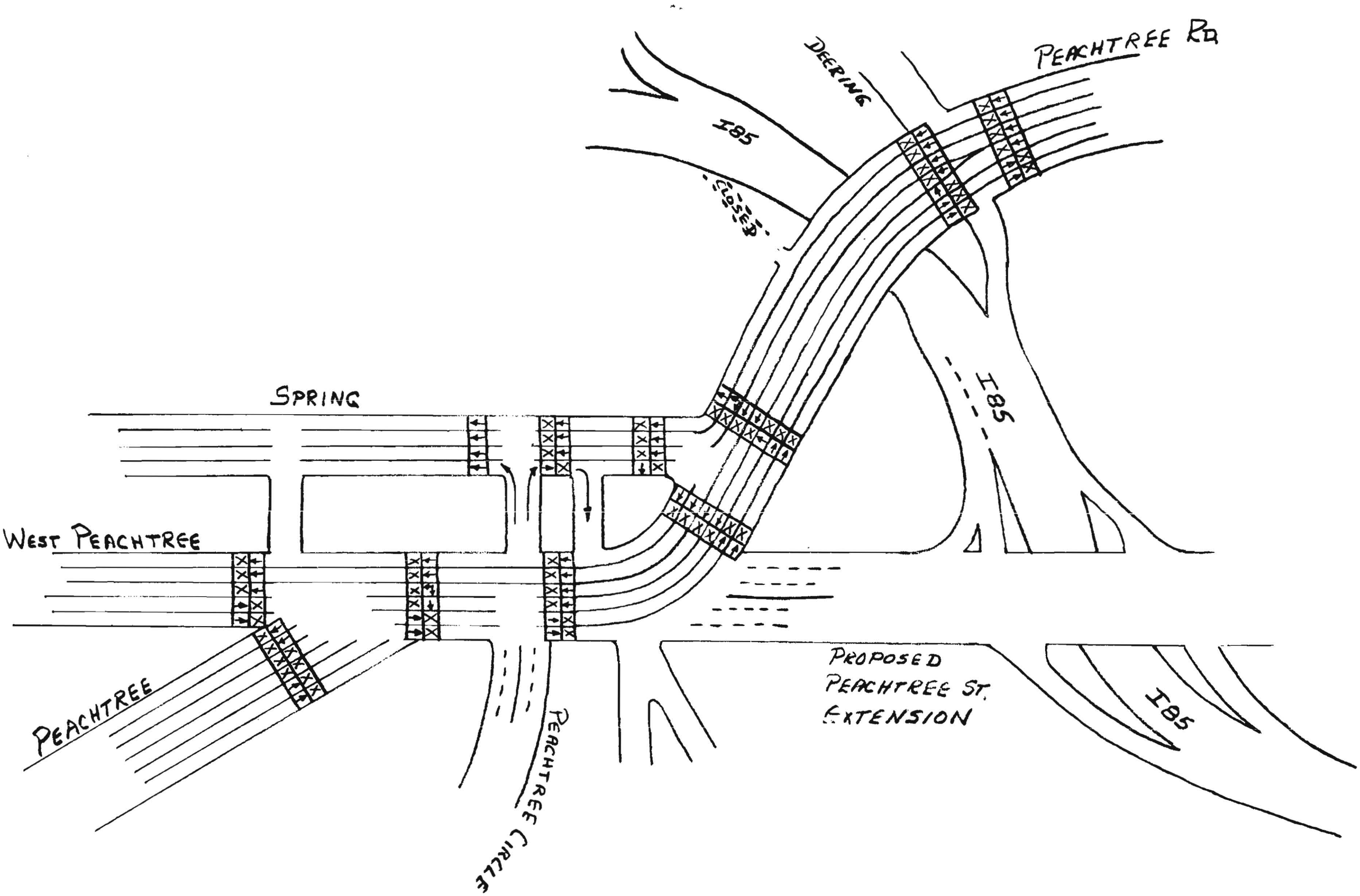

Figure C-16. Suggested Lane Control for Widened Peachtree Road, Brookwood-Pershing Point Area, (Peak A.M. Period).

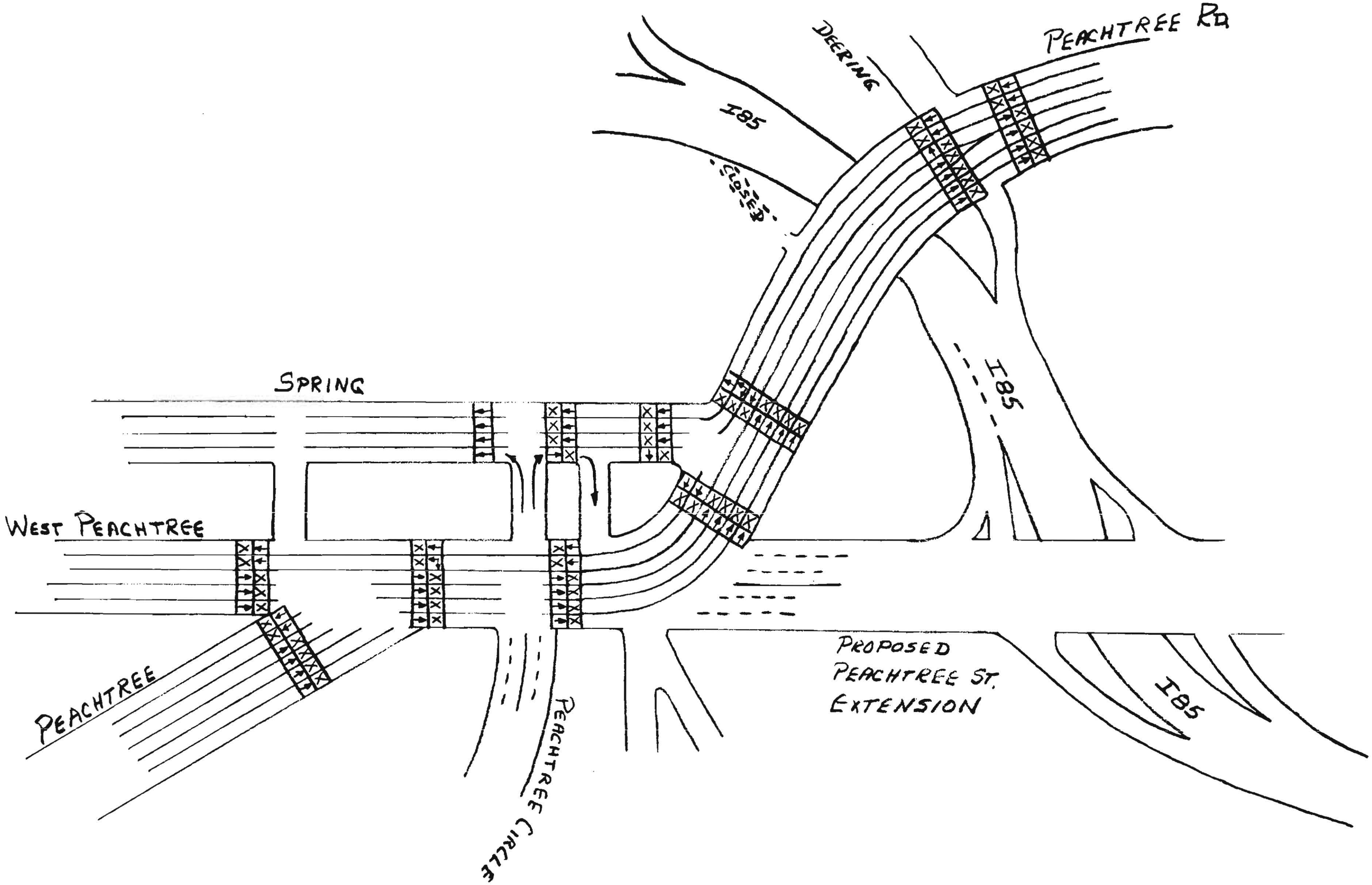

Figure 17. Suggested Lane Control for Widened Peachtree Road, Brookwood-Pershing Point Area, (Peak P.M. Period).

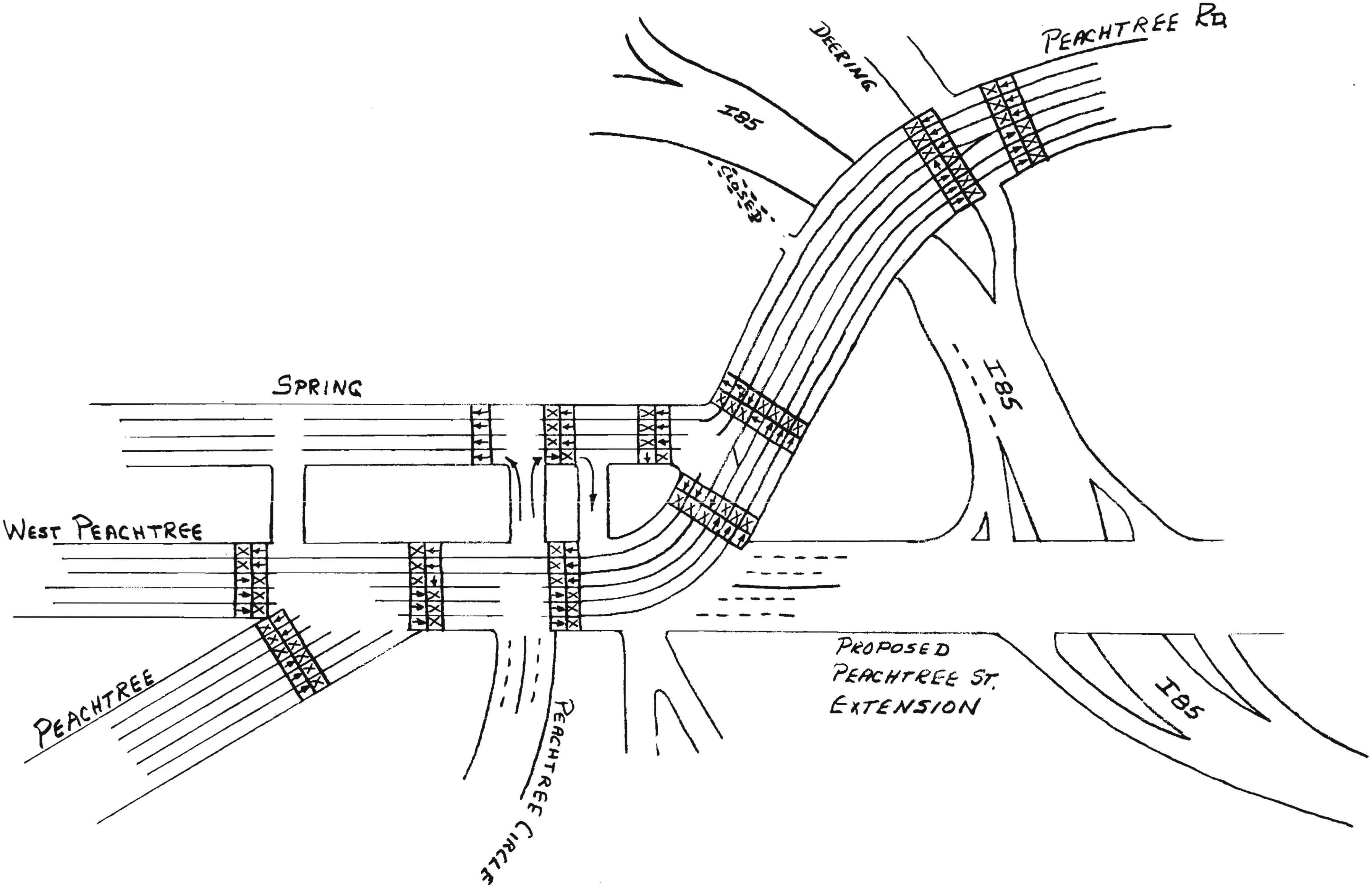

Figure 18. Suggested Lane Control for Widened Peachtree Road, Brookwood-Pershing Point Area, (Normal Periods), and Suggested Interchange of Peachtree Extension With I85.

7. Arterial Connector from Pershing Point northward to Piedmont Road

a. A major artery is needed as a connector from the Pershing Point area of Peachtree Road northward. It is understood that this connector has been proposed. It is to extend northward (in line with West Peachtree Street) across I85 to the SOU Railroad; thence, it is to extend northeast along the railroad to connect with Piedmont Road at the extension of Marian Road.

b. It is believed that such an artery would greatly facilitate traffic flow to and from the northeast side of the City. Past measurements[33] indicated that approximately 80% of the current north-south traffic has terminal points northeast of Peachtree Road. Therefore, such a connector should accommodate large volumes of traffic. Also, it should significantly reduce future volume demands on Peachtree and Piedmont Roads. Thus, it would be anticipated that some of the traffic congestion problems in the Brookwood area on Peachtree Road and the Piedmont-Cheshire Bridge and the Piedmont-Lindbergh intersections would be alleviated.

c. It is believed that these reasons justify a principal priority for the construction of this proposed connector. Further, this connector, together with an appropriate interchange with I85, can be constructed without waiting for completion of a new interchange between I75 and I85 at Brookwood or without waiting for completion of the proposed Freeway extension from I75-85 westward and southward to the western part of the City.

d. A suggested interchange for this connector is shown in the previous Figure C-18. There appears to exist sufficient right-of-way for entrance and exit ramps for I85. Thus, a deceleration lane could be provided for I85 northbound exit traffic to this connector for access to Peachtree Road, either northbound or southbound. Thus, the current I85 northbound exits to Peachtree Road could be closed. This should eliminate the slow-down presently experienced in this area for I85 northbound traffic. Entrance and exit of I85 southbound traffic could be accomplished on the north side of the connector overpass.

e. It is argued that the connector and its interchange with I85 do not have to be established as an integral part of any proposed new interchange at Brookwood between I75-85 or other proposed Freeways. At least two reasons are evident:

(1) All north and southbound traffic on the proposed connector can be accommodated by West Peachtree Street (southbound, three or four lanes) or by Peachtree Street (northbound, four lanes).

(2) All north and southbound traffic on I85 can readily access this proposed connector or Peachtree Road, without the need for utilization of any other exchange(s) in the Brookwood area.

8. Suggested Expressway Modifications

a. Several proposals have been submitted [15,30] for existent expressway modifications. It is believed that the suggestions concerning the Williams Street entrance ramp (northbound) are of principal importance. It is agreed [15] that the Williams Street ramp should not be provided with an exclusive expressway lane. In spite of comments to the contrary, there does not appear to be a sufficiently large volume demand (even during the peak P.M. period) to warrant an exclusive expressway lane for this street. This statement can be justified when the volume ratio is considered between the volume demands from northbound P.M. expressway traffic and the volume demands from northbound Williams Street traffic.

b. It is of principal importance that three through-lanes of northbound traffic be provided on the expressway in this interval. Currently, the exit lane to North Avenue is essentially useless for a traffic handling capability: there does not exist a sufficient volume demand for this exit traffic. Therefore, this lane is essentially useless, immediately south of the exit. Also, lane changing is necessitated on the expressway south of this exit .

c. It has been stated that the Williams Street ramp cannot be utilized successfully or safely as an entrance ramp, for instance, similar to those at North Avenue, 10th Street and 14th Street. The reasons are stated as follows:

(1) There would exist a safety hazard for entering traffic (from Williams Street) because of the proximity to the curve on I75-85 northbound.

(2) There would exist an insufficient acceleration distance for the Williams Street ramp.

d. It is believed, that both of the above reasons are incorrect. There would exist at least 500 feet of unobstructed sight along the entrance lane (western lane) of I75-85 northbound. At 50 mph, this amounts to approximately 7 seconds of response time for initiation of any necessary stoppage of slow-down on I75-85 northbound. In addition, the present, rather awkward lane curvatures for the two through-lanes on I75-85 would be eliminated. In this regard, an appreciable safety hazard would be eliminated,[15] particularly for northbound tractor-trailer units on I75-85.

e. The actual space available for an acceleration lane for the Williams Street ramp is greater than currently exists for all other entrance ramps in this area. In addition, a parallel angle of entry is possible.

f. From the above discussions, it is concluded, therefore, that the State's recommended treatment [15] for the Williams Street ramp is an excellent suggestion.

APPENDIX D

PROPOSED AUTOMATED COMMUNICATION LINKS

A. General

1. This appendix describes a proposed system for the operation of communication links between a digital computer facility (for an automated traffic control system) and remote devices (local controllers and vehicle detectors). In current automated installations, a separate (private) communication line is utilized for information transfer (commands and responses) between the digital facility and the remote devices. Each communication line from the computer to each individual controller or detector comprises a communication link (or channel of communication).

2. The system proposed herein utilizes a single communication line (two-wire pair, for instance) to provide several communication links (or channels) to several different remote devices. Essentially, several remote devices (controllers and/or detectors) are connected in series (or in tandem) along a two-wire communication line. Therefore, the number of different communication lines which are currently required in an automated traffic control system can be reduced significantly.

B. Communication Links and Information Bits

1. Information theory relates to the process of communications. For traffic control systems, the specific information to be communicated relates either to the computer commands to each controller or the responses from each controller and from each vehicle detector. The amount of required information which must be transferred is small. Therefore, the communication system can be rather simple.

2. Generally, the elements of communication may be words, sounds, frequencies, electrical voltage levels, light intensity levels, etc. Various symbols may be used to construct communication elements, such as letters for words, etc. For information transfer, however, there are information units which comprise the basic intelligence from which the symbols and words may be constructed. The devices which recognize and assemble (or de-assemble) the information units are referred to as decoders (or encoders). As such, these devices are not of interest at the moment.

3. The information unit of interest in this appendix is the "bit." (The term derives from a binary digit.) A bit has two states and may be defined by a choice of two equiprobable events. For instance, a voltage pulse of +1 volt or -1 volt could be utilized as a bit. For subsequent usage in these discussions, a bit will be specified by one of two values, i.e., 0 or 1. The symbol "1" means that the bit is present; the symbol "0" means that the bit is absent. Thus, the presence or absence of a bit can convey two states of information.

4. Communication lines, decoder and encoder equipments, etc., have characteristics which limit their capacity for handling intelligible rates of information transfer. A voice-grade telephone line, for instance, can accommodate 1200 bits/second for short distances. (For longer distances, other associated equipments are usually necessary to compensate for line losses, crosstalk, dispersion, etc.) For essentially error-free communication links between a digital computer and the local controller, therefore, the kind of information bit to be used and the bit rates need to be examined carefully. This is particularly true when a two-wire pair must accommodate several communication links. Moreover, the system must not be complex. Otherwise, the

costs of the associated decoder and encoder equipments will be large. This, in turn, will negate the cost savings to be realized from the use of a smaller number of communication lines.

C. Proposed Bit Transfer Scheme

1. In a traffic control system, a command to a local controller could be comprised of a voltage pulse (placed on the communication line) which activates the drum solenoid of a dial controller and thereby causes the controller to advance to the next phase (see text, Chapter IV, Section B for dial controller operation). If several different local controllers were to be instructed in this manner (via the same communication line), several different pulses would be required (one for each controller). In addition, some unique means of associating a given pulse with the appropriate controller must be devised. For a series of pulses on the same line, pulse dispersion must be considered also. (Pulse dispersion can be considered as pulse degradation, whereby pulses may become "washed-out" or "spread-out," such that distinction between different pulses becomes difficult.)

2. Finally, if voltage pulses were to be used, the sequence of events and actual information transferred must be considered carefully. For a given controller which is already in synchronization with the system, a single pulse could be utilized to command a stepping of the controller to the next phase; also, a single pulse could be utilized (coming from the controller) to indicate that the command had, in fact, been obeyed. However, if malfunctions occur, it may be necessary to know the <u>state</u> of the local controller. Thus, a single pulse cannot convey this information. A different kind of pulse would be necessary for each different state of the controller, in order to

convey this type of information. If there were 16 different intervals possible within one time cycle of a local controller, then a representation of the particular, existent state of a local controller would require one of sixteen different kinds of pulses. If several controllers are to be instructed on a two-wire pair, and if each controller is to be instructed at least once every few seconds, there is not sufficient "room" for all of the different kinds of pulses to be placed on the line (together with an error-free detection capability) within an allotted time of one or two seconds. (This approach is not beyond the capabilities of the state-of-the-art. It is considered to be too complex, too costly, and rather inefficient.)

3. For the above reasons, it is believed that information bits for traffic control should not be comprised of voltage pulses. (This statement is particularly true for a single communication line which is to service several communication links.) On the other hand, an information bit could be composed of a "burst" (or interval) of some specified electrical frequency. For instance, one cycle of a 2 kHz sine wave might be used. (2 kHz means two thousand cycles per second.) The presence of the information bit (bit value = 1) would be indicated by the presence of the single cycle of a 2 kHz wave; the absence of the information bit (bit value = 0), would be indicated by the absence of the single cycle of a 2 kHz wave. The real time occuppied by one cycle of 2 kHz is five hundred millionths of a second (500 microseconds). If each bit were separated by an equal interval of time (for detection purposes), then one bit of information would require 2 x 500 microseconds of time (= 1 milisecond). Thus, 1000 bits of information could be conveyed in 1 second. If each controller required sixteen different commands, then approximately 62 controllers might be serviced on a single two-wire line within one second.

4. Unfortunately, encoding and decoding equipment for one cycle of 2 kHz is not very practical. The number of cycles of a 2 kHz wave could be increased, for instance, to 55 cycles. (Commercial tone decoders are available which can detect this "pulse" of a 2 kHz wave.) Then, 27.5 miliseconds would be required per information bit. If a bit spacing of 3.7 miliseconds were assumed, then 32 different information bits could be transferred each second. However, if one information bit were required for each command, and if 16 different commands were required for each controller, then only two controllers could be serviced.

5. The manner described above in paragraphs 3 and 4 for the utilization of information bits, however, is inefficient. Bit order or bit pattern can also be utilized and a significantly larger amount of information can be conveyed. Generally in the binary system, the amount of information which can be conveyed by n bits is 2^n. This value represents the number of different combinations possible for n bits. Thus, if the bit pattern is recognized, 3 bits could convey as many as 8 states, illustrated as follows: 0 0 0; 0 0 1; 0 1 0; 0 1 1; 1 0 0; 1 0 1; 1 1 0; and 1 1 1. Therefore, five bits in a bit pattern might suffice for all commands to a local controller. Also, five bits might suffice to describe all possible states of the local controller. Finally, since five bits can represent the maximum number of 32 (= 2^5), the data output from a vehicle detector can also be represented. (For a line of vehicles traveling at 60 mph, a vehicle detector will be actuated no more than 4 times every 1.59 seconds, based on 2 actuations per vehicle with a minimum-safe separation distance of 140 feet.)

6. Commercial tone decoders are available (~$20) which can detect a single tone and cause a relay closure. These units appear to require a response time (time for sensing the tone to be detected) which is equivalent to fifty-five or sixty complete cycles of the tone frequency being detected. For a 2 kHz wave, this response time would amount to 30 miliseconds. Therefore, with one bit being represented by 60 cycles of a 2 kHz wave and with a 10 milisecond spacing between bits, five bits would occupy 200 miliseconds. Thus, 5 local controllers might be serviced on a two-wire pair communication line. Actually, other procedures are possible which appear to be more efficient and at the same time may be less expensive. Such a system is described in the following paragraphs.

7. At the computer facility, a circuit is provided which will generate a synchronization pulse at a repetition rate of one per second. For instance, the pulse could consist of sixty cycles of a 3 kHz wave. The computer commands for each individual controller can be provided by a pattern of six information bits; for instance, each bit can be in the form of eight cycles of a 4 kHz wave. Thus, each bit initially would occupy 2 miliseconds of time. If each bit were spaced by a 3 milisecond time interval, then six bits would occupy 30 miliseconds of time. The circuitry provided at the computer facility places the synch pulse and the groups of six information bits (commands) on a two-wire communication line. In one second there are 1000 miliseconds. With a synch pulse of 20 miliseconds, therefore, approximately 32 time slots can be provided in the remaining 980 miliseconds. Each time slot represents a "space" for any computer command to a given controller. Thus, 32 controllers could be instructed from a two-wire line.

8. Each local controller on a communication line would be designated by a number from 1 to 32. Within each controller, there would be provided a correspondingly numbered sensor circuit. The sensor circuit detects the synch pulse, and time measurement is initiated by an internal counting circuit. For instance, if the controller were #5, any commands to the controller would be contained in the fifth time slot after the synch pulse. Therefore, the counting circuit counts 120 miliseconds (4 x 30 miliseconds) and opens an electronic gate. The information contained in the fifth time slot (6 bits) can then be detected via the electronic gate. A simple procedure for both detection and bit pattern recognition is described as follows.

a. The same counting circuit (or a different counting circuit) can initiate time measurement at the beginning of the electronic gate (which is at the beginning of the fifth time slot in the present example). This time measurement is a complished by counting; each subsequent 5 milisecond period is measured, and a different electronic gate is opened for each 5 milisecond time period.

b. Since the command information is contained in a six bit pattern, and since each information bit occurs sequentially in each 5 milisecond time interval, each particular bit value can be transferred to separate circuits (via one of the six 5 milisecond electronic gates).

c. Each of the values of the bits (which now exist in separate circuits) can be detected also by simple counting circuits. Ideally, if eight cycles of a 4 kHz wave were transmitted from the computer facility for a particular bit, all eight cycles could be detected simply by means of a counting circuit which counted the eight cycles. If eight cycles were not present (or were not counted), the counting circuit would not "detect" (or indicate to other circuits) the 4 kHz wave. Thus, the bit value of 0 would be assumed. On the other hand, if detection were made, the bit value of 1 would be assumed.

d. Line losses, dispersion, etc., will probably degenerate the bit or eight cycle "burst" of the 4 kHz wave considerably. However, in actual practice, it would not be necessary to "detect" all eight cycles of the 4 kHz wave. Actually, all that is needed is an indication of the presence or absence of the wave. Therefore, the counting circuit needs to count only a few cycles (perhaps, four cycles) of the 4 kHz wave in order to verify its presence or absence. (The actual number of cycles which need to be counted would depend primarily on line noise and the probability that four or five noise spikes would occur in a sequence of 250 microsecond time intervals, such that the noise spikes would be "counted" as cycles of the 4 kHz wave.)

9. As described above in paragraph 8, the values of the six bits for each local controller can be detected in their proper order or bit pattern. Thus, the internal electronic circuits would be sequentially activated and controlled by the bit pattern. This sequence of events can be envisioned on a much longer time scale (slower speed) by the interaction of a sequence of relays. Thus, if #1 relay is activated and closes, the #2 relay is allowed to be closed if it is subsequently activated. On the other hand, if #1 relay is not activated, then #3 relay is allowed to be closed if it is subsequently activated, but #2 relay is not allowed to be closed whether it is activated or not.

10. The preceding paragraphs describe a possible means for a digital computer facility to provide unique instructions to each local controller. It is also desirable that each local controller response to a command be verified. If the only information desired is the fact that a given local

controller has responded to a previous command, this information can be conveyed by a single bit (bit value = 1). This bit would be placed on the communication line in the appropriate time shot for the given local controller, during the successive 1 second time interval. Thus, the verification of commands to a local controller (or the inputing of vehicle detector data to the computer) can be described as follows.

a. Computer commands are placed on the line in the appropriate time slots following a given synch pulse. The local controller responses (or existent states) and/or local detector data are placed on the line in the appropriate time slots following the successive synch pulse. Thus, computer commands can be initiated once every two seconds. The controller responses (and detector data) can be furnished once every two seconds. The two different sets of data occur alternately, once each second.

b. The same kind of synch pulse (3 kHz) or a different kind (2 kHz, for instance) could be utilized to initiate the counting circuits in the sensors in each local controller and/or detector. For instance, for #5 local controller, the counting circuit would count to the fifth time slot, 120 miliseconds after the synch pulse (4 x 30 miliseconds). At this time, the electronic gate could simply "dump" on the line the desired information. Thus, if only the verification of response to a previous command is desired, eight cycles of a 4 kHz wave could be placed on the line. This represents a bit value of 1 in the fifth time slot and signifies response to a previous command (the command having occurred during the previous 1 second synch pulse interval). On the other hand, if the existent state of the local controller were desired, this information could be "dumped" in exactly the same sequence from the electronic gates which previously detected the command. For instance, it is assumed that the previous command from the computer instructed the complete state which was desired for the local controller; if the state has been accomplished, the information bits for the original command can be returned to the computer as a verification.

11. In the sensor circuit for each local controller, the utilization of counting and gating circuits may be questioned with respect to accuracy, cost, etc. Actually, the state-of-the-art for solid state devices of these types is well established. Excellent stability is available at speeds greater than those required for traffic control mechanisms. Such circuits for mili-second time intervals are readily available with accuracies of 0.1 milisecond and costs are only a few dollars. It is estimated that the proper integration of such circuits into an appropriate operating package would cost less than $300.

D. Proposed Information Transfer Scheme

1. In the following discussions, the position of a bit is indicated by a square symbol □. The value of the bit will be 1 or 0. The bit sequence is determined by the position or order of the bit. For instance, in a sequence of four bits, as

□ □ □ □

the first bit, second bit, etc. are the first, second, etc. positions, as

$\boxed{1}$ $\boxed{2}$ $\boxed{3}$ $\boxed{4}$

(The numbers in the squares must not be taken as bit values. Rather they simply indicate the bit position with respect to time. The first bit precedes the second bit which precedes the third bit, etc.)

2. As an example, simple computer commands can be established as follows (three bits are assumed):

a. On- and off-line control can be instructed by the first bit in the sequence:

□ □ □	←	bit positions
0 □ □	→	controller goes to (or remains) off-line
1 □ □	→	controller goes to (or remains) on-line

b. Main street green or red can be instructed by the second bit in the sequence:

1 0 □	→	controller goes to MSG
1 1 □	→	controller goes to MSR

c. An emergency condition can be instructed by the third bit in the sequence:

□ □ 0	→	signifies normal operation. Thus,

item b above would actually appear in an operating bit stream as

1 0 0	→	controller goes to MSG
1 1 0	→	controller goes to MSR.

On the other hand, the emergency condition can be indicated by the value 1 for the third bit as

□ □ 1	→	signifies emergency operation. Thus,

item b above would appear as follows for emergency vehicle operation:

1 0 1	→	controller flashes rapid green on main street (and red on side street)
1 1 1	→	controller flashes rapid red on main street (and green on side street)

3. The emergency indication suggested in paragraph 2c above is an adaptation from the Charleston installation. Thus, a local controller can be made rapid flashing green on the main street (rapid flashing red on the side street) when the emergency vehicle is expected to proceed along the main street. Vehicles on the main street are thus forewarned to provide passageway; vehicles on the side street are forewarned that an emergency vehicle is proceeding across their street at the intersection. The converse would be true for an emergency vehicle proceeding on the side street, where a rapid flashing green would appear on the side street.

4. Response information from the local controller can be conveyed by three bits in a simple system. An example is given as follows:

0	□	□	→	local controller is off-line
1	□	□	→	local controller is on-line
1	0	0	→	local controller is on-line on MSG (no emergency is indicated by third bit value of 0)
1	1	0	→	Local controller is on-line on MSR (no emergency is indicated by third bit value of 0)
1	0	1	→	local controller is on-line, in emergency condition, rapid green flash on main street (rapid red flash on side street)
1	1	1	→	local controller is on-line, in emergency condition, rapid red flash on main street (rapid green flash on side street)

5. At a given intersection, other phases may be desired. For instance, leading left-turn arrows, separate pedestrian walk signals, or a three-phase light may exist. More bits of information will be necessary to command these various phases as well as detect their states. However, five or six bits

will adequately handle these situations. For instance, for a five bit stream there will be 4 bits available for control functions, if the first bit is utilized for on- and off-line control (as indicated above in paragraphs 3 and 4). Thus, 2^4 will allow 16 separate functions. For a six bit stream, 5 bits would be available, and 2^5 would allow 32 separate functions.

6. It should be noted that if the controllers were operated in a simple system (as illustrated above in paragraphs 3 and 4), it would appear that 3 bits are sufficient. If this were the case, the arguments given in the previous section would indicate that perhaps as many as 64 local controllers could be operated on a two-wire communication line. If the emergency vehicle function were not needed, then 2 bits would be sufficient. As a result, as many as 98 different controllers might be serviced on a two-wire communication line. This latter characteristic would be particularly attractive along arterial routes such as Peachtree Road.

7. Finally, it should be noted that the proposed communication system is not particularly sensitive to line losses, dispersion, etc. Phase shifts and amplitude attenuations of the eight cycles of the 4 kHz wave (bit) are not critical, so long as sufficient amplitude remains for detection and so long as one bit does not produce detectable information in an adjacent bit time interval. This also means that simple communication line amplifiers can be utilized where they are needed for longer distances.