Commercial Highway Service Districts And the Interstate

Their Proper Relationship in an Urban Setting

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A method is suggested by which local officials can better guide land-use development opportunities available as a result of Interstate highway construction. The question of location near interchanges of commercial highway service districts is examined from the point of view of interchange function and design, traffic conditions, user costs and land-use environment. Indices are suggested to guide decisions on locating service districts. A method for determining the amount of land that should be made available in service districts for highway-oriented uses is presented. This method is based on the assumption that there exists a relationship between the amount of land for highway-oriented uses and the volume of traffic associated with arterial streets serving such uses. An association through time was made along selected arterial strips and yielded a correlation coefficient of 0.81. Also demonstrated are the differences in land development occurring when highway-oriented land-use planning principles are recognized and followed or when they are ignored.

•IMPACT IS a totally overworked term in the jargon of the Interstate highway researcher today. Conversely, the work opportunity has not been sufficiently used. How many times has the question been asked, "What impact will the Interstate have in my community?"

Actually the Interstate per se will have absolutely no impact on urban communities. What does occur is that a range of opportunities are available to urban communities because Interstates are located within them. However, the actual effect or impact which results is directly dependent on the policies of the local community toward this transportation media. If a community seeks to make optimum use of the opportunities as a stimulus for guiding carefully conceived land-use development plans, then beneficial accomplishment of broad community goals will result. If, however, the community looks with a jaundiced eye at the Interstate and fails to take responsible interest in its ultimate development, then indeed trying days are ahead for that community.

A major question facing urban America today is whether or not local officials and agencies will assume this responsible interest. Emphasis must be placed on the responsible role which local officials must play in the unfurling drama of our developing Interstate Highway System. The role I refer to is not the harassment of state and Federal officials for additional design features or schedule changes, but is the preparation of sensible land-use development plans for those areas immediately adjacent to the new

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highway facilities. Naturally, these plans should become an integral part of the community's overall plan. In addition, the local officials are also responsible for developing and adopting the appropriate land-use controls which will systematically guide the orderly implementation of land-use development while protecting effective and efficient movement of traffic between the Interstate and local street systems.

The immediate focus of the problem inherent in relationships between land-use development and traffic movement lies within those confined areas where arterial streets function as mediators or adaptors between the high-capacity Interstate system and the local urban street system. The reason for the problem is that land uses are not alike in their generation or attraction of trip movements. In fact the range of differences is drastic. The following information developed for land uses in the Duluth study sharply focuses this statement (1):

1. Residential uses produced 6 to 10 vehicle trips per dwelling unit per day.
2. Industrial uses produced 20 to 30 vehicle trips per acre per day.
3. Highway-oriented uses produced 200 to several thousand vehicle trips per acre per day.

As development increases around interchanges, the traffic on the Interstate and the intersecting arterials increases; thus, the vehicular capacity of the interchange area becomes more critical. It is obvious that the location of highway-oriented uses will aggravate this situation far more than most other uses. It is also obvious that the highway-oriented uses greatly desire such locations. It is inherent to their very nature that they locate in response to the presence of large traffic volumes.

This point is effectively brought out in a study carried on along a major circumferential highway in the Twin Cities (Minneapolis-St. Paul, Minn.) Metropolitan Area (2). It was found when studying a 16-mi stretch of this highway that 56 percent of all highway-oriented uses were located within 1,000 ft of eight major intersections with the highway and 91 percent of all highway-oriented uses were located within 2,500 ft of these same intersections. Clearly portrayed here is the attractiveness of interchanges for highway-oriented uses. As a solution, it would be sheer folly to suggest that local land-use control ordinances simply ban the highway-oriented uses from these areas. This is either postponing, shifting or evading the problem; it is not facing the problem. Even though the highway-oriented uses are extreme traffic generators, their location in an interchange area is necessary to provide adequate service to road users. The amount of land property devoted to such uses as the specific location of such uses is a very delicate problem since three interests must be served simultaneously. They are the general public, the abutting property owner, and the road user. The public's substantial investment in a new highway facility demands that it operate efficiently and its purpose not be negated by indiscriminant land development. The abutting property owner must have the opportunity to develop his land to the fullest potential consistent with the well-being of his neighbors and community. The road user must be able to obtain needed service without endangering life and property because of confused or congested traffic conditions.

It is, however, possible to balance these interests when local officials assume their responsibility of evaluating the interchange areas, developing prudent land-use development plans, and establishing positive controls which will guide and promote development of such plans. Truly such responsible action embraces the very spirit of the 1962 Highway Act, for it develops a cooperative effort on the part of state and local officials and it coordinates, in the most critical areas, comprehensive land-use and transportation planning.

COMMERCIAL HIGHWAY SERVICE DISTRICT

Local communities should consider the addition of a special commercial highway service district zoning classification to their ordinances. In general, this district (also termed service district) is an established and defined land-use area in which land is available and used for the specific purpose of servicing the needs of persons and vehicles traveling the highways. It should cater to the needs of the road user. Only busi-

nesses which directly serve the road user should be permitted as a "use by right" in these service districts. All others are better suited in other locations. The businesses which directly serve the road user fall into three basic groups, which are as follows:

1. Automotive service—a complete line including auto and truck service stations, auto and truck repair garages, tire service and repair stations, and all other automotive services of this general nature;
2. Highway-oriented retail service—curio and novelty gift stores, sporting goods and bait stores, fruit and produce stands, and other similar highway-oriented retail establishments; and
3. Highway-oriented personal service—restaurants, tea rooms, confectioneries, motels, drive-in restaurants, drive-in confectioneries, drive-in dispensing machines, drive-in receiving and pick-up stations, and other similar highway-oriented personal service establishments.

Various protective regulatory standards to guide proper site development should be established specifically for these districts. In addition to the usual specifications, such as ample lot area, adequate setback and yard areas, sufficient off-street and loading spaces, it is essential that a traffic control plan accompany every request for a permit in these districts. No permit should be issued until after the submitted traffic control plan is approved. Such a plan should be reviewed promptly by the local traffic engineer and the district office of the state highway department. The plan should show the location and extent of proposed: (a) street easements and surfaced portions of all public thoroughfares adjacent to property; (b) ingress-egress to property; (c) internal traffic circulation; (d) off-street parking and loading; (e) structures, islands and miscellaneous traffic barriers; and (f) traffic control devices and signs, including channelization.

One overriding factor should be made sufficiently clear at this point. In spite of how much care is taken in the drafting of specific protective regulatory standards, it is imperative that the service district be properly located and sufficiently large in area. Unless such is the case, it will be ineffective and will not provide adequate service.

LOCATION OF COMMERCIAL HIGHWAY SERVICE DISTRICT

When considering locations for such a district in West Duluth (1) the following factors were appraised, scaled and analyzed: interchange function, interchange design, traffic conditions, user costs, and land-use environment.

Interchange Function

Streets do not all have the same function; they are generally classified according to their general function. Interchanges also vary in function and it is necessary that they also be classified. This is particularly important when considering the establishment of service districts because, as will be seen from examples later in this paper, the ultimate function of the interchange is a major determinant in the actual physical location of the service district.

In simple practical terms, interchanges function at three levels. Some basically transmit road users from one road system to another for purposes of continuing their trip. These might be termed express interchanges. Others carry the dual function of exchanging traffic between two road systems and providing access to arterial streets which immediately service important abutting land uses. These might be termed arterial interchanges. A third type has the principal function of providing convenient service for road users, and secondarily of serving both important abutting land uses and traffic exchange purposes. This might be termed a service interchange. Table 1 illustrates these respective functions.

Interchange Design

Although this paper does not purport to examine exhaustively interchange design as related to service districts, a few observations are in order. Ideally, the desirable

TABLE 1

INTERCHANGE FUNCTION

Interchange	Service		
	Traffic	Land	Road User
Express	x	-	-
Arterial	x	x	-
Service	x	x	x

location for a service district is adjacent to the frontage roads connecting the two halves of a split-diamond interchange. Such location permits road users to leave an express facility, secure needed services (gas, food, lodging) and return to the express facility without increasing travel distance, with a minimum of turning, and with a retention of the driver's sense of direction. In other words, unnecessary traffic congestion is held to a minimum. As is shown later in this paper, the distance necessary between the ramp termini of the two half diamonds is proportional to the volume of traffic to be served. However, it is not practical to allow this distance to be less than 800 ft nor greater than 3,200 ft.

Generally the least desirable location for a service district in a dense urban setting is in the vicinity of a diamond interchange. When such a district must be placed in conjunction with a diamond interchange, it is then recommended that at least 400 to 800 ft, measured along the intersecting arterial, separate the district from the terminus of the nearest interchange ramp.

Traffic

Traffic conditions comprise a third factor requiring extensive evaluation. A careful appraisal must be made of elements such as total vehicular volume and capacity of the interchange and the connecting arterials, conflicts arising from cross streets and turning movements (particularly left-hand turns), the physical disposition function and capacity of local streets in the interchange area, positioning and numbers of mid-block ingress-egress points along the arterial street leading to the interchange, and site distance involved. All of these elements must be assimilated and analyzed under varying conditions of land-use trip generation rates when considering the advisability of various possible locations for the service district.

User Costs

A fourth consideration is a comparison and projection of the actual cost accruing to the road user when seeking service at different service district locations. Such a comparison between three specific interchanges was made in the West Duluth study (1) by means of the following equation:

$$NC = X(\$0.137) - Y(\$0.093) \quad (1)$$

where

X = distance via local streets from Interstate ramp egress point to center of commercial highway service district to Interstate ramp ingress point;
Y = distance via Interstate from a point on a direct line with this egress point to a point on a direct line with this ingress point;
$0.137 = operating cost per mile on local street;
$0.093 = operating cost per mile on Interstate; and
NC = net cost of seeking service by one road user.

After the cost of seeking service by one road user has been determined for each interchange, only a simple expansion (NC times the number of such trips per day times the time interval desired) is required to determine comparative cost figures for each interchange. Table 2 shows the specific comparison of these interchanges surveyed in the West Duluth study.

TABLE 2

TWENTY YEAR USER COST ENCOUNTERED BY SERVICE SEEKING ROAD USERS

Interchange	Distance (mi)[a]		Operating Cost ($)[b]			20-Yr User Cost ($) (7,300 days)
	Via Interstate	Via Local Streets	Interstate	Local Streets	Diff.	
Cody St.	1.93	1.93	180.00	260.00	80.00	584,000.00
Central Ave.	0.00	0.33	0.00	50.00	50.00	365,000.00
Oneota St.	0.53	0.53	50.00	70.00	20.00	146,000.00

[a]Distance computed for local streets from Interstate ramp egress point to center commercial district to Interstate ramp ingress point; for Interstate, distance computed along Interstate from a point on direct line with this egress point to a point on a direct line with ingress point.
[b]Computed at $0.093 per Interstate mileage and $0.137 per local street mileage.

Land-Use Environment

The nature and characteristics of land surrounding an interchange require careful consideration when locating a service district. Such items as the following might be considered:

1. Land uses surrounding the interchange;
2. Amount of land devoted to these uses;
3. Disposition of these land uses;
4. Major land uses and their special needs, if any;
5. Their trip generation characteristics;
6. Potential future expansion rates;
7. Significant basic changes occurring in the land-use pattern;
8. Scale of the existing land uses;
9. Purpose served by existing land uses;
10. Dominating or restricting topographic features;
11. Potential physical capability of available unused land;
12. Types of uses potentially best suited for the area;
13. Availability of water, power and sewer facilities to the area;
14. Population of the existing area;
15. Potential population growth rate;
16. The specific social and economic characteristics affecting the disposition and use of land in the area;
17. Prospects of using urban renewal to create a better functioning land-use environment;
18. General attractiveness of area and the availability of related services;
19. Location of other service areas; and
20. Compatibility of the service district with other uses found in the area.

SCALING AMOUNT OF LAND NECESSARY IN SERVICE DISTRICTS

After the location of a service district has been determined, the amount of land necessary for highway-oriented uses in such a district must be determined. Gross misjudgment here will severely limit the effectiveness of the service district. Overoptimism will leave permanent pockets of undeveloped and unimproved land, invite marginal construction and uses, and create a pattern of scattered, inefficient development. Underestimating needs, however, will produce crowded developments which encroach on each other, thus creating congestion, improper spacing of traffic generators, and generally abdicating the opportunity for effective internal circulation of traffic at individual establishments.

The proper amount of land to be provided within service districts can be determined if there is a relationship between the amount of land used for highway-oriented uses and the volume of traffic associated with arterials serving these uses. In another study, it was found that at intersection nodes, a lineal relationship existed between the percent of total acreage found in these uses and the percent of total traffic volume (2).

For purposes of future land-use planning at service districts, it is necessary to know the magnitude or approximate lineal frontage of land needed for highway-oriented use purposes. To project these needs, the following method was developed and used in the West Duluth study.

1. Strips of commercial development along major arterials within urban development were selected. Criteria were that all strips be of similar length (approximately eight blocks long), begin at first occurrence of commercial zoning along the arterials, have been continually zoned for commercial purposes since the first establishment of zoning (within Duluth, 1924), have vacant property available for development if desired by private property owners, and be located outside of any distinguishable retail shopping area.
2. Two classifications of land use were defined—highway-oriented (gas, restaurant, motel, fruit and produce stands, drive-in restaurants and confectioners, drive-in dispensing machines, drive-in receiving and pick-up stations, auto repair, bars, auto accessories, gift and novelty, nursery, commercial recreation, used car and trailer sales) and non-highway-oriented (all other uses). The highway-oriented uses are adapted from the highway-oriented-urban arterial uses used by Borchert (2).
3. The lineal frontage of land used in each class was recorded. In Duluth, 1948, 1956, 1960 were the years used since they were the only time periods for which reliable traffic volume information was available.
4. The ADT volumes are then recorded for each strip.
5. The association between lineal feet of highway-oriented uses and traffic volume was computed. An association between lineal feet of highway-oriented uses and traffic volumes yielded a correlation coefficient of 0.81 and a coefficient of determination of 0.66. Therefore, two-thirds of the variance was associated with changes in the independent and dependent variables. Because the general magnitude and not a precise measure of future highway-oriented use needs was desired, further efforts to identify the other one-third variance was not necessary.
6. The association of lineal frontage of highway-oriented uses with traffic volumes was then plotted as in Figure 1 where the lineal association is quite apparent.
7. It was assumed that the lineal pattern would continue outside of the observation area.
8. Therefore, with the determination of a projected ADT volume for a particular year, the approximate amount of lineal frontage needed for highway-oriented uses could be scaled off, as was done in Figure 1 for the West Duluth study.

EXAMPLES OF ACTUAL HIGHWAY SERVICE DISTRICTS

Figures 2, 3 and 4 demonstrate the actual use of principles developed in the West Duluth study and discussed in this paper. The examples shown on these figures are not hypothetical but are the actual application of highway-oriented land-use planning principles to specific interchange areas in Duluth. Each figure shows how land would fully develop under the land-use development plans which predated the Interstate and how land will fully develop under the proposed land-use development plans based on highway-oriented land-use planning principles. In addition, each figure represents an interchange having a different basic function, i.e.,(express, arterial, service).

Express Interchange

The purpose of this interchange is primarily to exchange traffic between the Interstate system and a major trunk highway. Actually this interchange is required to provide very little local service to the residentially surrounding land uses. As seen in Figure 2a, the commercial uses would have been allowed to encroach to the very ramp termini of this interchange.

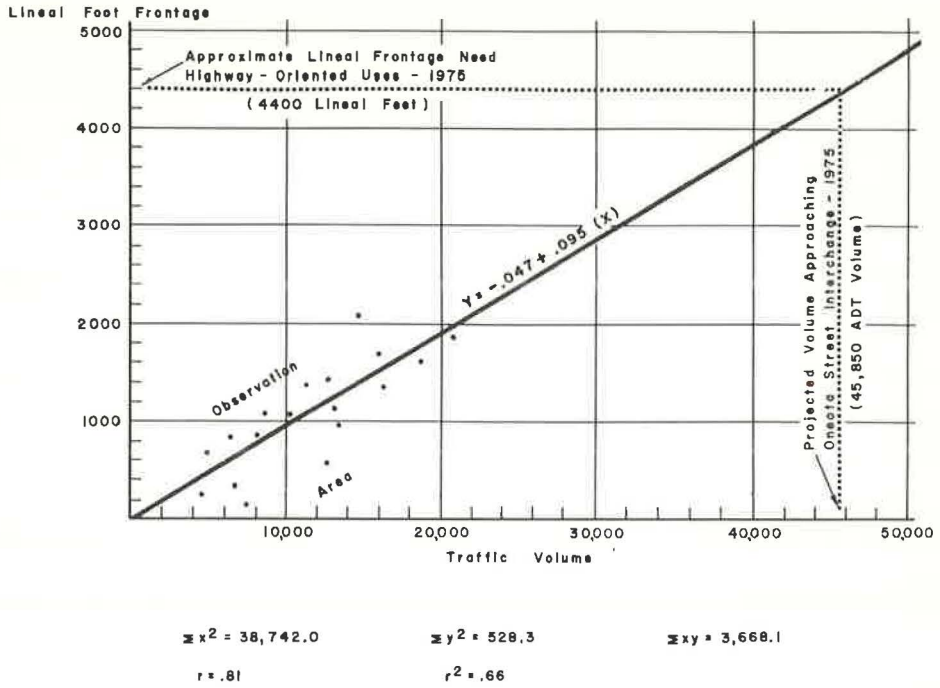


Figure 1. Relation of traffic volume to lineal frontage highway-oriented uses.

The characteristic trip passing through this interchange is of considerable length. Therefore, it is completely unnecessary that a service district be allowed to exist immediately on top of the interchange. In Figure 2b a service district has been created, commencing approximately 2, 600 ft from the ramp termini. The changes in local street entrances into the major arterial street may be seen.

Arterial Interchange

This interchange exchanges vehicles between the Interstate and a major trunk highway, and, possibly more important, it services the major land-use concentration of the existing West Duluth business district (commercial shopping area). Figure 3a shows how the commercial uses again encroach on the interchange, thus creating traffic congestion at this point.

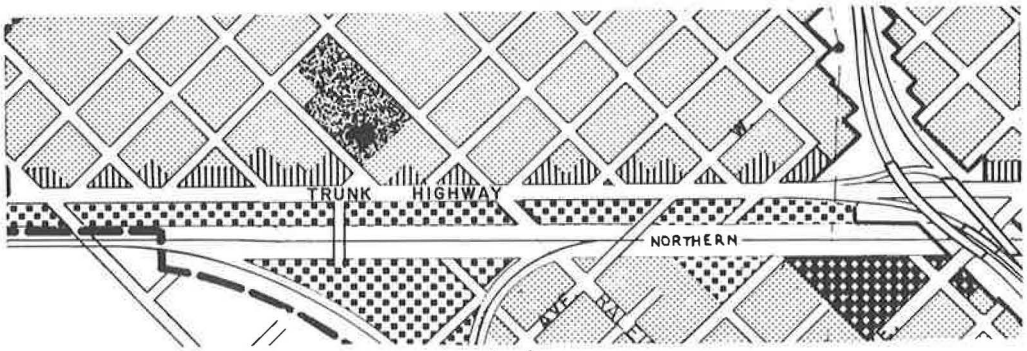
In Figure 3b, an urban renewal project has completely revamped the former business district. The service district has now been removed from the major arterial street and aligned to work with and complement the shopping area. Residential land uses have also been incorporated around this interchange.

Service Interchange

This interchange provides the opportunity of service to the road user who will travel a great distance on the Interstate, both before and after reaching this interchange. In Figure 4a, land-use development is completely inappropriate for this very strategic interchange.

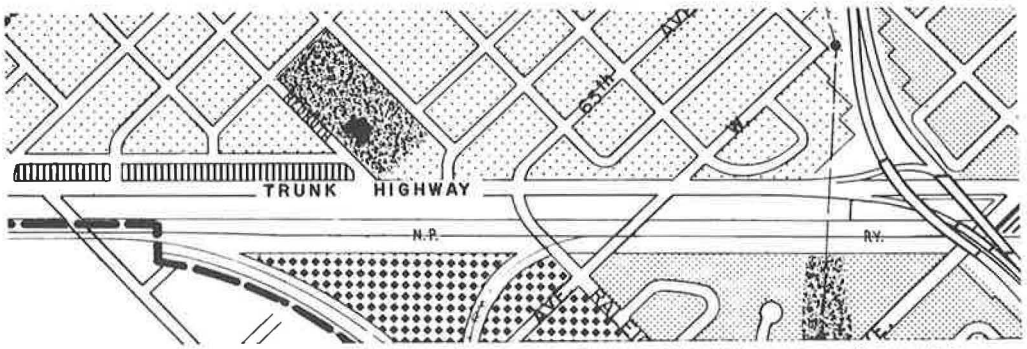
Figure 4b shows how conveniently a road user can slip out of the Interstate, secure needed services, and return to the Interstate when highway-oriented land-use planning principles are used.

PRIOR EXISTING LAND USE PLAN



(a)

PROPOSED LAND USE DEVELOPMENT PLAN



(b)

GENERALIZED LAND USE

- RESIDENTIAL 0-15 D.U. per acre
- RESIDENTIAL 15-30 D.U. per acre
- RESIDENTIAL 30-60 D.U. per acre
- SCHOOLS - PARKS
- COMMUNITY SHOPPING AREA
- SERVICE COMMERCIAL DISTRICT
- LIGHT INDUSTRY
- HEAVY INDUSTRY

SCALE 0 1000 2000 FT

Figure 2. Land development at an express interchange.

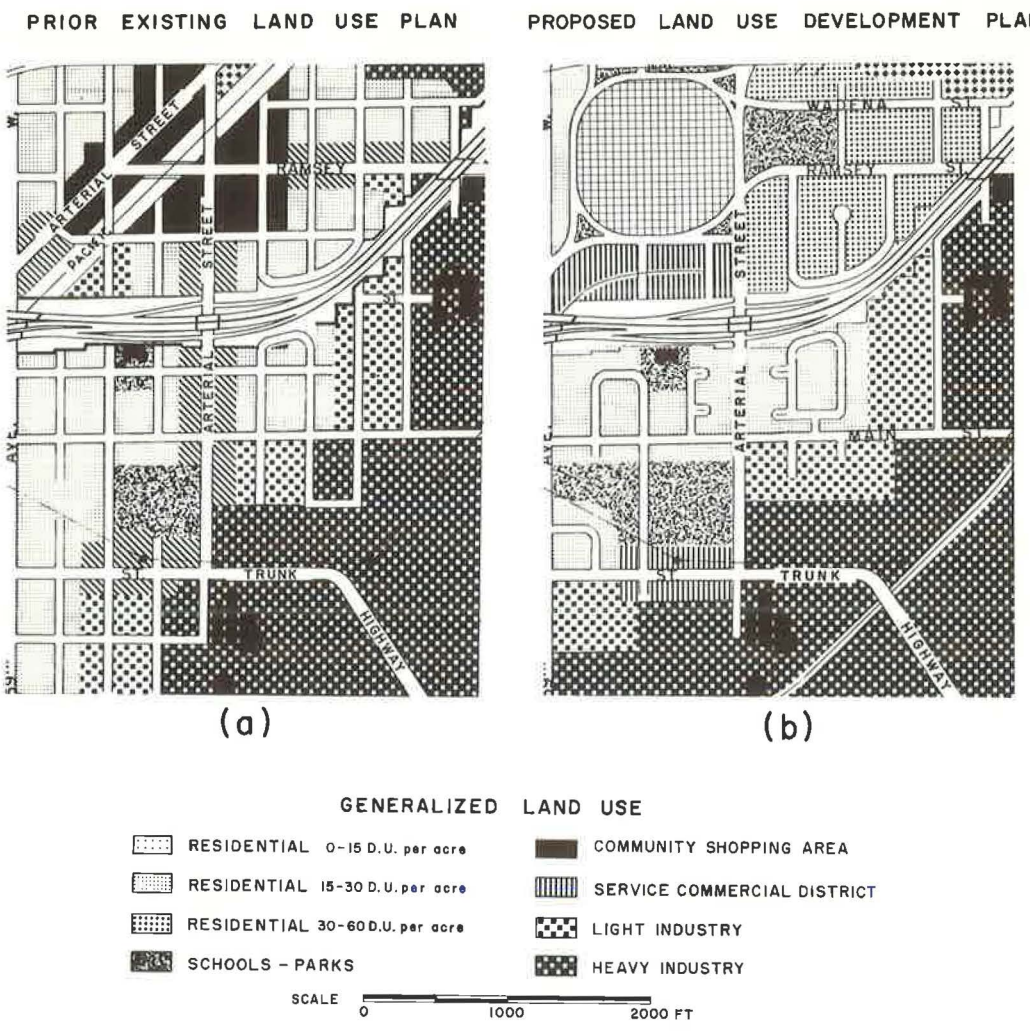


Figure 3. Land development at an arterial interchange.

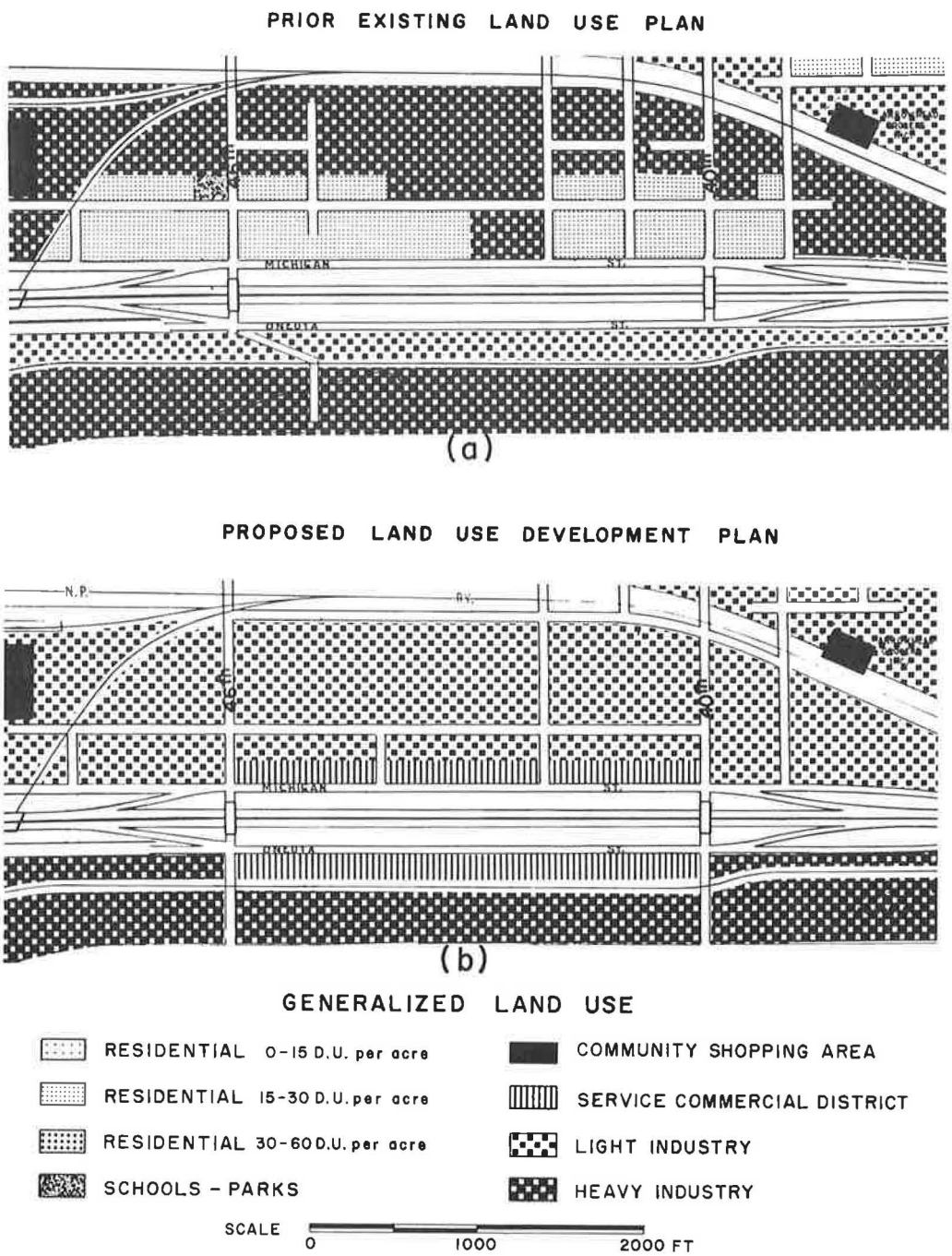


Figure 4. Land development at a service interchange.

CONCLUSION

In this paper, the commercial highway service district has been discussed from the point of view of what it is, where it should be located and how much land area it should include. These are technical aspects which can be scaled and measured, and thus lead to definable solutions. The ultimate test of these solutions, however, is their actual application in the field, as seen in the immediately preceding section. This application will only occur when local officials recognize and accept the important role they must play in the development of the Interstate Highway System.

Although the specific application of various land-use controls is usually strictly a local responsibility, the whole question of promoting and effecting proper land-use controls at interchanges is not. In the immediate future, prudent control of land use at interchanges will only be accomplished through the cooperative efforts of state and local authorities. In many states, local communities possess adequate authority for assisting proper land-use development at interchanges, but many are reluctant to use this authority fully. These communities must be helped to understand the potential ramifications of the problem. In this area, the cooperative effort of a state agency in providing information would be very helpful.

On the other hand, many state legislatures have not granted adequate planning authority to local communities, such as authority to adopt an official map. The absence of such authority leaves a large gap in the planning process of the local communities. When such authority is lacking, state agencies should be willing to cooperate with local communities in presenting and securing the necessary enabling legislation.

The wisdom of deliberate cooperative efforts by state and local authorities is recognized in an instructional memorandum of the U. S. Bureau of Public Roads concerning urban transportation planning. This memorandum states that the Bureau will not approve any program for highway projects entailing expenditures of Federal funds in urbanized areas unless they find "that such projects are based on a continuing comprehensive transportation planning process carried on cooperatively by State and local communities...". This cooperation can only lead to beneficial results. The local planner will better grasp and understand the specific problems of the highway engineer. The highway engineers will develop a greater appreciation and understanding of the goals and aspirations of the local community. From practical experience in our relations with the Minnesota Department of Highways, we have found that such cooperation does not lead to compromise solutions, but to more intelligent and enlightened solutions.

REFERENCES

1. Flaherty, Mark C., et al. Highways, Opportunities and Land Use Controls, A Case Study in Duluth. Duluth, Oct. 1964.
2. Borchert, John R. Beltline Commercial-Industrial Development. Univ. of Minnesota, Nov. 1960.