SUBDIVISION DESIGN GUIDELINES TO FACILITATE TRANSIT SERVICES

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OTTAWA
MARCH 1979
WORKING PAPER FOR DISCUSSION PURPOSES ONLY

SUBDIVISION DESIGN GUIDELINES TO FACILITATE TRANSIT SERVICES

PREPARED FOR

THE MINISTRY OF STATE FOR URBAN AFFAIRS
CENTRAL MORTGAGE AND HOUSING CORPORATION
TRANSPORT CANADA

WORKING PAPER
FOR DISCUSSION PURPOSES ONLY

LAVALIN INC.

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FOREWORD

In recognition of the desirability of planning and developing land use in conjunction with transportation facilities the Ministry of State for Urban Affairs, Central Mortgage and Housing Corporation and Transport Canada commissioned a study to examine the relationship between subdivision/neighbourhood design and urban transportation. More specifically the study aimed to investigate the design characteristics of existing neighbourhoods which affect the efficiency of feeder transit services and to develop design criteria and preliminary standards for new neighbourhood planning which would facilitate local transit services.

The past few decades have seen a gradual shift in basic residential layout from the earlier gridiron to the current indirect cul-de-sac/cresent/collector system. This shift has in large measure resulted from the increased use of private automobiles by almost all suburban families. The present layouts reduce traffic speed, increase pedestrian safety and in general limit the use of residential streets by through-traffic. Their success in servicing while at the same time controlling the automobile society is pointed out by the increasingly common tendency of older neighbourhoods to copy the circulation principles embodied in modern subdivisions. Street closures, one way flow systems, pedestrian precincts or environmental areas help to provide older areas with much the same protection from traffic intrusion as is found in a modern planned layout. However these systems in many instances, have created a flow pattern which mitigates against the provision of adequate public transport service.

Through an examination of Canadian legislation, an extensive review of the literature, an investigation of several case studies and numerous personal contacts those institutional, planning and design aspects which would serve to improve the operation of transit services in Canadian neighbourhoods are presented as a series of design guidelines. It is recommended that a process be developed (or institutionalized) whereby the trade-offs between physical design and transit provision be considered early in the design stage and furthermore that negotiation of the factors between urban planning authorities and transit operators should be a formal part of the subdivision approval process.

While the project was funded by the Ministry of State for Urban Affairs, Central Mortgage and Housing Corporation and Transport Canada no responsibility for the views or conclusions expressed should be attributed to these departments or this agency.

Patrick Hallett
September/1979

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1. INTRODUCTION

1.1 Background

Urbanization and the concomitant need for more urban space has pushed cities far beyond their original boundaries. This has been especially evident over the past 30 or so years. The advent of the automobile allowed many people to work in the city yet live and seek refuge in the suburbs. This particularly North American phenomenon resulted in new urban forms for development. No longer was the conventional grid system necessary or desirable; families wanted privacy from through-traffic and related noise and safety problems. As a result subdivisions with circuitious street patterns developed which were designed specifically to restrict through-traffic.

Today, with national and urban objectives changing, primarily due to energy conservation questions and the peak hour journey-to-work problem, increased efficiency and effectiveness of public transit systems are desirable. Unfortunately provision of public transit service in these same neighbourhoods is inherently restricted due to the geometry of the streets and the lack of full co-ordination between land use and transportation planning.

Because of the process by which most cities are allowed to grow and because initial decisions regarding the design of their streets, lot layouts, and other infrastructure have such an enduring impact, it seems almost imperative that there should be control over this process in the light of the public interest. With public concern for providing viable alternative transportation facilities to the private automobile in residential areas, it seems natural to seek ways and means by which this co-ordination of public transport and subdivision design can be affected.

1.2 Purpose and Objectives

This report documents a study on behalf of the Ministry of State for Urban Affairs, Central Mortgage and Housing Corporation and the Urban Transportation Research Branch of Transport Canada concerning the relationship between neighbourhood design and urban transportation. The two major tasks of the study were:

1. To investigate the design characteristics of existing neighbourhoods which might restrict or increase the cost of provision of local feeder transit service.

2. To develop design criteria and preliminary standards for the planning of new neighbourhoods which will facilitate the provision of local feeder transit service.

It is the purpose of this research effort to uncover the relationships between subdivision and neighbourhood designs and levels of service of urban public transportation that will lead to useful and practical guidelines which explicitly increase public transit use while maintaining the attractive features of subdivision design and planning.

The information analyzed in this study has been obtained from an examination of Canadian legislation relating to urban planning and public transit, an extensive review of literature on current trends and innovative design, and a series of case studies prepared after visits to seven Canadian cities.

1.3 Definitions

This study straddles two disciplines: transportation engineering and urban planning. It is principally concerned with the area of interaction between the two fields. Each discipline has developed its own terminology. For the sake of clarity some of the terms employed in this study are defined below:

Arterial Routes: a major highway, primarily for through-traffic, characterized by a high vehicular carrying capacity and its continuity to other adjacent streets.

Level of Service: a variable definition which represents the quality of a transportation service as it is defined by quantitative and non-quantitative factors of comfort and convenience.

Feeder Transit: a transit service which is formulated primarily to serve another transit line or lines which serve the CBD or downtown area directly.

Timed Transfer: a transit service which is scheduled so that most transfers from this service to another bus service occur at approximately the same time.

Dial-a-Bus: any bus service which operates from a demand actuated schedule whereby the passengers themselves determine the frequency.

Conventional Buses: denotes a bus normally containing 40 to 50 passengers which operates on a fixed frequency.

Minibus: a type of bus which contains less than 30 passengers.

Modal Split: the proportion of total person-trips that use a designated mode of transportation.

"Pulse" services: a system of bus scheduling whereby buses meet at common transfer points within a restricted range of time.

Line-Haul: a direct-line (non-stop) bus or light-rail service arranged to serve major destinations rather than a series of collector points.

Neighbourhood: a district which forms a distinct community within a town or city.

Subdivision: an area of land divided into residential building lots.

conclusion

2. CONCLUSION

The relationship between neighbourhood design and urban transportation in Canada can be described as having undergone three phases.

In the first phase,transportation systems were the determining factors in structuring urban growth. Communities developed along transportation routes with concentrations of commercial activity near transit stations and stops.

In the second phase, the post-1945 period, urban growth took place with little consideration for public transportation which was forced to adapt to automobile oriented subdivisions. Neighbourhoods came first and transportation systems had to adapt to them.

The third phase, which is currently developing, is characterized by a growing awareness of the interdependence of public transportation and neighbourhood design. Cities such as Edmonton and Ottawa are developing institutions to provide for joint planning and the citizens are benefiting.

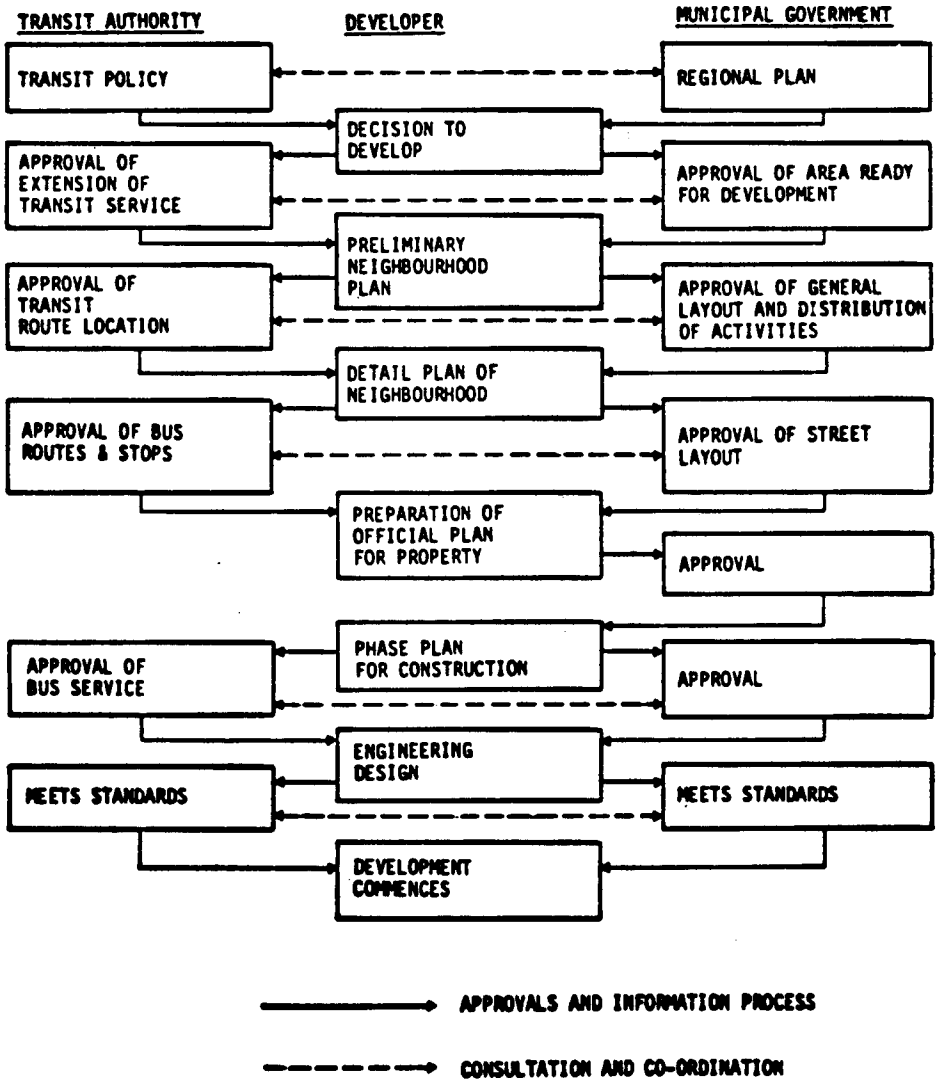
The complexity of the design process and the numerous trade-offs between transit, urban planning and engineering considerations make the task of ensuring that design of neighbourhoods is responsive to transit requirements a difficult one. Only increased awareness of the problem by municipal authorities and inclusion of transit requirements in municipal planning by-laws will contribute to a successful solution to the problem.

For the transit user, improved co-ordination between transit and urban planning means improved transit service: better routes, improved accessibility, shorter travel time. The neighbourhood resident can expect a quieter and more stable environment - transit vehicles operating on collector streets without deviations onto local roads. Both the transit operator and municipal government will expend more effort in the planning process but will gain considerably in economy of operation and response to regional and local objectives.

The developer-builder will certainly recognize the improved availability and standard of transit service as a strong sales incentive. However, the increased planning and approvals required and the restrictions which will result may be viewed as impediments to development. There is already opposition to existing controls which lengthen the approvals process and a criticism that prices to the consumer are increased by additional controls. There is a general trend to stricter controls in Canada and developers appear to be adapting to the trend. The principal requirement is that the same controls apply to all developers.

2.1 Institutional Relationships

The institutional relationships between the parties involved in the subdivision approval and transit planning process play a major role in determining the success of provision and use of feeder transit services within the neighbourhood. Typical relationships during the development process are shown below:



2.2 Design Guidelines

There are no simple formulas for neighbourhood design which can be substituted for adequate consideration of all factors during the design process by competent designers. Some of the major factors to be considered by designers have been identified in the design guidelines section. These are summarized in the table on the following page.

2.3 Recommendation

It is recommended that federal agencies, such as the Central Mortgage and Housing Corporation as well as provincial planning departments undertake to publicize the necessity for consideration of transit requirements in the design of neighbourhoods. This can be accomplished by appropriate references in provincial planning acts, by the preparation of draft texts for inclusion in municipal by-laws, by publicizing the factors to be considered in the design process and by further research into design standards such as walking distance and bus stop spacing.

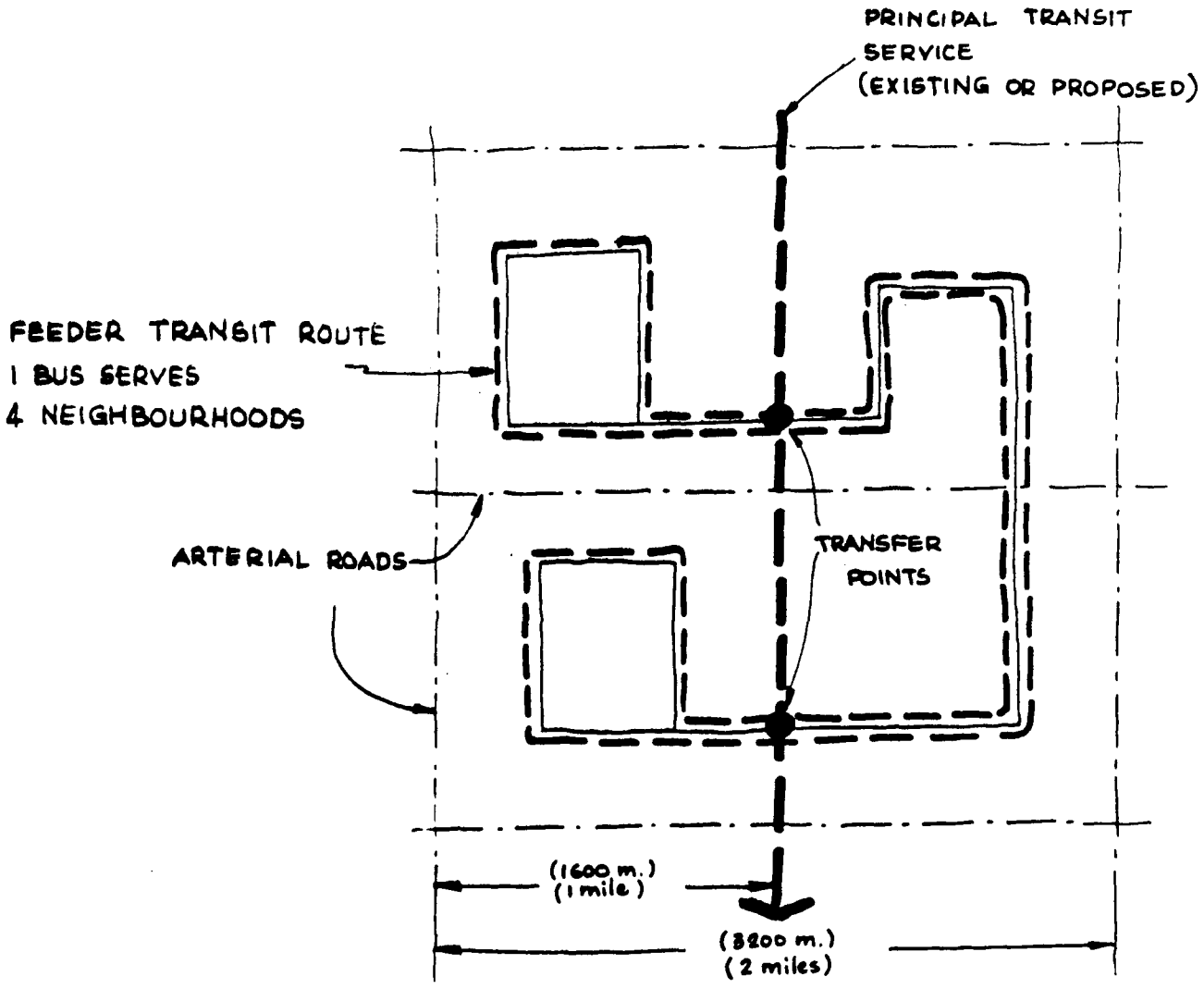
DESIGN GUIDELINES

GUIDELINE NO.	TITLE	OBJECTIVE	RECOMMENDATION	IMPLICATIONS				
				USER	RESIDENT	DEVELOPER	TRANSIT	MUNICIPAL
1	TRANSIT POLICY	CO-ORDINATE WITH REGIONAL PLAN	INSTITUTIONAL RELATIONSHIPS	AVAILABILITY OF SERVICE	NO SURPRISES	RATIONAL INVESTMENT POLICY	IMPROVED CAPITAL BUDGETING	EMPHASIZE URBAN OBJECTIVES
2	INTEGRATED TRANSIT SERVICE	MAXIMUM ACCESSIBILITY TO MULTIPLE DESTINATIONS	TIMED-TRANSFER FOCAL POINT SERVICE	IMPROVED ACCESS SHORTER TRAVEL TIME	QUIETER NEIGHBOURHOOD	BETTER RETURN ON INVESTMENT	REDUCE COSTS INCREASE RIDERSHIP	REDUCE DOWNTON CONGESTION
3	TRANSIT LEVEL OF SERVICE	SERVICE APPROPRIATE TO NEIGHBOURHOOD	RANGE OF STANDARDS	BETTER SERVICE LOWER FARES	LITTLE EFFECT	FEATURE OF DESIGN	ECONOMY OF OPERATION	SOCIAL OBJECTIVES LOWER TAXES
4	TRANSIT ROUTES	ADAPT TO NEIGHBOURHOOD DESIGN	ROUTE LOCATION WITH SUBDIVISION APPROVAL	SECURITY OF SERVICE	HOUSE SITE SELECTION	MARKETING DEVICE	EFFICIENT SERVICE	ZONING DECISIONS BUILDING LOCATION
5	TRANSIT CHANGES	MINIMIZE EFFECT OF TRANSIT CHANGES	PLAN FOR FUTURE CHANGES	MINIMUM DISRUPTION	NO SURPRISES	HIGHER COSTS BETTER MARKETING	LONG TERM ECONOMY	AFFECTS URBAN OBJECTIVES
6	DIAL-A-BUS	CONSIDERATIONS OF SERVICE	BEST LEVEL OF SERVICE BUT HIGH COST	BETTER SERVICE SMALL CHARGE	MINIMAL	LESS CONSTRAINTS ON DESIGN	HIGHER COSTS	HIGHER SUBSIDY
7	NEW NEIGHBOURHOODS	PROVIDE EARLY SERVICE	PHASED CONSTRUCTION	LESS AUTOMOBILE DEPENDANCE	NO TEMPORARY ROUTES LESS NOISE	HIGHER COSTS	INITIAL DEFICITS BETTER MODAL SPLIT	REDUCED COST OF DEVELOPMENT
8	NEIGHBOURHOOD SIZE AND SHAPE	RELATE TO TRANSIT ALTERNATIVES	PLANNING APPROVAL FOR ENTIRE UNITS	IMPROVED SERVICE	BETTER ENVIRONMENT HIGHER PROPERTY VALUES	HIGHER PLANNING COSTS VIABLE PROJECTS	ECONOMY OF OPERATION	CONTROL OF DEVELOPMENT
9	COLLECTOR ROADS	USE FOR TRANSIT MINIMIZE ROUTE LENGTH	DESIGN ROUTES WITH SUBDIVISION	ACCESS TO MORE DESTINATIONS	LESS NOISE AND TRAFFIC	ECONOMY OF LAND USE	ECONOMY OF OPERATION	MINIMAL
10	LEVEL OF SERVICE DESIGN FACTORS	DESIGN TO APPROPRIATE STANDARDS	WALKING DISTANCE AND BUS STOP SPACING	BETTER SERVICE	QUIETER NEIGHBOURHOODS	OBLIGATION TO PLAN FOR TRANSIT	LOWER COSTS MORE RIDERS	ADDITIONAL APPROVALS
11	WALKING DISTANCE	DETERMINE BAND OF TRANSIT COVERAGE	STANDARD BASED ON DENSITY GRADIENT	REDUCED WALKING DISTANCE	BETTER PEDESTRIAN ACCESS WITHIN N'HOOD	CONSTRAINT TO DESIGN COST OF PLANNING	BETTER COST/ REVENUE RATIO	MINIMAL
12	BUS STOP LOCATION	MAXIMUM ACCESSIBILITY TO TRANSIT	EXISTING STANDARDS ACTIVITY NODES	IMPROVED ACCESSIBILITY	NEIGHBOURHOOD STABILITY	RESTRICTIONS ON LAND USE	MORE RIDERS	ECONOMY IN SERVICES
13	TRANSIT DEPENDANTS	IMPROVE ACCESSIBILITY FOR DEPENDANTS	ZONING AND DIRECT ACCESS	REDUCED TRIP TIME	NO DETOURED BUS ROUTES	RESTRICTIONS ON LAND USE	REDUCE COSTS	SOCIAL SERVICE ADMINISTRATIVE RESPONSIBILITY
14	LOCAL STREETS AND BUS STOPS	MAXIMUM ACCESS TO MINIMUM STOPS	DETAIL DESIGN OF INTERSECTIONS	SHORTER WALK BUS-SHELTERS	KEEP TRANSIT OFF LOCAL STREETS	NO ADDITIONAL COST	FEWER STOPS SHORTER TRIP TIME	MAINTAIN STREET DESIGN STANDARDS
15	LOCAL STREET DESIGN	SHORTEST WALKING DISTANCE	DIRECT ROUTES	SHORTER WALK	NO INCREASED AUTO TRAFFIC	NO ADDITIONAL COST	MORE RIDERS	NO DIRECT IMPLICATIONS
16	WALKING ROUTES	BEST ALL-WEATHER MAINTENANCE	ROUTES ALONG ROADS SIDEWALKS	MORE ATTRACTIVE WALKING ROUTE	LESS WALKWAYS	REDUCE DEVELOPMENT COSTS	NO DIRECT IMPLICATIONS	REDUCE MAINTENANCE COSTS
17	PEDESTRIAN WALKWAYS	BEST USE	MULTIPLE DESTINATIONS	NOT BEST WALKING ROUTE	BEST FOR CHILDREN	INCREASED COST	MINIMAL	JUSTIFY COST OF MAINTENANCE
18	BUILDING SETBACK REGULATIONS	MINIMIZE WALKING DISTANCES	REDUCED SETBACKS DETAILED SITE PLANNING	IMPROVED ACCESS CLIMATIC SHELTER	PARKING AT REAR OF BUILDING	NO COST MARKETING PROBLEM	MORE RIDERS	RE-ASSESSMENT OF TRADITIONAL PRACTICE

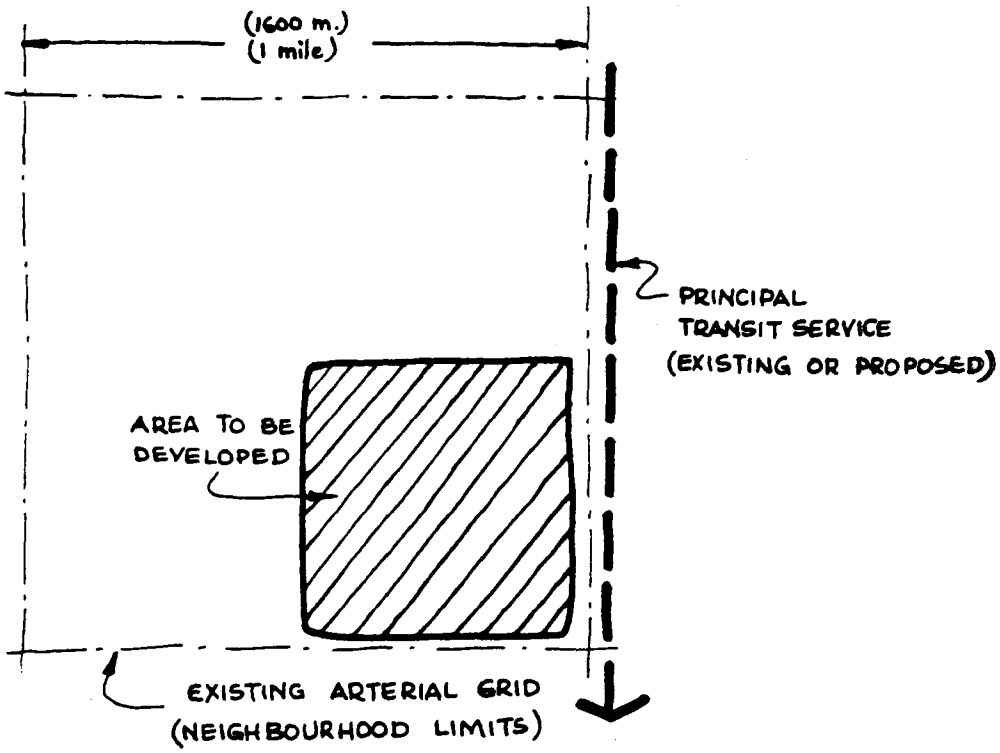
2.4 Design Procedure

Based on the development guidelines the following is a recommended design procedure to combine transit objectives with the planning process. It is assumed that the many other factors relevant to design (topography, vegetation, climate, servicing, etc.) will be considered in parallel with this procedure.

1. Determine regional transit policy and range of transit options available.



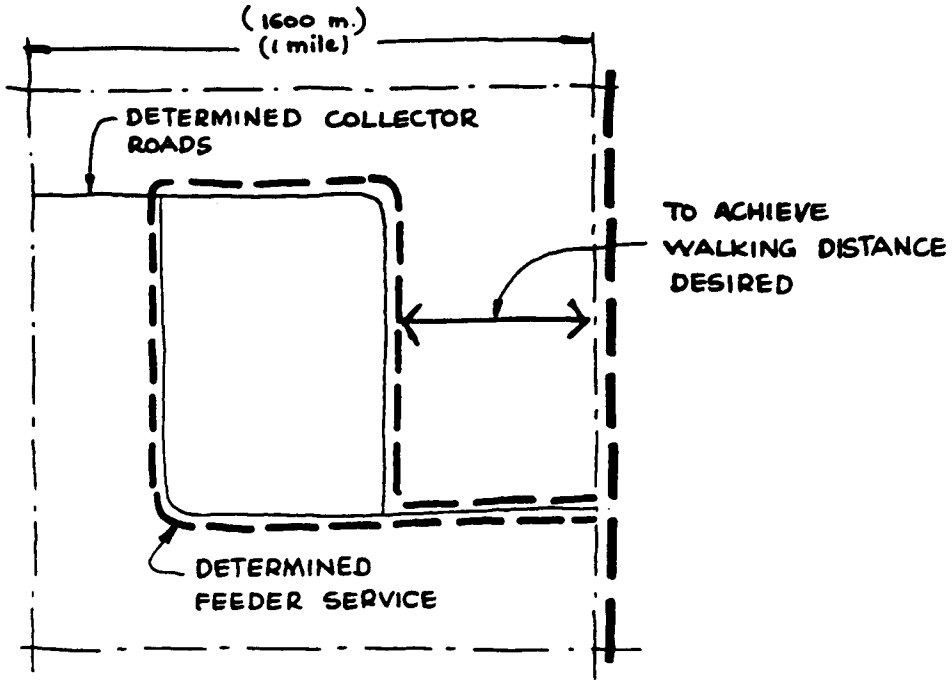
2. Determine neighbourhood size and shape (as compared to property being considered) in relation to transit, arterial road system and regional plan.



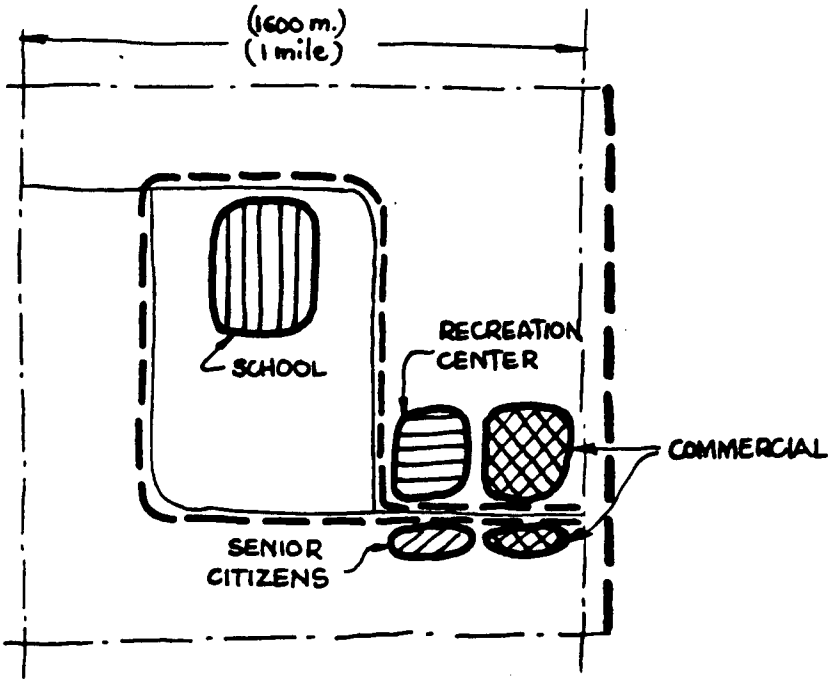
3. Determine external destinations for transit and vehicular traffic.

4. Based upon proposed neighbourhood characteristics determine appropriate transit level of service, walking distance standards and band of transit coverage.

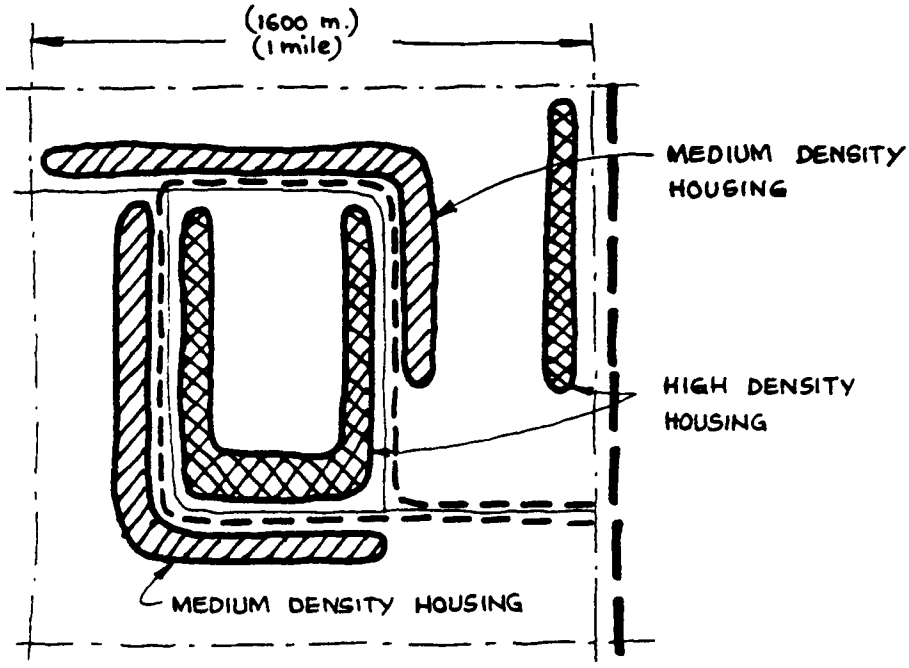
5. Determine basic location and orientation of transit routes within neighbourhood.

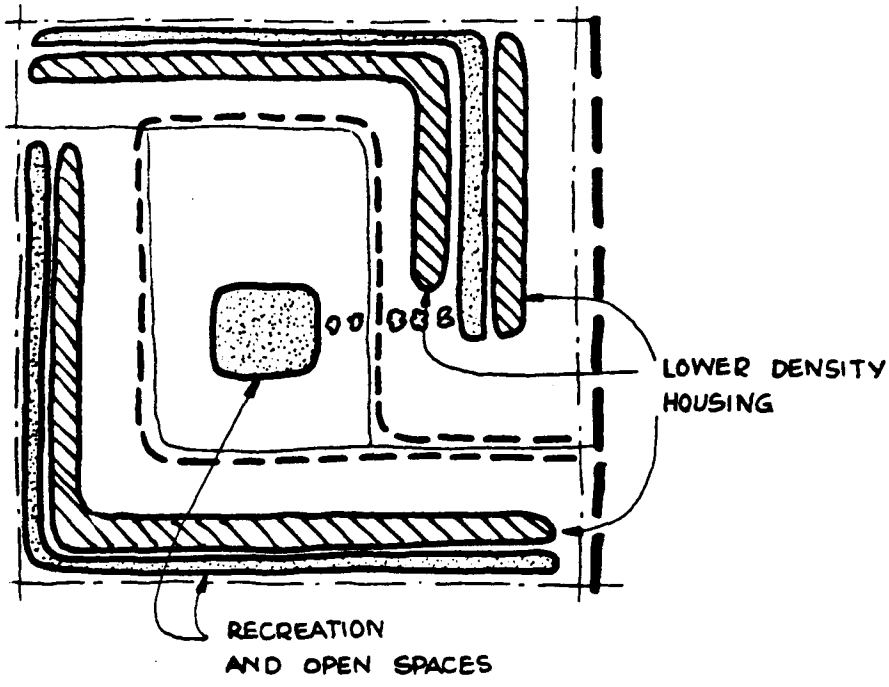


6. Determine collector street system attempting to accommodate bus routes on arterials and collectors streets and providing:
   a) for a pattern which permits provision of service along permanent routes during first phase of construction;
   b) for development on both sides of streets;
   c) appropriate route geometry.



7. Determine location along transit routes of activity nodes and concentration of housing in following priority:
   a) transfer points;
   b) bus stops;
   c) along routes.





8. Determine location of bus stops and co-ordinate with design of intersections with collector and local streets.

9. Design local streets:
   a) street design should be direct, avoiding backtracking and oriented towards bus stop location:
   b) shortest walking distance along road is preferred to pedestrian walkway;
   c) when walkways are provided they should have multiple destinations.

10. Detail design:
   a) plan detailed siting of buildings and design for bus stop location to encourage maximum use;
   b) consider minimum setbacks of commercial, industrial and high density buildings along bus routes;
   c) provide adequate parking as required but avoid parking lots between buildings and bus routes.

11. Co-ordinate with engineering design:
   a) pavement and roadbase design;
   b) righ-of-way widths;
   c) pavement widths.

research

3. RESEARCH

3.1 Canadian Legislation

Responsibility for community planning and urban transportation systems is assigned to the provinces under the B.N.A. Act. The federal government therefore has no direct control in these areas. However, federal agencies such as C.M.H.C., through lending policies, have indirectly exerted influence.

The review of Canadian legislation has concentrated on the powers conferred by provincial legislation which might require or permit integration of requirements related to urban transportation systems and community planning.

3.1.1 Transportation Systems

Urban transportation systems in Canada are operated by various types of organizations including private companies (Saint John, New Brunswick), municipal departments (Edmonton, Alberta), regional governments (Ottawa, Ontario), provincially chartered commissions (Laval, Québec) and provincial agencies (British Columbia).

The degree to which planning agencies can affect decisions of the transit companies is as varied as the types of organization. In Edmonton, local by-laws provide for a mutual approvals process involving the transportation planning and community planning departments of municipal government. In Ottawa, the Regional Municipality of Ottawa-Carleton exercises direct control over OC Transpo.

In one of the case study cities there exists no mechanism for dialogue between the planning department and the transit company. The only control exercised by the city council relates to general budget approval (usually agreement to pay annual deficits). In another city, officials complain that they have little input to transit decisions since they are not asked to contribute to costs.

Provincial legislation conferring powers upon municipalities to create transportation agencies or systems generally makes no mention of special requirements to meet community planning objectives. In Manitoba, for example, the Municipal Act provides for establishment of public transportation systems as follows:

The council of any municipality may pass by-laws:

(i) for establishing, constructing, operating and maintaining ... of a local transportation system ...

(ii) for regulating, governing, controlling and managing any such transportation system.

Thus, although there is no specific mention of community planning objectives, sub-paragraph (ii) provides the framework for including such objectives in the municipal by-laws.

In general, when transportation agencies are operated or created directly by Provincial governments they are not charged with any particular responsibility to co-ordinate with the community planning process. When transportation agencies are created by by-law of municipal or metropolitan governments, through powers conferred on them by the province, the enabling legislation, although there is no direct reference, can usually be interpreted as permitting inclusion of requirements to co-ordinate with community planning.

3.1.2 Community Planning

All of the Canadian provinces have enacted statutes to deal with planning. In some provinces there are planning acts (Newfoundland, P.E.I., New Brunswick, Nova Scotia, Ontario, Manitoba, Saskatchewan, Alberta) while in others the planning powers are conferred by the municipal act (Québec, British Columbia).

In all cases,powers are conferred on local governments, with varying degrees of provincial control, to adopt master or official plans and statutes detailing specific authority such as zoning by-laws, subdivision by-laws and subdivision agreements.

The object of all planning legislation is to regulate the use and development of land in an orderly and controlled way. The Manitoba Planning Act describes its purpose as:

> "to secure suitable provision for vehicular and pedestrian traffic, proper sanitary conditions, public safety, general well-being, amenity and convenience,in connection with the laying out of subdivisions, streets, roads and the use and development of land and of any neighbourhood lands for building or other purposes".

This is typical of most provincial legislation in that reference is made to roads and traffic but no specific reference is made to public transportation systems.

References to transportation and public services can be interpreted as encompassing public transportation systems but this element appears to have been largely neglected in both general and specific by-laws adopted by municipalities.

The Ontario Planning Act, for example, requires that an application for subdivision approval includes location and dimensions of highways, land maps, adjacent subdivisions, land use, dimensions of lots, natural and artificial features, water supply, soil conditions, etc. The only reference which can be construed as including public transportation is to:

> "the municipal services available or to be available to the land proposed to be subdivided".

The research has identified no direct reference in provincial legislation to consideration of public transportation as a criterion for either master plan preparation, subdivision approval or zoning.

Nevertheless, the general nature of provisions will permit municipalities to include such considerations in local by-laws. This practice has been the rare exception rather than the rule.

3.2 Literature Review

The literature review of local feeder transit related neighbourhood design innovation in North America and Europe was conducted with the intent of identifying design principles of potential applicability in the Canadian context.

The literature review has revealed little existing documentation referring specifically to the relationship between feeder transit and neighbourhood design or to the institutional process. Most of the sources consulted refer to particular aspects of either transit planning or neighbourhood design.

The detailed review may be found in Appendix A of this report. The review has been divided into six sections - global context, walking distance, bus stop spacing, neighbourhood determinants, road networks and design principles. A detailed summary appears at the beginning of each section of the detailed review. Section numbers opposite the summary paragraphs key the conclusions into their source in the literature review.

Data and conclusions from the literature review are incorporated into the Discussion portions of Section 3.2 of this report.

In the literature, diverse physical design principles are proposed to facilitate local feeder transit provision. The principles have been reviewed with regard to their relevance to Canadian conditions. Comments have been divided into 3 categories:

- principles which do not appear to be relevant;
- principles which have potential for application in specific situations;
- principles which appear to have potential for widespread implementation.

3.2.1 Principles not considered to have potential for Canadian application

1. Avoidance of curvilinear streets and cul-de-sacs. These two elements are blamed for many of the transit ills of the contemporary suburb. Curvilinear routes can make efficient transit routes as they minimize right-angled turns; cul-de-sacs can provide pedestrian paths of maximum theoretical efficiency.

   The intent of these statements discouraging curvilinear streets and cul-de-sacs is probably aimed at avoiding situations where the improper orientation of these elements obliges pedestrian and/or transit vehicles to backtrack; and street designs that do not anticipate feeder transit routes. Curvilinear streets and cul-de-sacs can be arranged to satisfy these conditions.

2. Use of pure, linear form. Linear forms for neighbourhood organization (development along both side of a single linear arterial road) increase walking distances to central services and may not permit provision of flexible regional distribution networks. Loops, figure 8s and other forms can preserve the linear relationship while satisfying these other needs.

3. Direct routing. Savings attributed to direct routing (usually assumed to go through the middle of a residential neighbourhood) only apply to dispersed settlements. Arterial routes have roughly the same band of coverage as central routes, and do not need special roadways or bus links. Central routes are not free of the obligation to have the same density gradients as arterial routes, and they must also pass through neighbourhood centres. Therefore the central route should only be used to serve a plan with central emphasis. The arterial route should be used to serve neighbourhoods with peripheral emphasis.

4. Use of radial street networks to facilitate timed transfer focal point service. "Pulse" services may be beneficial, but radial street networks, or even modifications thereof, are not suitable for anything but inter-regional travel. "Pulse" services can operate on local street networks which have been designed with transit in mind.

5. Proposals to change relationships between elements of the road hierarchy. Changes to well established design principles for the relationships between road elements should not be proposed without fully considering the implications of such actions. Reducing the number of levels in the hierarchy may be more direct for para-transit routes, but entries onto collectors will be multiplied. Similarly, re-orienting collectors solely to arterials and not to other collectors frustrates neighbourhood travel and may encourage through-traffic. Continuity of local roads with one another may create cross-intersections in place of the safer T-junctions.

6. Grade separation. Separation of pedestrian and vehicular routes has not proven effective where walking time to traverse vehicular routes is greatly increased or where unpleasant and sometimes unsafe bridges or underpasses are created.

3.2.2 Principles with potential for application in only specific instances

1. Use of private busways for feeder service. These installations may be justified in busway-oriented new town situations but do not appear to be appropriate for general suburban designs. Bus routes using neighbourhood roads with short bus-only links when required to achieve continuity, may be preferable.

2. Orientation of bus routes to pedestrian networks rather than roads is only recommended where the density gradient around the pedestrian network is high, and the pedestrian right-of-way not excessively wide.

3. Pedestrian/transit patron amenities at bus stops. Amenities of this type are to be encouraged, but their influence on modal split is not believed to be great. Simple shelters are recommended in British Columbia because of the rainy climate. In many of the provinces, partially enclosed unheated shelters are unlikely to provide effective weather protection but opposition by local residents, maintenance authorities and the police to fully enclosed heated shelters is considerable. Timed transfer scheduling, dial-a-bus, and home telephone information services may reduce the need for shelters in residential areas.

3.2.3 Principles with potential for widespread application

1. Reduce walking distance by concentrating development. Minimize length of road per dwelling or activity, intersections, and frontage per lot. Locate bus stops at foci in pedestrian network and at activity nodes. Encourage higher density development, particularly around bus stops.

2. Optimization of walking distance and bus stop spacing by grouping a maximum number of people around a minimum number of stops. Pedestrian routes should radiate from bus stops. Use of cul-de-sacs, loops, and p-loops perpendicular to transit routes will reduce walking distance. A network similar to a fine grid may approximate this performance.

3. Reduce walking distance at destinations. Encourage bus penetration of shopping precincts. Re-examine zoning principles for commercial buildings and industrial parks which enforce large setbacks. It may be possible to revise some of these standards without overlooking the original intention of such zoning.

4. Introduce service early in development cycle, anticipating staged increases, fully developed demand and reductions of service.

5. Continuous development. Development should be continuous along both sides of the bus route. Long stretches of undeveloped land which do not generate demand should be avoided. Design bus routes so that buses follow the same route in both directions of travel.

3.3 Case Studies

To ensure that this study accurately reflects regional variations across Canada the analysis has been based on a series of case studies selected on a national basis. A series of field visits were undertaken in November 1977 to verify at first hand the design and environmental qualities of the selected neighbourhoods and observable features of traffic conditions and transit provision. The researchers visited the offices of municipalities, transit authorities and developers and reviewed current files with key personnel in these organizations.

Cities were selected on the basis of varying size, regional representation, provision of transit service and innovative practices and designs.

The selected cities were Saint John, New Brunswick; Laval, Québec; Ottawa, Ontario; Toronto, Ontario; Regina, Saskatchewan; Edmonton, Alberta; and Vancouver, British Columbia.

Within each city at least two neighbourhoods or subdivisions were selected. Every attempt was made to obtain the widest range of community characteristics within relatively mature areas with some form of public transit provision.

The detailed case study descriptions and analyses may be found in Appendix B of this report. Discussion of each case study is divided into ten areas of analysis: neighbourhood selection, location, demographic characteristics, neighbourhood characteristics, road hierarchy, pedestrian ways, transit organization, transit planning, level of service and neighbourhood feeder service.

A summary of the principal observations for each city appears at the beginning of each case study. These observations are incorporated into the Discussion portions of Section 3.2 of this report.

General conclusions drawn from the case studies are:

1. Conventional buses are often used for transit routes along local streets involving many turns and stops, excessive slopes and narrow pavements. Buses do not appear to have major difficulties but speed is reduced and travel time increased considerably. Residents' complaints of noise and heavy traffic are frequent.

2. Transit routes are determined to best serve users and destinations. Use of main roads is not a prime criterion.

3. The institutional relationships between the parties involved in the subdivision approval and transit planning process play a major role in determining the success of provision and use of feeder transit services within the neighbourhood.

4. Provision of transit service to neighbourhoods being developed is a major problem for transit companies. Problems are both physical (no direct routing, temporary use of local streets) and financial (not enough customers).

5. Attempts to increase transit ridership (modal split) by limiting parking at the destination have succeeded while attempts to limit parking at origins have failed.

6. Pedestrian walkways are not a major factor in providing access to transit systems. When provided for in subdivision plans they are often not built. When built they are frequently not used.

7. The only transit alternatives presently considered appropriate for neighbourhood feeder service are conventional buses (either along arterials or loop service) and dial-a-bus.

8. Any automobile-oriented subdivision works well for the dial-a-bus system. The dial-a-bus system involves operational costs which are two or more times those for fixed routes. Passenger capacity is lower yet the cost of operating minibuses is the same as for conventional buses. Maintenance and labour costs are higher and bus life is shorter. This offsets the initial lower capital cost.

3.4 Analysis

Following the literature review and case studies, a series of investigations and studies were prepared on several of the significant parameters of neighbourhood design. These may be found in Appendix C of this report and consider design parameters, design standards, design variables and transit ridership variables.

Design parameters were considered in relation to arterial grid size, route spacing and road hierarchy, new development shape, feeder transit alternatives, organizational patterns, zoning and land use, density and existing neighbourhoods.

Design standards were studied in relation to elements affecting level-of-service variables such as walking distance, route length, route geometry and bus stop spacing. A series of detailed studies show the effects of modifications to bus stop and walkway patterns.

Design variables were considered in relation to the global, neighbourhood and local context. Particular attention was given to spacing of intersections, direct routes and siting considerations.

An attempt was made to evaluate transit ridership variables using an existing transit model. Although a model was used and the results analyzed, the results indicate that there is no model available in existing literature, calibrated on a neighbourhood scale, which predicts feeder transit ridership and which can be used by the subdivision designer to fully evaluate alternative transit options.

design guidelines

4. DESIGN GUIDELINES

4.1 Design Process

The development and design process can be divided into three phases:

1. Institutional
2. Planning
3. Engineering

The institutional process is oriented towards determining policies, providing the necessary base data to designers and an approval process to ensure quality and conformity to standards.

Observations made during the field trips suggested that the highest quality of subdivision design and feeder transit provision is occurring in regions with the best mechanism for negotiation between provincial, regional and local authorities, transit operator and developer.

It is considered essential that a process be developed whereby consideration is given to trade-offs between physical design and transit provision early in the design process. Negotiation of these factors between urban planning authorities and the transit operator should be a formal part of the approval process. A one-step approval bureau for the developer should be considered. Although the necessity for a formal institutional process is increasingly recognized, it is strongly recommended that every effort be made to publicize the necessity for and advantages of joint consideration of transit and urban planning requirements.

The planning process, when considered at the neighbourhood level is concerned with the development of particular areas. The entire range of physical and transit variables must be considered by the designer in an attempt to determine optimal arrangements which satisfy basic (usually market) requirements.

Regional considerations at one extreme, and the built and natural environments at another, are as important to neighbourhood design as feeder transit provision. Each of these quantities has its own inputs. Final design results from the interaction of all design variables. Thus, although the recommendations of Section 3.2 of this report concentrate on planning/transit requirements, the designer cannot neglect all the other factors which must be considered.

Engineering design and standards will be applied to the elements determined in the initial planning. At the neighbourhood level, engineering design for feeder transit will relate principally to pavement width, pavement and foundation capacity, and road geometry. These factors, beyond the scope of this study, should be considered as the detailing of the neighbourhood design rather than as determining elements. Observations from the field trips indicate that these considerations tend to be either ignored (resulting in costly maintenance and delays) or subject to rigid standards and overdesign (increasing capital cost).

4.2 Guidelines

The guidelines proposed, which arise out of the conclusions of the literature review, case studies and analysis, must be evaluated on a range of levels (micro to macro in relation to the city structure). These levels are:

1. Transit user.
2. Neighbourhood resident.
3. Developer - builder.
4. Transit operator.
5. Municipal government.

Transit user considerations are principally concerned with the qualitative-convenience aspects of the trip from home to destination.

Neighbourhood residents are principally concerned with community impacts - safety, privacy and noise. Presumably those residents who locate on collector streets along bus routes have chosen these locations.

Developer-builder concerns relate to marketability (both what to build and how product is perceived) and economy in use of land (consumption and servicing).

Transit operators are concerned with capital and operating cost implications (almost always deficit operation) in relation to service commitments. At the neighbourhood level, this involves maximum modal split at lowest capital and operating cost.

Municipal government concerns relate to quality of life (physical and social environment) and capital and operating costs (servicing, street and walkway maintenance, contribution to transit deficits).

1. Transit Policy

OBJECTIVE: To ensure that transit company policy is co-ordinated with the provisions of the regional development plan.

RECOMMENDATION: Institutional relationships and a mutual approvals process must be established between authorities responsible for transit policy and authorities responsible for regional planning. This can be accomplished:

1) by changes in the provincial planning acts;

2) by appropriate municipal legislation (by-laws) or

3) by relating financial participation by the municipalities to participation in transit decisions.

The regional plan is a basic starting point for the transit system. Transit service must be reviewed periodically as a function not only of ridership and cost but in relation to urban objectives in close co-operation with municipal planning agencies.

DISCUSSION: Recent studies of the influence of metropolitan and/or regional factors indicate that the success of neighbourhood transit systems is highly related to external factors such as the size of the downtown area served, the distance from it, and the shape of the metropolitan density gradient.

For the neighbourhood designer this means that the range of transit options cannot be decided on the basis of neighbourhood function alone, but must emerge from metropolitan and regional considerations.

To best use the range of options available and adapt them to local requirements transit policy should be determined at the regional level and co-ordinated with the regional development plan.

In some of the case study cities a lack of co-ordination of planning, traffic and transit decisions has been observed. For example, a private transit company was asked to conform to decisions of the city transit committee at the same time as the city decided to cancel subsidies for public transit.

In another city, there is no formal mechanism for dialogue between the transit company and the city. The only contact is at budget time when the city must approve the transit company budget within a fixed time or the budget comes automatically into force.

On the other hand, in Ottawa, transit planning is part of the subdivision approval process and the necessary legal powers have been provided to the regional planning authority. In Edmonton, there is a very high level of institutionalized co-ordination between transit and city planning. This is possible largely because both are city departments.

IMPLICATIONS:

User: When transit policy is determined in advance and on a regional basis, the users, particularly those moving to suburban neighbourhoods, can rely on transit and develop travel habits which may decrease their dependance upon the automobile.

Resident: For the resident of the neighbourhood, a clear policy co-ordinated with the regional development plan provides awarness of long range projects and may tend to minimise objection to transit routes and conditions of service.

Developer: For the developer, a clear regional transit policy will provide important information concerning investment and location of projects. This may be viewed as a disadvantage by speculators who, in the absence of such policy, purchase low cost land and request transit service (and other services) to increase land value.

Transit: For the transit company a policy developed in co-operation with the regional planning authority will minimise conflict with both citizens and developers and relieve the company of much of the obligation to negotiate with individuals or companies. It can also permit the transit company to improve budgeting for funding of expansion and improvements to transit service.

Municipal: For municipalities, the opportunity to participate in the formulation of transit policy and to emphasize urban objectives would appear to be an essential part of the planning process. Metropolitan and city governments will provide much of the basic input for transit policy. Suburban areas will perhaps have less effect on policy but will be able to make use of policy decisions in their planning.

2. Integrated Transit Service

OBJECTIVE: To provide integrated transit service with maximum accessibility to the greatest number of destinations.

RECOMMENDATION: Transit service should be integrated, permitting ready transfer between modes. Timed-transfer focal point service can provide better service between more destinations with the possibility of cost savings.

Transfer points should be located close to activity nodes and where possible should be physically integrated with buildings providing climatic shelter.

DISCUSSION: Given that shopping and employment destinations in large metropolitan areas are changing, and that timed-transfer focal point transit systems have been successfully implemented in several Canadian cities; it would appear that especially for the larger metropolitan areas, basic transit policy emphasizing central destinations merits re-examination. Day-long timed transfer focal point service with peak-hour express routes may satisfy changing needs better than total central business district orientation.

The timed-transfer focal point system appears to be working particularly well in Edmonton where the system has recently been extended to include transfers to the LRT system.

In Regina, the timed-transfer system operates for transfer between the dial-a-bus system and regular bus service.

Intermediate walking distance at transfer points can be reduced by integrating transfer points for all modes including bus, paratransit, rail and park & ride, at local centers. Climatic shelter in a pleasant environment is provided and high quality service to a local centre is an additional benefit.

Integrated transit service permits ready transfer between modes, co-ordination of schedules and avoids duplication of service.

In one case study city, the main feeder transit routes for one neighbourhood are shopping and activity-oriented,providing relatively poor work-trip service with connecting bus service to the train station. The shopping and activity node and the line-haul transit station are in separate locations and planners were forced to choose between them. The advantage of having both these facilities in one area were evident during the case study investigations.

IMPLICATIONS:

User: For the user an integrated transit service, particularly one offering timed-transfers, provides improved access to a greater number of destinations with shorter trip time due to shorter waits at transfer points. Passenger comfort is improved when climatic shelter is provided at these points. When transfer points are located at activity nodes this also provides improved access to these locations.

Resident: For the neighbourhood resident, concentration of activity around nodes may result in quieter neighbourhoods.

Developer: For the developer, concentration of activity provides an area in which he can be assured of a better return on his investment through concentration of clientele. The speculator,however,may no longer be able to reap the benefits of haphazard development.

Transit: For the transit company, integrated service may result in increased ridership and lower costs, through the elimination of duplicate services.

Municipal: For the municipalities, integrated transit service and concentration of activity can respond to urban planning objectives. Good transfer between suburban focal points may direct cross-city traffic away from the central area and reduce congestion.

3. Transit Level of Service

OBJECTIVE: To provide public transit at a level of service appropriate for a particular neighbourhood unit.

RECOMMENDATION: Transit operators must recognize that varying the level of service for different neighbourhood units may be desirable. Procedures should be developed for application of a range of standards as opposed to a single standard system.

DISCUSSION: Level of service has been defined in the literature as consisting of the following components:

1. Accessibility: a) Walking distance.
   b) Topography.
2. Travel time: a) Internal - major factors are route length, route geometry and number of stops.
   b) External - includes transfer time, primary and feeder travel time and walking time to destination.
3. Frequency.
4. Reliability.
5. Directness: a) Number of transfers.
6. Density: a) Passenger - seat ratio.
7. Amenities: a) Shelters, heating, seating and maintenance.
   b) Bus cleanliness and comfort.
   c) Passenger information services.
   d) Driver conduct.

Although all of the factors can be shown to be inter-related, two are of particular relevance to the neighbourhood designer: accessibility and internal travel time.

These factors, and to some extent directness, can be affected by the physical design of subdivisions. All of the others depend mainly upon decisions of the transit company or regional authority.

Presumably, once certain minimum standards have been met, it is the purpose of the transit company to so adjust level of service as to obtain maximum modal split within a particular neighbourhood.

Preliminary studies to determine if existing transit models could be used indicate that there is no model available, calibrated on a neighbourhood scale,which predicts feeder transit ridership and which can be used by the subdivision designer to fully evaluate alternative transit options. The model used indicated that transit ridership varies in direct proportion to density and did not indicate increased modal split with increased density. This is in contradiction to some of the empirical conclusions found in the literature and merits further study. The model also indicated income level as a significant parameter affecting modal split.

Level of service can be adapted to the characteristics of the individual neighbourhood. In Regina, Saskatchewan, for example, off-peak dial-a-bus service is provided for activity trips, while during peak periods fixed route service (for work trips) is provided.

In the Ottawa region, mini bus service on a low frequency schedule is provided in some high-income neighbourhoods where there is resistance to the use of full size buses on local streets. Presumably, the residents of these neighbourhoods are prepared to accept less frequent service with the benefit of quieter neighbourhoods.

Special services may have to be provided to special groups - transit dependants. More frequent service may be necessary in low-income areas, for example, because these users have no choice - they depend on public transit.

IMPLICATIONS:

User: If transit policy relates level of service to user requirements then the system will obviously provide greater benefits to the user. This will apply to the majority of users but could result in less service for a small percentage of users. Economy of operation should keep fares down.

Resident: There should be no major advantages or disadvantages for the neighbourhood resident as level of service changes.

Developer: If the developer is aware of a level of service policy and can predict its application to his development, then design can incorporate this as a feature.

Transit: For the transit company, a flexible level of service policy should provide maximum economy of operations and better use of available resources.

Municipal: Changes in level of service can enable the municipal government, through the transit company, to respond to social objectives. Lower transit company deficits will reduce taxes.

4. Transit Routes

OBJECTIVE: To adapt transit routes to particularities of neighbourhood design.

RECOMMENDATION: Determination of location of routes and type of service must form part of the subdivision approvals process. This would provide for both approval by the transit operator of proposed routes and involve a commitment by the transit operator to provide service.

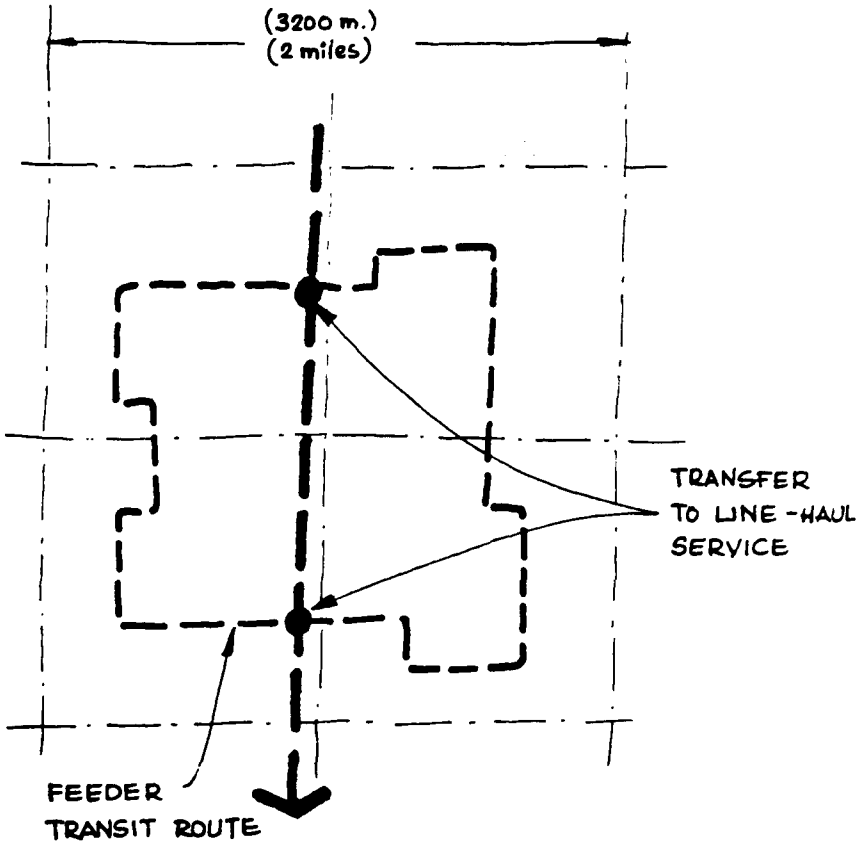
DISCUSSION: In the case studies, conventional buses were observed to use local narrow streets, negotiate bad turns and travel on slopes of 20 to 50% on a regular basis, since these routes best served the population of the neighbourhood. This was particularly evident in Saint John, New Brunswick. The use of main roads was not the prime criterion for bus route location if main roads did not provide proper access to transit users. In Laval, major local feeder transit route deviations were observed to serve activity nodes such as shopping centres.

In many cases, transit routes are planned after neighbourhoods are well established. They use local streets and make an excessive number of turns to provide service to activity areas and transit users. It is essential to proper provision of transit service, particularly with regard to new neighbourhoods, that route location be determined at the same time as subdivision design takes place.

Consideration of feeder service route length and frequency of service may determine that a single bus must provide service to more than one neighbourhood unit. The effect of this requirement is to tie transit routes to the design of several

neighbourhoods. In the sketch following, if the length of route through each neighbourhood is approximately 3 kilometres and if the bus travels at 24 km/h on a 30-minute frequency, a single bus can provide service to four neighbourhood units.

(4 x 3 km ÷ 24 km/h = 30 minutes).



IMPLICATIONS:

User: When transit routes are planned in advance and adapted to neighbourhood design, the user can depend on security of service and can plan transit use on a permanent basis.

Resident: For the neighbourhood resident, knowledge of transit route location can enable selection of a house in a quiet area. Noise and traffic can be avoided with some assurance that routes will not be changed and that what was once a quiet street will not become a bus route.

Developer: For the developer, knowledge and security of tenure of bus routes should be a good selling point.

Transit: For the transit company, pre-determination of routes involving participation in subdivision decisions will provide economical routes but will also involve a commitment to provide service.

Municipal: For the municipalities, pre-determined transit routes provide needed information for co-ordination with zoning decisions and can assist in the location of public buildings.

5. Transit Changes

OBJECTIVE: To minimize the effects of major transit changes by providing design which can accomodate the possible range of future changes.

RECOMMENDATION: Transit operators and regional planners must provide those involved in the subdivision process with detailed information as to possible future transit changes.

DISCUSSION: A major change in neighbourhood feeder service can occur due to changes in the destinations of feeder buses. An example is Edmonton, Alberta, where until recently feeder bus service was downtown-oriented. With the recent introduction of the light-rail system feeder buses are now oriented to the LRT stations.

Flexibility in design is necessary to provide for future changes in regional transit service. Excessive attempts at specialization can render systems inflexible for future changes. For example, a decision to change from fixed-route bus to dial-a-bus could be very wasteful if buses were operating on private busways.

When transit operators make planners aware of possible changes particularly to the line-haul system, then flexibility can be built into planning to provide for these changes.

IMPLICATIONS:

User: For the user, awareness of possible future changes in line-haul service will mean minimum disruption when changes occur. This will improve security of service and the reliance on service by the user.

Resident: For the neighbourhood resident, provision for accomodating to a change in service means there will be no surprises caused by changes in traffic patterns.

Developer: For the developer, the provision for future changes in service may mean that he will be required to provide additional right-of-way for either roads or transit location. These may be additional costs of development but are economies in the long run for the municipal authority. Proper provision for future service can result in increased sales for the developer if he makes proper use of publicity about provisions for future service improvements.

Transit: For the transit operator, planning for the future can provide economies related to the acquisition of right-of-ways. The immediate additional costs for the transit operator in terms of planning and publicity required are offset by the greater savings over the long term, particularly if right-of-way is obtained at the same time as street right-of-way and at no cost.

Municipal: For the municipality, awareness of future transit changes can affect long range urban objectives. The municipality will be able to evaluate, for example, the costs of provision of additional collector streets if there is to be a change in direction of feeder transit service and to determine whether costs should be absorbed now or in the future.

6. Dial-a-bus

OBJECTIVE: To discuss the considerations related to provision of dial-a-bus service.

RECOMMENDATION: Dial-a-bus appears to offer the best level of service for feeder transit but at high cost. Further evaluation of methods to reduce operating and maintenance costs for smaller buses are necessary before dial-a-bus can be considered as a serious option.

DISCUSSION: Dial-a-bus has been tried in several Canadian communities and is still being operated (with some variations) in a few cities.

Principal reasons for discontinuing the dial-a-bus system are related to its high costs which are two or more times those for fixed routes. High costs are due to:

- labour (one driver per minibus of a dial-a-bus costs the same as one driver for a conventional bus);
- maintenance (minibus vehicles currently used have high maintenance requirements and low service lives compared to conventional buses).

These costs offset any initial benefits due to lower capital cost.

Dial-a-bus provides transit service to the elderly and handicapped without special bus systems.

Dial-a-bus provides the highest level of service to the user, especially when combined with timed-transfer service. Any automobile-oriented subdivision works well for dial-a-bus.

IMPLICATIONS:

User: For the user, dial-a-bus theoredically provides the highest level of feeder transit service. There is usually a small fare surcharge. This is minimal cost compared to service provided.

Resident: For the neighbourhood resident, dial-a-bus means that buses will travel on almost all streets at some time. The use of minibuses minimizes problems due to noise and pollution.

Developer: Increased sales will be likely with publicity given to high quality transit service. There are fewer constraints to design.

Transit: For the transit company dial-a-bus means higher operating cost plus additional costs for the operation of the telephone and dispatching system.

Municipal: For municipal government, dial-a-bus means the necessity of higher subsidies for transit,which means higher taxes. Increased use of public transit may achieve other objectives such as lessening downtown congestions.

7. New Neighbourhoods

OBJECTIVE: To provide service to new neighbourhoods at the earliest possible date.

RECOMMENDATION: Staged neighbourhood growth and early introduction of transit service are essential for integrating a neighbourhood into the transit system.

Subdivision by-law requirements for phased construction of neighbourhoods should provide for location of temporary service routes along the same roads as final service.

Some relaxation by the transit company of cost recovery requirements for new routes is required to provide adequate service before use of other modes becomes established.

DISCUSSION: The provision of service to new neighbourhoods before they have developed to maturity and preferably to coincide with the arrival of the first residents presents two problems - physical and financial. The physical problems are related to route location during a period when neighbourhood construction is not completed. Financial problems are related to recovery of costs when full service is not established.

In one city, transit officials complained that a major new neighbourhood, considered to be well planned, will be almost impossible to serve until development is completed because staging of construction does not provide for transit routes.

In Ottawa, staging of neighbourhood development and transit routes are co-ordinated to facilitate provision of immediate service.

In Edmonton, where this is also attempted, officials explained that staging of service during construction of neighbourhoods is a problem particularly when temporary service is better (for some residents) than the final route.

At the False Creek development in Vancouver, day-one service has been provided to project residents although the population size did not justify transit. Bus service is provided by the charging of a $0.35 base fare (similar to the city service) in addition to a $5.00 per month per household assessment regardless of whether the service is or is not used. Operating costs are still not fully covered. This special charge will be eliminated when transit operation is at "normal deficit" levels.

IMPLICATIONS:

User: For the transit user, early provision of service will establish transit use habits and provide for less automobile dependence.

Resident: Properly planned day-one service and staging of construction can eliminate temporary routes. The direct benefit to residents is less noise and quieter neighbourhoods.

Developer: For the developer, this procedure provides an obligation to phase development. Phasing of development may involve higher costs for the developer who may be obliged to develop areas with higher service costs in the initial phases. Provision of early transit service, however, should be seen by the developer as an aid to sales.

Transit: For the transit company, provision of day-one service may result in initial deficits but, in the long run, costs may be balanced by modal split benefits if transit use habits can be developed.

Municipal: For municipal government, proper phasing of development can reduce additional cost due to leap-frogging development and can increase economy in maintenance of systems. For example, a properly phased development providing for a continuous road system may be cheaper to maintain with regard to snow removal than an poorly phased area with dead-end streets.

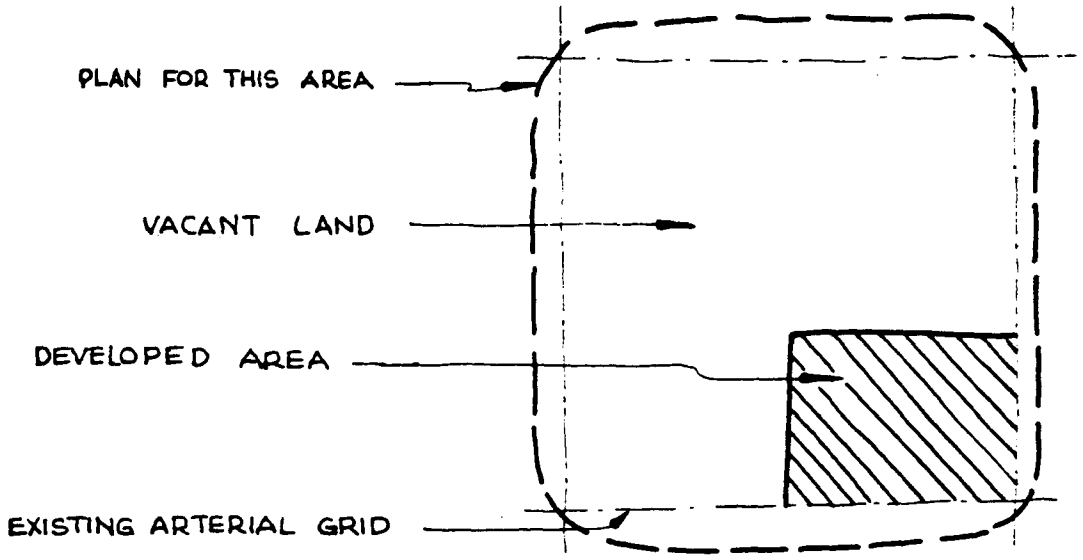
Municipal government, through payment out of revenue for transit service, will be called upon to subsidize early service.

8. Neighbourhood Size and Shape

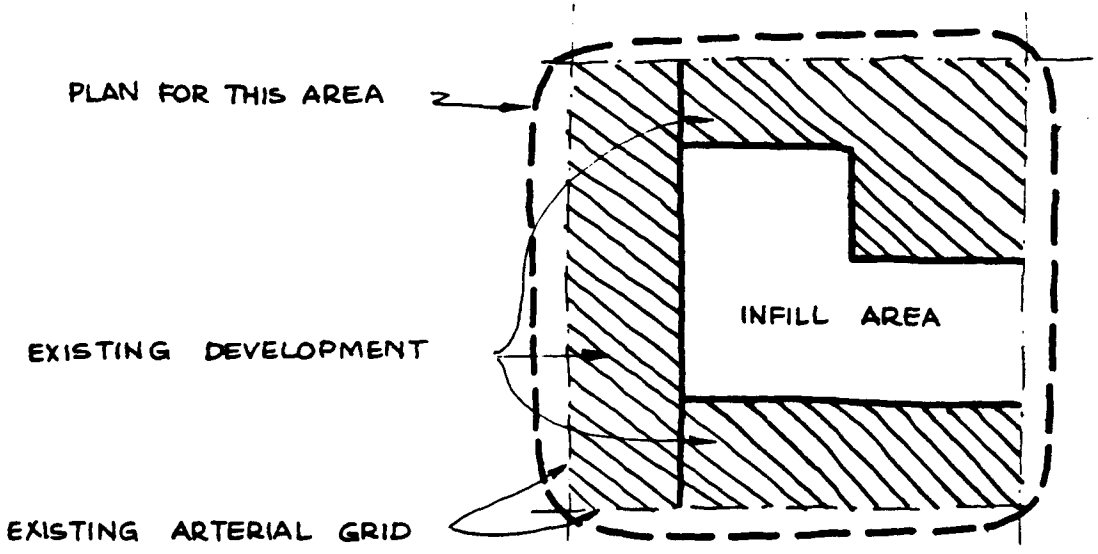
OBJECTIVE: Neighbourhood size and shape must be suited to the available transit alternatives.

RECOMMENDATION: The regional plan should provide for the preservation of or alterations to the arterial road system as a function of neighbourhood size as related to transit.

Neighbourhood units should be determined, based on size criteria. Planning approvals should be provided for entire units only.



Planning for infill situations should be based on consideration of the entire neighbourhood.



DISCUSSION: The historical pattern of arterial road spacing in Canada is one-mile (1600-metre) spacing. Other spacings are noted but not widely. Development generally conserves this pattern.

Spacing of line-haul bus routes is usually a direct function of the available road network operating most frequently along the arterial grid.

The attainability of a rational location of routes within the neighbourhood is decided by the choice of neighbourhood size and shape. One-mile diameter, or slightly under, appears to be an optimal neighbourhood size given normal suburban densities.

If services are to be provided internally the square or circular neighbourhood provides the lowest average walking distance.

Linear forms of neighbourhood organization increase walking distances to central services and may not permit provision of flexible regional distribution networks. In Toronto, neighbourhoods where the street pattern forms a half-mile grid are considered by transit officials to be relatively well served. Elsewhere, however, a one-half mile collector street sub-grid does not provide sufficient transit access to meet walking distance criteria and population demand because routes have had to be diverted onto local streets to improve service.

Even in infill situations or where land ownership patterns determine parcels for development smaller than either the historical arterial grid or the optimum neighbourhood size, it is advisable to plan for the entire neighbourhood. Otherwise, fragmented neighbourhood development and sub-optimal regional transportation will result.

IMPLICATIONS:

User: For the transit user, planning on the basis of integrated neighbourhoods tied to an arterial road system should result in improved service both within the neighbourhood because of concentration of development, and outside the neighbourhood through better line-haul service.

Resident: For the neighbourhood resident, planning on the basis of an integrated neighbourhood will provide a better environment and increase property values.

Developer: For the developer, controls of this nature will involve higher planning costs and probably approval delays. In the long run, however, they are likely to ensure more viable developments.

Transit: For the transit operator, planning for integrated neighbourhoods provides less dispersion of residential areas and economy of operation of the transit system.

Municipal: For municipal governments, the requirement to plan for entire neighbourhoods is a valuable planning tool to control development. Preservation of the historical arterial grid is usually seen as a short term economy. One of the principal problems related to preserving the historical road systems as the neighbourhood limits is that the rights-of-way for these roads are generally smaller that standard, resulting in congestion. Planning for the entire neighbourhood can at least make provision for either replacing these arterials within the new plan or for future widening.

9. Collector Roads

OBJECTIVE: To minimize route length and provide maximum co-ordination between bus route location and collector roads within the neighbourhood.

RECOMMENDATION: The neighbourhood plan must provide for proper orientation of collector roads to serve transit destinations.

Bus routes should be designed at the same time as neighbourhood layout and should, wherever possible, coincide with collector routes within the neighbourhood.

DISCUSSION: One of the basic choices facing the subdivision designer concerns external and internal emphasis design options and the corresponding choice of transit routes.

The external option concentrates activity from commercial and higher density housing (sometimes recreation and schools) along the arterial roads defining the neighbourhood. The same arterials are then used as main transit routes providing both local and through service. Secondary transit service within the neighbourhood is usually to a much lower level of service as it serves low density residential areas only.

The internal design option concentrates activity within the neighbourhood with little or no contact with arterials. Transit routes may be within the neighbourhood only or may be a combination of internal and external routes, possibly with a transfer point.

The subdivision designer, in selecting a basic option, must choose between what he wishes to accomplish in terms of creating an urban environment and economy of design of possible transit routes. The basic trade-off is between local service (providing feeder transit along the activity concentration with best and closest access to the transit route) and through service (providing a route with minimum interruptions and maximum speed to provide shorter travel time).

Whatever the choice of option, it is essential that routes be provided which are oriented in the direction to be used by transit.

Study of a series of design alternatives and case study observations led to the following conclusions:

- straight-line routes provide the best through service but offer no opportunity for lateral movement. Toronto is a good example of this type of service;

- "S" curve routes and feeder loops provide best service when running perpendicular to main routes. Routes providing the broadest range of service between destinations within the neighbourhoods as well as to external points consist of loops or "S" curves within the arterial grid with transfer to main lines along the grid.

No special design requirements exist to accomodate bus service on neighbourhood collector roads. ITE standards state that collectors built to recommended standards will be adequately sized for bus operation. During the case studies, buses were observed operating on roads well below collector widths, slopes and geometry.

In one case study city, where road construction standards (quality of pavement) are not co-ordinated with transit routes, there has been a serious deterioration of some road surfaces.

For feeder service within the neighbourhood,bus routes may be fully accomodated on collector streets. Without additional external traffic justification, busways do not appear to be economically suited to a local feeder service.

In another city, reserved busways were observed to be used as collectors by automobile traffic because there was no physical barrier to traffic (only signs). The physical pattern encouraged through traffic and there was no obvious requirement for a reserved busway within the neighbourhood.

The dangers of over-designing for transit were noted in the example of a collector street in a third case study city which was constructed especially to accomodate transit. The pavement is extra-wide, sidewalks have been built on both sides and bus bays built on both sides at transit stops. The transit line runs on a parallel street - no sidewalks, narrow pavement, but that is where the passengers are.

IMPLICATIONS:

User: For the user, proper orientation of streets within the neighbourhood will permit flexibility of use of the transit system and access to more destinations.

When bus routes are designed to be fully accomodated on neighbourhood collectors, the user may find that travel time is reduced and that the ride is smoother with better accessibility.

Transfer between neighbourhood feeder service and line-haul may be viewed by some users as an incovenience particularly in the Canadian climate.

Resident: For the resident, confining buses to collector streets will provide a better environment with less noise and traffic on local streets. Transit service is likely to stay on collectors if they are properly oriented and not be diverted to local streets.

Developer: For the developer there is little additional cost in providing properly oriented streets systems. Additional transit benefits may be used in marketing a project.

The developer will have only one major right-of-way to cede if bus routes coincide with collectors thus providing an economy of land use. Requests for private bus lanes and links are viewed as wasteful of land by developers.

Transit: The transit operator can provide a more rational system tied to regional economic requirements if he can provide bus service along properly oriented routes. Foreknowledge of the existence of properly oriented routes within the neighbourhood will improve transit planning.

Transit officials may view bus routes coinciding with collectors as preferable to bus routes on local streets but at the same time meaning longer travel times than for buses accomodated on reserved bus ways.

Municipal: For the municipality, the necessity to provide a proper orientation of route can be an additional restriction to planning and may add additional administrative procedures. However, since transit destinations are likely to be automobile destinations the general orientation of collectors for transit should also serve automobile traffic. Some traffic problems may result from bus routes coinciding with collector roads.

10. Level of Service Design Factors

OBJECTIVE: To design neighbourhoods with provision for desired level of transit service.

RECOMMENDATION: Level of service factors which directly affect physical design - walking distance and bus stop spacing - should be considered basic design criteria and should be indicated on all documents submitted for subdivision approval.

DISCUSSION: The elements affecting level of service which must be considered by the subdivision designer are:

1. Walking distance.
2. Route length.
3. Route geometry.
4. Bus stop spacing.

Route length is a function of design at the neighbourhood level and relates to location of arterials and collector streets based upon walking distance considerations.

Route geometry is adequately covered by existing standards and is generally not a significant factor when transit routes coincide with arterial or collector streets.

Thus, the two variables which must be taken into account by the designer are walking distance and bus stop spacing. An optimization of walking distance and bus stop spacing would provide the maximum number of people grouped around the minimum number of stops. Both these factors should be an inherent part of the subdivision design process.

In Edmonton, the subdivision approvals requirements are that transit routes and stops be indicated on plans submitted.

IMPLICATIONS:

User: For the user, incorporating level of service standards for transit access with subdivision design means better service and a more even application of standards for access to transit.

Resident: There is likely to be no direct implication,for the resident of a neighbourhood,by design for these factors beyond the possibility of quieter neighbourhoods through increased use of transit.

Developer: For the developer, provision of level of service criteria as basic subdivision requirements is an obligation to provide good planning. Developers may contend that this would increase costs, require provision of a higher level of information and lengthen the approvals process.

Transit: For the transit operator, proper application of these standards should increase modal split, decrease costs of providing adequate service and shorten the length of route necessary to provide coverage.

Municipal: For municipalities, application of these standards will require additional approval surveillance. They present additional constraints to trade off against other planning related to topography, vegetation, soils, etc.

11. Walking Distance

OBJECTIVE: To determine a band of transit coverage related to actual walking distance as a standard for the subdivision designer.

RECOMMENDATION: Standards for actual walking distance must be established. It is recommended that they be based upon:

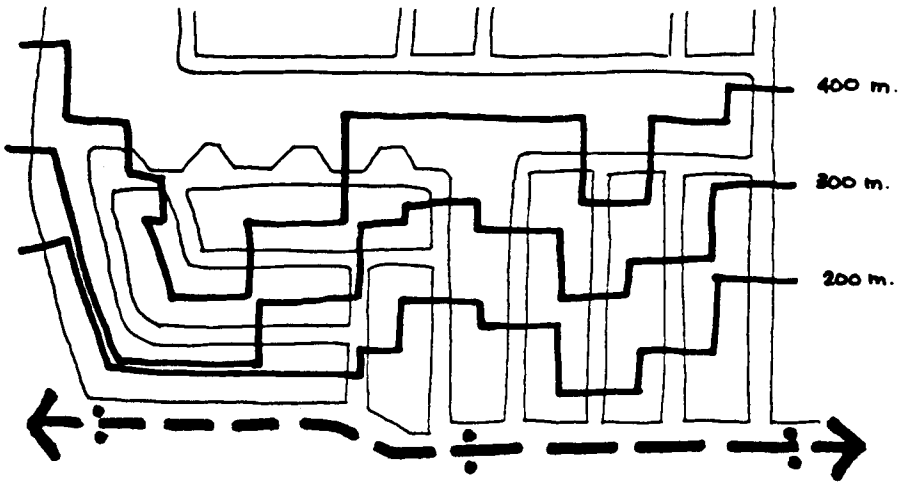
a) Minimum percentage of potential users within a specified distance.

b) Maximum percentage of potential users beyond a specified distance.

A rational criterion for new neighbourhoods would appear to be a minimum of 40% of users within 200 m (660 feet) actual walking distance and a maximum of 15% of users beyond 400 m (1320 feet) actual walking distance. This implies a density gradient with concentration of development around bus stops.

For existing uniform density neighbourhoods a rational criterion would appear to be simply a maximum of 15% of users beyond 400 m (1320 feet) actual walking distance.

Subdivision plans submitted for approval should be required to indicate walking distance contours.



DISCUSSION: In Canada and the United States, the accepted rule of thumb for transit coverage is ¼ mile (400 m), as the crow flies, to the route (not the stops). True walking distances where this standard is applied are usually substantially longer. European standards do not appear to differ greatly. There is a continuing trend both in Europe and North America to reduce walking distance standards. The trend in North American literature is to call for reductions of up to 50% in current walking distance standards mostly on the basis of observed travel behaviour.

Recent service standard reviews have selected about 400 m true walking distance as a maximum and determine that the equivalent measure of route coverage is a 300 m (1000 feet) wide band on either side of the route. The change from a 400 m band of coverage to 300 m is a significant reduction in actual walking distance.

Walking distance standards expressed as a maximum are not the most effective way of evaluating level of service. Willingness to walk does not vary linearly with distance. There is an exponentially increased accessibility value of land close to a bus stop. Walking distances expressed as a frequency, applied by designers to site specific situations, will result in increased densities around bus stops.

Walking distance standards must also be adjusted to compensate for obstacles in the user's path, such as slopes and busy intersections, or limits on the users physical mobility caused by age, handicap, carrying parcels or accompanying children.

IMPLICATIONS:

User: For the user, any reduction in walking distance may be viewed as a direct improvement in service. The principal requirement would appear to be to relate the type of user to location. That is, to provide the population most likely to require transit with the more favoured sites within a neighbourhood.

Resident: There would appear to be little benefit to reduce walking distances to the resident of a neighbourhood who is not a transit user. When non-transit destinations are grouped with transit destinations, proper planning for short walking distances may also provide better pedestrian access to activities without use of transit within the neighbourhood.

Developer: For the developer, application of walking distance standards presents a constraint to design and offers the advantage of improved transit service. The cost of providing walking distance contours with subdivision plans should add less than five percent to planning costs.

Transit: For the transit operator, proper application of walking distance criteria will result in higher ridership at an improved revenu/ cost ratio.

Municipal: There would appear to be little direct advantage to municipal government with walking distance standards designed to improve transit access. However, when these are combined with other activities there can be considerable savings. When design can provide (as in Toronto) pedestrian walkway systems to eliminate school buses, municipal costs are reduced.

12. Bus Stop Location

OBJECTIVE: To provide maximum accessibility to transit through bus stop location and bus stop spacing.

RECOMMENDATION: Existing standards for bus stop spacing appear adequate and no particular benefit appears to result from decreased spacing.

High density residential, institutional and commercial uses should be grouped along bus routes with densities increased around bus stops and primary transit stations.

Transfer points should be located directly on the bus route, preferably grouped with some of these uses.

DISCUSSION: Present and proposed standards for bus stop spacing are 250 metres (750 feet) sometimes stated as 4 stops per kilometre (7 stops per mile) to allow flexibility in bus stop location. At this spacing, average speed cannot exceed roughly 24 kilometres (15 miles) per hour. Actual average speed on local roads would probably be less.

In a detailed study prepared in conjunction with this report, (Appendix C) of two of the case study areas, Laval, Québec and Mill Woods, Edmonton, an attempt was made to improve the walking distance coverage through shorter bus stop spacing. The results were only marginally effective if the optimum walking distance was considered to be 400 metres (1320 feet). Even when bus stops were almost doubled with spacing reduced from 366 metres to 183 metres the improvement in walking distance coverage was less than 10%.

As may be expected the results are more significant for shorter walking distance. The improvement in reduced bus stop spacing for 200 metre walking distance is 40%. From this we may conclude that it is important to reduce walking distances by concentrating development around bus stops.

Although different patterns of concentration of zoning are possible it is essential that commercial, public and high density uses be concentrated along transit routes and at stops.

IMPLICATIONS:

User: When bus stops are combined with a concentration of uses, service is improved by providing accessibility and long range security of stop location. Stops which coincide with activities are not likely to be changed.

Resident: When bus stops coincide with activity nodes they provide an identified urban environment which once again is unlikely to change and thus provide stability for the neighbourhood. This is regarded as desirable by residents.

Developer: For the developer, this requirement, as any zoning requirement, may be seen as providing restrictions on land use. This requirement, together with that for phasing of development, may make it necessary to develop the high cost areas first, thus a financial disadvantage to the developer.

Particularly in suburban situations, developers have traditionally (because of market conditions) built low-density residential areas first with commercial and higher density residential areas being developed only after a population base has been established.

Transit: For the transit operator, tying bus stops to activity locations means that routes are unlikely to change and the reduced walking distances and activity nodes are likely to provide more riders and thus a better modal split for the transit company.

Municipal: For the municipality, the concentration of activities will provide an economy in services and maintenance.

13. Transit Dependants

OBJECTIVE: To provide maximum accessibility to public transit for transit dependants such as the handicapped and senior citizens.

RECOMMENDATION: During the planning process, sites for institutions grouping transit dependants (such as homes for senior citizens) should be provided in close proximity to bus stops along logical transit routes.

Sites along secondary routes may be preferred to provide a quieter environment - good transfer conditions (time and shelter) to primary routes are then necessary.

In areas with harsh climatic conditions direct access to the bus from a building entrance is desirable.

These requirements can be accomplished through:

1) Appropriate zoning by the municipality.

2) A clear policy by the transit agency.

3) Adoption of standards by agencies subsidizing housing for special groups (e.g. C.M.H.C.).

DISCUSSION: Transportation for special groups can be provided either by special bus service or by improved accessibility to public transit. Reduced fares for senior citizens, for example, are in effect in many cities (e.g. Ottawa, Toronto).

Although it is not possible to design transit to accomodate transit dependants living in their own homes or with relatives because of the difficulty in predicting locations, it is possible to design for concentrations of these people such as those found in senior citizens' residences.

B.C. Hydro transit officials in Vancouver, for example, consider provision of services to senior citizen facilities to be a major problem. Facilities are planned in locations remote from transit services. When opened, they request bus service and this can cause major routing changes.

This has been observed in most case study cities. In Coquitlam, a transit route was modified to pass in front of a senior citizens home. The route now requires 2 extra turns, travels on local narrower streets and provides a longer trip time for all users.

The TRRL Runcorn Busway Study indicated that average walking speed for men and women aged over 60 is 5.0 km/h as compared to 6.0 km/h for men under 30. For a 400 m walking distance the walking times are 4.8 minutes and 4 minutes. The time difference is not significant and we must assume that the requirements for service close to the residence are to minimize physical effort and to obtain shelter from the weather.

The criteria for location of institutions and selection of bus route most likely to satisfy their requirements imply that they be located in close proximity to bus stops.

IMPLICATIONS:

User: The benefits to the transit dependants are obvious. The benefits to other users are in reduced trip time (no detours), smoother ride (less turns) and improved accessibility (transit stays on main routes).

Resident: For the city resident,benefits are reduced noise and traffic on local streets due to elimination of detoured bus routes.

For the resident of the institution, location near bus stops may mean proximity to additional noise from general traffic and activity. The question is whether these groups require a totally tranquil environment or if they prefer being "where the action is". Current trends in senior citizen home location, for example, indicate the latter may be more important.

Developer: For the developer, setting aside a site in a prime location, near a bus stop on a transit route, may be considered a waste of high value land which could be sold for commercial or high density residential purposes.

Transit: Location of institutions near bus stops on best route locations minimize operating costs and relieve the pressures to change route or provide alternate (e.g. minibus) service.

Municipal: For the municipal authority this requirement imposes the responsibility to preserve sites for institutions through planning procedures, zoning or outright purchase. There is an additional requirement to defend this policy which may require purchase of costlier sites for these institutions.

The benefits will be less traffic in neighbourhoods, and lower contribution to special services.

14. Local Streets and Bus Stops

OBJECTIVE: To provide maximum access to bus stops.

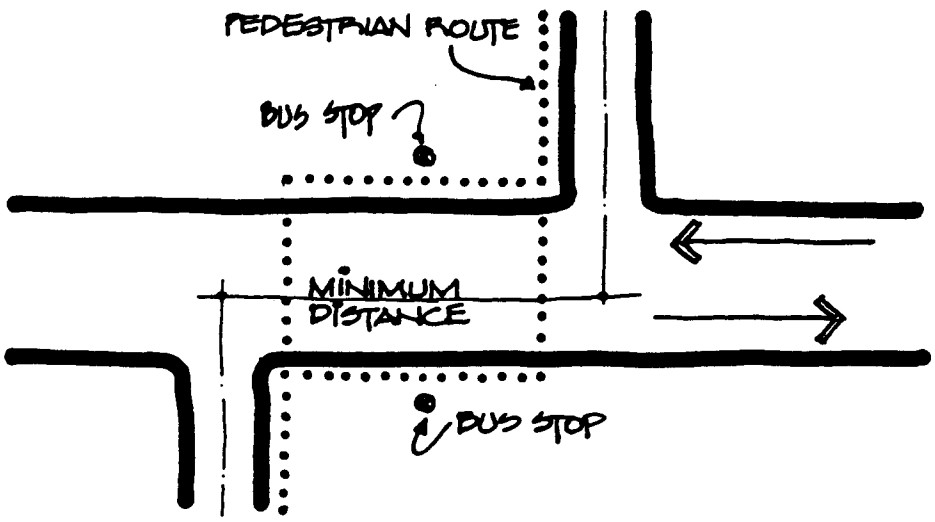
RECOMMENDATION: Locate intersections of local streets with collectors to coincide with bus stops. Provide for bus stops to be accessible to local streets on both sides of collectors.

DISCUSSION: Collector roads and transit routes having been determined, one of the principal decisions in local street design relates to the spacing of intersections with these routes. Ideally, these intersections will coincide with bus stops and spacing will be determined on the basis of the selected walking distance and to meet transit company standards. Previous studies indicate that reduced bus stop spacing increases the coverage for shorter walking distances but have little effect on longer distances. Closer spacing should thus be considered for areas with concentrated or high-density development along bus routes.

Development on both sides of streets used for feeder transit within the neighbourhood will increase the number of potential transit users.

There is a possible conflict between planning criteria to avoid cross intersections and bus stop locations which serve areas on both sides of a collector with maximum penetration.

One solution is locating intersections along collectors in pairs on opposite sides at the minimum separation with bus stops located between the local streets (far-side stops). If sidewalks or pedestrian paths are built on one side only they should be on the sides nearest the bus stops.



IMPLICATIONS:

User: For the transit user, proper location of intersections and bus stops will provide for shorter walking distances. Concentration of users will increase the possibility of a bus shelter being erected. For example, where the criterion for erecting a shelter is 250 users per peak hour.

Resident: For the neighbourhood resident, proper location and spacing of bus stops will ensure that transit service remains on collectors away from local streets.

Developer: No additional costs to the developer are involved if design is undertaken in early stages of development.

Transit: For the transit operator, proper co-ordination of stops with intersections to serve both sides means fewer stops and decreased travel time.

Municipal: Proper design can satisfy transit requirements without sacrificing criteria for automobile and pedestrian safety. Proper locations for bus stops can result in payment of installation or maintenance by advertising companies.

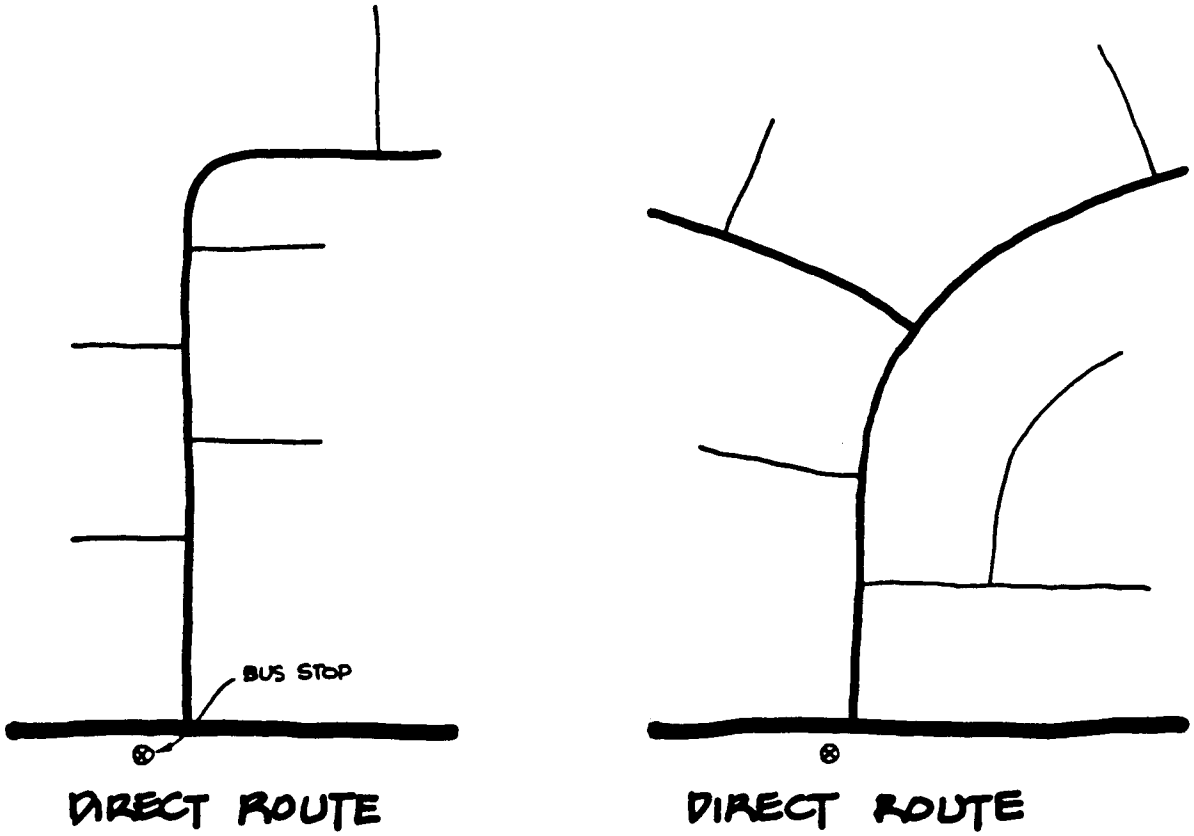
15. Local Street Design

OBJECTIVE: Provide shortest direct walking distance to bus stops along local streets.

RECOMMENDATION: Street design should be direct, avoiding backtracking and oriented towards bus stop locations.

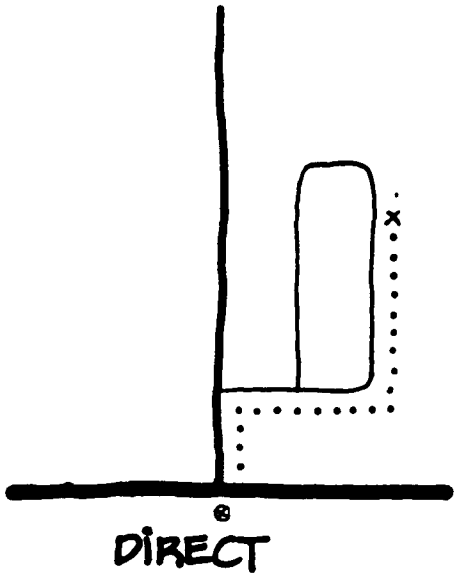
DISCUSSION: Roads to serve local residents should be planned as direct routes from the bus stop or main intersection and avoid backtracking.

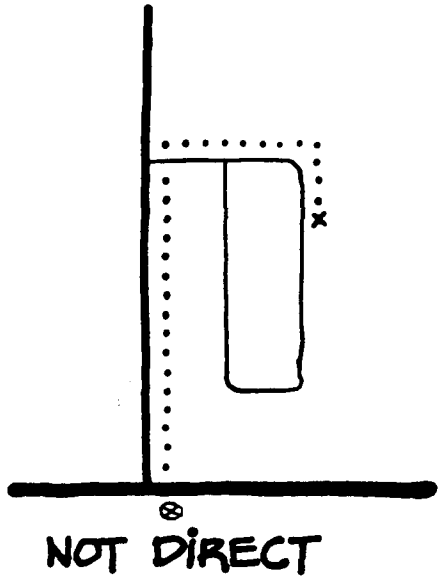
Only very minor differences in walking distance penetration result if the sub-collectors are straight or curved.

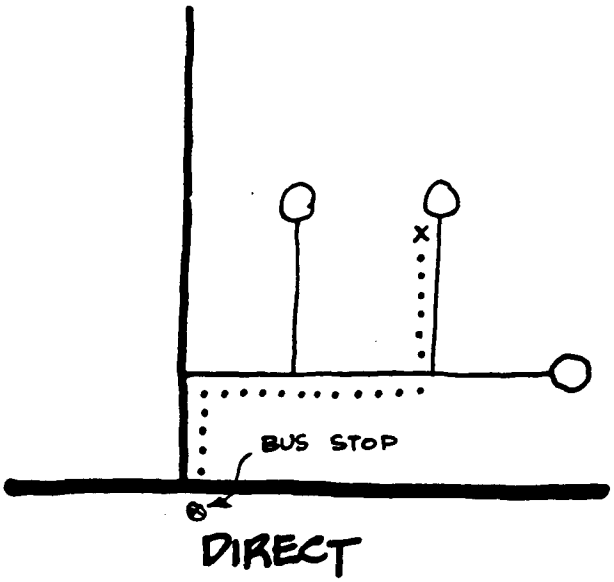


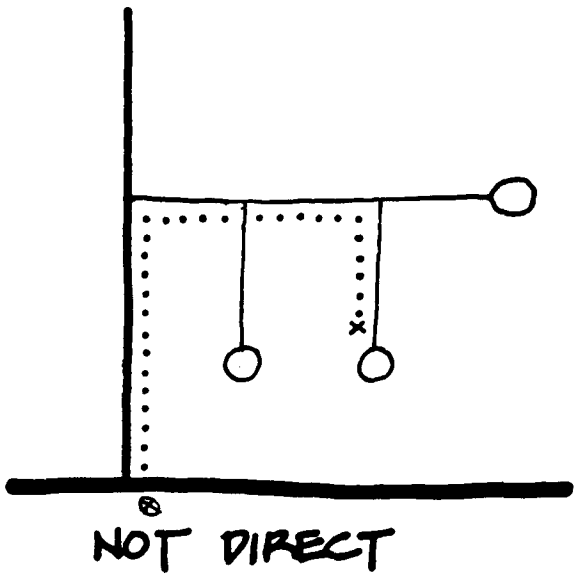
The essential criterion appears to be directness.

Systems designed to discourage automobile penetration can work equally well and still observe this criterion.

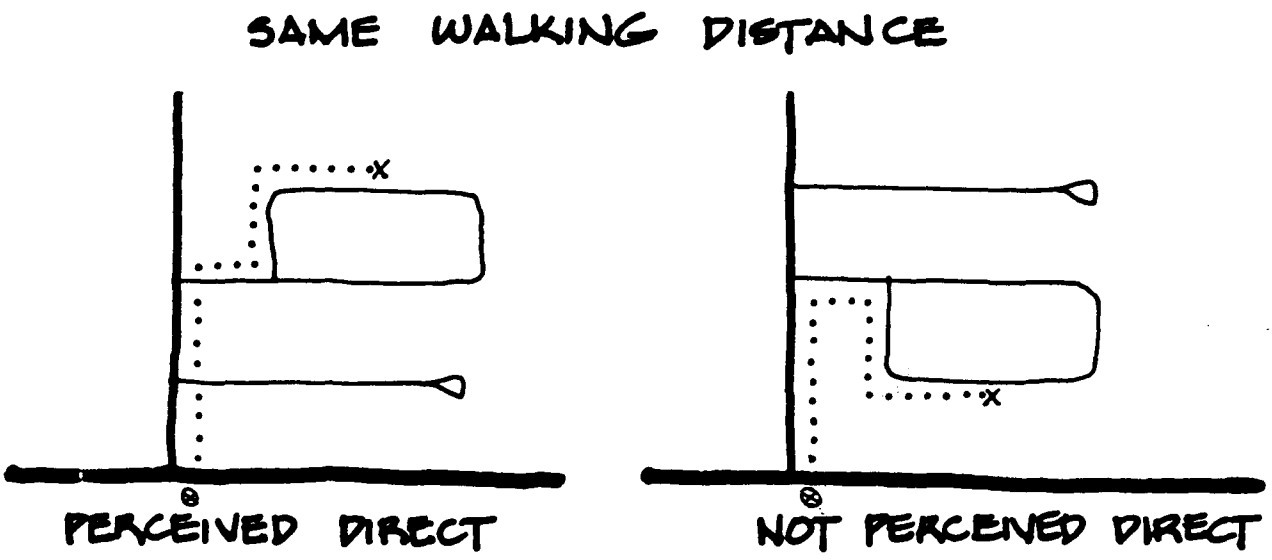




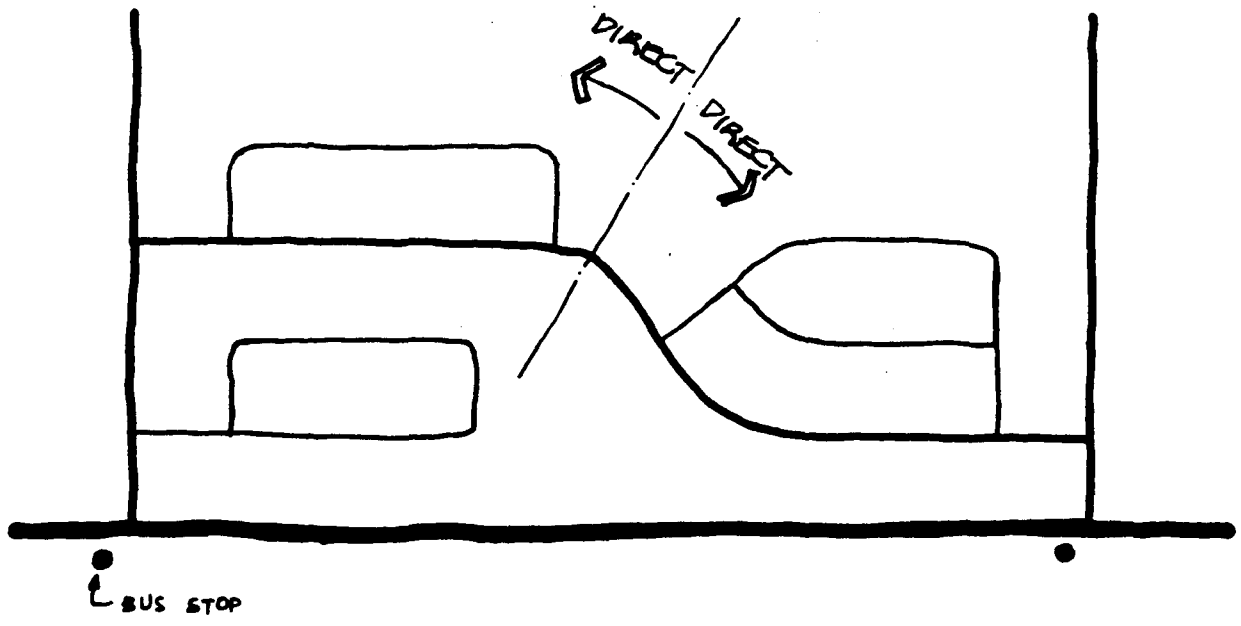




Equally important may be the perception of walking distance by the individual. Thus different patterns may have similar walking distances but may not be perceived as direct.



Use of direct routes for pedestrians need not restrict use of continuous street systems within the neighbourhood.



IMPLICATIONS:

User: Proper direct street design can considerably lower walking distance to destinations.

Resident: If design does not incorporate traffic short-cuts, the direct routes should not increase automobile traffic within the neighbourhood.

Developer: Direct design involves no additional costs for the developer. In fact, direct design is often the most economical, providing the lowest proportion of land to be ceded as streets.

Transit: There are no implications which affect routes and operations. Ridership may be increased.

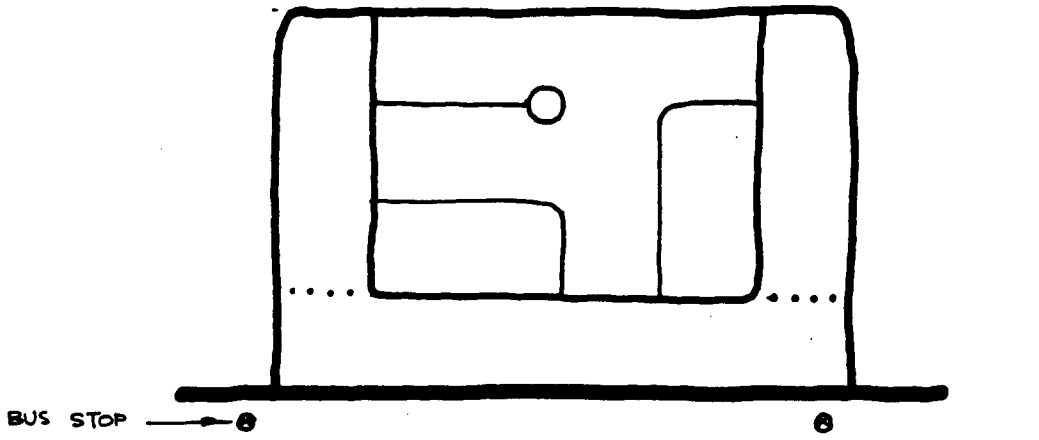
Municipal: There are no direct implications. Topography and sewer system design may cause some conflicts.

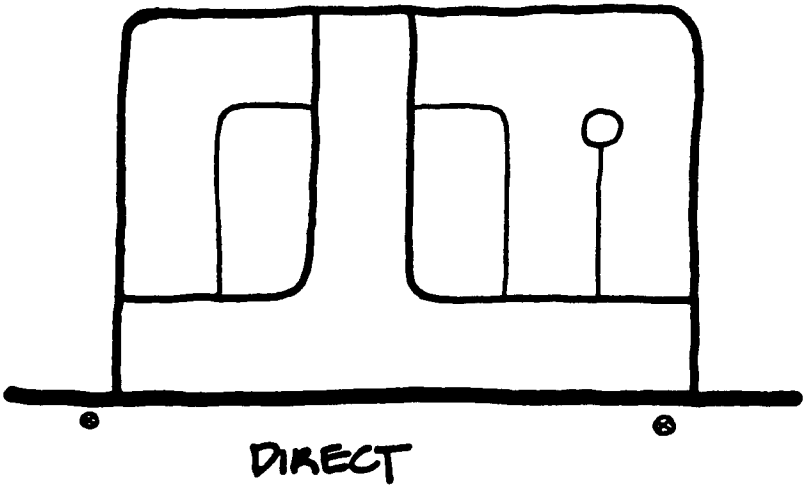
16. Walking Routes

OBJECTIVE: To provide for walking routes likely to receive best all-weather maintenance.

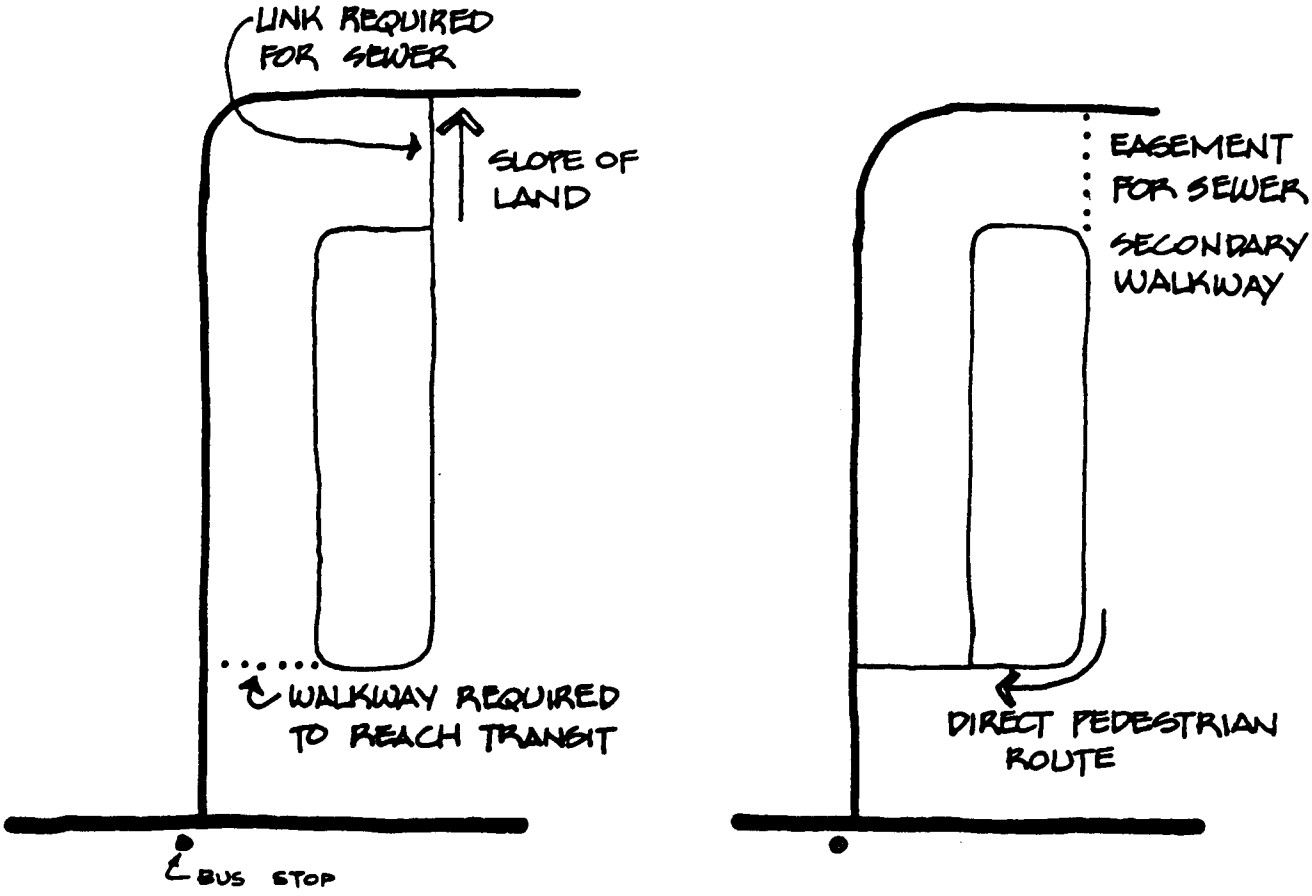
RECOMMENDATION: Shortest walking distance along road is preferable to a pedestrian walkway particularly when a sidewalk is provided.

DISCUSSION: It may be desirable to provide direct routes along streets and to minimize use of walkways since, in the Canadian climate, winter maintenance of walkways has been observed to be poor. Walkways are still snow covered although streets are cleared and could offer a route to the bus stop.





In areas where sidewalks are not built along all local streets the provision of sidewalks should be related to transit stops and walking routes to stops. When it is desired to limit entrances to discourage through-traffic, slope of land and sewer line installation may become determining factors and walkways are suggested as the solution. There is no reason not to provide the direct street link for pedestrians and to use a walkway for a secondary link and as a sewer easement.



IMPLICATIONS:

User: Direct pedestrian routes along streets can provide both shorter walking distances (or extended route coverage) and a attractively-perceived route for pedestrians.

Resident: Residents bordering walkways often object to them as an intrusion into their private living space.

Walkways may be safer, particularly for children, than routes which cross streets and traffic.

Developer: Savings or additional costs due to right-of-way requirements are minimal.

Transit: No direct implications.

Municipal: Walkway maintenance is a major problem. Many municipalities do not keep walkways clear in winter. Others give them last priority.

Many police departments consider that walkways contribute to incidence of vandalism and crime.

Public works departments may object to the proposal to build sewer system links in walkways.

17. Pedestrian Walkways

OBJECTIVE: To make best use of pedestrian walkways.

RECOMMENDATION: When pedestrian walkways are provided they should be:

1) co-ordinated to serve transit as well as other destinations
2) built in the initial stages of development.

DISCUSSION: The case studies and analyses of effects of adding walkways to existing subdivisions have indicated that pedestrian walkways have only limited potential in reducing overall neighbourhood walking distance.

Walkways used for transit purposes may be most effective when also oriented toward schools, recreation and other activities, particularly if they can be used to eliminate school busing. However,even school locations can change because of oversupply of classrooms on a regional basis. The walkway system most likely to remain permanently open and maintained is one serving multiple purposes and the widest variety of interest groups.

The case study visits and discussions with planning officials have shown that walkways must be developed before home occupancy to win neighbourhood acceptance. Design in residential areas incorporating walkway right-of-way for future development, or walkway introduction to existing neighbourhoods, can be expected to meet substantial opposition from residents.

IMPLICATIONS:

User: If walkways are to provide access to the transit system then they must be built and maintained. Lack of maintenance or detours may decrease transit use.

Resident: Walkways are viewed as advantageous only when they provide safe, traffic-free routes to destinations for children.

Developer: Unless an extensive walkway system is an integral part of a master plan with a perceived sales value, walkways are provided by developers only to satisfy regulation. In areas where walkways must be built by the developer, they are seen as contributing to higher costs.

Transit: Provision of walkways have little implications for transit operators.

Municipal: Construction and maintenance of walkways are considered to have low priority in most cities.

Extensive and costly school-oriented pedestrian walkway systems have been built and maintained to eliminate school buses in Toronto. Presumably the direct cost savings have been recognized.

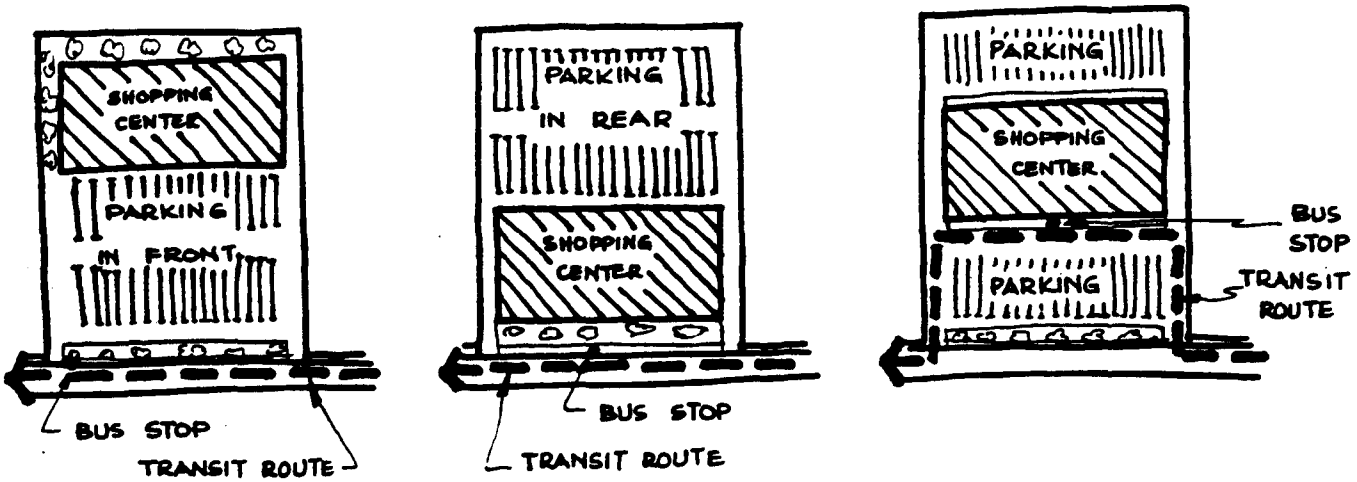
18. Building Setback Regulations

OBJECTIVE: To minimize actual walking distance through setback regulations.

RECOMMENDATION: Design to permit minimum setbacks of commercial, industrial and high density residential buildings along bus routes.

Development plans should provide for detailed siting of buildings and should include design of bus stop location to encourage maximum use.

DISCUSSION: Siting of buildings and setbacks can have considerable effect on walking distance. This is particularly true for commercial, institutional and high density residential uses. The walk across the parking lot may be enough to discourage the pedestrian from using public transit. A building with parking at the rear could be at 5 metres from the street line. A front parking lot could increase this to 50 metres or more. Design must attempt to place buildings closer to transit stops and routes. This may be accomplished by lowering setback requirements, locating parking at the rear. Maximum setbacks are still desirable along automobile routes without transit.



CURRENT PRACTICE REDUCED SETBACK BUS STOP AT BUILDING

Access can be improved by bringing transit into shopping centres with stops located near building entrances. If major apartment building entrances were designed to accomodate buses then the stop should be located at the front door.

IMPLICATIONS:

User: For the user, access to transit is improved and its use encouraged. Combining bus stops with building entrances provides climatic shelter.

Resident: Decreasing setbacks and providing parking at the rear may move automobile traffic off collectors onto local streets. Detail design must attempt to minimize access to rear parking lots from local streets.

Developer: Although there are no costs involved, shopping centre developers consider the visible parking lot as their best advertisement. For the developer, bringing the transit stop into the centre is the preferred solution.

Transit: Improved access means increased numbers of users. Moving the stop off-street to a building entrance increases travel time.

Municipal: For the municipality, any proposal to decrease setback standards involves re-assessment of traditional practice and possibly controversial changes to zoning regulations.