ACHIEVING INFRASTRUCTURE EFFICIENCY

Prepared by

IBI Group

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Achieving Infrastructure Efficiency

1.0 INTRODUCTION

In June 1992, Canada Mortgage and Housing Corporation and the Canadian Home Builders' Association will sponsor a workshop entitled "Infrastructure and Housing: Challenges and Opportunities" at the Centre for Studies in Construction at the University of Western Ontario. As a background paper for this conference, CMHC commissioned IBI Group to undertake a literature study of ways of achieving infrastructure efficiency through alternate planning approaches.

While the extent of municipal infrastructure costs is difficult to determine, CMHC noted in a report on Urban Infrastructure in Canada that total expenditure on roads, parking lots, runways, bridges, tunnels, watermains, filtration plants, storage tanks, sewers, drains and sewage treatment plants totalled $8.5 billion in 1988. (CMHC, 1989, p. 6). This should be compared to the estimated requirement in 1984 dollars of $12.3 billion (approximately $14 billion in 1988 dollars) to bring the existing municipal infrastructure in roads, bridges, sewer, and water systems up to an acceptable standard. (ibid, p. 12). This amount is based on the 1984 municipal survey undertaken by the Federation of Canadian Municipalities, and extrapolated to the national population.

To the costs of upgrading and maintaining the present system must be added those costs necessary to expand the systems to meet the needs of an increasing population.

It is in this context that one must ask: Can we design our cities differently so as to reduce infrastructure costs?

2.0 THE INFRASTRUCTURE PROBLEM

As the Federation of Canadian Municipalities (FCM) has noted, (FCM, 1985) the health and well being of Canadians depends on basic services like roads, sewers, water supply networks, schools and transit systems. Roads and other transportation and communication facilities are necessary for the economy to function. Sewers and water supply are necessary for human health and survival. Schools, hospitals and other human service facilities are necessary to maintain and enhance the health, welfare and safety of Canadians, particularly in a time of increasing global competition. Virtually all of these services, known collectively as "infrastructure" are supplied by municipal governments, with some assistance from the provincial governments.

Unfortunately, with increased emphasis on health, education, welfare, and other social services, the amount of money available to maintain, upgrade, and expand the transportation and water/sewer systems has been declining across Canada. One result has been a gradual and continuing deterioration of the physical quality of the basic municipal infrastructure.

2.1 COST ESTIMATES

In 1985, the FCM published a study of the physical condition and funding requirements for a number of elements of the urban infrastructure. Specifically, the study concentrated on six items: sewage collection; sewage treatment; water distribution; water treatment; roads; and bridges. The magnitude of the cost involved is difficult to determine. But from the information collected, the FCM concluded that the amount required to bring facilities up to an acceptable level in those municipalities in Canada with a population greater than 10,000 persons was $791.00 per capita (within that total, the amount required in urban centres of greater than 100,000 population was $680.00 per capita). Assuming a 20% increase in the inflation rate since the FCM study was undertaken, the cost per capita today to upgrade facilities would be approximately $950.00. Assuming a national population of approximately 25 million with 77% of that in urban areas greater than 10,000 population, the total cost today to upgrade the existing infrastructure would be between $18 and $19 billion, less any upgrading undertaken in the meantime. The Coalition to Renew Canada's Infrastructure notes in their submission to the Minister of Transport that "FCM's current published estimate is $15 billion, although numbers as high as $20 billion have been mentioned" (op cit, p.1).

The Coalition to Renew Canada's infrastructure also noted that a 1990 report from the Transportation Association Canada entitled "Canada's Roading Infrastructure: Selected Facts and Figures" had compared national expenditures and needed expenditures for both roads and structures. In 1988/89 fiscal year total federal, provincial expenditures

were $8.4 billion, while needed expenditures to maintain current standards were $11.4 billion.

But money is also required to expand existing systems in order to meet growth in population. For example, Metropolitan Toronto recently estimated that the cost of expanding the sewage collection system (i.e. the Don River and Keele Street sewer systems) would be $480 million to handle an additional 490,000 persons. This figure does not include increases to the sewage treatment plant itself, but is only the cost of increasing the collection system capacity.

In 1990, IBI Group undertook a study for the Province of Ontario which examined to costs and benefits of different growth scenarios. Exhibit 7 of the Summary Report displayed the capital costs necessary to handle a population growth of 2 million persons (from 4 million to 6 million) in the 30 years form 1990 to 2021. Total major road costs range from $13.2 billion (for a concentrated or centralized growth scenario) to $19.9 billion (for a dispersed or "spread" scenario). Water sewer costs would be about $3.7 billion, regardless of the growth pattern chosen, while local road and servicing costs would range from $9.0 billion (centralized) to $15.8 billion (spread). (IBI Group, 1990, Summary Report).

Total capital costs, including human services, environmental upgrading and transit would total about $2.55 billion per year, compared to the actual expenditures in the 1984-88 period of about $1.78 billion per year (ibid, Exhibit 8). A follow-up report by IBI Group, reviewing the Urban Structure Concepts Study, estimated that annual capital expenditures on roads in the Greater Toronto Area had been approximately $350 million (in 1989 dollars) in the 1984-88 period; were projected to be $385 million in the 1990-94 period; and needed to be between $550 million (concentrated option) and $790 million (spread option) to meet 2021 requirements.

2.2 AMO'S REPORT

The Association of Municipalities of Ontario (AMO), in a March 1985 report, also discussed the problems facing municipal infrastructure in Ontario. The report was largely based on the FCM task force set up in 1984, as well as on information from the Ontario Good Roads Association, and the Road Information Program of Canada. AMO noted that the vast amounts of infrastructure constructed just after the second world war, to handle the rapid increase in urban population in Canada, had been maintained until the 1970s. Since that time, however, maintenance has slipped on the existing infrastructure. This is a result of pressures on budgets, particularly during times of recession and restraint, for other social purposes, the fact that some of the post war infrastructure is now nearing the end of its life, and a reluctance of municipalities to borrow money necessary for infrastructure

maintenance at high interest rates. In addition, there has been a reduction in federal and provincial funding for infrastructure. The termination of the federal involvement in the community services contribution program is estimated to have cost municipalities in Ontario approximately $175 million in construction of water and waste treatment facilities annually. Federal money spent on community renewal in Ontario decreased from $218.7 million in 1978, to $66.1 million in 1983. Over the same period, provincial expenditures declined from $39.2 million to $7.9 million.

Provincial contributions to infrastructure in Ontario have also decreased. As the AMO report notes, 73% of all municipalities in Ontario had to finance part of their annual road budget without provincial cost sharing even though the work done was eligible for subsidy under current government policy. In 1985, it was concluded that 28% of all municipal roads and streets are inadequate by MTO standards. At the provincial level, the budget of the Ministry of Transportation declined from 30% of the provincial budget in 1960 to 6% in 1986. The AMO report, which was based on a brief from the Ontario Good Roads Association, recommends that the provincial government increase the municipal allotment for roads by $75 million a year in order to meet 50% of the annual needs.

In March 1985, AMO reported on sewer and water services in Ontario and noted that unless the total dollars available from the provincial government are increased, sewer and water project construction will decrease. Ministry operated sewer and water plans had, in mid 1985, an accumulated operating deficit of over $22 million and AMO recommended that the provincial government consider relieving the municipality of at least 25% of the accumulated operating debt for sewer and water.

While the easy answer to municipal costs related to infrastructure is to request greater amounts of federal and provincial funding, the fact is that this funding cannot be made available unless either senior levels of government increase their taxes, go further into debt, or reduce expenditures in other areas. Given a federal government gross debt of $400 billion, equivalent to over 60% of the gross domestic product, it is unlikely the federal government would see increasing that debt as an acceptable solution. Moreover, yearly public debt charges are over $38 billion for the federal government. The provincial governments collectively pay an additional $18 billion dollars in interest on their debts. By comparison, the total municipal interest on public debt is about $3.7 billion a year. It is also very unlikely that the provincial or federal governments will happily raise taxes, as such a move would not be politically positive. Finally, while there may be opportunities for senior levels of government to reduce expenditures in other areas,

many of these opportunities would require substantial and usually unacceptable sacrifices to be made in other government services. The question then becomes whether we can find ways of reducing public sector infrastructure expenses through the way we plan and develop our cities. The alternative would be even heavier reliance on the private sector and/or greater use of user charges.

Even if expenditures of senior governments could be directed towards urban infrastructure investments, possibly as a means to stimulating employment, the magnitude of the problem, coupled with ongoing maintenance costs, still require us to find a more efficient way of developing our cities.

3.0 POPULATION/ SOCIO-ECONOMIC TRENDS

3.1 REGIONAL CHANGE

The population of Canada continues to grow albeit at a decreasing rate. A report by CMHC entitled "Urban Infrastructure in Canada", April 1989, outlines the magnitude of the growth in the country. In the 30 years from 1956 to 1986, the population of Canada increased by 58%; from 16 million to 25.3 million. That population growth was not, however, uniformly distributed across the country. Geographically, one could divide Canada into three approximately equal population groupings: the East, including Quebec and the Atlantic provinces; the Centre, or Ontario; and the West, which would include the Yukon and Northwest Territories. In 1956, the East was the largest in terms of population with 39.7% of the Canadian total. The Centre was second at 33.6% and the west had 22.7%. By 1986, the order had changed: the Centre had gained slightly to 35.9% and was then the largest region in Canada. The East had decreased significantly to 34.8%, while western Canada had climbed to 29.3%. However, even the slowest growth region, eastern Canada, had increased its population by 38% in that 30 year period.

Table 1: East-West Population

Year	East		Central		West		Canada
	Pop.	%	Pop.	%	Pop.	%	Pop.
1956	6,392	39.7	5,405	33.6	4,284	22.7	16,081
1986	8,818	34.8	9,113	35.9	7,421	29.3	25,354
% Change	37.95		68.60		73.23		57.66

3.2 CITY SIZE CHANGE

A similar change has taken place with the distribution of population among the various urban size groups. As Table 2 shows, the population in Canada can be divided into four urban size groupings which, in 1956, were of a similar size. The first group consists of the six largest census metropolitan areas in Canada (Toronto, Montreal, Vancouver, Ottawa, Edmonton and Calgary). The next group are the remaining 19 CMAs as they existed in 1986. The third group consists of "other urban"

population, and the last group is the rural population. In 1956, the largest group was the rural population which accounted for one third of the total Canadian population (33.4%). Behind that was the population of the six largest areas, at 29.5%, then the other urban population, 18.7%, and the 19 next CMAs at 18.4%. By 1986, the population in the sixth largest areas had increased to just under 40% of Canada, the rural population accounted for 23.8%, the next 19 CMAs 20.3% and the other urban 16.4%.

Interestingly enough, the order of the growth rates of the various groupings coincide to their municipal size ranking. The sixth largest grew by 111%, the 19 next largest grew by 75%, the other urban by 38% and the rural population by 13%.

Simmons and Bourne, in their paper "Urban Growth Trends in Canada, 1981-86" note a similar trend. The "counter-urbanization" of the 1970's, which witnessed out-migration from Metropolitan Areas and economic growth shifting to the resource-based periphery, was reversed in the 1980's, which accelerated growth of the largest centres. On aggregate, small urban centres (less than 30,000) declined by 0.8% while the largest cities (over 300,000) grew by 62%.

Table 2: Population by Urban Size

Year	6 Largest Metro Areas		19 Other Metro Areas		Other Urban		Rural	
	Pop.	%	Pop.	%	Pop.	%	Pop.	%
1956	4,740	29.5	2,964	18.4	3,011	18.7	5,366	33.4
1986	10,005	39.5	5,150	20.3	4,158	16.4	6,041	23.8
% Change	111.08		73.75		38.09		12.58	

3.3 HOUSEHOLD CHANGES

Another trend affecting the demand for infrastructure has been the growth in the number of two income families. The so called "traditional family" of the mid 50s, i.e. a father at work, a mother at home looking after the children, and two children in school, has been replaced by a large number of different household types. Single person households, single parent families, childless couples, and two parents working have increased within the country. The decrease in number of

children per family and the increase in single person and single parent families has meant that the total number of dwelling units within Canada has increased at a faster rate than the total population. People have also, relatively speaking, become richer over the last 30 years. With this increase in prosperity, the number of automobiles per household has increased, as has the amount of living space consumed by each household. The growth in the number of two income families, in situations where the employment locations are widely separated, has resulted in a situation where an increasing number of families cannot move closer to work so as to avoid car usage, even if they so wished.

The result of these trends has significantly increased the demand for a number of elements of the urban infrastructure. Table 3 shows the figures for the Greater Toronto Area (GTA) and the hinterland around the GTA, for 1961 and 1986. These figures are from a report entitled **Infrastructure Issues and the GTA Hinterland** prepared by Neal Irwin of IBI Group, in 1989, for the Central Ontario Planners Conference. While the GTA population has increased by 77%, the total employment has increased by almost twice that at 142%. The result is a 45% increase in the number of trips per capita resulting in an increase of 157% of the total daily trips. It should also be noted that the average length of the work trip has increased by one third over the 25 year period.

Interestingly, the sanitary sewage usage has increased at about the same rate as the population as a whole, and water usage has probably also reflected the population increase. On the other hand, the amount of solid waste produced has increased twice as fast as the number of people, a reflection of our growing affluence.

Table 4 indicates a projection for the future. As the baby boom population is now within the working age group and as the female participation rate, which increased rapidly from 1961 to 1986, is likely to remain constant, the expected increase in employment over the next 25 years is expected to mirror the increase in total population. However, the average work trip length is expected to increase slightly and solid waste production will either reflect the growth in total population, or will be twice as high, depending on the efficacy of programs to reduce solid waste, and on changing attitudes and values in today's consumer society.

Later work by Neil Irwin has updated the expected 2011 figures, but has not significantly changed the relationships. In work done for the Infrastructure Working Group looking at GTA requirements for 2021, total population between 1986 and 2011 is expected to increase by 46%, employment by 59% and total daily trips by 49%. Sanitary

INFRASTRUCTURE ISSUES AND THE GTA HINTERLAND
EXHIBIT 3: PAST GROWTH IN DEMAND: 1961-1986

	GTA			GTA Hinterland		
	1961	1986	1961-86 % Increase	1961	1986	1961-86 % Increase
Population (Millions)	2.11	3.73	77%	1.40	1.99	42%
Employment (Millions)	0.85	2.05	142%	0.52	0.96	84%
Daily Trips Per Capita	1.40	2.03	45%	1.40	2.03	45%
Daily Trips (Millions)	2.95	7.58	157%	1.96	4.04	106%
Average Work Trip Length (km)	11.4	15.1	33%	-	-	33%
Auto Ownership (Millions)	0.63	1.94	207%	0.50	1.25	148%
Sanitary Sewage (M. Gal./Day)	239	441	84%	157	231	47%
Solid Waste (M. Tonnes/Year)	1.58	4.10	159%	1.05	2.19	109%

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INFRASTRUCTURE ISSUES AND THE GTA HINTERLAND
EXHIBIT 4: FUTURE DEMAND PROSPECTS: 1986-2011

	GTA			GTA Hinterland		
	1986	2011	1986-2011 % Increase	1986	2011	1986-2011 % Increase
Population (Millions)	3.73	5.33	43%	1.99	2.54	28%
Employment (Millions)	2.05	2.97	45%	0.96	1.25	30%
Trips Per Capita	2.03	2.04	1%	2.03	2.04	1%
Daily Trips (Millions)	7.58	10.87	43%	4.04	5.18	28%
Average Work Trip Length (km)	15.1	16.2	7%	-	-	7%
Auto Ownership (Millions)	1.94	2.93	51%	1.25	1.68	34%
Sanitary (M. Gal./Day)	441	631	43%	231	295	28%
Solid Waste (M. Tonnes/Year)	4.11	5.86-8.00	43-95%	2.19	2.80-3.81	28-74%

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sewage flows would increase by 57%, whereas solid waste is expected to increase by between 57% and 147%.

4.0 PRESENT TRENDS IN DEVELOPMENT AND CHANGE

With the decrease in average household size brought about by lower fertility rates, higher divorce rates, and aging population, and an increase in single parent families, there has been a general decline in total population in the already built up parts of Canada's cities. Most cities have experienced an increase in the total number of dwelling units through intensification and redevelopment, but this has generally only been enough to offset the decline in average household size. Some cities, such as Toronto, have encouraged enough redevelopment to offset the total population decline and have actually gained population over the past 10 years, but now the ring of inner suburban municipalities has begun to experience population declines (see Simmons and Bourne, 1989).

New population growth is occurring primarily on the outskirts of Canadian cities. The amount of growth here is greater than one might expect from the total population increase figures for the entire metropolitan area as the outer suburban areas are compensating for the decline in the population in the already built up areas. In addition, there is a significant growth rate of population in the ex-urban area surrounding the major Canadian cities. These are new housing developments, usually on septic tanks and wells, and on one to five acre lots. This process, particularly in southern Ontario, has been facilitated by the desire of many farmers to separate off one or more lots from their farms to provide either a retirement place for themselves, a place for their children to own a separate home, or to sell on the open market as a means of gaining some amount of financial relief, or retirement income.

The problems with this reliance on septic systems, particularly for multi-lot subdivisions, has been highlighted in Ontario by the Commission on Planning and Development Reform (The Sewell Commission). The December 1991 Newsletter highlights septic issues as "A Sleeping Giant". Province-wide reports of septic system problems and failures are increasing. In the short term, failures result in health hazards from exposure to sewage; in the longer term, drinking water is at risk of contamination. There are now close to 1,000,000 septic systems in Ontario, with annual approvals doubling from 17,000 to 33,500 between 1984 and 1989. One-third of new installations have been in subdivisions, many with large houses equipped with all sorts of water-using appliances. Complaints and investigations have climbed from 5,000 in 1984 to 9,000 in 1990 and a "guesstimate" is that 30% of all systems are failing. A Region of Waterloo study of 560 wells found that 68% of shallow wells and 22% of drilled wells had unacceptable bacteriological counts. Nitrate infiltration into the water table and phosphorus loadings of lakes are other problems associated with septic

systems. The answer to such problems is often a costly retrofitting of a communal or municipal sewage treatment facility.

Another trend presently underway in Canada is the dispersion of employment opportunities. Industrial operations that were previously in the central parts of the major cities, often adjacent to either rail lines or port facilities, are increasingly moving to new locations on the periphery where good truck access is available. Increasing congestion in the central cities, crowded and antiquated buildings, a move of the labour force to suburban homes, increase in complaints from urban dwellers regarding industrial noise, dust, smell, vibration and truck movements, and a greater reliance on "just in time" inventory systems have led industries to locate on larger properties with new buildings at suburban locations adjacent to major arterial roads.

At the same time, office employment, previously concentrated in the centre of the city has begun to disperse to a number of nodes or clumps of development in the suburban areas and to low density, low rise "office parks" which, like new industrial locations, are frequently located at points of high road accessibility. Overall, suburban employment is not concentrated as it was in the central city, but is dispersed along arterial streets and at industrial parks and shopping malls.

The major source of employment growth has occurred within the service sector, 80% for example of new employment in the Toronto area. The number of workers in primary activities and manufacturing actually declined. Most of the growth in service jobs occurred in the largest urban centres with already well developed service sectors. In fact, the key determinant of regional growth appears to be the ability to attract service sector jobs . (Simmons and Bourne, 1989).

This shift from manufacturing to service employment may have several implications for infrastructure requirements. Some industries have requirements for water and sewers as part of their manufacturing activities and there would be a reduction in this demand. Moreover, service employment typically works at more workers per hectare and a shift to service jobs would reduce overall land requirements thereby reducing the kilometres of roads, water and sewer systems. On the other hand, storm water runoff increases with intensity of development and ditches and streams may have to be piped to meet the resulting loads. Also, as intensity increases with service employment, land values rise, and the remaining manufacturing activities may increasingly locate further from the metropolitan centre thereby increasing the need for inter-municipal highways. Overall, the shift from manufacturing to service employment probably reduces infrastructure costs, but the magnitude of this decrease is not clear.

5.0 CURRENT PLANNING PRACTICES

5.1 ZONING

The main driving force behind present day city planning in North America is to avoid "incompatibility" between various land uses. The origins of zoning, which is the control tool used by planners, are related to the laws of nuisance. Before the use of zoning, a property owner had to take an adjacent property owner to court when suffering from the effects of noise, smoke, odour, or other negative effects from the neighbouring activities. Unfortunately, nuisance provided only a financial penalty and operated in some way as simply a licence fee to carry on the polluting business. To avoid the negative effects of neighbouring uses, the concept of zoning was introduced to separate those uses which produced negative impacts, generally smoke stack industries, from those uses which suffered from such effects, usually single family houses. The buffers between incompatible uses could be wide streets, railway tracks, river valleys or public green spaces. At the same time, other uses such as offices and retailing could occupy locations between single family homes and industry, as they were not as adversely effected by the pollution from the industries, nor were they as much of a nuisance to the single family home owner.

From such a beginning, the zoning by-law has evolved over time into a more and more detailed and intricate set of controls. Frequently, these controls are used to protect the financial values of residential properties by excluding those uses which are seen to reduce property values. The by-laws thus frequently operate in a way to socially segregate different parts of the total residential population by controlling the density and type of dwelling units permitted.

5.2 LAND USE HIERARCHIES

The differentiation of land uses into more and more detailed sub-sets and the spacial separation of different uses applies not only to residential uses. Retail commercial activities, once seen as being part of a neighbourhood with corner grocery stores and neighbourhood shopping strips, have now been replaced by a hierarchy of largely single purpose commercial centres. Retail commercial areas are now separated from residential areas and neighbourhood stores are generally prohibited, or discouraged. The proliferation of local stores has been replaced by the concept of single use retail centres. A hierarchy of centres has been developed, from neighbourhood to district to regional centres, and large retail shopping plazas have been encouraged. Those stores which do not easily fit into a shopping centre, such as retail furniture warehouses and lumber supply stores, are encouraged to spread out on large lots adjacent to arterial or other major roads. Moreover, as part of the policy of separation of uses, streets, although

wider now than in the past, are not seen as the appropriate location for vehicle parking. Thus, all new commercial centres must provide adequate amounts of on-site parking. Planners, erring on the side of caution (from their perspective), require more rather than less on-site parking to minimize the chance that overflow parking might spill onto adjacent streets. Thus, shopping locations on average become further and further from the homes of the customers, and more and more the design of those centres is of a number of stores surrounded by a sea of parking spaces. In this way, planners create increasingly auto dependent cities.

Industrial uses are also isolated from other activities. Ironically, as industries have become cleaner and less of a nuisance than in the past, regulations have become more onerous. Not only are residents being protected from industries, but industries are now "protected" from other employment activities. Office and retail activities are frequently prohibited from industrial zones, even as the distinction between industrial and office activities becomes increasingly blurred and difficult to determine. While most industrial activities could now happily coexist with residential uses, industrial-residential mixing is almost universally prohibited.

5.3 ROAD HIERARCHIES

Just as land uses have been turned into hierarchies and separated one from the other, so does present day city planning deal with public roads. A hierarchy of roads has been produced from controlled access freeways, to major limited access arterials, to arterial roads, to major collectors, to minor collectors, and to neighbourhood streets. In the best of all possible planning worlds, intersections only take place between streets in the same category or with streets in the immediate above or below categories. New arterial streets are designed with very large rights-of-way to permit eventual massive pavement widening and all adjacent residential uses are forced to turn their back on the arterial road and to have access only from the interior parts of the neighbourhoods. Frequently, this reverse lot treatment applies to collector roads as well. The neighbourhood streets, on which houses abut, are designed in a confusing and curvilinear fashion to actively discourage any amount of through traffic. Thus the street pattern reinforces the land use pattern to create single use enclaves separated not only from other uses, but also from other enclaves of the same use.

One of the results of this hierarchy of road design is an increase in the amount of roadway required per capita. Many miles of streets are produced with no directly fronting land use. Also, the curvilinear street pattern which discourages through vehicles also discourages transit vehicles. Thus the transit vehicles are restricted to the arterial roads which have no abutting customer generating uses. Travel distances are greater as cars must navigate the local road pattern to reach the

collector road, in order to reach the arterial, in order to travel to another arterial road where the same process continues in reverse.

5.4 RESIDENTIAL PREFERENCE

Within this spatially separated and hierarchically organized pattern of land uses and connections, the current planning practice is to strongly favour the production of single family homes over other types of residential units. This appears to be based on a belief that as lot sizes and house sizes increase, the value of the properties increase and, hence, the assessment and taxes per house increase. There is also a belief that people who live in cheaper and/or smaller dwelling units, particularly in rental accommodation, are economically poorer than people who live in larger units, and that poorer people put greater loads on the social welfare system. Thus, large houses on large lots are seen to increase municipal revenues while decreasing municipal expenditures, and small houses, particularly row houses, co-ops and social housing are considered to decrease revenues while increasing expenditures.

The relationship between density tax revenues and expenditures is not clear, particularly given the vagaries of the assessment and mill rate setting process, but the following hypothesis may help to explain the view often held by suburban municipalities.

Given an area of land with a residential road pattern set, including lot depths, the subdivider may be indifferent to the number of lots and frontage of those lots. If land is selling at so many dollars per foot frontage, the same total value would apply whether two 60 foot lots, three 40 foot lots, four 30 foot lots, or five 24 foot lots were produced. This situation existed in the suburban Toronto housing market during the late 1980s.

Also, during the late 1980s, there was a rough rule-of-thumb that the building cost of the house should reflect the land value; double the cost of the lot, then double the cost of the house. Under those circumstances, not only would the total land value be the same regardless of the lot pattern, but the total building value plus land value would similarly remain unaffected. For example, at $3,000 per foot frontage, a 30 foot lot would be worth $90,000. Building a $90,000 home on the property plus adding 10% profit would produce a house with a market value of $198,000. In a similar way, a 40 foot lot would produce a market price for house plus lot of $264,000. The 60 footer would go for $396,000 while the 24 footer would result in $158,400. Thus in all cases, 120 feet of frontage would produce a market value of $792,000. Now, assuming that assessment is related to market value, the municipality's tax revenues would be constant, regardless of the size or number of homes.

On the municipal side, looking at the costs and revenues associated with development of a given area of land, the road, sidewalk, sewer, water, street lighting and other land related costs remain the same on a per hectare basis regardless of the number of units produced. If anything, the costs may be slightly reduced due to fewer cars on the streets and less wear and tear on the services. (Of course, the infrastructure cost per unit would increase as the number of units decrease.) On the other hand, people related costs, including schools, parks, recreation programs, welfare, daycare, and other social services would largely be related to the number of units. Ignoring for a moment the possibility that smaller and less expensive housing may produce higher per household costs, simple doubling the number of households would double social service costs, with no offsetting increase in revenue.

The municipality's preference for fewer but larger lots would be greater if smaller lots did, in fact, generate higher social costs and/or if larger lots produced luxury housing which was relatively more expensive that simply a ratio to smaller lots (ie. a 60 foot lot does not produce a $400,000 house compared to $200,000 or a 30 footer, but actually results in a $750,000 mansion).

The position as described above, shows the difference between a land area viewpoint versus a people viewpoint. The view described above only works where a municipality is part of a larger urban area and hopes to attract more than its share of rich residents in big houses and less than its share of poorer residents. It is a view based on maximizing revenues and/or minimizing costs for a given area of land. It also is based on the premise that assessment revenues from retail and employment would not be similarly reduced if the population were reduced.

The equation changes if the municipality is a "stand alone" municipality or is the province as a whole. In this case, the social service demand is fixed; the people all exist and the question is how to house them so as to reduce those costs which are affected by the development pattern and density. But given the fragmented municipal jurisdictional system created in many of our provinces, it is also clear why it may be financially prudent for a given municipality to pursue a policy of large lots where such a policy is not prudent for a metropolitan area or a province as a whole. It is in this regard that the province of Ontario has a policy of requiring 25% of new housing units to be affordable; people have to be housed somewhere and the policy attempts to distribute them equally among different municipalities in a region.

5.5 NIMBY

The values of planners and the planning approaches are very similar to the values of established, property owning residents of Canada's cities. A "not in my backyard" or Nimby syndrome infuses much of the planning debate in Canada today. People who have purchased expensive homes (and to the occupant all homes are expensive) resist any change which they think might adversely effect their property values and, where the impacts of change are unknown, frequently assume that they will be negative and resist those changes as well. This desire to protect property values is augmented, particularly in times of rapid social change and/or economic uncertainty, with a neighbourhood desire to maintain stability, security and predictability. Local retail stores and restaurants are prohibited because they may produce noise, litter or traffic. Intensification, i.e. adding additional dwelling units into an existing residential fabric, is resisted because it may introduce undesirable people into the area as well as increase traffic and park and school usage. Even minor changes such as replacing a small house by a larger house, or adding a second floor to a bungalow, or converting an existing house into two self-contained flats are opposed by ever vigilant neighbourhood groups.

This protection of residential areas from change is reflected in an effort to use zoning and planning to prevent economic and employment change. Large industrial plants, formerly occupied by unionized, blue collar workers often stand empty for long periods of time. The previous manufacturing function may have been replaced elsewhere by a newer more automated system; the plant may have moved to a suburban location in the same metropolitan area where road access is superior; or the plant may have moved to another jurisdiction where manufacturing costs are lower; but, in an effort to protect the remaining blue collar jobs and, perhaps in a forlorn hope of enticing industrial employment to return, planners and local councils frequently refuse application to permit old industrial sites to be redeveloped for other uses. This prohibition includes opposition to other employment uses, such as small offices or retailing, which might, in fact, provide employment to neighbouring residents.

5.6 RESULTS OF SEGREGATION

The net result of current planning practices is that everything becomes further and further away from everything else and harder to get to. Walking to anything other than to a neighbour's house in a residential subdivision or to the local park or primary school is discouraged and virtually impossible. Almost no one in a new residential subdivision walks to shop. The distances are too great, the directions are too circuitous, and the shopping centre is a formidable obstacle, with its sea of parking, for a pedestrian to cross. Cycling is discouraged. The lack of connection and continuity from area to area by local streets requires cyclists to use the major arterials. These streets are designed for heavy, high speed vehicular traffic and are unattractive and dangerous to

cyclists. The result of present day city planning is a city that is more and more dependent upon the use of the private automobile to get between origins and destinations which are increasingly further apart and require the use of major roads. At the same time, planners have been consistent in ensuring that adequate parking is available for the automobile at both the origin and destination into the trip and have set aside vast acreage of the modern North American city to provide for that parking.

5.7 LOCAL SERVICES

In addition to the distribution of uses in density and design of road systems through local official plans and zoning by-laws, current planning practice also addresses itself to the design of local subdivisions. The general philosophy here is that as much of the cost of new subdivisions as possible should be passed through the builder to the new owner rather than being borne by the municipality as a whole. Inasmuch as the new owners are not present when the design and standards for the subdivision are imposed, new owners frequently have very little input to subdivision standards.

Road rights-of-way in new subdivisions are very wide. Local streets, which by design will discourage all but very local traffic, are frequently required to have a 66 foot right-of-way, which is the same amount that was previously used for arterial roads which carry heavy traffic and often have abutting retail uses. This wider right-of-way is to permit not only a wider pavement, but also to ensure that there is adequate space for all of the various underground utilities to be located if each requires its own separate trench.

While the streets have been designed only to serve the abutting homes, on-street parking is still discouraged and considered to be a nuisance. Thus all homes must not only provide an attached garage, but also must be setback far enough from the right of way that the driveway in front of the garage door can accommodate one or two additional cars.

As part of the design of providing an upscale community, new subdivisions require curbs and sewers rather than ditches and drainage swails. Sidewalks are required, often on both sides of the street despite the very local nature of the road surface. All utilities are required to be located underground and each may require its own location in the right-of-way. The builders of new homes are also required to provide all of the parks for the new residents, frequently at a standard higher than that which exists in the older parts of the city where the parks were frequently paid for out of general taxes. Large developers are also expected to contribute other community and social services. A library, a community centre, provisions for daycare and land for social housing are all costs that must ultimately be passed on to the eventual house buyer. New legislation in Ontario may result in new homes

paying an additional levy for school and municipal infrastructure upgrading to meet the additional demands of new residents. Of course, the new residents will also be required to pay through their general taxes for any upgrading of schools or municipal facilities in the older parts of the municipality.

6.0 GROWTH MANAGEMENT

A new buzz word in the planner's lexicon is the concept of growth management. While a dynamic, systems based approach to managing population and employment growth may be quite preferable to the present static, legalistic official plan and zoning by-law approach to managing change, growth management generally refers to techniques to try to limit or stop population growth.

6.1 TO RESIST CHANGE

Growth management can be motivated by an extreme type of nimbyism: the residents of an area having achieved their goals for residential living now wish to prevent others from enjoying the same standards. An example of this is where city people move to a rural setting through the creation of new, large residential lots and then, when established, try to change regulations to prevent new lot creation and hence new population because such increased population, it is felt, would ruin the very rural character of the area that had attracted the first new residents in the first place.

6.2 TO UTILIZE FACILITIES

Growth management can also be an attempt to balance the demand for new services with the supply of existing services. The City of Toronto's 1976 Central Area Plan was motivated by a concern of residents around the Central Area about increasing vehicular traffic through their streets. Their solution was to simply prohibit any further employment increase in the downtown. The planners noted that the existing subway lines into the downtown were running at considerably less than capacity in the off or non-peak direction. Therefore, what started out as a reaction to the increased traffic turned into an exercise to use more fully the under-utilized capacity of the subway by encouraging new job creation to take place at locations at the outer end of the existing subway lines so as to achieve maximum usage of the expensive facility. In this way, employment growth in the downtown, while not curtailed entirely, was seen to be significantly reduced. At the same time, the aspirations of the suburban municipalities to generate their own focus of activity and create their own downtown was encouraged. The savings to the public at large would be that a new subway line, that otherwise would have been required, could be postponed if not abandoned altogether.

6.3 TO AVOID SPRAWL

A third type of growth management, which is now being considered in cities such as Toronto and Winnipeg, is to limit the sprawl of new housing into the surrounding agricultural and other non-urban lands. (See Institute of Urban Studies, and IBI Group 1990). The motivation for such growth management is twofold: to save farmland for farm and natural purposes; and to encourage intensification within the already built up area in order to utilize existing facilities more fully.

6.4 RESULTS OF LIMITS

Such growth management, characterized in a previous era by the London, England and Ottawa greenbelts, will likely result in increased land values in the built up area. William Fischell in his paper "What Do Economists Know About Growth Controls?" notes that there is a significant reduction of land costs just outside the urban boundary and an increase in prices just inside the boundary. Increased prices, of course, are the economic system's way of reacting to scarcity and would indicate that increased densities are required to make better use of what is now a scarce resource and to keep per unit costs essentially unchanged.

One problem that results from increased land values is that the present political and planning system cannot respond quickly to changes. "Unless great care is taken in curtailing redevelopment within the existing built-in areas (which requires some lead time) major price increases for all development would occur." (Metropolitan Toronto, 1990). As noted above, nimbyism works against intensification within existing communities. Moreover, while some inner cities, for example Toronto and Vancouver, are encouraging the introduction of residential uses along the older commercial strips, most of the suburban areas of Canada's major cities do not have commercial uses along the major roads. The only locations for intensification in these areas are in industrial districts, where there are strong opponents to introducing residential uses, and as part of shopping centres, where there are frequently contractual agreements that make intensification difficult. Thus if the control over, and subsequent shortage of, residential land is not reflected at the same time in increased permissions for greater density and residential redevelopment, the price of the single family home, and indeed of all existing dwelling units, will go up. While existing residents would not be adverse to such a result, new arrivals to the metropolitan area, young people starting out in marriage and home buying, and poorer households would be adversely affected by these increased housing prices.

With increased demand and a reduction in the supply, several results would likely occur. Increased use of obsolete industrial and warehousing buildings for residential purposes and increased use of illegal basement and other apartments in existing homes are one of the results. As these uses are illegal, the normal protection to tenants is lacking. Tenants cannot complain about temperature in the rooms, harassment by landlords, escalating rental rates, lack of fire escapes and other safety measures, or any other legal safeguards because any complaint would bring the activity of the accommodation to the attention of the municipal officials and would likely result in all the tenants being expelled from the premises and the illegal residential activity curtailed.

The other effect of squeezing the supply while demand continues would be leapfrogging. New residents would jump over the area of controls and locate in adjacent municipalities beyond the control limits. This may, in the short run, benefit some middle distance small towns that would see their previous decline in population reversed, but over time would also see their social and physical infrastructure requirements increased. Such leapfrogging would also consume land in adjacent agricultural areas.

Leapfrogging would produce an inefficient regional settlement pattern. The total agricultural land consumed continues to increase as it would in a non-controlled situation, albeit at a greater distance from the central city. Transportation costs and individual commuting times would be higher: increased demand on the roads would result in higher maintenance costs and increases in road widening. The increased travel between various parts of the overall urban area would place pressure on political bodies to permit selective intensification and introduction of new uses along the linking roadways. As populations of the distant communities increase, business locations along the connecting road provide the benefit of being able to serve clients and businesses in both the centres. Such demand can translate into low density ribbon development along the connecting links, eventually coalescing it into a continuous linear urban area.

7.0 TRENDS IN INFRASTRUCTURE USAGE

The number of cars owned per capita will continue to increase, albeit at a slower rate than in the past, and this, plus a continued increase in the total population, will result in continuing pressure for volume increases on urban arterial roads. With limitations on the ability to increase arterial capacities, particularly at intersections, congestion will continue to increase. As the total urban populations increase, average travel distance for the commute to work will also continue to increase, particularly for members of multi-income households whose employment locations are widely dispersed.

To some degree the increasing journey to work distance and time will be offset by the growth of dispersed employment concentrations. Gordon and Wong in their article "The Cost of Urban Sprawl: Some New Evidence", note that work trip lengths actually begin to decrease as the urban region grows and turns from a monocentric to a polycentric form. P. A. Stone, in a study conducted in the U.K. examining the cost implications of a range of city sizes (Stone, 1973), also noted that, regardless of size and shape of an urban area, the per capita costs for main roads are greater for urban areas with centralized employment patterns than those which are de-centralized (as summarized in Frank, 1989). William R. Code in his article "The Relativity of Sustainability" also concludes and advocates that a polycentric pattern of self-contained nodes is a reasonable compromise between efficiency and livability.

One of the implications of a transformation of an urban area from monocentric to polycentric is that there is an increase in reverse commuting. Such an increase is one example of designing a city to make use of under-utilized infrastructure presently in place. The polycentric form, however, is not one that is arbitrarily chosen by law makers and implemented by planners but is an evolutionary type of development experienced throughout North America in response to the increasing congestion, trip lengths and commute times associated with a growing monocentric urban area.

Another trend likely to continue into the future is a continuing reduction in the number of transit trips per capita. As congestion increases on the roads, a transit system, particularly one separated from the roadways, becomes a viable alternative. Use of transit is further increased by an increase in downtown parking rates. However, the urban system solution of generating dispersed employment works against the use of transit. While it is true that the transit system in the off-peak direction has under-utilized capacity, this will only result in increased transit usage if the new, dispersed employment locations are at points of high transit accessibility. As employment disperses to locations adjacent to freeways and major arterial roads, the transit

usage to these jobs becomes increasingly reduced from that found in the central areas. The roads are less congested in the off-peak direction and parking is generally free and readily available at the new suburban employment locations.

On the other hand, Robert Cervero in his book "Suburban Gridlock" notes that very suddenly and very recently suburban congestion problems have arisen in the United States, particularly around the largest and fastest growing cities. The explosion of office development in the suburbs has resulted in the total United States office space outside of central cities growing from 25% in 1970 to 57% in 1984; 80% of suburban office space in less than 15 years old compared to 36% of central city space; northeastern New Jersey has close to the same amount of space as mid-town Manhattan.

With this employment growth has come automobile congestion. Roads designed to move people to downtown are ill equipped to handle lateral and peripheral trips. Dispersed employment locations are difficult to handle by fixed route transit services or even by van pooling. For many residents of suburban areas, transportation ranks as their number one problem. In 1980, 33% of work trips within U.S. Metropolitan areas were within the central city; 20% were from suburb to city, 7% from city to suburb, and 40% from suburb to suburb (Cervero, p.10).

The design of these new office centres with their low densities, open spaces, dispersed labour force and free parking are "effectively preordained for drive alone auto commuting" (ibid p.13). The solution of integrating housing with the office developments is often resisted by developers, some public officials and even residential neighbourhoods. Traditional zoning, with its segregated land uses, remains fully entrenched in the suburbs. Resistance to housing increases if it seems to be "affordable" and thus a drain on public services. One result of this segregation of home and work has been a nationwide increase in commuting distances from 11.1 miles in 1975 to 12.1 miles in 1980. Thus the resulting decrease in work trip lengths that occurs as an area changes from monocentric to polycentric form (as noted by Gordon and Wong) appears to be, like the free flow road conditions in the off peak direction, only a temporary improvement that ends as the number of suburban to suburban trips increases. It is in this regard that Newman and Kenworthy in their book "Auto Dependent Cities" conclude that a denser, more compact urban form which can be served by transit is necessary to reduce auto usage and to handle the overall commuting demands.

8.0 INFRASTRUCTURE/ PLANNING RELATIONSHIPS

8.1 DENSITY

Density of development can refer to either the intensity of building of any given site development, or to the number of households or workers per geographical area. Discussions regarding office buildings frequently revolve around the question of whether the permitted density on a site is four or five or some other number times the area of the lot. This number, often called the floor space index (f.s.i.), is a measure of the number of square feet or square metres of floor space in a building compared to the number of square feet or square metres of land area on the site. Increasing the density or f.s.i. permits more floor space and hence more income for any given piece of land.

In examining the effects of density on infrastructure cost, however, the density of specific projects is not significantly important. Given a specific demand for employment space, higher densities on any one site may be compensated for by lower densities on adjacent or neighbouring sites. Of greater importance is the overall density, as measured by the number of employees or number of residents per square mile or square kilometre. A given number of dwelling units at a low suburban density of, for example, ten dwelling units per hectare consumes twice as much residential land in total than the same number of dwelling units at twenty units per hectare. A density of forty units per hectare, generally considered the upper end of density for single family detached homes, consumes one quarter of the land as would the same number of dwelling units at the lower suburban densities. Obviously, the implications for land consumption become even more significant when one moves to townhouse and low-rise apartment densities of 100 units per hectare up to high-rise apartment densities of 150 to 250 units per hectare and beyond.

With the higher densities, the total size of the urban area necessary to support a given number of dwelling units becomes significantly smaller. This smaller area results in a reduction of the number of kilometres of roads that must be built and maintained. In the same way the lengths of sewer pipes, water lines, curbs, sidewalks and other utilities are reduced for the same population.

Of course, not all land requirements are so closely tied to residential densities. While some economies of scale may result from more intensive residential activities, parks and school requirements are more related to total population size. In the same way, retailing land requirements remain related to total population and not to density

(unless significant mixing of uses on the same site occurs). Likewise, the land requirements for major roads, sewage treatment plants, and water purification facilities relate more to total urban size than to residential densities.

As densities increase, however, the number of persons that are within walking distance of a transit route also increases, thus facilitating higher service levels of transit operations. These increased service levels, ie. more buses per hour on any given link, attract even more people to use public transit. With increased transit usage, the need to further widen roads and undertake other expensive intersection improvements also decreases.

Of course, as an urban area grows, increased transit usage can, at some time, require expensive infrastructure for dedicated transit lines for rapid transit, busway and subway operations. However, even in those instances where transit investments are required, the alternative in a city of a similar population but with lower density and greater car usage would be the construction of expensive and difficult to locate new expressway linkages.

Density also effects the cost of providing such services as education, police and fire protection. For school purposes, if limits are to be placed on the distances that children must travel to school, i.e. the catchment area size, then a lower density population requires more but smaller schools than would a higher density development. There are economies of scale in school construction, school operations and school land requirements and these would be lost at the lower densities, unless the children were bused. On the other hand, if the school sizes and numbers are to be held constant, then lower density requires larger catchment areas and greater reliance on school bus operations. With lower densities, more teachers and, in secondary schools, more students will drive to school and hence larger parking areas are required.

A similar situation exists regarding fire protection. If the placement of fire halls is to be determined by the distance or area served by a fire station, then lower densities require greater numbers of fire halls for a given population. If the fire halls are to be kept constant in number, then lower densities result in larger travel distances and hence slower response times and fire service level decrease. For police protection, more patrol cars are required and more time is involved to patrol streets with lower densities than for higher density areas given the same total population.

Very low density development can sometimes be seen, however, as an alternative with lower municipal costs. If developments are built at densities that can be served by wells and septic tanks and on roads that

have no curbs or sidewalks, then municipal infrastructure costs are reduced. Unfortunately, there are upper limits to the ability of the area to support increased septic tank usage and, as the population increases, pollution problems, run-off problems and chemical loadings on lakes and rivers increase. The increase in septic tanks in an area can also affect the water quality of wells; and the amount of water in wells is also adversely affected by increased residential development, even at lower densities. The net effect of very low density development, unless the development is vigorously capped and controlled in number, is that very expensive municipal remedial measures become required as pollution and health problems increase.

A publication produced by the American Planning Association, edited by James Frank and Robert Rhodes, entitled "Development Options" contains a discussion of public service costs as related to development densities. The information is summarized in the following table which was prepared by Paul Downing and included in the publication "Local Service Pricing Policies and Their Effect on Urban Spacial Structure". Clearly, both capital and operating costs decline per household as density increases.

On the other hand, one must keep in mind the situation that faces a municipality dealing with a given area of residentially designated land with fixed infrastructure costs. In that case, it may be fiscally prudent to opt for as few and as large lots as possible to reduce the social costs generated from the development of those lands while still maintaining the same level of taxation income. Of course, the social costs have not been reduced; they have merely transferred to another area or municipality.

8.2 URBAN SIZE

There are economies of scale that can result from increased urban size. Sewage treatment and water filtration plants can experience economies of scale. Transit systems can become more cost effective as they become larger.

The question of other infrastructure costs as a relationship to size is more difficult to determine. A study undertaken by P. A. Stone in England in 1973 concluded that, in comparing municipalities of 50,000, 100,000 and 250,000 persons, the road costs per capita were 50 percent higher in the 250,000 population city than in the 50,000 population city. On the other hand, James Nicholas in his book "The Costs of Growth: A Public Versus Private Sector Conflict or a Public/Private Responsibility" concluded that average infrastructure costs tended to climb to a certain point then remain constant as population sizes increase. The trend is similar for law enforcement and fire protection. Cities of over 250,000 up to 2,500,000 show strong economies of scale

Table 3–2
The Cost of Providing Public Services by Property Type and Density, 1973

	Single-Family Homes (1000 Units)				Multi-Family Homes (1000 units)				
					Townhouses	Walk-Up Apartments		High-Rise Apartments	
	1 Unit/ acre	2 Units/ acre	3 Units/ acre	5 Units/ acre	10 Units/ acre	15 Units/ acre	30 Units/ acre	30 Units/ acre	60 Units/ acre
Capital Cost									
Police	$ 113,852	$ 111,752	$ 109,652	$ 105,452	$ 104,852	$ 104,252	$ 103,652	$ 103,652	$ 103,052
Fire	119,918	108,368	96,818	73,718	52,974	52,974	52,974	52,974	65,474
Sanitation	29,220	27,620	25,220	23,140	21,244	18,140	17,380	15,796	14,820
Schools	5,353,582	5,353,582	5,353,582	5,353,582	4,538,155	4,538,155	4,538,155	1,646,167	1,646,167
Water Supply	7,529,720	3,833,744	2,563,857	1,739,362	1,163,154	855,900	485,304	566,792	334,777
Storm drainage	4,835,868	2,420,383	1,595,857	1,068,046	710,649	462,420	231,274	284,552	117,684
Sanitary sewerage	2,963,624	1,586,257	1,121,045	813,398	594,021	438,451	354,678	345,062	274,509
Total Capital Cost	$20,945,784	$13,441,706	$10,865,360	$9,176,693	7,185,049	$6,470,292	$5,886,917	$3,027,495	$2,556,483
Yearly Capital Cost	1,828,203	1,167,283	939,488	788,740	617,607	555,001	494,079	264,018	222,446
Operating Cost									
Police	$ 69,817	$ 66,267	$ 62,717	$ 55,617	$ 52,067	$ 49,700	$ 46,150	$ 46,150	$ 42,600
Fire	135,711	116,011	96,311	56,911	41,589	41,589	41,589	54,722	54,722
Sanitation	35,287	33,142	30,315	27,780	25,469	21,686	20,760	18,850	17,640
Schools	1,168,258	1,168,258	1,168,258	1,168,258	988,526	988,526	988,526	269,598	269,598
Water Supply	31,821	31,821	31,821	31,821	30,103	30,103	30,103	25,538	25,538
Storm Drainage	--	--	--	--	--	--	--	--	--
Sanitary Sewerage	41,289	34,401	32,133	30,604	28,022	27,250	26,679	22,825	22,476
Yearly Operating Cost	$ 1,483,183	$ 1,449,900	$ 1,421,555	$1,370,991	$1,165,776	$1,158,854	$1,152,807	$ 437,683	$ 432,574
Total Annual Costs per Dwelling Unit	$ 3,311	$ 2,617	$ 2,361	$ 2,160	$ 1,783	$ 1,714	$ 1,647	$ 702	$ 655

Source: Paul B. Downing and Richard D. Gustely, "The Public Service Costs of Alternative Development Patterns: A Review of the Evidence," in Paul B. Downing (ed.), *Local Service Pricing Policies and Their Effect on Urban Spacial Structure* (Vancouver, B.C.: University of British Columbia Press, 1977), Table 8.

in providing services while cities under 250,000 population are more expensive to service.

If a decision has to be made between directing growth to one urban centre in a region as opposed to distributing the growth among several centres, it is not clear which would be the cost effective preferable solution. The specific infrastructure cost for incremental improvements would have to be calculated for different services among the several potential cities. It may be that, for a time, it is most cost effective to direct growth to one centre until a major infrastructure investment is required. At that time, it may be better to direct growth to a number of other centres.

8.3 MIXTURE OF USES

The spacial pattern of different uses throughout a city can also affect the demand for various infrastructure investments. A shorter distance between residential areas and both retail areas and employment areas not only provides better accessibility for residents, i.e. shorter distance and time, but also permits a greater use of bicycles and walking. Reduced car usage results in reduction in land area required for parking as well as widening of roads and improving intersections to handle increasing volumes.

A finer mixture of uses also results in greater amounts of two-way commuting. Traffic volumes are distributed more evenly throughout the area, reducing the necessity of major road investments at key congestion points. The balance produced by two-way commuting also makes better use of existing transit services; buses which now run virtually empty in the off peak direction can now carry reverse flow commuters; otherwise additional buses and drivers would have been required to move those commuters in the peak direction. As noted above, this desire to better utilize the off peak transit direction was one of the motivating factors behind the 1976 Downtown Plan for Toronto. Office location at the end of subway lines permits an increase in the number of commuters while not requiring major transit investments.

A study undertaken by David Nowlan and Greg Stewart (Nowlan and Stewart, 1991) examined the number of commuters coming into Downtown Toronto as compared to the increase in Downtown employment. Their conclusion is that the total number of commuters is less than would be expected by the number of jobs due to the construction of new downtown residences. In fact, each new downtown dwelling unit results in 1.2 fewer trips.

Mixing facilities either on the same lot or in close proximity to each other can also reduce the need for additional parking spaces. Uses which compliment each other can use parking spaces at different times of the day and night. A mixture of residential and employment uses

not only provides the ability for individuals to live and work in the same location but also permits parking spaces to be used during the day by workers and in the evening and night time by the residents. Schools and community centres can share parking during and after school hours. Further savings can be made when uses which occur at different times occupy the same building. Schools, daycare centres, senior citizens' homes, government offices, libraries and community centres sharing a single complex can share the cost of the heating, the maintenance, the insurance and the parking required. Overall, the total land required and the total number of buildings required can be reduced when functions are combined.

The mixture of uses can also assist better utilization of public transit facilities. The more that uses can be placed along a single transit line, the more that transit line can be used throughout the day and into the evenings. Hospitals, with their high visitor volumes in the evenings, education institutions with evening students, restaurants, libraries, recreational activities and other evening uses can be located along a transit line that already functions because of the commuting demand that is being handled. Thus not only is there balanced two-way flow on the transit system, but there is an increase in use balance throughout the day.

9.0 RECENT PLANNING SUGGESTIONS

While the current planning practice, as outlined above in Section 5, tends to lead towards segregation of uses and single use areas, recent planning suggestions have begun to encourage the development of more intensive nodes and corridors. Work on the GTA Concept Study and for the Metropolitan Toronto Official Plan have encouraged the development of nodes of activities located at positions with high transit accessibility and linked together by corridors, which function as transit lengths, where a medium density development is to be encouraged.

On a regional scale, the GTA concepts envisage a regional system of activity nodes based on existing towns and villages and linked together by a high-speed rail system.

Within the built-up area, both the City of Toronto and Metropolitan Toronto as well as the City of Vancouver have been encouraging the development of residential intensification along the main streets. This main street development is one manifestation of the quite recent planning position of encouraging infill and intensification.

Infilling generally applies to the construction of new facilities, usually residential developments, on vacant land in the already developed urban area. This vacant land can be vacant lots or can be the rear parts of lots presently developed at the street frontage. Intensification relates to the redevelopment of land for a similar use but at a higher site density.

The redevelopment of obsolete industrial areas for other purposes, notably housing, is an idea that is also beginning to be expressed. While there remains much reluctance and resistance to redesignate land that might once again be used for industrial purposes, municipal housing developments such as St. Lawrence in downtown Toronto are examples of a reuse of industrial land. In other areas, industrial land is being retained for employment purposes but is being used for office and retail development.

10.0 POTENTIAL FOR COST SAVINGS

The most immediate potential for infrastructure cost savings comes about through the use of infill and intensification. (Noted in Wheaton and Schussheim, 1955). Where the infrastructure already exists and has excess capacity, additional population can be added with little or no incremental infrastructure cost. Given that the new residents will pay municipal property taxes, there is a significant increased financial benefit to the municipality through such infilling. Even if some of the infrastructure elements require upgrading or expansion, in most instances other infrastructure will have excess capacity. Declining enrolments in central city schools means that additional pupils can be handled with little or no additional cost. Roads, sewers, curbs and sidewalks already exist and additional infrastructure expenses are often not required. Moreover, if the area where the infilling is taking place is one already possessing a transit system, the infill population can then increase ridership without additional costs required.

In some of the older cities of Canada, significant sums of money must be expended in the near future to reconstruct and upgrade existing infrastructure, particularly existing sewer systems. If this required reconstruction can be combined with infilling and intensification, an enlargement of the capacity of the existing system can be brought about simultaneously with the required upgrading. In this way, the costs can be borne by both the new and existing residents. The contrary situation would have required the existing residents to bear the cost of the required renewal, while the new residents would have had to pay the cost of an extension of the services into the urban fringe.

The use of infilling and intensification as a major aspect of the handling of new residents also leads to overall higher densities. Thus not only is there a saving on new infrastructure not required on the outskirts of the urban area, but the result is less total infrastructure kilometres to be maintained by the given population. Also, the increase in densities as a result of intensification and infilling provides better support for transit operations. This increased use of transit can itself reduce further the costs that would otherwise be required for road and intersection widenings.

The programs outlined for main street intensification in several of Canada's cities are examples of infilling in locations already possessing municipal infrastructure, including transit operations. However, infilling can take place in a more dispersed pattern throughout an urban area without any significant localized problems of over-building or congestion. Permitting basement apartments and other flats in existing homes can result in increased population without any external increase in built-form or density. Decreasing the minimum size requirements for building lots for residential purposes can permit the occasional

construction of new housing along an already developed residential street. While there would be a resulting increase in the number of building units, the overall character and flavour of the single family neighbourhood would remain unchanged. Other infilling could take place on particularly deep lots, at the rear part of the lot served, perhaps, by a rear laneway.

Another type of intensification would be to permit residential uses to be added to shopping centres and retail shopping strips. In addition, both as a means of intensification and also as a means of providing a range of housing types, housing can be added to sites containing libraries, community centres, recreational buildings and schools.

Further examples of intensification would include the conversion in use of land held for industrial purposes to provide for increased residential populations.

In all instances of infilling, it would be necessary to determine the adequacy of the existing infrastructure to handle the proposed increase in population. In some instances, additional population may be acceptable only for a limited period before major infrastructure upgrading is required. Municipalities should examine their overall infrastructure to determine those locations where new development can take place with minimal cost. Inasmuch as intensification utilizes existing capacities, more and more new residential and employment development can be handled without the necessity of added new infrastructure on the urban fringes.

10.1 HIGHER DENSITIES

Where new development does take place on the edges of municipalities, the density of that development (units per hectare) should be increased to a level higher than that normally developed over the last 20 years. Higher densities require less land to house the same number of people. Higher densities require less miles of linear services to be installed by the land developer. Higher densities reduce the length of arterial or collector streets that would have to be provided by the municipality to reach new development. With these higher densities, transit systems become more economically feasible. A goal would be to develop new residential areas with a minimum density of 40 units per hectare. With the higher densities fewer but larger schools, libraries and community centres can be developed to serve the increased population.

Metropolitan Toronto, 1990, notes that a population density of 3,000 persons per square kilometre (p/km^2) can support a minimum level transit service; 4,000 p/km^2 can make transit a viable alternative for commuting and other trips, due to the frequency and quality of service (p.12). At the present time, Metropolitan Toronto has a density of

3,500 p/km^2, while the urbanized G.T.A. outside of Metropolitan Toronto is developed at a density of 2,100 p/km^2. (4,000 p/km^2 is equal to 40 persons per gross hectare). As a comparison, Paris, London and Vienna have densities of 47, 57, and 72 persons per hectare, while Tokyo and Hong Kong are 104 and 289 per hectare. (Kenworthy and Newman, 1987).

10.2 NEO-TRADITIONAL PLANNING

The concept of neo-traditional planning harkens back to that of the traditional cities, particularly as built between the first and second world wars. One aspect of such planning is a non hierarchical road system. In other words, major arterial roads are not set aside for only heavy volumes of through traffic; arterial roads are also seen as places to support abutting development and provide local service to those facilities. With a greater use of a grid system, the total length of roads per household is reduced for any specified overall density. The mixed use arterial road also provides an ideal location for bus operations, as many residents and employment locations are within walking distance of bus stops. With a finer grained arterial grid than exists at present, traffic loads are balanced over more arterial and collector streets, reducing point congestion at intersections. A grid system of roads, coupled with mixed use development, provides a large number of routes for people to travel between home and work and home and shopping. Such a system encourages a greater use of walking and bicycles and also permits a greater amount of the travel distance to be made without using the through arterial roads. This combination of more balanced traffic, a greater use of public transit, and a greater reliance on bicycles and walking further reduces the requirements for further road widening and other improvements.

The mixing of residential and commercial uses also results in a reduction in the need for parking spaces. With less reliance on the private automobile, there is a reduction in the need of providing additional parking spaces at every house and frontyard setbacks can be reduced. With reduced frontyard setbacks, and the possible elimination from local streets of sidewalks from at least one side of the street, and coupled with the reduction in street right-of-way widths, a significant increase can be obtained in the number of dwelling units per acre. Not only does this increase in unit yield provide a better return to the land developer, it also requires less investment in linear infrastructure.

11.0 IMPLEMENTATION

Urban intensification through infilling, redevelopment, and increased densities results in a reduction in the amount of new land required for urban development. Correspondingly, there is a reduction in the cost of all of the services necessary to prepare raw land for development purposes. On the other hand, however, there is a need to preserve the stability of existing lower density residential areas, both for the enjoyment of the existing residents and also to avoid escalating land prices.

The Urban Structure Concept Study prepared for the office of the GTA, by IBI Group, identified three broad development scenarios. These range from a low density sprawling type of development, similar to the present urban trends, to a very concentrated type of development largely built within the already urbanized envelope. The third, and somewhat in between scenario, was for the development of a number of nodes of increasing density of development at a variety of locations throughout the GTA. In their responses to the IBI study, the municipalities of the GTA generally favoured the nodal approach.

The Metropolitan Toronto Planning Department (Metropolitan Toronto, 1990) also examined the impact of a concentrated pattern development: "The accommodation of growth through concentrated redevelopment and intensification may have significant negative impacts on existing neighbourhoods and industrial areas. The physical changes that would have to occur would be major; within the next 20 years, at least one third of Metropolitan Toronto's industrial area would have to be redeveloped for housing, if one half the population growth was to be accommodated there; the other 500,000 persons would be accommodated in the existing urban areas as redevelopment, infill, or accessory apartments. ... Unless great care is taken in curtailing development in the regions, and escalating redevelopment within the existing built up areas (which requires some lead time), major price increases for all development would occur." (p.57).

To implement, therefore, an intensification of land use as a means to reduce per capita infrastructure costs will require a gradual move away from present development patterns. The first step for municipalities to undertake is to remove those regulations and requirements that would prevent intensified development, should such development be desired. As a minimum, new subdivisions should be able to provide small lots and multiple family housing, should such development be seen as economically feasible. In the case of new subdivisions, there is not the same concern existing neighbouring residents whose lifestyle and tranquillity would be upset by intensive adjoining developments.

Municipalities should also permit intensification of development and the introduction of mixed uses along traditional commercial shopping streets and on newer shopping centres. While it is unlikely, due to the inertia caused by tenant leases, that many commercial centres would intensify development and add residential uses, nevertheless, such intensification ought not to be precluded by municipal regulations.

Municipalities should also carefully examine older industrial areas. Portions of these areas have been vacated by previous industrial uses and they are often now vacant or under utilized. Residential, retailing, and other employment uses could be permitted in some of these areas without significantly adversely affecting the viability of the existing remaining industries.

As a means to encourage and to serve higher density residential areas, municipalities should also be integrating their transit planning with greenfields residential development. Bus routes should be laid out, temporary turning loops provided, and bus service implemented coincident with residential units coming on stream in all new subdivisions. A report, soon to be released by the Province of Ontario on Transit Supportive Guidelines, lists a number of design and planning features which encourage transit use. Primary amongst those techniques is an increase in density of development. Therefore, those interested in reducing infrastructure costs through intensification should strongly support all measures which would encourage greater use of public transit.

Other techniques to increase intensification and permit infilling may run up against the nimby syndrome. Permitting basement apartments, "granny flats", the further subdivision of large lots, infill development, and house behind a house on deep lots are all techniques which can permit intensification while at the same time preserving the general fabric, appearance, and functioning of existing neighbourhoods. The first step in this type of intensification is public education. As Paehlke notes in his report "The Environmental Effects of Urban Intensification" (Paehlke, 1991) in the 1970s environmentalists were negative about cities; the solution was to reject the city and return to the land. The result was greater commuting distances and an expanding urban shadow. At the same time, urban reformers limited heights and densities within the urban core, thereby helping to push the swelling urban population ever outward. Today, however, it is increasingly recognized that preserving nature and developing a sustainable economy require higher population intensities. (p. 3). The first step, therefore, is to educate existing residents on the fact that cities need to become more dense and more functionally integrated if there is to be either a quality regional countryside, or a quality global environment.

At the same time, existing residents need to be informed of the savings in municipal expenditures (and their own taxes) if new development can utilize existing infrastructure and assist in contributing to its repair and maintenance. It would also be helpful to demonstrate to existing residents that intensification of land use not only does not reduce property values but can, through market pricing, increase property values as intensification progresses.

One of the difficulties in gaining public acceptance to intensification is the history of large scale residential redevelopment of the 1960s and 1970s. In this type of intensification, existing stable and functionally viable residential neighbourhoods were bought up, existing homes destroyed and new development produced at a scale, height and density completely different from the previous development and, as well, different from the remaining neighbours. Intensification and infilling in the future should be seen as a gradual and incremental process. Residential development should be street related rather than turn inwards as some type of project development. Heights should be compatible with adjacent uses. Stacked townhouses, walk-up apartments, and low rise apartment buildings with grade related units on the lower floors can integrate into an existing neighbourhood where 20 plus storey apartment towers set back 100 feet from the street edge can and do not.

While the easier job is to increase the residential densities and mixture of uses in new developments, the greatest savings will be found through intensification in an already built up area. Even a more intensified form of new development still requires new parks, new roads, new schools, new retail areas, and new linear service, although, perhaps, not as much as lower density development. Infilling and urban intensification, on the other hand, can result in little or no new greenfield development required over the short to mid-term future. The Metropolitan Toronto Planning Department (Metro Toronto, 1990) is proposing what it calls "Reinvestment Centres". This scenario for development of GTA combines intensification within Metropolitan Toronto with the remaining growth accommodated within the existing urban envelopes of the communities in the surrounding area. In those areas, growth would be handled through intensification of the existing built up areas, the development of the undeveloped acreage at higher densities than currently proposed, and through intensification and filling in of the Yonge Street corridor, and a new development at Seaton, just east of Toronto. The Metro Planners see a delay in growth beyond the existing urban envelopes until investment and rationalization of the existing urban envelopes has already been taken place. Ultimately, growth would move into new and expanded centres, but not until intensity potential of the existing urban envelope has been realized.

Seaton is included as a Reinvestment Centre, even though it does not exist at the present time. Seaton is a community planned by the Province of Ontario for presently agricultural land in the Town of Pickering, east of Toronto. This community, with an expected population of 90,000 persons, was originally designed to complement the development of a new airport, immediately to the north. Original plans envisaged a standard greenfields development with segregated land uses, industry to the north, a commercial core, several retail centres, and a range of housing types. Density, overall, would be medium (90,000 residents, plus an unknown number of jobs in 7,000 acres) and the community would be connected to Toronto by a proposed freeway, arterial roads, and bus and GO train services. However, little has been heard of the proposal since its most recent announcement in March 1990.

12.0 CONCLUSIONS

Infrastructure costs of new traditional suburban development have been increasing as population density declines and total commuting distances increase. At the same time, much of the already built urban infrastructure in Canada has seen declining maintenance and deteriorating quality. Given the absence of major sums of money to renovate and maintain the existing infrastructure and to provide new infrastructure, it becomes necessary to examine how cities are constructed in order to find ways of reducing infrastructure costs.

The answer is two fold: first, and foremost, is to locate new residential and other development within the existing urban envelopes at locations where most, if not all, of the infrastructure already exists. This intensification also permits both the existing and new residents to pay for the costs of renovating and upgrading existing infrastructure, while expanding its capacity to handle the new development. The second approach to reducing infrastructure costs is to ensure that new "greenfields" development takes place at higher densities. This increase in densities can be accomplished through a reduction in width of right-of-ways and lot sizes, while still producing single family homes. A second technique is to add to new subdivisions a mixture of semi-detached, row townhouse, stacked townhouse, and walk-up apartment development in order to not only further increase intensification but to provide for a wider range of housing opportunities.

At the same time, new commercial development should be integrated into the community with residential uses added to retail uses. The combination of on-site residential development coupled with a higher density adjacent residential neighbourhood with convenient pedestrian connections can result in a reduction in parking requirements on the commercial site and, hence, a further saving in land requirements.

Fortunately, for those interested in reducing infrastructure expenditures, the necessary intensification coincides with similar conclusions being reached by environmentalists, transit advocates, and social activists. The emerging ideal of a compact, mixed-use, human scale, urban form is starting to be accepted in Canada. Paehlke notes some 15 advantages for urban intensification, including:

- opportunities for access by proximity which can reduce the need for motorized transportation;
- more viable, convenient and cost effective public transportation;
- enhanced cycling and walking opportunities;

- reduction in need for and cost of transportation based services such as school buses, postal services, deliveries, and waste collection;
- multiple dwelling units are more energy and materials efficient per unit than detached single family dwellings;
- compact cities reduce the energy and materials used for infrastructure such as roads, sidewalks, watermains, telephone and cable liens, energy utility conduits;
- greater reuse, recycling and repair of existing facilities and structures;
- protection of agricultural land;
- a more efficient food system;
- protection of environmentally significant areas;
- efficient and effective utilization of existing facilities;
- some land devoted to automobiles can be freed for other uses;
- significant enhancement of regional and global air quality;
- reduction of water demand. (Paehlke, 1991, p.11 to 20).

Present development with a separation of land uses, very low density residential development, and privately owned interior shopping malls may also contribute to the growing sense of social alienation and juvenile crime. The lack of the traditional shopping street with its variety of people and ages can result in the loss of a sense of community. Street life and animation, "Eyes on the Street" and both day and evening activities can enhance a sense of community and public security.

The goal to reduce infrastructure costs is part of a shift towards what has been called "neo-traditional planning". Such a reduction in infrastructure costs goes hand in hand with urban intensification, mixture of uses, increase transit usage, finer grained and more incremental types of redevelopment, and a greater emphasis on pedestrian and cycling activities. Once the consistency of these positions and the resulting social and financial benefits are more widely known, nimbyism can be reduced and significant strides made in implementing a compact form of urban development.

REFERENCES

Association of Municipalities of Ontario, "Municipal Infrastructure in Canada"; Toronto, 1985

Canada Mortgage and Housing Corporation; "Urban Infrastructure in Canada"; Ottawa, 1989

Canada, Department of Finance; "Quarterly Economic Review Annual Reference Tables"; Ottawa, June 1991

Cervero, Robert; "Suburban Gridlock"; Rutgers University; New Brunswick, N.J., 1986

City of Vancouver, Task Force on Atmospheric Change; "Clouds of Change"; Vancouver, 1990

Coalition to Renew Canada's Infrastructure, (The); "Submission to the Honourable Jean Corbeil, Minister of Transport"; Ottawa, 1992

Code, William R.; "The Relativity of Sustainability"; University of Western Ontario, mimeographed

Commission on Planning and Development Reform, Ontario, "New Planning News", Vol. 1 No. 3, December 1991

Downing, Paul B. (ed); "Local Service Pricing Policies and Their Effect on Urban Spacial Structure"; University of British Columbia Press; Vancouver, 1977

Federation of Canadian Municipalities; "Status of Municipal Infrastructure: Physical Condition and Funding Adequacy"; Ottawa, 1985

Fischell, William A.; "What Do Economists Know About Growth Controls?"; article in Understanding Growth Management, Urban Land Institute; Washington, 1989

Frank, James E. and Rhodes, Robert M. (ed); "Development Exactions"; American Planning Association; Chicago, 1987

Frank, James E.; "The Costs of Alternate Development Patterns: A Review of the Literature"; Urban Land Institute; Washington, 1989

Garreau, Joel; "Edge City: Life on the New Frontier"; Doubleday; New York, 1991

Gordon, P. and Wong, L.; "The Costs of Urban Sprawl: Some New Evidence"; from Environment and Planning, vol. 17, 1985

IBI Group; "Review of the Urban Structure Concepts Study"; Toronto, 1990

IBI Group; "Greater Toronto Area Urban Structure Concepts Study"; Toronto, 1990

Institute of Urban Studies; "Workshop Proceedings: The Urban Limit Line"; Winnipeg, 1990

Irwin, Neal; "Infrastructure Issues and the GTA Hinterland"; IBI Group; Toronto, 1989

Kenworthy, J. R. and Newman, W.P.G.; "Learning from the Best and the Worst: Thirty-Two International Cities with Implications for Gasoline Use and Emissions"; Murdoch University; Perth (Australia), 1987

Metropolitan Toronto Planning Department; "The GTA: Concepts for the Future"; Toronto, 1990

Nicholas, James C.; "The Costs of Growth: A Public vs. Private Sector Conflict or a Public/Private Responsibility"; article in Understanding Growth Management, Urban Land Institute; Washington, 1989

Nowlan, David M. and Stewart, Greg; "Downtown Population Growth and Commuting Trips; Recent Experience in Toronto"; Journal of the American Planning Association, vol. 57, No. 2, 1991

Paehlke, Robert; "The Environmental Effects of Urban Intensification"; Ontario Ministry of Municipal Affairs; Toronto, 1991

Simmons, J. W. and Bourne, L. S.; "Urban Growth Trends in Canada, 1981-86"; Major Report No. 25, Centre for Urban and Community Studies, University of Toronto; Toronto, 1989

Stone, P.A.; "The Structure, Size and Costs of Urban Settlements"; Cambridge University Press; Cambridge, 1973

Wheaton, William L. and Schussheim, Morton, J.; "The Cost of Municipal Services in Residential Areas"; U.S. Department of Commerce; Washington, 1955