neptis

Toronto-Related Region Futures Study

Sketch Modelling of Four Alternative Development Concepts

This report has been commissioned by the Neptis Foundation for consideration by the Central Ontario Smart Growth Panel established by the Government of Ontario. This report does not necessarily reflect the views of the Government of Ontario.

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IBI GROUP

in association with

METROPOLE CONSULTANTS

and

DILLON CONSULTING LIMITED

February 26, 2003

Mr. Anthony C. Coombes
Executive Director
The Neptis Foundation
50 Park Road
Toronto, Ontario M4W 2N5

Dear Mr. Coombes:

Toronto-Related Region
Sketch Modelling of Four Alternative Development Concepts

As commissioned by the Neptis Foundation for consideration by the Smart Growth Secretariat and the Central Ontario Smart Growth Strategy Sub-Panel, we have prepared this study of four alternative development concepts for the Toronto-Related Region. The report builds on the August 2002 interim report: ***Implications of Business-As-Usual Development***, by describing three alternative urban development and physical infrastructure concepts to 2031 and comparing them with the Business-As-Usual (BAU) concept described in the earlier report.

The bulk of the work was carried out during the fall of 2002 and involved presentations/discussion of the results with the Strategy Sub-Panel and the Gridlock Sub-Panel of the Ontario Central Zone Smart Growth Panel. This report documents the work.

The study team acknowledges with thanks the advice and input of both Neptis and staff of the Ontario Smart Growth Secretariat, while accepting responsibility for the findings and conclusions of this report.

Respectfully submitted,

IBI GROUP

Neal A. Irwin
Chairman Director

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Encl.

TABLE OF CONTENTS

LIST OF EXHIBITS

Toronto-Related Region
Sketch Modelling of Four Alternative Development Concepts

SUMMARY

This report describes four alternative growth scenarios for the Toronto-Related Region to 2031.

This report is a sequel to the report ***Toronto-Related Region Futures Study: Implications of Business-As-Usual Development*** (2002) prepared by IBI Group and Dillon Consulting Limited on behalf of the Neptis Foundation. The earlier report describes a projected pattern of urban development and related transportation and water/wastewater infrastructure systems for the Toronto-Related Region to 2031, under "Business-As-Usual" (BAU) assumptions. The present report describes subsequent work, carried out on behalf of Neptis, to develop three alternative growth scenarios for the same area, based on alternative assumptions. The four development concepts (BAU plus the three alternatives) are compared in terms of patterns of urban growth, amount of newly urbanized land, and infrastructure costs and performance, based on projected conditions in 2031 under each of the four sets of assumptions. The four development concepts are designated as follows:

A. Business-As-Usual
B. Consolidated
C. Multi-Centred
D. Dispersed.

These concepts were designed to show the implications of differences in the settlement patterns and urban structure as well as infrastructure requirements and performance for the study area, which comprises the Cities of Toronto and Hamilton and the Regional Municipalities of Durham, Halton, Peel and York (referred to in total as the inner study area), as well as the Regional Municipalities of Niagara and Waterloo, the Counties of Wellington (south part), Dufferin, Simcoe, Peterborough (south part) and Northumberland, plus the City of Kawartha Lakes (collectively referred to as the outer study area).

The development concepts do not constitute a plan for the region. Rather, they are "what if" concepts to help inform discussions of possible alternative future development strategies.

None of the development concepts is put forward as a plan. Rather they are "what if" concepts to help inform discussions of possible alternative future development strategies for the Toronto-Related Region.

Following a brief description of the study purpose and approach in Chapter 1, Chapter 2 describes the four alternative development concepts and the sketch modelling approach. Chapter 3 provides a comparison of the concepts, focussing in particular on land use, transportation, and water/wastewater infrastructure, and Chapter 4 provides a summary of findings and draws a number of conclusions based on them.

The summary and conclusions are presented on the following three pages.

COMPARISON HIGHLIGHTS

Highlights of the key projected differences in 2031 among the four development concepts are summarized here.

URBAN STRUCTURE: COMPARISON HIGHLIGHTS

The key differences among the four development concepts in terms of urban structure are :

The Consolidated concept puts most development into existing urban areas; the Multi-Centred concept puts more new development into outlying centres; and the Dispersed concept has the highest amount of growth on currently unurbanized land.

- Relative to the other concepts, the Consolidated concept has the most development in existing urban areas (51.3% more population and 21.2% more employment than under the BAU concept), the highest density (50.1 population plus jobs per hectare, versus 46.7 for the BAU concept and 45.8 in the base year 2000), and the lowest growth in new urbanized land (22.9% lower than for the BAU concept).

- The Multi-Centred concept has more new development in outlying centres (19.9% more population and 29.6% more employment), medium density (46.1 population plus jobs per hectare), and slightly higher growth in new urbanized land (3.8%) relative to the BAU concept.

- Relative to the BAU concept, the Dispersed concept has 17.9% more exurban population (in outlying centres plus dispersed rural, non-farm development), the lowest density (45.1 population plus jobs per hectare), and the highest growth in new urbanized land (11.4% more than for BAU).

TRANSPORTATION: COMPARISON HIGHLIGHTS

Key differences among the four development concepts in terms of transportation performance and costs are summarized below:

Under the Consolidated concept, the number of kilometres travelled by vehicle would be lowest, and the market share of transit would be highest.

- Daily auto vehicle-km of travel (VKT) would be 6.4% lower for the Consolidated concept relative to the BAU concept (reflecting more use of transit, shorter trips), 1.3% lower for the Multi-Centred concept (reflecting a better balance of jobs and population in existing urbanized areas) and 2.5% higher for the Dispersed concept (reflecting lower-density, spread development).

- The Consolidated concept would achieve a 20% increase in municipal transit market share relative to BAU while the Multi-Centred concept would achieve a 9.8% increase, but the Dispersed concept would show a 10.3% reduction. Changes in market share of GO Rail travel for the three concepts would be 21.1%, 5.0% and –2.3%, respectively, relative to the BAU concept.

- The Consolidated and the Multi-Centred concepts would achieve the greatest reduction in auto delay per trip (reduced by 16% from BAU), but these concepts would still experience more than twice base year levels of auto delay. At the

All four scenarios show increases in auto delay relative to levels in 2000.

subarea level, increases in auto delay are most pronounced in the new suburbs, which would experience delays of 13 to 15 minutes per trip in all concepts, versus 2 minutes per trip in 2000.

The Consolidated concept achieves the greatest reductions in transportation fuel use and emissions relative to the Business-As-Usual concept. However, emissions of carbon dioxide are estimated to worsen under all four concepts relative to 2000.

- The Consolidated concept would achieve the greatest reduction in transportation fuel use and emissions relative to the BAU concept (-6% to -15%); emissions and fuel use would also be less for the Multi-Centred concept (-2% to -8% relative to BAU), while the Dispersed concept would have 1 to 2% higher emissions of nitrogen oxides and carbon dioxide and fuel consumption, but 4 to 5% reduction of carbon monoxide and volatile organic compounds emissions relative to the BAU concept.

Annual public-sector expenditures in 2031 would be lowest in the BAU concept, but annual combined public- and private-sector expenditures (including auto operating costs) would be lowest for the Consolidated concept.

- Annual public-sector expenditures in 2031 would be lowest in the BAU concept, but annual combined public- and private-sector expenditures (including auto operating costs experienced by drivers) would be lowest for the Consolidated concept.

- Overall, significant improvements in transportation performance could be achieved with the Consolidated concept followed by the Multi-Centred concept, but projected delays and emissions of carbon dioxide are estimated to worsen under all four concepts relative to the base year.

WATER/WASTEWATER: COMPARISON HIGHLIGHTS

Highlights of the water/wastewater system cost estimates are summarized below:

- Investments would be significant and approximately the same for all four concepts, as about 80% of the investment is for system renewal and upgrades, which are common to all four concepts.

The Consolidated concept requires the least amount of new water and wastewater infrastructure; the Multi-Centred concept requires the most.

- The estimated capital expenditure of about $33.6 billion averages about $1.1 billion per year over the 31-year study period, about 20% higher than existing annual capital expenditure, estimated at about $0.9 billion per year. Funding the additional investment is expected to require full-cost recovery through water/ wastewater rates, anticipated to be achieved through legislation recently passed by the provincial legislature.

- The most significant cost differences for growth-related costs (20% of total investment) are between the Consolidated and Multi-Centred concepts (a difference of 10%), reflecting the greater ability to use existing facilities in already urbanized areas under the Consolidated concept. The timing and extent of plant expansions also vary somewhat among the concepts.

- The drive to full-cost recovery, higher levels of treatment, groundwater protection, and more management expertise will likely spur system consolidation, particularly in the outer study area, under any of the concepts.

CONCLUSIONS

The following preliminary conclusions are based on the sketch modelling results:

Continuing rapid growth, no matter what form it takes, will pose challenges related to transportation performance, environmental protection, and energy consumption.

- Continuing rapid growth, as projected for all concepts, will create significant challenges, particularly in terms of growth in urbanized land, reductions in transportation performance, and related environmental and energy consumption issues.

- The Consolidated concept is projected to be most effective in addressing these issues, followed by the Multi-Centred concept.

- An integrated approach to planning, funding, and delivery of transportation and land use will be necessary to move effectively towards either of these concepts or a combination.

- Transportation user charges (e.g., fuel taxes, road pricing, parking rates, vehicle registration fees) are a policy tool that could not only help to address traffic congestion but also provide a reliable revenue stream to fund transportation improvements; these were not considered in the present report.

Transportation user charges (e.g., fuel taxes, road pricing, parking rates, vehicle registration fees) could help to address traffic congestion and provide a reliable revenue stream to fund transportation improvements.

- Sketch modelling can be used to assess possible hybrid concepts and/or test the implications of user charges regarding travel behaviour and transportation system performance.

- Required water/wastewater system investments are similar for all four development concepts; a key issue is to achieve full-cost recovery in order to provide ongoing funding for system renewal, upgrading, and expansion, which are essential to achieve and maintain reliable supplies and management of water resources in the face of continuing rapid growth.

1 INTRODUCTION

BACKGROUND

The Neptis Foundation commissioned IBI Group in 2001 to describe and assess a "Business-As-Usual" (BAU) future for the Toronto-Related region to 2031. As described in the resulting 2002 report ***Toronto-Related Region Futures Study: Implications of Business-As-Usual Development*** (referred to herein as the ***BAU Report***), the pattern and extent of urban development was projected, along with transportation and water/wastewater infrastructure systems, based on the assumption that development policies, approval processes, regulations, and investment levels would remain in future largely as they have been in the recent past.

The Business-As-Usual Report , completed in 2002, suggested that if future growth patterns resembled those of the late 20th century, low-density, single-use areas would proliferate on currently urbanized land. These areas would be difficult to serve cost-effectively by transit.

The study team identified a number of key issues in examining the BAU trends. These include the following:

- a large growth in population, employment, and related activities, which will result in a significant increase in the urbanized area and related impacts on the uses of rural land, including agricultural land;
- the proliferation of relatively low-density, single-use areas on newly urbanized lands which are difficult to serve cost-effectively by transit, walking, or cycling and require automobile use;
- major increases in automobile travel, with reductions in municipal transit ridership and in modal choice available to travellers;
- increases in commuting and other travel times and costs due to increasing travel distances and congestion; this in turn would affect the region's economic competitiveness, as goods movement times and costs also increase due to automobile congestion;
- continuing reliance primarily on limited local governmental funding sources and development charges for capital funding of transportation and water/wastewater infrastructure – estimated to total $77 billion over the period to 2031 – of which about three-quarters ($59 billion) is required for system rehabilitation, renewal, and upgrading, and the remainder ($18 billion) for growth-related investment. While the latter is driven primarily by overall growth in population and employment, it would also be subject to change if alternative urban structure and infrastructure policies were put in place rather than the BAU assumptions considered in the report.

This report represents the next step in forecasting growth in the Toronto-Related Region, and tests the performance and cost implications of three alternative growth patterns.

The ***BAU Report*** presents the assumptions on which the Business-As-Usual concept is based, detailed tabulations and graphics describing the projected development and infrastructure, and a description of the performance and cost implications of urban development and infrastructure under these assumptions. The next step, as planned by Neptis, was to conduct similar studies for two or three alternative development concepts, in order to test the performance and cost implications of alternative

development patterns and infrastructure systems. Discussions between Neptis and the Ontario Smart Growth Secretariat took place as these concepts were being considered, and it was agreed that Neptis and the Secretariat would cooperate in supporting this phase of the work, which would be carried out by IBI Group et al. The results were provided as input to the Ontario Smart Growth Panel's deliberations regarding a smart growth strategy for the Central Ontario Zone.

PURPOSE AND APPROACH

This report describes three alternative development concepts and the transportation and water/wastewater infrastructure systems considered to be appropriate for each. The four development concepts (BAU plus the three alternatives) are compared in terms of patterns of urban growth, amount of newly urbanized land, and infrastructure costs and performance, based on projected conditions in 2031 under each of the four sets of assumptions.

The sketch modelling approach is slightly less detailed and more approximate than the computer modelling conducted for the Business-As-Usual report.

A "sketch modelling" approach was used to describe and analyze the projected development pattern and infrastructure implications likely to be experienced in 2031 under each of the four concepts. A computerized model was used to estimate transportation demand and performance, as described in the ***BAU Report***, but it was applied on a somewhat more approximate basis, reflecting the strategic level of analysis and the limited time available for this work during fall 2002.

As pointed out in the ***BAU Report***, none of the development concepts is put forward as a plan. Rather, they are "what if" concepts to help inform discussions of possible alternative future development strategies for the Toronto-Related Region.

2 ALTERNATIVE DEVELOPMENT CONCEPTS

The pre-eminent role of the Toronto-related region in Canada and its continuing attractiveness to international immigrants suggest that the region will continue to grow rapidly at a rate of about 100,000 persons per year, adding some three million people over the coming three decades. Proportionately strong employment growth is also anticipated. A smart growth strategy can build on the opportunities provided by this growth, while providing a framework which seeks to maintain or improve the region's performance in environmental, economic, social, and financial terms, recognizing the challenges of maintaining quality of life during periods of rapid growth.

All four growth concepts use the same growth projections for the Toronto-Related Region: from 7.36 million people in 2000 to 10.53 million in 2031 and from 3.53 million jobs in 2000 to 5.45 million in 2031.

Defining and testing alternative development concepts provide an important means of visualizing and understanding the implications of alternative futures. Four concepts were studied:

A. Business-As-Usual
B. Consolidated
C. Multi-Centred
D. Dispersed

As outlined below, these concepts were designed to show the implications of differences in the settlement patterns and urban structure, density and mix of land uses, infrastructure including transportation and water/wastewater systems, and related measures of infrastructure cost and performance. The same level of overall growth is projected for all four concepts: from 7.36 million people in 2000 to 10.53 million in 2031 and from 3.53 million jobs in 2000 to 5.45 million in 2031. The study area comprises the Cities of Toronto and Hamilton and the Regional Municipalities of Durham, Halton, Peel and York (referred to in total as the inner study area) as well as the Regional Municipalities of Niagara and Waterloo, the Counties of Wellington (south part), Dufferin, Simcoe, Peterborough (south part) and Northumberland, plus the City of Kawartha Lakes (collectively referred to as the outer study area).

The Toronto-Related Region used in this report is slightly smaller than the Central Ontario Zone defined by Ontario's Smart Growth initiative.

It should be recognized that this is not exactly the same as the Provincial Central Ontario Smart Growth zone, which was adopted for the Panel's work after the Neptis study area was defined.[*] The study areas are sufficiently similar, however, that the Neptis sketch modelling results can provide useful input to the Panel's development of a preferred smart growth strategy.

[*] The Neptis study area has about 4% less population in 2000 than the Central Ontario Smart Growth zone.

A. BUSINESS-AS-USUAL DEVELOPMENT CONCEPT

The Business-As-Usual concept assumes that regional plans and policies and development processes will not change in the next 30 years.

This concept is based on the assumption that existing regional plans, policies, development approval processes, and infrastructure development/investment will remain largely as they were during the past decades. Overall growth, its distribution, and the provision of physical infrastructure would therefore follow existing trends. A detailed description and analysis of this concept is presented in the ***BAU Report*** and it provides a benchmark against which to consider and investigate possible alternative concepts.

B. CONSOLIDATED DEVELOPMENT CONCEPT

The Consolidated concept emphasizes development and redevelopment in areas such as older, underused industrial districts with infrastructure capacity beyond existing and current projected demands.

This concept would focus on significant differences in the distribution of population and employment between established centres and subcentres (i.e., increased resident population, compared to the BAU concept) and development on newly urbanized land (i.e., less population than in the BAU concept) in an effort to achieve a closer live-work relationship in all parts of the study area and reduce pressures for long commuting trips and extensive urbanization of rural land. The concept would emphasize development and redevelopment in areas (e.g., older, under-utilized industrial areas) with available infrastructure capacity beyond existing and current projected demands.

This concept would:

- identify existing capacities, needs, resources, and development opportunities in existing communities across the region, in already-urbanized areas; direct as much of the new growth as possible to these locations; accommodate remaining growth at the urban fringe, emphasizing transit-supportive nodes, corridors, and densities of development;

The Consolidated concept represents a move towards balancing jobs and housing, protecting agricultural land, and improving transit.

- provide opportunities to protect some key agricultural lands in preserves large enough to help maintain a viable agricultural industry;
- attempt to balance jobs and housing locally;
- use new development strategically to make the best use of transportation infrastructure;
- focus transportation on transit improvements in existing and newly urbanized areas, with relatively less emphasis on expanding the road network;
- provide water/wastewater facilities appropriately to serve the new growth in both established and newly urbanized areas.

C. MULTI-CENTRED DEVELOPMENT CONCEPT

The Multi-Centred concept would redirect 30% of employment growth to smaller regional centres, particularly those in the outer parts of the region, north of the Oak Ridges Moraine, west and south of the Niagara Escarpment, and in the eastern part of the region.

This concept would contain elements similar to that of Concept B, with the added intention of achieving greater employment growth in smaller regional centres, particularly those in outer parts of the region. It would seek to redirect a moderate yet significant proportion of new employment to the smaller regional centres, through appropriate urban structure, infrastructure, and related policies.

Key points of the concept would therefore be as follows:

- approximately 30% more of the new employment growth, relative to the BAU concept, would be allocated to smaller regional centres, particularly those north of the Oak Ridges Moraine, west and south of the Niagara Escarpment, and in the eastern parts of the overall region, with corresponding reallocation of some additional population to these areas aimed at an enhanced live-work juxtaposition;

- remaining growth would be accommodated in a manner similar to that described above for Concept B;

- the smaller regional centres would receive additional commuter rail service where feasible plus enhanced priority/express bus services and appropriate highway development;

- the water/wastewater system would be developed accordingly.

D. DISPERSED DEVELOPMENT CONCEPT

This concept would be based on the premise that the BAU pattern of growth would be accepted and additional road expansion investments made in an attempt to address some of the traffic congestion implications identified for the BAU concept. This concept would assume increased expansion of the expressway network, adding 560 lane-kilometres to the network assumed for the BAU concept. Urban development in this concept would be somewhat more spread out than that in the BAU concept, with more development north of the Oak Ridges Moraine, reflecting the greater emphasis on dispersed development likely to result from the expanded road network.

The Dispersed concept is similar to the Business-As-Usual concept, but slightly more spread out, and with additional expressway expansion to serve new development.

Key attributes of this concept would be as follows:

- most growth would continue to be on currently non-urbanized land providing housing and commercial development in configurations similar to those described for the Business-As-Usual concept, but at slightly lower densities;

- there would be more significant residential growth in outer parts of the overall region, largely on currently non-urban land around existing communities;

- the expansion of the transportation system would focus on expressways, with correspondingly less emphasis on municipal transit and commuter rail, similar to that assumed for the BAU concept;

- the water/wastewater system would be modified as appropriate to serve the more dispersed development.

SKETCH MODELLING OF THE ALTERNATIVE CONCEPTS

The sketch modelling approach was applied to compare the four concepts in terms of development patterns and densities, requirements for new urban land, and the cost and performance of transportation and water/wastewater infrastructure.

This report does not suggest what kinds of policies are required to direct growth to certain areas; rather, it shows what would happen if policies succeeded in achieving growth patterns as described for the alternative concepts.

This work does not address the policy or implementation issues and requirements influencing future development patterns of employment and population growth. It demonstrates what impact successfully implementing such policies would have on development patterns, new urban land, transportation infrastructure, and water/wastewater infrastructure, if the concepts studied here could be achieved.

Alternative pricing/taxation policies could be considered as "overlays" on these concepts; for example, road pricing or other transportation user fees could be modelled as a means of moderating the rapid growth of single-occupant vehicle use in peak periods and providing a possible source for funding infrastructure development. "Hybrid" development concepts could also be assessed, combining various attributes of the four concepts or others. However, the sketch modelling has concentrated initially on comparing the four concepts as described above without considering such overlays or hybrid combinations.

3 COMPARISON OF DEVELOPMENT CONCEPTS

LAND USE

Defining Growth Patterns for the Alternative Concepts: Method

As described in the ***BAU Report***, the study area was divided into 2,052 traffic zones as a basis for applying the transportation demand forecasting model. The 2031 population, employment, urbanized land, and development densities were estimated by traffic zone for this purpose. A similar level of information was required for each of the other three concepts in order to conduct the sketch modelling.

The 2031 population, employment, urbanized land area, and development densities were estimated by traffic zone. The Region is divided into 2,052 traffic zones, and these zones were categorized into 10 possible types. Each type was assigned a different growth rate. All the traffic zones of the same type together form a "superzone."

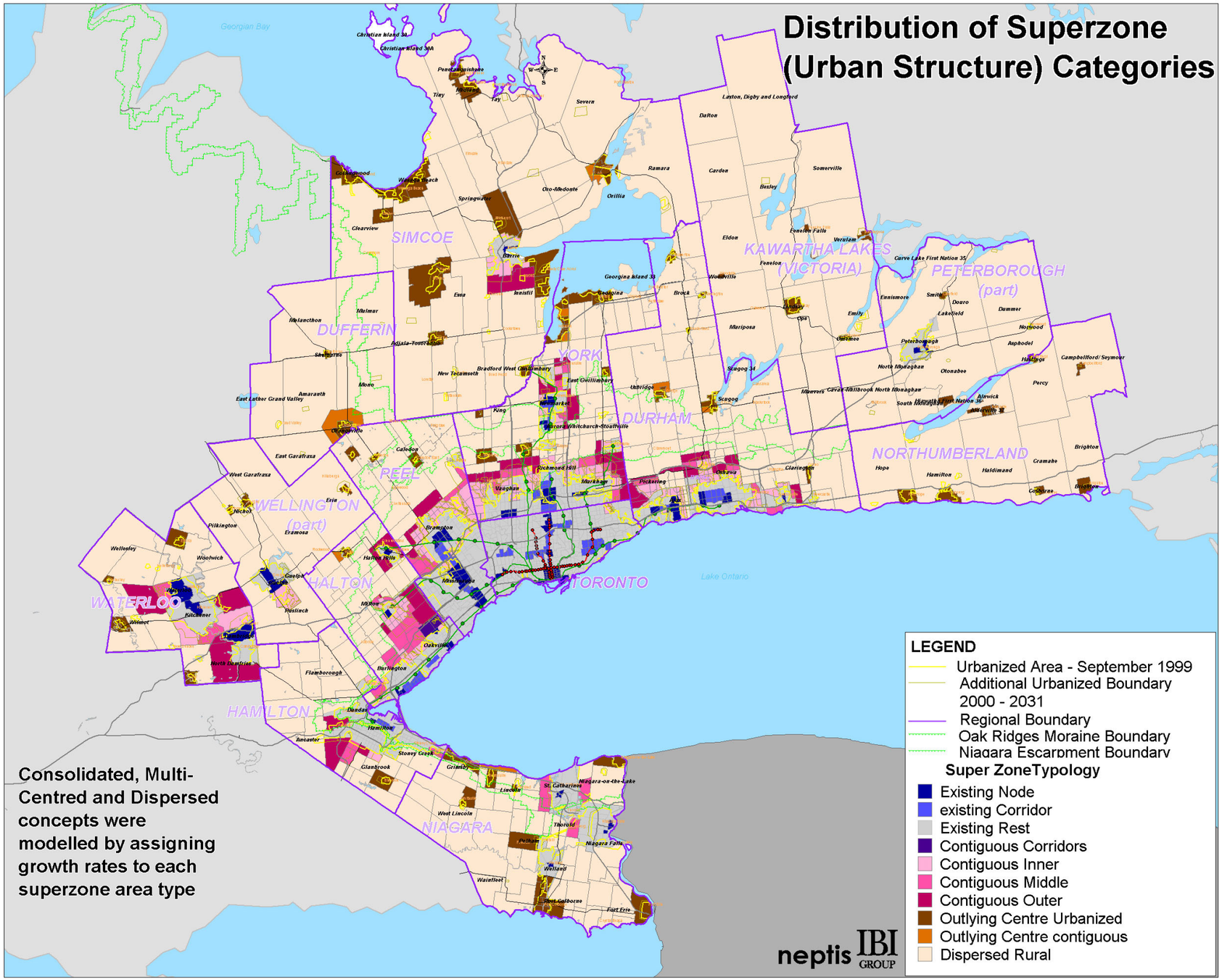
In order to develop this information at a strategic level of detail, each upper-tier municipality (UTM) in the study area was divided into up to 10 types of areas, referred to here as "superzone" areas, which are based on urban structure categories and are defined as :

1. Existing urban areas, nodes
2. Existing urban areas, corridors
3. Existing urban areas, remainder
4. Contiguous, corridors
5. Contiguous, inner (first decade of BAU development)
6. Contiguous, middle (second and third decades of BAU development)
7. Contiguous, outer (beyond third decade of BAU development)
8. Outlying Centres, already urbanized
9. Outlying Centres, greenfields
10. Dispersed Rural, non-farm

All areas of each type (e.g., all "existing urban areas, nodes") were aggregated into one "superzone," with that label, for the entire study area. The superzones were delineated in map form, shown in Exhibit 3.1, and used as a basis for allocating future population and employment growth to each type of area under each of the three alternative concepts (Consolidated, Multi-Centred and Dispersed) relative to the BAU concept. Differential growth rates were applied to each type of area in order to quantify the differences in distribution of population and employment among the alternative concepts.

It was assumed that all of the traffic zones falling within a given superzone would experience the same percentage share as projected for the entire superzone area, thereby resulting in a distribution of future population and employment by traffic zone for each of the concepts which reflects the differences in growth allocation by type of area among the four concepts.

Exhibit 3.1: Distribution of Superzone (Urban Structure) Categories



Growth Patterns for the Alternative Concepts: Results

The results of this allocation are summarized in Exhibit 3.2, which tabulates the 2000-to-2031 population and employment changes by superzone category (with the categories slightly aggregated to simplify the presentation) for each of the four concepts. Also shown, in the central and right hand columns of the table, are the absolute and percentage difference in the amount of population or employment allocated to each superzone category for the three alternative concepts relative to the BAU concept.

Under the Business-As-Usual concept, the population in existing urbanized nodes and corridors would grow by 265,000; under the Consolidated concept, by 526,000, under the Multi-Centred concept, by 225,000 and under the Dispersed concept, by 212,000.

As shown in the table, there are very significant differences in the allocation of the new population and new employment into the various types of superzone areas from concept to concept, and these differences are a quantification of the conceptual differences described in Chapter 2.

For example, as shown in the first line of Exhibit 3.2, while the population in nodes and corridors within existing urbanized areas in the inner study area is projected to grow by 265,000 under the BAU concept, it is projected to grow by 526,000 (a difference of 261,000 or a 98% greater growth) under the Consolidated concept, by 225,000 (40,000 fewer people or 15% less than the BAU growth) under the Multi-Centred concept, and 212,000 (52,000 fewer people or 20% less than the BAU concept) under the Dispersed concept.

As another example, reading from the lower half of the table, the employment increase for outlying centres in the outer study area (including both "already urbanized" and "all other" parts of these centres) from 2000 to 2031 is projected to be 84,000 jobs under the BAU concept, 93,000 jobs (an additional 9,000 jobs or 11%) under the Consolidated concept, 108,000 jobs (an additional 24,000 jobs or 29%) under the Multi-Centred concept, and 86,000 (an additional 2,000 jobs or 2%) under the Dispersed concept. This reflects the additional employment projected in the outlying centres under the Multi-Centred concept.

The outer study area would receive the greatest amount of employment growth under the Multi-Centred concept and the least under the Business-As-Usual concept.

For the inner study area (GTA plus Hamilton) the Consolidated concept is projected to result in 10% greater population growth (243,000 more people) by 2031 than projected for the BAU concept, while the Multi-Centred concept is projected to result in 5% less of the new population (113,000 fewer people) in the inner study area. The Dispersed concept is projected to result in 2% less (51,000 fewer people) than the BAU concept in the inner study area.

Exhibit 3.2: Concept Growth Comparisons by Superzone Category

Change in Superzone Population from 2000 to 2031 by Concept and Absolute and Percentage Difference from BAU of Other 3 Concepts *

	Population Change from 2000				Absolute Difference from BAU			Percentage Difference from BAU		
	BAU	Consolidated	Multi-Centred	Dispersed	Consolidated	Multi-Centred	Dispersed	Consolidated	Multi-Centred	Dispersed
Inner Study Area (GTA + Hamilton)										
Existing Urbanized Areas, Nodes and Corridors	265,000	526,000	225,000	212,000	261,000	-40,000	-53,000	98%	-15%	-20%
Existing Urbanized Areas, All other	680,000	1,008,000	631,000	541,000	328,000	-49,000	-139,000	48%	-7%	-20%
Contiguous Areas	1,289,000	976,000	1,240,000	1,360,000	-313,000	-49,000	71,000	-24%	-4%	6%
Outlying Centres, Aready Urbanized	102,000	118,000	122,000	114,000	16,000	20,000	12,000	16%	20%	12%
Outlying Centres, All other	19,000	0	23,000	57,000	-19,000	4,000	38,000	-100%	21%	200%
Dispersed Rural, Non-farm	55,000	25,000	55,000	73,000	-30,000	0	18,000	-55%	0%	33%
Total GTA + Hamilton	2,409,000	2,652,000	2,296,000	2,358,000	243,000	-113,000	-51,000	10%	-5%	-2%
Outer Study Area										
Existing Urbanized Areas, Nodes and Corridors	50,000	51,000	60,000	40,000	1,000	10,000	-10,000	2%	20%	-20%
Existing Urbanized Areas, All other	155,000	155,000	185,000	124,000	0	30,000	-31,000	0%	19%	-20%
Contiguous Areas	148,000	77,000	177,000	202,000	-71,000	29,000	54,000	-48%	20%	36%
Outlying Centres, Aready Urbanized	207,000	207,000	249,000	208,000	0	42,000	1,000	0%	20%	0%
Outlying Centres, All other	8,000	0	9,000	33,000	-8,000	1,000	25,000	-100%	13%	313%
Dispersed Rural, Non-farm	202,000	36,000	202,000	214,000	-166,000	0	12,000	-82%	0%	6%
Total Outer Study Area	769,000	526,000	883,000	821,000	-243,000	113,000	51,000	-32%	15%	7%
Total Study Area										
Existing Urbanized Areas, Nodes and Corridors	315,000	577,000	285,000	252,000	262,000	-30,000	-63,000	83%	-10%	-20%
Existing Urbanized Areas, All other	835,000	1,163,000	816,000	665,000	328,000	-19,000	-170,000	39%	-2%	-20%
Contiguous Areas	1,437,000	1,053,000	1,417,000	1,562,000	-384,000	-20,000	125,000	-27%	-1%	9%
Outlying Centres, Aready Urbanized	309,000	325,000	371,000	322,000	16,000	62,000	13,000	5%	20%	4%
Outlying Centres, All other	27,000	0	32,000	90,000	-27,000	5,000	63,000	-100%	19%	233%
Dispersed Rural, Non-farm	257,000	61,000	257,000	287,000	-196,000	0	30,000	-76%	0%	12%
Total Study Area	3,178,000	3,178,000	3,178,000	3,178,000	0	0	0	0%	0%	0%

Change in Superzone Employment from 2000 to 2031 by Concept and Absolute and Percentage Difference from BAU of Other 3 Concepts

	Employment Change from 2000				Absolute Difference from BAU			Percentage Difference from BAU		
	BAU	Consolidated	Multi-Centred	Dispersed	Consolidated	Multi-Centred	Dispersed	Consolidated	Multi-Centred	Dispersed
Inner Study Area (GTA + Hamilton)										
Existing Urbanized Areas, Nodes and Corridors	323,000	456,000	289,000	258,000	133,000	-34,000	-65,000	41%	-11%	-20%
Existing Urbanized Areas, All other	549,000	579,000	494,000	439,000	30,000	-55,000	-110,000	5%	-10%	-20%
Contiguous Areas	543,000	397,000	512,000	672,000	-146,000	-31,000	129,000	-27%	-6%	24%
Outlying Centres, Aready Urbanized	28,000	32,000	37,000	33,000	4,000	9,000	5,000	14%	32%	18%
Outlying Centres, All other	3,000	1,000	4,000	21,000	-2,000	1,000	18,000	-67%	33%	600%
Dispersed Rural, Non-farm	32,000	16,000	32,000	54,000	-16,000	0	22,000	-50%	0%	69%
Total GTA + Hamilton	1,478,000	1,480,000	1,367,000	1,477,000	2,000	-111,000	-2,000	0%	-8%	0%
Outer Study Area										
Existing Urbanized Areas, Nodes and Corridors	78,000	123,000	101,000	62,000	45,000	23,000	-16,000	58%	29%	-21%
Existing Urbanized Areas, All other	133,000	155,000	172,000	106,000	22,000	39,000	-27,000	17%	29%	-20%
Contiguous Areas	75,000	51,000	97,000	100,000	-24,000	22,000	25,000	-32%	29%	33%
Outlying Centres, Aready Urbanized	79,000	92,000	102,000	78,000	13,000	23,000	-1,000	16%	29%	-1%
Outlying Centres, All other	5,000	1,000	6,000	8,000	-4,000	1,000	3,000	-80%	20%	60%
Dispersed Rural, Non-farm	71,000	16,000	71,000	85,000	-55,000	0	14,000	-77%	0%	20%
Total Outer Study Area	439,000	437,000	550,000	441,000	-2,000	111,000	2,000	0%	25%	0%
Total Study Area										
Existing Urbanized Areas, Nodes and Corridors	401,000	579,000	390,000	320,000	178,000	-11,000	-81,000	44%	-3%	-20%
Existing Urbanized Areas, All other	682,000	734,000	666,000	545,000	52,000	-16,000	-137,000	8%	-2%	-20%
Contiguous Areas	618,000	448,000	609,000	772,000	-170,000	-9,000	154,000	-28%	-1%	25%
Outlying Centres, Aready Urbanized	107,000	124,000	139,000	111,000	17,000	32,000	4,000	16%	30%	4%
Outlying Centres, All other	8,000	2,000	10,000	29,000	-6,000	2,000	21,000	-75%	25%	263%
Dispersed Rural, Non-farm	103,000	32,000	103,000	139,000	-71,000	0	36,000	-69%	0%	35%
Total Study Area	1,917,000	1,917,000	1,916,000	1,917,000	0	0	0	0%	0%	0%

* Rounded to the nearest 1000; columns may not add to totals due to rounding errors.

As the accompanying maps show, the Consolidated concept places much more population growth in the existing built-up areas in both the inner and outer study areas; the Multi-Centred concept puts more growth in the outlying centres; and the Dispersed concept puts more growth in the outlying areas, relative to the BAU concept. Employment follows patterns that are generally similar to those for population, except that employment is more decentralized than population in the Multi-Centred concept.

Conversely, in the outer study area the Consolidated concept would achieve a population growth 32% less than that under the BAU concept, while the Multi-Centred concept would attract 15% more of the population growth and the Dispersed concept would attract 7% more of the population growth than the BAU concept. The major differences in the employment distribution are under the Multi-Centred concept, which would attract 8% less of the employment growth (111,000 fewer jobs) to the inner study area and 25% more of the employment growth (111,000 more jobs) to the outer study area, relative to the BAU concept.

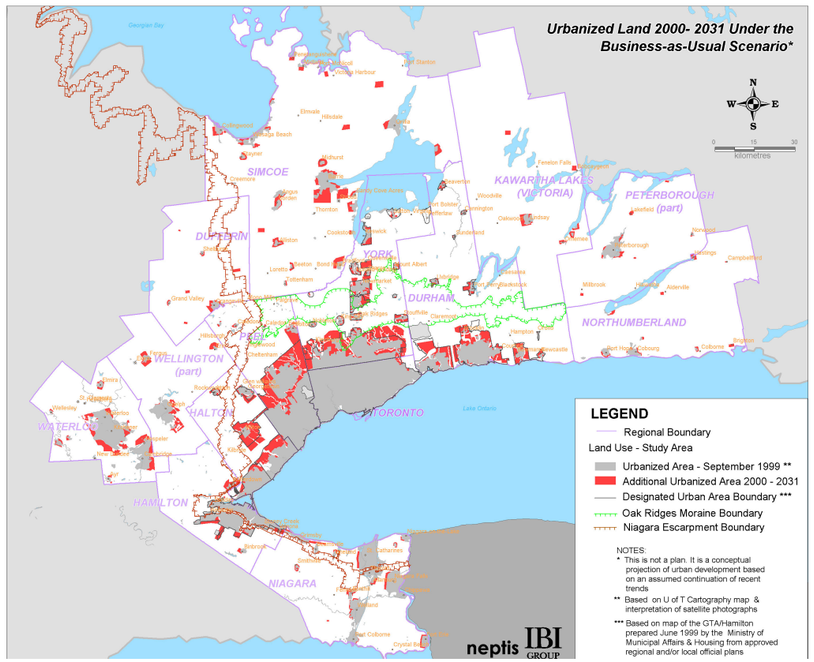
The results of this process are shown in map form in Exhibits 3.3 and 3.4. Exhibit 3.3 shows, in the upper left corner, the land which would be urbanized between 2000 and 2031 under the BAU concept,* while the other three maps show, at the traffic zone level, the differences in the 2031 population plus employment between each concept and the BAU concept. These three maps provide a striking presentation of the differences among the concepts: the Consolidated concept shows considerably more growth in the existing built-up areas in both the inner and outer parts of the study area; the Multi-Centred concept shows considerably more growth in the outlying centres; and the Dispersed concept shows more growth in the outlying areas, relative to the BAU concept.

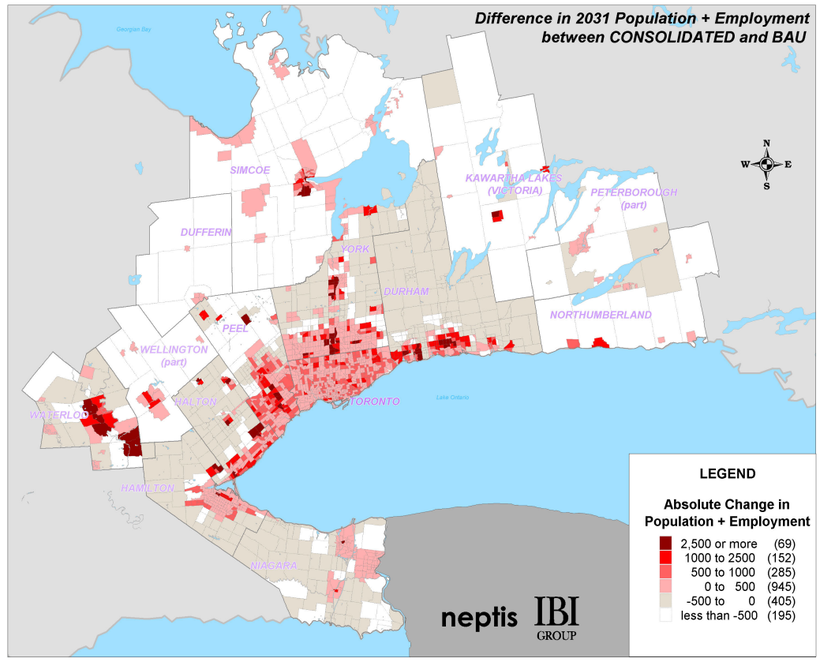
Owing to the size of individual traffic zones – particularly in the outer study area – and the grouping of growth level categories for purposes of colour coding, the maps provide only an approximate display of differences among the concepts. Nonetheless, significant differences can be identified.

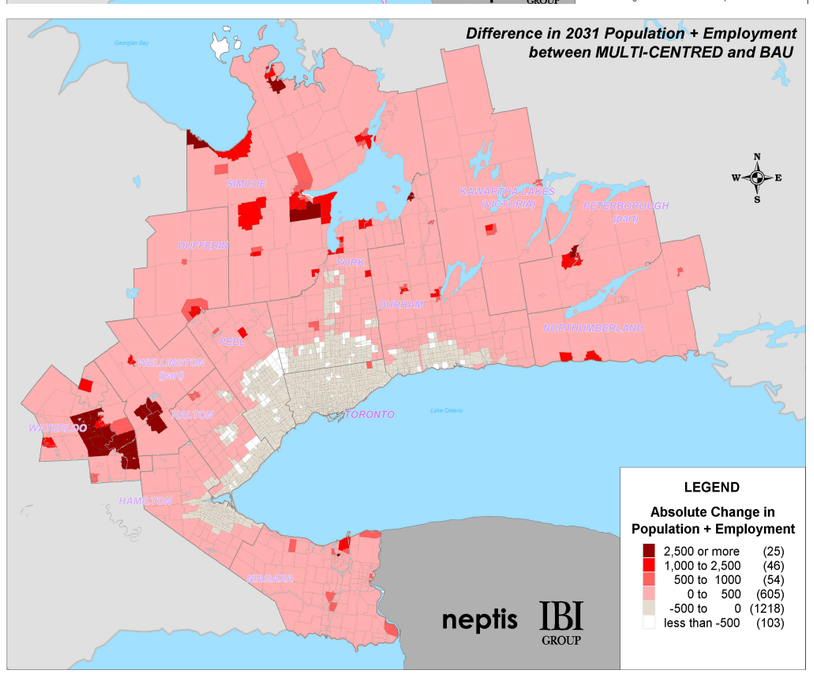
Exhibit 3.4 illustrates these differences separately for population growth and for employment growth. The top row of maps shows, at the traffic zone level, the difference in population between each of the three alternative concepts and the BAU concept, while the bottom row shows the same information for employment. In terms of population, the maps illustrate the greater allocation of 2031 population to existing built-up areas in the Consolidated concept relative to the BAU concept, while the greater population in outlying centres is illustrated for the Multi-Centred concept and the more widespread distribution of population, particularly in the outer study area, is illustrated for the Dispersed concept. Employment follows patterns similar to those for population except for some differences by concept: in the Consolidated concept, there is more employment growth in existing built-up areas (with the exception of the City of Toronto) than is projected for the BAU concept; there is more employment growth in the outlying centres in the Multi-Centred concept; and, again, employment is more widely distributed in the Dispersed concept.

* This is Exhibit 2.7 from the report ***Toronto-Related Region Futures Study: Implications of Business-As-Usual Development*** referred to on page 1.

Exhibit 3.3: Differences in 2000 – 2031 Population Plus Employment Growth between the BAU Concept and Each Alternative Concept







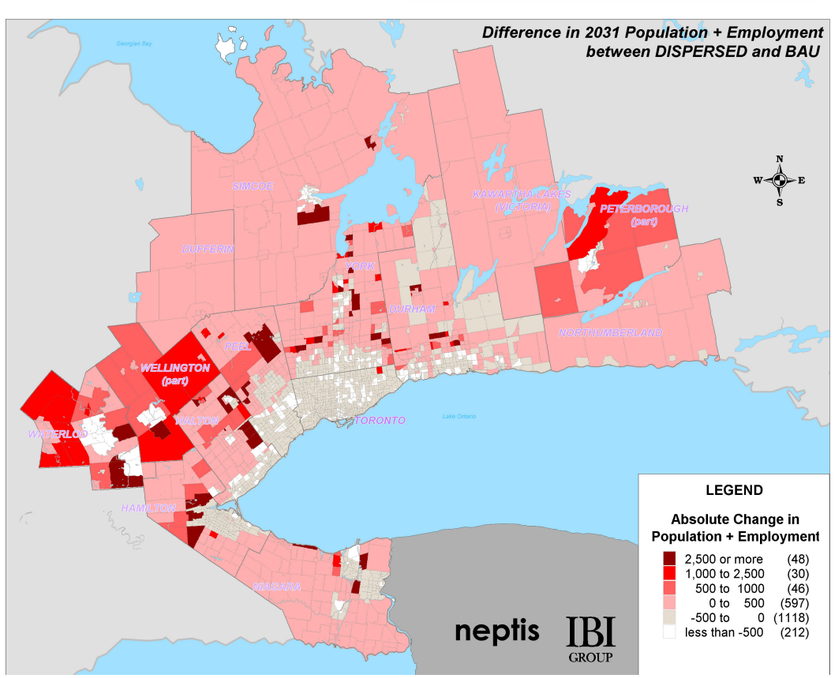
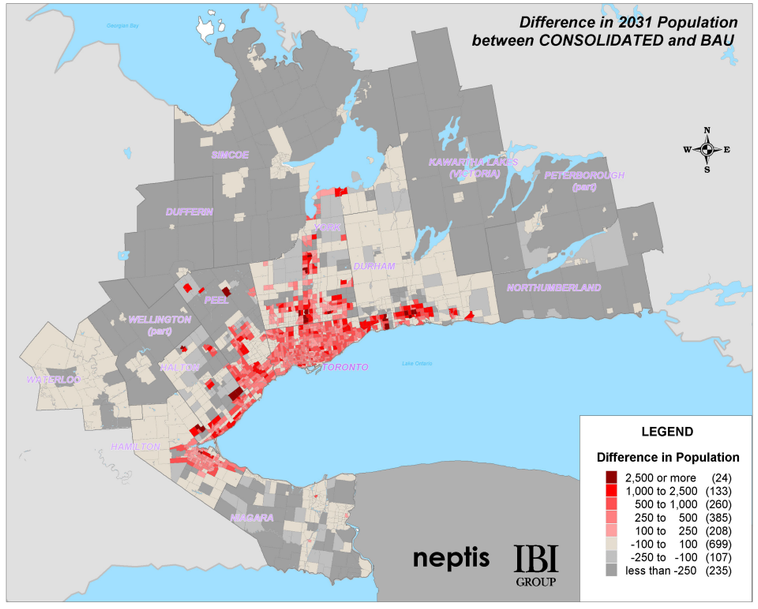
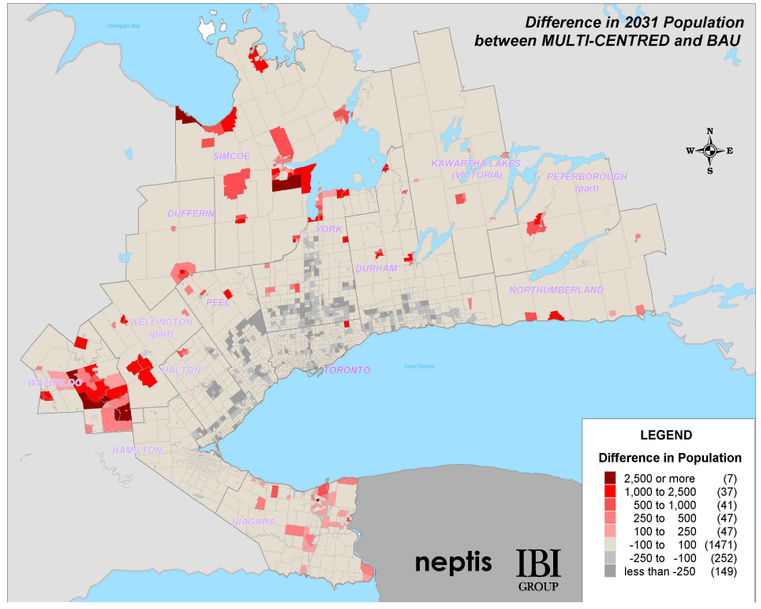
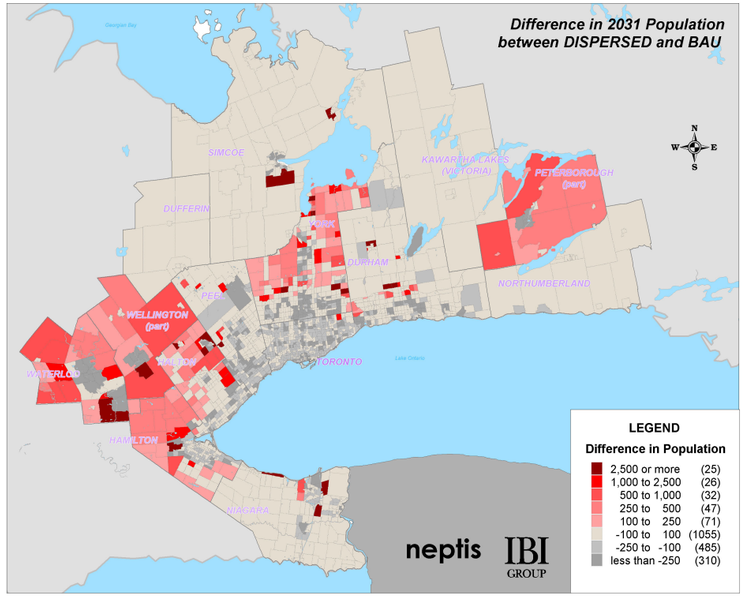
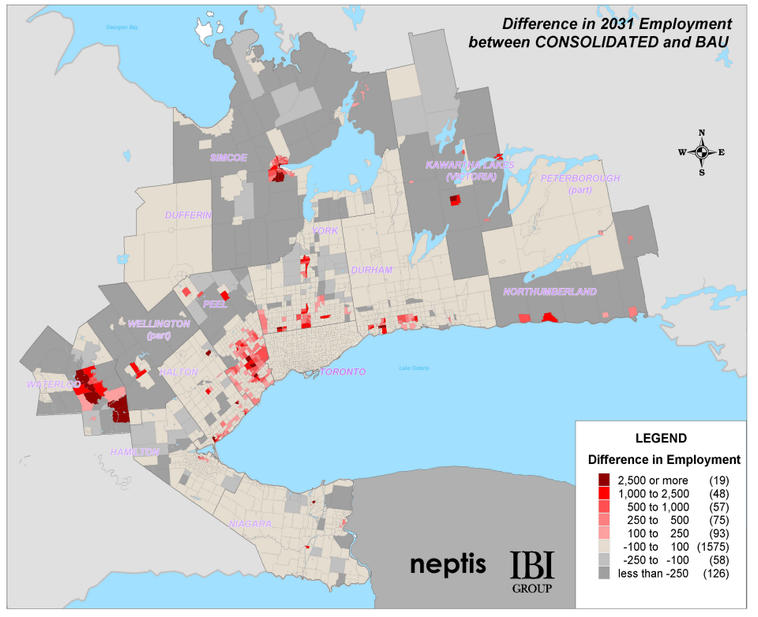


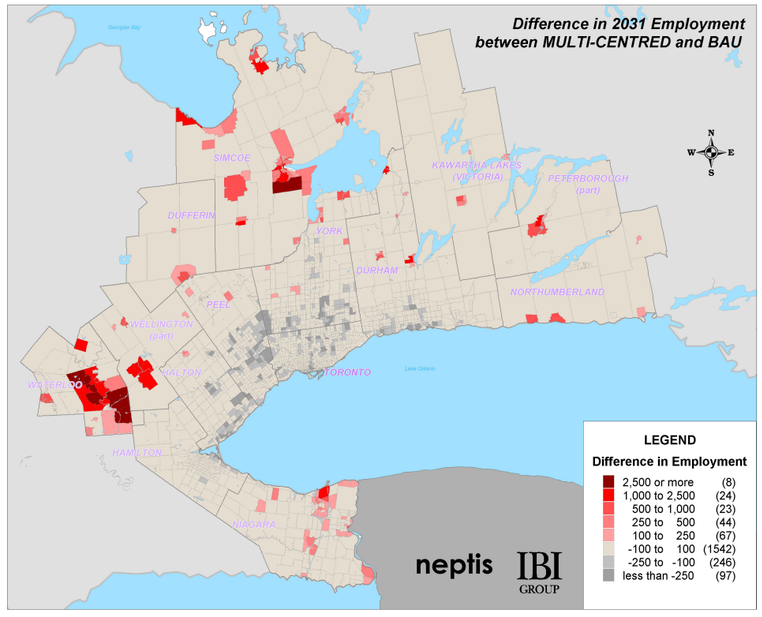
Exhibit 3.4: Differences in 2031 Population and Employment between the BAU and Each Alternative Concept at the Traffic Zone Level

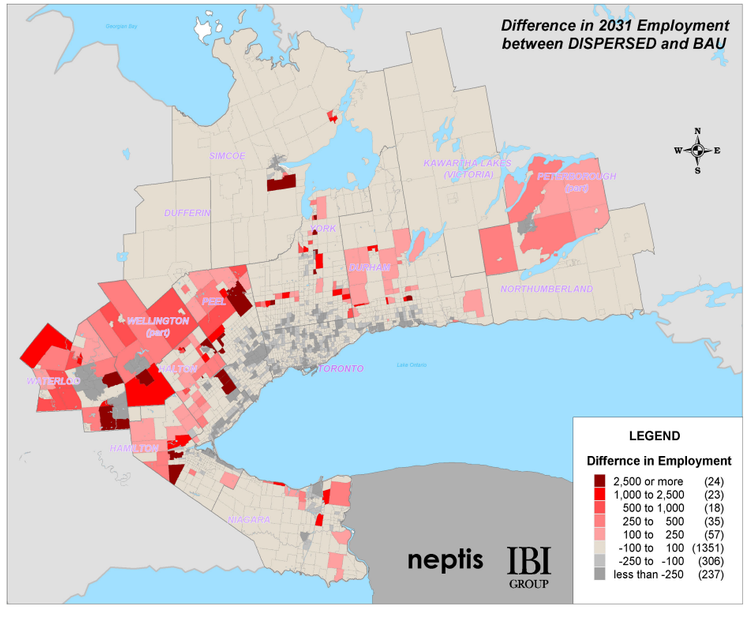












*While the concepts direct growth to different places within an upper-tier municipality, the **total** for most upper-tier municipalities is roughly the same under each concept. The one exception is the City of Toronto.*

Exhibit 3.5 shows the 2031 population, employment, activity rate (employment divided by population), urbanized area, and gross density in each of the upper-tier municipalities as of 2031 for each of the four concepts. This table reflects the differences among the concepts, but the differences show up less sharply when aggregated at the UTM level. This is because, while the concepts may direct growth to different places within a UTM, the total for most UTMs is roughly the same under each concept. The most significant difference is the projected population in the City of Toronto under the Consolidated concept in 2031, which is 194,000 people greater than the projected BAU population for the City.

As shown in Exhibit 3.5, the gross density in terms of population plus employment per hectare of urbanized land for the study area as a whole is projected to increase from 45.8 resident population plus jobs per hectare in 2000 to 46.7 in 2031 under the BAU concept, 50.1 under the Consolidated concept, 46.1 under the Multi-Centred concept and to decline slightly to 45.1 under the Dispersed concept. The differences are more pronounced for the inner study area, with a density of 51.3 people plus jobs per hectare in 2000, increasing slightly to 52.2 under the BAU concept, quite significantly to 57.3 under the Consolidated concept, and declining to 51.5 under the Multi-Centred concept and 50.8 under the Dispersed concept. At both scales, the greatest increase in density would be experienced under the Consolidated concept, followed by the BAU concept and then by the Multi-Centred and Dispersed concepts.

Gross density in 2031, which represents population plus jobs per urbanized hectare, is highest for the Consolidated concept and lowest (slightly lower than in 2000) for the Dispersed concept.

The differences in the distribution of population and employment are illustrated in Exhibit 3.6, which shows for each of the four concepts the 2000–2031 growth in population (upper half of the graph) and employment (lower half) by the superzone categories illustrated in Exhibit 3.1 and tabulated in Exhibit 3.2. As shown in the top half of Exhibit 3.6, population growth in the nodes and corridors of existing urbanized areas for the Consolidated concept is approximately double that of the BAU or the other two concepts and approximately 50% higher in the other parts of the existing urban areas, and significantly lower in the contiguous areas and for dispersed rural non-farm growth in both the inner and outer study areas.

Similar differences are illustrated for employment in the bottom half of the exhibit, with less pronounced differences between the Consolidated concept and the others (although still significant in the existing urbanized areas and contiguous areas in the inner study area). The Multi-Centred concept has more population and employment in the existing urbanized areas in the outer study area and in the already urbanized outlying centres, while the Dispersed concept has more population and employment growth in contiguous areas and in rural non-farm development in both the inner and outer study areas.

Exhibit 3.5: Concept Land Use Characteristics in 2031 by Upper-Tier-Municipality

Inner Study Area

Year	2000	BAU 2031	Consolidated 2031	Multi-Centred 2031	Dispersed 2031
Durham					
Population (P)	512,000	915,000	938,000	907,000	917,000
Total Employment (E)	185,000	364,000	364,000	358,000	364,000
Activity Rate	0.361	0.398	0.388	0.395	0.397
Urbanized Area (sq. km) (U)	165	303	276	301	309
Gross Density ([P+E] / ha)	42.3	42.2	47.2	42.0	41.5
Halton					
Population (P)	385,000	702,000	728,000	686,000	703,000
Total Employment (E)	197,000	390,000	389,000	372,000	418,000
Activity Rate	0.512	0.556	0.534	0.542	0.595
Urbanized Area (sq. km) (U)	159	286	252	282	295
Gross Density ([P+E]/ha)	36.7	38.2	44.3	37.5	38.0
Hamilton					
Population (P)	498,000	601,000	663,000	598,000	599,000
Total Employment (E)	192,000	248,000	248,000	245,000	248,000
Activity Rate	0.386	0.413	0.374	0.410	0.414
Urbanized Area (sq. km) (U)	175	218	210	217	231
Gross Density ([P+E]/ha)	39.4	39.0	43.4	38.8	36.7
Peel					
Population (P)	978,000	1,475,000	1,483,000	1,448,000	1,472,000
Total Employment (E)	541,000	835,000	837,000	813,000	861,000
Activity Rate	0.553	0.566	0.564	0.561	0.585
Urbanized Area (sq. km) (U)	358	519	483	515	527
Gross Density ([P+E]/ha)	42.4	44.5	48.0	43.9	44.3
Toronto					
Population (P)	2,524,000	2,900,000	3,094,000	2,868,000	2,828,000
Total Employment (E)	1,300,000	1,700,000	1,700,000	1,664,000	1,620,000
Activity Rate	0.515	0.586	0.549	0.580	0.573
Urbanized Area (sq. km) (U)	490	495	495	494	494
Gross Density ([P+E]/ha)	78.1	93.0	96.9	91.7	90.0
York					
Population (P)	727,000	1,439,000	1,369,000	1,413,000	1,462,000
Total Employment (E)	369,000	724,000	726,000	699,000	750,000
Activity Rate	0.508	0.503	0.530	0.495	0.513
Urbanized Area (sq. km) (U)	294	537	474	532	556
Gross Density ([P+E]/ha)	37.3	40.3	44.2	39.7	39.8
Inner Study Area Subtotal					
Population (P)	5,623,000	8,031,000	8,276,000	7,919,000	7,981,000
Total Employment (E)	2,784,000	4,262,000	4,264,000	4,151,000	4,260,000
Activity Rate	0.495	0.531	0.515	0.524	0.534
Urbanized Area (sq. km) (U)	1,640	2,357	2,190	2,342	2,411
Gross Density ([P+E]/ha)	51.3	52.2	57.3	51.5	50.8
TOTAL STUDY AREA					
Population (P)	7,362,000	10,539,000	10,541,000	10,540,000	10,540,000
Total Employment (E)	3,535,000	5,453,000	5,453,000	5,453,000	5,453,000
Activity Rate	0.480	0.517	0.517	0.517	0.517
Urbanized Area (sq. km) (U)	1,944	2,887	2,672	2,904	2,957
Gross Density ([P+E]/ha)	56.0	55.4	59.9	55.1	54.1

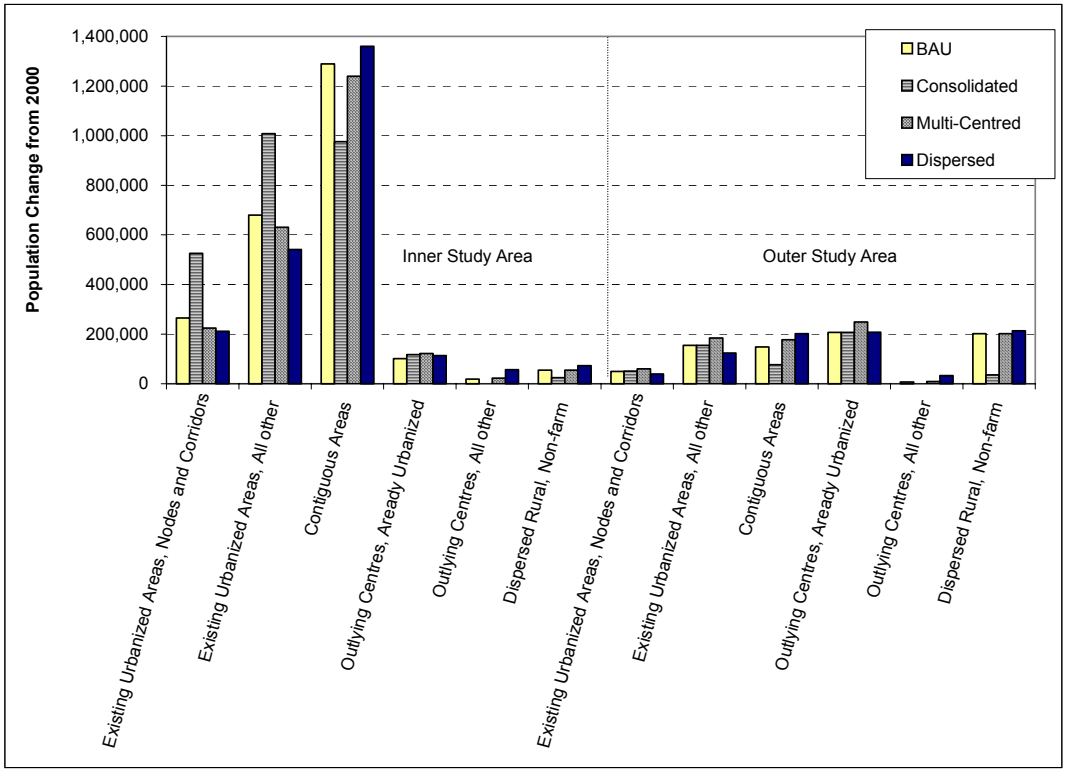
Exhibit 3.5: Concept Land Use Characteristics in 2031 by Upper-Tier-Municipality (Cont'd)

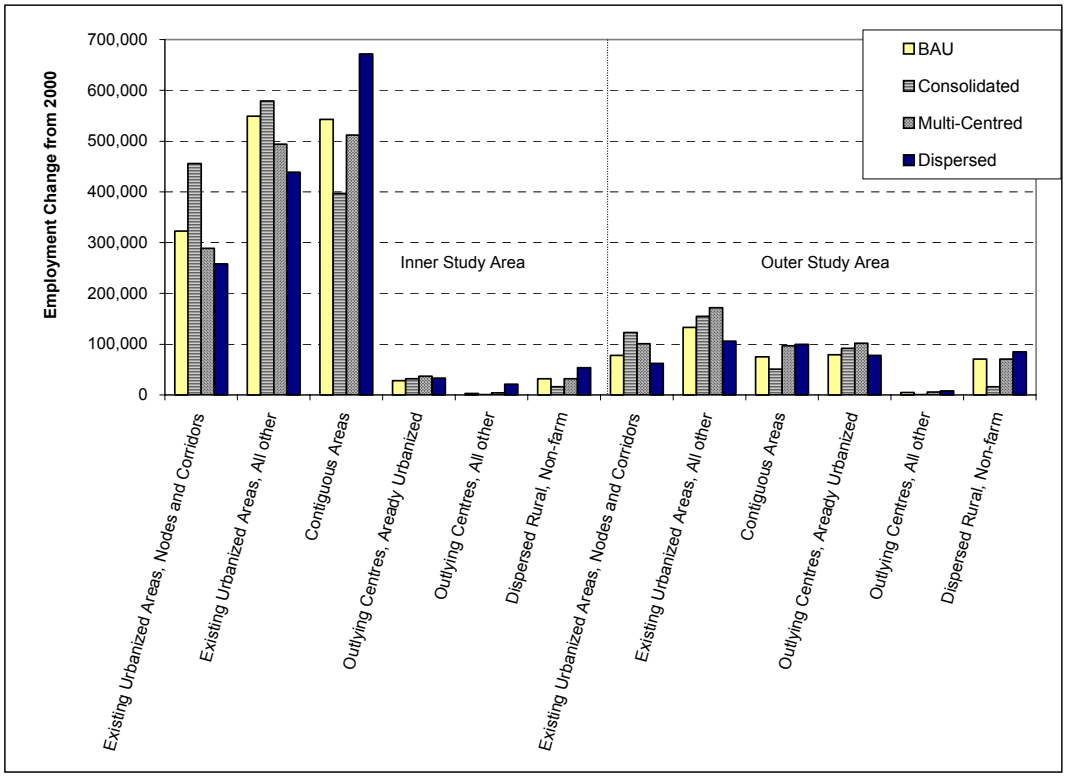
Outer Study Area

Year	2000	BAU 2031	Consolidated 2031	Multi-Centred 2031	Dispersed 2031
Niagara Region					
Population (P)	424,000	517,000	494,000	531,000	537,000
Total Employment (E)	178,000	223,000	223,000	236,000	225,000
Activity Rate	0.420	0.431	0.451	0.444	0.419
Urbanized Area (sq. km) (U)	252	285	278	292	319
Gross Density ([P+E]/ha)	23.9	26.0	25.8	26.3	23.9
Waterloo Region					
Population (P)	451,000	622,000	577,000	655,000	623,000
Total Employment (E)	223,000	387,000	386,000	434,000	386,000
Activity Rate	0.494	0.622	0.669	0.663	0.620
Urbanized Area (sq. km) (U)	186	256	243	275	273
Gross Density ([P+E]/ha)	36.3	39.5	39.7	39.6	37.0
Dufferin County					
Population (P)	51,000	88,000	75,000	93,000	88,000
Total Employment (E)	16,000	30,000	30,000	33,000	30,000
Activity Rate	0.314	0.341	0.400	0.355	0.341
Urbanized Area (sq. km) (U)	11	24	22	26	24
Gross Density ([P+E]/ha)	60.4	48.6	47.6	49.0	4859.0
Northumberland County					
Population (P)	87,000	110,000	103,000	113,000	110,000
Total Employment (E)	33,000	45,000	45,000	46,000	44,000
Activity Rate	0.379	0.409	0.437	0.407	0.400
Urbanized Area (sq. km) (U)	25	37	37	38	36
Gross Density ([P+E]/ha)	48.3	42.4	40.4	41.7	42.4
Peterborough County (Part Only)					
Population (P)	117,000	144,000	138,000	147,000	144,000
Total Employment (E)	53,000	67,000	67,000	71,000	67,000
Activity Rate	0.453	0.465	0.486	0.483	0.465
Urbanized Area (sq. km) (U)	38	49	49	51	50
Gross Density ([P+E]/ha)	45.3	42.9	42.1	42.6	42.4
Simcoe County					
Population (P)	381,000	682,000	569,000	723,000	710,000
Total Employment (E)	148,000	283,000	282,000	313,000	283,000
Activity Rate	0.388	0.415	0.496	0.433	0.399
Urbanized Area (sq. km) (U)	159	291	254	311	299
Gross Density ([P+E]/ha)	33.4	33.1	33.5	33.3	33.2
City of Kawartha Lakes					
Population (P)	73,000	115,000	92,000	118,000	115,000
Total Employment (E)	22,000	39,000	39,000	40,000	39,000
Activity Rate	0.301	0.339	0.424	0.339	0.339
Urbanized Area (sq. km) (U)	14	37	31	37	37
Gross Density ([P+E]/ha)	70.2	42.2	41.6	43.0	42.1
Wellington County (Part Only)					
Population (P)	154,000	230,000	217,000	242,000	232,000
Total Employment (E)	78,000	118,000	117,000	128,000	119,000
Activity Rate	0.506	0.513	0.539	0.529	0.513
Urbanized Area (sq. km) (U)	59	93	89	98	100
Gross Density ([P+E]/ha)	39.3	37.5	37.4	37.7	35.2
Outer Study Area subtotal					
Population (P)	1,738,000	2,508,000	2,265,000	2,621,000	2,559,000
Total Employment (E)	752,000	1,191,000	1,189,000	1,302,000	1,192,000
Activity Rate	0.433	0.475	0.525	0.497	0.466
Urbanized Area (sq. km) (U)	305	531	482	561	546
Gross Density ([P+E]/ha)	81.8	69.7	71.6	69.9	68.7

* Note: There are minor differences (less than 0.5%) in the base year and BAU 2031 land use and density numbers presented here compared to those in the August 2002 Interim Report ***Toronto-Related Region Futures Study: Implications of Business-As-Usual Development*** owing to the strategic nature of the sketch modelling approach. Population and employment numbers in this table are rounded to the nearest 1000, which may lead to apparent discrepancies in column totals.

Exhibit 3.6: Concept 2000–2031 Growth by Superzone Category



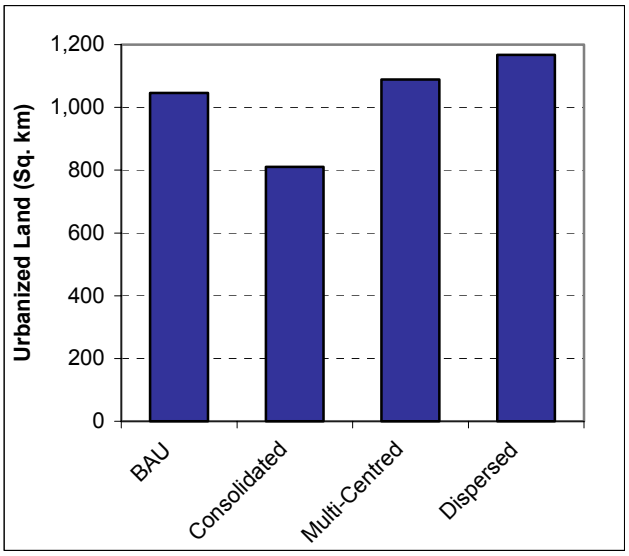


Growth in Urbanized Land

The amount of land urbanized between 2000 and 2031 varies from 810 sq. km for the Consolidated concept to 1,170 sq. km for the Dispersed concept.

Exhibit 3.7 shows graphically the difference in the growth in urbanized land from 2000 to 2031 for the four concepts. As indicated, the newly urbanized land over the 31-year period is projected to be about 1,050 sq. km under the BAU concept, 810 sq. km under the Consolidated concept, 1,090 sq. km under the Multi-Centred concept, and 1,170 sq. km under the Dispersed concept. These differences reflect the higher density of development under the Consolidated concept, slightly lower density under the Multi-Centred concept, and a further reduction in density under the Dispersed concept, relative to the BAU concept.

Exhibit 3.7: 2000 to 2031 Growth in Urbanized Land* by Concept



* Existing (1999) urbanized land = 2,370 km^2

TRANSPORTATION

System Characteristics and Costs

Exhibits 3.8 to 3.11 summarize the transportation system assumed for each development concept. The modal balance and geographical coverage differ among the four systems, in accordance with the development patterns and densities projected for each alternative concept.

Characteristics of the projected expressway and arterial road systems in 2031 assumed for the four alternative development concepts are described in Exhibit 3.8 and shown in map form in Exhibit 3.9. Characteristics of the municipal transit and commuter rail systems assumed for the four alternative development concepts in 2031 are tabulated in Exhibit 3.10 and illustrated in map form in Exhibit 3.11.

The projections for transportation do not include the movement of goods, only passenger transportation. However, the results have implications for goods transportation, since increased road congestion affects trucking.

The analysis in this paper deals with passenger transportation, and the movement of goods is not within the study scope. Clearly, the extent to which the road system is used for passenger transportation affects the ability to move goods on the same system and, conversely, the movements of trucks affect automobile traffic speeds and performance. The effects of truck traffic on road capacity available for autos are taken into account in general terms in the traffic model, but the results reported below regarding automobile congestion levels (e.g., average speed, average delay per trip) may not fully reflect the levels of congestion likely to be experienced on roads heavily used by trucks. The obvious issue in terms of auto traffic impacts on trucking is the extent to which heavy automobile use during peak periods impedes the movement of truck traffic on major expressways and trade routes. The results reported here provide only a broad basis for comparing the four concepts in this regard, based on the relative levels of auto trip delays projected.

Exhibit 3.8: Expressway and Arterial Road Systems Assumed for the Four Alternative Development Concepts In 2031

Development Concepts / System Components	A. Business-As-Usual (BAU)	B. Consolidated	C. Multi-Centred	D. Dispersed
Expressways	Widening of Highways 407, 403, 404, 406, 410, and the QEW Extensions of 400, 404, 407, 427 New Highways: Red Hill, Creek Expwy. and Mid Peninsula Corridor Increase from 6,110 lane-km (in 2000) to 7,980 (in 2031) or 31% No toll roads except 407 (As described in ***BAU Report***)	Same as A, except for omitting extensions of Highways 404 and 427 to Barrie (terminate at Bradford By-pass), omitting the Mid-Peninsula Corridor. Increase from 6,110 to 7,390 lane-km or 21%.	Same as A, except for extending express bus routes to major peripheral centres such as Niagara Falls, St. Catharines, Cambridge, Kitchener, Waterloo, Guelph, Barrie, Peterborough, Whitby, Oshawa, and Bowmanville, as an extension of the priority bus grid network, generally in mixed traffic, without adding or taking additional lane-km.	Same as A, except for an additional 4-lane east-west expressway in the Highway 7 corridor from Highway 427 in the east to west of Guelph and then south to connect with Highway 401 and the Mid-Peninsula Corridor. Also added is a 2-lane highway extending the Bradford by-pass west from Highway 427 and south to connect with the new expressway described above in the vicinity of Guelph. Increase from 6,110 to 8,560 lane-km or 40%.
Arterial Roads	Committed network improvements per 10 year municipal plans. Beyond 2011 continuing road widenings and extensions to keep pace with the expanding urban envelope, generally matching the density of roads in adjacent urbanized areas. Lane-km increased 6%, from 41,500 to 44,000 lane-km. (As described in ***BAU Report***)	Same as A, except for using one lane in each direction on major arteries as HOV and priority bus lanes, in order to create a grid of priority bus routes throughout the urban and urbanizing area.	Same as B	Same as A.

Exhibit 3.9: Map of 2031 Expressway and Arterial Road Systems by Concept

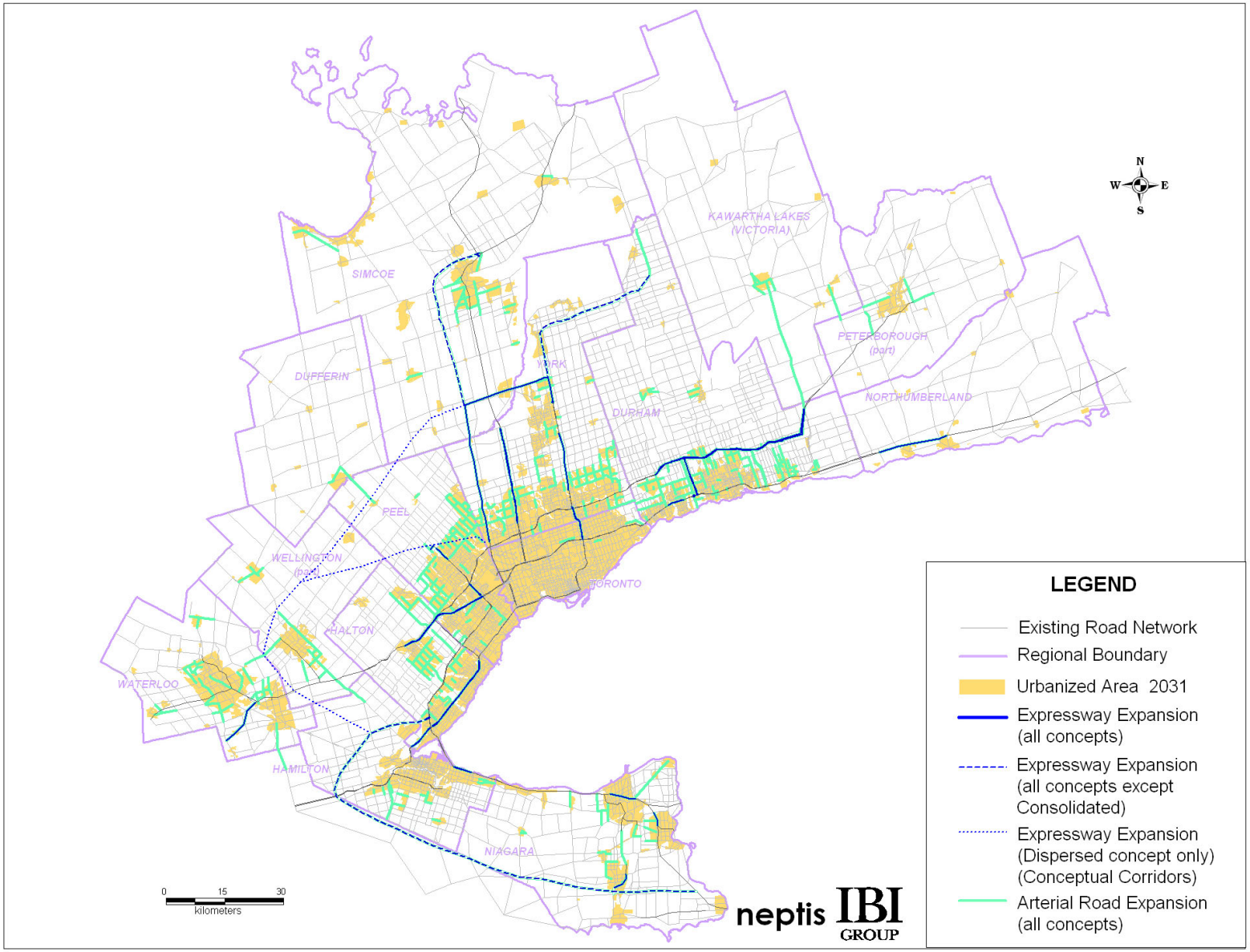
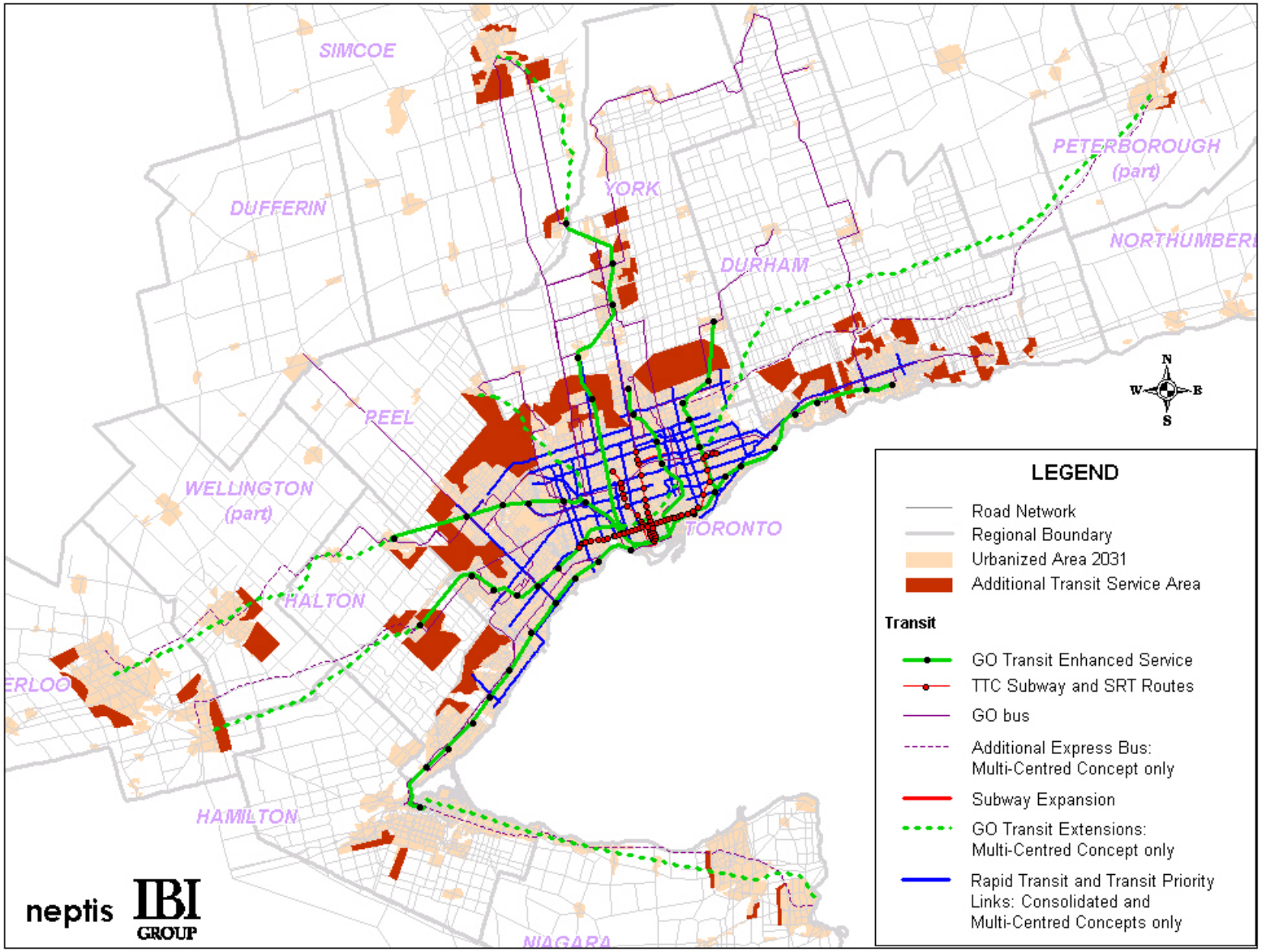


Exhibit 3.10: Municipal Transit and Commuter Rail Systems Assumed for the Four Alternative Development Concepts In 2031

Development Concepts / System Components	A. Business-As-Usual (BAU)	B. Consolidated	C. Multi-Centred	D. Dispersed
Municipal Transit	No new subways except for Sheppard Phase 1 line. No rapid transit in the suburban regions. Expansion of conventional bus network into urbanizing areas with the bus fleet expanding in proportion to population expansion in the transit service areas (785 additional buses). Limited priority bus routes and express bus routes. (As described in ***BAU Report***).	New rapid transit lines in the Highway 7/407/403 corridor through York, Peel and Halton connecting to north-south rapid transit lines, serving the Hurontario, Keele/Jane, Yonge, and Warden corridors, augmented by the priority bus grid network described above for this concept (average speed 30 to 40 km/hr). Bus fleet grows in proportion to population growth (785 additional buses) following addition of 1,027 additional buses to reduce the waiting time on all routes by 10% and on routes in the inner study area except Toronto by 50%.	Same as B, except for extending express bus services as described above for this concept (80 additional buses) and adding fewer urban buses. Bus fleet grows in proportion to population (785 additional buses) plus 273 additional buses to reduce the waiting time on all routes by 10%.	Same as A.
Commuter Rail	Implementation of 10-year GO Transit plan by 2011 and 2021 plan (February 1998 report) by 2021, with increased train frequencies on all lines to achieve 40% ridership increase by 2011 and 100% increase by 2021. (As described in ***BAU Report***)	Same as A, except that train capacities are increased by an additional 15% to accommodate increased ridership.	As in A, plus new lines: e.g., Mactier subdivision to Bolton, North Toronto subdivision, Havelock subdivision to Peterborough, and extensions of Lakeshore West line to St. Catharines/Niagara Falls, Milton line to Cambridge, Georgetown line to Guelph and Kitchener, and Newmarket line to Barrie.	Same as A.

Exhibit 3.11: Map of Municipal Transit and Commuter Rail Expansion by Concept



Transportation System Performance

Under the Business-As-Usual concept, expressway and arterial road lane-km are projected to increase by 9.2% and GO Rail capacity by 39.8%, while per capita municipal transit and GO bus capacity would decline by 6.4%. Relative to the BAU concept in 2031, the most pronounced differences are a 32% increase in municipal transit and GO bus capacity for the Consolidated concept, and a 29% increase in GO Rail capacity for the Multi-Centred concept. Expressway lane-km are 7.4% lower in the Consolidated concept and 7.3% higher in the Dispersed concept relative to the BAU concept.

The projected 2031 transportation supply, demand, and performance measures are shown in Exhibit 3.12.

Transportation Supply

The expressway and arterial road lane-km are projected to grow from about 47,600 in 2000 to 52,000 in 2031 under the BAU concept, a growth of 9.2%, while the seat-km per capita of municipal transit and GO bus services are projected to decline by 6.4%, and seat-km per capita of GO Rail service are projected to increase by 39.8% for the BAU concept relative to the base year, 2000.

The expressway lane-km in 2031 relative to the BAU concept are about 7.4% lower for the Consolidated concept, equal to the BAU concept for the Multi-Centred concept, and 7.3% higher for the Dispersed concept. Arterial roads lane-km are the same in all concepts, but with greater use of high-occupancy vehicle (HOV) and bus priority lanes in the Consolidated and Multi-Centred concepts. The seat-km per capita provided by municipal transit and GO bus, relative to the BAU concept, are projected to be 32% higher in the Consolidated concept, 6% higher in the Multi-Centred concept, and unchanged in the Dispersed concept. For GO Rail, the seat-km per capita are unchanged for the Dispersed concept relative to the BAU concept, 15% higher for the Consolidated concept, and 29% higher for the Multi-Centred concept.

Transportation Demand

The daily auto vehicle-kilometres of travel (VKT) is projected to increase from 157 million in 2000 to 258 million for the BAU concept in 2031, an increase of 64.2%, while the modal share of municipal transit is projected to decrease by 10.6% and the modal share of GO Rail is projected to increase by 57.9% under the BAU concept relative to the base year.

Vehicle-kilometres travelled would increase by 64.2% under the Business-as-Usual concept. This increase would be lower for the Consolidated and Multi-Centred concepts and higher for the Dispersed concept.

The daily vehicle-kilometres of auto travel, relative to the BAU concept, are 16 million lower for the Consolidated concept (a reduction of 6.4%), 3 million lower for the Multi-Centred concept (a decrease of about 1.3%), and 7 million higher for the Dispersed concept (an increase of 2.6%).

The morning peak period municipal transit modal share in the study area (number of trips) relative to the BAU concept would increase by 20% under the Consolidated concept, increase by 9.8% for the Multi-Centred concept, and decrease by 10.3% for the Dispersed concept. GO Rail ridership, relative to the BAU concept, would increase by 21.1% for the Consolidated concept, increase by 5.7% for the Multi-Centred concept, and decrease by 2.3% for the Dispersed concept.

Exhibit 3.12: Projected 2031 Transportation Supply, Demand, Performance and Cost Measures

	2000	2031				% Change from 2000				% Change from BAU 2031		
IMPLICATION	Existing	BAU	Consolid-ated	Multi-Centred	Dis-persed	BAU	Consolid-ated	Multi-Centred	Dis-persed	Consolid-ated	Multi-Centred	Dispersed
Transportation Supply												
Arterial and Highway Lane-km	47,600	52,000	51,400	52,000	52,560	9.2%	8.0%	9.2%	10.4%	-1%	0%	1%
AM Peak Period Transit Seat-km per capita												
Municipal Transit and GO Bus	1.34	1.25	1.65	1.33	1.25	-6.4%	23.5%	-0.5%	-6.4%	32%	6%	0%
GO Rail	1.02	1.43	1.65	1.85	1.43	39.8%	61.0%	80.6%	39.8%	15%	29%	0%
Transportation Demand												
Daily Auto VKT (millions)	157	258	242	255	265	64.2%	53.8%	62.0%	68.4%	-6.4%	-1.3%	2.6%
AM Peak Period Transit Modal Share (Excluding GO rail) (1)												
Within Toronto	32.9%	35.1%	37.4%	38.2%	35.28%	6.8%	13.7%	16.2%	7.3%	6.6%	8.9%	0.5%
Originating in Toronto	28.0%	29.2%	31.3%	31.8%	28.8%	4.1%	11.7%	13.6%	3.0%	7.3%	9.1%	-1.1%
Within the Inner Study Area (Excluding Toronto)	4.2%	2.2%	5.6%	3.9%	3.2%	-47.6%	33.3%	-7.1%	-23.8%	154.5%	77.3%	45.5%
Within Inner Study Area	14.8%	13.4%	15.8%	14.6%	12.3%	-9.5%	6.8%	-1.4%	-16.9%	17.9%	9.0%	-8.2%
Total Study Area	12.6%	11.2%	13.5%	12.3%	10%	-10.6%	7.2%	-1.8%	-19.8%	20.0%	9.8%	-10.3%
GO Rail Modal Share	1.5%	2.3%	2.8%	2.5%	2.3%	57.9%	91.2%	65.8%	54.3%	21.1%	5.0%	-2.3%
Travel Characteristics												
AM Peak Period Average Auto Trip Length (km)	15.6	16.9	16.5	17.0	17.7	8.6%	5.7%	8.9%	13.4%	-2.6%	0.3%	4.4%
AM Peak Period Average Auto Trip Time (minutes)	15.3	22.2	20.4	20.6	21.2	44.6%	33.0%	34.3%	38.3%	-8.0%	-7.1%	-4.4%
AM Peak Period Average Auto Travel Speed	61	46	49	50	50	-24.9%	-20.5%	-18.9%	-18.0%	5.8%	8.0%	9.2%
AM Peak Period Delay per Auto Trip (min)	3.6	9.3	7.8	7.8	8.0	161.3%	118.6%	118.6%	123.1%	-16.3%	-16.3%	-14.6%
Environmental Impact												
Annual Emissions and Fuel Use from Passenger Automobiles												
Nitrogen Oxides (kilotonnes of Nox))	69	22.5	21.1	22.1	23.0	-67.7%	-69.6%	-68.2%	-66.9%	-6.1%	-1.6%	2.4%
Carbon Monoxide (kilotonnes of CO)	437	283	246	260	269	-35.3%	-43.7%	-40.5%	-38.5%	-13.1%	-8.2%	-5.0%
Volatile Organic Compounds (kilotonnes of VOCs)	51.1	26.0	22	24.2	25.0	-49.1%	-56.9%	-52.6%	-51.1%	-15.4%	-7.0%	-4.0%
Carbon Dioxide (kilotonnes of CO_2 equivalents)	10,871	15,455	14,341	15,081	15683	42.2%	31.9%	38.7%	44.3%	-7.2%	-2.4%	1.5%
Fuel (billions of litres) (2)	4.4	6.3	5.9	6.2	6.4	44.4%	34.6%	41.4%	46.4%	-6.8%	-2.1%	1.4%
Transportation Expenditures (millions of 2000 $)												
Average Annual Public Sector Capital Expenditures (3)	1,400	1,422	1,410	1,537	1,502	1.6%	0.7%	9.8%	7.3%	-0.8%	8.1%	5.6%
Net Annual Public Sector O&M Expenditures	701	851	935	916	857	21.4%	33.4%	30.7%	22.3%	9.9%	7.6%	0.7%
Annual Public Sector Expenditures	2,101	2,273	2,345	2,453	2,350	8.2%	11.6%	16.8%	11.9%	3.2%	7.9%	3.4%
Annual auto Driver Expenditures (4)	4,580	7,510	7,030	7,410	7,700	64.0%	53.5%	61.8%	68.1%	-6.4%	-1.3%	2.5%
Annual Public Sector Plus Auto Driver Expenditures	6,681	9,783	9,375	9,863	10,050	46.4%	40.3%	47.6%	50.4%	-4.2%	0.8%	2.7%

Notes:

1. Based on share of motorized trip origins
2. Gasoline used for trips generated by study area residents and employees on a typical weekday, factored to annual consumption. Does not include fuel used for commercial vehicle trips, farm machinery, intercity/tourism, or weekend recreational trips, or fuel purchased in the study area by tourists and other visitors.
3. Averaged over the 2000–2031 study period
4. Based on fuel, oil, tires, and maintenance costs of 11.05¢/vehicle-km for a Chevrolet Cavalier, as published by the Canadian Automobile Association for 2000

Travel Characteristics: Total Study Area

The morning peak period auto trip length is projected to increase from 15.6 km in 2000 to 16.9 km in 2031 under the BAU concept (an increase of 8.6%) while the average auto trip time is projected to increase from 15.3 to 22.2 minutes (an increase of 44.6%), the average auto travel speed is projected to decrease from 61 to 46 km/hour (a decrease of 24.9%), and the average delay per auto trip (time spent travelling more slowly than the free flow speed, effectively the speed limit) is projected to increase from 3.6 to 9.3 minutes per trip (an increase of 161%).

Average trip length for morning peak period travel would be highest for the Multi-Centred and Dispersed concepts, lower for Business-As-Usual, and lowest of all for the Consolidated concept. However, average trip time and auto trip delay would be lower and average speed higher for all three concepts relative to the Business-As-Usual projections.

Exhibit 3.12 shows that the average auto trip length relative to the BAU concept level of 16.9 km would decline to 16.5 km for the Consolidated concept (a decrease of 2.6%), increase to 17.0 km for the Multi-Centred concept (an increase of 0.3%), and increase to 17.7 km under the Dispersed concept (an increase of 4.4%). Reflecting these changes in average trip length, as well as estimated traffic flow conditions, the peak period average auto trip time would be reduced by 8.0% for the Consolidated concept, reduced by 7.1% for the Multi-Centred concept, and reduced by 4.4% for the Dispersed concept, relative to the BAU concept. Average peak period auto travel speeds would vary as follows relative to the BAU concept: a 5.8% increase for the Consolidated concept, an 8.0% increase for the Multi-Centred concept, and a 9.2% increase for the Dispersed concept. The estimated peak period delay per auto trip would be about 16.3% lower than the BAU concept for the Consolidated concept, 16.3% lower for the Multi-Centred concept, and 14.6% lower for the Dispersed concept.

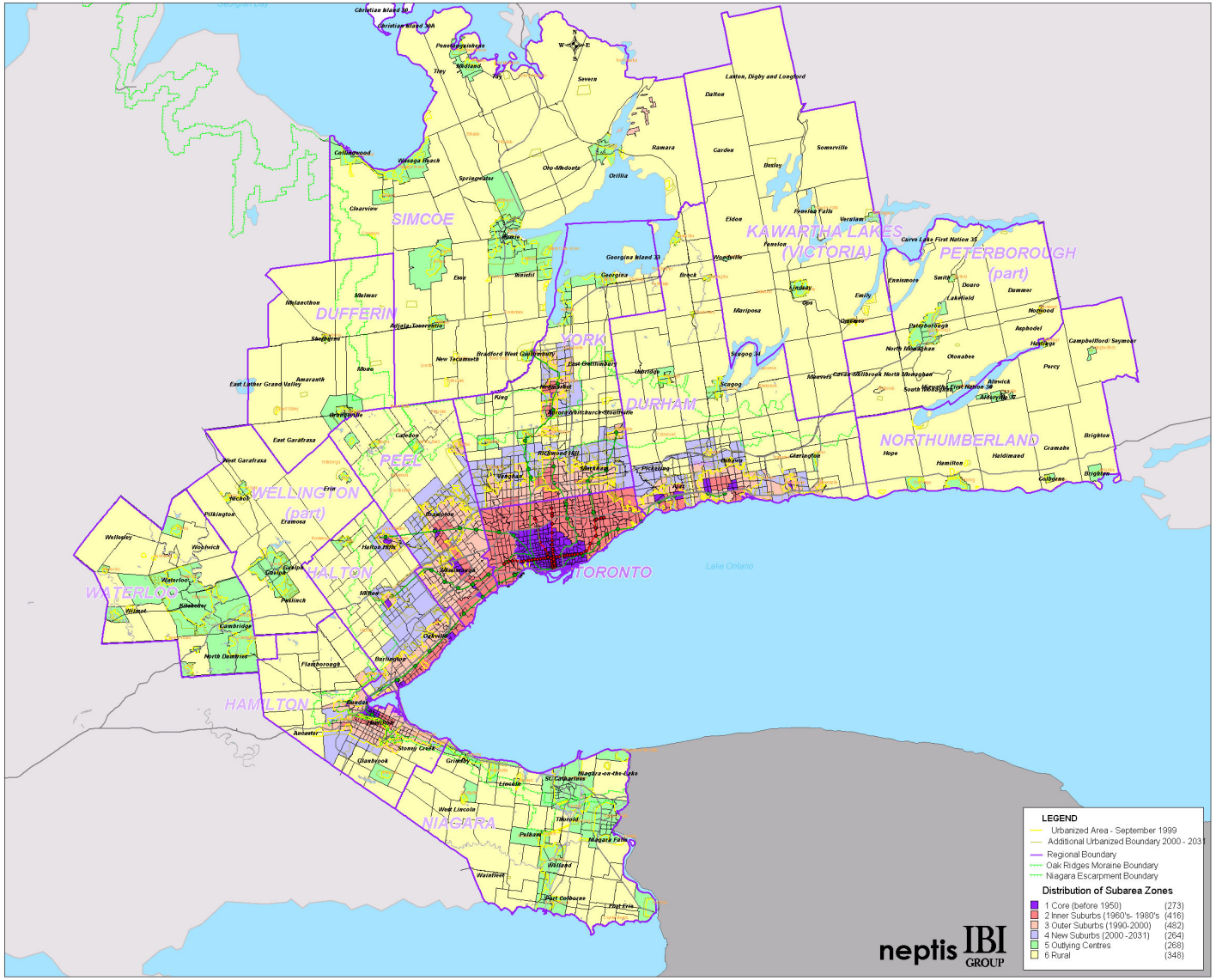
Travel Characteristics by Subarea

As illustrated in Exhibit 3.13, six subarea zones were defined, as follows:

- **Zone 1: Core Areas:** central areas of cities and towns, generally developed before 1950;
- **Zone 2: Inner Suburbs:** areas contiguous to core areas, generally developed during the 1950s, 1960s, 1970s, and 1980s;
- **Zone 3: Outer Suburbs:** areas contiguous to the inner suburbs, generally developed during the period 1990 to 2000;
- **Zone 4: New Suburbs:** contiguous to outer suburbs, generally projected for development between 2000 and 2031;
- **Zone 5: Outlying Centres:** urban and urbanizing centres situated in the outer study area;
- **Zone 6: Rural Areas**.

The six subarea zones are identified by colour codes in Exhibit 3.13.

Exhibit 3.13: Distribution of Subarea Zones



The characteristics of each subarea zone – population, employment, and activity rate (employment divided by population) – are shown in Exhibit 3.14 for the base year 2000 and for each of the four development concepts in the year 2031.

Exhibit 3.15 shows four selected travel characteristics for the base year 2000 and for each of the four concepts in 2031, in the same format as Exhibit 3.14. These characteristics are:

- daily auto vehicle kilometres of travel (VKT);
- average auto trip distance in kilometres;
- transit modal share, expressed as a percentage;
- average auto trip delay, measured in minutes.

In Exhibit 3.16 the variation in each of the travel characteristics by zone is illustrated for each of the four development concepts in the morning peak period of a typical weekday. Looking first at **daily auto VKT**, it can be seen that the inner and outer suburbs (Zones 2 and 3) generate the most VKT in the base year 2000, followed closely by the outlying centres (Zone 5). In contrast, the new suburbs (Zone 4) generate the smallest amount of VKT in the base year. While, as would be expected, VKT generated in Zone 4 becomes much more pronounced by 2031 in all four development concepts, the two zones producing the most VKT under the Business-As-Usual (BAU) concept in 2031 are the outer suburbs (Zone 3) and the outlying centres (Zone 5), with the inner suburbs (Zone 2) and new suburbs (Zone 4) as the next largest generators of VKT. The new suburbs and outlying centres generate somewhat less VKT in the Consolidated concept, while the inner and outer suburbs generate somewhat higher levels of VKT in this concept. The profiles of VKT across the six zones for the Multi-Centred concept and the Dispersed concept are quite similar to that for the BAU concept, except that the outlying centres generate more VKT in both of these concepts than in the BAU concept.

The Consolidated and Multi-Centred concepts produce lower overall levels of automobile travel than the Business-As-Usual and Dispersed concepts, in terms of vehicle kilometres travelled during the morning peak period.

The profile across the six zones for **average auto trip distance**, as shown in the upper right portion of Exhibit 3.16, is quite similar for the base year and the four concepts in 2031. The core and inner suburbs have the shortest trips (about 13–14 km in 2000 and 14–15 km in 2031) while 2031 auto trip lengths in the outer suburbs are about 16–17 km, in the new suburbs about 20 km, in the outlying centres about 17–20 km and in rural areas about 29–32 km.

Transit modal share is highest overall for the Consolidated concept and lowest for the Dispersed concept.

The distribution of **transit modal shares** across the six zones is also quite similar among the four concepts and for the base year. Typically the modal split for trips generated in the core areas is in the range 32 to 36%, in the inner suburbs 19 to 24%, in the outer suburbs 8 to 11%, in the new suburbs 6 to 8%, in the outlying centres 2 to 4%, and in rural areas 1 to 2%.

Exhibit 3.14: Zonal Characteristics by Concept

Zones	Indicator \ Concept	Base Year 2000	BAU 2031	Consolidated 2031	Multi Centred 2031	Dispersed 2031
Zone 1 Core (Before 1950)	Population	1,273,000	1,424,000	1,568,000	1,403,000	1,384,000
	Employment	806,000	1,082,000	1,125,000	1,058,000	1,027,000
	Activity Rate (emp/pop)	0.63	0.76	0.72	0.75	0.74
Zone 2 Inner Suburbs (1950s - 1980s)	Population	2,141,000	2,497,000	2,781,000	2,460,000	2,432,000
	Employment	920,000	1,200,000	1,292,000	1,167,000	1,140,000
	Activity Rate (emp/pop)	0.43	0.48	0.46	0.47	0.47
Zone 3 Outer Suburbs (1990s - 2000)	Population	1,771,000	2,225,000	2,387,000	2,194,000	2,139,000
	Employment	870,000	1,186,000	1,213,000	1,152,000	1,125,000
	Activity Rate (emp/pop)	0.49	0.53	0.51	0.53	0.53
Zone 4 New Suburbs (2000 - 2031)	Population	194,000	1,468,000	1,154,000	1,419,000	1,539,000
	Employment	125,000	667,000	521,000	637,000	796,000
	Activity Rate (emp/pop)	0.64	0.45	0.45	0.45	0.52
Zone 5 Outlying Centres	Population	1,422,000	2,109,000	2,028,000	2,247,000	2,199,000
	Employment	666,000	1,067,000	1,122,000	1,187,000	1,076,000
	Activity Rate (emp/pop)	0.47	0.51	0.55	0.53	0.49
Zone 6 Rural	Population	561,000	818,000	623,000	818,000	847,000
	Employment	149,000	251,000	180,000	251,000	288,000
	Activity Rate (emp/pop)	0.27	0.31	0.29	0.31	0.34
Total Study Area	Population	7,362,000	10,540,000	10,541,000	10,540,000	10,540,000
	Employment	3,535,000	5,453,000	5,453,000	5,453,000	5,453,000
	Activity Rate (emp/pop)	0.48	0.52	0.52	0.52	0.52

Exhibit 3.15: Selected Travel Characteristics by Zone and Concept

Zones	Indicator \ Concept	Base Year 2000	BAU 2031	Consolidated 2031	Multi Centred 2031	Dispersed 2031
Zone 1 Core (Before 1950)	Daily Auto VKT	17,261,000	20,412,000	22,742,000	20,315,000	21,295,000
	Average Auto Trip Distance (km)	13.14	13.72	14.45	14.05	14.63
	Transit Modal Share	32.3%	33.9%	35.8%	35.8%	32.1%
	Average Auto Trip Delay (min)	3.78	7.12	6.73	6.13	6.27
Zone 2 Inner Suburbs (1950s - 1980s)	Daily Auto VKT	37,034,000	46,421,000	49,377,000	45,036,000	45,758,000
	Average Auto Trip Distance (km)	12.87	13.56	13.71	13.80	13.99
	Transit Modal Share	19.1%	21.5%	23.7%	24.0%	20.5%
	Average Auto Trip Delay (min)	3.83	7.91	6.80	6.52	6.81
Zone 3 Outer Suburbs (1990s - 2000)	Daily Auto VKT	43,909,000	58,850,000	61,157,000	57,391,000	57,021,000
	Average Auto Trip Distance (km)	15.18	15.83	16.05	15.88	16.10
	Transit Modal Share	7.8%	10.2%	12.5%	10.6%	8.4%
	Average Auto Trip Delay (min)	4.33	10.84	9.38	8.85	8.37
Zone 4 New Suburbs (2000 - 2031)	Daily Auto VKT	5,956,000	45,176,000	35,374,000	42,342,000	45,995,000
	Average Auto Trip Distance (km)	19.05	18.62	18.99	19.05	19.25
	Transit Modal Share	5.6%	6.0%	8.4%	7.5%	5.8%
	Average Auto Trip Delay (min)	4.67	15.05	13.32	12.83	12.91
Zone 5 Outlying Centres	Daily Auto VKT	33,900,000	57,573,000	50,878,000	60,141,000	63,506,000
	Average Auto Trip Distance (km)	16.52	17.83	16.70	17.27	19.16
	Transit Modal Share	3.6%	3.3%	3.8%	3.8%	2.9%
	Average Auto Trip Delay (min)	2.18	6.22	4.82	5.75	6.04
Zone 6 Rural	Daily Auto VKT	19,314,000	29,978,000	22,473,000	29,774,000	31,425,000
	Average Auto Trip Distance (km)	30.39	31.04	29.11	30.73	31.45
	Transit Modal Share	0.7%	1.0%	1.0%	1.5%	0.9%
	Average Auto Trip Delay (min)	2.42	7.88	5.27	6.52	7.26
Total Study Area	Daily Auto VKT	157,000,000	258,000,000	242,000,000	255,000,000	265,000,000
	Average Auto Trip Distance (km)	15.61	16.95	16.50	17.00	17.70
	Transit Modal Share	14.1%	13.6%	16.2%	14.8%	12.4%
	Average Auto Trip Delay (min)	3.57	9.32	7.80	7.80	7.96

Exhibit 3.16: Variation by Zone of Travel Characteristics in Each Concept

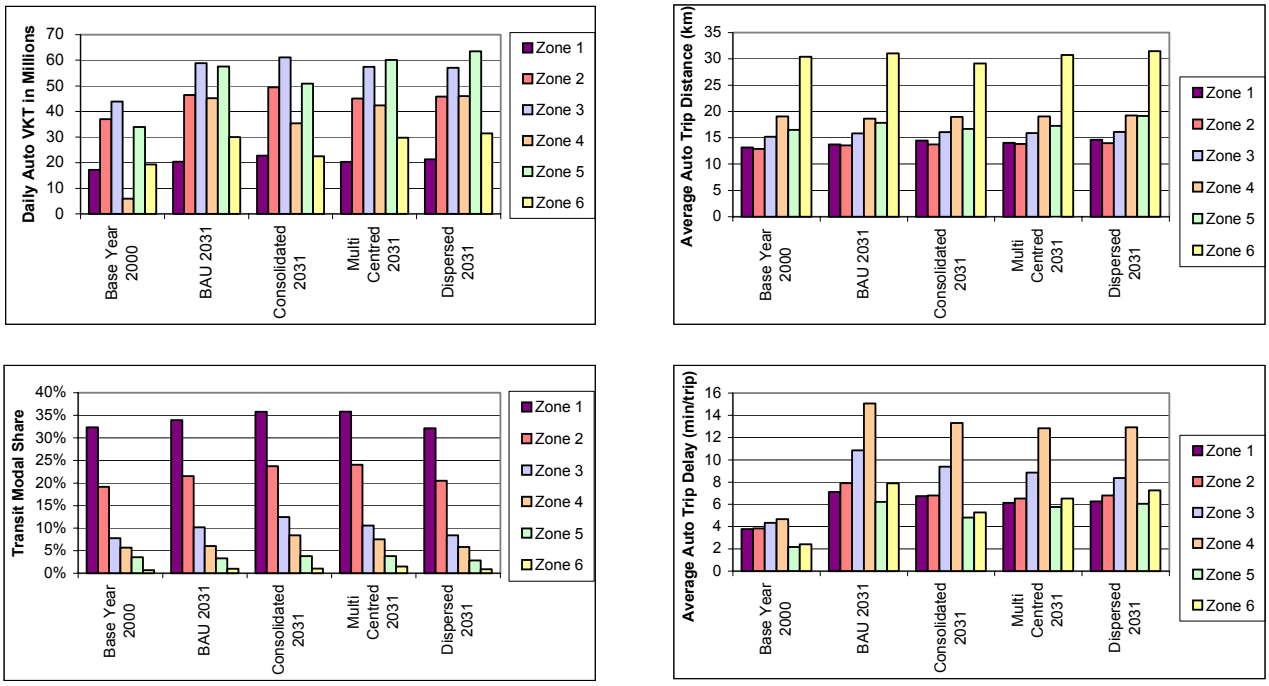
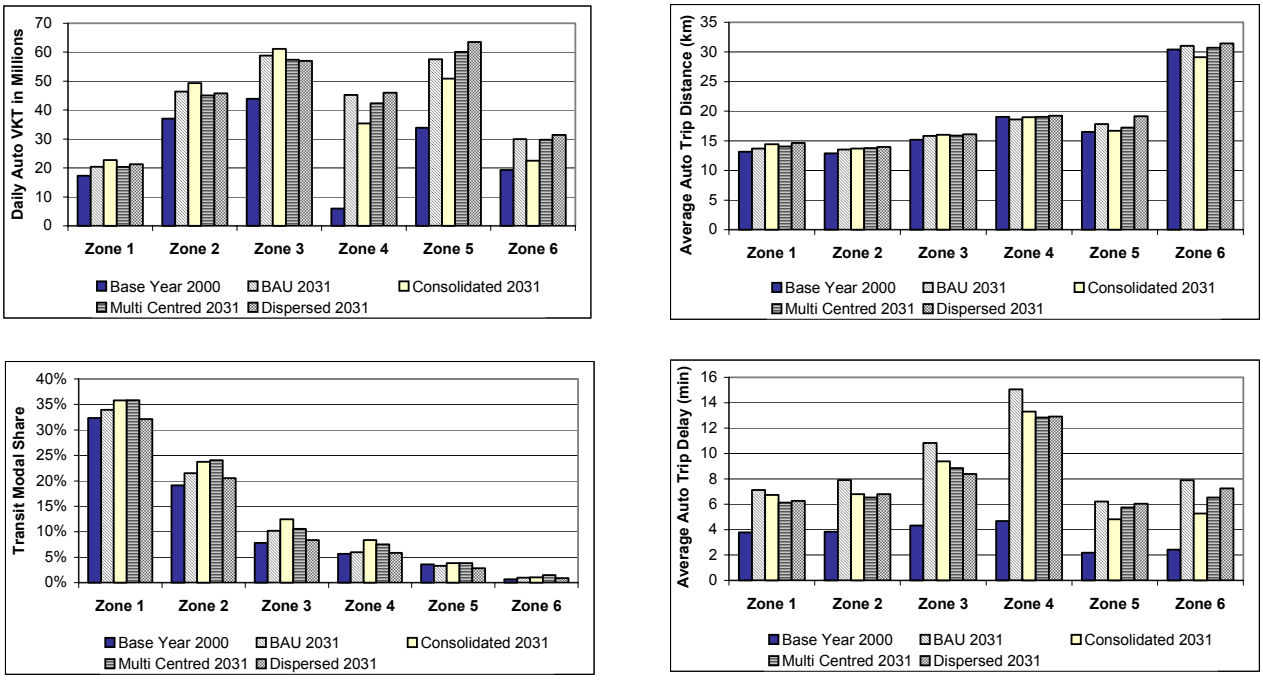


Exhibit 3.17: Variation by Concept of Travel Characteristics in Each Zone



In the base year, **average trip delay** is somewhat higher in the outer suburbs and new suburbs than in the core and inner suburbs, with lower levels of delay in the outlying centres and rural areas. This general profile persists for the four development concepts in 2031, except that there is a very large increase in delay estimated in the new suburbs and a somewhat smaller but significant increase for the outer suburbs, relative to the other zones. Overall, delay levels are substantially higher in 2031 than in 2000 as shown in Exhibit 3.12.

Exhibit 3.17 shows the same data, but organized in terms of each of the six zones, with a profile of travel characteristics for the base year and the four development concepts by zone. There is considerable uniformity in the travel characteristics across the four development concepts in each zone, with some exceptions. For example, **daily auto VKT** levels are quite similar in the base year and in 2031 for all development concepts in the core areas (Zone 1) and a similar profile is projected (but with substantially higher VKT levels) in the inner suburbs (Zone 2) and outer suburbs (Zone 3), with the Consolidated concept generating the highest VKT in these three zones. In contrast, the Consolidated concept generates the lowest VKT in 2031 in Zones 4, 5 and 6 and the Dispersed concept generates the most VKT in the three outer zones.

The BAU concept shows the highest levels of auto trip delay in all zones, particularly in the new suburbs, outer suburbs and inner suburbs, with the Consolidated concept showing the next highest levels of delay in those three zones, followed closely by the Multi-Centred and Dispersed concepts.

As shown in the lower right corner of Exhibit 3.17, the substantial projected growth in **average auto trip delay** is largest in the new suburbs, followed by a somewhat smaller increase of delay in the outer suburbs, and smaller yet significant increases in the other zones. The BAU concept shows the highest levels of auto trip delay in all zones, particularly in the new suburbs, outer suburbs and inner suburbs, with the Consolidated concept showing the next highest levels of delay in those three zones, followed closely by the Multi-Centred and Dispersed concepts. In contrast, the Consolidated concept has significantly lower levels of auto trip delay in the outlying centres and rural areas, while the BAU, Multi-Centred, and Dispersed concepts have roughly equal but higher levels of delay in these two zones.

Average auto trip distances are quite similar across the concepts and for the base year in each zone, with the lowest average distances in Zones 1 and 2, distances which are 10 to 30% higher in Zones 3, 4 and 5, and distances which are more than twice as long in Zone 6.

As would be expected**, transit modal shares** decline as one moves from Zone 1 to Zone 6. While the variations within each zone are relatively small, the Multi-Centred concept shows somewhat higher modal split levels in the core area, inner suburbs, outlying centres**,** and rural areas, and the Consolidated concept shows higher modal splits in the outer suburbs and modal split levels which are equal to those of the Multi-Centred concept in the new suburbs.

Exhibit 3.18 shows the **average trip delay** information in map form: the first map shows average auto trip delay (in minutes per trip per km, colour-coded into eight delay categories) for trips originating in each traffic zone in the morning rush hour in the base year 2000; the second map shows the same information for the Business-As-Usual concept in 2031, and the third map shows the **change** in delay experienced between 2000 and 2031. As shown, there is a very substantial increase in delay (as signified by the various shades of red) between 2000 and 2031 and, as shown in the third map, delay increases are particularly pronounced in the outer suburbs and the new suburbs.

Environmental and Energy Implications: Total Study Area

The projections assume that Tier II emissions standards will be introduced for 2004 and later vehicles. As a result, emissions of nitrogen oxides, carbon monoxide, and volatile organic compounds will decrease, despite the increase in vehicle kilometres travelled. The greatest decreases would occur under the Consolidated concept.

Under the assumption that "Tier II" emissions standards will be introduced for vehicles (including sport utility vehicles) manufactured in the 2004 model year and following, emissions of nitrogen oxides, carbon monoxide, and volatile organic compounds are all projected to decrease (by 67.7%, 35.3%, and 49.1%, respectively) under the BAU concept in 2031 relative to the base year, as the considerably more stringent regulations would more than offset the 64.2% increase in automobile VKT. On the other hand, transportation emissions of carbon dioxide are projected to increase from 10.9 to 15.5 million tonnes per year (an increase of 42.2%) and consumption of transportation fuel* is projected to increase from 4.4 billion litres in 2000 to 6.3 billion litres in 2031 under the BAU concept (an increase of 44.4%). Even if Tier II emissions standards are not implemented, the emissions of nitrogen oxides, carbon monoxide, and volatile organic compounds would be reduced by 2031 under all four concepts under Tier I standards, but by smaller amounts. A more detailed description of these projections and the underlying assumptions is presented in the ***BAU Report***.

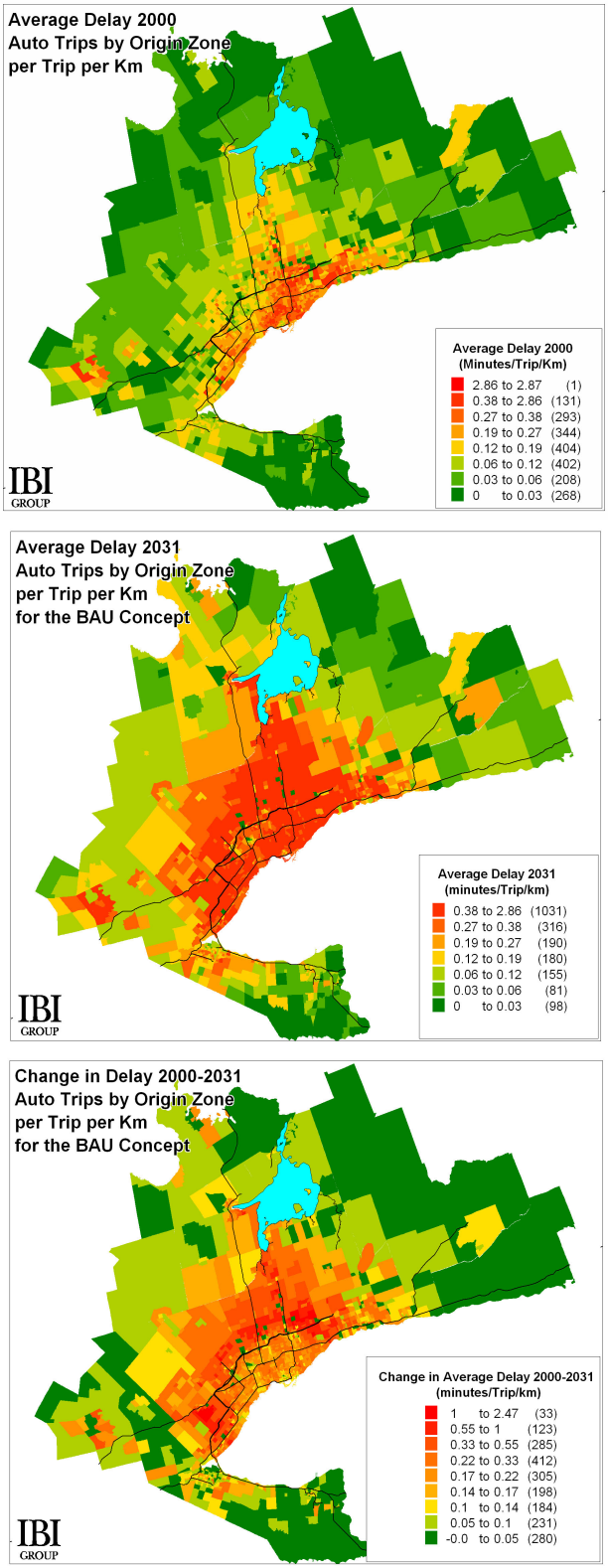
Relative to the BAU concept, transportation emissions in 2031 would be lowest for the Consolidated concept (reductions of 6 to 15%) relative to BAU emissions, and next lowest for the Multi-Centred concept (reductions of 2 to 8%). Emissions for the Dispersed concept would be similar to those for the BAU concept (increases of 1 to 2% for nitrogen oxides and carbon dioxide and reductions of 4 to 5% for carbon monoxide and volatile organic compounds).

Overall fuel consumption for weekday auto travel would be lowest for the Consolidated concept, and highest for the Dispersed concept.

Relative to the BAU concept, which would consume about 6.3 billion litres of fuel per year for transportation, the Consolidated concept would consume about 400 million fewer litres of fuel (a reduction of 6.8%), the Multi-Centred concept would consume about 100 million litres less per year (a decrease of 2.1%), and the Dispersed concept would consume about 100 million litres more per year more (an increase of about 1.4%).

* Fuel consumption levels quoted here reflect weekday auto travel by area residents only. They do not include fuel for goods movement, off-road vehicles, weekend recreational travel, or travel by tourists in the study area.

Exhibit 3.18: Mapping of Auto Trip Delay by Traffic Zone



Environmental and Energy Implications by Subarea

Exhibit 3.19 shows the base year and projected 2031 levels of the four types of auto emissions and of auto fuel use for each of the four concepts in the same format as Exhibit 3.15. This information is shown graphically in Exhibits 3.20 and 3.21.

Exhibit 3.19: Auto Emissions and Fuel Consumption by Zone and Concept

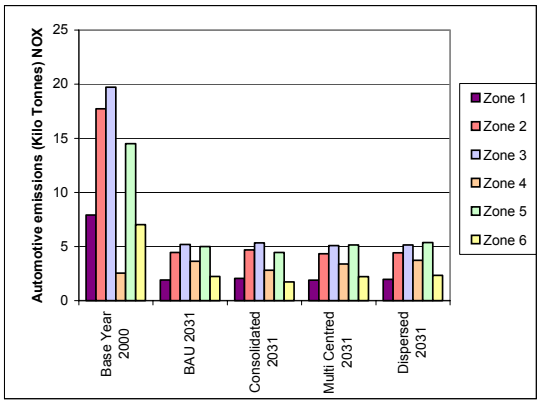
Emissions of nitrogen oxide, carbon monoxide, and volatile organic compounds by zone are generally similar for the four concepts.

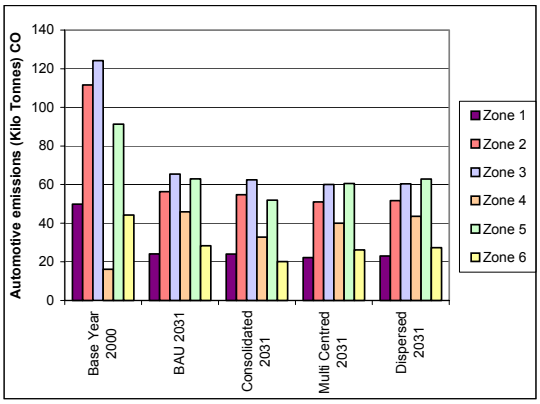
Zones	Indicator / Concept	Base Year 2000	BAU 2031	Consoli-dated 2031	Multi Centred 2031	Dispersed 2031
Zone 1 Core (Before 1950)	Automotive emissions (Kilo Tonnes)					
	NOx	7.9	1.9	2.1	1.9	2.0
	CO	49.9	24.1	24.0	22.2	23.1
	VOCs	5.8	2.2	2.1	2.1	2.1
	CO_2	1240	1318	1401	1287	1345
	Gasoline Fuel Use (billions of litres)	0.5	0.5	0.6	0.5	0.6
Zone 2 Inner Suburbs (1950s - 1980s)	Automotive emissions (Kilo Tonnes)					
	NOx	17.7	4.5	4.7	4.3	4.4
	CO	111.6	56.3	54.7	51.0	51.7
	VOCs	13.0	5.2	4.9	4.7	4.8
	CO_2	2774	3075	3190	2960	3014
	Gasoline Fuel Use (billions of litres)	1.1	1.3	1.3	1.2	1.2
Zone 3 Outer Suburbs (1990s - 2000)	Automotive emissions (Kilo Tonnes)					
	NOx	19.7	5.2	5.4	5.1	5.2
	CO	124.2	65.5	62.4	60.0	60.4
	VOCs	14.5	6.0	5.6	5.6	5.6
	CO_2	3089	3574	3637	3483	3519
	Gasoline Fuel Use (billions of litres)	1.2	1.5	1.5	1.4	1.4
Zone 4 New Suburbs (2000 - 2031)	Automotive emissions (Kilo Tonnes)					
	NOx	2.6	3.6	2.8	3.4	3.7
	CO	16.1	45.9	32.8	40.0	43.6
	VOCs	1.9	4.2	2.9	3.7	4.1
	CO_2	400	2504	1910	2322	2545
	Gasoline Fuel Use (billions of litres)	0.2	1.0	0.8	1.0	1.0
Zone 5 Outlying Centres	Automotive emissions (Kilo Tonnes)					
	NOx	14.5	5.0	4.5	5.1	5.4
	CO	91.3	63.0	51.9	60.6	62.8
	VOCs	10.7	5.8	4.6	5.6	5.8
	CO_2	2269	3438	3028	3514	3664
	Gasoline Fuel Use (billions of litres)	0.9	1.4	1.2	1.4	1.5
Zone 6 Rural	Automotive emissions (Kilo Tonnes)					
	NOx	7.0	2.2	1.7	2.2	2.3
	CO	44.2	28.3	20.2	26.1	27.4
	VOCs	5.2	2.6	1.8	2.4	2.5
	CO_2	1099	1546	1176	1517	1598
	Gasoline Fuel Use (billions of litres)	0.4	0.6	0.5	0.6	0.7
Total Study Area	Automotive emissions (Kilo Tonnes)					
	NOx	69.5	22.5	21.1	22.1	23.0
	CO	437.2	283.1	246.0	260.0	269.0
	VOCs	51.1	26.0	22.0	24.2	25.0
	CO_2	10871	15455	14341	15081	15683
	Gasoline Fuel Use (billions of litres)	4.4	6.3	5.9	6.2	6.4

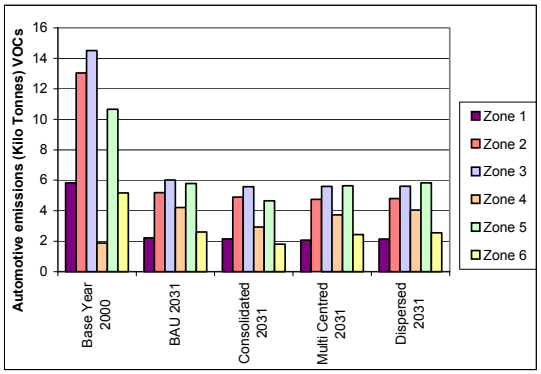
In Exhibit 3.20 the variation of each of the emissions and energy use characteristics by zone is illustrated for each of the four development concepts in the morning peak period of a typical weekday. As shown in the first three histograms within this exhibit, the profiles of the first three types of auto emissions (NO_X, CO, and VOCs) are very similar across the six zones, for the base year and each of the four concepts in 2031. Emissions levels in the central area are lower than those in the suburban areas across all four concepts, with the 2031 emissions being highest in the outer suburbs and

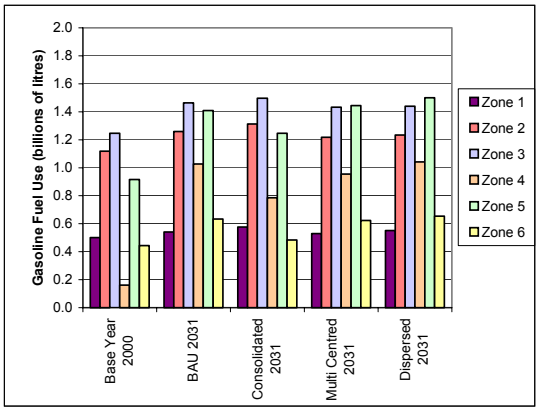
outlying centres, somewhat lower in the inner suburbs, and lowest in the new suburbs. Emissions levels in the rural area remain similar to those in the central area across all four concepts. There is significant growth in emissions in the new suburbs, relative to base year levels, but this zone continues to have the lowest emissions levels of the four suburban types of zones.

Exhibit 3.20: Variation by Zone of Auto Emissions and Energy Use in Each Concept







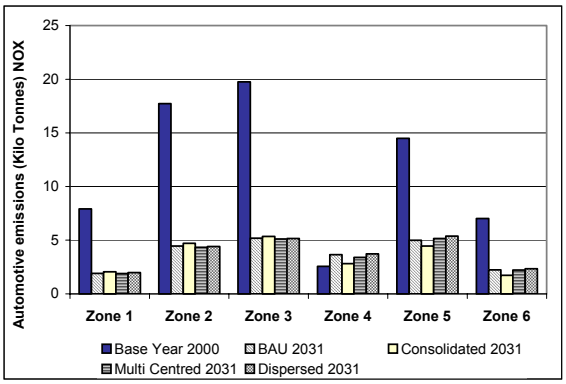


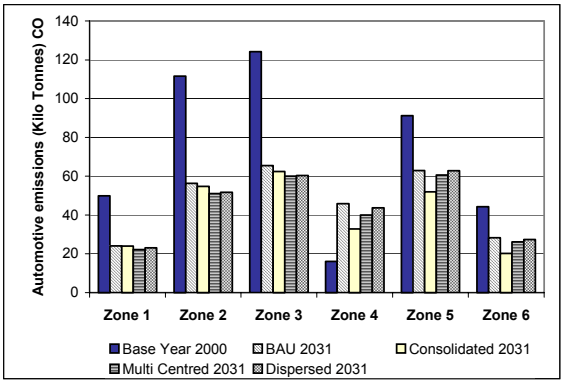
The profiles for carbon dioxide emissions and gasoline fuel consumption are similarly distributed by zone for all four concepts.

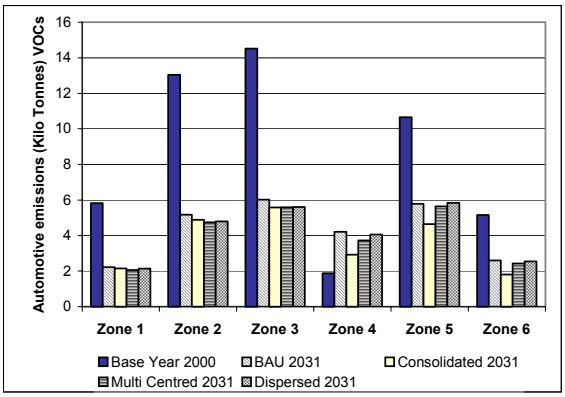
A similar profile is shown for emissions of CO_2. The profile for gasoline fuel use is also essentially the same as that for CO_2 emissions, since the two are very closely related.

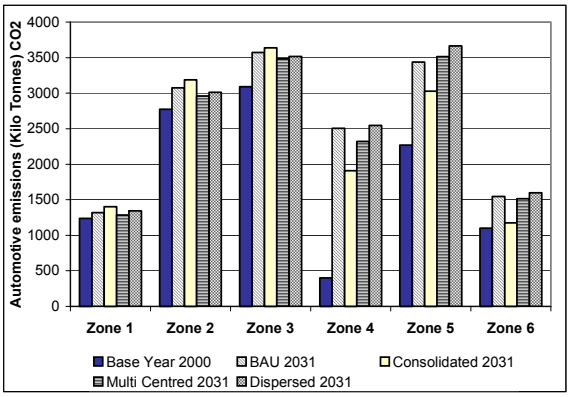
Exhibit 3.21 shows the same data, but organized in terms of each of the six zones, with a profile of emissions and energy characteristics for the base year and the four development concepts by zone. There is considerable uniformity in the emissions of NO_X, CO, and VOCs across the four development concepts in each zone, the main feature being the very significant drop in emissions levels from the base year to 2031 in all zones except the new suburbs, where the base year emissions levels are very low. Similarly, the profiles for CO_2 emissions and gasoline fuel consumption are virtually identical, with the Consolidated concept having the highest emissions in the central zone, inner suburbs, and outer suburbs, but the lowest future emissions in the new suburbs, outlying centres, and rural areas.

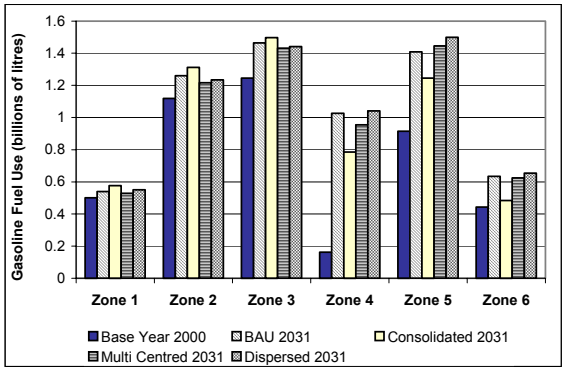
Exhibit 3.21: Variation by Concept of Auto Emissions and Energy Use in Each Zone











Transportation Expenditures

The Consolidated concept calls for greater public investment in transit; the Dispersed concept for greater public investment in expressways.

The projected public-sector capital expenditures for the transportation systems under each concept are shown in Exhibit 3.22. There are differences in the required investment by mode, reflecting the differences summarized in Exhibit 3.8. Relative to the BAU transportation system, the major differences are lower costs for provincial highways in the Consolidated concept and higher costs in the Dispersed concept; higher costs for municipal transit in the Consolidated and Multi-Centred concepts; and higher costs for GO Rail in the Multi-Centred concept. The total public-sector capital expenditures during the 2000 to 2031 period are estimated to range from about $43.7 billion to $47.7 billion or about $1.41 to $1.54 billion per year, in 2000 dollars. The lower end of this range overlaps with the upper end of the range of current (1990s/2000) expenditures of about $1.25 to $1.45 billion a year.

Exhibit 3.22: Projected Public-Sector Capital Expenditures for Transportation by Mode (Millions of 2000 Dollars)

	A. Business-As-Usual		B. Consolidated		C. Multi-Centred		D. Dispersed	
Sector	Average Annual	Total	Average Annual	Total	Average Annual	Total	Average Annual	Total
Provincial Highways	599	18,573	510	15,805	599	18,573	679	21,052
Arterial Roads	374	11,590	374	11,590	374	11,590	374	11,590
Municipal Transit	308	9,553	374	11,605	363	11,268	308	9,553
GO Rail	141	4,370	152	4,716	201	6,226	141	4,370
Total	**1,422**	**44,086**	**1,410**	**43,715**	**1,537**	**47,657**	**1,502**	**46,565**

Overall, public-sector expenditures would be lowest for the Consolidated concept and highest for the Dispersed concept. However, the projected arterial roads and municipal transit systems for the four concepts are based on relatively conservative assumptions about future capacity and service levels.

The estimated public-sector capital investment, relative to the $44 billion investment for the BAU transportation system, would be about $0.4 billion lower for the Consolidated concept, $3.6 billion higher for the Multi-Centred concept, and $2.5 billion higher for the Dispersed concept. It should be stressed that the sketch modelling process has not provided the opportunity to adjust the transportation systems in light of initial findings regarding system costs and performance measures, so these findings are very much a "first-cut" based on a priori assumptions regarding the most appropriate transportation system for each of the development concepts. The cost estimates are at the pre-engineering level of accuracy, based on typical per unit costs for each mode. It should also be stressed that the projected arterial roads and municipal transit systems are, in general, based on relatively conservative assumptions regarding future capacity and service levels for the various concepts.

Exhibit 3.23 shows the same information presented in terms of investments for system expansion and system rehabilitation. Essentially, slightly more than a quarter of the total investment is required for system expansion in the BAU and Consolidated concepts, while this increases to about 32% for the Multi-Centred concept and 30% for the Dispersed concept, reflecting the significant expansion of the GO system in the former and the additional highway expansion in the latter. The percentage of the total

investment projected to be required for system rehabilitation varies between about 68% and 73%, making up the rest of the total investment required.

Exhibit 3.23: Projected Public-Sector Capital Expenditures for Transportation Rehabilitation and Expansion (Millions of 2000 Dollars)

Capital Expenditure Type	A. Business-As-Usual		B. Consolidated		C. Multi-Centred		D. Dispersed	
	Total	Percent	Total	Percent	Total	Percent	Total	Percent
System Expansion	11,719	26.6%	11,637	26.6%	15,298	32.1%	13,926	29.9%
System Rehabilitation	32,367	73.4%	32,078	73.4%	32,359	67.9%	32,639	70.1%
Total	**44,086**	**100.0%**	**43,715**	**100.0%**	**47,657**	**100.0%**	**46,565**	**100.0%**

Public-sector operations and maintenance costs are highest for the Consolidated concept, followed by the Multi-Centred concept.

Exhibit 3.24 shows the estimated net annual transit and gross annual road operations and maintenance expenditures by the public sector for each of the four concepts. These essentially reflect the same range of variation among the concepts as shown in Exhibit 3.22, except that the public-sector operations and maintenance costs are highest for the Consolidated concept, reflecting the emphasis on municipal transit in that concept and next highest for the Multi-Centred concept, reflecting its emphasis on extended GO Rail services. The total annual costs increase from $851 million for the BAU concept to $857 million for the Dispersed concept, $916 million for the Multi-Centred concept, and $935 million for the Consolidated concept.

Exhibit 3.24: Net Annual Transit and Gross Annual Road Operations & Maintenance (O&M) Expenditures by the Public Sector (Millions of 2000 Dollars)

Sector	2000	2031			
		A. Business-As-Usual	B. Consolidated	C. Multi-Centred	D. Dispersed
Provincial Highways	178	194	188	194	200
Arterial Roads	291	316	316	316	316
Municipal Transit	193	249	325	284	249
GO Rail	40	92	106	123	92
Total	**701**	**851**	**935**	**916**	**857**

Under the Business-As-Usual concept, annual public- and private-sector expenditures on transportation are projected to increase 46.4% between 2000 and 2031 A 64.0 % increase in auto operating costs is the main reason for this increase. This overall increase would be lower under the Consolidated concept, but higher under the Multi-Centred and Dispersed concepts.

The average annual public-sector capital expenditure on transportation is projected to increase from about $1.4 billion in 2000 to $1.42 billion in 2031 under the BAU concept (an increase of 1.6 %), while the net annual public-sector operations and maintenance expenditure is projected to increase from $0.70 to $0.85 billion (an increase of 21.4%). Annual auto operating expenditures, experienced by auto drivers, (see Exhibit 3.12) are projected to increase from $4.58 billion in 2000 to $7.51 billion in 2031 (an increase of 64.0%). Overall, this means that the annual public- and private-sector expenditures on transportation in 2031 (not including transit fares paid or truck driver expenditures) are projected to increase from $6.68 billion in 2000 to $9.78 billion in 2031 under the BAU concept (an increase of 46.4%).

Relative to the BAU concept, the average annual public-sector capital expenditure would be 0.8% less under the Consolidated concept, 8.1% more under the Multi-Centred concept and 5.6% more under the Dispersed concept. On the other hand, the

net annual public-sector operations and maintenance expenditure, relative to the BAU concept, would be 9.9% higher for the Consolidated concept, 7.6% higher for the Multi-Centred concept and 0.7% higher for the Dispersed concept. The annual auto driver operating expenditure relative to the BAU concept is projected to be 6.4% less under the Consolidated concept, 1.3% less under the Multi-Centred concept and 2.5% more under the Dispersed concept. Taking these annual expenditures together, annual public-sector plus auto driver expenditure, relative to the BAU concept, is projected to be 4.2% less under the Consolidated concept, 0.8% more under the Multi-Centred concept, and 2.7% more under the Dispersed concept, as shown earlier in Exhibit 3.12.

These estimates reflect the effects of the settlement patterns and transportation supply assumptions for each concept. As noted earlier, different assumptions regarding either or both of these variables would produce somewhat different results. The results presented here are based on the sketch modelling approach described earlier and reflect the uncertainties of any long-range forecast. While the **absolute** levels of future estimates should be interpreted with caution in this light, the **relative** levels are felt to provide a reasonable basis for comparing the four development concepts at a strategic level of analysis.

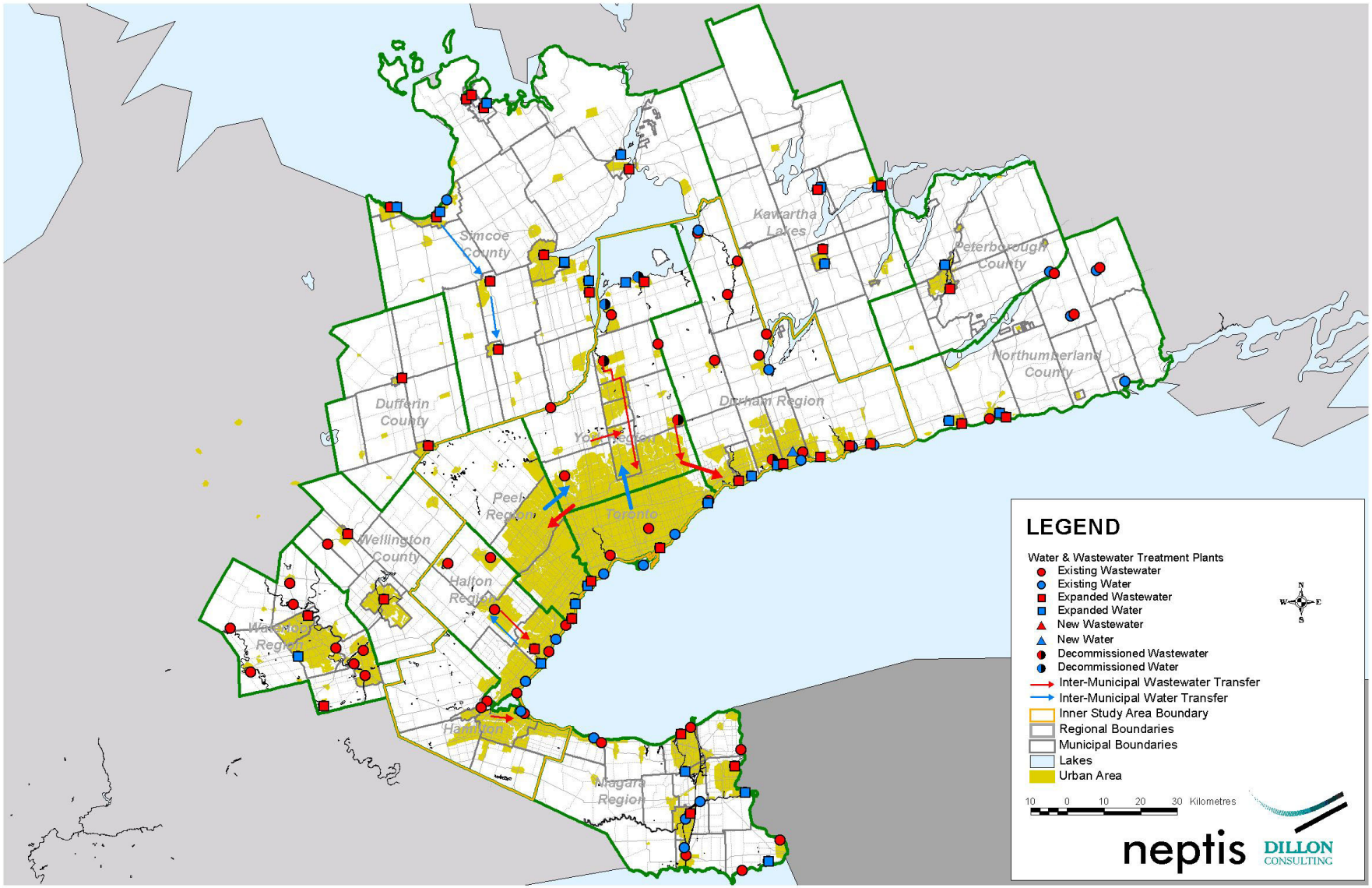
WATER/WASTEWATER

Analysis Methodology and Assumptions

Costs for water and wastewater infrastructure do not vary widely among the four concepts. The main differences relate to the size and timing of new or expanded treatment plants.

The same methodology and water/wastewater infrastructure assumptions that were used for the Business-As-Usual (BAU) Concept in the ***BAU Report*** have been used in this assessment. Exhibit 3.25 shows the existing, new, expanded, and decommissioned water and wastewater treatment plants over the 31-year planning period for the BAU development concept in the inner and outer study areas. The growth-related changes to the treatment plants will be essentially the same for the other three development concepts (Consolidated, Multi-Centred, and Dispersed), except that the size and/or timing of plant expansions may vary according to the growth forecast for each concept.

Exhibit 3.25: Water/Wastewater: Existing System and Projected Changes to 2031



Cost Estimates

Costs for system renewal (rehabilitation and replacement) and system upgrades to improve water quality are identical for all four concepts, since they are based on existing infrastructure.

As for the BAU Concept, capital cost estimates were prepared for the other three development concepts for three water/wastewater system components in the inner and outer study areas:

1. **System Renewal Costs:** costs for upkeep of existing infrastructure through rehabilitation and replacement.

2. **System Upgrade Costs:** costs to improve water quality, including upgrades to existing treatment plants, and improvements to address existing combined sewer overflows and existing stormwater discharges to receiving bodies.

3. **Growth-Related Costs:** costs of new infrastructure to service development growth for the 31-year planning period.

As the system renewal costs and system upgrade costs deal with existing infrastructure, these costs were the same for all four development concepts. The only costs that changed between concepts were growth-related costs.

The methodology and assumptions used for the BAU Concept in the ***BAU Report*** for growth-related costs were used in this assessment. For the other three development concepts, water and wastewater treatment plant costs were prorated based on capacity needs. Water and wastewater system costs (e.g., pipes) were estimated based on population growth.

Preliminary cost estimates are summarized below.

Projected Water/Wastewater System Costs to 2031

Growth-related costs are highest for the Dispersed concept and lowest for the Consolidated concept, but the differences are small.

The three water/wastewater system cost estimates are summarized in Exhibit 3.26 for the four development concepts.

Exhibit 3.26: Water/Wastewater System Capital Costs for the Total Study Area

	Capital Cost Estimates for the period 2000 – 2031 ($millions)			
Development Concepts	**BAU**	**Consolidated**	**Multi-Centred**	**Dispersed**
System Renewal	22,500	22,500	22,500	22,500
System Upgrades	4,500	4,500	4,500	4,500
Growth Related	6,635	6,405	6,590	6,685
Total Costs	$33,635	$33,405	$33,590	$33,685

The total water/wastewater costs for the inner and outer study areas are summarized in Exhibit 3.27 for each of the four development concepts.

Under the Consolidated concept, growth-related costs for the inner study area are highest; they are highest for the outer study area in the Multi-Centred concept.

Exhibit 3.27: Water/Wastewater System Capital Costs for the Inner and Outer Study Areas

	Capital Cost Estimates for the period 2000 – 2031 ($millions)			
Development Concepts	**BAU**	**Consolidated**	**Multi-Centred**	**Dispersed**
Inner Study Area	26,580	26,805	26,355	26,560
Outer Study Area	7,055	6,600	7,235	7,125
Total Costs	$33,635	$33,405	$33,590	$33,685

Communities such as Mississauga and Toronto may have additional capacity in their existing pipe infrastructure to accommodate the Consolidated concept, whereas communities such as Barrie would have no existing capacity to support additional new growth under the Multi-Centred concept.

Depending on the development concept, treatment plant expansions were either larger or smaller when compared with the BAU concept. Generally no new plants would be required when compared to the BAU concept, but in some cases plants would be expanded earlier or later than projected for the BAU concept; e.g., for the Consolidated concept, Toronto would require an additional plant expansion, whereas Barrie would require fewer expansions in the 31-year planning horizon. Likewise, when considering water transmission and wastewater collection pipes, some areas would need additional pipes for a given development concept, while other areas would have less. Generally, communities such as Mississauga and Toronto may have additional capacity in their existing pipe infrastructure to more readily accommodate the Consolidated concept, whereas communities such as Barrie would have no existing capacity to support additional new growth identified in the Multi-Centred concept.

As indicated in Exhibit 3.27, capital cost estimates for all four concepts are similar at about $33.6 billion over the 31-year study period, with very slightly lower costs for the Consolidated concept (about $0.2 billion less than the BAU system capital cost). This is an average of about $1.1 billion capital expenditure per year, about 20% higher than current capital expenditures, which average about $0.9 billion per year in the study area. The additional expenditure reflects the major requirements for system renewal and system upgrades, in addition to growth-related costs, as summarized in Exhibit 3.26.

4 SUMMARY OF FINDINGS

Highlights of the key projected differences in 2031 among the four development concepts are summarized in this final chapter.

URBAN STRUCTURE: COMPARISON HIGHLIGHTS

The key differences among the four development concepts in terms of urban structure are :

In terms of urban structure, the greatest differences are found in comparing the Consolidated concept, which has the highest densities and the smallest amount of newly urbanized land, and the Dispersed concept, which has the lowest densities and consumes the greatest amount of land.

- Relative to the other concepts, the Consolidated concept has the most development in existing urban areas (51.3% more population and 21.2% more employment than under the BAU concept), the highest density (50.1 population plus jobs per hectare, versus 46.7 for the BAU concept and 45.8 in the base year 2000), and the lowest growth in new urbanized land (22.9% lower than for the BAU concept).

- The Multi-Centred concept has more new development in outlying centres (19.9% more population and 29.6% more employment), medium density (46.1 population plus jobs per hectare), and slightly higher growth in new urbanized land (3.8%) relative to the BAU concept.

- Relative to the BAU concept, the Dispersed concept has 17.9% more exurban population (in outlying centres plus dispersed rural, non-farm development), the lowest density (45.1 population plus jobs per hectare), and the highest growth in new urbanized land (11.4% more than for BAU).

TRANSPORTATION: COMPARISON HIGHLIGHTS

Key differences among the four development concepts in terms of transportation performance and costs are summarized below:

The Consolidated concept suggests greater use of transit and shorter trips; the Multi-Centred concept suggests a better balance of jobs and population in existing urbanized areas.

- Daily auto vehicle-km of travel (VKT) would be 6.4% lower for the Consolidated concept relative to the BAU concept (reflecting more use of transit, shorter trips), 1.3% lower for the Multi-Centred concept (reflecting a better balance of jobs and population in existing urbanized areas) and 2.5% higher for the Dispersed concept (reflecting lower-density, spread development).

- The Consolidated concept would achieve a 20% increase in municipal transit market share relative to BAU while the Multi-Centred concept would achieve a 9.8% increase, but the Dispersed concept would show a 10.3% reduction. Changes in market share of GO Rail travel for the three concepts would be 21.1%, 5.0% and –2.3%, respectively, relative to the BAU concept.

Auto delay more than doubles and emissions of carbon dioxide worsen between 2000 and 2031 under all four concepts.

- The Consolidated and the Multi-Centred concepts would achieve the greatest reduction in auto delay per trip (reduced by 16% from BAU), but these concepts would still experience more than twice base year levels of auto delay. At the

subarea level, increases in auto delay are most pronounced in the new suburbs, which would experience delays of 13 to 15 minutes per trip in all concepts, versus 2 minutes per trip in 2000.

- The Consolidated concept would achieve the greatest reduction in transportation fuel use and emissions relative to the BAU concept (–6% to –15%); emissions and fuel use would also be less for the Multi-Centred concept (–2% to –8% relative to BAU), while the Dispersed concept would have 1 to 2% higher emissions of nitrogen oxides and carbon dioxide and fuel consumption but 4 to 5% reduction of carbon monoxide and volatile organic compounds emissions relative to the BAU concept.

Annual public-sector expenditures on transportation in 2031 would be lowest under the BAU concept, but annual combined public- and private-sector expenditures (including auto operating costs) would be lowest for the Consolidated concep and highest for the Dispersed concept.

- Annual public-sector expenditures in 2031 would be lowest in the BAU concept, but annual combined public- and private-sector expenditures (including auto operating costs experienced by drivers) would be lowest for the Consolidated concept.

- Overall, significant improvements in transportation performance could be achieved with the Consolidated concept, followed by the Multi-Centred concept, but projected delays and emissions of carbon dioxide are estimated to worsen under all four concepts relative to the base year and highest for the Dispersed concept.

WATER/WASTEWATER: COMPARISON HIGHLIGHTS

Highlights of the water/wastewater system cost estimates are summarized below:

- Investments would be significant and approximately the same for all four concepts, as about 80% of the investment is for system renewal and upgrades which are common to all four concepts.

The most significant cost differences for growth-related water and wastewater infrastructure are between the Consolidated and Multi-Centred concepts, reflecting the greater ability to use existing facilities in already urbanized areas under the Consolidated concept.

- The estimated capital expenditure of about $33.6 billion averages about $1.1 billion per year over the 31 year study period, about 20% higher than existing annual capital expenditure estimated at about $0.9 billion per year. Funding the additional investment, is expected to require full-cost recovery through water/wastewater rates, anticipated to be achieved through legislation recently passed by the provincial legislature.

- The most significant cost differences for growth-related costs (20% of total investment) are between the Consolidated and Multi-Centred concepts (a difference of 10%), reflecting the greater ability to use existing facilities in already urbanized areas under the Consolidated concept. The timing and extent of plant expansions also vary somewhat among the concepts.

- The drive to full-cost recovery, higher levels of treatment, groundwater protection, and more management expertise will likely spur system consolidation, particularly in the outer study area, under any of the concepts.

5 CONCLUSIONS

The following preliminary conclusions are based on the sketch modelling results:

Continuing rapid growth, no matter what form it takes, will pose challenges related to transportation performance, environmental protection, and energy consumption.

- Continuing rapid growth, as projected for all concepts, will create significant challenges, particularly in terms of growth in urbanized land, reductions in transportation performance, and related environmental and energy consumption issues.

- The Consolidated concept is projected to be most effective in addressing these issues, followed by the Multi-Centred concept.

- An integrated approach to planning, funding, and delivery of transportation and land use will be necessary to move effectively towards either of these concepts or a combination.

- Transportation user charges (e.g., fuel taxes, road pricing, parking rates, vehicle registration fees) are a policy tool that could not only help to address traffic congestion but also provide a reliable revenue stream to fund transportation improvements; these were not considered in the present report.

- Sketch modelling can be used to assess possible hybrid concepts and/or test the implications of user charges regarding travel behaviour and transportation system performance.

- Required water/wastewater system investments are similar for all four development concepts; a key issue is to achieve full-cost recovery in order to provide ongoing funding for system renewal, upgrading, and expansion, which are essential to achieve and maintain reliable supplies and management of water resources in the face of continuing rapid growth.