City of Hamilton

Development of Policy Papers for Phase Two of the Transportation Master Plan for the City of Hamilton
LEVEL OF SERVICE POLICY PAPER

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1. INTRODUCTION

1.1 Study Background and Objectives

The City of Hamilton *City-wide Transportation Master Plan* will provide inputs to the *Growth Related Integrated Development Strategy* (GRIDS) and make recommendations to Council on the adoption of a City-wide Transportation Policy that is cognisant of Vision 2020 and other City of Hamilton long-term planning objectives. The project has been divided into three distinct phases. The first phase consisted of the technical calibration of the existing transportation model to reflect current transportation conditions in Hamilton. The second phase, which is the object of this and other policy papers, will focus on the development of 23 policy papers in the following areas: Travel Demand, Urban Development, System Performance, Infrastructure Planning and Infrastructure Financing. Following the completion of the Policy Papers, the City will proceed to develop transportation scenarios (Phase 3 of the project) based upon the results of the policy work performed in Phase 2 and the land use scenarios developed through the broader GRIDS study, and will test the efficiency and viability of these scenarios by integrating them into the calibrated model.

1.2 Description of Level of Service

Historically, the most common form of measuring transportation system performance has been a level of service (LOS) grading system that is based on a letter grading system, which ranges from LOS A to LOS F. The Highway Capacity Manual (ITE, 2000) defines level of service (LOS) as a "quality of measure describing operational conditions within a traffic stream, generally in terms of such service measures as speed and travel time, freedom to manoeuvre, traffic interruptions, and comfort and convenience." In general, the term "level of service" is typically associated with traffic operations; however, a LOS measure is equally applicable for all modes of travel.

Many jurisdictions and agencies regularly review LOS performance of their existing transportation systems, to identify existing and future deficiencies and prioritize improvements projects. LOS for a particular mode of travel falls into six letter grades with LOS "A" describing the highest quality of service and LOS "F" describing the lowest.

There is no "universal" tool for measuring LOS for all road users in a transportation system. The primary reason being that a road users' expectation of transportation system service and the quality of service is a function of the travel mode and the type of facility. A couple of examples to exemplify these facts:

Mode of Travel – A motorist travelling along an arterial roadway may measure the quality of service of the roadway based on travel speed, delay at intersections and freedom to manoeuvre; whereas a cyclist may evaluate the same system based on the bicycle facilities provided, the roadway condition and the safety and security associated with adjacent vehicle travel lanes. A third differing perspective of the pedestrian walking along the same roadway, would reflect quality of service measures such as the presence of a sidewalk, controlled crossing opportunities and presence of potential conflicts with other road users;

Type of Facility – A motorist driving on an uninterrupted system such as a freeway, would base the LOS performance of the facility on travel speed and their ability to manoeuvre. Alternatively, the same motorist on an arterial roadway would expect to be periodically stopped by traffic signals and

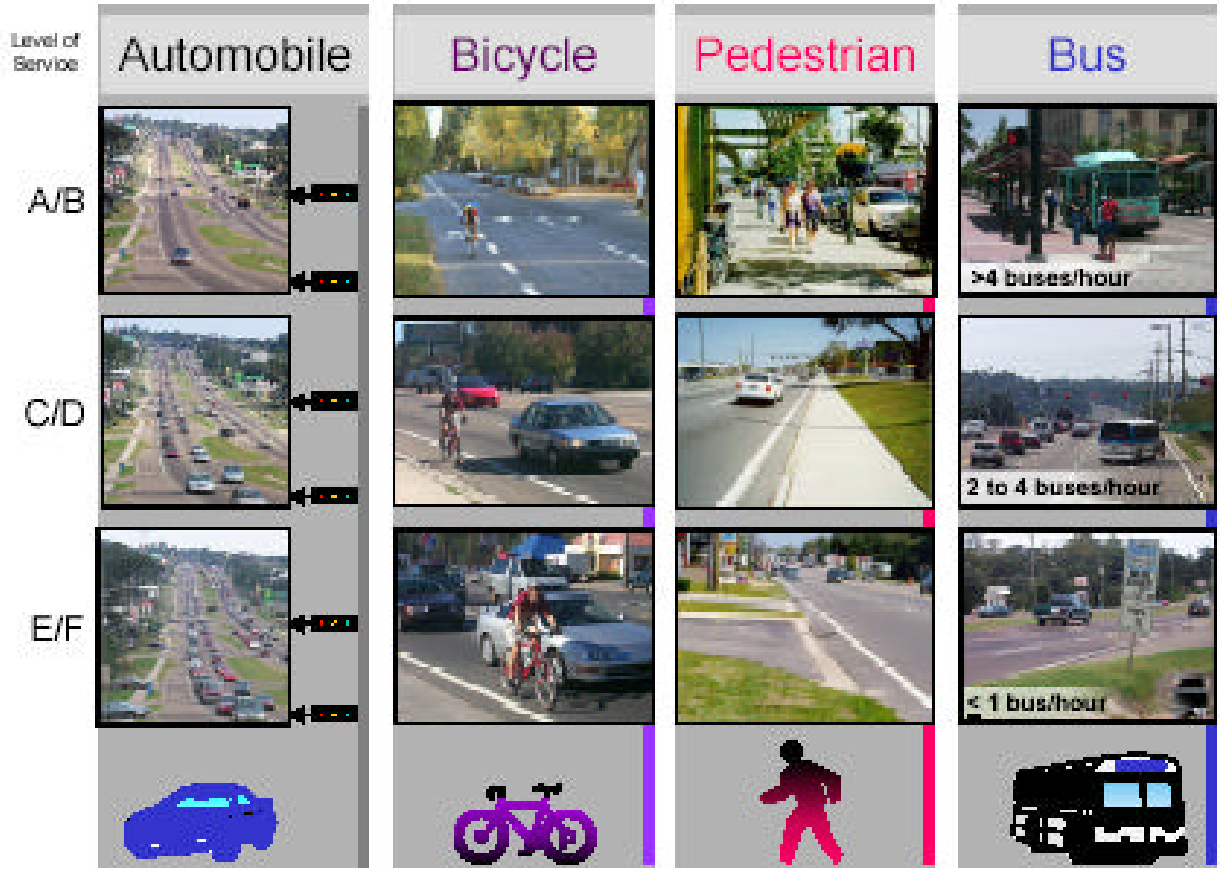
other interruptions; therefore, performance measures on these facilities would also include stopped delay.

As result of the above, LOS for traffic, bicycle, transit and pedestrian modes are centred on a variety of criteria; and therefore, they are calculated through different methods. Provided in Exhibit 1.1 is a summary of example criteria that are normally used for LOS determination. Exhibit 1.2 is an attempt to illustrate level of service concepts by mode.

Exhibit 1.1: Typical LOS Measures by Mode

Mode of Travel	Typical Quality of Service Measures
Walking	Presence, connectivity and width of sidewalks Walking distances Crossing opportunities on major roadways Delay/interruptions at intersections and accesses Perceived safety and comfort (lateral separation from other road users, barriers and buffers, motorist travel speeds, etc)
Cycling	Roadway conditions Presence of bicycle facilities Perceived safety and comfort
Transit	Walking distance to fixed route services Passenger loads Travel times Service hours and frequency Service reliability
Vehicle	Average stop delay at intersections Average speed on arterial roadways Traffic density (expressways and freeways)

Exhibit 1.2: Typical LOS Measures by Mode



Source: Florida Department of Transportation, Quality/Level of Service Handbook

2. REVIEW OF EXISTING CITY OF HAMILTON POLICIES

2.1 Current Roles and Responsibilities

There are a number of City's departments that are responsible for the level of service for road users through planning, design and operations of the City's transportation network. Included in Exhibit 2.1 is a summary of the general duties.

Exhibit 2.1: Department Responsibilities

Department	Responsibilities
Traffic Operations	Traffic operations Pedestrian operations Bicycle operations
Development Engineering	Road network layout Sidewalk provisions Bicycle networks and facilities
Planning and Development	Planning of communities to provide an acceptable level of service to all modes
Hamilton Street Railway	Determination of transit routes, facilities, hours of service and frequency. Accessible transportation

2.2 Review of Existing City of Hamilton Policies

2.2.1 VEHICLE LEVEL OF SERVICE

The Downtown Transportation Master Plan identified a number of Study Guiding Principles including:

> " vii) Ensure a reasonable level of service for vehicular traffic during the peak hours"

The former Region of Hamilton-Wentworth Official Plan identified a road network system that would recognize the various functions of individual corridors and infer the relative level of service provided to each mode. Section 4.3.1, "Road Network", of the Hamilton-Wentworth Official Plan, sets out the following provisions, in part:

> "Even as alternative modes of transportation are increasingly utilized, the road network will remain an essential element of the integrated transportation system. In addition to the safe and efficient movement of people and goods, roads provide transit corridors and rights-of-way for municipal services, utilities and emergency vehicles. Accordingly, efforts must be made to ensure that roads are maintained and improved to sustain the integrated system envisioned for this Region."

In addition, the Hamilton-Wentworth Official Plan outlines a road system classification, which includes a network of roadways required to support general vehicular and truck traffic:

> "a) Inter-regional Highways – strategic links in the road network with a primary function to carry long distance traffic into, out of, and through the Region;
>
> b) Red Hill Creek Expressway is a Regional Road linking Hwy. #403 in the west to the QEW in the east.
>
> c) Arterial roads - strategic links in the road network needed to carry relatively high volumes of long distance traffic within, between or through Area Municipalities, and/or to provide access past major geographic barriers and to inter-regional highways; and, …"

Other sections of the Hamilton-Wentworth Official Plan and provisions in the Downtown Master Plan identify other corridors/policies that are intended to provide priority level of service to pedestrians, cyclists and transit, sometimes at the expense of vehicle level of service. These provisions are outlined in the following sections.

2.2.2 PEDESTRIANS

In December 1998, Regional Council adopted the recommendations of the Regional Transportation Review, which recommended "greater priority for pedestrians, public transit and bicycles in the downtown roadway rights-of-way".

The Hamilton-Wentworth Official Plan indicated a number of key policies to improve the level of service to pedestrians:

- Design safe, pedestrian-friendly streets that are visually appealing, make walking more inviting, provide weather protection with overhangs at store fronts, discourage the placement of objects that will impede pedestrians, reduce or eliminate vehicle traffic by design in areas of high pedestrian activity, provide exclusive pedestrian links in areas of high pedestrian activity and vehicular traffic, separate vehicular and pedestrian traffic, and provide adequate lighting; and

- Encourage area municipalities to improve sidewalk construction and design standards to ensure that sidewalks continue into shopping areas, recreation areas and other similar public complexes; sidewalks are of sufficient width to comfortably accommodate pedestrian traffic; and sidewalks can be easily used by disabled persons.

This document recognizes the need to provide exclusive pedestrian amenities and improved pedestrian level of service in higher activity areas.

2.2.3 BICYCLE LEVEL OF SERVICE

The 1999 Cycling Plan for Hamilton-Wentworth (Shifting Gears) represents the most recent comprehensive bicycle planning document in the City of Hamilton. It reviewed a number of the bicycle specific polices that were included in the 1992 Bicycle Network Study, the 1995 Hamilton-Wentworth Official Plan and the 1996 Regional Transportation Review.

Although the City does not have official "LOS standards" for bicycle operations, key considerations that have been included in their bicycle network planning guidelines reflect many of the LOS measures identified in Section 1.2. From the City's cycling plan, proposed route locations are evaluated using the criteria listed in Exhibit 2.2.

Exhibit 2.2: Considerations for Locating Bicycle Routes

Criteria Area	Considerations
Continuity and Linkage	Total length of the route Number of stop signs and traffic signals encountered Important destinations on or near the route Direct connections to neighbourhoods Directness between origin and destination
Safety and Comfort	Number and width of travel lanes adjacent to the route Volume and speed of traffic Percentage of trucks and buses encountered Pavement condition Personal security
Ease of Implementation	Presence of on-street parking Need to adjust lane widths Impacts on traffic controls Cost Implementation time

2.2.4 TRANSIT LEVEL OF SERVICE

Transit Availability

The Hamilton-Wentworth Official Plan promoted the availability of transit, by guaranteeing its presence near most residential areas:

> *3.1.1.8 Promote the integration of transit plans into the design of neighbourhood and secondary plans to achieve a distance of approximately 400 meters or a five minute walk between 90% of residential units and transit stops.*

The 1996 Regional Transportation Review's Transit plan set out the following objectives:

- Improve existing transit services to encourage and accommodate the Official Plan target goal of 100 annual trips per capita through provision of high operating speeds, reliable service and good passenger amenities;
- Support the economic and social rejuvenation of Downtown Hamilton by focusing transit services on the Central Area and significantly improving accessibility to the area from all parts of the Region;
- Develop and implement a more uniform level of service throughout the urban areas of the Region,
- Provide a greater integration of public transit services with urban land use and with other travel modes, particularly pedestrian, cyclists and autos (park and ride), and
- Develop full accessibility to public transit services for people with mobility limitations.

The plan also proposes the development of rapid transit corridors toward Eastgate Mall, Limeridge Mall, and McMaster, radiating from the central area terminal, which would concurrently facilitate transfer to the GO Rail Station, upgrading the current McMaster-CBD-Eastgate "Beeline" service.

Frequency

Major hubs for HSR service include Jackson Square (downtown), McMaster University, Lime Ridge Mall (Central Mountain), and Eastgate Mall (Stoney Creek). Lines in the downtown area such as the King or Barton lines run every six to ten minutes. Lines on the mountain tend to run every ten or fifteen minutes during peak hours and every 20 to 30 minutes off peak. Other lines that serve a specific destination, such as the University line, tend to run ever 15 minutes during peak and every half an hour off-peak, with interruptions in service when activity at the destination is reduced.

3. SUPPORTING INFORMATION AND ANALYSES

3.1 Trends

Person Capacity Versus Automobile Capacity – In a number of municipalities, a fundamental shift has occurred which moves towards explicit consideration of an acceptable level of service for all modes, as opposed to the provision of pure traffic capacity. Many municipalities have chosen to view their roadways as transportation corridors serving all modes and not just automobiles and trucks. Other jurisdictions have chosen to provide special designations and objectives for specific corridors or area road networks where the level of service for sustainable transportation modes, such as walking, cycling and transit, takes precedent over the movement of general traffic. Examples of this include, "multimodal transportation districts" in the State of Florida and "pedestrian-oriented" arterial street designations in many communities.

Safety Considerations – Roadway capacity and accommodating heavy vehicle turning movements at intersections, require large cross-sections, multiple turning lanes, unconventional phasing plans, etc. In some cases, these physical or operational situations increase the potential for collisions. The transportation profession has always recognized the importance of ensuring that public safety is of greater importance than providing additional roadway capacity; however, road user safety and security are becoming more explicit considerations in all facets of the decision-making process. Some examples include:

- The elimination of high speed right turn channelized islands at intersections to reduce pedestrian conflict points;
- Removal of bus bays which facilitate better general traffic flow; however, create diverge and merging conflicts for the transit vehicles;
- Increased pedestrian crossing times at intersections at the expense, in some cases, to through roadway capacity; and
- Removal or reduction of vehicle travel lanes to provide adequate bicycle facilities.

Pedestrian and Bicycle Level of Service Considerations – In the majority of high level planning and transportation planning documents, the need for improved bicycle and pedestrian facilities is identified as a key objective in all area or specific corridors/locations within a jurisdiction. More progressive jurisdictions are aggressively promoting these needs at all levels of planning, design, operations and maintenance.

Transit Quality of Service Versus Capacity and Speed – Many of the traditional level of service techniques for transit have focused on the transit vehicles operating characteristics (i.e. speed, travel times) and have neglected the service provided to the transit passenger. It is recognized that in order to compete with the convenience and comfort of the private automobile, a holistic look at all the transit service components must be conducted to ensure that transit is a viable option to all perspective patrons. That is one must consider both "availability" of service, i.e., frequency, hours of service and service coverage; and "quality" of service, i.e., schedule reliability, passenger loads, transit travel time comparisons with the personal automobile.

4. REVIEW OF PRACTICES IN OTHER JURISDICTIONS

4.1 Traffic Operations

The vehicular level of service provided by the road network in most urban areas is assessed, monitored and projected (for planned road improvements and development) on regular basis. Given this ongoing activity and interest, one would expect that formal LOS standards for traffic would be in place in most jurisdictions. Realities being contrary to this assumption, most jurisdictions do not have a formal policy regarding acceptable LOS standards. For example, informal conversations with municipal staff in the Greater Toronto Area has netted a number of general practices; however, no documented LOS policies.

As a surrogate, a sample of traffic level of service standards, which municipalities and agencies have identified as thresholds for development related transportation improvements, was undertaken. Included in Exhibit 4.1 is a summary of the level of service and v/c standards that have been documented in traffic engineering documents and transportation impact study guidelines.

Exhibit 4.1: Jurisdiction Level of Service Standards

Jurisdiction/Reference	Overall intersection	Through/shared Movements	Left turn Movements	Unsignalized Intersection Movements
	Volume to capacity ratio	Volume to capacity ratio	Volume to capacity ratio	Level of Service
City of Toronto	> 0.85	> 0.85	> 1.0	N/A
Region of Halton	> 0.85	> 0.85	> 0.95	< LOS "E"
City of Vaughan	> 0.9	> 0.9	> 0.95	< LOS "E"
Ministry of Transportation of Ontario	• Level of Service B – rural intersection design • Level of Service C – urban/commuter intersection design			
ITE Traffic Engineering Handbook (Fifth Edition)	• Communities with a population < 25,000 – LOS C • Communities with a population > 25,000 – LOS D • In central or major outlying business districts LOS D or E can be tolerated for minor traffic movements			
Town of Milton	> 0.9	> 0.9	> 0.95	N/A
Town of Ajax	> 0.85	N/A	N/A	N/A
References: Metro Planning (Toronto) – Guidelines for the Preparation of Transportation Impact Studies Traffic Control Signal Timing and Capacity Analysis at Signalized Intersections (MTO, 1989) City of Vaughan Draft TIS Guidelines Town of Milton TIS Guidelines Region of Halton – Guidelines for the Preparation of Traffic Impact Studies **Notes:** N/A – not available/not identified				

4.2 Pedestrians

The majority of jurisdictions do not have formal processes or policies to assess or explicitly consider pedestrian level of service of existing and future roadways. A number of recent research efforts have sought to quantify how well a corridor accommodates pedestrian travel to assist in planning, design and funding of roadway and pedestrian facilities. In addition, some jurisdictions have undertaken efforts to provide better pedestrian level-of-service through policy development and special operational and safety projects. Provided below is a summary of these recent pedestrian initiatives.

Highway Capacity Manual (HCM)

Previous editions of the HCM had limited provisions for the assessment of pedestrian level of service. The HCM 2000 has incorporated some advances in this regard and defines a pedestrian LOS as a function of ranges of space per pedestrians, flow rates, opposing road user flows rates and speeds. Provided in Exhibit 4.2 is a general summary of the quantitative measures that are included in the HCM methodologies.

Exhibit 4.2: HCM Pedestrian LOS Measures

Facility	Level of Service Measure	Key Considerations
Walkways and Sidewalks	Space and density	Available space Pedestrian flow rate Speed Presence of a stairwell Cross flows
Queuing Areas	Space and density	Available space
Shared Pedestrian-Bicycle Facilities	Hindrance and frequency of events	Number of passing and opposing events (a function of mean pedestrian/bicycle speed and flow rates)
Signalized Intersections	Delay for pedestrians	Cycle length and effective green time
Unsignalized Intersections	Delay for pedestrians	Gap acceptance and likelihood of risk-taking behaviour

Although the quantitative analysis techniques are the focus of the Chapter 18: Pedestrians section of the HCM, it is recognized that there are other environmental factors that affect the “perceived” LOS afforded to a pedestrian on a particular route. The general comfort, convenience, economy, safety and security factors that have been identified include:

- Presence of weather protection, shelter, transit shelters, and other pedestrian amenities;
- Walking distances, pathway directness and connectivity, barriers such as stairs and grades;
- Conflict potential with other road users; and
- Lighting, sight lines and degree of street activity.

Transportation Research Board

Included in Transportation Research Record is a methodology to assess Pedestrian LOS developed by Landis B. et al (TRB Paper No. 01-0511). The model was developed by determining the statistical roadway and traffic variables that describe a pedestrian's perception of safety and/or comfort, based on over 1200 field observations of 75 people walking on a roadway course in Pensacola, Florida. A pedestrian LOS model was developed and was a function of:

- Presence of a sidewalk
- Lateral separation from traffic
- Barriers and buffers between pedestrians and traffic
- Traffic volume, composition and speed; and
- Driveway frequency and access volume.

City of Toronto

The City of Toronto Transportation Services has initiated the "We're All Pedestrians" program, which identifies pedestrian related safety and operational priorities in the City. Through this program, the following initiatives are being pursued to increase the pedestrians LOS:

- **Sidewalk Links** - City Council has developed a new policy to provide sidewalks on both sides of collector and arterial roads that will result in a program to eliminate many of the "missing links" in the City's sidewalk network.
- **Pedestrian Safety Initiatives** – The City of Toronto has three pilot projects underway to review broad pavement markings, leading pedestrian intervals and passive pedestrian detection at the City's intersections. The latter two improvements provide improved LOS to the pedestrian at the expense of green time for traffic.

City of Ottawa

The City of Ottawa has incorporated walking and bicycling into its Official Plan, *Ottawa 2020*, as well as the supporting *Transportation Master Plan*. The City recognizes several factors that influence pedestrian trip making including: suitable distances between origins and destinations, positive individual attitudes toward walking and safe direct routes.

The Transportation Master Plan commits the City to:

- Develop comprehensive Pedestrian and Cycling Plans;
- Implement and maintain a cycling network;
- Provide sidewalks, high quality rapid transit stations, and pedestrian connections across hazardous transportation facilities;
- Develop level of service indicators to assess pedestrian and cycling facilities;
- Coordinate transit priority and bicycle facilities."

The City also agrees to address several measures that support pedestrian and bicycling improvements, including promoting "safety and fair access for all road users".

Florida Department of Transportation (FDOT)

The FDOT recently developed and adopted a detailed method of determining the pedestrian level of service and quality of service. Their pedestrian LOS model seeks to measure the accommodation of a pedestrian on a corridor, from the pedestrian's perception of safety and comfort, and reflects corridor characteristics such as:

- Presence of sidewalk;
- Buffers between the sidewalk and general travel lanes;
- Presence of protective barriers such as trees or on-street parking;
- Width of outside travel lane; and
- Motor vehicle speeds and volumes.

Each of these factors is weighted and added into a numeric score, which is then converted to a Pedestrian LOS score from A to F. Florida uses a combination of the HCM methodologies and their Pedestrian LOS procedure to assess their corridors. The HCM methods are typically used for off-street paths and walkways and for heavily used sidewalks with adequate walking environment.

Florida has developed legislation to establish multimodal transportation districts under a local government comprehensive plan, to assign a secondary priority to vehicle mobility and a primary priority to an efficient, safe and comfortable pedestrian environment. Within these districts, the pedestrian LOS is assessed against that provided to the other modes through a "multimodal LOS" developed by FDOT.

Gainsville, Florida

The City of Gainsville developed level-of-service performance measures for pedestrian and bicycle travel through the Gainsville Mobility Plan Prototype, a congestion management plan for the City. Roadway corridors were assessed using the typical LOS measures A to F, which were a function of a point system from 1 to 21. Pedestrian accommodation in a corridor is based on pedestrian facility provided (max. value 10 points), conflicts (max. value 4 points), amenities (max. value 2), motor vehicle LOS (Max value 2 points), maintenance (Max value 2 points), and TDM initiatives (max value 1 point). From this weighted scoring system, it is apparent that basic pedestrian facilities and conflict potential are the key factors in the pedestrian level of service.

Vancouver, Canada

In 2002, the City of Vancouver approved their Downtown Transportation Plan, which includes improved level of service for pedestrians. Through the City's plan, a number of key pedestrian corridors were identified for improvements such as, widening sidewalks, creating corner bulges, improving pedestrian lighting, safer sidewalk crossings at lanes and intersections, enhancing weather protection and creating curb ramps.

Other pedestrian improvements in the Downtown may include removing pedestrian holds (advance right-turns for cars), eliminating crosswalk restrictions and improving crosswalk design and width.

Prior to this policy initiative, the City of Vancouver has implemented other pedestrian improvements relating to LOS and safety. These improvements include, but are not limited to:

- Reduced pedestrian wait times – In June 2001, Council directed staff to apply a system-wide reduction in pedestrian waiting times at the City's traffic signals. Improvements included reduced cycle lengths, removal of pedestrian holds that accommodate right turn vehicle movements in advance of the pedestrian phase and increased pedestrian walk times

- Removal of right turn channels – implemented at a number of intersections to provide a more controlled crossing for pedestrians; and

- Provision of mid-block crossing opportunities – these improvements included marked crosswalks with pedestrian activated amber flashing lights and "Flight-lite" crosswalks with in-pavement beacons.

4.3 Bicycle

Currently, there are no "industry-standard" LOS measures for bicycle travel. However, current research efforts and the recent revisions to the HCM point to the need that an analytical approach, similar to that used to define vehicular LOS, is required to assess and predict bicycle LOS to identify impacts on these systems and improvement requirements. Provided below are some of the recent efforts in research and jurisdictional policy.

Highway Capacity Manual

The 2000 revision to the HCM has recognized bicycle operations as more than just an input into intersection traffic capacity analysis. The HCM 2000 defines bicycle level of service much like it does for pedestrians, as a function of number of vehicles, delays and hindrance. Included in Exhibit 4.3 is a general summary of the HCM LOS calculation.

Exhibit 4.3: HCM Level of Service Measures of Bicycle Facilities

Facility	Level of Service Measure	Key Considerations
Off-Street Exclusive Bicycle Path	Frequency of events (passing and meeting manoeuvres)	Bicycle flows in either direction Passing events Opposing events
Off-Street Shared Path	Frequency of events	Pedestrian flow rates Bicycle flow rates
Signalized and Unsignalized Intersections	Control delay	Cycle length Saturation flow rates Capacity Effective green
Urban Streets	Bicycle travel speed	Running speed Average delay at intersections

One drawback to the capacity-based approach is that bicycle capacity is not typically an issue with cyclists or on cycling routes. The majority of the recent research has been based on the factors affecting a cyclist's perception of safety and convenience of a route and how these factors affect a traveller's decision to cycle for work or recreation.

Toronto

The City of Toronto has incorporated walking and cycling issues into its larger planning processes including the City's Official Plan and their Bike Plan (2002). Through these documents walking and cycling are recognized as important components of mobility, access and recreation. Although bicycle level of service is not explicitly defined, the following recommendations in the Bike Plan reflect improved LOS standards:

> **"Make city streets safer and more amenable to bicycle riders.** The City of Toronto proposes to improve bicycle detection at traffic signals, amend by-laws to exempt bicycles, use traffic calming to enhance safety and maintain access, investigate two-way bike access on one-way streets, provide wide curb lanes on arterial roadways, develop a pavement repair reporting system, ensure street cleaning practices, respond to cyclists' needs, continue catchbasin grate replacement program, and review practices for cyclist safety during road construction; …
>
> **Coordinate bicycling and transit.** The City of Toronto should gather information on the needs of cycling transit users, provide bike racks on buses, improve bicycle access to stations, and develop Bike-and-Ride promotion strategies;
>
> **Improve bicycle parking throughout the City.** Develop a city-wide bicycle parking strategy, install new bike racks, investigate alternative bike parking tools, review zoning laws to facilitate bike parking, produce bike parking guidelines for developers, and develop a strategy for reducing bicycle theft."

City of Ottawa

The bicycle LOS related policies included in the City of Ottawa Official Plan, *Ottawa 2020*, and the supporting *Transportation Master Plan* are outlined in the above section on pedestrian LOS, as they are address together in the City's plans (Refer to Section 4.2).

Gainsville, Florida

As with the pedestrian LOS measures, the City of Gainsville assesses roadway corridors for a bicycle LOS with an A to F scale and a similar point system from 1 to 21. Bicycle accommodation in a corridor is based on bicycle facility provided (max. value 10 points), conflicts (max. value 4 points), speed differential (max. value 2 points), motor vehicle LOS (Max value 2 points), maintenance (Max value 2 points) and TDM initiatives (max value 1 point). From this weighted scoring system, it is apparent that basic bicycle facilities and conflict potential are the key factors in the bicycle level of service.

Federal Highway Administration (FHWA)

The Federal Highway Administration (FHWA) has developed a Bicycle Compatibility Index (BCI) to be used by transportation professionals to evaluate the ability of existing and future corridors to accommodate/attract bicycle travel.

The BCI method was developed by having a group of cyclists view a number of road section examples and rate level of comfort they would have riding on the sample roadway. The BCI method incorporates the following factor into a mathematical model:

- Presence of a bicycle lane or paved shoulder;
- Curb lane width;

- Number of lanes;
- 85th percentile speed;
- Presence and occupancy of a parking lane;
- Area type; and
- Traffic adjustment factor accounting for trucks, right turn volumes and parking turnover.

4.4 Transit

Highway Capacity Manual

The 2000 revision of the Highway Capacity Manual reflects the both the "capacity" and "quality" LOS measures. The Quality of Service measures are measured on a scale from LOS A to LOS F defined by characteristics of the individual measure. These are outlined in Exhibit 4.4 below.

Exhibit 4.4: Typical Transit Quality of Service Measures

Quality of Service Measure	Typical Measure	LOS Range
Service Frequency for Urban Transit Service	Vehicle headways	LOS A = < 10 minutes LOS F = > 60 minutes
Hours of Service	Hours per day	LOS A = > 18-24 hours LOS F = 0 to 3 hours
Passenger Loads	Square meters per passenger	LOS A = > 1.2 m^2 LOS F = < 0.4 m^2
Service Reliability	On-time percentage	LOS A = 97.5–100 % (one late bus per month) LOS F = < 0.8 (one late bus per direction per week)

In addition two other performance measures relating to transit systems are identified: service coverage and transit/automobile travel time on a corridor or area wide basis. Definitive LOS standards are not identified in the HCM for these measures.

Regional Municipality of York

The Region of York, in a public-private consortium agreement, is planning and now constructing the first phases of a rapid transit system termed the York Rapid Transit Plan (YRTP). The Region has recognized that in order to attract travellers to public transit, the services must be convenient, safe, accessible and comparable to automobile travel times. The YRTP plan includes service improvements such as reduced transit waiting times, improved off-peak service, longer service hours and transit priority initiatives (queue jump lanes and transit signal priority in the short term and dedicated right-of-way operations in the longer term).

The long-term plan is providing additional transit capacity, through dedicated transit lanes, on a number of the Region's key transportation corridors, as opposed to using the right-of-way for further traffic improvements. In some cases, traffic capacity and access will be forgone in order to provide an efficient transit service.

Ottawa

Ottawa's commitment to transit has succeeded in keeping transit mode shares at 15% of all motorized trips in the PM peak period. Ottawa's Transportation Master plan seeks to increase this share to 30% by 2020 through an extensive infrastructure plan. Key elements within Ottawa's transit strategy that are related to transit level of service, are as follows:

- " … Transit service strategy initiatives related to route network structure and service standards, fares and funding, service to villages and rural areas, interprovincial transit service, and service from adjacent municipalities …

- … Transit priority initiatives that will reduce delay and increase reliability for transit vehicles operating on arterial roads …"

Transportation Research Board (TRB)

The Transportation Research Board published the Transit Capacity and Quality of Service Manual (TCQSM) that provides the transportation professional with a consistent set of tools for evaluating the capacity and quality of service of transit systems, facilities and services. The TCQSM recognizes that there are two components to determining transit service, namely the Quality of Service (service provision from the user's perspective) and Capacity Concepts, which address the number of people and vehicle that can be serviced. The latter reflecting similar concepts to the Highway Capacity Manual.

Although the TCQSM provides transit performance measure techniques, it does not set policies for minimum or desirable levels of service.

Site Design Guidelines for Alternative Modes

The CITE is currently preparing a set of guidelines for use in the site design process to promote non-automobile travel. The guidelines will be published later this year and will outline a number of key on-site layout, design and operation considerations to promote walking, cycling and transit travel to a development.

5. IDENTIFICATION AND ASSESSMENT OF POLICY OPTIONS

Based on the above analysis and industry scan, a number of policy options were identified and assessed for the City of Hamilton. These policy options and their assessment are outlined below.

5.1 Consideration of a Multimodal LOS Procedure and Standard for Hamilton

Similar to the Florida Department of Transportation (FDOT) model, consideration was given to developing a "multimodal LOS" for the City of Hamilton. This process would assist in assessment of the level of service afforded to the various road users along an existing or planned city corridor. Having taken a cursory review the methods, they appear to be very data intensive and attempt to provide a quantitative measure to "safety" and "comfort" that are qualitative measures.

In addition, these methods, while having the appearance of being scientific, rely on a number of assumptions or judgements. It is also difficult to develop a one-size-fits-all procedure that is applicable to the many different types of neighbourhoods and corridors in an urban area, particular those as diverse as Hamilton.

This option was abandoned in favour of a less rigorous and more qualitative approach to ensuring that the LOS for each travel model is explicitly considered in each planning, design and operational review study in the City.

5.2 Establishing an Acceptable Minimum LOS for Each Mode

Based on the above policy review, it is apparent that there are a number of primary measures for each mode, which determine the level of service that is provided to the traveller. It is recommended that LOS "C" or better be used as a desired minimum standard for all planning decisions throughout the City of Hamilton. This would apply to all modes, not just automobiles.

Minimum levels of service can be defined at various levels including individual turning movements, individual facilities or across a screenline (i.e. multiple facilities representing a broad corridor). For the purpose of developing a policy on minimum LOS standards, it is recommended that LOS be defined at the screenline level. This recognizes that there needs to be some flexibility in applying this policy. For example, LOS may be poor on a particular roadway due to local capacity constraints, but adjacent facilities have high levels of unused capacity. In these cases, it may be more appropriate to accommodate traffic growth on the adjacent facilities rather than widen the single facility operating poorly.

While determining level of service for motorized vehicles is relatively straight-forward, methodologies for determining level of service for other modes are less developed. As an initial step, it is recommended that the City adopt a basic checklist for staff and development proponents to utilize in the assessment of existing or planned transportation corridors. Exhibit 5.1 summarizes the basic considerations to be included. Ideally, a quantitative LOS measure would be developed for each mode; however, based on a review of other jurisdictions and existing practices, this may not be possible. Level of service by mode should therefore be discussed or quantified to the extent possible using some of the references identified in this report, with the overall objective of maintaining LOS C for all modes.

Exhibit 5.1: Framework for Establishing Level of Service

Mode	Potential Level of Service Considerations
Pedestrian	Presence, connectivity and width of sidewalks Lateral separation from traffic Barriers and buffers from traffic Crossing opportunities on arterial and collector roadways Delays at intersections Driveway frequency and volumes
Bicycle	Presence of a dedicated facility Network connectivity Number and width of travel lanes adjacent to the route Volume and speed of traffic Percentage of trucks and buses encountered Pavement condition
Transit	Frequency and hours of service Reliability of service Passenger loads Travel times
Automobile	Corridor travel times Intersection delay

With these measures in hand, transportation system improvements and impacts to one mode can be measured with and against the improvements and impacts of the other modes, for example, the benefits of widening of a roadway to provide a transit lane or bicycle lane can be viewed in the context of increasing pedestrian crossing distances and reducing vehicular capacity at an intersection.

It is possible that providing an equivalent of LOS "C" for all modes in a particular corridor may not be possible. However, if level of service for all modes is explicitly identified, at least appropriate trade-offs can be made across all modes.

5.3 Consideration of Reduced Level of Service Standards for Motorized Vehicles

Some jurisdictions have, either formally or informally, adopted reduced level of service standards for vehicular traffic in order to promote more sustainable transportation behaviour and/or reduce or delay capital investments in roadway improvements.

There are a number of shortcomings to this approach

- As vehicle level of service is decreased, vehicle queues, aggressive driving and haphazard manoeuvres increase. All of these situations provide a less desirable pedestrian and cycling environment;

- The City's transit system operates on the road network. A decrease in roadway LOS would result in a reduced LOS for transit;

- A reduction in the LOS standards for in-house applications, will invariably be met by requests from the development community to utilize similar standards for determination of

the need for major and local transportation improvements associated with a development or redevelopment proposal. Essentially, all "players" in the planning, design and operations departments will be starting from a "lower baseline" set of standards.

Due to the number of potential downfalls of adopting lower level of service standards, this approach is not considered appropriate for the City of Hamilton. Moreover, if a multi-modal approach to assessing corridor level of service is adopted, there is less of a need to consider reduced vehicle capacity as a means of promoting sustainable transportation modes. Similarly, if a balanced approach is adopted for transportation funding, capital needs for walking, cycling and transit infrastructure will be given the same consideration as basic road infrastructure. Because capital funding is constrained, and will continue to be for the near future, this has the effect of delaying roadway expansion projects and indirectly reducing the level of service of existing facilities.

5.4 The Need for Corridor Specific Level of Service Priorities

In many of the jurisdictions reviewed through the literature, there are formal or informal special policy areas where a mode of travel or a number of modes are given priority to promote their use. This may be along a specific corridor or in a downtown area. In many cases, the ability to provide a good LOS to all travel modes may not be possible. For example, providing a dedicated lane for buses may reduce capacity for automobiles within the specific corridor, but significantly improve transit performance on a larger network basis. In this case, the comparison of level of service by mode may go beyond the specific corridor. In another corridor, the focus may be on pedestrian needs such as wider sidewalks, which may have an effect on road capacity for buses.

To recognize this reality, local area Transportation Master Plans may incorporate special roadway designations or identify critical areas where one or more modes should be given priority, in some instances, at the expense of others. Examples include:

- Pedestrian-oriented areas – downtown, retail areas, community-based land uses or transit hubs.
- Primary transit corridors – where transit priority is given; and/or
- Primary bicycle routes – where general travel lanes may be reduced or eliminated to provide suitable bicycle facilities.

5.5 Consideration of Pedestrian, Bicycle and Transit Travel in the Site Design and Development Process

Through a number of the City of Hamilton practices, on-site design and operations to accommodate walking, cycling and transit are being pursued. It is becoming increasingly recognized that the promotion of sustainable transportation modes, such as pedestrians, cycling and walking requires explicit consideration in the provision of all facilities along their travel route, including on-site characteristics. The attractiveness, safety and security from a multi-modal perspective, in some cases, dictates the mode of travel that a visitor will use. The Canadian Guide to Promote Sustainable Transportation Through Site Design currently being prepared by the Canadian Institute of Transportation Engineers (CITE) will be a good reference in developing policies and practices for the City in this regard.

Further discussion of this issue is provided in the Urban Design Policy Paper and the Walking and Cycling Policy Paper.

6. RECOMMENDED POLICIES

Based on the above review, the following policies are recommended for consideration in the Transportation Master Plan:

Recommended Policy

When planning, designing and building transportation corridors, balance Level of Service (LOS) across all modes, with the objective of providing a minimum level of service of "D" for all modes as defined below.

Implementation

- Minimum Level of Service will generally be defined as the typical peak hour level of service across a screenline or screenlines used for planning purposes (varies by project and location). Reduced LOS will be accepted for individual turning movements, intersections or facilities provided the overall LOS for all facilities in the planning area is LOS "D" or better. Reduced LOS may also be considered where it is demonstrated that this occurs for a short duration of the peak period.

- Adopt a "check list" incorporating key criteria and factors that impact or define level of service for each major mode – walking, cycling, transit and vehicles and apply this checklist in all planning activities;

- Revisit the bicycle facility and operation considerations outlined in the "Shifting Gears" document to establish a list of primary considerations in providing high levels of service to cyclists.

- Review site development applications in terms of their impacts on the level of service for all modes, including walking, cycling and transit, both within the site as well as on adjacent transportation facilities.

Recommended Policy

In future local area or corridor transportation master plan studies, consider improving the level of service of one or more modes relative to the personal automobile in order to achieve specific local objectives or network-wide level of service objectives.

Implementation

- Level of service for transit vehicles will be given priority in designated transit corridors;

- Level of service for pedestrians will be given priority in downtown and community retail shopping areas;

- Level of service for bicycles will be given priority in designated bike route corridors.

- Consider impacts of corridor planning decisions on the ability to efficiently move goods throughout the City;

7. IMPACTS OF POLICY OPTIONS

7.1 Assessment Factors

Assessment of policy options is based on factors for achieving sustainable growth and development across all of the policy papers developed in this project. They fall under the three major categories of **social, economic and environmental** impacts, and they are described briefly below.

Exhibit 7.1: Assessment Factors

Impact	Acts on	Description (or examples)
Social	Residential communities	Improves quality of life in neighbourhoods
	Safety and security	Reduces collisions; improves personal safety and security
	Ease of implementation & governance	Provides clarity, measurability, accountability
Economic	Development	Attracts employment, capital, optimal use of transportation infrastructure capacity, and future land use
	Land value	Increases land value, or does not decrease land values
	Operating and capital costs	Reduces or defers public and private costs of transportation capital (construction or acquisition of fixed infrastructure and rolling stock) and operations (maintenance, enforcement, delay, fuel, etc.)
	Congestion	Maintains traffic flow at acceptable level
Environmental	Air quality	Reduction of Criteria Air Contaminants
	Noise and vibration	Minimizes noise impacts
	Natural environment	Improves water quality, green spaces, flora and fauna etc.

The rating system that will be used to apply these criteria is a visual five-point scale, to reflect a range from strong positive impact to strong negative impact. (**+, +, o, --, --**)

+ Represents the strong positive impact, **o** represents absence of significant impact either way, and **--** represents strong negative impact.

7.2 Summary of Evaluation

The factors described in Section 7.1 are applied to the policy options described in Section 6. The results of a preliminary qualitative assessment using the rating scheme described previously are provided in Exhibit 7.2.

Exhibit 7.2: Impacts of Policy Options

Policy Option	Social			Economic				Environmental		
	Residential Communities	Safety and Security	Ease of Implementation and Governance	Development	Land Value	Operating and Capital Costs	Congestion	Air Quality	Noise and Vibration	Natural Environment
When planning, designing and building transportation corridors, consider and balance Level of Service (LOS) across all modes, with the objective of providing a minimum level of service of "C" for all modes as defined below.	**+**	**+**	**+**	**-**	**+**	**-**	**-**	**+**	**+**	**+**
In future local area or corridor transportation master plan studies, consider improving the level of service of one or more modes relative to the personal automobile in order to achieve specific local objectives or network-wide level of service objectives.	**+**	**+**	**-**	**+**	**+**	**0**	**-**	**0**	**0**	**0**