Ministry of Transportation and Infrastructure

Planning and Designing Access to Developments

Promoting expedited approvals and safe, efficient traffic flow through the analysis of site traffic impacts due to proposed land use development and re-zoning.

Cover Photograph:

Source: BC MoT archives

Location: Highway 97/33 intersection, foreground Enterprise Way extension and connector, Kelowna, BC. Upgraded in 2006 by BC MoT (Highway 97/33) and City of Kelowna.

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Planning and Designing Access to Developments

BC Ministry of Transportation and Infrastructure

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Foreword

This manual is a substantial update of the original *Site Impact Analysis Requirements Manual* published in by the BC Ministry of Transportation and Infrastructure (BC MoT) 1997. It has the same basic intent: to promote a consistent approach to the design process. New or revised details are provided to better ensure that potential impacts on highway and road system performance will be foreseen and that appropriate measures will be taken to mitigate them.

A key change is the requirement to integrate the work of the various professionals involved in the design process from "Day One" of the project design. This should ensure that a truly integrated design addressing both on- and off-site concerns is produced as easily as possible, reducing development costs and delays in the approval process.

We have made some very important procedural changes to ensure the preparation of an adequate integrated design report for a development:

- **Integrated Design** – The design of the on-site circulation and access systems must be fully integrated with the building layout on the site, and the design of the off-site access and adjacent roadway systems.
- **Timely Communications –** Developers and/or their professional representatives must meet with Ministry staff and local government stakeholders to obtain terms of reference before starting on the project design. Past experience has shown that this results in quicker approval of compliant projects.
- **Transparency –** The report must clearly show all assumptions and calculations in order for our staff to make a timely review. We have provided a new check list that enables staff to indicate the key issues to be addressed, and enables the transportation engineer to show where those issues are covered in the report.
- **Flexibility –** Future traffic volumes and travel patterns are crucial inputs, and since they can never be known with certainty, we require appropriate flexibility in the site design for the possibility that a successful development may generate demand for site access that is greater than average.
- **Quality –** The development proponent and all professional parties involved in preparing the design report will certify the quality of the report. by providing Letters of Assurance.

The provincial highway system constitutes an irreplaceable public asset. It is essential for supporting the economy and for helping citizens to travel safely and efficiently between activity centres. The Ministry of Transportation and Infrastructure places the highest priority on ensuring that land development is in harmony with protecting this asset.

Disclaimer

While the Province has used considerable effort to prepare a comprehensive manual, the information contained herein is supplied solely for informational purposes and as a guide.

The content, information, and other material attached or referenced in this manual are not represented, guaranteed or warranted to be accurate by the Ministry, nor are they necessarily exhaustive, complete, or up to date.

Under no circumstances, including, but not limited to, negligence, gross negligence and negligent misrepresentation, shall the Ministry, and its employees, agents, servants, representatives and advisors be liable for any direct, indirect, incidental, special or consequential damages or any loss that results from the use of any content, information, or material attached or referenced in this manual.

About This Manual

Previous Documents

This manual is a significantly revised and updated version of the Ministry's *Site Impact Analysis Requirements Manual,* originally published in 1997. It also includes some material previously published in the companion *Parking and Trip Generation Rates Manual,* published in 1996, which is now outdated and no longer used by the Ministry. The Ministry now uses the ITE publications *Trip Generation* and *Parking Generation* (See **Appendix C – References, Trip Generation and Parking Guidelines**).

The 1996 and 1997 manuals were produced by Denise Kors, P. Eng., BC MoT Highway Planning Branch. This manual was produced under the direction of Jon Conquist, P. Eng., Manager, Highway Planning, by Richard James, P. Eng., PTOE, Richard James & Associates and communications consultant Lynda Griffiths.

Regional and District ministry representatives provided input at key stages. Input was also received from various municipal staff and consultants early in the process.

Intended Users

The primary audience for the manual is those who work in the development community, particularly those working on projects where the Ministry is the road authority, or where the Ministry has joint jurisdiction with municipalities (see **Section 1.1.3**). These users include:

- Developers and their:
    - Transportation engineering consultants
    - Architects
    - Civil engineers
- Ministry approvals staff
- Municipal staff dealing with projects with joint jurisdiction

It is hoped that the development community, and all regulatory staff in the various jurisdictions in BC, will follow the technical guidelines in this manual in the context of their own policies and technical guidelines. To aid this process, we have written much of the manual in a "jurisdiction-less" context and referred to specific ministry policies or procedures accordingly.

Manual Format

The manual is produced as an Adobe PDF document (Acrobat 9 format) and is available at no cost to users from the Ministry's website. Manual updates will be provided periodically. Registered manual holders will be advised when updates are released. Users should refer to the ministry website for this manual to obtain information on how to register as a manual holder.

Users should keep their contact information up-to-date with the Ministry. The manual is designed to be read as a book with two-page spreads and is set up for double-sided printing, should users desire.

Two identifiers are used in the text: the **Important** and **Keyword** icons.

This icon identifies a concept that is important to the process and should be followed by users in preparing a design and report. Failure to follow critical items may result in delay or rejection of the developers submission.

This icon identifies a **word or words that are being defined or explained**. These are important concepts in the context of the manual. Misinterpretation of these words could lead to delay or rejection of the developers submission.

Colour has been used to distinguish between elements in the graphics, however it does not have a specific meaning unless noted in a graphic or the text. In some graphics, colour association is used to group related elements (e.g., in some flow charts).

Text in **blue is a hyperlink** to external references or other relevant sections in the document. Use the "previous view" navigation buttons to go back to the original page (i.e. where the link was located).

A PDF index is included for cross-file searching (PDAD 2009.pdx and the index folder) in the "separate files" version of the document. These should be placed in the same directory (file folder) as the document files.

The document is designed for 2-up display as in a printed document. Bookmarks to each heading are provided.

Context of the Manual

The manual is intended as a guide to assist users in developing the best access to developments. It is neither a comprehensive "it must be done this way" rule book, nor a teaching document. It is intended to identify issues that may not have been adequately addressed in the past and to guide users to develop superior access to developments, maintaining the essential function of the roadway system.

Throughout the manual, reference is made to legislation that must be followed and to design guidelines produced by other organizations. These guidelines have not been reviewed or approved by the Ministry, however they are generally held as being authoritative in their specific areas.

Reference is also made to ministry procedures for the review of submissions for rezoning and access permits. These procedures include identification of:

- the appropriate level of analysis for the project
- documentation that is required
- how the documentation should be presented

Section 2 of the manual contains key information about what is required for and how to submit a proposal for rezoning or access to the Ministry.

Professional Responsibility

The Ministry is not responsible for the design professional's analysis, or their interpretation of the results, even if specific procedures or references identified in this manual have been used.

It is the design professional's sole responsibility to ensure that due diligence is followed and that all applicable legislation, regulations, Ministry and municipal policies and guidelines are adequately and professionally addressed in the Transportation Design Report and in all drawings and other materials submitted as part of an application to the Ministry.

The Quality Assurance requirements (**Appendix B**) must be followed by the developer and the design professionals for all projects where BC MoT has sole or joint jurisdiction.

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1 Introduction

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1.1 Background

Transportation and land use go together. Land use without transportation facilities would be impossible, and vice versa. It follows that land use has an impact on the transportation system.

The BC road and highway system is one of the key elements in the province's transportation infrastructure. Roads and highways make short trips possible: to and from friends, school and the corner store. They also facilitate intermediate length trips to and from work and shopping as well as longer trips between cities, provinces and countries. Roads are heavily used for the transportation of goods to and from markets for local, provincial, national and international consumers.

Many of the roads constructed by the province and municipalities were built a long time ago when traffic volumes were much lighter. Over the years, development and the accompanying traffic volumes have continued to increase. As new intersecting roads and accesses are constructed and traffic signals erected, the speed and capacity of roads decrease and motorists experience increased traffic congestion and more conflicts.

More and more of the existing road system is reaching its practical capacity and improvements are now required. With limited funds available to upgrade these roads, it is essential that a proactive stance be taken to ensure that developments are planned to minimize their impact on the highway network system and properly coordinate with other plans and transportation modes.

The BC Ministry of Transportation and Infrastructure (the Ministry or BC MoT) manages access to all roads in unincorporated areas. The Ministry has also regulated rezoning as well as access to developments that are in close proximity to major provincial highways in municipalities since 1977, through the Controlled Access Highways legislation (see **Section 1.1.3**). The aim of this legislation is to ensure that the impact of such developments on highways, especially in terms of access to and from the highway, is provided in a safe and effective manner. In this way, the Ministry can ensure that existing capacity is maintained and that upgrades are considered in terms of local and regional system plans.

> ! Managing the impact of all new developments on the road system must be an integral part of both the site design and the approval process. The intention of this process is to approve land use where the transportation impact can be handled with appropriate mitigation.

This manual treats the entire development approval process as a design review, not as an "after the design" impact study (see **Section 1.1.4**).

1.1.1 Purpose of the Manual

The purpose of this manual is to provide a comprehensive guide to the roadway, access and parking design requirements related to Ministry, regional and local government development review processes.

This manual does not cover issues such as:

- Drainage
- Environmental impacts
- Utility relocations
- Requirements of other legislation including the *land titles act* and subdivision regulations
- Other issues not directly part of the operational design of the roadways and adjacent parts of the site

These issues are covered in other documents that the designer must refer to for guidance.

This manual is intended for those involved with preparing or reviewing the transportation design. It is a reference manual that:

- Outlines legislative and regulatory authority
- Justifies design requirements
- Defines the design and review process
- Outlines the key elements and recommended practices
- Presents ministry policies related to design and operations that are relevant to development projects
- References policies of other road authorities (see **Section 1.1.3**)

It outlines general requirements and specific policies or requirements of the Ministry. It also refers to, and is intended as an aid for following municipal requirements.

The intention of this manual is to provide a consistent approach to the transportation design process for development projects. This approach recognizes the need for flexibility in cases where site-specific elements or technically justified alternatives allow. It is the developer's responsibility to ensure that a reasonable range of feasible alternatives are properly reviewed. Any requests for consideration of variances to the methodologies and design requirements outlined must be discussed and approved by the Ministry and other appropriate road authorities before commencing the design.

This manual was prepared with consideration of technical processes defined by the Transportation Association of Canada (TAC), Institute of Transportation Engineers (ITE), and Transportation Research Board (TRB) as well as by legislative requirements and processes administered by the Ministry and local governments.

While the manual does not repeat detailed technical information that can be found elsewhere, it does discuss a number of important issues. It focuses on the process and overall requirements to achieve an *integrated transportation design* for development projects.

1.1.2 Manual Overview

This manual is intended for use by the staff members of: the BC Ministry of Transportation and Infrastructure, local government, the developer's transportation engineering consultants and other design team members whose work relates to transportation issues (e.g., the project architect). The general public may also wish to use this manual as a reference document.

The manual:

- Identifies where the ministry has sole or joint jurisdiction (**Section 2 – things you must do**)
- Outlines the level of detail required by the design and review process jurisdiction (**Section 2 – things you must do**)
- Outlines the procedures for both a simplified design process and for conducting a detailed transportation design including preparing the Terms of Reference, going through the ministry's review process, identifying stakeholders and obtaining reference materials (**Section 2 – things you must do**)
- Outlines how to establish the parking and trip generation rates to be used in the detailed transportation design (**Section 3 – parking and trip generation rates**)
- Discusses various analysis techniques to be used in the detailed transportation design (**Section 4 – traffic analysis**)
- Describes the various on-site planning and design elements required in the detailed transportation design (**Sections 5** and **6** cover important design issues)
- Lists references and documents for further reading (**Appendix C**).

The following are provided in the Appendices:

- **Appendix A** – Templates for defining the Terms of Reference and design requirements, and confirming that the intended items have been addressed
- **Appendix B** – Quality Assurance (see also **Section 2.3.1**)
- **Appendix C** – A list of references and further reading materials
- **Appendix D** – Additional material:
  - A list of potential stakeholders
  - Technical background material
  - Glossary of Terms

The following are provided on the Ministry's website:

- **Index to additional relevant resources**
- **Ministry offices, and contact personnel**
- **List of Controlled Access Highways**
- **List of numbered highways**
- **PDF version of this manual**

1.1.3 Legal and Legislative Authority

Keyword

In this manual, the words **highway** or **road** are generally used to refer to any public road (excluding Forestry and resource access roads, etc.).

Keyword

The term **road authority** is used in a similar way to refer to the government body responsible for any given road.

Keyword

A **Controlled Access Highway (CA Highway)** means the highway or portions of it designated or designed for through traffic as defined in Division 3 of the *Transportation Act*. These are generally the numbered provincial primary highways. A list of Controlled Access Highways is available on the **Ministry's website**. (Note that some numbered highways have been devolved to municipalities in past years. The Ministry's official Numbered Highway List contains the current list of provincial numbered highways.)

Keyword

An **Arterial Highway** as defined in the legislation means a Ministry facility within the boundaries of a municipality. These are generally part of the numbered highway system (e.g., Highway 1 in Burnaby, Highway 97 through Kelowna and Prince George).

Keyword

A **municipal road** is any road within a municipality that is not defined as an Arterial Highway under BC MoT jurisdiction

In some rare cases a road may not lie on the gazetted right-of-way, or there may be no gazetted right-of-way. These roads then fall under Section 42 of the *Transportation Act*. The Ministry may require dedication of the full right-of-way width. If these roads abut or fall within an Indian Reserve, or in an area subject to a land claim, then additional considerations may apply. The District Office is to be consulted prior to any planning or design work involving these roads.

Jurisdiction for roads in British Columbia is split between different levels of government. Table 1.1 shows the relationships.

Table 1.1 - Road Authorities

Area / Road Authority	Unincorporated Area	Municipality	Other
Ministry	All public highways[1]	Arterial Highways	Provincial Highways through IRs[2]
Municipality		All other roads	
Federal Gov't			National Parks, Military Lands, etc.
Indian Bands			Roads on IRs

[1] Excludes Forest Service, resource access roads, etc.
[2] IR – Indian Reserve as defined in federal legislation. See also BC *Transportation Act*.

Table 1.2 provides the legislative authority for roads and the regulation of development within and outside of municipalities.

Table 1.2 – Legislative Authority			
Ministry	**Municipality**	**Regional Districts**	**Federal Lands incl. Indian Reserves**
Roads			
Transportation Act	*Community Charter*	No authority	*Indian Act* (Federal)
Zoning			
Transportation Act; Traffic Impact on CA Highways only	*Community Charter*	*Local Government Act**	*Indian Act* (Federal)

* Some Regional Districts do not have, or have not implemented, land use zoning over some, or all, of their jurisdiction.

The Ministry and municipalities are responsible for the construction and operation of roads as defined in the legislation. Regional districts and municipalities are responsible for land use (zoning) and other services.

The Ministry's role in matters relating to land use is solely to provide and manage the transportation facilities required to service the land use. In this context, the Ministry only reviews the transportation issues and does not review or comment on the type of land use.

While roads within municipalities generally fall under municipal jurisdiction, the Ministry of Transportation and Infrastructure is responsible for Arterial Highways within municipalities. Under certain circumstances, as designated in the legislation, the Ministry has joint jurisdiction over the approval of land use in municipalities where changes in land use may impact the Arterial Highway.

These circumstances are:

a. Rezoning of a site within 800 metres of an intersection of a Controlled Access Highway with any other public road (*Transportation Act,* Section 52).

b. Subdivision of a parcel of land adjacent to a Controlled Access Highway within an incorporated area (*Land Title Act,* Section 80).

c. Requests for a development permit to construct a commercial or industrial building over 4,500 m^2 gross floor area on a site where a zoning bylaw is subject to (a) above (*Local Government Act,* Section 924).

d. Requests for an access permit onto a Controlled Access Highway (*Transportation Act,* Section 49).

e. Requests for a permit to construct an access to a provincial (arterial) highway in a municipality (*Transportation Act*, Section 62).

f. A heritage revitalization agreement or amendment by a local government covering land subject to number 1 above (*Local Government Act,* Section 930 [4]).

g. An amendment of a land use contract or a request for a development variance permit or a development permit on land subject to number 1 above (Municipal Act, Section 982 [3]).

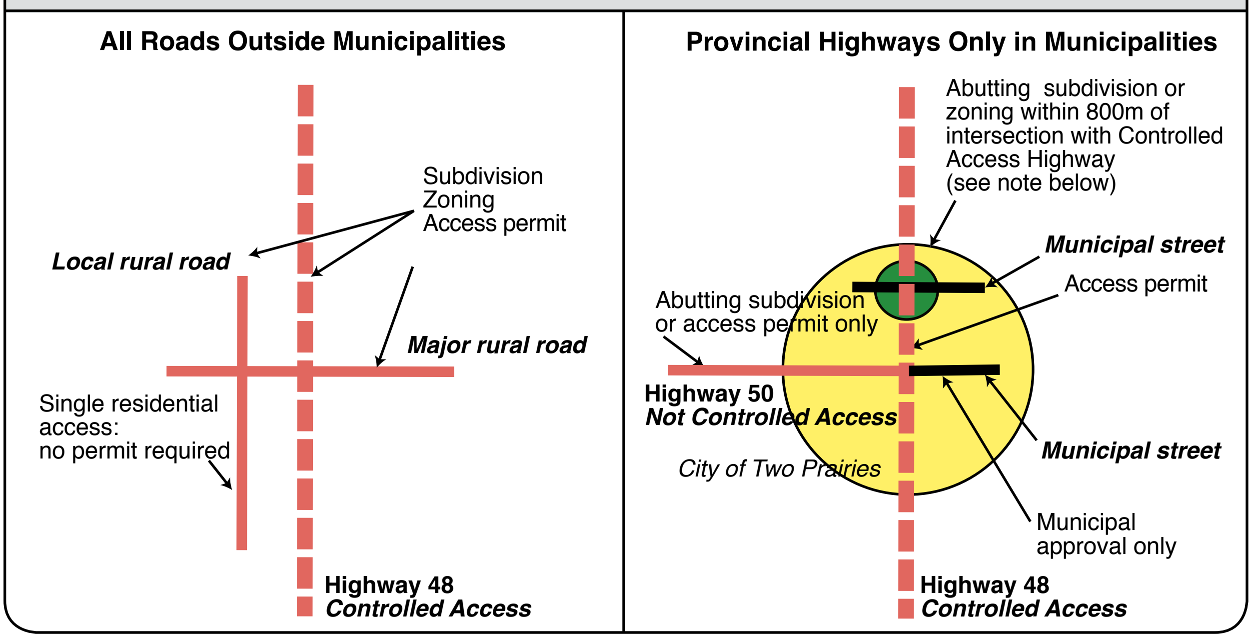
In unincorporated areas the Ministry's jurisdiction includes:

h. Subdivision of a parcel of land in an unincorporated area (*Land Title Act*, Sections 77 [2] and 83 [1]).

i. Request for a permit to construct an access to a road in a rural area (*Transportation Act,* Section 62).

Figure 1.1 illustrates these circumstances. (Each site must be reviewed and the jurisdiction confirmed by the appropriate road authority.)

Figure 1.1 – Jurisdiction



The Ministry may also have jurisdiction if a Development Permit, Heritage Agreement, Land Use Contract or Development Variance Permit is involved.

1.1.4 Integrated Transportation Design Requirement

The road system serves as a network of routes for the safe and efficient movement of people and goods. It was constructed and is maintained at significant public expense and forms an irreplaceable public asset. The Ministry and municipalities are responsible for the effective management and maintenance of all roads within their systems to preserve their safety, functional integrity and public use for present and future generations.

Developments must be designed to appropriately manage the impacts of the traffic they generate, both on and off the site for all modes of travel, in order to maintain existing and future highway facilities.

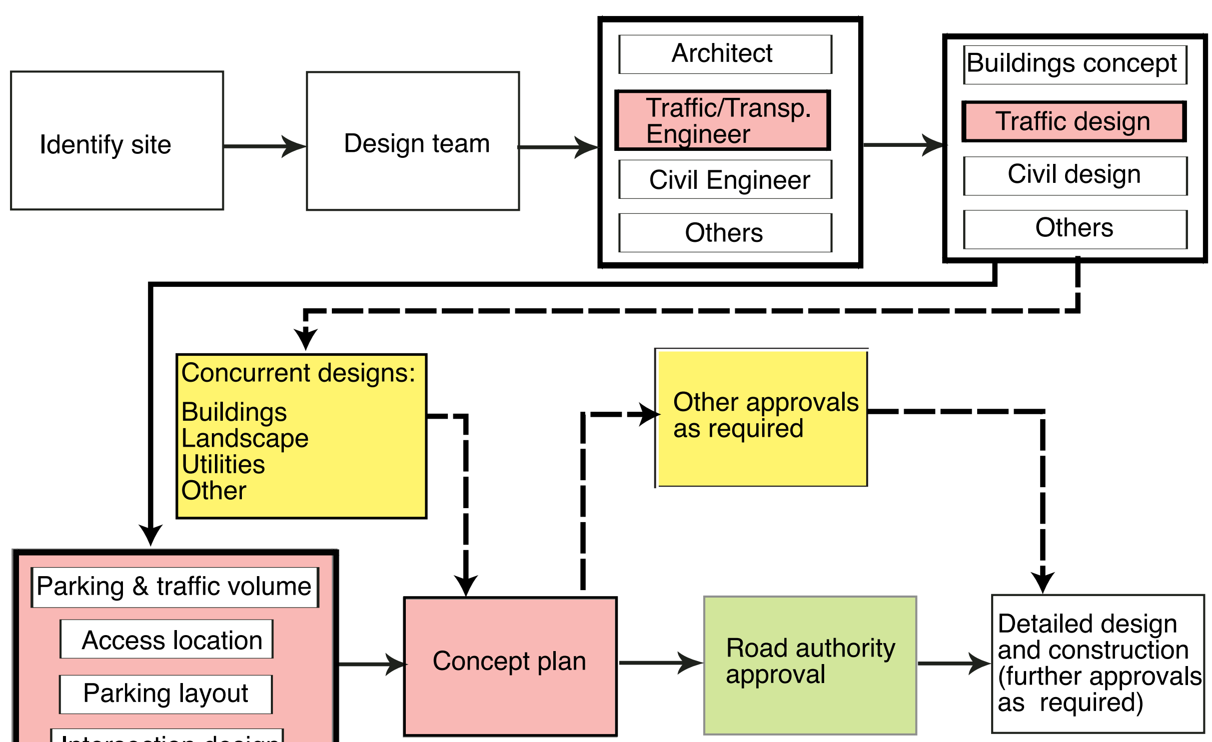
It is essential that detailed consideration of transportation requirements be given from the earliest design concepts through all stages of the design process. This will minimize the cost to the developer and the road authority and ensure the proposal proceeds as quickly as possible through the approval process.

Keyword

This process is referred to as **integrated transportation design**.

Figure 1.2 illustrates the required workflow.

Fig 1.2 – Integrated Transportation Design



See Figures 1.5 and 1.6 for process details.

Optimal provision for parking, circulatory roads and access to the public road system is just as important as building location and configuration on the site for ensuring a successful development. The developer must ensure that the transportation design Terms of Reference (see **Section 2.2.8**) are identified in the earliest part of the project and that this work is integrated with the work of the other design team members in order to achieve an optimal design. This means that the project architect, transportation engineer and civil engineer must work together from "day 1" to ensure this level of integration.

The transportation analysis will identify parameters that control the on-site roadway and parking layout, the access point design and any required mitigation on the adjacent roadways.

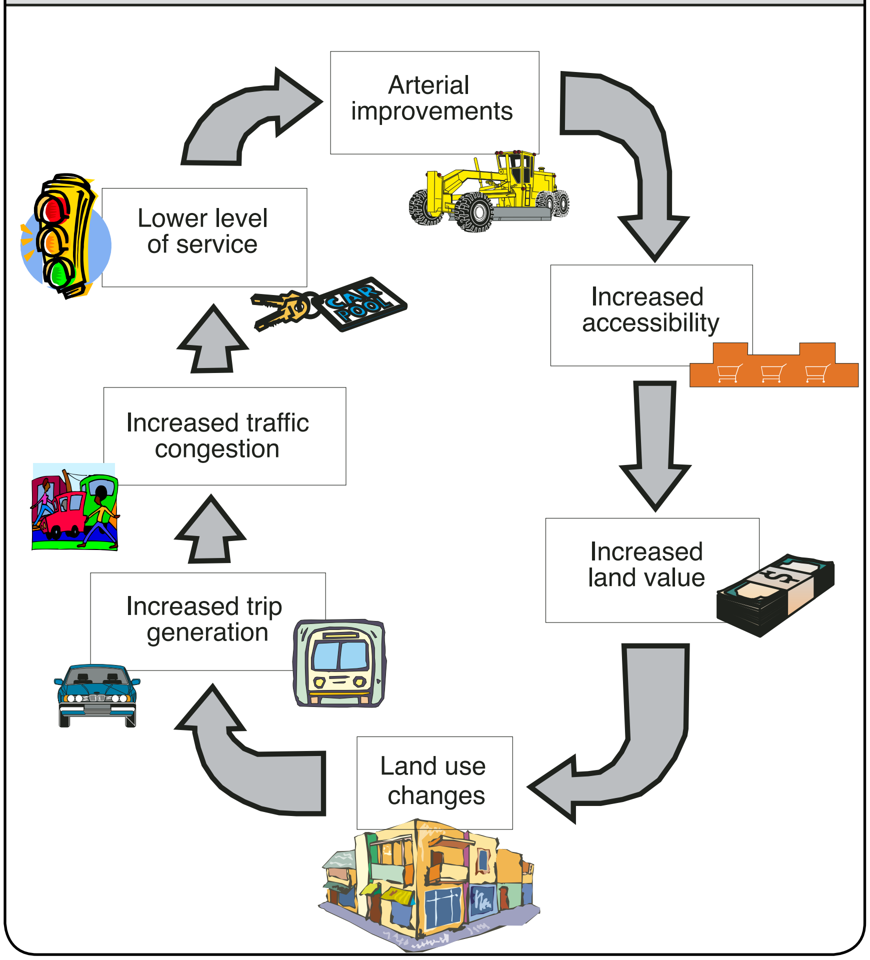
1.1.5 Context of Integrated Transportation Design

The transportation design must consider the proposed development within the context of highway system plans, corridor plans, major road network plans, access management plans and other transportation plans that define the function of the provincial and municipal road systems. Before beginning the design, it is important to review any previous plans in order to ensure that the proposed development takes place within the context of these existing plans.

Site development often focuses primarily on local land use planning and building layout requirements, but it is also important to consider the transportation planning elements. In British Columbia, transportation plans consider the complete range of perspectives for all modes of travel, from the entire provincial transportation system right down to individual segments of corridors. These transportation plans provide a context in which land use and development can be viewed.

Planned future roads and road improvements contribute greatly to the transportation system's ability to safely and efficiently handle the additional traffic that comes from increased development. In turn, new developments contribute to economic growth, increasing the demand for the movement of goods. In this way, developments benefit from improvements to both the local and the regional transportation system. Figure 1.3 illustrates the land use and transportation life cycle.

Figure 1.3 - Transportation and Land Use Life Cycle



As communities develop, the land use changes, generally becoming more intensive. The demands on the transportation system (and other services) increase and improvements become necessary. Developers must recognize this and make appropriate provision to mitigate their development's direct impact and facilitate the mitigation of overall regional impacts. Eventually redevelopment will occur again as the cycle continues indefinitely. A cycle can last from 10 to 30 or more years.

1.1.6 Stakeholders

Keyword

The recommendations of the Transportation Design Report may have an impact on many different groups or **stakeholders** who may have a direct interest in either the development of the site itself or the effects of the traffic generated by the development. Appendix D.1 contains a list that must be used to identify potential stakeholders and their level of interest in a development project.

1.2 Technical Issues

This section introduces three issues: jurisdiction, appropriate design process and design domain. Readers are referred to the appropriate resources for these issues.

1.2.1 Determining Jurisdiction

Jurisdiction is based solely on legislation (**Section 1.1.3**) and is illustrated in Figure 1.1.

In unincorporated areas, the Ministry has sole jurisdiction. The Ministry also has joint jurisdiction within municipalities if the property abuts, or is within 800 m of an intersection with a Controlled Access Highway (see **Section 1.1.3**).

1.2.2 Determining the Appropriate Design Process

When the Ministry has sole or joint jurisdiction, the selection of the appropriate design process (detailed design or simplified design) is based primarily on:

- The potential traffic impact of the proposed development
- The adjacent roadway functional classification
- Adjacent roadway traffic volumes

> The key criterion is an increase of more than 20% (or 100 vehicles per hour, whichever is greater) in the peak hour to and from the site (two-way volume). Such an increase may result from rezoning or a change-of-use within the existing zoning. The Ministry uses ITE trip generation data exclusively for determining trip generation (see **Section 3**).

Other site-specific conditions may require a detailed design even though the traffic generated is less than 100 vehicles per hour. These are reviewed in **Section 2.2.2**. Ministry procedure is discussed in **Section 1.3.**

Municipalities may also have defined design processes. Road authorities must endeavour to make their individual processes compatible, however, in general, the highest requirements must be met.

Table 1.3 provides some examples of land uses that generate 100 vehicles per hour.

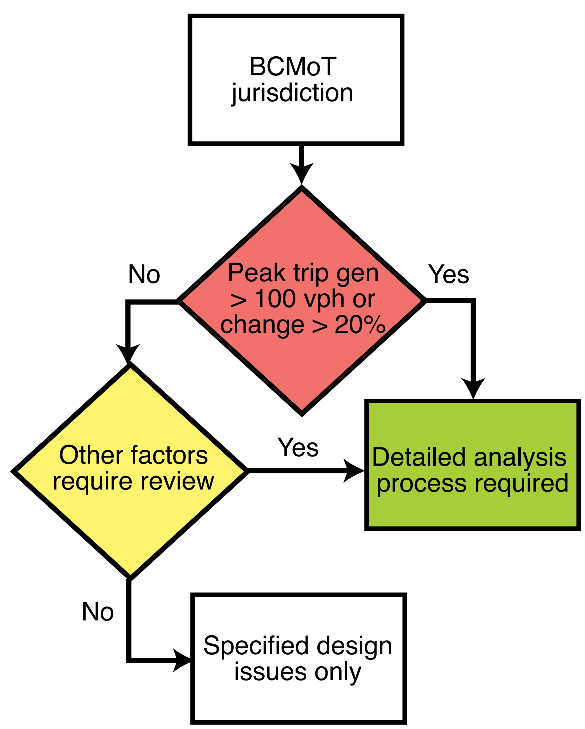
Table 1.3 - Sample Threshold Trip Generations

Land Use	ITE Category	Measure	Units	Rate*	Trips
Single family residential	ITE 210 p.m. peak hr.	per unit	93	Eqn	100
Condominium/townhouse	ITE 230 p.m. peak hr.	per unit	180	Eqn	100
Neighbourhood conv. store	ITE 851 a.m. peak hr.	per 100m^2	1.5	67.0	100
Retail - shopping centre	ITE 820 Sat. peak hr.	per 100m^2	3.4	Eqn	100
Gas station, gas only	ITE 944 p.m. peak hr.	per fuelling position	8	Eqn	100
Gas station with vehicle wash and conv. store	ITE 946 p.m. peak hr.	per fuelling position	8	13.3	106
Fast food with drive-thru	ITE 934 Sat. peak hr.	per 100m^2	1.6	59.2	102
Quality restaurant	ITE 931 Sat. peak hr.	per 100m^2	8.5	Eqn	99
General office	ITE 710 p.m. peak hr.	per 100m^2	18	Eqn	100
Medical office	ITE 720 p.m. peak hr.	per 100m^2	97	Eqn	100

* Eqn – The regression equation may give a significantly different result than "average rate."

Figure 1.4 provides an overview of how the appropriate design process is determined.

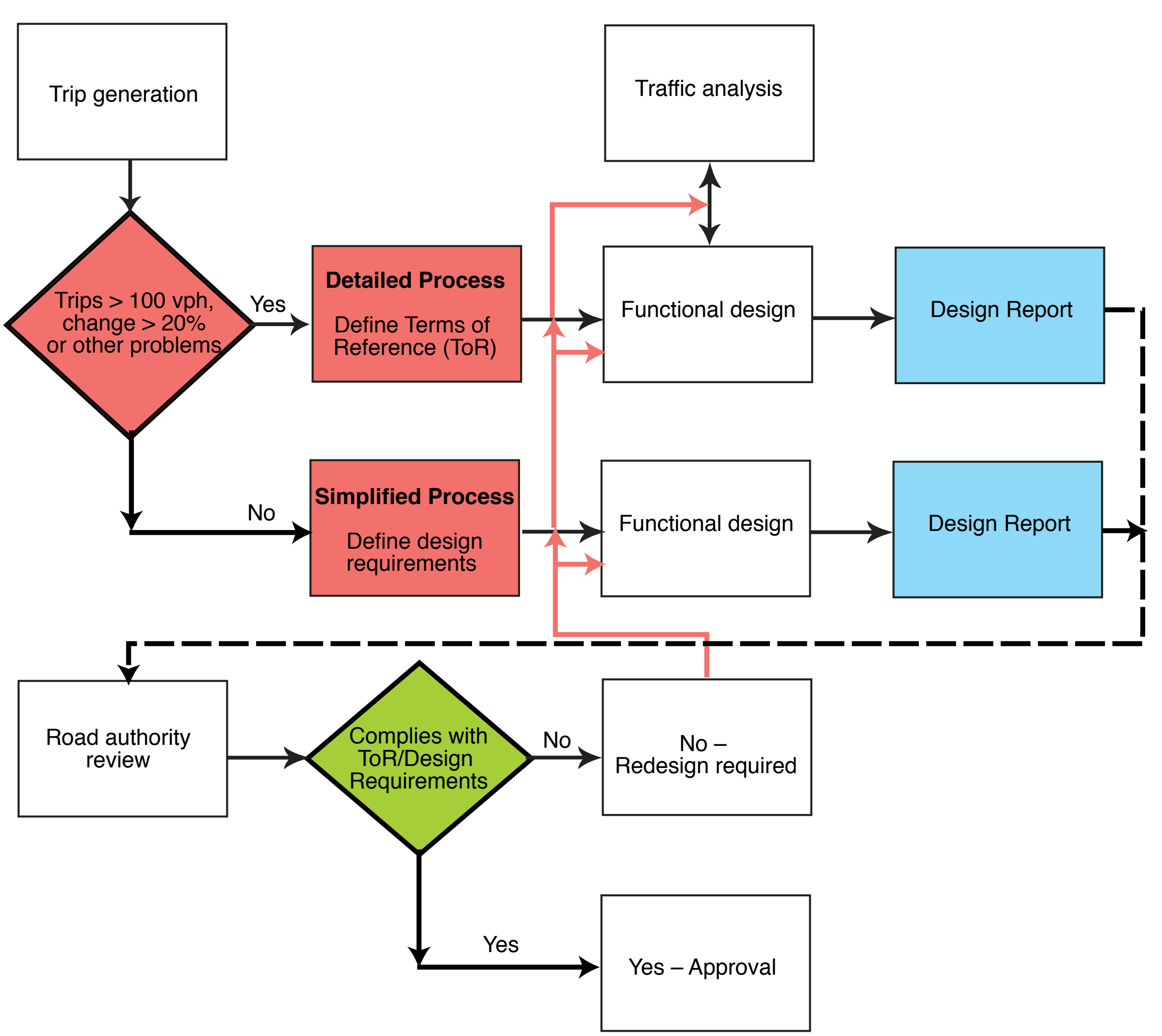
Figure 1.4 – Simplified Decision Process



Within the two design processes (simplified and detailed), several levels of detail may be required. These vary from the design of simple roadway improvements (e.g., a left turn lane), to a full transportation model analysis including the operational analysis of multiple complex intersections and the full design of new roadways for a regional shopping centre or large scale, multi-phase residential subdivision.

Figure 1.5 provides an overview of the detailed and simplified design and review processes.

Figure 1.5 – Process Flow Chart



1.2.3 Design Domain and Ambient Guidelines

The TAC *Geometric Design Guide for Canadian Roads* discusses the "design domain" concept (in Section 1.1.5 of that manual).

The BC Ministry of Transportation and Infrastructure has adopted the TAC guide, as amended in the *BC Supplement*, for use on their facilities in BC.

The TAC guide allows road authorities to specify a single value, or narrower range of values, for any design parameter, with the implication that it will be within the wider domain identified in the guide. The application of design domain concepts is discussed in **Section 5.2.1.**

The Ministry has developed ambient guidelines (see *Corridor Ambient Geometric Design Elements Guidelines*, on the **Ministry's website**, see tab 13 under "Individual Chapters") that are applied by the Ministry to some road corridors where achieving an upgrade to a higher standard is deemed impractical. The intent of these ambient guidelines is to provide a consistent roadway environment in keeping with the adjacent roadway sections and the specific local environment. In some ways this is analogous to "context sensitive design." The application of ambient guidelines concepts is discussed in **Section 5.2.2**.

> ! It is the designer's responsibility to ensure that all parameters requiring Ministry approval (i.e., all parameters to which the Ministry has not already assigned single values) are identified in the Terms of Reference and approved by the Ministry before they are used in the design. All decisions regarding appropriate parameter values are to be reported in the Transportation Design Report that is submitted to the Ministry for review. The approval may be delayed if this is not done.

1.3 Process

1.3.1 Process Overview

This section primarily deals with the Ministry's review when it has sole or joint jurisdiction. Where any road that falls within the project scope is under municipal or joint jurisdiction, then the municipality's requirements also apply to that road. Where joint jurisdiction exists, and there are differing requirements, the Ministry normally takes the higher requirement as ruling unless both jurisdictions agree to the lower standard.

1.3.2 Applications for Review

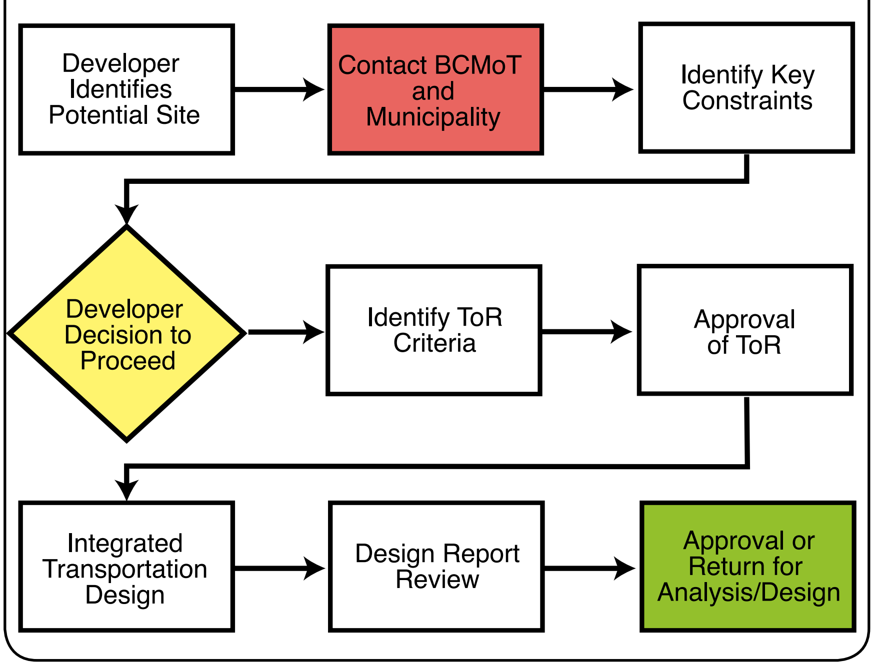
For roads where the Ministry has sole jurisdiction, all applications must be submitted to the Ministry through the District Office. For roads under joint jurisdiction, the municipality is the primary authority and contact must be made through their offices first. In the latter case, the Ministry will respond through the municipality. The Ministry development review process occurs at the district level with support from regional staff where required.

It is critical that developers contact the Ministry's District Office before submitting an application and/or a design in order to determine what is required. **Section 2.2.2** provides guidance on how the need for a study is determined.

The overall process is illustrated in Figure 1.6. The level of detail available at the initial discussion with the road authorities is expected to only identify general site parameters and the context of the overall road system. A detailed plan or analysis are not required since the potential constraints on access and the potential off-site impacts are unknown at this stage. The purpose of this discussion is to provide a framework for identifying and resolving these issues through the Terms of Reference, analysis and the Integrated Transportation Design process.

Where there is joint jurisdiction, the local government must also be contacted to determine their study requirements and to obtain information on any local issues, land use plans and the feasibility of alternate access. A more complete listing of stakeholders is provided in **Appendix D.1.**

Figure 1.6 – Overall Process Steps



1.3.3 Determining the Need for a Detailed Design

When a project requiring Ministry approval as outlined in **Section 1.1.3** is proposed, Ministry staff will determine whether a detailed design must be submitted in support of the application or whether the simplified design and review process may be followed.

The Ministry uses criteria recommended by the Institute of Transportation Engineers and the Transportation Research Board to determine when a detailed design is required or when the simplified process can be used. These apply to both new sites and existing sites where there is a proposal for a change-in-use of an existing access. The requirements are detailed in **Section 2.2.2**.

Municipalities may have their own processes for specifying the level of detail required for a Transportation Design Report. In general, the higher of the two standards will need to be met.

1.3.4 Ministry Process – Overview

The three main components of the process for undertaking a transportation design include:

- Determining whether the detailed review process is required or if the simplified review process can be used (**figure 1.4**)
- Identifying the Terms of Reference for the design or review
- Establishing required content of the Transportation Design Report

Section 2.2.2 outlines the process for determining whether a detailed design or simplified review is required. Sections **2.2.8** and **2.3.2** provide information on elements of the detailed design and review process and Sections **2.2.3**, **2.2.8** and **2.3.2** outline the simplified design and review process. The developer must contact the District Office to confirm the requirements for each project (listed on the **Ministry's website)**.

The process is illustrated in Figure 1.7. In this flow chart, colour boxes are used to identify key elements in this flow chart:

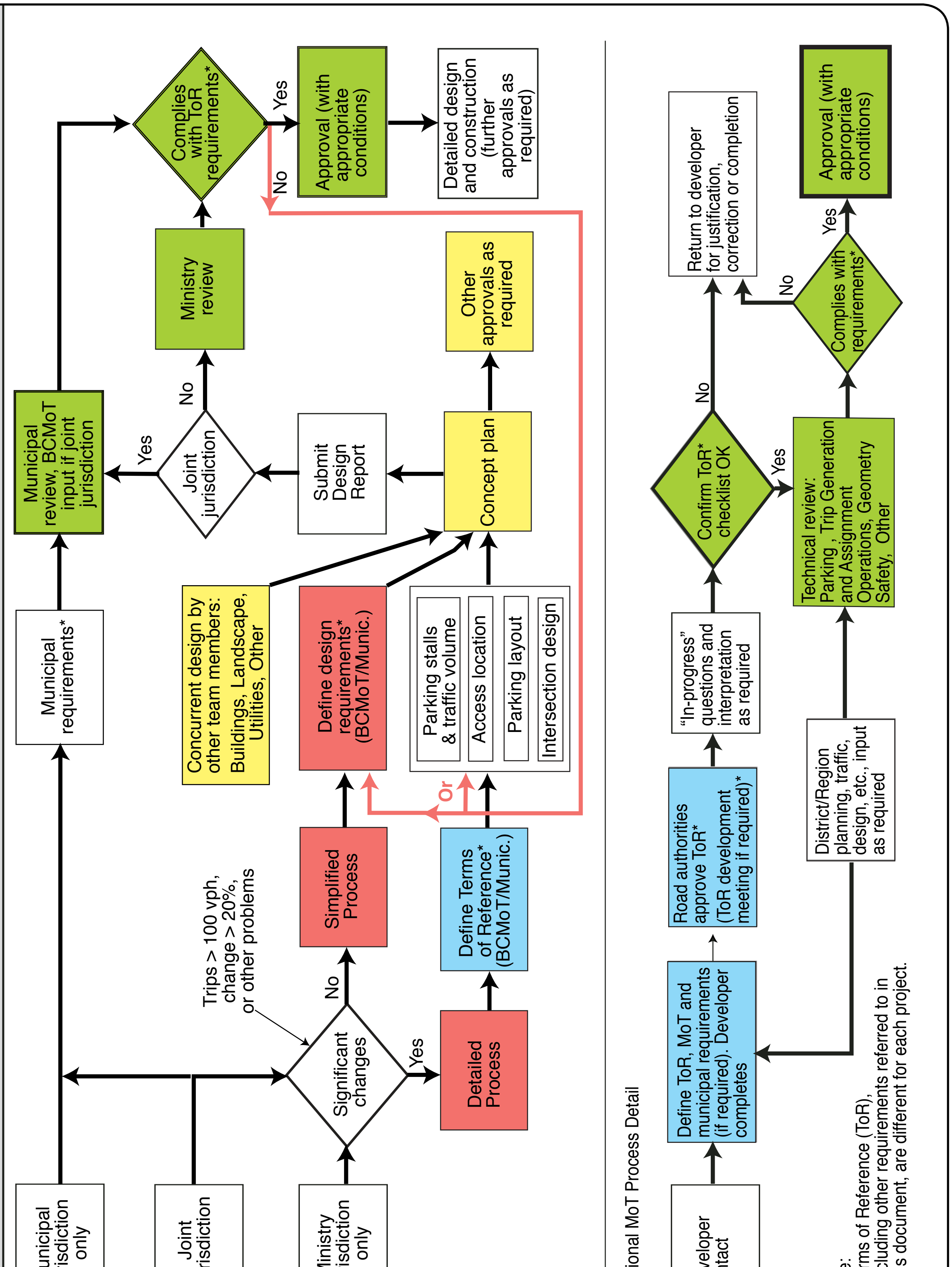
- Red – Identifies whether the process is simplified or detailed.
- Blue – Identifies when the key items are defined.
- Yellow – Identifies what else takes place concurrently.
- Green – Identifies the timing of the review steps.

If a review fails, the process returns to an earlier stage in either the simplified or detailed process (i.e., some steps need to be repeated) as indicated by the red line.

1.3.5 Terms of Reference

Appropriate Terms of Reference must be identified by the developer and approved by the road authorities before commencing the project design. In the case of small projects where a detailed review is not required, the road authority may choose to indicate the appropriate design elements that must be included by the civil design engineer.

Figure 1.7 – Overall Design/Approval Process



Note:
* Terms of Reference (ToR), including other requirements referred to in this document, are different for each project.

1.3.6 Ministry Review Process

The Ministry review process includes the following major steps:

1. Advise the developer of the requirements and the need for Ministry approval (documented in this manual).
2. Determine the level of design or analysis needed for the project and advise the developer of the appropriate level of expertise required.
3. Review and approve the Terms of Reference.
4. Review and approve any changes to the Terms of Reference, or complete the preliminary review and give approval to continue with key design issues or concepts during design.
5. Complete initial review of the submitted design for compliance with the Terms of Reference and return to the developer for changes or completion, if necessary.
6. Review and approve the design.

1.3.7 Municipal Process

Each municipality will have its own technical requirements and processes. The developer must contact the municipality to determine what these are.

1.3.8 Key Reference Material

The Ministry's detailed requirements are based in large part on the following key references (see **Appendix C – References** for full citations). Other references are provided throughout the manual.

- Ministry website (online references to current **BC MoT material**)
- *Access Management Manual*
- *Transportation Impact Analyses for Site Development*
- TAC *Geometric Design Guide for Canadian Roads (2007 update)*
- *BC Supplement* to the TAC manual, on the **Ministry's website**
- Technical Bulletins and Technical Notes, on the **Ministry's website**
- BC Legislation including the *Motor Vehicles Act* and *Regulations*, *Transportation Act, Municipal Charter, Local Government Act and Land Titles Act*
- *Highway Capacity Manual* (HCM 2000)
- *ITE Trip Generation* and *ITE Parking Generation*

In all cases, the current version of all referenced documents and software must be used in all work for Ministry approval.

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2 Things You Must Do

Table of Contents

Other Sections

Appendices

2.1 Background

This section outlines some of the key issues that will assist in developing the transportation component of a development proposal in order to:

- Provide the most effective design process
- Help the road authorities manage the review and approval process in the most effective manner

Utilizing this process will assist the developer by minimizing redesign. It will also provide more effective access to the road system and result in quicker approval for the project, thereby reducing development costs.

The rest of this manual provides guidance on technical issues and ministry policies that must be followed in order to meet the expectations of this section. These technical items are common to all road authorities. Specific ministry policies apply when the Ministry has sole or joint jurisdiction.

A key feature of this process is that it is not a review of a completed proposal; rather, it is an Integrated Transportation Design process that considers access, on-site circulation, parking and off-site mitigation as integral parts of the design process that must be addressed from the earliest concept development stages of the project. These are issues that are as important as matching the building's form to its function.

2.1.1 Professional Responsibility

A key change in this revised manual is a rigorous definition of when in the design process transportation issues need to be addressed, and who is required to do the necessary analysis and design.

The Transportation Design Report (see **Section 2.2.2**), required in either a simplified or complete process for almost all projects under the Ministry's jurisdiction, is a living document. It follows the development of the project from its earliest stages including definition by the Transportation Engineer of acceptable access locations and configurations, to completion of the design for final approval by the Ministry and, if appropriate, local government.

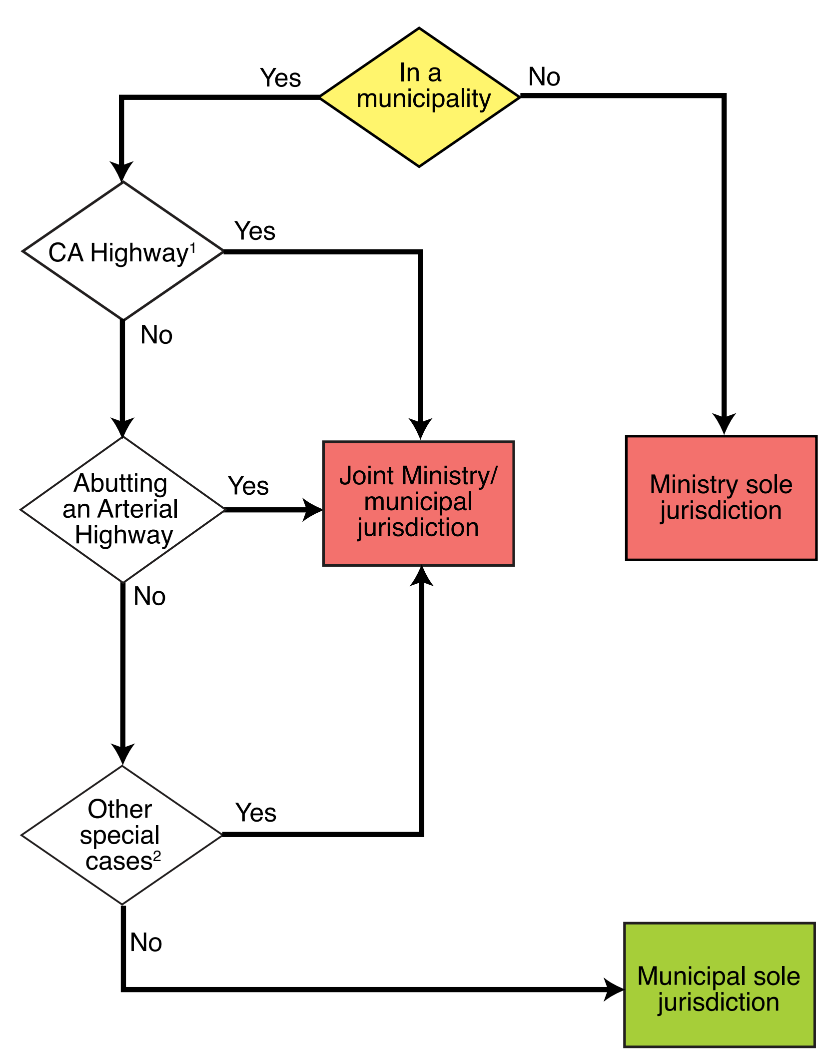
This report must be completed by suitably qualified professional as described in **Section 2.3.1**. In most cases this will be a Professional Engineer qualified in transportation planning and design.

2.2 Technical Issues

2.2.1 Jurisdiction

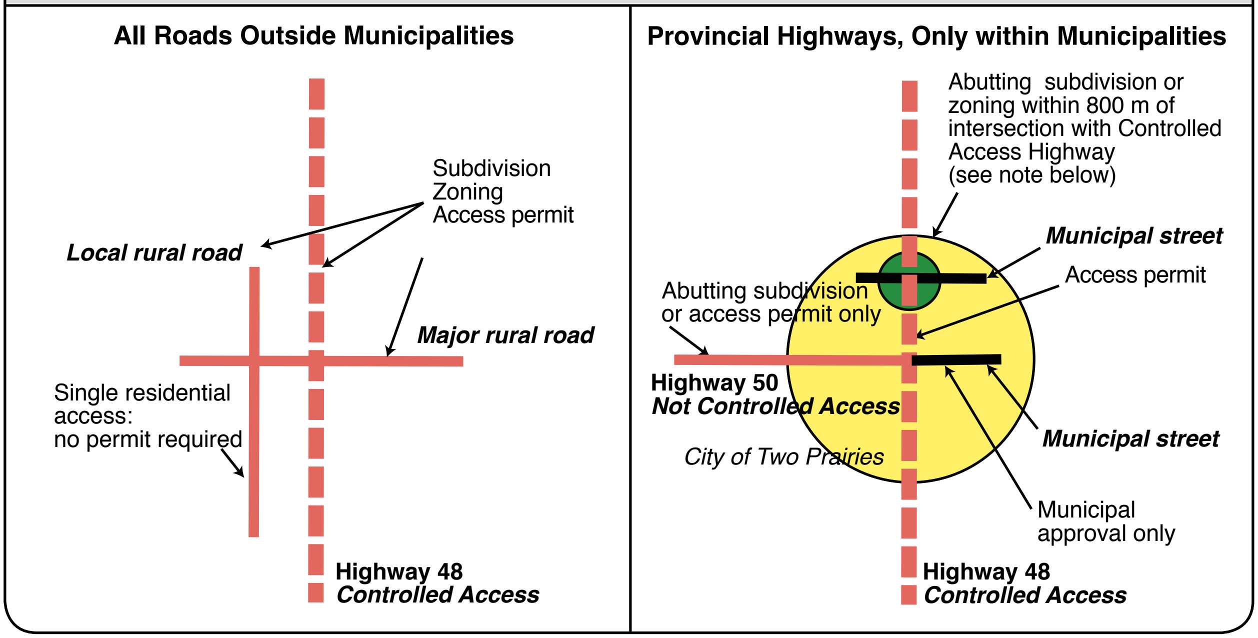
The Ministry has jurisdiction as defined by legislation referred to in **Section 1.1.3.** The decision process is summarized in Figure 2.1 and illustrated graphically in Figure 2.2.

Figure 2.1 – Jurisdiction Decision



[1] On a Controlled Access Highway or within 800 m of an intersection with a Controlled Access Highway
[2] See **Section 1.1.3**

Figure 2.2 – Jurisdiction



The following examples illustrate jurisdiction decisions:

Outside of a municipality – All public roads are under BC MoT jurisdiction (excludes Forest Service, resource access roads, etc.).

No permit is required for isolated single-family residential accesses. Normal procedures apply for multi-lot subdivisions and other uses.

Within a municipality – The "800 m rule" is illustrated where BC MoT has joint jurisdiction if a proposed development is abutting any Arterial Highway, or is within 800 m of an intersection with a Controlled Access Highway. Developments abutting other roads need only municipal approval.

Note: The Ministry may also have jurisdiction if a Development Permit, Heritage Agreement, Land Use Contract or Development Variance Permit is involved.

2.2.2 Transportation Design Report

The Ministry does not prescribe a design procedure for development projects. Rather, it requires a specific level of reporting on the analysis and design decisions as well as justification for the proposed access and mitigation design. The report must also address on-site design elements (beyond the access area) if they may impact the safe and efficient operation of the access. The Ministry may require a Transportation Design Report for projects that require its approval (the level of detail varies depending on the impacts of the proposed development as discussed in this section). Road authorities other than the Ministry may have reporting requirements of their own.

This manual identifies the specific issues that the Ministry may wish to see addressed and documented. Other road authorities, or interested parties such as transit companies, may have other specific issues that must be addressed. Additional site-specific issues, not explicitly detailed in this manual, may also have to be addressed.

The report requirements and Terms of Reference required to meet them must be determined and agreed upon with the road authority (or road authorities) before significant site planning and design is undertaken. This is critical to the smooth flow of the developer's work and the road authorities' review process.

The Terms of Reference of the report will vary depending on the project's potential impact on the adjacent roadways. The impact is dependent on: the type and size (traffic generation) of the project; the functional and access classification of the affected roadways; and the traffic volumes on the affected roadways.

Reporting requirements fall into two broad categories:

Keyword
- **Detailed report** – For larger projects, or where significant roadway-capacity or safety issues exist that need to be addressed. A detailed report also includes detailed traffic analyses as well as consideration of other design issues.

Keyword
- **Simplified report** – Deals primarily with design issues where the impact is considered to be low.

A general overview of how the requirement for the detailed Transportation Design Report is determined is provided below and shown in Figure 2.3.

A detailed Transportation Design Report is required for a project requiring ministry approval, when:

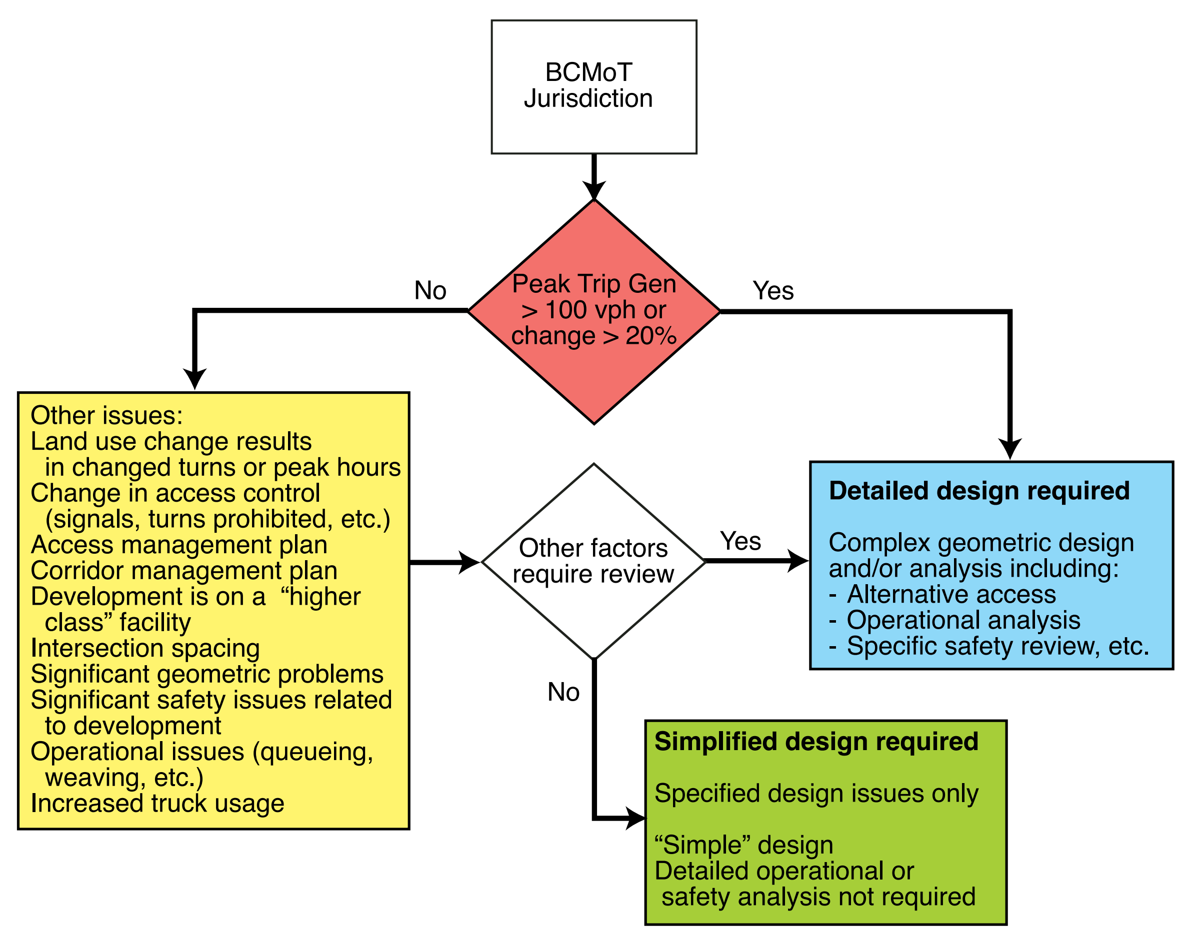
- A new development generates more than 100 vehicle trips in the peak hour.
- A change-in-use of an existing development results in:
  - more than 100 additional vehicle trips in the peak hour.
  - a change in the type of access operation (permitted turns, and/or type of intersection control, etc.) for a development generating more than 100 vehicle trips in the peak hour.
  - the access being relocated for a development generating more than 100 vehicle trips in the peak hour.
  - a change in the traffic volume, type of access operation, or its relocation, if the site generates less than 100 vehicle trips in the peak hour when, in the opinion of the Ministry Traffic Engineer (District or, if no District Traffic Engineer, Regional Traffic Engineer), the proposed change may adversely impact the operation of the access point or the highway.
- The peak hour volumes (total volume or any turning movement) at any one access, or intersection in the study area, or the aggregate volume change such that:
  - the actual or proposed traffic volumes on any access or individual turning movement in the design hour increases by the higher of 20 per cent or 100 vehicles per hour (vph).
  - the actual or proposed use of the access will shift the peak hour from that for which the access was originally designed, requiring that a new design hour be evaluated.
  - the daily use of the access by vehicles exceeding 13,500 kilograms gross vehicle weight increases by 10 vehicles per day or more.
- The free flow of vehicles entering the property is restricted or entering vehicles queue or hesitate on the highway, creating a safety hazard.
- The proposed access location does not meet the minimum turning or decision sight distance requirements of the TAC *Design Guide*.
- There are other considerations including:
  - significant collision history (higher than the critical collision rate, see Section 4.2.11 - Critical Collision Rate)
  - compatibility with existing, proposed or potential corridor plans, access management plans, etc.
  - intersection control types or operational changes (signals, etc.)
  - functional or access management classification of the roads, etc.

Some of these issues are shown in Table 2.1 and Figure 2.3 and may result from several causes. This table also lists some changes that do not result in the need for a Transportation Design Report.

Table 2.1 – Change-in-Use

A change-in-use may include:	A change-in-use DOES NOT include:
• Modifications to, or relocation, of an access • Expansion of an existing building or construction of a new building on the site, whether or not rezoning is required • Change in the type of business conducted (whether or not rezoning is required) • Change in zoning • Property subdivision, creating new parcels	• Modifications in advertising signage unless sightlines are impacted • Landscaping unless it impacts sightlines • General maintenance • Changes to aesthetics that do not affect internal or external traffic flow, parking supply, sight distance or safety

Figure 2.3 – Detailed Report Decision



The safety and efficiency of the highway may be compromised and a review may be required in the situations listed above in order to determine the adequacy of the existing access design or whether reconstruction, relocation or closure of the access is required. Ministry staff will also wish to consider municipal Major Street Network Plans, Regional System Plans and/or Corridor and Access Management Plans to determine whether alternative access is available for relocation of the site access.

In the case of "higher class" facilities, the road authorities may require a detailed traffic analysis, even if the volumes are below the 100 vehicles per hour threshold, if there may be operational issues even with these lower volumes (e.g., weaving between an exit and a left turn lane).

Keyword

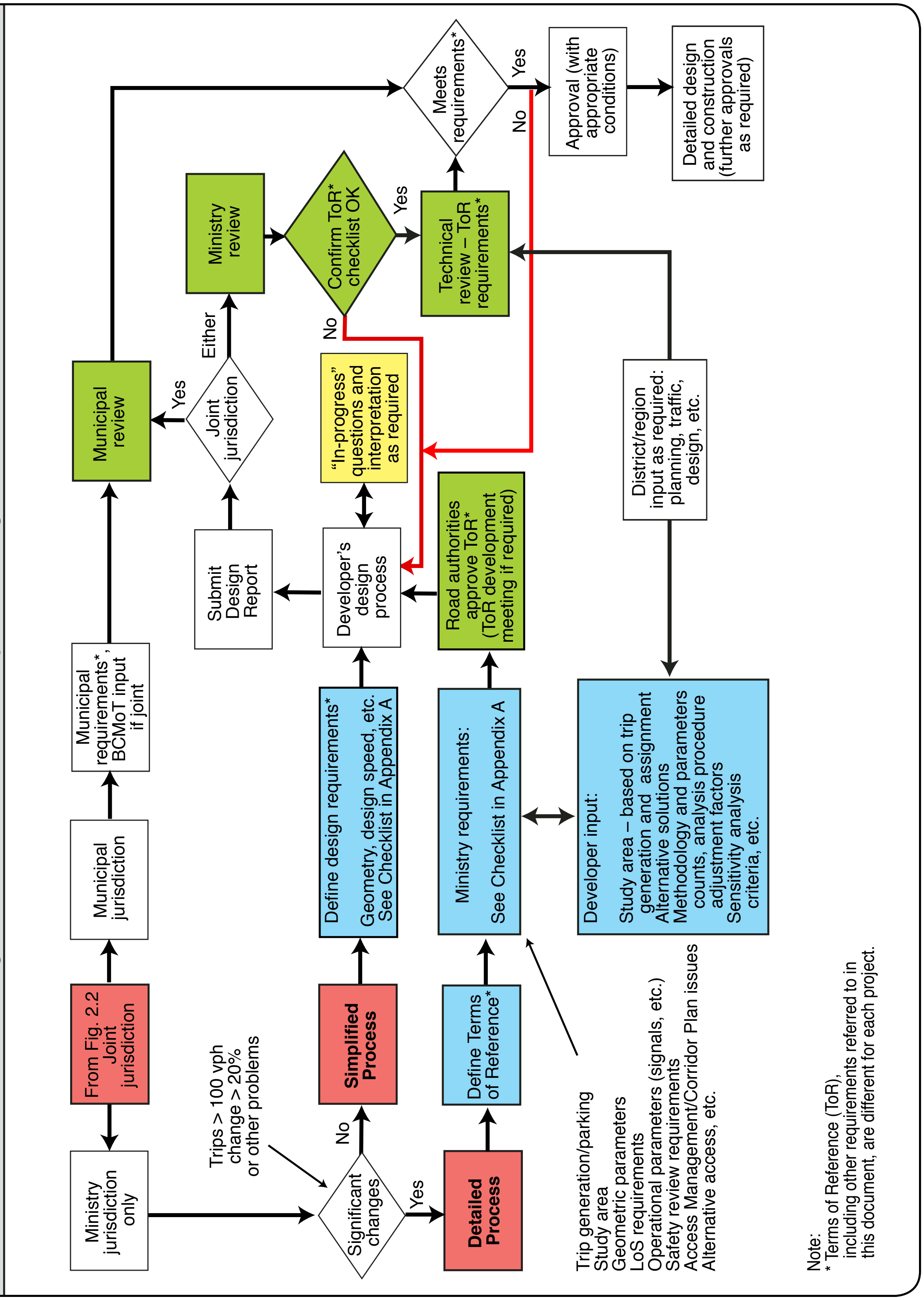
Higher class facilities are primary and secondary highways and major roads designed for intra- and inter-provincial, inter- and intra-regional traffic and high-volume urban traffic flows (see **Functional Classification, Sections 4.2.9 and 5.2.2**). They are more than two lanes wide in all but the smallest communities, with speed limits above 50 km/h except in urban core areas with limited or no direct access (or that have Access Management Plans that indicate that as the goal).

All numbered provincial highways are higher class facilities, as are all freeways and expressways. Urban and rural arterials (major roads) are also considered as higher class facilities. If it is unclear whether a detailed Transportation Design Report is required based on site-specific issues, the applicant must contact the road authorities for a review. These site-specific issues will be documented in the Terms of Reference for the design.

> Local governments may have their own guidelines regarding Transportation Design Reports and permits. Developers must contact the appropriate local government to determine their requirements. Local governments should refer any developers who may be affected by the requirements outlined in this manual to the Ministry's District Office where more information on ministry requirements is available.

The detailed design review process is shown in Figure 2.4.

Figure 2.4 – Detailed and Simplified Design Review Processes



2.2.3 Simplified Transportation Design Report

Where Ministry staff determine that a design report is required, the Ministry will allow a simplified Transportation Design Report to be submitted where the criteria for a detailed Transportation Design Report are not met. This is primarily an engineering Transportation Design Report that identifies an appropriate design for the access. Also, it does not require the traffic operations analysis required in a Detailed Report.

If the Ministry has determined that a detailed Transportation Design Report is not required as outlined in **Section 2.2.2,** then a simplified review process takes place. The simplified review process is outlined in Figure 2-4.

2.2.4 Access Permits

Municipalities do not generally use Access Permits. If an existing Ministry Access Permit is in place and the Transportation Design Report identifies a need to change the access to the site, then the developer must make the changes that are identified as a condition of the approval of the subdivision, rezoning or access permit.

An existing Access Permit lapses with a change of ownership or use. If only the ownership changes, a Transportation Design Report or review is not required. However, the new owner must still apply for an Access Permit to confirm the present access and land use.

Any new development must have an Access Permit issued by the Ministry that states the allowed access configuration and land uses for the site. Any change in the site that goes beyond that described in the permit, invalidates the permit requiring the owner to apply for a new permit for the changed conditions.

2.2.5 Comply with Guidelines

The Ministry requires that the designs of all development accesses comply with the current TAC *Design Guide* as modified by the *BC Supplement* to those guidelines and any ambient design guidelines adopted for the adjacent sections of highway by the Ministry.

Designs for municipal or other jurisdiction roads must comply with the requirements of those road authorities. They must also comply with legislated requirements in the *Motor Vehicle Act and Regulations* (*MVAR*) as noted in the following list.

In addition, all designs must comply with details and/or procedures laid out in other ministry documents and equivalent municipal documents, including:

- *Manual of Standard Traffic Signs & Pavement Markings* (*MVA* requirements)
- *Electrical and Traffic Engineering Manual* (includes *MVA* requirements)
- *Standard Specifications for Highway Construction*

The Ministry also specifies certain analysis procedures that must be used for intersections and interchanges (see **Section 4**).

All road authorities require compliance with all applicable standards and guidelines established for road design and construction in their respective jurisdictions.

> The designer must review the proposed design to ensure that it complies with currently accepted "good practices" appropriate to the functional classification of the roadways.
>
> Specific attention must be given to the safety of the travelling public. It is important to provide the most appropriate access to the proposed development with regard also being given to the effective operation of the public road system.

"Good practice" in the context of this manual means the results of the design comply with the requirements in such a way that an independent expert reviewer could see that not only are the minimum requirements met, but that the design, taken as a whole with the surrounding road system, results in a safe, operationally efficient and cost effective system that addresses public interest considerations.

2.2.6 Recognize Other Studies

It is very important to consider all other studies and plans that may impact current and future traffic flows in the study area when undertaking a project design. Where available, items and information that must be obtained include the following (see also **Section 4.2.9**):

a. Municipal Major Road Network Plans, Regional System Plans and Corridor Plans, Access Management Plans

b. Ministry planning studies for potentially upgrading existing, or constructing, new Arterial Highways or other highway facilities outside of municipalities

c. Studies outlining proposed future accesses to adjacent lands

d. Official Community and Local Area Plans

e. Municipal or regional district road and planning studies including those that deal with: traffic operations, parking, new roads, network planning, transportation demand management (TDM), bike and pedestrian network plans, local area plans, traffic management plans and transit and inter-city bus plans

f. Road and highway improvements including signalization, as provided for in the Ministry's current program and the municipality's capital works program

2.2.7 Recognize Transportation System Changes

The transportation network must be examined both with and without potential improvements when undertaking a project design since an improvement such as an alternate route may change traffic volumes or patterns on the existing road network. It is important to be able to identify what improvements may be required, both with and without the proposed network improvements in place, so that the impact of the system improvements on the design recommendations can be determined. Sometimes, these proposed improvements are long term with no current funding or definitive time frame for implementation.

!

The use of transportation system changes in the study must be outlined and justified in the Terms of Reference. The transportation system changes will be identified in the Terms of Reference and must be confirmed by the road authorities before becoming part of the approved Terms of Reference.

Unless the approved Terms of Reference indicate that network improvements and major highway upgrading projects are currently funded and can be used, the Transportation Design Report must not assume any reduction to the background traffic volumes that would result from planned future projects.

2.2.8 Transportation Design Terms of Reference

This section describes the different levels of detail required in the Terms of Reference for detailed and simplified Transportation Design Reports.

!

Development of the Terms of Reference is done jointly by the road authority (or road authorities) and the developer because neither party has a full knowledge and understanding of the project. The road authorities define basic criteria and methodology and the developer's consultants supply the details to provide a complete document for approval by the road authorities.

It is the responsibility of the developer and their traffic engineering consultant to ensure that the Terms of Reference are developed before starting the overall site design in order to ensure that there is a coordinated approach to determining the requirements for a detailed Transportation Design Report.

Detailed Transportation Design Report

A copy of **Appendix A** must be provided to the developer when the need for the Transportation Design Report has been established as described in **Section 2.2.2**. Each reviewing agency's staff must identify any special conditions that must be addressed in the Transportation Design Report.

The developer and their traffic engineering consultant will then prepare a proposed Terms of Reference statement for the project. It is to be based on, and include, the road authorities' requirements and the background information they have provided. The form in **Appendix A** is to be used for this purpose.

The proposed Terms of Reference must be tailored to the specific issues, existing information, constraints and alternatives of the site and must identify any special techniques and/or variances from the requirements outlined in this manual. It must also outline any existing sources of information and/or analyses for the site or study area that could be used in the study.

Without proper coordination, the local government and the Ministry could issue separate instructions on the requirements for the Transportation Design Report, potentially leading to two different sets of guidelines or analysis criteria. The Terms of Reference must be developed and approved by all agencies before commencement of the site design.

The proposed Terms of Reference must consider all the elements outlined in this manual as listed in **Appendix A** including:

a. The functional classification of the adjacent and other impacted roads

b. A clear definition of the required study area

c. Any Access Management or Corridor Plans, Official Community Plans (OCPs), Local Area Plans (LAPs), Major Road Network Plans (MRNP), committed or planned projects, potential network changes, etc., that the Ministry and/or the local government are considering and that the Transportation Design Report must include in the evaluation

d. Any known problem intersections, safety issues or other conditions that must be addressed

e. Any specific access restrictions, laning requirements, analysis criteria and level-of-service requirements

f. Any site-specific issues, conditions, operational criteria and corridor objectives that will affect/limit the range of possible solutions that may be considered in the study

g. A reasonable range of options for access location and design including no direct access to any numbered highway, other Controlled Access facility or major municipal road (if requested by the municipality)

h. Any specific tools (e.g., regional or area transportation models) or methods to be used

i. All pertinent background data ("as-built" drawings, current surveys, traffic data, etc.)

j. Whether any variance in required parameters, analysis, or design guidelines and standards may be considered for the site

If information becomes available during the design process that impacts the already-approved Terms of Reference, the developer must contact the Ministry and other reviewing agencies in order to determine whether a revision to the Terms of Reference is warranted. Terms of Reference revisions must be approved by the road authorities in writing and must accompany the application and Transportation Design Report when submitted.

Terms of Reference Development Meeting

A Terms of Reference Development Meeting must be scheduled if it is required to resolve items to be included in the Terms of Reference for the project. This may not be required on simple projects, but would be required for complex or contentious projects unless the Ministry agrees that it is not required. This meeting must be held prior to commencing the design.

The purpose of this meeting is to bring together the developer, their traffic engineering consultant, local government staff, ministry staff (district and regional) and other reviewing agencies to review the proposed Terms of Reference and provide the required elements for the Transportation Design Report. Developers must be prepared to provide preliminary maps, plans and documents to illustrate the site, ownership, land use, traffic volumes, existing and proposed adjacent public roads, available access and proposed access alternatives.

A critical issue, especially for larger developments and those on highly developed corridors, is the relationship of the site and access points to other adjacent accesses and intersections.

The preliminary meetings, comments and recommendations to proceed in a particular manner that are documented in the agreed Terms of Reference, will guide the developer in the design and the road authorities in their review. However, an agreement to consider or review an issue will not bind the road authorities to approve the design if it does not meet the road authorities' stated requirements (e.g., levels of service, minimum geometric requirements, signal operation parameters, etc.).

It is intended that the developer and their traffic engineering consultant come away from the Terms of Reference Development Meeting with a clear and comprehensive understanding of what must be included in the study to address the needs of all reviewers.

A copy of the discussion items and requirements outlined in this Terms of Reference Development Meeting will be recorded in the meeting minutes.

The template in **Appendix A** will be updated to include all required items and will form the Terms of Reference statement along with any supporting narrative.

Simplified Review Terms of Reference

Where the simplified review process is applicable, a simplified Terms of Reference statement is required. The forms provided in **Appendix A** must be used for this purpose.

> A Transportation Design Report is still required in the simplified review process but will be shorter due to the reduced Terms of Reference of the project.

A Terms of Reference Development Meeting would not normally be required for these projects unless the Ministry indicates that a specific problem requires discussion.

> If information that impacts the already-approved study Terms of Reference becomes available during the design process, the developer must contact the Ministry and other reviewing agencies in order to determine whether a revision to the Terms of Reference is warranted. Terms of Reference revisions must be approved in writing by the road authorities and must accompany the application and Transportation Design Report when submitted.

2.2.9 Study Area

The extent of the area to be included in a Transportation Design Report depends on many factors including:

- Functional classification of the adjacent roads
- Location and size of the proposed development
- Existing conditions on the adjacent road network

Large, urban development proposals on major travel routes require more extensive areas of analysis than smaller sites on less heavily used roads. This is because larger developments often generate traffic volumes that have a regional, rather than local, impact.

The study area must be outlined in the proposed Terms of Reference. Elements that must be considered in determining the study area include:

- Functional classification of the adjacent roads
- The site's traffic generation and existing traffic conditions on adjacent roadways
- Other developments about to take place within the study area
- Anticipated changes to the road network
- Future traffic conditions

The extent of the impact resulting from site traffic is defined as the furthest point along each approach and all intersecting roadways where the change in volumes as defined in **Section 2.2.2** is exceeded, or where the change in volumes may, in the opinion of the road authority (or road authorities), exacerbate an existing operational or safety issue.

In any Transportation Design Report, the minimum study area must include all of the site's access points and the next adjacent street intersection on each approach road.

In some cases, the road authorities may determine that analysis of only key or major intersections within the study area is acceptable. Any request for a change to the extent of the study area must be requested and justified in the Terms of Reference prior to commencing the study. If the road authorities agree that the change to the study area is justified, it will be approved by the road authorities before becoming part of the approved design Terms of Reference.

Normally the study area would not exceed two kilometres from the site. However, there may be conditions where it may be desirable to extend the study area. These conditions include the following:

- There is an intersection outside the two kilometre radius where there are known design, capacity or safety problems that will be significantly impacted by the development.
- Adequate analysis of diverted or linked trips requires that a larger study area be considered.
- The proposal includes a large development that will have a major regional impact on the road network (e.g., a regional shopping centre, sports arena, large industrial park or a development with numerous "big-box" warehouses).
- There is an already congested or hazardous area that could experience a significant deterioration in safety and/or capacity with the addition of the development-generated traffic.

The Ministry or any other reviewing agency reserves the right to define the study area to ensure that it is appropriate for the location and the proposed development. Figure 2.5 illustrates a study area and the features that define it.

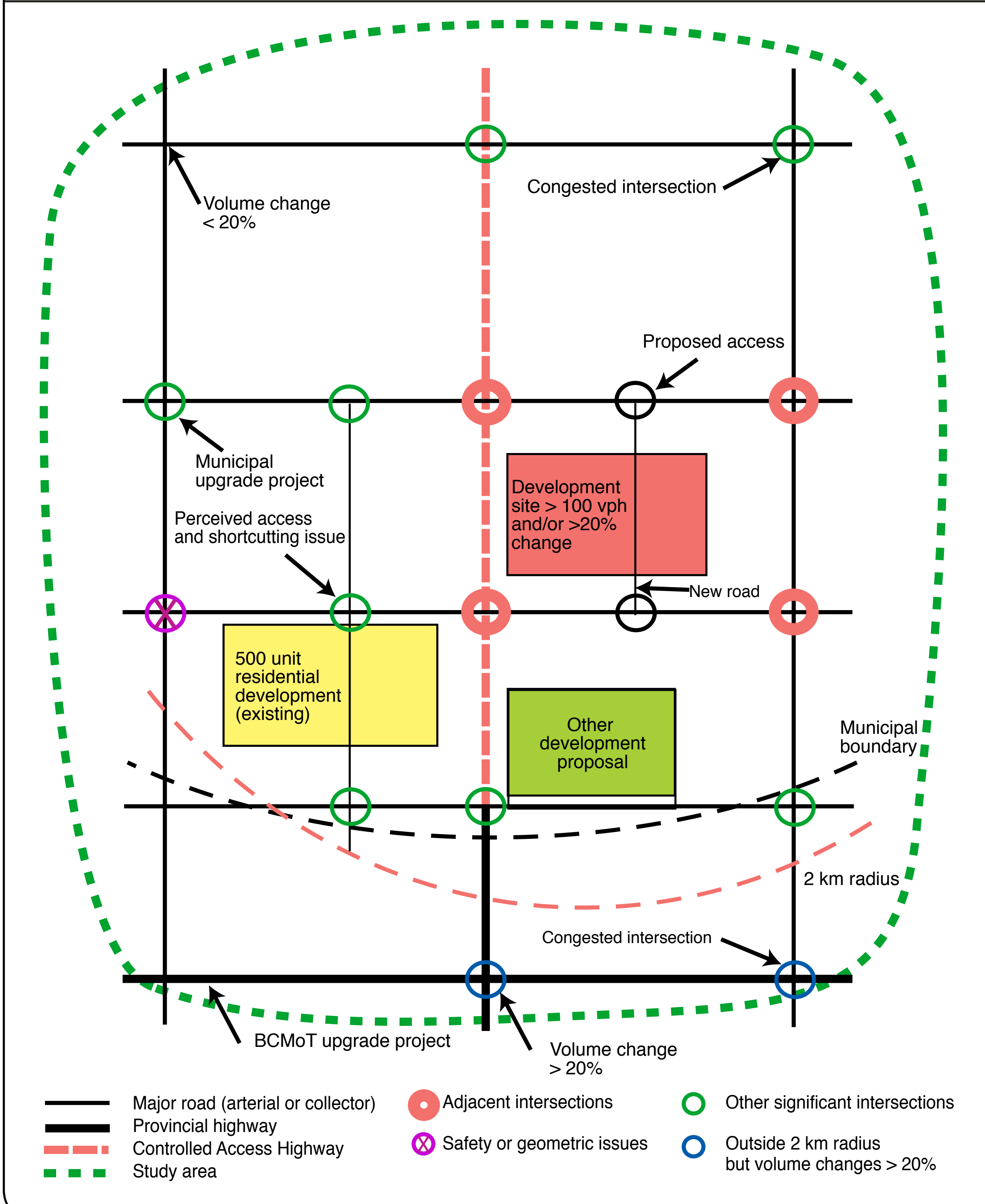
2.2.10 Design Completion

The design work required for submission of the Transportation Design Report must at least be to the functional design level (the horizontal and vertical geometric design for the phase preceding the development of the final detailed, design drawing). Functional design drawings are developed at a scale of 1:500 or 1:1000, using detailed field survey information, or accurate and field-verified orthophoto mapping. (See *BC Supplement*, section 103.6 on the **ministry website**.)

When approving the report, the road authorities may indicate that design modifications are necessary. At this point, the developer can complete the final design including items not covered in the Transportation Design Report such as:

- Utility relocations
- Drainage
- Pavement design
- Landscape design
- Permits related to non-roadway issues (environmental, etc.) as required
- Construction drawings, including signage and pavement marking and electrical (if traffic signals or lighting are required)
- Signal timing plans and checklists if signal modifications or new signals are required

Figure 2.5 – Study Area



2.3 Procedures

2.3.1 Qualified Persons

All Transportation Design Reports requiring traffic and/or safety analysis must be undertaken by, or under the direction of, a Professional Engineer (or Limited Licensee), qualified in the field of traffic/transportation engineering and registered in the province of British Columbia.

Reports submitted under the simplified review process, where only civil engineering design is required, may be completed by qualified Civil Engineers with experience in the design of roadways to ministry standards.

Some small projects may be appropriately designed up to the level required for BC MoT review by a suitably qualified Architect, if previously approved by BC MoT. However, all engineering work must be carried out by a Professional Engineer registered in BC. The signing matrix on the following page identifies when this may be appropriate.

A qualified person meets at least one of the following criteria:

1. Is the listed professional employed by a firm on the Ministry's qualified list under the Registration, Identification, Selection and Performance Evaluation program (RISP) for traffic engineering (Category 25), and/or highway design (Category 05) as appropriate to the project.
2. Is certified as a Professional Traffic Operations Engineer (PTOE) with acceptable experience in transportation planning, traffic operations and functional design.
3. Has experience appropriate to the project that is acceptable to the Ministry.

The Ministry prefers the first criterion as it is expected that errors will be avoided or minimized and delays in processing applications will be less likely to occur.

The Ministry will, on request, provide a list of organizations qualified under RISP. A list of certified PTOEs is available from the Transportation Professional Certification Board. (See **Appendix C – References**).

This qualified person must be identified as the primary contact for the reviewing agencies and must sign and seal all reports and Quality Assurance documents (see **Appendix B – Quality Assurance**).

Matrix of Typical Requirements for Reports

Appendix B (Quality Assurance) describes the roles of professionals which may be involed in projects, and how BC MoT's CPE/EOR requirements apply. Table 2.2 below shows typical situations along with typical reporting requirements. The notes reference quality assurance issues.

Table 2.2 – Matrix of Typical Requirements for Reports

	Single lot residential	Multiple lot residential	Small non-residential development	Large non-residential development
No public roads (single driveway only, no turn lanes required)	See Note 2	N/A[1] (public roads)	See Note 3	N/A[1]
Strata roads only[4]	N/A[1]	Small (single driveway): See Note 2 Large: Full report, P.Eng	Simplified report, P. Eng	Full report, P. Eng
Minor work on public roads[5], simplified design process	See Note 6	Simplified report, P. Eng	Simplified report, P. Eng	N/A[1]
Significant public road construction and/or full design process[7]	N/A[1]	Full report, P. Eng	Full report, P. Eng	Full report, P. Eng

Notes:

[1] N/A – not applicable, mutually exclusive criteria

[2] Driveway design must follow designated BC MoT design and construction standards.

[3] Requires knowledge of this manual and good design practice. An Architect with acceptable training and experience may be able to assure quality for a simple project (if approved by BC MoT). More complex projects require a P. Eng for layout. A P. Eng must produce final design drawings for work on the public right-of-way.

[4] Strata roads are the responsibility of the strata corporation; the driveway must conform to BC MoT standard designs. BC MoT may require on-site roadway design to BC MoT standards if there is potential to become public roads in the future. An Architect with acceptable training and experience may be able to assure quality for a simple project (if approved by BC MoT). More complex projects require P. Eng for layout. A P. Eng must produce final design drawings for work on the public right-of-way.

[5] "Minor work" includes a single access requiring a LT lane and/or acceleration/deceleration lanes on tangent with adequate sight distance and use of BC MoT standard drawings only, if approved by BC MoT. A P. Eng must produce final design drawings for work on the public right-of-way.

[6] As in Note 4, but any safety issues or sight distance problems must be addressed by P. Eng.

[7] If more than one driveway, or road widening other than for LT or acceleration/deceleration lanes, then traffic analysis required.

An Architect can sign the Quality Assurance that the requirements of this manual and the design guide have been followed only if:

1. No traffic analysis is required.
2. No significant construction on public roads is required.
3. The appropriate standard layout has been identified in the Terms of Reference.
4. The Architect has training and experience acceptable to the Ministry that enables the architect to apply the appropriate layouts and design guidelines both on and off the site.
5. BC MoT has indicated in the terms of reference that signature by the specified Architect is acceptable for the project.
6. A P. Eng must prepare construction drawings for work on the public right-of-way.

2.3.2 Transportation Design Report Review Process

The review process is similar for both the simplified and detailed report requirements. The differences are in the extent of the design/analysis required, the number of issues and their complexity, and the relative balance between analysis and design issues.

It is important to the developer that a single set of requirements/comments come from the Ministry's district and regional staff members. The primary point of contact for the applicant is the District Office unless otherwise indicated to the developer. Although the application review process takes place at the District Office, regional planning/traffic engineers may also review the project. This ensures that communication to the developer only takes place after both district and regional staff members have had a chance to review the material and their responses have been coordinated.

Terms of Reference

The road authorities' requirements are provided using the forms in **Appendix A**. The Terms of Reference document explaining the requirements, including the **Appendix A** forms, are to be completed by the developer or their traffic engineering consultant and included as an integral part of the Transportation Design Report with appropriate page references provided in the form.

The Terms of Reference are to be submitted to the District Office electronically as PDF files. The developer must also forward a copy of the Terms of Reference to the appropriate local government and any other reviewing agencies in order to ensure that all parties have had the opportunity to review the document.

The District Office may forward the Terms of Reference to the regional planning and/or traffic engineer. After the Ministry's district and regional staff members have reviewed the Terms of Reference, the district staff may schedule a Terms of Reference Development Meeting. The Terms of Reference will be finalized through discussion of the Ministry's and other reviewing agencies' comments or revisions at the Terms of Reference Development Meeting.

When the Terms of Reference have been approved and returned, the developer has the information necessary to begin the transportation design process. This document will then become the approved Terms of Reference for the Transportation Design Report for the project.

General Transportation Design Report Contents

The Transportation Design Report must document the purpose, procedures, assumptions, findings, conclusions and recommendations. It is important to consider the four most common uses for these reports when preparing the Transportation Design Report. They are:

- To provide the developer and design team members with recommendations on site selection, access location and any mitigation necessary to meet the road authorities' operational and design requirements.
- To clearly and completely document the design process and design decisions including the selection of criteria using the "Design Domain" concept as outlined in the TAC *Design Guide* (see **Section 5** for details).
- To assist public agencies in reviewing the attributes of the proposed development in conjunction with any request for annexation, land subdivision, zoning changes, building permits, access or other development reviews and to establish mitigation requirements where off-site impacts require improvements.
- To assist some public agencies in determining development cost charges or to assess developer contributions to roadway facility improvements.

The analysis must be presented in a straightforward and logical sequence. **Appendix A** of this manual provides a template that will assist in producing an acceptable report. This section outlines the criteria used to determine whether the report is complete.

> A reasonable range of feasible options for providing access, as outlined in the approved Terms of Reference, must be evaluated. The study must lead the reviewer through the various stages of the analysis and to the resulting conclusions and recommendations. Sufficient detail must be included so that the staff members of the Ministry and any other reviewing agencies will be able to follow the logic and methodology of the analysis.

If the assumptions made in the analysis are based on published sources, then those sources must be referenced. If other, less readily available sources are used, a more detailed explanation and prior approval is necessary and their use must be approved in the Terms of Reference document.

Sections that are listed, but not checked as required in the forms in **Appendix A** do not need to be included in the report. The approved Terms of Reference provide direction as to what is to be included and what may be omitted from the report. This may be amended throughout the duration of the study development and review process if justification is submitted and agreement is provided in writing from the Ministry and other reviewing agencies (see **Section 2.2.8**).

The transportation design for the project must comply with the following requirements:

a. The physical inspection of the site and observation of traffic operations, roadway conditions, etc., must be documented.

b. All assumptions, data and calculations used to arrive at the conclusions presented in the report must be documented (this includes provision of electronic copies of all analysis files with a clear index and references to files in all summary tables).

c. The report must address all requirements specified in the approved Terms of Reference, this manual and all applicable standards documents.

d. The report must include clear and concise documentation of the methodologies, findings and recommendations.

e. The report must include the name, address, e-mail address, and telephone number of the report's author.

f. Quality Assurance documents must be provided to indicate that it has been prepared with due diligence and regard for quality using the template provided in **Appendix B**. The forms must bear the professional stamp, and if applicable, PTOE certificate number, and signature of the Engineer responsible for the report.

Report Drawings

The developer must provide AutoCAD drawings (or PDF files created from AutoCAD drawings) that show, as a minimum requirement, the following details:

a. Full geometric details to functional design standards of both sides of all adjacent roadways (full frontage distance), driveways to the subject and all adjacent developments, and any other intersections that require improvements including:

- basic geometric data such as curve radius (centre line, and curbs or edge of lane in intersections), grades, including profile flattening at intersections
- centre line and all lane lines
- back of shoulder or curb line
- sidewalks, bike lanes, etc.
- stop and crosswalk lines, islands, painted medians, etc.
- location of all required traffic control signs (regulatory, warning, direction and information signs using standard graphic symbols)
- location of all signal heads and poles including illustration of lens functions (e.g., left turn lenses, etc., must be identified)
- street lighting pole locations, if required
- proposed landscaping areas that fall within sightlines, including required corner clearance area
- confirmation that the design vehicle(s) can negotiate all relevant movements within their assigned lanes on all public roads and the immediate driveway areas (turning templates must be shown where critical)
- where improvements are proposed to intersections, the relevant drawings must show all the above details within the intersection functional area of the intersection

b. Full on-site details including:

- aisle and parking stall layout including typical and any non-standard dimensions, summary of the parking stall count by stall size if more than one size is used
- all pavement markings and islands as noted above
- truck loading areas (dimensioned) and turning templates showing that access and egress from/to the public road system is feasible
- pedestrian and bicycle facilities including sidewalks, crosswalks at building entrances showing adequate sightlines, queuing and circulation space, safe routes into and through parking areas and to/from the public road system
- transit facilities, if required, including turning templates showing access routes

- landscaping plans showing that required sightlines are not obstructed by landscaping
- location and type of any traffic calming measures proposed on major circulation roadways within 150 m of the queuing area (inbound and outbound, whichever is the larger) of any access point

c. Other information as appropriate including:

- location of all adjacent driveways even if not within the project site frontage, including key geometric details and turn restrictions (if any) if:
  - the driveway is within the intersection functional area
  - traffic volumes to/from the adjacent driveway impact traffic operations at any site driveway or intersection that is proposed for upgrading
- when there are concurrent, adjacent development proposals, the drawings must clearly show their relationship to the subject site and show that the required improvements for all developments do not conflict
- if relevant to the design, drainage details (not normally required unless there are significant problems that are to be resolved)

All drawings must be legible when printed at half size (or 11 inches by 17 inches) in black/white and in colour without the use of plotter set-up files (this means that any colours, and their grey scale equivalents, must be legible on white paper).

All drawings must be dimensioned in metric units and shown at a rational metric scale (1:250, 1:500, 1:1000, etc). AutoCAD files must be based on the Ministry's survey system and use metric units of measure (metres).

Drawings for construction on any roads under ministry jurisdiction must comply with ministry drawing standards (see ministry website for the **BC Supplement** under tab 12 and ministry website for **AutoCad Standards**). Illustrations and concept drawings submitted for the purposes of review only, must be reasonably compatible with BC MoT standards to expedite review.

Transportation Design Report Recommendations

Transportation improvements related to providing the required level of site access, and mitigation of the adverse effects of the development-related traffic on the transportation network, must be described.

Recommendations must be made for any required off-site roadway improvements such as additional through-lanes, auxiliary lanes and traffic control devices necessitated as a result of the development. Required improvements to the internal roadway system and facilities for transit, pedestrians and cyclists must be developed and presented.

If required improvements to the surrounding road system are identified during the analysis, the recommendations must specify:

- The time period within which the improvements must be made (by opening day or later, if appropriate)
- Links between the improvements and the various phases of the development construction
- Links between the improvements and the assumed values of the trip generation and parking rates attributed to the site (sensitivity analysis)
- The estimated cost of the improvements if the road authority is expected to pay any part of them
- Any monitoring of operating conditions and improvements that may be required

In-Progress Review

The transportation designer is encouraged to request review of any critical items that arise during the course of the design so that the appropriate action may be agreed (in writing) with the Ministry and other agencies.

Transportation Design Report Review

The Transportation Design Report is to be submitted electronically, as PDF files, to the applicable District Office, along with any required application forms. Copies must also be submitted to the local government and other reviewing agencies when the study recommendations may have an impact on municipal roads or planned improvements of other agencies. The study will be given an initial review by the district staff to determine whether it is complete. All submitted materials become the property of the Ministry.

The report must:

a. Contain the Quality Assurance (see **Section 2.3.1**) referred to under "General Transportation Design Report Contents" (see **Section 3.2.3 and Appendix A**)

b. Include the Terms of Reference template with page numbers indicated for all applicable sections

c. Include all required calculations (as electronic files if software is used)

d. Provide cross references to the source data (files) for all summary tables

The Transportation Design Report will be accepted for ministry review when it has been determined that it conforms to:

- The approved Terms of Reference
- All applicable policies and procedures outlined in this manual
- Any other correspondence or revisions approved or issued by the Ministry in writing

Failure to provide this information with the report will result in the return of the report, and any accompanying application, without detailed ministry review. It is the developer's responsibility to ensure that all required information is provided.

If, initially, the report is determined to be complete by the District Office, then a detailed review will take place according to Figure 2.4. The District Office may forward a copy of the study to the regional traffic and planning engineers for review. Their comments are returned to the District Office (Development Approvals staff).

If the Transportation Design Report has addressed all the technical requirements of the Terms of Reference and recommended proposed mitigation to the satisfaction of the Ministry, the proposed design will be approved. If the Report is technically deficient, or the proposed mitigation does not meet ministry requirements, then the Ministry will indicate what changes are required to address these deficiencies and return the report without approval.

In the case of minor design detail deficiencies, the Ministry may give "subject to" approval. In this case the approval of the final design is contingent on rectification of these deficiencies.

If there is joint jurisdiction with another agency, the Ministry will not approve a proposal without the agreement of the other agency.

All submitted materials become the property of the Ministry.

2.3.3 Permits, Inspection and Final Acceptance

After approval of the Transportation Design Report (which is to the functional design level), the developer prepares the final design drawings for work on the public roads and their approaches to the site and submits them to the road authorities for approval to construct.

> It is the developer's responsibility to ensure that the following construction inspection process is followed once the final design is complete and has been approved by the Ministry. This process must be followed to ensure that any construction on ministry right-of-way is completed according to ministry standards and specifications.
>
> 1. Where approved road improvements or driveway construction are required on a public road right-of-way, the Ministry issues a permit to construct on the highway right-of-way.
> 2. The applicant may be required to provide a letter of credit, bond or security deposit to the Ministry's District Office or the local government.
> 3. The developer must arrange for construction inspection services to the satisfaction of the District Office prior to commencement of work, to be provided both during and at completion of the construction.
> 4. When the work is compete, a final inspection is required either by ministry staff, local government staff where applicable, and other reviewing agencies. This may also be delegated by the Ministry to an approved engineer. In all cases an engineer's Quality Assurance is required.
> 5. When the final inspection is approved, a letter of acceptance will be issued and the security deposit, where provided, will be returned.

Ministry requirements for permits, construction and inspection are available on the Ministry's **Permits and Approvals** website.

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3

Parking and Trip Generation Rates

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Other Sections

Appendices

3.1 Background

The amount of new traffic entering a highway from an adjacent development must be determined, and the access and layout configuration of the development designed, to manage and maintain the integrity of existing and future highway facilities. Two key aspects that need to be considered when determining the adequacy of the access and layout of a development are:

- The amount of parking required for the various uses proposed for the site
- The number of trips expected to be generated by the various uses proposed for the site

This section discusses several factors and issues associated with parking and trip generation. It emphasizes the land uses affected by each factor, how these factors influence parking and trip generation rates and the issues that need to be considered when planning and designing development projects and reviewing Transportation Design Reports. According to the research, in general, the quantitative impact of individual factors on parking and trip generation rates cannot be reliably predicted. However, the road authorities may wish to encourage demand-side trip reduction and may consider variances where they are supported by technical justification and documentation.

> Where a variance is permitted, the road or parking system must be analyzed and reported both with and without the variance, and the difference in mitigation discussed (see **Section 3.1.4**).

3.1.1 BC vs. ITE Rates

In the mid 1990s the Ministry reviewed the available parking and trip generation data and produced the *Parking and Trip Generation Rate Manual* (1996, BC MoT). It was based on ITE data with the addition of some data collected in BC. The review also examined 85th percentile values and 50th percentile (average) rates. The use of 85th percentile data was not pursued for the review of development proposals.

The purpose of collecting specific BC data was to determine if there was a real difference between BC data and that collected elsewhere in North America (i.e., the ITE data). Data collected by other organisations (e.g., Urban Land Institute) indicated that for the categories studied, there was little or no statistical evidence of differences between geographic areas. In general, the *Parking and Trip Generation Rate Manual* showed “a few” BC data points vs. “tens to hundreds” of ITE data points for categories where a comparison was made. While there was some variation between BC and ITE data, the BC sample sizes were very small and the results were generally well within the range expected of a sub-sample (see **Appendix D.2**). Table 3.1 illustrates one land use case.

Table 3.1 – ITE (2001)/BC (1996) Trip Generation Rate Comparison				
Source, Type, Units and Time Period	**No. of Points**	**Average**	**Range**	**R^2**
BC, SFD, per DU, 7-9 a.m.	9	0.99	0.59 – 1.85	"Low"
ITE – 210, SFD, per DU, 7-9 a.m.	274	0.75	0.33 – 2.27	0.89
BC, SFD, per DU, 4-6 p.m.	9	1.20	0.35 – 2.02	"Low"
ITE – 210, SFD, per DU, 4-6 p.m.	302	1.01	0.42 – 3.98	0.91

SFD = single family dwelling; DU = dwelling unit

ITE has published three handbooks relevant to the topics covered in this section (current edition must be used):

- *Trip Generation Handbook* (2004, ITE, 2nd edition)
- *Trip Generation* (2008, ITE, 8th edition, 3 volumes)
- *Parking Generation Handbook* (2004 , ITE, 3rd edition)

The *Trip Generation Handbook* gives specific guidance for the identification of valid local variation between ITE and local data. However, a review of the BC data indicates that it generally falls within the acceptable range of ITE data. Therefore, there really is no validity in using separate data for BC.

To date, statistically valid data samples have not been collected in BC to establish that there is a true difference between ITE and BC-only data. At this time there is no coordinated effort to do so. In addition, there are a number of factors that influence both trip generation and parking demand rates that are not adequately measured by the simple "per dwelling unit" or "per m^2" Gross Leasable Area (GLA) measures commonly used.

Some key factors include:

- Transit availability/use
- Urban area (or catchment area) size
- Specific business factors (e.g., competitiveness, market share, etc.)
- Transportation demand management (TDM) measures

The Ministry has elected to use ITE data only, for both trip generation and parking requirements. The ITE handbooks provide detailed explanations of the data, cautions in its use and a methodology for collecting additional data. These procedures must be followed for all designs carried out for developments accessing highways under ministry jurisdiction.

Section 3.2 provides some discussion of key issues appropriate for this work in BC. Other road authorities may have different expectations regarding generation rates.

3.1.2 Average vs. Bylaw vs. Reality

ITE regression equation rates representing average sites are used if they are available, otherwise the average rate for that category is used. However, there is no guarantee that any one site will actually produce average rates.

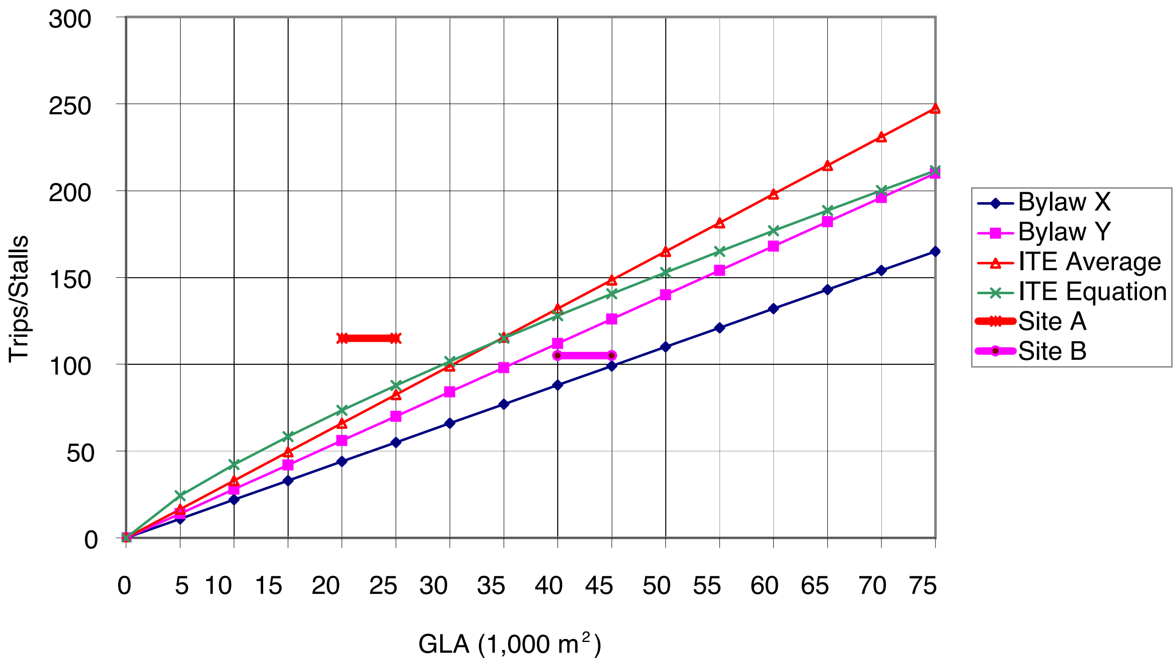
Municipal bylaw rates are often quoted or regarded as minimum rates, with the expectation that they are all that the development needs to provide. Unfortunately, many municipal rates are poorly documented, do not contain statistically valid data and often no rationale is provided to support their use.

In reality, there is significant variation in individual site rates (see Table 3.1), with ranges typically one-half to two times the average rates.

It is the developer's responsibility to identify and justify a realistic rate for design purposes. It must address the future needs of owners and tenants on the site as well as the road authorities' needs in maintaining capacity and safety on the road system. This topic is discussed further in Section 3.2.

Figure 3.1 illustrates some hypothetical situations comparing bylaw rates with ITE rates (both average for the use and the regression equation), and two actual sites. It is intended to illustrate the differences discussed here. Both bylaw rates lie below the ITE average/regression 50th percentile rates, while Sites A and B straddle the 50th percentile rates (as would be expected).

Fig 3.1 – Trip/Parking Rate Comparison



3.1.3 Impact of Errors

Three primary groups are impacted by gross errors in assessing the appropriate value for parking or trip generation rates:

- **Owners or tenants** through loss of business if the site is under-designed or through added infrastructure cost if the development is over-designed
- **Customers** who experience difficulty in accessing the site if it is under-designed
- **The road authority** that is faced with upgrading a public facility at public expense in order to fix the deficit created by the developer if it is under-designed

In traffic operations terms, the impact is most noticeable if the site is grossly under-designed resulting in problems such as:

- Overflow of parking onto community streets
- Blockage of access due to circulating traffic looking for parking, causing queuing on the adjacent streets
- Overloading of adjacent intersections caused by failure to provide adequate lanes to accommodate traffic demand

All these conditions negatively impact the attractiveness of the development to customers, potentially reducing income from the project.

3.1.4 Sensitivity Analysis and Contingency Plans

The road authorities may require that a sensitivity analysis be used to identify the impact of changing rates in order to address the inherent uncertainty of projecting parking and trip generation rates that are appropriate to the site (see **Section 3.3.3**).

Road authorities may also require that a contingency plan be identified if the analysis shows that the higher rate causes significant operational problems. The contingency plan must show the required additional works, on or off the site, that are required to meet the objectives of the Terms of Reference (this is generally the specified minimum levels of service).

Keyword

A **sensitivity analysis** is an analysis comparing the changed results if different assumptions are made (see **Section 3.2.10**).

3.1.5 Post-Approval Changes

Where a proposed zoning category allows uses that have traffic characteristics that may result in more significant impacts than those identified for the proposed uses, the road authorities may either:

- Require that this situation be specifically analyzed as a design case or included in the sensitivity analysis;

  or

- Require a covenant, or specify conditions in a BC MoT Access Permit or other legal means of restricting the uses to those which have been analyzed and for which the required improvements have been made.

3.2 Technical Issues

This section discusses many of the concerns that have been identified in proposed designs, their documentation and reports that have been submitted to road authorities in the past. In many cases, it is the documentation, rather than the technical work, that has been less than adequate. However, the technical issues are reviewed here to clarify for developers what is required and why.

Some of these issues are discussed more fully in ITE's *Parking Generation Handbook* and *Trip Generation Handbook* and the Urban Land Institute's publication *Shared Parking*.

Section 3.2.1 reviews general information and parameters for parking and trip generation rates. **Sections 3.2.2 to 3.2.9** discuss specific issues that may modify the appropriate rates for a site from the average rate, or modify how the site and other traffic interact.

The designer must justify and fully document any proposed adjustment (variance) from the average rates, and obtain the road authorities' agreement to use adjusted rates. To avoid possible redesign, it is strongly recommended that this be done prior to site design and submission of a Transportation Design Report.

> Guidance on the use of the ITE trip and parking generation rates is provided in the ITE handbooks. The designer must be familiar with the correct usage of these materials, their limitations and the circumstances where the use of these rates may not be appropriate.

3.2.1 Principles of Parking and Trip Generation

This section refers to the most recent versions of the ITE *Trip Generation Handbook*, *Trip Generation*, and the *Parking Generation Handbook* collectively as the "ITE handbooks."

The technical background material to this section is in **Appendix D.3**. The material here covers key definitions only.

Keyword

A **parking** or **trip generation rate** is a value per unit measure that specifies the average requirement for each land use that needs to be considered in designing a development. The parking generation rate specifies the parking demand (number of stalls) and the trip generation rate specifies the volume of traffic that must be considered in the design.

> These rates are specific to each land use category and specified time period. The designer must identify the appropriate rates and adjustments required for use in the design hour.

The choice of trip generation and parking rates used must reflect the conditions of the site as well as those of the sites where the data was collected. For example the rates for an "urban style" (e.g. condominium) development in a rural area must reflect the lack of any alternative to the car for transportation and use an appropriate rate such as one similar to an urban single-family dwelling (SFD) residential category.

Keyword

The **design hour (for volumes)** is the time period corresponding to the set of concurrent one-hour volumes that represent the worst combination of turning and through-traffic at an intersection. There may be a different hour for different combinations of turning movements (see **Section 4**).

Keyword

The **design hour (for parking)** is the hour during which there is the greatest accumulation for parking on the site. This is not necessarily concurrent with any of the design hours for volumes and typically it is not concurrent; it generally occurs before the peak hour for discharging traffic.

One hour means 60 concurrent minutes to the nearest five or 15-minute step. "Clock hour" cannot be used to define design hours.

Different rates, adjustments and time periods may apply to different uses on the site, different days of the week and times of the year.

All parking or trip generation values per unit measure that are used by the Ministry of Transportation and Infrastructure, municipalities, the Institute of Transportation Engineers or other agencies are referred to as rates.

Keyword

The term **rate** indicates a measurable value derived from empirical data which may be updated when new information is available.

Keyword

The term **standards** implies an unchanging and outright correct value and is not used in this manual.

Both the site traffic volumes for the peak hour of the site and the peak hour of the adjacent street must be reviewed with their concurrent street/site volumes to determine which is the most critical case for each turning movement.

For some land uses, the peak hour of the site and of the adjacent street will be the same time period. Other uses may have different peak characteristics (e.g., some land uses will have higher peaks on weekend days rather than weekdays).

The worst-case combinations must be analyzed for each intersection or turning movement. (This means that if a specific turning movement has a peak time that differs from the others, both cases must be evaluated to determine which will give the lowest level of service or longest queue, etc., when analyzed in detail.) See also **Appendix D.3** and **Section 4.2.11**.

The designer must evaluate the requirements for the design hour for the site and adjust the average rate accordingly. This must be addressed in the sensitivity analysis as discussed in **Section 3.2.10**.

Average vs. Real Rates

Trip generation and parking rates given in the ITE handbooks are derived from data collected at multiple sites for each land use type. These rates may be presented based on one or more independent variables. The derivation is either a regression equation or, if there is insufficient data, an average rate. The range in rates is also given.

The regression equation must be used when available, rather than the average rate, unless specific circumstances indicate that it is inappropriate (such as a small site where the equation does not pass through zero trips at zero use), and the change must be documented in the report.

There is no reasonable way to predict exactly what generation rate a particular site will have. The design process therefore has to rely on sensitivity analysis and the "design domain" approach (see **Section 5**) where the domain is the range of rates appropriate for the size of the development.

See additional material on this topic in **Appendix D.3**.

3.2.2 Elements of Parking and Trip Generation

The technical background material to this section is in **Appendix D.4**.

A number of factors other than the size of a development influence the choice of parking and trip generation rates appropriate for an individual development.

When a "first principles" analysis is required (i.e., there is no existing data for a proposed land use, or the data does not refer to the required design hour), analysis of the factors outlined in **Appendix D.4** is required to determine the appropriate rates.

3.2.3 Regional Characteristics

The technical background material to regional characteristics associated with parking and trip generation rates are discussed in **Appendix D.5**.

These include:

- Weather conditions
- Degree of urbanization
- Local economic conditions
- Local habits and lifestyles

3.2.4 Shared-Use Sites

This section refers to both trip generation and parking demand at sites that are not shopping centres but have multiple uses on the same or adjacent sites that share access driveways and/or parking spaces. They include many uses, but typically include some mix of retail, office and residential use.

Shared parking is a parking supply strategy that is dependent on parking demand that peaks at different times for various users. Shared parking itself does not affect parking or trip generation. Successful implementation of shared parking requires that parking accumulation patterns of the different user groups be defined.

Multi-destination users can also refer to drivers who park at one location and then visit more than one development in the vicinity of that location (this is not the same as multi-destination linked trips, see **Section 3.2.8**).

Multi-destination users and shared parking are similar; the primary difference is that shared parking implies a formal agreement amongst owners while multi-destination is more informal. In terms of rate adjustment, only one adjustment can be used.

Shared or multi-destination use occurs most frequently at mixed-use commercial developments (excluding shopping centres) where several development types (e.g., restaurants, retail outlets and recreational complexes) are clustered together within reasonable walking distance. (Shopping centre data explicitly includes this factor and no further adjustment is appropriate.) Research has shown that 200 metres (the length of two football fields) is about the maximum distance that customers are willing to walk between adjacent developments. Otherwise, they would prefer to move their cars closer to the second destination (and thus become linked trips). Surveyed parking and trip generation rates do not specifically identify multi-destination user trips.

The clustering of commercial developments tends to encourage multi-destination use and shared parking. In addition, the clustering of developments consisting of residential, commercial, employment and recreational components results in more independent communities, which may significantly reduce both parking and trip generation.

Keyword

When such communities are planned, they may be referred to as **planned unit developments** (PUDs). Developments that are part of PUDs need to be assessed in this context, and the parking and trip generation rates for single-use developments may need to be modified.

Surveys may have to be conducted to determine the extent to which PUDs reduce the generation rates of various land uses.

> Shared parking occurs where land uses with different characteristics occur on the same or adjacent sites and the parking area is common to all users (i.e., no parking is reserved for particular individuals or groups). This does not apply to shopping centres where the method of analysis records total parking/trip generation for the whole site.

Keyword

Shared access occurs either as a result of shared parking on a single site, or, as a result of access management strategies that require adjacent parcels to share one or more common access points.

The shared parking and access design must be conducted in accordance with guidelines in the following publications:

- *Shared Parking,* (2005, Urban Land Institute)
- *Shared Parking Planning Guidelines,* IR-086 (1995, ITE)
- *Trip Generation Handbook*, Chapter 7 (2004, ITE)

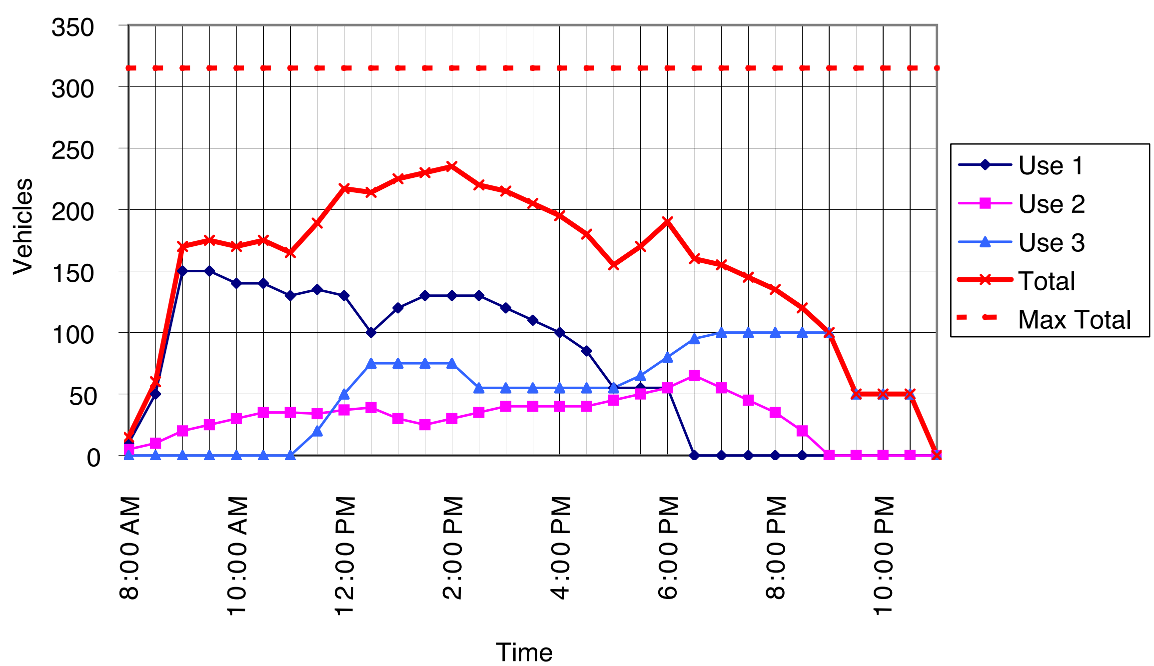
A particular land use may generate different patterns of vehicle arrivals and departures and consequently, different parking accumulation and trip generation patterns for the different user groups. In such cases, the analysis has to combine the demand/generation for each use and produce a composite profile.

Because the peak parking accumulation for each user group may occur at a different time, the overall peak parking accumulation is usually less than the sum of the individual peak parking accumulations.

Parking accumulation data may be obtained from site surveys and/or from the references noted above.

In Figure 3.2, Use 1 peaks at 150 stalls occupied, Use 2 peaks at 65 stalls occupied, and Use 3 peaks at 100 stalls occupied. This totals 315 stalls, but the maximum occupied at one time is 235, thus by allowing for shared use, 80 stalls are not required. (The same type of graph illustrates the effect of the associated trip generation rates.)

Figure 3.2 – Example of Shared Parking



These issues must be addressed when considering shared parking:

a. **All uses of the proposed development must be considered.** Peak usage times may occur at normal as well as other times. For example, churches may generate significant parking demand for weddings, funerals and meetings that are held during the week and on Saturdays in addition to the traditional service-related church uses on Sundays. Golf courses may generate significant parking demand during weeknight banquets held at the clubhouse in addition to the golf-related daytime weekend use of the facilities.

b. **Future changes among the developments sharing the parking may need to be monitored and controlled.** For example, a shared parking or access scheme that assumes a furniture store (primarily daytime use) and movie theatre (primarily evening use) may fail if a quality restaurant (noon and evening peaks) is developed instead of the furniture store.

Very explicit control mechanisms for the selected uses may need to be established and implemented. A control mechanism defines the type and size of each land use that may occupy the site in the future (thereby restricting the land use mix to combinations that will not generate parking or traffic volumes in excess of what is provided for), or restrict the use of assigned/reserved parking within the area.

Control mechanisms such as, specific zoning clearly defining the permitted uses as narrow categories, or Ministry Access Permits, are administered by the road authorities and the developer as part of the development and business permit process.

c. **Site access, on-site circulation and the integration of parking areas require particular attention** if shared parking is to be successfully implemented. Shared parking is feasible only when there is efficient circulation between the shared parking areas so that drivers can find vacant parking spaces. Drivers also need to feel comfortable that they are parking legally in a space that is available for the portion of the development that they are accessing.

d. **Reciprocal parking or access agreements may be required.** Where the parking to be shared is on separate parcels, a reciprocal access agreement that is registered on the title of all the properties is required. These are administered by the road authority.

Shared parking does not reduce the parking or trip generation rates for the individual uses. It modifies the number of parking stalls required but not the peaking characteristics of the individual traffic flows.

Where a developer wishes to incorporate an adjustment for shared parking in their development, the designer must carefully consider and document what objectives are reasonable, how the results will be monitored and what contingency plan is appropriate should the objectives not be met. The analysis must clearly demonstrate the recommended solution, both with and without the expected usage.

The analysis procedure and data must be approved by the road authorities before use in the analysis.

This analysis may include:

- Conducting multi-day parking surveys
- Analyzing parking demand peaks
- Developing a parking management plan

In a shared parking analysis, all uses of the development must be considered unless a specific use on the site is to have its own reserved parking. Any reserved parking spaces must be excluded from the analysis.

If shared parking analysis is undertaken to justify a reduced number of parking spaces, then the land use with the highest generation rate within the current zoning must be included in the analysis (highest and best use). The road authority (or road authorities) will require a legal agreement and/or restrictive covenant agreement in order to accept shared parking for the site.

3.2.5 Transportation Demand Management

Keyword

Transportation demand management (TDM) is a term used to describe measures designed to:

- Reduce the use of single-occupant vehicles
- Shift travel to non-peak times

TDM is usually directed at travel by employees. Its purpose is to reduce congestion and improve air quality by minimizing the total vehicle distance travelled in the transportation system. TDM attempts to maximize the utilization of existing transportation facilities and to delay capital expenditures on new facilities. A detailed examination of TDM is outside the scope of this manual, but various aspects are briefly discussed here to highlight its potential impact on parking and trip generation rates.

Where a developer wishes to incorporate an actively managed and permanent TDM program in their development, the designer must carefully consider and document what objectives are reasonable, how the results will be monitored and what contingency plan is appropriate should the objectives not be met. The analysis must clearly demonstrate the recommended solution both with and without TDM in place.

The road authorities may decline a TDM plan if it is not satisfied that it can be carried out, that there is no effective way of ensuring that it is carried out or if there is no government authority responsible for monitoring and compliance.

Components of a TDM Strategy

Many TDM plans have been in place around the world for a number of years. While levels of commitment, enforcement and success have varied, they are now generally considered as a viable means of managing travel demand.

The development of TDM strategies is well documented in numerous references (see **Appendix C - References**).

Components of a TDM strategy might include:

- Facilitating mode choice changes from single-occupant vehicles (SOVs) to transit, bicycling or walking by providing incentives
- Providing supportive facilities (e.g., bike racks, changing rooms, showers and lockers)
- Providing "guaranteed ride home" services
- Providing ride-matching services for car pooling
- Developing true mixed-use projects with a balanced mix of residential and on-site employment

The key issues for road authorities are: the level of commitment to such a strategy, the way in which results are to be achieved and the contingency plan to deal with failure to achieve the expected results.

Factors Affecting TDM Effectiveness

TDM plans require that employees modify existing commuting and lifestyle habits. Undoubtedly the inherent resistance to changing commuting habits is closely tied to the North American dependence on the personal vehicle.

Other issues that reduce the attractiveness of TDM plans include the level of service offered by transit compared with the convenience of the personal vehicle and problems associated with carpooling.

TDM and Parking and Trip Generation Rates

TDM plans have a potentially significant impact on the trip generation rate and parking demand at a development site, thereby affecting the parking supply strategy and the road improvement requirements adjacent to the site.

Documented experience to date indicates that TDM plans are more likely to be successfully implemented at large, commuter-dependent developments that have work forces concentrated in relatively few areas of origin. It is likely that in the future, TDM plans will be more prevalent in areas of severe congestion or air pollution (e.g., Metro Vancouver (formerly the GVRD) and the CRD). Areas that are experiencing high growth (e.g., Kelowna) have included TDM in their land use policies and transportation plans.

TDM can only be used to significantly modify trip generation and parking rates in large urban areas and at larger employment sites where an employer-run management system can be implemented.

3.2.6 Transit

Transit services are often regarded as the primary alternative to using a private vehicle and may be a key component of TDM strategies. Transit can have an impact on the vehicle trip and parking generation of a development. Most of the ITE parking and trip generation data is based on sites that are not well served by transit, such as suburban locations.

The following points need to be considered to address the relationship between transit and the generation rates:

- **Transit is most effective in reducing vehicle trips when there is a transit stop within two to three blocks of the development, and when the transit service provides good route coverage** (i.e., a network, not "go downtown and change buses") **and service frequency** (better than 20-30 minute intervals)**.** Transit is effective to a lesser degree if it is located within five blocks of a development. The effectiveness goes down between five and 10 blocks from the development. Beyond 10 blocks, the effect of transit on reducing vehicle trips is negligible.
- **Transit service needs to be frequent, dependable and available during hours that are critical for the development.** For example, the peak parking and traffic generation periods at entertainment developments (e.g., theatres and restaurants) may occur at night when bus service is infrequent or unavailable. In such cases, transit cannot be expected to reduce the vehicle parking demand.
- **Transit services must be linked with the development by an effective and safe pedestrian route** consisting of sidewalks, pathways, crosswalks and pedestrian overpasses. If these are not available, the effect of transit in reducing vehicle trips is dramatically reduced.
- **Transit may effectively reduce vehicle trips for developments that are single destinations,** such as employment centres. However, it is unlikely to be as effective for developments that are secondary destinations and that are often accessed as part of a linked trip. Transit is unlikely to be used for trips involving more than one destination because of the delays associated with waiting for service on each leg of the trip.

Adequate transit service is rarely available in rural areas. It is most effective when serving urbanized areas, where several destinations can be served along a single route.

However, transit is the only mode of travel for some sectors of the population (i.e., those under the driving age, seniors and those who do not own or have access to a personal vehicle). Because transit is also seen as a way of reducing the emissions and congestion caused by personal vehicles, there is a trend to encourage its use. However, for such a trend to have a measurable impact on congestion and pollution, existing transit services may need to be significantly improved and expanded.

A reduction in rates for transit may be justified for employment-based (typically offices) or residential land uses if an adequate transit service is available. A reduction for non-employment based destination uses (typically retail) is not appropriate unless it can be shown to be realistic, such as in a central business district (CBD) area). The reduction would not exceed the area-wide modal split attributable to transit for the peak period(s) being analyzed. (This information may be available from regional statistics or a regional transportation model).

> Where a project developer wishes to incorporate an adjustment for transit use in a development, the designer must carefully consider and document what objectives are reasonable, how the results will be monitored, and what contingency plan is appropriate should the objectives not be met. The analysis must clearly demonstrate the recommended solution with and without the expected transit usage.

3.2.7 Car Pools and Car Share Co-ops

Carpooling and car share co-ops can be encouraged as ways to reduce the use of single-occupant vehicles and the requirement for parking. As a transportation demand strategy, carpooling is most likely to succeed at commuter-generating developments such as office buildings and business parks, particularly large single-tenant offices. Car share co-ops reduce parking demand at the residential trip end rather than at destinations.

Like transportation demand management, carpooling programs require a significant commitment on the part of the employer in order to succeed. A central matching service and incentives to encourage carpooling need to be maintained. The program also needs to be strictly monitored and controlled.

A reduction in rates for carpooling would be included in a TDM adjustment. A reduction for car share co-ops would be addressed for multi-unit residential developments only when its permanence is assured by a binding agreement with (for example) a strata council.

Where a project developer wants to incorporate an adjustment for car-pooling or car share co-ops in their development, the designer must carefully consider and document what objectives are reasonable, how the results will be monitored, and what contingency plan is appropriate should the objectives not be met. The analysis must clearly demonstrate the recommended solution with and without the expected usage.

3.2.8 Multi-Destination Linked Trips

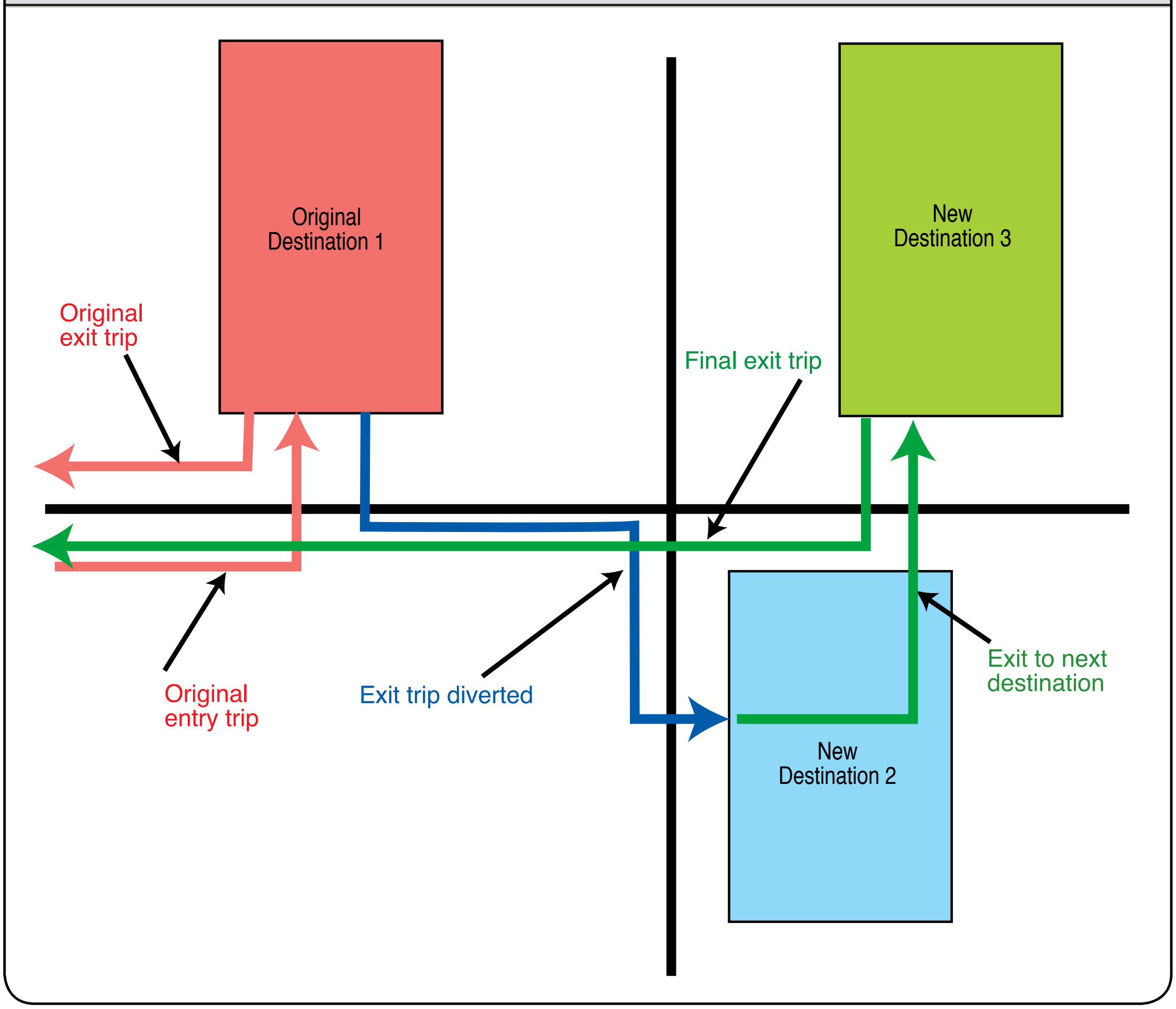
Keyword

The term **multi-destination linked trips** refers to drivers who park at one location and then move their vehicle to another destination. (See also **Section 3.2.9**.)

They may have been on the adjacent road system before the development was constructed, then they become diverted or pass-by trips, or may be new traffic to the roads around the site.

Diverted linked trips proceed to their original destination and the entering and exiting movements connect to the previous routing. Figure 3.3 illustrates the impact of this type of trip.

Figure 3.3 – Multi-Destination Trips



In this example:

- The original single-destination trip is shown in red.
- A multi-destination trip is shown leaving destination 1 and visiting new destinations 2 (blue line) and 3 (green line).
    - It is added to the driveways for those destinations as well as the intermediate streets.
    - But it is not added to the streets to the left of destination 1.
    - It also has a different direction at the original site intersection when leaving its original destination (1).

Use of multi-destination assignments has to be fully documented in the report and accepted by the road authorities.

3.2.9 Pass-By and Diverted Trips

Keyword

The term **pass-by trips** refers to the percentage of trips generated by a development that is already on the immediately adjacent roads. Pass-by trips are therefore part of the "base" traffic on the road system, and are not new trips generated by the development. The percentage of pass-by trips out of the total trip generation at an existing development is determined by interviewing the drivers of vehicles that access the development. (See also **Section 3.2.8**.)

Pass-by trips are most commonly associated with smaller retail and service developments where parking duration is relatively short and turnover rate is high. Neighbourhood and community commercial centres, service stations, and fast-food restaurants are examples of developments that typically attract a high percentage of pass-by trips.

Keyword

Diverted trips are trips that are already on the road system but not on immediately adjacent roads. Some land use types or scales of development are capable of attracting such traffic. These are typically larger retail developments such as regional shopping centres. Drivers who are diverted do not continue on to their previous destination. The entering and exiting trips appear to be the same as a "new" trip to the site.

Pass-by and diverted trips are illustrated in Figure 3.4.

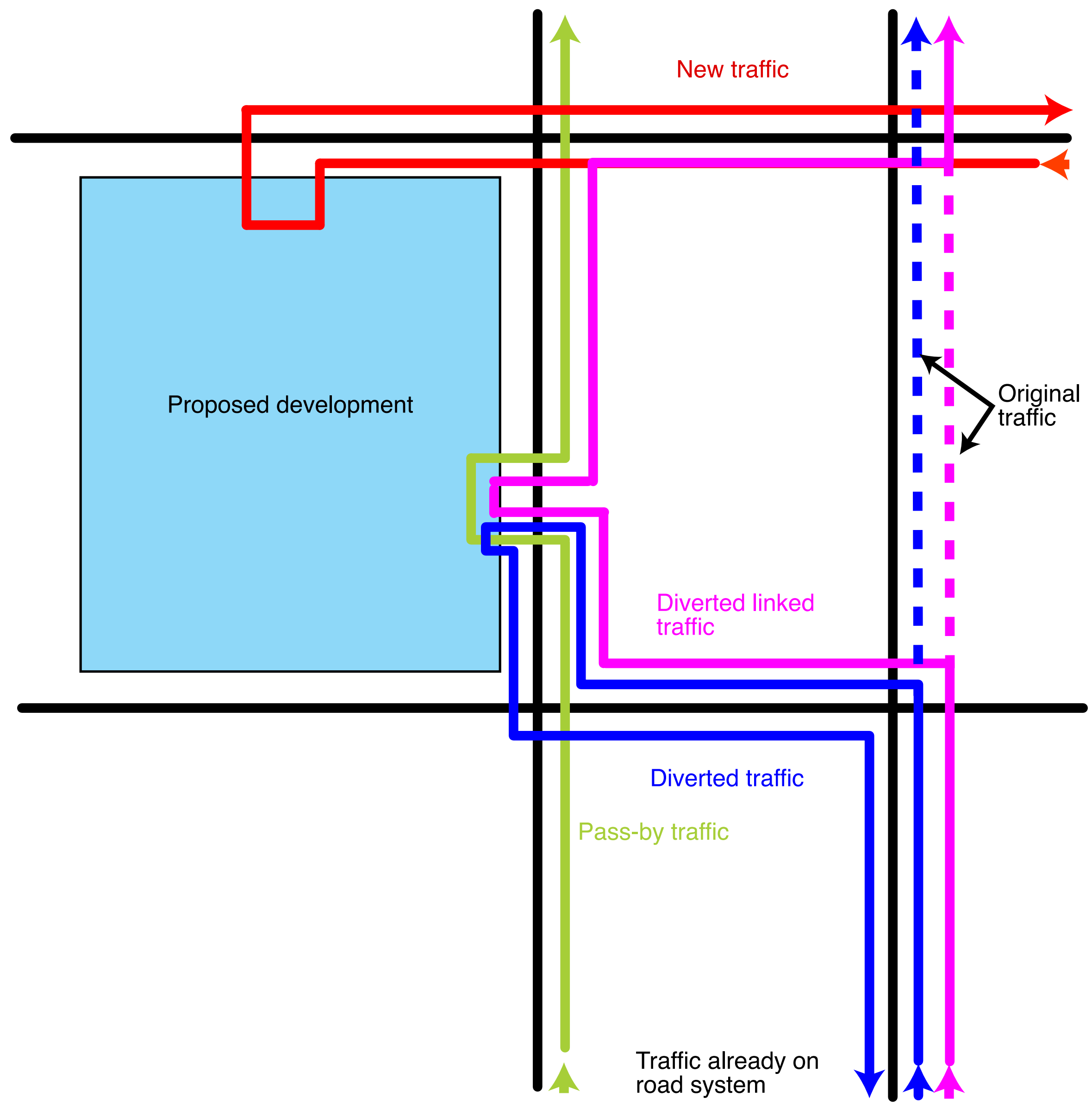
> The percentage of pass-by or diverted trips is irrelevant to the actual parking and trip generation rates of a development and does not affect the number of vehicles arriving and parking at a development because this is already included in the trip generation rate. This percentage is relevant to the impact of the development on the adjacent road network, however. The higher the percentage of pass-by or diverted trips, the less "new" traffic is added to the road system by the development.

> Changes in turning movements may result in higher or lower volumes compared to considering the development as all "new" traffic.

Some information regarding surveyed pass-by rates is provided in the ITE *Trip Generation Handbook*, however the issue is not well documented.

The development requirements for access capacity, on-site circulation and parking supply do not change with the percentage of pass-by or diverted trips. The analysis is completely dependent on the pass-by rate for the land use categories, the adjacent street traffic, and whether the traffic is turning left or right into the site. Figure 3.5 illustrates this.

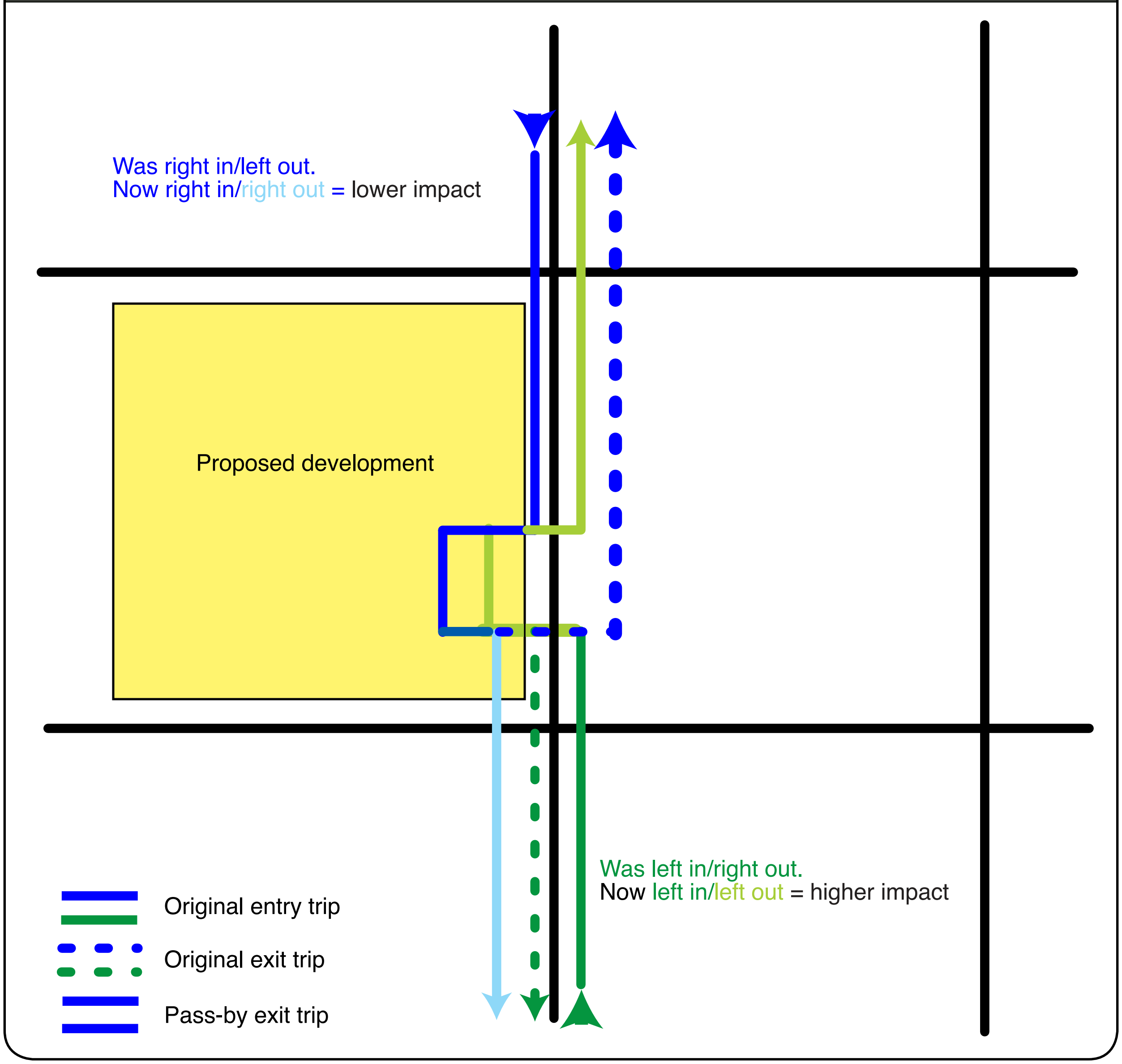
Figure 3.4 – Pass-By and Diverted Trips



In this example:

- Pass-by traffic (green) is diverted into the site but remains on the road.
- Diverted traffic (blue) turns from a parallel road then returns to it's origin using the road it arrived on. It no longer follows it's original route (blue dashed line).
- Diverted linked traffic (magenta) turns from it's original route, enters the site, then returns to it's original route.

Figure 3.5 Pass – By Traffic Impacts



In this example:

- Northbound traffic (green) would normally exit to the south (left in/right out). It now exits to the north (light green), a left out with higher impacts.
- Southbound traffic (blue) would normally exit to the north (right in/left out. It now exits to the south (light blue), a right out with lower impacts.

3.2.10 Sensitivity Analysis

Sensitivity analysis is required to address the uncertainty of traffic and parking projections. This applies to the projection of both site-generated traffic and "background" traffic.

The requirement is to identify the possible range of values for key parameters and the overall range of projected volumes. These are then used for operational analysis to identify the range of operating conditions that may result as a consequence of the development. They are also used to identify appropriate mitigation measures and the resultant range of operating conditions.

ITE trip generation and parking rates are 50^{th} percentile values. Thus half of a relevant sample of sites with similar land use and other parameters are expected to have higher rates. The 85^{th} percentile, or other approved higher rates, must be reviewed in the sensitivity analysis.

The intention of this analysis is not to result in a "worst-case" design, but to identify the robustness of the proposed design and its ability to continue to operate satisfactorily in the future. The outcome of the analysis would be a contingency plan to ensure that the road authorities can maintain reasonable operations and to help identify cost responsibility.

The sensitivity analysis must identify and review the key factors relevant to the proposal including:

a. Trip generation and parking rates, including all accepted adjustments
b. Highest and best use land use for the site
c. High and low ranges of background traffic growth
d. Alternative site traffic routing patterns (assignments), if they exist
e. The construction of proposed or planned improvements to the surrounding roadway system, if or when they are built, if they are not "committed" projects and are identified as such in the Terms of Reference

The net impact of each of these may be assessed independently or they may be aggregated, if appropriate. For each factor (or the aggregate) the analysis must identify:

a. The range of uncertainty (e.g., one-half to two times or more for some trip generation rates)
b. A probable higher range value given the general characteristics of the site and locale (e.g., 85^{th} percentile trip generation rate from a "successful" development in a large community)
c. The impact on traffic operations (e.g., change in level of service, with and without mitigation)

The result of the sensitivity analysis is a table comparing the results (level of service) and required improvements for each parameter that is tested. This is then used to compare the required improvements for each case, to the improvements proposed for the project.

Some cases, when analyzed, will reveal that the change does not significantly impact level of service; others will indicate either that additional improvements are required or that the target level of service cannot be obtained with any reasonable improvements.

Table 3.2 illustrates a simple case where only the trip generation rate and background traffic growth rates are changed to one alternate value each, and then combined. The text must clearly document the choice of ranges analyzed (i.e. justify why +/- 50% and 3% were used in this example).

Table 3.2 – Sensitivity Analysis

Parameter	Base Case	Level of Service	Change	Level of Service
Existing conditions		B		
Background traffic growth	2%	C	3%	C
ITE trip generation rate	Equation	C	*Eqn + 50%*	*E*
Trips + background, no improvement	ITE eqn + 2%	D	***Eqn + 50%, + 3%***	***F***
Trips + background, add left turn lane	ITE eqn + 2%	C	***Eqn + 50%, + 3%***	***D***

If the original values (assumed to be average site traffic generation and mid-range growth) are accepted, the development apparently does not need any roadway improvements if the target is level of service D (grey shaded cells).

However, if higher values are selected:

- Trip generation only (italic), or,
- Both trip generation and background traffic (bold italic),

then improvements are required (red cells). The last line shows the result with improvements (green).

The risk involved in accepting a level of improvement below that required to address the worst case then has to be assigned between the developer and road authorities.

3.3 Ministry Policy

3.3.1 Land Uses Not Included in the ITE Handbooks

Where a proposed development includes land uses that are not documented in the ITE handbooks, the designer must either:

- **Collect data and develop a proposed rate for the particular land use.** In this case, the Ministry must be consulted to determine the applicability of conducting a rate survey for the specific site and the data must be collected according to ITE guidelines. The data must be statistically sound, be based on appropriately related land uses and the process must be fully documented.

or

- **Provide an analysis based on "first principles" justifying a proposed parking or trip generation rate.** The analysis must be technically sound, and reflect an appropriate range of variables and their potential range of values.

All data collected must:

- Comply with ITE guidelines
- Be presented in a ministry-approved electronic format
- Be submitted to the Ministry for review and future use

3.3.2 Applying Variances to the Rates

Section 3.2 of this manual and the ITE handbooks discuss several factors and issues associated with parking and trip generation rates and how they may be adjusted. As previously stated, there is a general lack of statistically reliable data about these adjustments and they are very dependent on specific local and site-specific characteristics, some of which may be subject to significant change over time.

There is a significant trend toward urban densification (to reduce travel demand and address other goals); yet, low-density fringe development is still taking place. Planning and analysis for developments must recognize the potential for future changes.

Achievement of these changes (densification) will depend on:

- The market support for such concepts
- The integration provided between these goals (e.g., reducing travel demand, etc.)
- The local government's development planning and approval process

The Ministry will allow for a variance process whereby a developer may present technical evidence to support their argument for a reduced rate. The developer's case would then be reviewed by one or more Professional Engineers in the Ministry and a site-specific variance issued in writing, if considered appropriate. Variances are based on the individual circumstances and do not bind the Ministry to consider or accept variances for other projects.

The potential for a variance process in a transportation design must be included in the project Terms of Reference and agreed to in writing by the Ministry and the local government before commencing the design. Agreement to allow the analysis of factors and issues impacting the rates does not bind the Ministry to accept the variance upon completion of the design.

3.3.3 Sensitivity Analysis Requirement

The Ministry requires that sensitivity analysis be used to identify the appropriate range of generation rates (and other key parameters where the use of a single rate is not appropriate) to be used in the analysis.

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4 Traffic Analysis

Table of Contents

Other Sections

Appendices

4.1 Background

This section details the issues and procedures that need to be addressed in the analysis of traffic operations. It identifies locations on the public road system as well as any on-site intersections that may impact operation of the access point intersections. (Safety issues are discussed in **Sections 5** and **6**.)

The focus of this section is on developments that require the detailed review process and the analysis of traffic operations. Layout details relevant to roadways and parking are dealt with in the following two sections but influence the analysis options and/or procedures discussed in this section.

The simplified review process may not require operational analysis. **Sections 5** and **6** provide the required design details to be included in a simplified report.

Suggested analytical techniques to be used in the Integrated Transportation Design are outlined in this section. However, this section does not provide an exhaustive list. It is the designer's responsibility to ensure that all relevant issues are adequately examined and documented using the appropriate procedures. The intention is not to limit analysis techniques, but rather to provide a guide for practitioners.

4.2 Technical Issues

This section discusses many of the concerns that have been identified in proposed designs, their documentation and reports that have been submitted to road authorities in the past. In many cases, it is the documentation, rather than the technical work, that has been less than adequate. However, the technical issues are reviewed here to clarify for developers what is required and why.

4.2.1 Study Area

The study area to be included in the review process is defined in the project Terms of Reference (**Section 2**). All intersections and, if appropriate, roadway segments included in the Terms of Reference, must be analyzed using the appropriate process discussed in this section.

4.2.2 Field Observations

The traffic engineering consultant must make at least one visit to the site. It should be made after available information has been obtained from the Ministry, local government and any other reviewing agency. By this time, the traffic engineering consultant will be more familiar with the site and the issues that need to be addressed. Any traffic count or field measurement information not already available could be obtained at this time.

Items to be checked while in the field include (see **Appendix A** for a checklist):

a. Confirm current land uses of adjacent sites

b. Confirm roadway features are shown on mapping, including:

- Curb, lane and shoulder locations and widths
- Medians, islands, sidewalks, bicycle, HOV or transit-only lanes
- Driveway and side street details
- Drainage details
- Overhead and underground utility locations
- Alignment details (curvature, grades, crossfall)
- Vertical and lateral clearances

c. Take note of traffic controls including:

- Speed limits
- Turn restrictions

- Signal locations and lane designations
- Parking provision or restrictions
- Street lighting

d. Observe actual traffic operations including queuing, conflicting traffic movements, delay, etc., during the appropriate peak periods

e. Identify, observe and record any other relevant details

Photographs provide an office record of the site and its environment for both the traffic engineering consultant and the agencies reviewing the study and its recommendations. It is common to require additional information once the site visit is over and a good photographic record can often provide this information.

4.2.3 Existing Conditions

The Transportation Design Report must include a review of existing traffic operation conditions in the study area before additional traffic is generated by the proposed development or before the proposed change-in-use of an existing development takes place. This will determine existing road, highway and intersection volumes, level of service, queue lengths, etc., and identify any available surplus capacity.

This analysis and documentation in the report should include the following components:

a. Existing zoning and uses on all lands within the study area including the site of the proposed development.

b. Peak hour traffic volumes (including bicycles and pedestrians, if significant) for each movement at all intersections (including access points to the proposed and adjacent developments to be analyzed, if existing) within the defined study area.

c. Percentage of trucks.

d. Traffic controls (signals, stop/yield signs, roundabouts, exclusive turn lanes, etc.).

e. Intersection lane configurations and geometrics including storage lane lengths.

f. Operational performance analysis for all intersections and access points.

g. BC MoT and municipal (if applicable) traffic signal warrant calculations, where appropriate.

h. Any known safety and operational problems within the study area, including traffic collision records (if required).

i. Sight distance restrictions.

j. Transit service including schedules, routes and stop locations.

k. Pedestrian facilities, including sidewalks, walkways and crosswalks.

l. Bicycle facilities, including bike lanes and bike paths.

Where the existing conditions are documented using available information (maps, aerial photography, etc.), the information derived from these sources must be verified in the field by a site inspection.

An index of the materials to be used in the documentation of existing conditions must be provided in the Terms of Reference (traffic counts, mapping, etc.).

4.2.4 Traffic Data Sources

The Ministry and local governments collect some traffic data on an annual basis (e.g., vehicle volumes, vehicle classification, vehicle speed, pedestrian movements, collision records, intersection counts, etc.). Data requirements may be matched with available data during the development of the Terms of Reference. Data collected by local governments may be acquired from the municipality or regional district. Data collected by the Ministry is available from the Ministry's **Traffic Data** website or District Office.

All data used in the analysis (including data supplied by other agencies or the developer) must be provided in the Transportation Design Report. Details should be provided in the appendices.

Summaries should be provided as required in the text. Both raw data and summary statistics must be provided. New data collected for the project must use electronic templates provided by the Ministry (MS Excel format or compatible files).

When non-ministry automatic (short) counts are used to derive 30th hour, annual average daily traffic (AADT), etc., or to adjust other counts, the Ministry's factoring process must be used to determine the appropriate conversions. The process was not web-ready at the time this manual was being finalized, but it will be posted to the **Ministry's website.**

Once the data is submitted to the road authorities along with the study and is accepted, it becomes the property of the road authorities. It will be included in the road authorities' data bases so that it can be used by others who may conduct future studies in the same area.

Failure to collect data according to the road authorities' requirements will result in a return of the study so that further documentation can be provided.

A suggested list of traffic data to be obtained for use in the study is provided in **Appendix A.**

Where current (no more than three years old) traffic data is not available, the applicant and their traffic engineering consultant are responsible for the data collection required to complete the transportation design (see **Section 4.2.6 – Establishing Existing Volumes – Traffic Counts**).

If the developer or their traffic engineering consultant has any questions regarding traffic data collection, they should contact the District Office. Calls will be directed to the appropriate person.

4.2.5 Use of Historic and Current Traffic Counts

Data for at least 10 prior years (10 data points, if some years are missing) is required for reliable trend line analysis. Historic growth rates are determined from annual or summer average daily traffic (AADT / SADT) or other data.

This data is obtained fromministry or municipal short count stations. It is derived from two to seven days of local data analyzed and projected based on matching algorithms using the Ministry's permanent count stations.

Intersection turning movement counts must be no more than three years old for use as existing data. If significant land use or roadway system changes have occurred within this period, new counts are required.

4.2.6 Establishing Existing Volumes

Design Hour Volumes

Keyword

Design hour volumes (DHV) for the existing conditions (or any future projected conditions) are the set of concurrent one-hour volumes that represent the critical combination of turning and through-traffic at an intersection. One hour means 60 consecutive minutes to the nearest five- or 15-minute step. "Clock hour" cannot be used to define DHV.

DHV is not the volume as counted on any random day. It is an adjusted set of volumes that represent the design criteria. These adjustments include:

- Day of week/month of year
- Adjustment for year if not the current year

All data must clearly show that the peak was identified. Data with the peak period starting or ending the survey period will not be accepted if that peak period is a design peak.

There may be different design hour volume combinations for the a.m., noon, p.m. or other peak periods. The critical case for each movement must be identified and analyzed no matter which peak it occurs in. In addition, the overall "worst critical case" for the intersection must be analyzed. Where signal progression is required, the "worst critical combination" of all intersections (narrowest bandwidth) must also be analyzed.

In addition to adjustments for seasonality, day of week and 30th hour or other considerations, the analyst has to identify the critical combination of volumes from a traffic count, site traffic projection or combination thereof.

Design hour volumes (DHV) for the existing conditions (or any future projected conditions) are based on the set of concurrent one-hour traffic count volumes that represent the critical combination of turning and through-traffic at an intersection. Worst combination includes both capacity and queuing for each individual movement.

Unfortunately this is not necessarily the peak hour as expressed by the highest hourly volume through the intersection. This issue is discussed in **Appendix D.3**.

At any intersection, there may be more than one set of concurrent volumes that produces a worst critical volume case for delay, queue length or signal progression for any given movement. If there is more than one set, the worst case for each movement becomes the design criterion for that movement and each case must be analyzed.

Traffic Counts

Traffic data must be collected, recorded and submitted in a way that is consistent with standard engineering practice as outlined in the current edition of the following Institute of Transportation Engineers (ITE) publications:

- *Manual for Transportation Engineering Studies*
- *Transportation and Traffic Engineering Handbook*

All traffic counts must be recorded using the road authorities' standard format, recorded in five-minute intervals and reported to not less than 15-minute intervals. Bicycles, pedestrians and trucks must be recorded where their numbers are significant enough to impact the analysis or required for calibration of the analysis parameters. (See **Appendix D.6** for details of BC MoT's count format consistent with this section.)

It may be necessary to factor-up counts taken in previous years to represent the current year in order to establish traffic volumes that represent existing conditions. Counts more than three years old should not be used. The developer is responsible for collecting more up-to-date traffic counts.

A comparison should be made between any 30th highest hourly volume data available from the road authorities' counts, peak hour intersection counts and automatic traffic counter data. Adjustments may be required to express all volumes as design hour volumes (DHV) for analysis purposes.

All new counts for a project should be collected on the same day, whenever possible.

If this is not done, then traffic volumes for the road and highway network in the study area must be adjusted if:

- There are significant disparities between adjacent intersection counts or short counts

and

- There are no accesses or major traffic generators to account for the difference in traffic volumes.

Any such adjustments should be recorded in the Transportation Design Report and are subject to review and approval by the road authorities.

Time periods selected for data collection should reflect local traffic operating characteristics and should accurately capture peak conditions.

Traffic counts must clearly show the duration of the peak period. If major employment sites are close to the proposed site, then shift changes must be identified and, if appropriate, count times adjusted. This may require review of automatic counts or signal controller counts before the data is collected to ensure that the survey time periods are adequate to capture the true peaks.

A count with the peak hour starting or finishing at the beginning or end of the count period is not acceptable.

Where traffic operations are in the range of saturated conditions for any movement, then both the discharge and arriving (back of queue) volumes must be reported. Counting must be carried out for the entire time period that saturation occurs. The analysis must be based on the arrival rate at the back of the queue.

Pedestrian movements must be counted for any intersection counts undertaken, unless they are not significant and the road authorities agree in the Terms of Reference. Cycling data should also be collected where a development may intersect an established bicycle route, where bicycle volumes are significant or transportation demand management measures are being considered.

Vehicle classification counts must be carried out unless it is determined that a default value can be used and the road authorities agree in the Terms of Reference.

Daily vs. Peak Hour Volumes

Care should be taken to differentiate between annual or summer average daily traffic (AADT or SADT) and peak hour or 30th highest hourly volumes. The hourly volume for a road which is at, or close to, capacity will increase at a very slow rate (perhaps less than one percent per annum), whereas the daily volume may continue to increase at a far higher rate (perhaps at five percent per annum or higher) as the peak hour spreads. This will impact queuing and total vehicle delays.

In some cases (e.g., heavy recreational traffic), average annual weekday traffic (AAWDT) may be significantly different from average annual weekend traffic (AAWET) and weekend traffic may need to be reviewed.

All operational analysis must be based on peak hour data from actual peak hour intersection turning movement counts (or equivalent for freeways). Using only factored AADT/SADT data to estimate peak hour turning volumes is not acceptable. AADT and truck data may also be required for pavement or bridge design purposes.

Factoring counts to adjust for seasonality, counts from different years, etc., based on AADT from short count or permanent count data is acceptable, but it cannot be used alone to estimate a peak hour without actual peak hour counts. This is logical since AADT, etc., is derived from actual count data, thus the raw data is available to be used.

Peak Hour Characteristics

All traffic data must be adjusted for peak hour characteristics (e.g., season, day of the week, etc.) and converted to design hour volumes for analysis. The traffic engineering consultant must use engineering judgment together with local knowledge to determine if the data is representative of normal conditions.

4.2.7 Horizon Years

The transportation design must address not only "opening day" conditions, but also future operations for the site. Other developments in the immediate area must also be accounted for.

The choice of horizon years is based on a number of factors including:

a. Project phasing (if it is a multi-phase project)

b. Planned roadway or network improvements

c. Capital improvement program planning horizon (e.g., five or 10 years)

d. Regional or municipal planning horizon years

e. Regional or municipal transportation model horizon years

f. An intermediate year (normally five years) and an ultimate horizon, normally 10 years for traffic operations (detailed report)

g. An additional long-range planning horizon of 20 years must also be addressed. The level of detail for this projection and analysis is to be defined in the Terms of Reference.

If any of a. to e. above apply, those years must be analyzed. If b. applies, both a before- and after-analysis is required for the improvement. If none of a. to e. apply, then the analysis is required for f. and g., five-, 10- and 20-year horizons.

An example of the horizon years evaluated is given in Table 4.1 for a single-phase project, see **Section 4.2.8** for discussion of phased projects

An acceptable alternative approach is to identify the traffic volumes at which the operational criteria (see **Section 4.2.11** for information on signalized and unsignalized intersections) are no longer met and calculate the projected year (or years, if improvements are staged) that this will occur.

Table 4.1 – Horizon Years Example – No Project Phasing				
	Growth Rate	**Site Traffic**	**Year**	**Comments**
Existing volumes only		Nil	2009	Current LoS = baseline
Opening day	2 years at 2%	Full site	2011	Opening day (2 years to build)
5 years without improvements	5 years at 2%	Nil	2011	5 years without site
Intersection/network upgrades	5 years at 2%	Full site	2014	5 years, site and required mitigation
Projected future*	20 years at 2%	Nil	2029	Without site
Projected future site*	20 years at 2%	Full site	2029	With site, ultimate impacts

* See also 4.2.7 g

If the analysis reveals that in a future year the system will reach capacity and no reasonable improvements are possible, then the developer may request that further analysis not be required. However, under these circumstances the road authorities may review the impacts and implications for the road system before making a decision on the mitigation required.

Future corridor volumes will be provided and must be used as an overall control on corridor volumes where they have already been determined by the local government or the Ministry (such as through a Transportation Planning Model). However, these volumes may require adjustment if the proposed development is not included in the land use parameter values used in the model or if assumed improvements to the road system are not yet committed.

It is important to note that such computer models may only be used to review the impacts of network road issues and should not be used directly to determine individual access driveway requirements (see discussion in **Appendix D.7**).

Unless network improvements and major road upgrading projects are currently funded, the designer should not assume any reduction in background traffic volumes resulting from planned future projects. These conditions, however, may be analyzed and their impacts noted.

Municipal/regional district requirements for identification of horizon years must also be addressed where joint jurisdiction exists. These will be included in the approved project Terms of Reference for the project.

4.2.8 Phased Developments

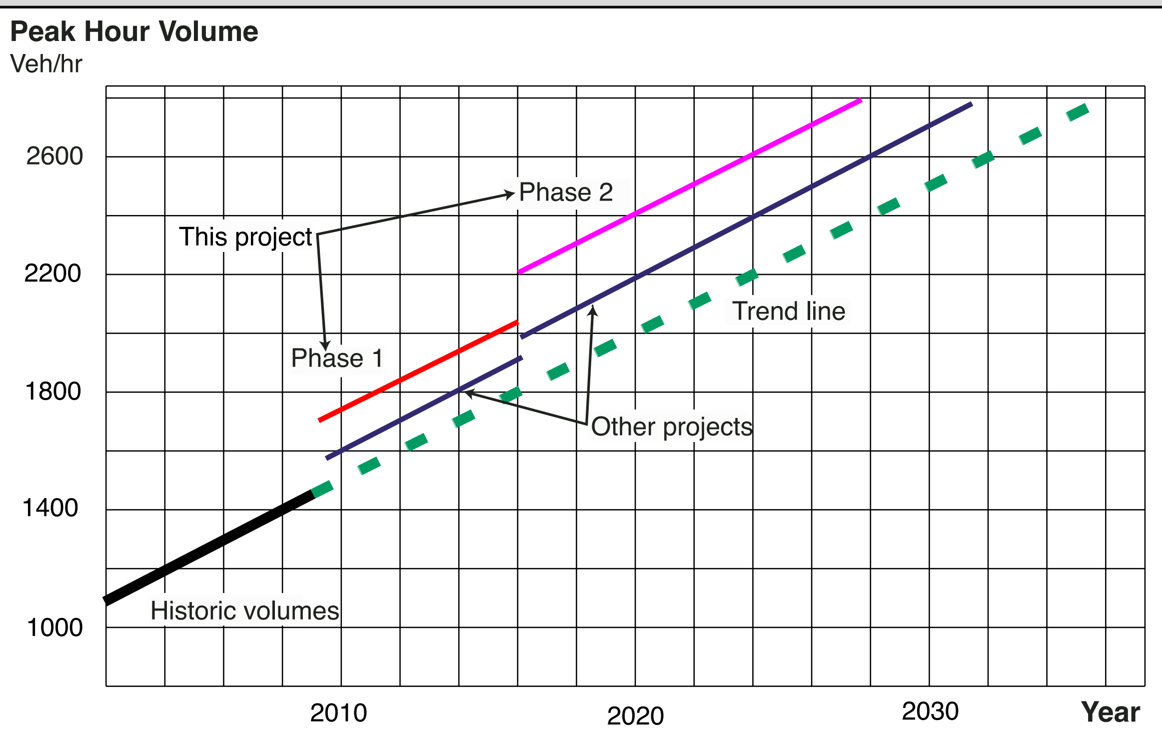
Some large development projects are constructed in a phased approach that may be spread out over ten years or more. If the development is to be phased, then it may not be necessary to provide all the road improvements within the first phase of the project. Instead, the number of trips generated by the site at the completion of each phase may be identified as well as the improvements required to adequately and safely accommodate the trips associated with each phase.

Two approaches can be used for phased developments:

a. **Design and approve each of phases 1 and 2 as a separate application.** This is the same as separate approvals for different developments (with no guarantee of approval of future phases).

b. **Design and approve all phases.** Implementation may be phased (design phases 1 and 2 and only build phase 1 initially) provided there is a written agreement that precludes construction of subsequent phases (i.e., phase 2) until the improvements required for that phase are built. (Future development is pre-approved provided conditions are met. This may include a reassessment of actual vs. projected volumes prior to construction of phase 2.)

Figure 4.1 – Phased Developments



The analysis of projected traffic conditions should be carried out at the end of each major phase when undertaking designs for such phased developments. This analysis includes:

a. Background traffic

b. Planned road and highway network improvements

c. Access points

d. Level of service at intersections

e. Identification of required improvements at each phase

The improvements required for each phase of the development will then be identified. If measured traffic on the roadways changes significantly between phases and affects the analysis and recommendations of the Transportation Design Report, the original analysis will have to be reviewed using the most up-to-date information. (This includes changes due to altered roadway networks.) Monitoring of the first phase traffic may be required and may result in the need for additional analysis to incorporate adjusted traffic projections for later stages.

Table 4.2 – Horizon Years Example – With Project Phasing

	Growth Rate	Site Traffic	Year	Comments
Existing volumes only			2007	Current LoS = baseline
Opening day	2 years at 2%	Nil	2009	Opening day (2 years to build)
Opening day plus Phase 1	2 years at 2%	Phase 1	2009	Opening day with site – Opening day impacts
Intersection/network upgrades	5 years at 2%	Phase 1	2012	Planned road improvements by road authorities – Interim impacts
Phase 2	10 years at 2%	Phase 1 + 2	2017	Opening day Phase 2 5-year network upgrades included
Projected future*	20 years at 2%	Nil	2027	Without site, 5-year network upgrades included
Projected future site*	20 years at 2%	Phase 1 + 2	2027	With site – ultimate impacts

* See also 4.2.7 g

The appropriate land use as designated in the local government's Official Community Plan (OCP) should be used in the analysis for each phase of the development. Where nearby land uses are unknown, the land use that represents the highest trip generation rate according to the existing or proposed future zoning should be used (e.g., if the current zoning is Urban Reserve, but the future zoning is Residential SFD, then SFD must be used).

A schedule of the required improvements must be provided for phased developments. This is important in order to determine the timing of the various improvements that are tied to the phases of the development and other road improvements. The appropriate traffic volume "triggers" must be identified for each phase.

> The applicant must provide a traffic phasing agreement before phasing of improvements is approved. (This may be a letter attached to the application as a condition that is then included in a rezoning by-law or access permit, a covenant registered on the title, or some other document that is binding on the property owner.) **The agreement must define what is approved and the required improvements.** This may be done through the zoning bylaws themselves, through restrictive covenants or through phased or spot zoning which would ensure that phases of the development are accompanied by the required improvements.

For a larger phased development proposal where the characteristics of the facility cannot be adequately documented, it may be appropriate for the Ministry and other reviewing agencies to review the project on a phase-by-phase basis (i.e., approval for subsequent phases will be based on the performance of operating phases in terms of trip generation, parking, roadway operation, etc.).

The Terms of Reference must provide information about whether a phased approach to the development will be requested. Ministry and local government staff will review the request and provide details of an acceptable approach to the phased development for the study. This must be documented in the approved Terms of Reference.

> These future requirements must be linked to the zoning and access permit in such a way as to inform subsequent property owners of their future obligations. This may be done through the zoning bylaws themselves, through restrictive covenants or through phased or spot zoning which would ensure that future phases of the development are accompanied by the required improvements. This will require the review and approval of both the Ministry and the local government as reviewing agencies, and will become part of the final agreement for site impact mitigation on a phased development.

4.2.9 Impacts of Transportation System Changes

It is important to consider all other studies and plans that may impact current and future traffic flows in the study area. Future plans may indicate changes to the current road system that are not apparent in the field. These must be recognized in the Transportation Design Report.

Functional Classification System

The Ministry has established a classification system for provincial roads and highways (*Highway Functional Classification Policy*). This classification system groups various roads and highways into classes according to the character of the service they are intended to provide. These classifications and their permitted connections are identified in Table 4.3.

This system is based, in part, on the TAC design classification that assigns cross section type and design speed in both rural and urban situations.

The BC MoT classification links strategic class, functional classification and acceptable connections together to form a hierarchy that is illustrated in Table 4.3 and Figure 4.2.

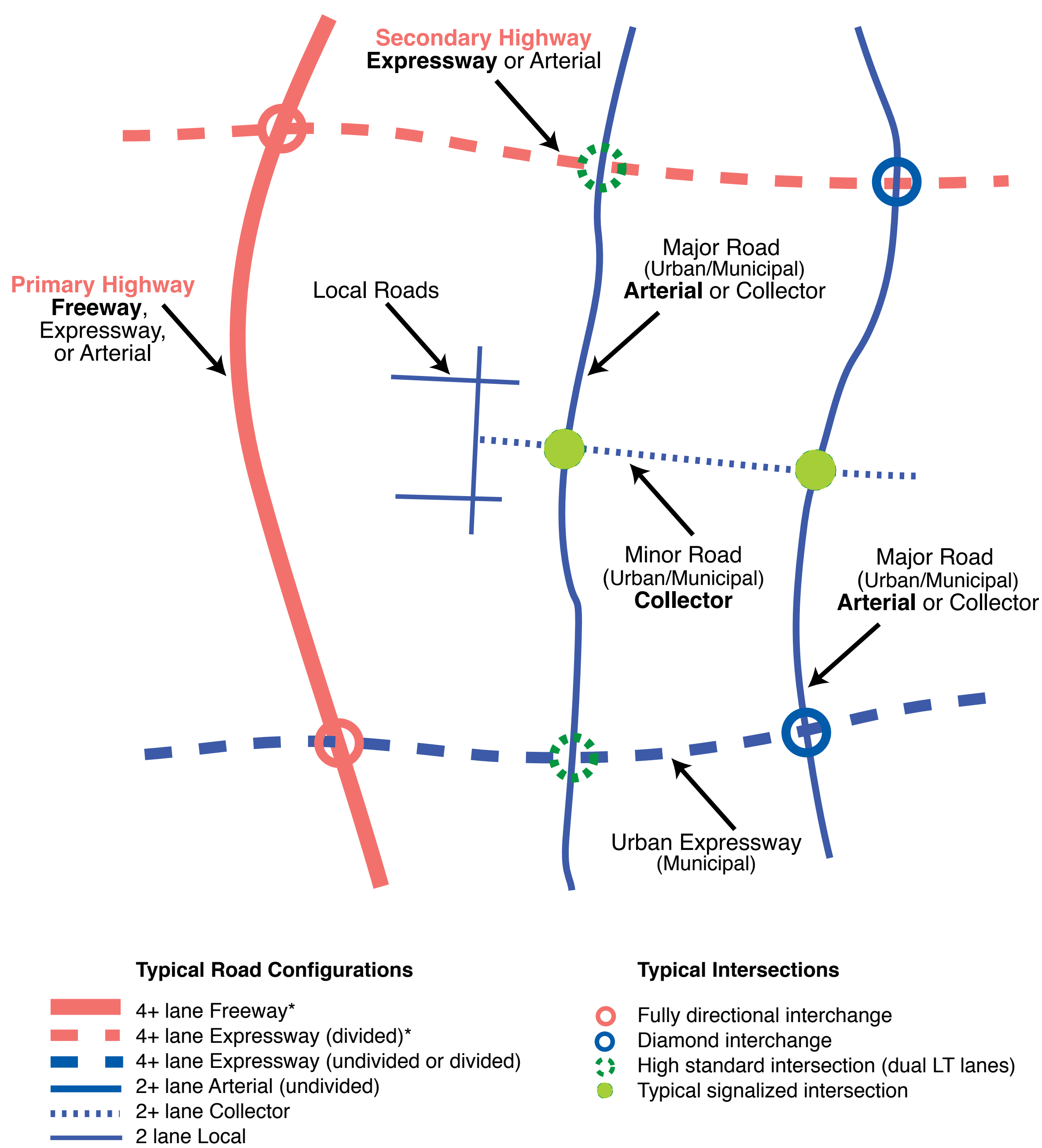
Systems such as these are also applicable to municipal streets and are powerful tools for determining the appropriate design speed, cross sections and access provisions for all roads. They should be referenced in the Terms of Reference.

Table 4.3 – Roadway Functional/Service Classifications

BC MoT Classification		Normally Connects With	TAC Functional Class	Municipal Classification
Strategic Class	**Service Class**			
Primary highway	**Freeway** Expressway Arterial	Freeway Expressway Arterial	Freeway	Major road
Secondary highway	**Expressway** Arterial	Freeway Expressway Arterial	Expressway	Major road
Major road	**Arterial** Collector	Expressway Arterial Collector	Arterial	Major road
Minor road	**Collector**	Arterial Collector Local	Collector	Collector
Local	**Local**	Collector Local	Local	Local

The strategic class is the primary determinant for BC MoT: the preferred service class is shown as bold text, the service class may be lower (not bold) until the strategic class objective is achieved. Municipalities may use various classification names including the TAC designations.

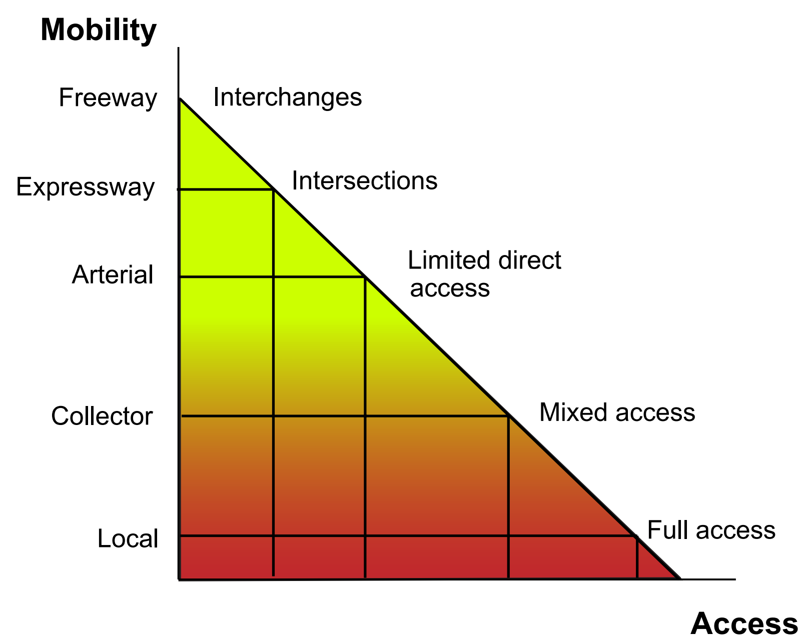
Figure 4.2 – Functional Classifications



* In urban areas these would typically be BC MoT facilities. Other roads would be municipal.

The character of service of each functional classification is largely dependent on the relative emphasis given to mobility on the one hand and access to adjacent lands on the other. The transportation design must consider the surrounding road and highway network in order to ensure that the functional classification is not compromised and that connections are made to appropriately classified roads. This is illustrated in Figure 4.3.

Figure 4.3 – Access vs. Mobility



The transportation designer must consider the provincial and local strategies and plans in order to determine land-use consistency with system goals and objectives. The functional classification of the surrounding network of roads and highways determines the required performance levels, the availability of direct access and the restrictions that may be required.

Consideration of the functional classifications of the surrounding road network will aid in the establishment of feasible alternative access for the proposed site. It is therefore essential that this issue be addressed in the approved Terms of Reference and agreed to by both the Ministry and the local government.

The functional classification of the roads determines a number of basic design parameters that must be adhered to in the design.

Links to Other Studies and Plans

Developers should obtain other relevant studies and plans where available including:

- Provincial Transportation Plan, Provincial Regional Network or Corridor Management Plans, etc.
- Functional Classification Plans and access class summaries
- Ministry planning studies (available from regional offices) for upgraded or new arterial or highway facilities
- Access Management Plans
- Studies outlining proposed future accesses to adjacent lands
- Municipal and/or regional district plans including Official Community Plans, Transportation Plans, Major Street Network, Local Area Plans, Neighbourhood Transportation and Traffic Management Plans
- Municipal and/or regional district studies on: traffic operations, downtown parking, new roads, transportation network planning and transportation demand management (TDM)
- Municipal and/or regional district master plans for sidewalks, bicycle paths and pedestrian networks
- Road improvements including signalization, as provided for in the ministry or municipal current capital works programs
- Transit services including bus stop locations, future service plans, etc.
- Site impact analysis studies concerning other developments in the study area
- Inter-city bus, rail and ferry services

Phased Transportation System Changes

When there are proposed roadway upgrading projects, they may be linked to proposed development or mitigation phasing if the traffic demand imposed by the development requires these improvements in order to provide the required mitigation.

> The method by which the phased improvements are to be linked to the project phases must be presented in the Transportation Design Report. This will require the review and approval of both the Ministry and the local government as reviewing agencies and will become part of the final agreement for mitigation.

4.2.10 Traffic Projections

This section deals with the multi-step process of estimating future traffic on the road system.

The steps, which are repeated for each horizon year, are:

1. Estimate background traffic on the road system.
2. Generate site traffic (see also **Appendix D.4**).
3. Distribute site traffic to the various approach directions (see also **Appendix D.7**).
4. Assign site traffic to the road system.
5. Estimate total traffic volumes on the road system.

Background Traffic

Estimates of the future background traffic or base traffic in the study area are required to complete the analysis of horizon year conditions on the surrounding road network. This is the traffic that would occur without the specific site in place in the given horizon year.

The three primary methods of projecting base traffic are:

a. Projection of past trends or growth rates into the future
b. Use of the build-up method
c. Use of area transportation plan or modelled volumes

All three methods have their appropriate use. The build-up method will normally provide the most accurate results, especially when considering developments in areas of moderate growth over a period of 10 years or less.

The use of transportation plan data or modelled volumes is most applicable to large regional projects that will be developed over a long period of time in an area of high growth. It is generally the second best method of projecting corridor volumes.

The use of growth rates relies on the availability of existing and historic traffic count data but does not readily take into account the possible impacts of changes to the transportation network or local land uses. If neither of the first two methods can be used, then the growth rate method may be appropriate.

Projection of base traffic will often utilize a combination of the above three methods. For example, trend line growth rates may represent regional growth, but specific sites in the immediate vicinity of the project may represent growth over and above historic changes and must be added to the analysis using the build-up method.

Traffic projections must be done for each approved horizon year as outlined in the approved project Terms of Reference.

The Terms of Reference must identify which traffic projection method or combination of methods is appropriate for the project.

The use of these methods is discussed in **Appendix D.7**.

Assignment of Development Traffic

Trip assignment involves estimating the amount of the traffic that has been distributed to each approach direction that should then be allocated to the alternative routes on the road network and, as a result, to each individual access point to the site. The product of this process is the total number of development-generated trips by direction and turning movement on each segment of the study area road network and at each access point. Trip assignment should be made considering:

a. Current and future development patterns

b. Logical routings considering the current and future road network

c. Available road and highway capacities

d. Access restrictions such as divided roadways or turn prohibitions (e.g., no left turn out)

e. Delays because of left turns or congestion at critical intersections

f. Location of traffic signals

g. Projected and perceived minimum travel times by different routes

> If a development is proposing more than one access point, then the number of access points must be justified based on road capacity and routing. In general, only the minimum number of access points required to service the site traffic volumes will be permitted for each development

If multiple potential paths exist, in order to achieve realistic estimates, traffic should be assigned among them rather than assigning all of the trips to the route with the shortest travel time. The assignment of trips should reflect the study horizon years and should consider future conditions such as funded road and highway improvements and proposed land use in and around the study area. The trip assignment should reflect the operating conditions during the peak periods or peak hours determined for the study. Trip assignments can be done either manually or with appropriate modelling software.

Total Traffic Volume Estimates

The total projected traffic for the horizon years is determined by superimposing the site-generated traffic volumes onto the projected base traffic volumes. The following are to be graphically illustrated and clearly documented in the Transportation Design Report:

a. Traffic volume conditions in the study area for existing and projected horizon years **without the site-generated traffic** from the proposed development.

b. Traffic volume conditions in the study area for existing and projected horizon years **with the site-generated traffic** from the proposed development.

c. Traffic generated by other surrounding developments that impacts traffic operations in the study area (if not included in the background traffic).

4.2.11 General Traffic Analysis Elements

This section reviews some issues that are a part of, or have an impact on, the traffic operations analysis. Issues that are more geometric in nature are addressed in **Sections 5** and **6**.

This section is not exhaustive and does not cover all aspects of the analysis. The basis of capacity analysis is outlined in the required reference document, the *Highway Capacity Manual* (HCM). Some analysis procedures go beyond the methodology outlined in the HCM. Use of such procedures, unless implied by acceptance of software programs (e.g., Synchro), must be documented and justified in the Transportation Design Report.

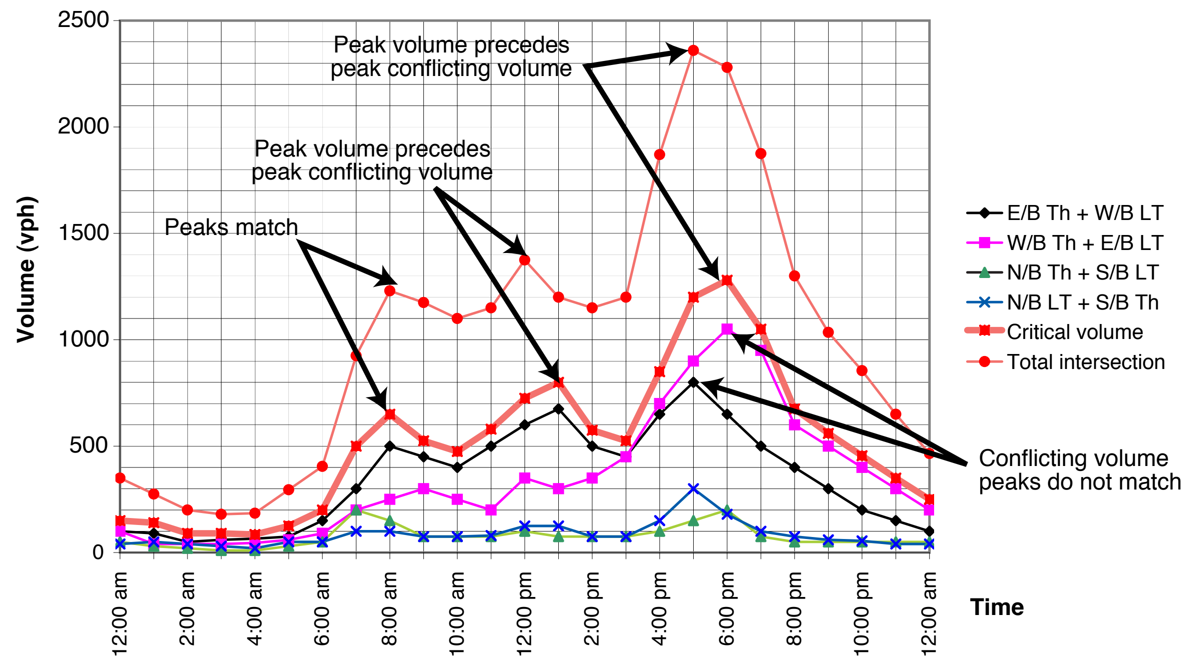
Although this discussion is focused on individual intersections or roadway segments, it is imperative that a "corridor" view be taken and that the designer ensures that the overall system operation is optimized to meet the performance targets – level of service, etc. (See also **Section 5.2.6**).

The analyst has to identify **the worst combination** of volumes from a traffic count, site traffic projection or any combination.

Design hour volumes (DHV) for the existing conditions (or any future projected conditions) are based on the set of concurrent one-hour traffic count volumes that represent **the worst combination of turning and through-traffic at an intersection**. Worst combination includes both capacity and queuing **for each individual movement.**

Unfortunately this is not necessarily the peak hour as expressed by the highest hourly volume through the intersection.

Figure 4.4 – Conflicting Traffic Volume Peaks



This graphic illustrates how differing peak hours for different movements can affect the design peak hour and combines this with the "critical movement" concept to determine the peak conflicts that need to be analyzed.

In the a.m. peak, the peak hour for conflicting movements matches the peak volume hour. However, in the noon and p.m. peaks, the peak volume precedes the peak conflicts and the latter must be used in the analysis, even though the total volume is lower.

In the p.m. peak, the peaks for each conflict pair are also different. This means that the capacity and storage requirement must be checked for these volumes using the timing plan for the peak hour derived from the intersection peak conflict hour volumes.

Intersection Types – Roundabouts

The road authorities may require evaluation of roundabouts as the primary choice for new or modified intersections. The Ministry now requires the evaluation of roundabouts as a first option where a greater degree of control than a two-way stop is required on all roads, including high-speed (70 km/h or greater) corridors and at interchange ramp terminals.

This must be documented in the Terms of Reference. The current ministry documents can be found at the **Ministry's Traffic Circulars** website under 2008, ***T06-08 Roundabouts*** and 2006, ***T12-06 Review of Roundabouts.*** All BC MoT facility roundabout designs must be reviewed by the Chief Engineer's Office for provincial consistency.

The designer may evaluate the requirement prior to an operational analysis. However, the operational analysis is a prime criterion if the intersection location can accommodate the required roundabout geometry. The prior evaluation would include issues such as: gradients or cross slope, how well the volumes are balanced, sight distances and right-of-way availability (existing currently or feasible to acquire).

Intersection Types – Other Intersections

On two-lane roads, generally the access points to most developments will be unsignalized, with left turns permitted if sight distances and traffic volumes allow and the access point is not within the intersection functional area of an adjacent intersection.

On roadways with four or more lanes, left turns become increasingly problematic, especially left turns out of the driveway. In these circumstances access may be restricted to right-in/right-out only, or may also include left turns in (with left turns out prohibited).

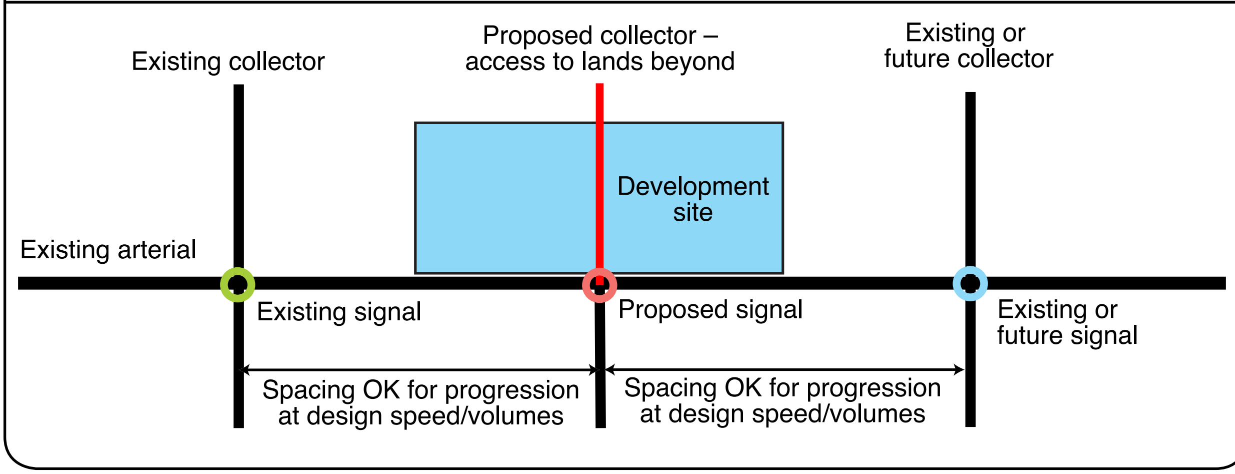
For larger developments, even with access to side streets, a signalized intersection providing a new public road through the site may provide better operation on the major adjacent road than restricting access or signalizing the side roads. Figure 4.5 shows such a situation.

This public road must also provide capacity for access to lands beyond which may be a requirement under the *Land Title Act* (see **Section 5**).

Nevertheless, such a signalized access, must not compromise existing, or preclude future, signalization of adjacent public roads that would otherwise be considered part of the system. This must be shown by a comprehensive signal progression analysis of all appropriate scenarios.

The decision to use a particular intersection configuration must be fully documented in the Transportation Design Report.

Figure 4.5 – Signalized Access



Intersection and Segment Analysis

All roadways and intersections (including freeway ramps, merges/diverges and mainline sections) and accesses included in the study area must be analyzed using criteria documented in the road authorities' traffic engineering manuals.

Where the Ministry is the road authority, the following analysis programs are acceptable:

- Synchro – All intersections in systems including any signals or potential signal systems must be analyzed as a system.
- HCS – only acceptable for:
  - isolated unsignalized low-volume intersections where queuing is not a concern and the roadway is unlikely to be signalized in the future
  - freeway operations except ramp/street intersections (must use Synchro for intersections)
  - rural, unsignalized roadways
  - arterial operations only, in addition to Synchro
- Sidra – roundabouts only
- Vissim – roundabouts, or in other special circumstances with BC MoT and municipal approval
- Other software – only in exceptional circumstances where its use addresses a site-specific issue that is not adequately addressed by any approved software, and only with BC MoT and, if required, municipal approval

All analysis must be performed using the current (at time of approval of the Terms of Reference) version of the software. If the software is subsequently updated to correct errors in calculation or interpretation, the project must be reviewed and the impact of these corrections documented.

Keyword

The primary standard used to evaluate the traffic operating conditions of the transportation system is referred to as the **level of service (LoS)**. (More information on level of service is available in the HCM.) This is a qualitative assessment of the quantitative effects of factors such as travel speed, road capacity, volume of traffic, turning movements, geometric features, traffic interruptions, delays and freedom to maneuver.

In addition, the volume/capacity ratio, progression bandwidth and queue lengths are also defined as measures of acceptable performance.

The intersection analysis for each proposed access to the site is required to show that the access design is adequate when considered as a system with adjacent intersections. The various options that are to be investigated for access to the development must be documented in the Terms of Reference. Intersection capacity analysis must be done for all design options, horizon years and time periods unless it is determined and documented that operations are not critical in each specific case. This includes all left turn and right turn lanes and signalization warrants.

Any intersection capacity analysis to be submitted with a Transportation Design Report must use the following standards and guidelines and provide the following information for the study area as required by the road authorities' traffic engineering manuals:

a. All signal timing parameters and road authorities' standards must be used unless specifically limited or expanded in the Terms of Reference template.

b. For existing coordinated systems, the highway bandwidth after development must not be significantly less than the existing bandwidth, unless overall operation is improved.

c. Pedestrian-activated crossing phases are required at all signals where pedestrians may be present. The minimum green time allowed for the cross street shall be no less than pedestrian phase plus clearance time. When pedestrian volume counts are negligible, pedestrian activation must be provided. However, the developer may apply for a waiver of the requirement for minimum phase times by presenting all applicable pedestrian counts, technical justification and by indicating the impact of any pedestrian movements that do occur on signal progression.

d. The analysis will use the posted speed limit(s) but the developer may submit an additional analysis if corridor plans allow and if it can be shown that a different speed is more efficient for progression, capacity, highway delay, queue management and travel time. Changes in delay must include both intersection delay and delay increase or reduction due to a change in travel time between intersections. (Submitting analysis for an operating speed other than the posted speed must be approved, in writing, by the road authorities before submission of the study and does not mean that a change in the posted speed will be approved.)

e. Analysis of 95th percentile queue lengths must be done for each lane group at all intersections and proposed accesses within the study area. Where queues exceed the available storage for any movement, and blocking occurs, the analysis must reflect those conditions.

f. If any option involves signalization, then it must be conclusively shown that:

   - there is no other viable option, or any other options provide a lower level of service for non-site traffic
   - the proposed signal does not significantly negatively impact signal progression or level of service

Model Calibration

Calibration of analysis models to existing conditions is critical to obtaining realistic projections of future traffic conditions. Calibration must recognize upstream and downstream constraints and measure demand on the system as well as throughput where saturated flow conditions and significant queuing occur.

Unrealistic values of future delay and queue length are often the result of inadequate calibration or inappropriate assumptions about future conditions (for example, not recognizing that queues are blocking lanes).

> Levels of service for existing conditions must be confirmed through field observation and traffic counts. These observations may include delay, queue lengths and saturation flow rates as deemed appropriate for calibration of the analysis model.

> All analysis models (HCS, Synchro, etc.) must be calibrated to local conditions unless the road authorities have accepted default values (i.e., BC MoT standard values) or those derived from other appropriate studies.

Alternative methods of calculating delay or queue lengths may be used as a preliminary check, or to confirm model projections (such as the TAC equation/nomographs see TAC *Design Guide*, Section 2.3.5.4). However the analyst must bear in mind that models use their internally calculated values to determine the reported level of service and adjust timing plans. The modelled values must be reported and used unless otherwise approved by a ministry traffic engineer in the Terms of Reference.

Traffic Signal Warrants and Spacing

Traffic signal warrant calculations must be undertaken for the approved horizon years using the road authorities' traffic engineering manuals. If a public road intersection warrants traffic signals, it must comply with the following key elements used in determining the acceptability of a signal location:

a. The proposed signal location must comply with: road authority-approved Access Management and Corridor Plans; Municipal Major Street Network Plans which have identified acceptable locations for signals given the road function; and the posted speed and the location of existing and proposed signalized and unsignalized intersections.

b. Where road authority-approved plans do not exist, the Terms of Reference for the design must outline a process whereby a network operations analysis is done to determine acceptable signal locations that maintain the posted speed limit(s) and ensure proper signal progression including all existing and future traffic signals.

c. The signal spacing must reflect both the existing street network structure and a progression analysis showing acceptable operation.

The basic requirements for signal spacing are given in Table 4.4, which is based on the TAC *Design Guide*, Table 2.3.1.1. Spacing greater than 800 m may reduce progression benefits.

In all cases, the analysis of a proposed option that includes a new traffic signal must be documented in the Terms of Reference. In every study, the developer must also present options that do not require signal installation so that the best overall solution for the study area can be identified.

Agreement to allow the analysis of signalization of an intersection does not bind the road authorities to accept the signal location upon presentation of the analysis results in the completed study.

Table 4.4 – Signal Spacing	
Design Speed	Range For Signal Spacing
50 km/h	400 – 700 m
60 km/h	500 – 825 m
70 km/h	600 – 1,000 m
80 km/h	700 – 1,100 m
90 km/h	750 – 1,250 m

Traffic Signal Phasing

All designs or reviews of existing signal phasing must be in accordance with the road authorities' standards for signal parameters and method of analysis.

> All analyses must consider signal progression. Changes in signal progression, due to the addition of new signals or changes in timing plans, must not provide significantly less than the existing bandwidth, unless overall operation is improved.

Traffic signal progression analyses submitted in the Transportation Design Report must include progression bandwidth, efficiency, level of service and queue lengths. All software output reports and files must be provided in the appendix to the report. The analysis must include all existing and future intersections (including access points), whether signalized or not, within the study area. Ministry traffic engineers and equivalent municipal staff should be contacted to advise of any specific phasing (or other parameter) requirements prior to commencement of the detailed analysis.

Operational Criteria – Level of Service

The objective of mitigation for development projects is to maintain close to the level of service that would be given without the development. In some cases the projected level of service without the development may be poor, for example on urban facilities which are expected to have continuing high travel demand and where viable improvement options are limited. In other situations, traffic unrelated to the proposed development may pose less of a constraint. In any case, direction will be provided in the Terms of Reference or in meetings before work commences on the Transportation Design Report.

Keyword

In discussion of level of service, a **change of one level** means that the delay (prime criterion in LoS) must be no greater than the same relative position in the next lower level than it was in the prior level. Thus a change from a 21-second delay (LoS C - signals) to a 36-second delay (LoS D) complies but a change to 54 seconds (just above LoS E, in the D range) does not, since the span is almost two LoS levels.

Operational Criteria – Signalized Intersections

The overall intersection level of service (LoS) is one of the most important measures of effectiveness for signalized intersection operation. Overall LoS for an intersection is based on a weighted average of the delays on individual movements. The relationship between level of service and average delay for signalized intersections is given in the *Highway Capacity Manual*. In most larger urban areas, overall LoS ratings of A to D are considered acceptable for signalized intersections. Levels of service E and F are undesirable. In suburban and rural areas, longer delays are less acceptable and expected LoS values are therefore higher, with A to C being the preferred range.

The intersection LoS is computed as a weighted average of the vehicle delay for all vehicle movements. Therefore, an intersection may have an overall LoS of C or D and have individual movements of LoS E or F. As a result, all movements must be analyzed and presented individually.

> The road authority will define the minimum LoS required for each movement type (through or turning), and by approach if required. The Report must demonstrate that the LoS targets can be achieved with the proposed mitigation.

However, it will not always be acceptable to reduce the percentage of the cycle available as green time (or bandwidth for progression) to the through-traffic stream on major roads. Reductions must be approved by the Ministry and other reviewing agencies prior to use in the design.

In urban areas, it is desirable that the volume/capacity (v/c) ratios for the design year are no greater than:

- v/c ratio of 0.85 and level of service D (based on delay) for the overall intersection
- v/c ratio of 0.90 for individual movements

In suburban and rural areas, it is desirable that the v/c ratio should be no higher than 0.80 for both the overall intersection and individual movements to reflect the lower tolerance for congestion in these areas.

Adequate queue storage lengths must be provided based on the 95th percentile queues for each lane group.

The mitigation required to achieve the stated LoS and queue/storage length targets must be identified in the Transportation Design Report. The analysis should be presented with and without the mitigation.

The addition of an unsignalized intersection or access within a signal network requires the analysis of the impact of platoon flows on its operation.

The gaps found in the time-space diagram could allow additional capacity. (If signals exist, are proposed, or may be required in the future, the analysis of unsignalized intersections must be done using Synchro.)

Operational Criteria – Unsignalized Intersections

Unsignalized intersection LoS is based on the delay that results from a stop or yield. The *Highway Capacity Manual* LoS procedures estimate average delay for each movement based upon:

- The critical time gap in conflicting traffic streams required to complete the maneuver
- The movement's traffic volume, grades and percent trucks, etc.
- The volume of traffic conflicting with the movement

The overall LoS for a four-way stop intersection is based on a weighted average of the delays on individual movements. The relationship between level of service and average delay for unsignalized intersections is given in the *Highway Capacity Manual*. No overall LoS is given for two-way stop intersections.

When left and right turns are to be permitted at an unsignalized road or access, an analysis of channelization warrants must be evaluated according to the TAC *Design Guide* and the road authorities' turn channelization warrants. A gap analysis based on the *Highway Capacity Manual* method may provide another assessment of whether separate turn lanes are needed. This analysis, combined with a traffic signal warrant study, will also aid in the determination of whether signalization would be appropriate within the horizon period.

The road authority will define the minimum LoS required for each movement type (through or turning), and by approach if required. The Report must demonstrate that the LoS targets can be achieved with the proposed mitigation. The same concept of "one level lower" applies as for signalized intersections but using the unsignalizsed LoS criteria.

Adequate queue storage lengths must be provided based on the 95th percentile queues for each lane group.

The mitigation required to achieve the stated LoS, queue and storage length targets must be identified in the Transportation Design Report. The analysis should be presented with and without the mitigation.

Turn Lane Warrants

The need for turn lanes may be determined by operational analysis that indicates the need based on capacity/delay criteria (typically for signals), or on turn lane warrants (more usually for unsignalized intersections). Auxiliary acceleration lanes may also be required. The requirements for these are discussed in **Section 5.2.8**.

Safety requirements (see **Section 5.2.11**) may dictate the need for left or right turn lanes even though volume-based warrants may not be met.

Weaving Analysis

The standard weaving analysis methodology provided in the *Highway Capacity Manual* is applied to freeways in the vicinity of ramps or mainline merges/diverges.

Weaving on urban streets is somewhat different and is much less well understood or documented than freeway weaving. Two recent papers are useful references:

- *Analysis Techniques of Weaving Section Under Non-Freeway Conditions,* Kien Y. Ho, P.E. (1998, ITE 1998 International Conference, ITE).
- *Determination of Offset Distance between Driveway Exits and Downstream U-Turn Locations for Vehicles Making Right Turns Followed by U-Turns,* Lu, Liu, and Pirinccoglu (2005, University of S. Florida/ Florida DoT, Tallahassee FL).

Although the second reference looks at U-turns, the operational movements are the same for left turns up to the intersection location. The authors make the recommendations shown in Table 4.5 (distances have been converted to metres and rounded off).

Table 4.5 – Right/Left Turn Spacing		
Turn Location	**Number of Lanes (2 way)**	**Offset Distance**
Median opening (unsignalized)	4	120 m
	6 or more	150 m
Signalized intersection	4	170 m
	6 or more	230 m

In the absence of other data, these distances should be used as initial guidelines.

This type of analysis is particularly important in determining whether or not there is sufficient separation between right-turn exit movements from a site's access and the beginning of the tapers for a left-turn lane at the next intersection. This distance must be adequate or weaving vehicles will cause delays, conflicting with through- traffic. Problems will occur especially if the proposed access is within the intersection functional area of the downstream intersection.

Weaving analysis requirements should be documented in the Terms of Reference.

Critical Collision Rate

Keyword

The **Critical Collision Rate (CCR)** represents the expected upper limit of collision rates of intersections with similar characteristics. If the actual collision rate is greater than the critical rate, the deviation is probably not due to chance but to the unfavourable characteristics of the intersection.

The CCR is a function of the average collision rate for sites with similar characteristics plus a positive adjustment to account for the desired level of confidence in the statistical test and the amount of traffic exposure at the particular site under investigation. If the actual collision rate exceeds the CCR, the site is flagged as collision prone (performing worse than average) and becomes a candidate for further investigation.

For additional information see *Corridor Management Plan Safety Review Guidelines*, Section 1.1, page 4, located at: on the **Ministry's website**.

4.2.12 Mitigation Measures

The design process is intended to identify any deficiencies when the development-generated traffic is analyzed on the existing road system with existing or future traffic volumes. The designer must identify a range of alternative mitigation measures that could be applied to the access location and design, the adjacent road network and the site itself. An appropriate range of mitigation options is to be analyzed and the most appropriate option, or combination of options, documented in the Transportation Design Report with the reasons for selecting the recommended combination.

All access points and other mitigation measures associated with the proposed development must be designed in accordance with good design practice to:

- Protect the functional classification of the highway
- Protect public safety
- Maintain smooth traffic flow
- Provide appropriate access to the development

4.3 Procedures

4.3.1 Terms of Reference Revisions

During the course of the design, the designer may arrive at results that conflict with items in the Terms of Reference, or may identify alternative solutions that provide a better design (e.g., safer, lower cost, higher capacity, etc.). The designer should request a review from the road authorities and provide all appropriate documentation. If the change is accepted, the element may be included in the design.

4.3.2 Reporting Design Criteria and Assumptions

The Transportation Design Report should contain sufficient documentation so that the reviewer can clearly and unambiguously see that the Terms of Reference and all applicable design criteria have been met and that all assumptions are clearly documented and justified. Nevertheless, it is the designer's responsibility to ensure that all applicable requirements have been met for the project even if they are not detailed in the Terms of Reference.

Calculations

All analysis calculations must be provided in a printed appendix or provided in a digital file.

Summary tables for each intersection must be provided and show the required information in a format similar to that shown in the example in Table 4.6.

Table 4.6 – Highway 51 at Main Street PM Peak 2020

	E/B			W/B			N/B			S/B		
	LT	Th	RT	LT	Th	RT	LT	Th	RT	LT	Th	RT
Volume	186	269	74	25	210	123	73	1610	29	263	1183	77
Total split (seconds)		25.7			25.7			28.8		8.5	41.3	
v/c	.96	.85		.14	.63		.71	.98		1.06	.51	
Delay (seconds per veh)	74	41		21	28		25	15		86	2	
Movement LoS	E	D		C	C		C	B		F	A	
Approach LoS	D			C			B			B		
95th percentile queue	14	19		1	13		4	27		14	4	
Cycle = 75 seconds / **Bandwidth**	n/a			n/a			25 seconds			40 seconds		
File: Hwy 51-Main PM 2020												

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5 Important Design Issues – Off-Site

Table of Contents

Other Sections

Appendices

5.1 Background

The design of off-site facilities must follow currently accepted practices and guidelines as documented in: the TAC *Geometric Design Guide for Canadian Roads*, the Ministry's *BC Supplement to the TAC Guide*, the Ambient Guidelines established for the relevant highway segments and, where applicable, relevant municipal requirements.

5.1.1 Design Domain and Design Guidelines

The appropriate design criteria must be selected for each roadway element and the selection documented in the Transportation Design Report. This is discussed more fully in **Sections 5.2.1** and **5.2.2**.

The designer is responsible for ensuring that the proposed design complies with the appropriate guidelines, provides adequate roadway capacity for the anticipated traffic volumes and meets accepted safety criteria. This must all be documented in the Transportation Design Report.

5.1.2 Role of Access Management

Access management plays a pivotal role in designing effective, high quality access to adjacent developments along highways. BC is in the process of developing comprehensive Access Management Plans for many key sections of provincial highways, especially in urban and suburban areas.

All new or changed developments must follow the concepts defined in the plans where Access Management Plans are in place. Where such plans do not yet exist, all new or changed accesses must be designed based on acknowledged "good practice" for access management. Accesses must conform to what would reasonably be expected in a comprehensive plan for the area in question.

The primary source for access management techniques is the TRB *Access Management Manual*. Other resources include: a Transportation Research Board committee (ADA70); a bi-annual conference; and the **Access Management website** devoted to access management issues.

Access management principles are not new. What is changing in BC is the understanding that we need to apply them rigorously, consistently and appropriately to each road across the province.

The *Access Management Manual* states:

Keyword

Access management is the systematic control of the location, spacing, design, and operation of driveways, median openings, interchanges and street connections to a roadway. It also involves roadway design applications, such as median treatments and auxiliary lanes, and the appropriate spacing of traffic signals.

The purpose of access management is to provide vehicular access to land development in a manner that preserves the safety and efficiency of the transportation system.

The contemporary practice of access management extends the concept of access design and location control to all roadways – not just limited-access highways or freeways.

5.2 Technical Issues

5.2.1 Design Domain

Background

The Ministry adopted the Transportation Association of Canada (TAC) *Geometric Design Guide for Canadian Roads* in 2001 as the basic geometric design guidelines for the roads under its jurisdiction. The Ministry maintains the *BC Supplement to the TAC Geometric Design Guide*. This document provides interpretation and specific BC requirements within the general scope of the TAC guide.

All ministry projects (including work carried out for mitigation by developers) must comply with these guidelines. Municipalities may have similar ones.

These geometric design guidelines do not deal with the provision or analysis of capacity, signage, and signal operations, etc., that are dealt with in other sections of this manual and other reference documents.

Basic Concept

The key concept in the TAC guidelines is that of **design domain**. This philosophy presents (in most cases) a range of limiting values for key design parameters. The designer's task is to select an appropriate value within this range that best produces a cost-effective and safe design that is consistent among elements and along its length. In some cases, the range may be quite narrow, may have single or multiple discrete value(s) or have an absolute value at one end of the range and be open-ended at the other end.

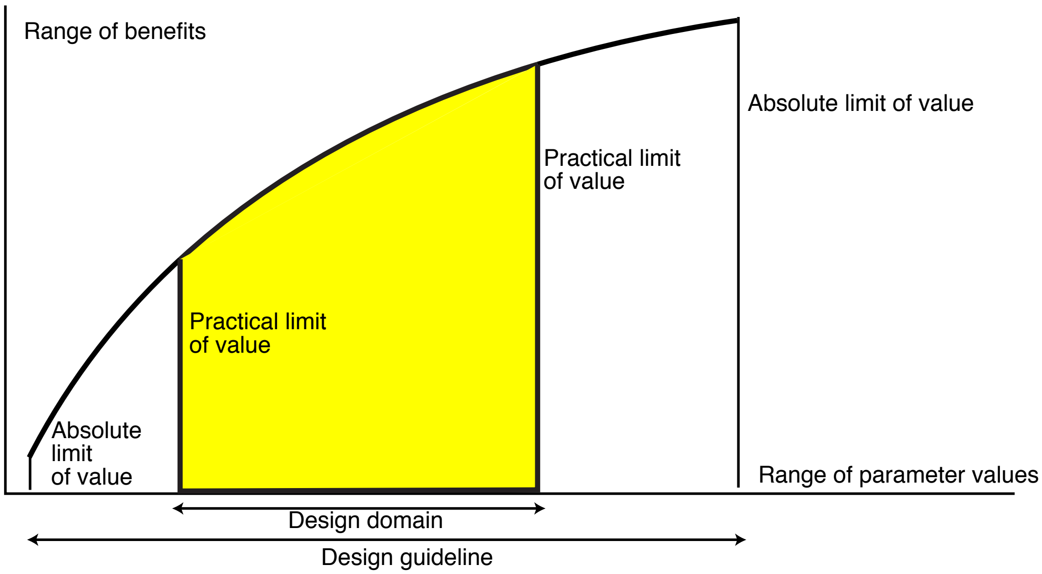
> In selecting the appropriate values from the design domain, the designer must ensure that multiple minimum values are not used.

Prior to development of the design domain concept, many designs were based on "look up the number in the table and use that value." Under the design domain approach, each decision has to be documented and justified as appropriate to the specific circumstances of the project.

The *BC Supplement* provides additional guidance. It limits some of these values to those defined by the Ministry as appropriate for BC conditions and financial capabilities. The documents have to be used together to develop the appropriate design criteria. Municipalities may have similar documents.

The design domain approach is discussed in Chapter 1 of the TAC *Design Guide*, specifically in Sections 1.1.5 and 1.1.6. The concept is illustrated in Figure 5.1 where an arbitrary parameter is shown with two ranges of values. In selecting the appropriate value for each project (which lies within the yellow range) the designer must consider the impact of the value of this parameter and all other related parameters.

Figure 5.1 – Design Domain



Key Concepts

A number of key design domain concepts are apparent:

- Consistency of parameters is a critical issue that impacts safety.
- Consistency in design between adjacent roadway segments is important to minimize driver errors (see **Section 5.2.2**).
- Choice of parameters above the minimum acceptable usually gives a more forgiving (safer) design and better visual appearance.
- Where the value of one parameter is constrained by external factors, the values of other parameters must be adjusted to retain consistency.
- Where the domain is defined or constrained by the project Terms of Reference, that definition/constraint should be followed, if practical.
- Where the domain is defined by the *BC Supplement*, the *BC Supplement* takes preference.
- In other cases, each parameter must be reviewed and the appropriate selection made so that it is consistent with those already defined.

This is not a complete list. Each project has to be evaluated individually.

As an example, the following parameters are all linked:

- Design speed is defined by the adjacent sections or corridorplan = 80 km/h. (Limits lower value of horizontal radius. A long radius/short tangent design is preferred but excessive radius can encourage higher speeds.)
- Signal progression speed = 80 km/h. (Consistency ensures smooth traffic flow, fewer conflicts.)
- With no street lighting, alignment is headlight controlled. (Limits lower K value, primarily for vertical curves.)
- Turn lane tapers and deceleration lengths are determined by design speed (limits lower value). Storage length required is determined by queuing analysis (limits lower value based on traffic volumes).

5.2.2 Ambient Design Guidelines

The Ministry has adopted (March 1999) a design philosophy called "Corridor Ambient Geometric Design", documented in BC MoT's document *Corridor Ambient Geometric Design Elements Guidelines*. It recognizes the need for cost-effective upgrades to the provincial highway system. These upgrades provide required safety improvements in a manner that is compatible with adjacent highway segments that function with an acceptable degree of safety. This philosophy also uses principles embodied in the Context Sensitive Design approach. The approach is compatible with the design domain principles in the TAC *Design Guide*. This philosophy is also applicable to development projects for the design of mitigation works and site access.

The philosophy and procedures are described in the Ministry's *BC Supplement*, "Geometric Improvements" section, in the *Guidelines for the Preparation of the Ambient Condition Rationale* and supporting documents. Municipalities may have similar design guidelines.

The road authorities will provide developers with the appropriate geometric design element dimensions or controls for those segments of highway applicable to each development.

The developer must use the geometric design element dimensions or controls pre-approved by the road authorities. Developers cannot develop reduced requirements in isolation and expect the road authorities to approve them when submitting a design (see **Section 2.2.8 – Terms of Reference**). The basic design element dimensions must be summarized in a Design Criteria Sheet (see **Appendix A – Terms of Reference**) and approved in the Terms of Reference. Justification for all design exceptions must be listed on this sheet.

The new work will have to be built to an equal or higher standard than the existing roadway as a prelude to upgrading of adjacent sections. Where this imposes undesirable transitions over a short length of roadway, the road authorities may require design to these standards but permit construction to match the existing roadway. This may mean, for example, design and earthworks construction to the desirable cross section, but construction of pavement to match the existing beyond any required turning or acceleration/deceleration lanes, where this is safe.

Ambient guidelines deal only with geometry (including cross sections and clear zones), and have no impact on the requirements to achieve designated levels of service (e.g., required lane configuration).

Over and above ambient condition considerations, safety issues that are likely to be made more significant by the addition of development traffic must be addressed as a condition of approval by the road authorities.

Functional Collector and Arterial Roads

Keyword

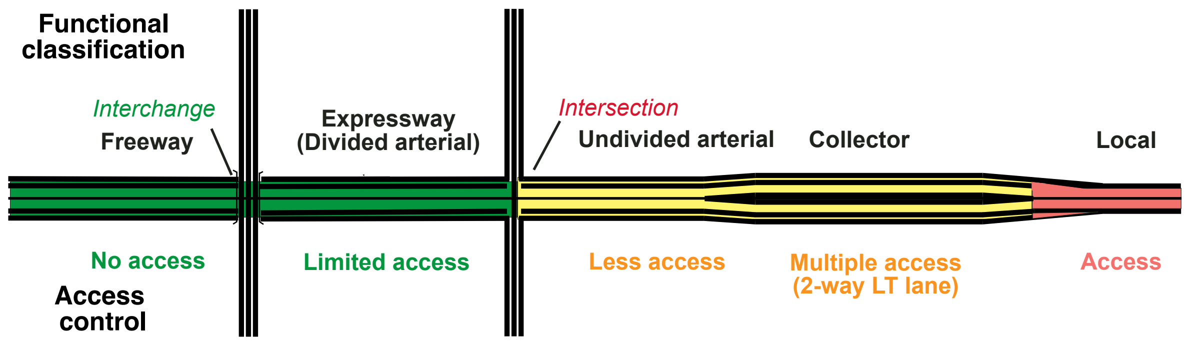
In this section, **functional collector and arterial roads** refers to classifications described in **Section 4.2.9 – Functional Classification System** as:

- All roads classified as major roads or higher in unincorporated areas
- All roads classified as arterial highways in municipalities
- All major road network plan elements

This is illustrated in Figure 5.2.

Any other roads connecting to any of the above roads in the immediate vicinity of the intersection (typically within the intersection functional area, see **Section 5.2.5**) must be designed so that the function of the higher class element is maintained.

Figure 5.2 – Functional Classification



Local Roads

In this section, **local roads** refers to all other roads in unincorporated areas. Ambient design considerations are not normally applicable to local roads under BC MoT jurisdiction.

In municipalities, local municipal design criteria apply to roads that are not provincial Arterial Highways or are outside the intersection functional area where they connect to an arterial highway.

5.2.3 Intersection Design Criteria

Development accesses should normally be considered as public roads where they lie within the intersection functional area and should be designed to appropriate standards for the type of intersection control and traffic volumes. Low volume residential and commercial accesses may, at the discretion of the road authority, be designed to lower standards where this does not impact operation or safety. On ministry facilities, any access requiring a detailed transportation design report must be designed to public road standards.

Design Vehicle

Intersections must be designed to accommodate the normal design vehicle within the appropriate designated lanes for that movement. Larger vehicles may, with the approval of the Ministry Traffic Engineer, use more than one lane on low standard facilities, but must not move into lanes designated for traffic in the opposing direction. Exceptional vehicles (such as fire trucks) may be accommodated outside of these criteria.

The type of development determines the design vehicle. Non-residential developments normally require access by semi-trailer vehicles such as WB-20s.

Approach Grades

Intersection approach grades must provide for adequate safe stopping by all vehicles. Approach grades should not exceed 3% for the length of the design vehicle (typically 20 m) and be less than 5% beyond that. For small residential subdivisions that are "dead-ended," the design vehicle may be reduced to an HSU vehicle and the grade maximum increased to 4% for the length of the vehicle, then 6% beyond that. For streets and commercial accesses see the TAC *Design Guide,* Section 2.3.2.3, and for residential driveways only see the *BC Supplement,* Section 1420.08 and Figure 1420.M.

Use of grades flatter than these maximum values is always preferred and may be required where approach curve radius is nearing the minimum for the design speed.

The approach profile must be such that surface water from the side road does not flow into or across the major road.

5.2.4 Key Access Management Principles

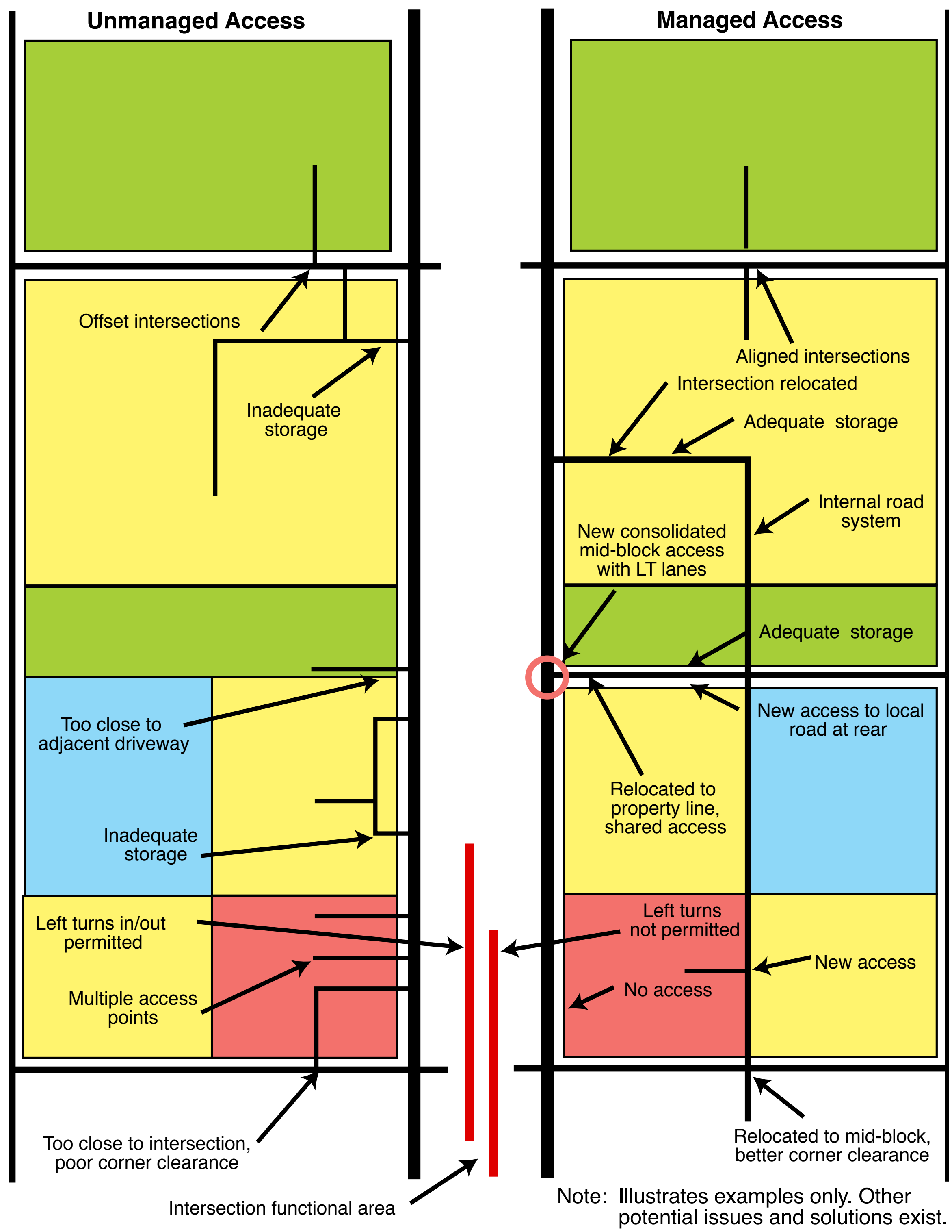
"Access management programs seek to limit and consolidate access along major roadways, while promoting a supporting street system and unified access and circulation systems for development. The result is a roadway that functions safely and efficiently for its useful life, and a more attractive corridor" (*Access Management Manual*).

Ten key planning and design principles are identified in the *Access Management Manual* that describe how to manage access. Any combination of these methods may be appropriate for a given roadway segment and development sites along or adjacent to it.

1. Provide a hierarchal roadway system.
2. Promote intersection hierarchy.
3. Provide a supporting street and circulation system.
4. Preserve the functional area of intersections and interchanges.
5. Locate signals to favour through movements.
6. Limit direct access to major roadways.
7. Limit the number of conflict points.
8. Separate conflict areas.
9. Remove turning vehicles from through-traffic lanes.
10. Use non-traversable medians to manage left-turn movements.

An example of how access management might be applied to a segment of roadway is illustrated in Figure 5.2.

Figure 5.3 – Access Management Principles



Note: Illustrates examples only. Other potential issues and solutions exist.

The designer of the project is responsible for ensuring that the site can be safely and effectively integrated into the public road system. In applying these principles to an individual site, recognition must be given to both the existing roadway configuration and the proposed configuration with an Access Management Plan in place.

This may require transitional provisions such as:

- Temporary direct access, or access restrictions, until such time as alternative access via a local road system is in place, or planned road authority upgrades are constructed .
- Restrictions to access location (see Section 5.2.5 on this page).
- Restriction on development density until alternative access can be provided.
- Dedication of right-of-way for future improvements.

Temporary access will only be approved in situations that are clearly time-limited (e.g., an imminent roadway improvement that will provide alternative access). The improvements must be defined in the report along with discussion of their implementation.

5.2.5 Intersection Functional Areas

The concept of intersection functional areas is critical to successful access management once the basic roadway network structure is defined. Any access point within this area will create operational problems for both the property owner and road authority. It is important to understand that "intersection" includes access points, and that the same considerations apply to the driveway leg as apply to the road. Key parameters are illustrated in Figures 5.4, 5.5 and Table 5.1

The corner clearance concept only applies to very low volume accesses on low volume, low-speed streets (typically urban residential subdivisions). These are minimum distances and they are not appropriate for most commercial accesses on significant roadways (see **Section 5.2.13**).

The intersection functional area includes the area within which traffic operations are affected by the operation of the intersection including:

- All acceleration (downstream) and deceleration (upstream) lanes
- The back of the longest queue or turn lane
- Distance travelled during perception/reaction time, and stopping distance at the back of queue
- The length of any dropped lanes on the downstream side of an intersection
- Not less than the stopping sight distance to the next intersection beyond any dropped or merged lanes if present

Fig 5.4 – Intersection Functional Area

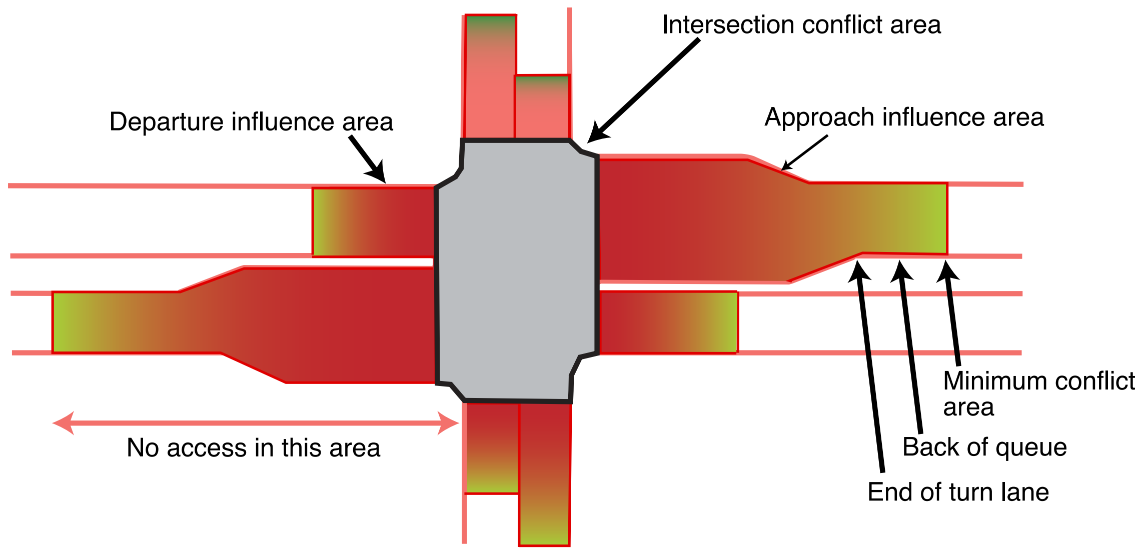
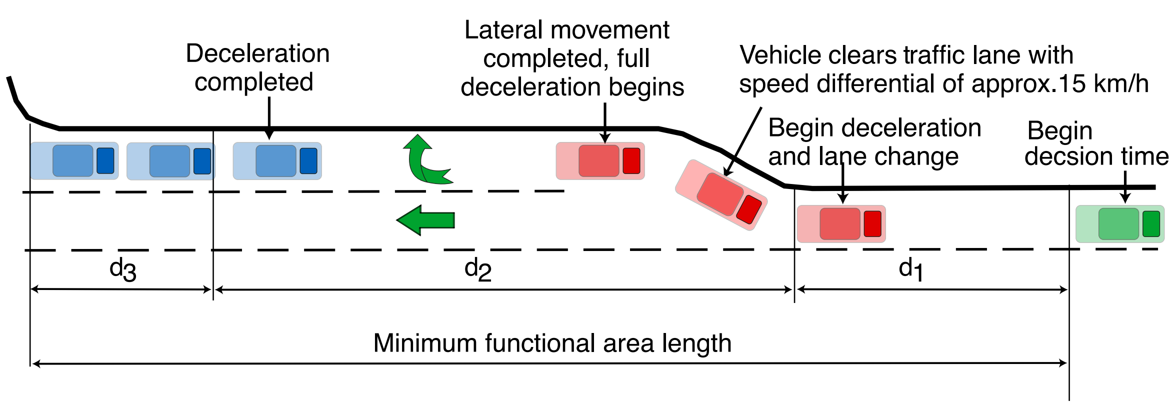


Fig 5.5 – Intersection Functional Area – Parameters



d_1 = Distance travelled during perception/reaction time
d_2 = Distance travelled while driver changes lanes and decelerates to a stop
d_3 = Storage length

Figures 5.4 and 5.5 are based on material in the *Access Management Manual.*

Table 5.1 – Intersection Functional Area						
Location	**Speed (kph)**	**Distance travelled in perception/ reaction time[a], d1 (m)**	**Maneuver distance, d2 (m)**	**Perception–reaction time, plus maneuver distances, d1 + d2 (m)**	**Queue storage length [b] d3 (m)**	**Upstream functional distance d1+d2+d3 (m)**
Rural	80	55	130	185	15 [c]	200
	100	70	185	250	15	270
	110	80	250	320	15	335
Suburban	50	35	50	80	115 [d]	200
	65	45	85	120	75 [e]	205
	80	55	130	186	40 [e]	225
Urban	30	15	20	35	150 [g, h]	190
	50	20	50	69	150 [g, h]	220

Source: *Access Management Manual*. Table 8.4 converted to metric units

[a] Perception-reaction time is also known as Perception, identification, evaluation and volition time (PIEV)

[b] Queue storage needs to be determined for each approach to each intersection using methods such as those discussed in the *Access Management Manual*, Chapter 10.

[c] Minimum storage of two automobiles or one truck.

[d] Example of storage for 15 automobiles.

[e] Example of storage for 10 automobiles.

[f] Example of storage for 5 automobiles.

[g] Example of storage for 20 automobiles.

[h] Dual left-turn lanes can reduce the queue storage length.

Application

The designer must clearly show that the proposed access points do not fall within the intersection functional area of any intersection, including access points to adjacent property.

If conflicts with adjacent access points occur, the designer must show how these may be eliminated by:

- Providing alternative access
- Consolidating access to adjacent properties (with reciprocal access agreements)
- Providing turn restrictions on the access
- Eliminating or relocating the access

In the case of a corner lot, the access point(s) must be limited to one on each roadway, and must be located at the lot line furthest from the adjacent intersection. The access may be restricted to right-in and/or right-out only unless the designer can show that use by other movements will not cause operational or safety concerns. Left turns to/from an access across or from an intersection left turn lane on the street will not be permitted.

If the adjacent lot has a similarly located driveway, then the driveways must be consolidated as a single shared driveway. Provision for alternative access to a corner lot must be made. If this would require access through adjacent property, this must be identified and protected.

5.2.6 Corridor Analysis

The project design must take a corridor-level view to determine the adequacy of the adjacent road system. Any intersections under analysis must be considered part of the total system and not be analyzed or optimized as individual entities. Intersection spacing must be consistent with the functional classification, desired operating speed and, if appropriate, signal progression of the associated roadway. Recommendations which do not conform to corridor plans, or which erode the function or proposed function of the study area roads, will not be accepted unless the Transportation Design Report shows that a better level of service to the general traffic stream is obtained.

5.2.7 Mitigation

Sections 5.2.7 to 5.2.15 provide more detailed information about the various measures that can be used to mitigate development impacts. The alternatives and access options being evaluated must be outlined in the Terms of Reference. If these alternatives and mitigation measures are acceptable to the road authorities and other reviewing agencies for analysis in the study, they become part of the approved Terms of Reference.

> All reasonable mitigation measures must be considered and presented in the Transportation Design Report. Failure to provide documentation of a comprehensive list of options will result in the return of the study to the developer without detailed road authority review.

All modifications and improvements must be made to the road authorities' design standards.

Site Access Alternatives

The transportation design must document a reasonable range of feasible access alternatives and options (existing and proposed), show that they have been reviewed and identify the impacts of these options. This includes not only those shown in the concept plans for the site, but also any other alternatives that may reduce the impact of the development traffic on the adjacent road network, including those requested by the road authority and other reviewing agencies and outlined in the Terms of Reference.

Access alternatives that must be considered include:

a. Provide alternate access routes to the municipal road network instead of the highway.

b. Amalgamate or relocate existing or proposed accesses.

c. Provide access roads, frontage roads or rear service roads.

d. Restrict turns at access points (must provide a physical barrier).

e. Provide auxiliary lanes to accommodate acceleration, deceleration and turning movements without impacts to through-traffic.

f. Provide separate one-way entrance and exit accesses.

g. Ensure that all site access movements are unsignalized.

h. Provide other reasonable access alternatives.

In all cases, no direct access to a Controlled Access Highway or other major facility will be granted if reasonable alternative access exists or could be provided by the developer. Direct access to these facilities can only be considered where it has been shown that no other reasonable alternative exists or that direct access or limited direct access would provide better overall performance of the study area network roads and does not compromise the safety of the travelling public. Where direct access is allowed, the development design must be able to take advantage of future alternate access when it is available, at which time the direct access will be removed.

All reasonable alternatives must be analyzed and evaluated regardless of their associated costs. (Although cost is an element of the ultimate selection process, a less safe or less efficient alternative will impose costs on society for many years into the future.) The recommended improvements and measures developed must be feasible and reasonable.

The traffic generated by the proposed development must not contribute to excessive deterioration of the highway corridor and/or road network operations in the study area. Acceptable access and intersection levels of service were previously discussed in **Section 4.2.11**.

If an acceptable level of service cannot be provided on the existing road network, then the transportation design must thoroughly investigate and document all possible road network improvements or mitigation measures required to accommodate site traffic and preserve the safety and mobility of the surrounding road network. Delay must also be considered.

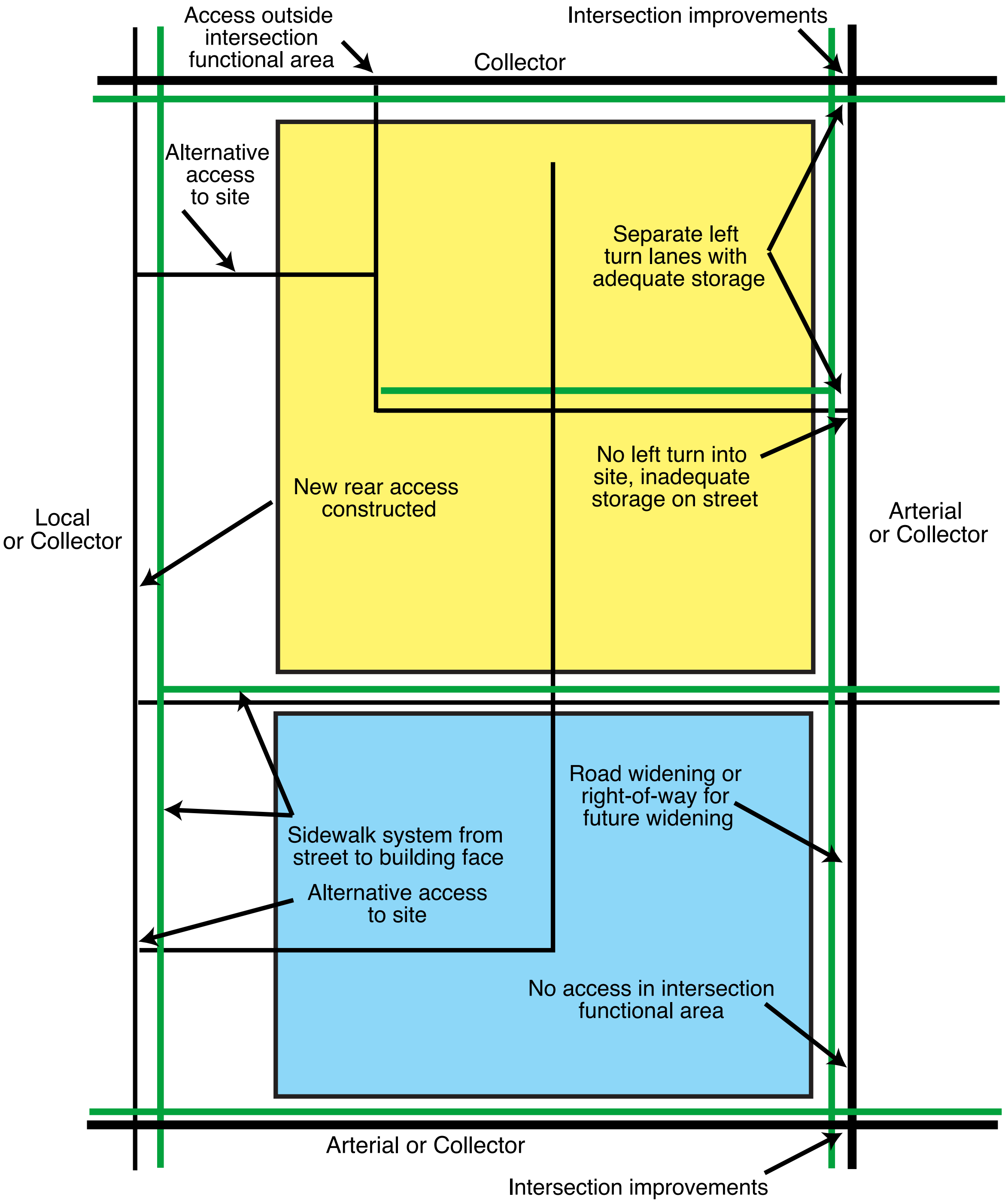
The improvements could include:

a. Widening of the surrounding network roads
b. Addition of left-turn or right-turn lanes at the access and/or other intersections
c. Construction of a new overpass or interchange
d. Construction of new frontage or rear service roads
e. Redesign, restriction or relocation of existing accesses (may include change of intersection type, such as roundabouts, shared access, rear access, etc.)
f. Signalization of an existing unsignalized public road intersection
g. Improved signal operation by changing phase sequence and/or timing changes
h. Coordination of signals
i. Relocation or closure of existing public street intersections
j. Construction of a missing link of the local or regional road network
k. Provision of new local road connections to provide alternative access locations for site traffic instead of direct access to major arterial roads or highways
l. Provision of centre left turn acceleration lane on the highway
m. Installation of median barrier or other median treatments

All highway network improvements must comply with the road authorities' design standards.

Figure 5.6 shows some off-site mitigation examples for an example site. Different sites will require different mitigation.

Figure 5.6 – Off-Site Mitigation Example



Note: Illustrates examples only. Other potential issues and solutions exist.

Special Cases

Some special cases impacting access location and design that must be documented include:

a. Access to lands beyond – The *Land Title Act* must be satisfied in respect to providing for future development of parcels with either no current road frontage, or which would not have road frontage with the proposed development.

b. Access may be restricted on cross streets close to freeway interchanges (must be shown to be operationally acceptable)

c. Freeway ramp terminals may be located at local roads prior to the cross street if it is clearly shown that there is adequate ramp queuing distance at all times and an adequate margin for future traffic growth beyond the design year. (In this context, the ramp terminal is the end of freeway regulations and driving conditions. The road beyond this point is a non-freeway facility.)

d. See **Section 4.2.10 – Assignment of Development Traffic** regarding multiple access points to one development.

5.2.8 Queue Storage Lengths and Turn Lane Guidelines

Appropriate (Ministry or municipal) turn and acceleration/deceleration lane guidelines must be used to determine the need for left and right turn lanes at intersections.

The ministry design guidelines for turn lanes are as given in:

- TAC *Design Guide,* Chapter 2.3 – Intersections and Chapter 3.2 – Access.
- *B.C. Supplement,* Chapter 700 – Intersections and Access

Turn lanes are required to:

- Protect through-lane traffic capacity
- Provide a safer location for drivers to wait for acceptable gaps in opposing traffic streams (unsignalized intersections)
- Provide storage for permissive left turns at signals during all phases, or for protected left turns at signals during the red phase
- Provide a safer waiting location if the sight distance for following vehicles is below the appropriate decision sight distance

Vehicle queuing analysis is an integral component of intersection design. Queuing areas must provide sufficient storage for vehicles so that they do not block other traffic. The queuing length to be provided at an intersection is related to the volume and available capacity of the lane group and the peaking characteristics of that traffic. The intersection analysis or simulation will provide queue length information. Sufficient storage for 95^{th} percentile queue lengths must be provided. The TAC *Design Guide* equation (Section 2.3.5.4) may only be used for a preliminary estimate of storage requirements. The design must be based on intersection analysis.

Where the analysis shows signal queues that block adjacent access points, alternative solutions must be considered and included in the Transportation Design Report.

Acceleration and deceleration lanes must be designed in accordance with the standards established in the TAC *Design Guide* and the *BC Supplement* or appropriate municipal standards.

In determining the need for acceleration and deceleration lanes, it is important to note the following:

a. When safety is a concern due to site specific conditions such as limited sight distance, a turn lane may be required even though the volume warrants are not met.

b. If the access will have a significant volume of vehicles exceeding 15,000 kilograms GVW, the access peak hour volumes must be adjusted (using PCU factors) in the interest of public safety, to reflect the impacts to auxiliary speed change lane warrants.

c. If a design element of the access is within two different speed zones, the criteria for the higher speed zone applies.

d. When there are three or more through lanes in the direction of travel, consideration may be given to dropping the requirement for the right turn acceleration and deceleration lanes, unless the site has a high volume access or a specific geometric safety problem exists. In waiving the requirement for a speed change lane, the posted speed and the function of the highway will also be considered. Prior approval is required, in writing, from the road authorities before a study with a waived requirement for a speed change lane can be submitted.

e. On multi-lane facilities, the traffic counts must determine the curb lane volume and the analysis must reflect any additional traffic in the curb lane from/to adjacent developments (existing, proposed and potential).

5.2.9 Traffic Control Signs, Pavement Markings and Traffic Signals

All traffic control signing, pavement marking and signal indications or head locations must comply with the *Motor Vehicle Act/Regulations* and the BC Sign, Pavement Marking and Signal manuals whether on provincial or municipal roads (see **Appendix C – References**).

Signs that do not comply with the legal requirements, that are incorrectly used, or not properly visible, defeat the purpose of providing simple, uniform and quickly recognized instructions to road users. Moreover, incorrect sign usage may lead drivers to misinterpret a sign when it is used correctly in other locations.

Although traffic control devices are not enforceable on private property, they should comply with legislation to avoid driver confusion and possible liability exposure for the owner. Road authorities may remove or replace non-compliant signs at access points.

5.2.10 Roundabouts

Road authority policy may now require consideration of roundabouts. BC MoT now requires consideration of roundabouts at all intersections including those on high speed corridors. The designer must consider the use of roundabouts for all intersections and access points where the road authorities require this review See **Section 4.2.11 – Intersection Types – Roundabouts**. The designer must justify why a roundabout is not appropriate if that is the case.

The primary BC MoT reference for roundabout design is the *Kansas Roundabout Guide* (see: **Kansas Roundabout website**) which is to be used in conjunction with Section 740 of the *BC Supplement*..

The FHWA document *Roundabouts: An Informational Guide* is an additional reference. Where a roundabout is to be designed, the road authorities may require an independent review of the proposed design.

5.2.11 Traffic Safety

Traffic safety is a critical concern; no development project should compromise the safety of the travelling public. However, it is not the intent of the road authorities to require a developer to take extraordinary measures to address existing safety problems unless the situation is so unsafe that the proposed access cannot be accepted without mitigation of the existing problems.

If specific safety problems exist that may not be apparent to the proponent, the road authorities must indicate this in the Terms of Reference (See **Appendix A – Terms of Reference**) and state how they are to be identified and documented. In some circumstances this may require a Road Safety Audit to properly identify the problems.

The designer must review the operation of the existing roadway from a traffic safety perspective and identify any features or operating conditions that may be made worse by the proposed development.

In addition to on-site observations, the initial review may include examination of the most recent five years of collision data or summarized data provided by the road authority.

> If there are significant problems and they may be made worse by the proposed development, a more detailed safety evaluation must be a part of the design process for each identified location.

All proposed designs must conform to current safe roadway design practices and must minimize hazards to the public.

Analysis for access design and roadway improvements must ensure safe stopping, decision sight distances and intersection sight distances. Vehicle conflicts, potential accident locations, pedestrian, transit and bicycle activities must also be considered.

Examples of safety-related issues include:

- Known collision history
- Inadequate geometry of the access and its impact on entering and exiting vehicles
- Conflicts between vehicles turning into or out of the site (especially left turns), and pedestrians walking along sidewalks or cyclists in bicycle lanes on the street or site driveways
- Location of bus stops in proximity to a new access or intersection
- Sight distances for through-traffic and vehicles entering or exiting the site
- Weaving distance for vehicles entering or exiting the site

5.2.12 Sight Distance

It is important to ensure that the proposed access has adequate vertical and horizontal (lateral) sight distance especially on a curve or on a road which passes through rolling or mountainous terrain. Sometimes landscaping, a median or lateral barrier may hinder the driver's ability to find a suitable gap in the traffic stream. The sight distance is adequate when a driver has an unobstructed view of the entire access, or intersection, and sufficient length of the intersecting road or highway to avoid conflicts (i.e., the intersection sight triangle).

Basic design requirements are provided in the TAC *Design Guide*. These must be compared with field observations to ensure that the sight distance criteria for the approved design speed are met.

The greater of the sight distances must be used; either the intersection turning sight or decision sight distances.

In addition, the statutory requirement for a "corner cut" sightline must be addressed. (*Transportation Act Regulations* 513/204, Part 3, Sections 11-13, or equivalent municipal bylaws)

5.2.13 Local Road Corner Clearances

One of the key elements in determining an acceptable location for a site access is its location with respect to adjacent roads and its proximity to the functional area of adjacent intersections (see Figure 5.2). The distance from an intersection to the nearest upstream or downstream access is called a corner clearance.

> For all roads other than local access roads, the driveway must be located outside of the intersection functional area (see **Section 5.2.5**).

For local access roads, a driveway may be located within the intersection functional area provided that the Transportation Design Report shows that this will not reduce capacity or produce safety problems. Minimum corner clearances for local access roads are discussed in Chapter 9 of the *Access Management Manual* and Chapter 3.2 of the TAC *Design Guide*.

In the case of a corner lot where the lot boundaries fall within the intersection functional area, the access point(s) must be limited to one driveway on the minor road that must be located at the lot line furthest from the adjacent intersection and:

- If the subject and adjacent lots are used for any purpose other than single-family residential use, and the adjacent lot has a similarly located driveway, then the driveways must be consolidated as a single shared driveway.
- Provision for future alternative access to the corner lot must be made.

If the lot cannot reasonably be served by a single driveway, then a right-in-only driveway may be provided on the major street subject to the above conditions and the Transportation Design Report showing that provision of this driveway will not cause conflicts with other traffic movements on the major road.

5.2.14 Pedestrian, Transit and Bicycle Facilities

The impacts of alternative modes of travel on the reduction of motor vehicle use are discussed in **Section 3** of this manual. Where appropriate, the project design must consider and document provisions that would encourage alternative modes of travel to and from the site. Where trip or parking rate adjustments are being requested (**Section 3.2.4 to 3.2.7**), provision of pedestrian, bicycle and transit facilities will be a large consideration in the review of the project Transportation Design Report.

Road authorities use various methods to identify where and when pedestrian and bicycle facilities are required. These include:

- Bicycle and pedestrian network plans
- Various warrant systems (see **Appendix C – References**)
- Individual site specific requirements usually based on the intensity of development

Pedestrian connections must integrate the site's buildings with:

- Sidewalks and bicycle facilities on the adjacent streets
- Transit stops
- Pick-up and drop-off points
- Other developments in the area

Proper design of pedestrian facilities can reduce the use of motor vehicles for trips within a development and between nearby developments. This is especially important when shared parking is being considered. Pedestrian facilities must consider the comfort and safety of the users through provision of:

- Adequate crosswalks
- Designated walkways lighting and security
- Curb cuts and ramps for wheelchair access

For pedestrian crosswalks across vehicular lanes, consideration may be given to delineating them with a surface that is different from the roadway (e.g., pavers or scored concrete). Nearby signals must provide adequate pedestrian crossing times.

Where sidewalks are provided on the adjacent streets or are planned as part of a pedestrian route plan, they must be provided on the development site and an internal sidewalk system must be provided to link the site to the street.

For large retail or other commercial developments, transit facility locations must be considered:

- For areas adjacent to building entrances
- At key locations along circulation drives
- At major pedestrian focal points along the external roadway system

The designer must review the adequacy of the road and bicycle path network within the study area to ensure that it provides a viable alternative mode. This includes features such as bicycle-safe storm sewer covers. Where a bicycle route plan exists, the identified provision must be made on the street and appropriate connections provided to and within the site.

Pedestrian, transit and bicycle facilities must be identified in the Terms of Reference for the project design. The road authorities' cycle policies must be used as a guide to providing cycling facilities. Other references are provided in **Appendix C – References**.

Pedestrian and bicycle facilities must be designed in accordance with appropriate Ministry and local government guidelines or standards and with adequate dimensions for the anticipated volumes. In the absence of BC specific requirements for pedestrian facilities, designers may wish to refer to the Ontario regulations (see **Appendix C – References**) or the *Americans with Disabilities Act (ADA)* guidelines and interpret them in the BC context.

5.2.15 Traffic Calming Devices

A road that is well designed in the context of its intended use, and is in the correct position within the network hierarchy, should not need traffic calming.

Traffic calming devices that impede vehicle flow cannot be used on roads intended to carry through traffic. Traffic calming devices may be part of a mitigation package if it is shown in the Transportation Design Report that they are needed to address the potential for traffic shortcutting through local streets that results from the development proposal. This would typically be the result of an inappropriate connection of a local street to a street of too high a classification. It could also be the location of the development in an area not served by a well-developed road network. Provision must be made for correction of these problems by improving the road network.

See **Appendix C** for references to some relevant documents.

5.2.16 Landscape Design Considerations

The purpose of this section is to identify landscaping issues that are relevant to traffic operations and safety. It is not intended to deal with the aesthetics of landscape design.

The off-site design considerations must include landscape elements that minimize the visual impact of the development on the operation of the adjacent road and highway network. Landscape design must consider the following key elements relevant to traffic operations and safety:

- Ensure preservation of sight distance at all intersections, including pedestrian and cyclist crossings both when planted and at maturity.
- Retain existing land forms to minimize noise and visual intrusion where these do not compromise sightlines.
- Preserve adequate visual clues to the development and its access locations.

These landscape concerns should be considered in terms of local government or regional environmental and landscape plans that may have implications on the way the site is designed. Site development plans must successfully accommodate landscape and visual concerns across a broad range of urban, suburban, rural and natural landscape situations. In general, design solutions for landscape and visual issues should be corridor- and site-specific, based on basic, accepted environmental planning processes and design principles.

5.3 Procedures

5.3.1 Terms of Reference Revisions

During the course of the design, the designer may arrive at results that conflict with items in the Terms of Reference or may identify alternative solutions that provide a better design (e.g., safer, lower cost, higher capacity, etc.) but that fall outside the agreed upon project Terms of Reference. The designer must request a review from the road authorities. Changes must be backed up with appropriate documentation. If the change is accepted, the element may be included in the design.

5.3.2 Reporting Design Criteria and Assumptions

The Transportation Design Report must contain sufficient documentation that the reviewer can clearly and unambiguously confirm that the Terms of Reference and all applicable design criteria have been met, and that all assumptions are clearly documented and justified. It is the designer's responsibility to ensure that all applicable requirements have been met for the project. The report content is discussed in **Section 2**.

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6 Important Design Issues – On-Site

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Appendices

6.1 Background

The road authorities' primary concern is the operation of the public roadways. However, some on-site issues can adversely affect street operations. These fall primarily into two broad areas:

- The design and operation of the access points
- The provision of adequate parking and on-site circulation

Providing adequate parking and on-site circulation reduces impact on the adjacent streets. It does this by eliminating queuing of traffic that is blocked from entering the site and by making it unnecessary for vehicles to use the streets to travel between access points while searching for parking stalls.

The road authorities may take differing levels of interest in the on-site issues raised in this section. In general, the further from the access point the "issue" is located, the lower its importance should be to the road authorities.

An access point is treated the same way as any other intersection on the public road system. Its design must meet all the applicable guidelines and the road authorities' requirements, including the portion that is on private property and falls within the intersection functional area.

6.2 Technical Issues

6.2.1 Access Design Elements

Access location with regard to external impacts on the street system was discussed in **Section 5**. However, there are also on-site design features of an access that are required for safe and efficient traffic operation. An access must be designed from the same perspective as an intersection that has similar characteristics and volumes.

The adequacy of a site access point is directly related to the:

- Directional distribution and peaking characteristics of site traffic
- Internal circulation system configuration
- Functional classification of the adjacent roads and highways
- Access point traffic control regime (unsignalized or signalized)

6.2.2 General Access Design Standards

Road authorities have adopted guidelines (and in some cases standard engineering practices) for use in locating and designing accesses. These guidelines are based on recognized engineering practices and exist to ensure that public roads and highways function safely and efficiently. Where access to public roads or highways is to be permitted, the guidelines for access design are contained in the documents listed in **Appendix C – References.**

Access design standards apply to such features as:

- Sight distances
- Access surface and profile
- Access width, radius and intersection angle
- Acceleration and deceleration lane warrants (off-site)
- Left-turn and right-turn lane requirements
- Access point and intersection spacing (intersection functional area)
- Access turn restrictions
- Vehicle queuing storage length and cross section
- Vehicle turning requirements (e.g., for trucks)
- Vertical clearance for the design vehicle height (e.g., parkades), and underbody clearance at grade transitions
- Traffic control and on-site advertising sign location
- Landscape and environmental requirements (e.g., aesthetics)

The design of the access magazine (the initial section of the on-site access) is critical. Sufficient distance between the street and the first on-site intersection must be provided to accommodate the maximum expected arrival and departure queues at the high end of the range of projected access and street traffic volumes. There should be no parking or traffic calming devices on the driveway in this area. The first intersection must be "free flow" for the major incoming and outgoing movements (e.g., four-way stops are not appropriate).

6.2.3 Access Queue Storage Lengths and Turn Lane Warrants

Queue storage issues on the access roadway impact both entering and exiting traffic. The first on-site intersections must provide free flow along the driveway to minimize problems (i.e., only a two-way stop control should be used, not a four-way stop control). (Roundabouts may be used. See **Section 6.2.5** for more information.)

Appropriate road authority turn and acceleration/deceleration lane guidelines must be used to determine the need for left- and right-turn lanes on the exit driveways. The ministry requirements for left or right turn lanes and storage lengths are discussed in **Section 5.2.8.** Municipal requirements may vary from these.

Turn lanes are required to:

- Minimize the access point delay (and phase length if signalized)
- Protect through-lane traffic capacity
- Provide a safer location for drivers to wait for acceptable gaps in opposing traffic streams (unsignalized intersections)
- Provide storage for permissive left turns at signals during all phases, or for protected left turns at signals during the turn red phase
- Provide a safer waiting location if the sight distance for following vehicles is below the appropriate decision sight distance

Vehicle queuing analysis is an integral component of intersection design. Queuing areas must provide sufficient storage for vehicles so that they do not block other traffic.

The amount of queuing length to be provided at an intersection is related to:

- The volume and available capacity of the lane group
- The peaking characteristics of that traffic

The intersection analysis or simulation will provide queue length information. Sufficient storage for 95th percentile queue lengths must be provided unless the Design Report documents why a lesser provision is adequate.

The location of the first on-site intersection on any driveway is determined by the queue analysis. The intersection must be located so that entering traffic queues do not impact the street intersection and exiting traffic queues at the street intersection do not impact the driveway intersection.

6.2.4 Pedestrian, Bicycle and Transit Facilities

The impacts of alternative modes of travel on the reduction of motor vehicle use were discussed in **Section 3**. Where appropriate, the project design should consider and document provisions that would encourage alternative modes of travel to and from the site. If trip or parking rate adjustments are being requested as outlined in **Section 3.2.4 to 3.2.7**, provision of these facilities will be a large consideration in the project Design Report review process.

Pedestrian, bicycle and transit facility requirements must be identified in the Terms of Reference for the project design.

Pedestrian Facilities

Proper design of pedestrian facilities can reduce the use of motor vehicles for trips within a development and between nearby developments. This is especially important when shared parking is being considered.

Pedestrian connections must integrate the site's buildings with:

- Sidewalks and bicycle facilities on the adjacent streets
- Transit stops
- Pick-up and drop-off points
- Other developments in the area

In addition, safe pedestrian travel between parked vehicles and building entrances is essential. In many cases, this is best provided for by appropriately placed building entrances, connecting sidewalks and clearly marked crossings of circulation roadways, especially at building entrances.

The design of pedestrian facilities must consider the comfort and safety of the users through provision of:

- Adequate crosswalks
- Designated walkways
- Lighting and security
- Curb cuts and ramps for wheelchair access

For pedestrian crosswalks across vehicular lanes, consideration may be given to delineating them with a surface that is different from that of the roadway (e.g., pavers or scored concrete). Nearby signals must provide adequate pedestrian crossing times.

Where sidewalks are provided on the adjacent streets or are planned as part of a pedestrian route plan, sidewalks on the roadways and an internal sidewalk system must be provided to link the buildings to the street.

Pedestrian walkways must be designed in accordance with local government guidelines or standards and with adequate dimensions for the anticipated pedestrian volumes. Where there may be a significant number of disabled users, special consideration must be given in the design (e.g., this may require wider facilities to accommodate passing wheelchairs, etc.).

Bicycles

Cycling is becoming more popular for environmental, recreational, economic and fitness reasons. Provision of bicycle parking may be required by municipal bylaws. This is especially important at developments such as schools, colleges and universities, where large numbers of cyclists can be expected. At developments such as office buildings, it is important to provide shower and change-room facilities if employees are to be encouraged to cycle to work. Additional guidelines in this area are provided in the Ministry's *Cycling Policy* and equivalent municipal documents.

Local conditions must be taken into consideration when addressing both bicycle and motorcycle parking. If travel habits in a local area indicate a significant dependence on either mode, serious consideration must be given to providing separate bicycle and motorcycle parking. Design requirements may need to be reviewed or developed for designated motorcycle parking stalls and bicycle parking. Providing bicycle and motorcycle parking is mainly a supply issue, although the availability of bicycle parking may encourage non-vehicular travel.

Provisions for cyclists should include:

a. Secure and sheltered parking facilities located in high-visibility areas close to building entrances (may be independent of the vehicle parking area)

b. Bicycle parking racks to encourage cycling and to provide parking for bicycle couriers in town centre areas

c. Shower and change-room facilities within developments where commuter cyclists are expected

The designer must review the adequacy of the bicycle circulation within the site to ensure that bicycling is a viable alternative mode.

Where a bicycle route plan exists, the provisions identified in the plan must be made on the street, and appropriate connections provided to and within the site.

Where the proposal relies on bicycle access to reduce parking or traffic volumes, the designer must review the adequacy of the road and bicycle path network within the study area to ensure that bicycling is a viable alternative mode. This includes features such as bicycle-safe storm sewer covers.

Motorcycles are treated as motor vehicles and it is uncommon for separate parking spaces to be designated for motorcycles. This is due to the relatively low percentage of motorcycle users and the difficulty of determining their number at any development.

Transit

For large retail or other commercial developments, transit facility locations must be considered:

- For areas adjacent to building entrances
- At key locations along circulation drives
- At major pedestrian focal points along the external roadway system

School bus facilities at schools are a special case of transit use where very high pedestrian circulation and waiting area demands are typical. They must be designed to provide adequate storage and loading areas for buses, as well as safe waiting areas for students that do not conflict with pedestrian circulation routes. School bus requirements, including vehicle routings, must be carefully documented and discussed with both the road authorities and school bus operators/school board staff.

Pedestrian, bicycle and transit facilities must be designed in accordance with road authority and transit agency guidelines or standards and with adequate dimensions for the anticipated pedestrian volumes. In the absence of BC-specific requirements for pedestrian facilities, designers may wish to refer to the Ontario regulations (see **Appendix C - References**) or the *Americans with Disabilities Act* (*ADA*) guidelines and interpret them in the BC context.

6.2.5 Roundabouts

Road authority policy may require consideration of roundabouts. The designer should consider the use of roundabouts on larger sites where main circulation aisles function as roads. Roundabout design criteria are referenced in **Section 5.2.10**. The reasons for not selecting a roundabout must be stated in the Design Report.

The use of a roundabout as the first internal intersection must be considered carefully. They must only be used where there is more than adequate queue storage in the on-site leg of the access point intersection to ensure that queues do not back up into the roundabout in either direction, under any of the sensitivity analysis cases.

6.2.6 On-Street Parking

The availability of on-street parking on municipal roads adjacent to a development may suggest an option to provide less on-site parking. However, even though on-street parking may currently be available, it could be restricted in the future, depending on municipal policy and required road capacity. This is especially so given the long-term time frame that road authorities must consider in order to protect the integrity of the transportation network.

A development that depends on on-street parking will experience a parking supply shortage if restrictions are later imposed on the on-street parking. This is particularly the case if alternative parking is not available. The result will be inefficient parking operations that may impede the movement of through-traffic on the road system.

Except in downtown areas, available on-street parking must therefore be discounted when determining the required on-site parking supply. In downtown areas where new uses or increased density are proposed, the designer must determine how much of the potential parking demand is to be supplied on the site. The overall availability of both publicly accessible off-street and on-street parking must be considered in the context of the municipality's overall transportation goals for the area.

6.2.7 Small-Car Stalls

Some municipal bylaws may allow a certain percentage of parking spaces to be reserved for small cars only. This percentage varies by land use and jurisdiction. Theoretically, the percentage should represent the actual percentage of small cars in the vehicle population. However, this figure is constantly changing and is affected by a number of factors including:

- **Vehicle design trends** – Since the early 2000s, vehicle design trends have blurred the distinction between small and standard car sizes. There is now no rational reason to designate specific areas for small vehicles based on the mix of sizes in the vehicle fleet (see *Dimensions of Parking*, ULI).
- **Regional trends** – Car sizes tend to differ on a region-to-region basis. More powerful cars and pick-up trucks are typically preferred in regions where winter driving conditions may be difficult, such as in northern BC and in areas where long-distance commuting and congestion are uncommon. Smaller, fuel-efficient cars may be more popular in regions where the climate is generally mild and in areas where commuting and congestion are common, such as in the Lower Mainland. Regional employment and economic and geographic trends may also influence the percentage of small cars.

> It is now considered appropriate to use small-car spaces only to fill isolated areas adjacent to landscaping or other obstructions. They must also be clearly designated as being limited to small cars through the use of pavement markings and elevated signs (see *Dimensions of Parking*, ULI).

It is rarely beneficial or possible to monitor or enforce the small-car parking restriction. Standard sized cars can squeeze into spaces reserved for small cars, resulting in unsafe parking maneuvers or loss of space if one standard car occupies one and a half small-car spaces. It may be counterproductive for a developer to oversupply small-car spaces in order to create more parking.

Small-car parking may help optimize the layout of parking spaces on a given plot of land or on the floor plate of a parking structure. Local conditions must be taken into account, however, and a realistic estimate of the number of small cars actually expected at the development must be used.

High turnover facilities (e.g., retail, or visitor parking in general) or small lots may encounter problems with the use of small-car stalls by larger vehicles if the layout does not provide an adequate number of standard sized stalls in the most attractive areas.

The following factors must be considered and documented in the report when small-car parking is being considered:

a. The number of small-car spaces to provide

b. The small-car space dimensions

c. The location of the small-car stalls on the site

d. The means of controlling the use of these spaces

> In order to ensure that small-car spaces are used first rather than last, they should be located close to the pedestrian entrances to the site's buildings. However, there must also be an appropriate number of standard size spaces located in such prime areas.

The municipal requirements are given in the municipality's zoning bylaws. The number of small-car spaces that may be provided where the Ministry has jurisdiction is discussed in **Section 6.3.3**.

The small-car stall dimensions and location in the parking area must be shown on the site plan and submitted with the Design Report.

6.2.8 Visitor Parking

Adequate visitor parking must be provided for certain developments, particularly multi-family (apartment, townhouse, condominium buildings and institutional developments such as schools and hospitals. Municipal bylaws may indicate the minimum number of visitor parking spaces required. However, the designer must ensure that this number is actually adequate for the proposed use (see **Section 3**).

Visitor parking is best placed in an area separated from occupier's parking and must be clearly signed and marked. Operational issues, such as access to the visitor parking area and segregation of visitor and non-visitor parking, need to be addressed.

Peak usage patterns for visitor parking need to be reviewed, as some land uses may have overlapping demands (e.g., hospitals). This may require plotting occupancy to identify periods of highest demand.

The actual percentage of parking that needs to be designated for visitors can be determined by considering the use and design of the development. Surveys of parking and trip generation rates include visitor trips and parking.

6.2.9 Disabled Parking

All developments need to be accessible to the disabled. Provision of parking spaces designed for and reserved for the disabled is a municipal bylaw requirement for most land uses. However, the minimum number of such parking spaces varies widely by municipality, as do the dimensions of the disabled parking spaces. A general requirement is that approximately 2% of the total parking spaces be reserved.

The number of disabled parking spaces, as determined by municipal bylaws, typically depends on:

- The community's awareness of the need to provide accessibility to the disabled
- The land use of the development (e.g., developments containing seniors' centres and medical offices typically require a greater proportion of disabled-accessible parking spaces)

Disabled parking spaces must be located close to building entrances that are equipped to serve the disabled and must be clearly marked. Provision of disabled parking is a supply issue and parking and trip generation rates are unaffected by its availability.

Disabled parking stall dimensions must allow full access to wheelchair lift-equipped vehicles from both sides and the rear within the stall area. Protrusion of loading devices into, and requiring space to access them from the aisle, are safety concerns and should not be allowed. Adjacent disabled spaces can share the loading area separating two stalls. The required loading width is also to be provided on the outside of multiple stall blocks of parking spaces.

The route(s) to be traversed by patrons using these spaces must be fully compliant with the relevant requirements. This includes a safe route from the vehicle loading area to a sidewalk or building (i.e., the vehicle door does not open into a circulation aisle).

Disabled parking stall dimensions used by municipalities are provided in their zoning bylaws. The Ministry uses those described in *Dimensions of Parking* (see Chapter 18).

The disabled parking stall dimensions and rates of both the Ministry and local government must be reviewed and the higher of the two rates and dimensions must be used. Disabled parking stalls must be provided in addition to the minimum required number of stalls and must be located close to elevators, ramps, walkways and building entrances.

These stalls should be clearly marked with signs and painted symbols on the pavement as defined in the BC *Manual of Standard Traffic Signs and Pavement Markings*.

In the absence of Canadian-specific criteria, the designer may wish to refer to the Ontario regulations or to the *Americans with Disabilities Act* (*ADA*) requirements and interpret the latter in the Canadian context.

6.2.10 Recreational Vehicle Parking

Many roads and highways in British Columbia carry a high percentage of recreational traffic, especially in the summer months. Designers must consider providing parking stall layouts and dimensions that will accommodate the larger dimensions of recreational vehicles for land uses including tourist attractions, boat launches, marinas, campgrounds and shopping centres that provide services to recreational traffic. In general, oversize vehicle and trailer parking must be arranged so that drivers can pull through the stall rather than back out. The dimensions for oversize vehicle and trailer pull-through stalls should be 3.0 to 4.5 metres wide by 12 to 15 metres long.

6.2.11 Service and Delivery Vehicle Facilities

Emergency service vehicles, service and delivery trucks require the use of different criteria for movement to and from the site as well as within the site. Design vehicles are described in the TAC *Design Guide*, however specific design vehicle templates may need to be developed for fire trucks and other special purpose vehicles. The appropriate vehicles must be selected based on the proposed uses on the site. In general, all retail developments require access by semi-trailer type trucks.

Loading/unloading areas are important features of several land uses, especially commercial and restaurant developments. The minimum number of stalls required for truck loading and unloading is typically established by municipal bylaws. The designer must ensure that the number and dimensions of stalls proposed is adequate for the proposed use of the site and buildings.

Among the issues to be considered when reviewing loading/unloading areas are:

- Adequacy of the proposed design for the appropriate design truck
- Access to the loading and unloading areas from the adjacent street network

Besides delivery trucks, loading/unloading areas are increasingly used by courier services. The number of short-duration parking spaces provided in loading/unloading zones must be in addition to the parking requirements of the development. The rates used to forecast development trip generation include loading/unloading trips.

For most developments, fire truck access to building faces is also required and must be addressed in the design.

In some special circumstances, trucks may have to unload in areas of the site used for other purposes. This particularly applies to fuel delivery for gas stations and delivery of vehicles to car dealerships. The site design must allow minimal customer use during these events. The parked vehicle must not use or obstruct any sidewalks or other parts of the adjacent roadway.

Recommended loading dock dimensions are given in *Transportation and Land Development* (ITE).

Consideration must be given to design elements including:

a. Design vehicle size, type and weight
b. Turning paths and manoeuvring space
c. Clearances (side and overhead)
d. On-site and off-site storage length impacts
e. Access and parking areas which minimize the impacts on internal and external traffic
f. Appropriate screening of service areas
g. Adequate design and location of loading bays
h. Appropriate mix of loading dock sizes
i. Signing
j. Dangerous goods routes

6.2.12 Surface Parking vs. Structure Parking

Structure parking, including underground and above-ground parking structures, has been provided in response to the reduced availability of land in more highly developed urban areas. It is significantly more expensive than surface parking, but may provide the only solution for satisfying parking demand where land area is limited. The decision to provide surface or structure parking is an economic and marketing issue that does not affect parking and trip generation rates.

Besides being more expensive, structure parking presents the following issues:

- **Security** – Structure parking may be perceived as less safe for both vehicles and drivers because of inadequate lighting, confined spaces, less visibility to the public and potential security issues. However, in cold winter areas it can provide shelter from weather conditions. Adequately designed structures that recognize appropriate design considerations can minimize all of these concerns.
- **Signage** – Structure parking requires that considerable attention be paid to external and internal signage. Externally, signage is required to direct drivers to the parking entrance points; otherwise the structure parking will be underutilized. Internally, signage is required to direct drivers to available parking spaces and exits and to ensure efficient and safe internal circulation.
- **Visibility** – Retail centre developers generally prefer parking areas that provide a sense of arrival to the development. Surface parking allows vehicle occupants to see the development entrance and frontage, which is a marketing consideration. Upon entering a parking structure, on the other hand, vehicle occupants cannot see the development they are accessing.

Structure parking, therefore, can lead to behaviours that may decrease utilization of the parking spaces provided.

Provision of efficient on-site circulation is crucial to the optimum use of available spaces. Without efficient on-site circulation, additional parking, beyond that required by the parking rate, may have to be provided. Where both at-grade and structure parking are provided on the same site, the site design must ensure that access and egress to structure parking is provided from the main internal circulation aisles.

It is critical that entrances to, and exits from, structure parking are fully integrated with surface parking circulation and provided from within the site. They must not be entered via separate access points requiring patrons to use public roads to circulate between parking areas. It must be possible for drivers to circulate between all parts of the site without using public roads and use obvious or clearly signed routes. Ideally, the access configuration should lead users directly to the most available parking stall areas.

6.2.13 Drop-Off Zones

Drop-off zones are an important feature of several land uses. They should be included in the parking plans of developments such as schools (especially preschools, kindergartens and elementary schools), hotels, quality restaurants, theatres, shopping centres, hospitals and recreational fields and arenas.

The number of short-duration parking spaces provided at a drop-off zone must be in addition to the parking requirements of the development. The rates used to forecast development trip generation include drop-off zone trips.

> Drop-off zones must be designed to minimize vehicle conflicts with pedestrians and to ensure efficient traffic circulation without interfering with the traffic operations of the adjacent street or the major on-site circulation aisles.

They must also accommodate the appropriate design vehicle (e.g., buses in the case of hotels, schools and recreational facilities; or, limousines in the case of theatres and quality restaurants). In locations where customers may be driven from seniors' facilities, provision for mini-bus parking adjacent to retail store entrances may be required.

Adequate circulation space for pedestrians and disabled users must be provided with appropriate disabled access provisions where required. Further information is provided in **Section 6.2.15**.

6.2.14 On-Site Mitigation Measures

In the site design, consideration must be given to identifying ways in which the on-site development impacts can be reduced. The goal of on-site mitigation measures is to maintain the acceptable strategic function and level of service for the highway corridor and the surrounding road network and to create a safe and efficient environment for vehicles entering and exiting the site. The project design can coordinate these on-site measures with any off-site road and highway improvements required to mitigate safety or specific operational concerns.

On-site mitigation measures that should be investigated as a means of reducing the impacts of the proposed development include:

a. Providing good internal circulation between access points and major parking areas

b. Ensuring access points operate effectively by providing storage consistent with **Section 6.2.3** and free flow through the first on-site intersection

c. Managing access by:
   - Providing access points onto lower speed adjacent local roads
   - Restricting turns at the access points
   - Relocating existing or proposed access points
   - Combining existing nearby accesses to reduce or eliminate the number or density of accesses
d. Adding on-site left- and right-turn channelization
e. Improving the access design standard
f. Using transportation demand management (TDM) measures

A reasonable range of on-site mitigation measures must be considered and discussed in the Design Report.

6.2.15 Parking Design Elements

The provision of an adequate supply of well-designed parking spaces within a development is an important element of the site's concept plan. If the parking is inadequate in terms of the number of stalls, dimensions of stalls or site layout, the resultant on-site congestion may cause vehicles to queue back onto the road system and result in overflow on-street parking. Both of these situations are undesirable when they impact the safety and efficiency of the surrounding road network and the viability of the development. Guidelines and policies regarding the determination of parking rates for a proposed development can be found in **Section 3** of this manual.

The parking area must support the type of land use with consideration given to the location of the development and the adjacent road infrastructure. It must be carefully planned and designed, regardless of whether the parking area is surface or structure. The parking area planning and design must consider the following key elements:

a. Parking area location, layout and size
b. Driveway and internal road layout
c. Access aisles
d. Individual stall dimensions and arrangements
e. Pedestrian movements from the parking areas and transit bays to the buildings
f. Security issues like lighting and proximity to public view
g. Grading, paving, landscaping and lighting of the parking area

For larger sites with multiple buildings, consideration should be given to using a number of smaller parking areas instead of a few large lots on the site. Smaller lots that are dispersed throughout the development and sized in proportion to the parking requirements for each adjacent building may be more user-friendly. They may also facilitate integration with landscaping and thus be more aesthetically pleasing. The designer should address general environmental considerations that may relate to parking design.

The Design Report must show how adequate internal circulation aisles and roadways are to be provided. Site circulation must be designed in such a way as to minimize the required number of accesses.

Internal circulation roadways must provide safe and efficient circulation of site traffic to and from:

- Accesses, buildings, and parking areas
- Pick-up/drop-off points (including those for transit)
- Service and loading areas

The on-site planning and design for the internal circulation must consider elements such as:

a. Horizontal and vertical alignments

b. Design vehicle turning movements

c. Internal intersection control, channelization and main circulation aisle location

d. Speed control, by appropriate design elements (e.g., appropriate alignments, raised crosswalks as opposed to speed bumps

e. Pavement marking and signage (should comply with legislation for consistency)

f. Paving delineation (materials and finishes) of all pedestrian areas including walkways and plazas

g. Sight distance

h. Emergency vehicle access

i. Transit facilities

j. Pedestrian and cyclist movements

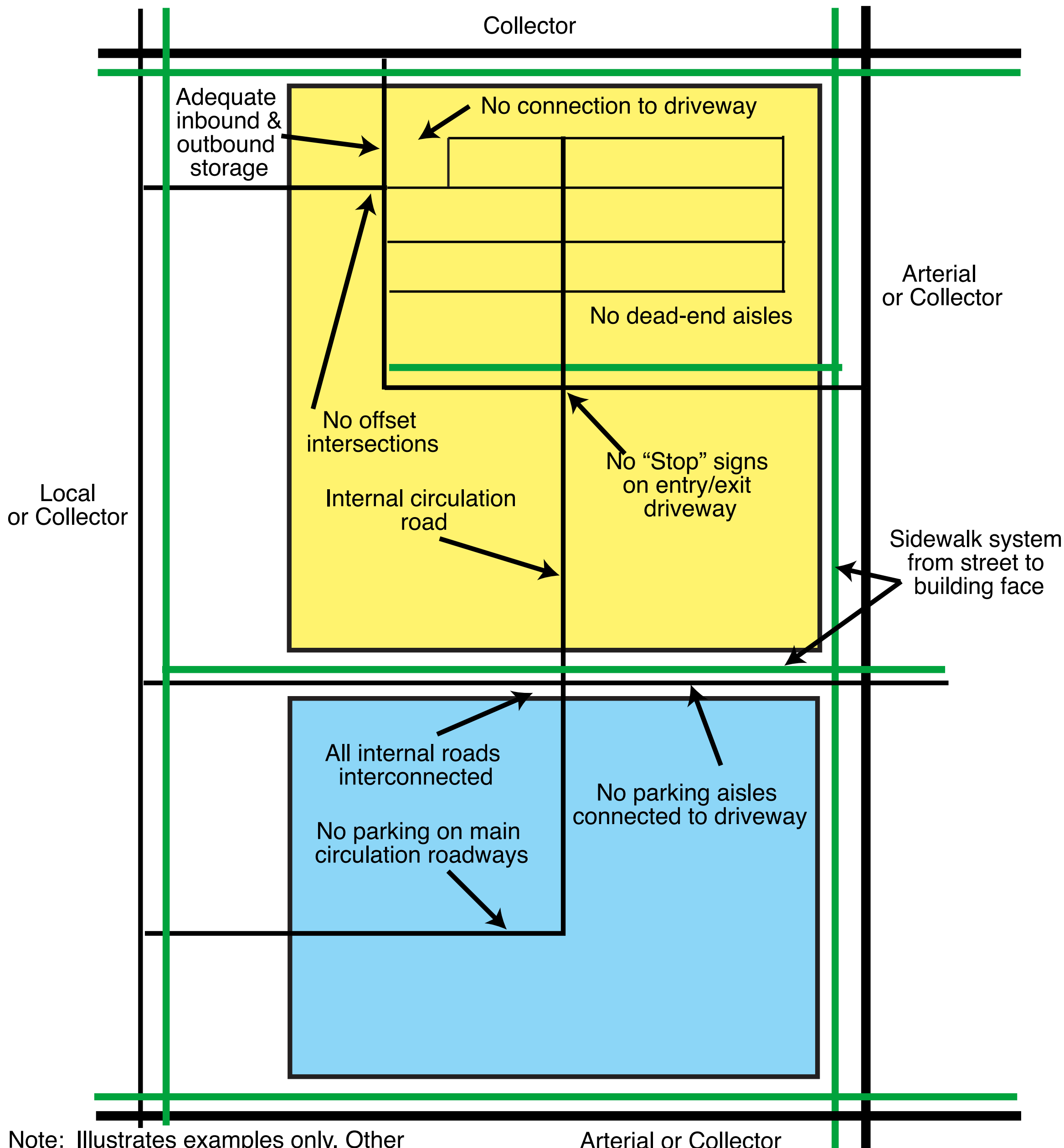
k. Site furnishings (e.g., lighting, bollards and benches)

l. Garbage bins and how they are accessed

m. Lighting and surveillance from adjacent buildings to discourage crime and vandalism

Figure 6.1 shows some on-site mitigation techniques for an example site. Different sites will require different mitigation.

Figure 6.1 – On-Site Mitigation Example



Note: Illustrates examples only. Other potential issues and solutions exist.

Parking Stall Dimensions

The designer must provide parking stalls of adequate dimensions to safely service the vehicle mix expected to use the site. Except for specific land uses that require parking for larger vehicles, all stalls must be suitable for use by cars, mini-vans, SUVs and pick-up style vehicles subject to accepted provisions for small vehicles (see **Section 6.2.7 and 6.3.3**) and disabled parking.

On sites with high tourist use, provision must be made for adequate recreational vehicle parking including buses or bus-style RVs.

If there is conflict between municipal and ministry requirements, the higher requirement must be met unless the Terms of Reference specifically permits justification by the designer for the use of the lower requirements.

The municipal requirements are provided in the municipality's zoning bylaws. The Ministry requires use of stall dimensions as shown in the current edition of *Dimensions of Parking* (ULI). The designer must justify the dimensions used where the specific land use, weather conditions or vehicle mix indicates that vehicles typically used in the area cannot be parked in standard size stalls. Specific examples of this would include ski hills (where the following are issues: ice/snow cover, loading/unloading of equipment and wind catching vehicle doors) and temporary unmarked parking for special events (which is often on unpaved surfaces).

> Typical aisle and stall dimensions must be shown on the site plan submitted with the Design Report. If non-typical dimensions are used, these must be individually identified on the plan with the appropriate type of use indicated (e.g., small car, RV, etc.)

The designer must ensure that the design vehicles can safely access all aisles and stalls without compromising the operation of main circulatory aisles. Adequate turning radius must be provided at aisle/circulation intersections.

The ULI document *Dimensions of Parking* and other documents cited in the references should be consulted for more detailed guidelines.

6.2.16 On-Site Intersections

On-site intersections must be treated in a similar manner to other intersections but in the context that they are low speed facilities not on a public road. This means that lower standards may be applicable, but they must still be designed to accommodate the design traffic volumes and vehicles. Operational efficiency and safety are key concerns to users and need to be addressed on site roads. The configuration of the first on-site intersection is discussed in **Section 6.2.3.**

6.2.17 Circulation Aisle Design

The main circulation aisles may carry significant traffic flows, especially in larger sites. The designer must consider the following general principles:

a. The design must be in context with the nature of the facility (e.g., a high-volume pedestrian area with frequent pedestrian crossings).

b. Speed control should be attained through alignment elements or raised crosswalks rather than the use of speed bumps.

c. Parking should not be accessed directly from the main circulation aisles.

6.2.18 Landscape Design Considerations

The on-site design considerations must include consideration of landscape elements and minimizing the visual impact of the development on the adjacent road and highway network. Local governments may also have their own requirements for landscaping.

While on-site landscaping is important, it must be placed and maintained so that sight distances are not compromised.

A landscape concept plan must be provided as part of the Design Report to ensure that the proposed landscaping does not compromise the required sightlines. The issues noted in **Section 5.2.16** also apply to the on-site landscaping.

6.3 Procedures

6.3.1 Terms of Reference Revisions

The designer may arrive at results that conflict with items in the Terms of Reference during the course of the design, or may identify alternative solutions that provide a better design (i.e., safer, lower cost, higher capacity, etc.) than those identified in the agreed-upon project Terms of Reference. In such cases, the designer must request a review from the road authorities. Changes must be backed up with appropriate documentation. If the changes are accepted, the element may be included in the design.

6.3.2 Reporting Design Criteria and Assumptions

The Design Report must contain sufficient documentation that the reviewer can clearly and unambiguously confirm that the Terms of Reference and all applicable design criteria have been met and that all assumptions are clearly documented and justified. It is the designer's responsibility to ensure that all applicable requirements have been met for the project.

6.3.3 Small-Car Stalls

Ministry policy restricts allowance for small-car stalls to the Greater Vancouver, Fraser Valley and Capital Region areas. Consideration will be given to provision of small-car spaces in other areas if agreed to in the project Terms of Reference and adequate justification is presented in the Transportation Design Report.

Where the Ministry agrees to permit small-car stalls, the number of small-car spaces may not exceed 20% of the site's total for all sites having 31 or more parking spaces. All parking spaces in parking areas which contain fewer than 31 parking spaces must provide 100% standard parking spaces.

A Appendix Terms of Reference

Table of Contents

Sections

Other Appendices

A.1 Terms of Reference Template

This form is to be used for all projects where BC MoT is the sole, or a joint road authority.

The form is in four sections (sections A , B and C, and Attachment A).

The developer and Ministry staff complete:

- **Simplified design projects** – Section A – General project description, signature sheet, and basic design criteria (Form Pages 1 to 4)

  or

- **Detailed design projects** –
  - Section A – General project description and signature sheet (Form Pages 1 to 3),
  - Section B – Project design and analysis criteria sheets (Form Pages 5 to 8),

    and

  - Section C1 or C2 – Roadway and intersection design sheets, one for each roadway segment (C1) or intersection (C2) where the same criteria apply (Form Pages 9 to 10).

Attachment A is for additional information about any criterion.

The completed form (Section A, and if required, Sections B and C, and Attachment A) is used to define the Terms of Reference for the project. It must be completed and agreed to by the developer and all involved road authorities before the design commences. Failure to do this will most likely result in rejection of a Design Report, as it will not have adequately addressed the road authorities' concerns.

The developer's transportation engineer completes and signs/seals Form Page 3 (Section A5) on completion of the project report and provides page numbers for all sections. All pages of the completed and agreed upon form must be submitted with the report.

The "BC MoT" and "Municipal" columns on the right of the form (shaded grey) are for use by Ministry and municipal staff to verify that the noted items have been adequately addressed and that the results comply with their requirements as expressed in the Terms of Reference.

Attachment A is a generic form to be used as required to provide added detail or to include project specific issues or criteria that are not covered in the forms. It forms part of the agreed Terms of Reference.

Transportation Design Terms of Reference

Project: ____________________ BC MoT file: __________ Dist/Region: __________
Major road: ____________________ Cross street: ____________________
Municipality/Reg Dist: ____
BC MoT contact: ____________________ E-mail: ____________________
Date received: ________________ Date completed: ________________
Report prepared by : ____ (firm)
Responsible professional: ____ (name)

Municipal Information:

❒ Subdivision ❒ Rezoning ❒ Development Permit ❒ Urgent
Municipal file number: ________________ Bylaw number: ________________
Municipal staff contact: ____________________Tel: __________ E-mail: ________________

Applicant Information:

Name: ____
Street address: ____
City: ____________________ Province: ______________ Postal Code: ______________
Tel: ________________ Fax:________________ E-mail: ____________________

Project Information:

Legal description: ____
____
Street address: ____
Topographic description: ____
____
Current land use: ____________________ Proposed land use: ____________________
Current zoning: ____________________ Proposed zoning: ____________________
Proposed study ToR prepared and submitted by:____________________ Date:__________
Proposed study ToR reviewed for BC MoT by:______________ Municipality: ______________
Date: ______________ Date: ______________

❒ Revisions required – *List on Attachment A.*

❒ ToR/Scope approved for BC MoT by (name)____________________ Date: ______________

Scope development meeting scheduled for (date and time): ____________________
Local government notified of meeting date and time by: ____________________
Scope development meeting attendees: ____
____

❒ Meeting minutes attached

Simplified application or detailed design?

❒ **Detailed design not required** – *Complete Section A only (Form Pages 1 to 4)*

❒ **Detailed design required** – *Complete Section A (Form Pages 1 to 3 only), Section B and Section C*

Reasons for detailed design review:

❒ Site traffic volume > 100 vph in peak hour

❒ Signals impacted

❒ Roadway geometry problems

❒ Safety issues

❒ Other: ______________________________

The following issues/criteria/design guidelines must be adequately addressed in the study.

The developer must provide page number references to the report in "Page Ref." column.

BC MoT and Mun. columns are for BC MoT/municipal use only.

Section A – Required for all Applications

	Page Ref.	OK	
		BC MoT	**Mun.**
A1 Known Roadway Issues			
❒ Geometric problems at site – *List on Attachment A.*			
❒ Documented safety concerns at site – *See B8*			
Other:______________________________			
A2 Access Restrictions (Additional restrictions may be required by analysis/mitigation.)			
❒ No left turns permitted to or from ______________			
❒ No direct access to major road ______________			
❒ Access to side-street **required** ______________			
❒ Rear access **required**			
❒ Shared access **required** with ______________			
❒ Freeway: **No access permitted** to freeway, ramps or street within 300 m of end of ramp ❒ Protection for interchange, no access permitted within 300 m of proposed freeway ramp			
❒ Other:______________________________ *Identify on Attachment A any restrictions or options to be assessed.*			

	Page Ref.	OK BC MoT	OK Mun.
A3 Environmental Issues			
❐ None ❐ To be identified by developer ❐ To be reviewed: ____________________			
A4 Cost Sharing			
❐ None ❐ To be identified by developer ❐ Municipal agreement			
A5 Results Summary			
Developer must provide report page numbers for key summaries: Trip generation rates used page ________ Parking stalls required/provided page ________ Required road improvements page ________ Sight distances page ________ Site plan drawing nos. ____________________ Roadway plans drawing nos. ____________________			
If a detailed review is submitted, **complete Sections B and C, and include** detailed capacity calculations as an appendix. ❐ Yes ❐ No – Reason: ____________________ ____________________ Intersection analysis summary (LoS, delay, $^{V}/_{C}$ ratio) page ________ Signal timing plans page ________ Magazine and turn slot storage lengths/queues page ________			

Submitted by: ____________________ Date: ____________

Signature: ____________________

P. Eng. Seal and Certificate No: __________

PTOE Certificate No: __________

Simplified Process Criteria (Simplified process only. For detailed review, complete Sections B and C)

A6 Highway Design Speed and Sight Distances for intersections

(Check required design speed – TAC Figures 2.3.3.4 and 2.3.3.6 – for 2 lane roads.)

Design Speed	Approaching Vehicle Sight Distance	Exiting Vehicle Sight Distance
❒ 50	200 m	125 m
❒ 60	240 m	155 m
❒ 70	275 m	200 m
❒ 80	310 m	250 m
❒ 90	350 m	310 m
❒ Other (> 2 lane, or other speed)	________	________

	Page Ref.	OK	
		BC MoT	Mun.
A7 Left Turn Lanes *(Attach copy of appropriate* BC Supplement *layout Fig. 710.D.1 to 710.L)*			
❒ Required on highway, length of storage _______ m ❒ Required on access, length of storage _______ m ❒ To be determined by developer			
A8 Acceleration or Deceleration Lanes Required on Highway			
❒ No ❒ Yes *(Select values for required design speed from* BC Supplement *Figs. 710.D.1 to 710.L and attach copy.)*			
A9 Parking			
❒ Municipal bylaw rate ❒ ITE parking generation rate			
❒ Number of stalls required _______ ❒ To be determined by developer			
❒ Municipal stall dimensions ❒ BC MoT stall dimensions			
❒ Minimum distance between access point and 1st on-site intersection _____m ❒ To be determined by developer			
❒ Other conditions: *See A11 or use Attachment A.*			

A10 Highway Realignment Required

❒ No ❒ Yes *(Describe, using Attachment A if required.)* ________________

____

A11 Other Requirements *(Describe, using Attachment A if required.)*

____
____
____
____
____

Section B – Required for Detailed Design Review Only (*See Form Page 2.*)

	Page Ref.	OK	
		BC MoT	Mun.
B1 Study Area			
❐ Study area plan attached, Drawing No. ______________________________ ❐ All access points ❐ Next street intersection on all adjacent roads ❐ All intersections within _____m on major road ❐ All intersections within _____m on other adjacent roads ❐ Other intersections: ______________________________ *Use Attachment A, if required.*			
B2 Existing Studies			
❐ Site on Major Road Network Plan facility			
❐ Corridor Plan exists ❐ Access Management Plan exists ❐ Pedestrian and/or Bike Network Plan exists			
❐ Site Impact Study exists for site ❐ Adjacent Site Impact Studies exist			
❐ Other Study/Plan			
❐ Committed BC MoT or municipal projects to be included.			
List all plans/studies and projects on Attachment A. All the above plans or studies and projects must be recognized in the analysis and design.			
B3 Traffic Count Data			
❐ Available from BC MoT (< 3 years old) ❐ Available from municipality (< 3 years old) ❐ New counts required, to be collected by Developer *List counts available and/or required on Attachment A.*			
B4 Trip Distribution and Assignment			
Based on: ❐ Traffic model land use distribution **or** ❐ Catchment area (no model exists) **or** ❐ Other: ______________________________ *Describe on Attachment A.*			
B5 Analysis Projection Years			
❐ Traffic model exists, horizon year of model ____ (must be used) ❐ No traffic model exists; use ________ as horizon year and use ❐ Required growth rate ___________ ❐ Use existing traffic data growth rate			
❐ Adjacent developments to be included: ______________________________ ______________________________			
❐ Other: ______________________________ *Describe on Attachment A.*			

Years to be Analyzed (Horizon year is normally 10 - 15 years from application.)

Analysis Scenarios	Without Site	With Site
Existing	Yes	N/A
Opening day	Yes	Yes
Phase 1, year _______		
Phase 2, year _______		
Site buildout	Yes	Yes
Intermediate year _______		
Intermediate year _______		
Horizon year _______	Yes	Yes

If development is phased, all major phases must be analyzed. If more than two phases, or intermediate years, use Attachment A.

	Page Ref.	OK	
		BC MoT	Mun.
B6 Parking and Trip Generation			
❒ ITE rates ❒ Municipal rates ❒ Rates from other sources ❒ Rates approved by BC MoT *(Use Attachment A, if required.)* ❒ Proposed rates to be submitted to and approved by BC MoT before analysis commences			
Peak Periods to be Analyzed			
Refer to ITE Parking Generation *manual.* ❒ Weekday peak of site ❒ Saturday – retail ❒ Evening – residential/accommodation parking ❒ Other – recreational/weekend, etc.: ______________________________ *Describe on Attachment A, if required.*			
Refer to ITE Trip Generation *manual.* ❒ Weekday AM ❒ Weekday PM ❒ Saturday (retail) ❒ Other – recreational/weekend, etc.: ______________________________ *Describe on Attachment A, if required.*			
Approved Adjustments (All adjustments require Regional/District Traffic Engineer approval.)			
❒ Shared use __________%			
❒ Approved TDM Plan ____________%			
❒ Small car (Only in CRD and GVRD) ___________%			
❒ RV parking required ___________%			
❒ Pass-by traffic _______% ❒ Transit, approved mode split ___________% ❒ Internal trips or diverted/linked trips			
❒ Other: ______________________________________ *List on Attachment A, if required.*			

	Page Ref.	OK	
		BC MoT	Mun.
B7 Safety Issues			
Safety Analysis – Only if significant collision history ❐ Not required ❐ Known issues ❐ To be determined by study ❐ Road Safety Audit – only if major road upgrade required ❐ Other: ____________ *List on Attachment A.*			
B8 Roadway Service Classification			

Study area defined on attached plan (see B1).

Road	Classification	C/F[1]	Required Design Speed

[1] Indicate if Controlled Access (C) or Freeway (F)

❐ *TAC Design Guide/BC Supplement* design parameters appropriate to each road's functional classification and design speed must be used.

❐ BC MoT Ambient Design Conditions apply. *See Attachment A, and attached design conditions (see Appendix A2).*

	Page Ref.	BC MoT	Mun.
B9 Design Vehicles (TAC designations)			
Parking			
❐ Passenger car (P) ❐ RV (HSU) or ❐ Bus (B-12) ❐ Other: ____________			
Access			
❐ MSU (10 meter) ❐ WB - 20 (Freeways, Expressways and major roads) ❐ WB - 15 (BC MoT designation – semi-trailer, lower volume access roads only) ❐ Bus B - 12 (transit on site) ❐ Other: ____________			
B10 Design Issues – On-site			
Pedestrian, Bicycle, Transit (C*heck all that apply.*)			
❐ Sidewalks required from street ❐ On-site transit service required ❐ Bike route required from street ❐ Bike parking/storage required			
Magazine length on-site required for in and outbound traffic queue ❐ 95% ❐ 90% ❐ 85% ❐ 75%			
Aisle Layout			
❐ Dead end aisles permitted ❐ Dead end aisles not permitted			

❐ Drive-thru window aisle queue storage required for: ❐ 95% ❐ 90% ❐ 85% ❐ 75%			
Stall Sizes ❐ BC MoT dimensions ❐ Municipal dimensions ❐ Other: *List on Attachment A.* ____________			
Handicapped Spaces ❐ Not required ❐ BC MoT dimensions ❐ Municipal dimensions ❐ Other: *List on Attachment A.* ____________			
Truck Access/Loading ❐ Not required ❐ Required: *See B9 for design vehicle.* ❐ Other: *List on Attachment A.* ____________			
B11 Roadway Design and Intersection Analysis			

If more than one roadway or intersection/access point is to be designed or analyzed, complete one copy of page C1 or C2 for each roadway, intersection or road segment where the same criteria apply.

List below each roadway, intersection or segment where uniform conditions apply.

If detailed geometric data is required, use one copy of the BC MoT Design Criteria sheet for each segment (see sample).

#	Roadway	From (or at)	To

Intersection Analysis

Analysis software used: Version _________ of Synchro or version _________ of HCS software is to be used.

If not the current version, explain on Attachment A.

Section C1 – Required for Detailed Study Only

# _____ **Roadway Segment** ______________________ (*Use one copy of this page per roadway segment with different criteria.*)	Page Ref.	OK	
		BC MoT	Mun.
Design Speed			
❒ As functional classification **or** ❒ Min. design speed on major road: _______ **and** ❒ Min. design speed on minor road: _______			
Acceleration Lanes			
Typical details BC Supplement *Figs. 710.D.1 to 710.L. Use Fig:* ________________ ❒ Not required ❒ Required on all roads ❒ Required on major road only ❒ Required for design speed ❒ Need to be determined by study			
Deceleration Lanes			
Typical details BC Supplement *Figs. 710.D.1 to 710.L. Use Fig:* ________________ ❒ Not required ❒ Required on all roads ❒ Required on major road only ❒ Required for design speed ❒ Need to be determined by study			
Sidewalks			
❒ None ❒ Required to match municipal facilities ❒ Shoulder only			
❒ Bus bay/stop required on ________________________________			
Bike Lanes			
❒ None ❒ Required to match municipal facilities ❒ Shoulder only			
Corner Clearance			
❒ To be based on operational conflicts (intersection functional area) ❒ Minimum as in TAC *Design Guide* (local to local road intersections only)			
Weaving Analysis			
❒ Freeway ❒ Required for major roads ❒ To be determined by study ❒ Known issues: *List on Attachment A.*			
Signage Analysis			
❒ Not required ❒ Required ❒ To be determined by study ❒ Known issues: *List on Attachment A.*			
Sight Distance Review			
❒ Not required ❒ Required (see table under A 6) ❒ To be determined by study ❒ Known issues: *List on Attachment A.*			

Section C2 – Intersection/Segment

# ___ Road: ________________ From: ______________ To: _______________ (Use one copy per intersection or roadway segment with different criteria.)	Page Ref.	OK BC MoT	OK Mun.
❒ **Signalized or may be signalized**			
❒ Approved new signal location (only if required, and no acceptable alternative)			
❒ Progression analysis required using: ❒ Synchro ❒ Other: ____			
Protected-only left turns required ❒ On major road ❒ On minor road			
❒ Rail (or bridge) interlock required ❒ Emergency vehicle preemption required			
❒ Existing timing plan provided **or** ❒ Timing specifications provided			
Change in posted speed permitted ❒ No ❒ Yes to: ________________			
Min. signal spacing: ______m ❒ May be altered to maximize bandwidth			
Max. cycle length: _________ sec. Min. bandwidth: __________ sec.			
Major Road: Min. movement LoS: ______________ Min. approach LoS: ______________ Max. movement v/c: ______________ Max. approach v/c: _______________			
Minor Road: Min. movement LoS: _____________ Min. approach LoS: _______________ Max. movement v/c: ______________ Max. approach v/c: _______________			
Turn lane queue storage required for: ❒ 95% ❒ 90% ❒ 85% ❒ 75%			
❒ Other: *List on Attachment A.*			
❒ **Unsignalized**			
Roundabout: ❒ To be considered ❒ Not acceptable, *Explain why not in Attachment A.*			
❒ 2-way Stop ❒ 4-way Stop ❒ Yield			
Min. movement LoS: ____________ Min. approach LoS: ________________			
Turn lane queue storage required for: ❒ 95% ❒ 90% ❒ 85% ❒ 75%			
❒ Other: *List on Attachment A.*			

Attachment A

Project: ____ **BC MoT File:** ______________________________

Section	Drawing	Notes	Page	OK	
				BC MoT	Mun.

A.2 BC MoT Design Criteria Sheet

This sheet would normally be used by BC MoT staff to assist in determining ambient guidelines for a roadway segment. It may also be used to set guidelines for developer mitigation work where the TAC guidelines are not appropriate for the particular classification in that location.

The samples show application to collector and local roads respectively. The original forms are available on the **Ministry's website**.

DESIGN CRITERIA for SUBDIVISION ROADS

SAMPLE

Project:_ABC Golf Course Heights Subdivision_______Date:March 3, 2007

MoT Region:__South Coast___MoT District:_South Island------

Regional District:_____Cowichan Valley Regional District (CVRD)_________

Col. #1: Design Elements & Controls	Col. #2: Guideline Reference BCMoT Supplement, chapter 1400		Col. #3: Achieved Guidelines Reasons for not meeting Guidelines in col. #2 (details in footnotes)
1) Collector Road			
Crown	0.02 m/m		0.02 m/m
Maximum superelevation	0.06 m/m		0.06 m/m
Design speed	70 km/h		70 km/h (1)
Minimum radius	60 km/h, normal crown	1290 metres	NOT APPLICABLE
	60 km/h, reversed crown	220 metres	NOT APPLICABLE
	60 km/h, superelevated section	120 metres	Minimum radius achieved 175 m
Minimum K factor crest	60 km/h	13	Minimum achieved: K=36
Minimum K factor sag (headlight control)	60 km/h	18	Minimum achieved: K=25
Maximum grade	8%		6% (2), (3)
Minimum stopping sight Distance	60 km/h	85 metres	140 m on crest 110 m on sag ((headlight control)
Minimum setback to utilities and fixed objects	2.0 m from the base of fill/top of cut slope or 2.0 m from the property boundary, whichever gives the greater offset from the road.		Underground power lines No lighting poles except on Commerce Street (frangible poles used) Fire hydrants are made of frangible cast iron. (at 2 metres from toe of fill or top of cut)
Side slope	2.0 to 1 or flatter		2.0:1
Back slope	1.5 to 1 or flatter		2.0:1
Lane widths	Paved vehicle travel lane: 3.6 m Travel lane shared with bicyclists: 4.3 m Parking lane: 2.4 m Bike lane: 1.5 m Bike Path Width: As per TAC Table 3.4.6.1		4.3 m provided with no parking On commerce street: two 3.6 m through lanes with two 1.5 m bike lane and two 2.4 m parking lanes.
Shoulder width	0.5 metre gravel for open ditch 0.6 curb plus 0.3 gravel support behind the curb		0.5m paved shoulder with 0.5 m gravel shoulder and open ditch except on Commerce Street which has a 0.6 m curb with sidewalk and underground storm sewer and utilities.
Sidewalk width	1.8 m		No sidewalk provided except on Commerce Street on both sides for 250 metres. Sidewalks are 2.8 metres wide (1.0 m from the curb is used for frangible streetscaping and lighting poles)
Ditch bottom	150 mm below subgrade In rock cut: 300 mm below subgrade		150 mm below subgrade
Minimum Overhead Clearance for utilities	5.0 metres		No overhead utility crossings

DESIGN CRITERIA for SUBDIVISION ROADS

SAMPLE

Col. #1: Design Elements & Controls	**Col. #2: Guideline Reference BCMoT Supplement, chapter 1400**		**Col. #3: Achieved Guidelines Reasons for not meeting Guidelines in col. #2 (details in footnotes)**
2) Local Roads			
Crown	0.02 m/m		0.02 m/m
Maximum superelevation	0.06 m/m		0.04 m/m on through local roads Normal crown on cul-de-sacs (4)
Design speed	50 km/h		50 km/h on through local roads 30 km/h on cul-de-sacs (5)
Minimum radius	50 km/h, normal crown	950 metres	Smallest radius on cul-de-sacs 450 meters (6)
	50 km/h, reversed crown	135 metres	
	50 km/h, superelevated section	75 metres	Small radius on local through roads 90 meters
Minimum K factor crest	50 km/h	7	Minimum K=36 on local through roads Minimum K= 23 on cul-de-sacs
Minimum K factor sag (headlight control)	50 km/h	12	Minimum K=18 on local through roads Minimum K= 12 on cul-de-sacs
Maximum grade	8%		Maximum grades on local through roads 8% except for Cul-de-sacs A, F & I (7)
Minimum stopping sight Distance	50 km/h	65 metres	On local through roads: 140 m on crest 85 m on sag ((headlight control) On cul-de-sacs: 111 m on crest 63 m on sag ((headlight control) (8)
Minimum setback to utilities and fixed objects	2.0 m from the base of fill/top of cut slope or 2.0 m from the property boundary, whichever gives the greater offset from the road.		Underground power lines No lighting poles on local roads & cul-de-sacs Fire hydrants are made of frangible cast iron. (at 2 metres from edge of pavement)
Side slope	2.0 to 1 or flatter		6.0:1
Back slope	1.5 to 1 or flatter		4.0:1
Lane width (vehicle travel width only)	3.6 m Paved Parking lane: 2.4 m Bike Path Width: As per TAC Table 3.4.6.1		11 meter total pavement width
Sidewalk width	1.5 m in residential area 1.8 m for commercial frontage		1.5 m sidewalk on one side on residential streets. No commercial frontage on local streets.
Shoulder	0.5 metre gravel for open ditch 0.6 curb plus 0.3 gravel support behind the curb		0.6 curb plus 0.3 gravel support behind the curb on one side. 0.6 curb with sidewalk on other side. Underground storm sewer on all local streets.
Ditch bottom	150 mm below subgrade In rock cut: 300 mm below subgrade		NOT APPLICABLE
Minimum Overhead Clearance for utilities	5.0 metres		NOT APPLICABLE

Notes / Discussion:

(1) The first 1.5 kilometers from the intersection with the highway are designed for 80 km/h
(2), (3) Due to steep topography and to reduce the impact on a park and creek they exceed 6% and 8% for the following sections of the collection road:

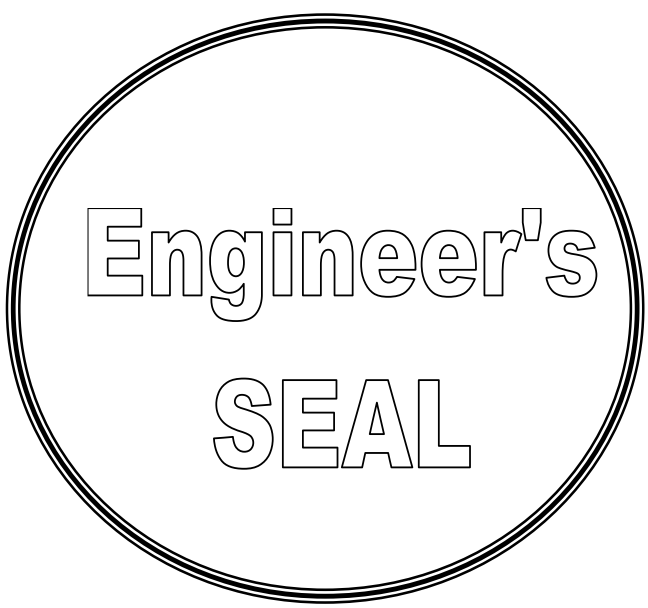
- Section 101+11.221 to 103.74.001 max. grade 7.1%
- Section 134+73.395 to 137+77.450 max. grade 8.6%

(4) In conformity with TAC Design Guide page 2.1.2.7 "Low Speed Urban Applications: Design Domain Quantitative Aids". This recommended exception was accepted by BCMoT SCR at the 50% design meeting on Feb. 2, 2007.
(5) All cul-de-sacs are less than 300 meters in length. This recommended design speed exception was accepted by BCMoT SCR at the start of the detail design work. (Ref. project correspondence and approved Design Criteria Sheet dated Dec. 18, 2006.
(6) In conformity with accepted 30 km/h design exception (5) and TAC Geometric Design Guide Table 2.1.2.4 .
(7) Cul-de-sacs A, F & I have grades of 8.4%, 9.0% and 8.6% as per exceptions accepted by BCMoT and risk analysis documented in project report dated Jan. 15, 2007. Submitted to BCMoT, accepted and signed off on March 19, 2007.
(8) For Cul-de-sac F the sight distance is 50 meters on a sag curve. This conforms with the accepted 30 km/h design exception (5) and TAC Geometric Design Guide Table 2.1.3.4 .

(List footnotes for clarification where appropriate and for items where deviations exist from the guidelines.)

RECOMMENDED BY: _____John Doe_______ Date: June 3rd, 2007

ENGINEERING FIRM: ______ROAD Design Services Ltd._______



A.3 Transportation Data Checklist

This form is intended as a guide to help determine what data should be collected to assist in the traffic projection and operational analysis components of the design.

Indicate data availability or requirement in "From" column: M (Ministry), LG (Local Government), O (Other) or D (Developer), and confirm acquisition of data in last column.

Type of Data		Data Required	From	✓
Land use (Local government)	1	Current land-use zoning, densities, and occupancy in the study area		
	2	Approved development projects and planned completion dates, densities, and land use types		
	3	Anticipated development on other adjacent undeveloped parcels		
	4	Land use master plan or Official Community Plans (OCP)		
	5	Approved land use zoning and growth rates in the study area		
Demographics (Local government, Stats Canada)	6	Current and future population and employment within the study area by census tract or traffic zone (as needed for use in site traffic distribution or modelling)		
Traffic volumes (Ministry, local government)	7	Current and historic daily and hourly vehicle volume counts		
	8	Recent intersection peak hour turning movement counts (including bikes and pedestrians if appropriate)		
	9	Information on seasonal variations. Wherever possible, counts must be carried out in the peak season (e.g., ski hills must be counted in winter).		
	10	Projected volumes from previous studies or plans		
	11	Vehicle classification counts		
	12	Field observations of current traffic operations confirming parameters to be used in the analysis (queue lengths, saturated flow, progression regime, etc.)		
Roadway features (Ministry, local government)	13	Lane assignments, widths, including shoulders, bike lanes, sidewalks, islands, medians, bus stop locations, etc.		
	14	Driveway and side street locations and details		
	15	Overhead and underground utility locations		
	16	Traffic controls (existing and planned), including turn restrictions, speed limits, parking restrictions, stop/yield controls, roundabouts, signal spacing, coordination, phasing, timing and head indications		
	17	Roadway profiles and curvatures, vertical and lateral clearances if they restrict sightlines or vehicle paths		
	18	Photographic record of the site and typical traffic operations		
Transportation system (Ministry, local government)	19	Roadway functional classification according to: local government's Official Community Plan (OCP) and Municipal Major Street Network Plan, and the provincial highway functional classification		
	20	Ministry's photolog (may no longer be available)		

Transportation system (Ministry, local government)	21	Adopted local and regional plans (Provincial Transportation, Corridor, Access Management, Major Street Network Plans, etc.)		
	22	Cadastral as legal plan of area showing all road rights-of-way		
	23	Proposed new or improved roads in the study area		
	24	Transit service and usage		
	25	Pedestrian and bicycle routes, linkages, volumes and usage		
Transportation system (cont.)	26	Available curb and off-site parking facilities		
	27	Implementation timing and availability of funding for study area transportation improvements		
Collision data (Ministry, local government)	28	Accident history (three years, if available) adjacent to site and at nearby major intersections if hazardous area has been identified		
Transportation Model (Ministry, local government)	29	Computer-based transportation planning models or their traffic projections for a horizon year		

B Quality Assurance

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Other Appendices

B.1 Consultant's Quality Assurance

The Ministry requires that all professionals retained by property developers, or their agents, will adhere to the same standards of quality management expected of professionals retained directly by the Ministry for similar work.

In 2009, the Ministry implemented a system of Quality Assurance that provides confirmation that qualified professionals have addressed all appropriate engineering issues. This system will use a mixture of **Coordinating Professional Engineers** (CPE) and **Engineers of Record** (EoR) as appropriate for each project (see **2009 Technical Circular T-06/09 Engineer of Record, Field Review Guidelines and Record Drawings**).

Appendix 2 addresses third party delivered projects. The second bullet states that "land development projects subject to Ministry review require identification of a CPE before any engineering work is carried out. If this requirement is waived by the Ministry, the proponent shall identify a CPE before the site design is completed."

On projects involving both Transportation Engineer(s) and Civil Design Engineer(s), the role of the CPE is to ensure that the engineers collaborate and make integrated decisions.

Architects often manage development projects. They should be made aware of these requirements to engage a CPE(s) and/or EOR(s) as required by the Ministry.

Notwithstanding that an Architect may be managing the project, all design and construction supervision on public road right-of-way must be carried out under the supervision of, and documents sealed by, Professional Engineers acceptable to the Road Authority for work on their rights-of-way.

The following text is consistent with this process.

Integrated transportation design work involves up to three different types of professionals on a development project: Transportation Engineer, Civil Design Engineer, and Architect. All must be licensed to practice in B.C. A high degree of co-ordination is required between the different professionals involved, as well as a commitment to manage the quality of their individual work and the quality of the overall project. Typical responsibilities are listed below.

Transportation Engineer (P. Eng.):

- Determines existing traffic patterns and traffic volumes, and forecasts these for the future.
- Determines the expected range of traffic volumes generated by the site and includes these in the analysis of future traffic operations.
- Determines the expected range of parking demand for the development.
- On the basis of this information, using traffic engineering and design principles, determines the key locations of, and dimensions for; adjacent intersections, roadways, access points and on-site traffic circulation that subsequently require detailed engineering design.
- Ensures that an appropriate design can be achieved.

When any Transportation Design (simplified or detailed, or specific analysis of an issue) is required by the Ministry, the Transportation Engineer will be expected to affirm that a quality report was produced and that the report is consistent with the Ministry's *Planning and Designing Access to Developments* manual and other design guidelines.

Civil Design Engineer (P. Eng.):

- Carries out detailed engineering design according to the designated standards used by the Ministry.
- Where recommendations have been made by a Transportation Engineer, they are followed unless they are not workable, in which case the issue(s) are resolved with the Transportation Engineer.

When detailed engineering design is required to support an Integrated Transportation Design Report, the Civil Engineer will be expected to affirm that a quality report was produced, and that the report is consistent with the highway design guidelines used by the Ministry (*TAC Manual, BC Supplement* etc.).

In cases where the involvement of a Transportation Engineer is not required, the Civil Engineer must also affirm that the design is consistent with the Ministry's *Planning and Designing Access to Developments* manual.

Architect (MAIBC):

- Makes site layout decisions complying with the criteria provided by the Transportation and/or Civil Design Engineers. Site layout decisions typically impact site access locations and internal site circulation, and thus off- and on-site road performance.
- Might co-ordinate the work of engineering professionals on behalf of the developer.
- For smaller projects, the architect may request at the beginning of conceptual design development, that the Ministry determine if the involvement of Transportation and/or Civil Design Engineers is required. For larger projects, the assistance of a Transportation and/or Civil Engineer will be required. Refer to the Signing Matrix in **Section 2.3.1** of this Manual.

If the Ministry deems that Transportation and/or Civil Design Engineers are not required to provide input to (and associated quality assurance on) the project, the Architect will be expected to affirm that a quality report was produced and provide accountability for compliance with the Ministry's requirements.

Developer

The Ministry expects that the developer will ensure that the professionals involved in the project have a quality management plan, work together as a team and provide the Ministry with any required sign-offs which assure quality.

C Appendix – References

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Sections

Other Appendices

This section provides a consolidated list of abbreviations, general technical resources and references relevant to the analysis and design of transportation designs for development projects.

Essential reference documents, supporting materials that have been specifically referenced and additional materials are listed. This list is not exhaustive, users should periodically check for new material.

C.1 Abbreviations

The following abbreviations are used:

- BC MoT– Ministry of Transportation and Infrastructure, Victoria, BC
- TAC – Transportation Association of Canada, Ottawa, ON
- ITE – Institute of Transportation Engineers, Washington, DC
- CITE – Canadian Institute of Transportation Engineers, Toronto, ON (a component of ITE)
- TRB – Transportation Research Board, Washington, DC
- FHWA – Federal Highways Administration, Washington, DC
- US DOT – US Department of Transportation (FHWA), Washington, DC
- AASHTO – American Association of State Highway and Transportation Officials

C.2 General Technical Resources

Transportation Association of Canada (TAC, Ottawa, ON) – Point-of-sale for TAC publications, research library, etc.

Institute of Transportation Engineers (ITE, Washington, DC) – On-line technical documents, point-of-sale for ITE and other publications, etc.

Transportation Professional Certification Board (Washington, DC) – Certification authority for Professional Traffic Operations Engineer (PTOE), Professional Transportation Planner, etc. Includes a searchable database of registered professionals.

Transportation Research Board (TRB, Washington, DC) – Resource for **US government publications** including the **TRIS search** engine which includes non-TRB documents.

C.3 Essential Material

C.3.1 Legislation

All BC and federal legislation and applicable regulations must be followed. The following is a list of key provincial and federal legislation that may be applicable. Municipal and regional district bylaws applicable to the jurisdiction for the project must also be followed. It is the developer's, and the design professional's, responsibility to identify and follow all applicable legislation and bylaws.

Transportation Act (RSBC, 2004, Chapter 44) – Defines the role and scope of BC MoT's involvement in the regulatory process (and other items) for land development and roads.

Motor Vehicle Act (MVA) and Regulations (RSBC, 1996, Chapter 3128, Reg 26/58) – Defines various regulatory items including signs, pavement markings etc. and their meanings.

Community Charter (RSBC, 2003, Chapter 26) – Defines the role and scope of a Municipalities involvement in the regulatory process (and other items) for land development and roads.

Local Government Act (RSBC, 1996, Chapter 323) – Defines some powers regarding provincial interests in property.

Land Title Act (RSBC, 1996, Chapter 250) – Subdivision requirements.

Indian Act (Federal, RS, 1986, Chapters 1-5) – Roads on Indian Reserves.

C.3.2 Regulatory Requirements

These documents interpret or apply relevant legislation and must be followed for all projects. Equivalent municipal and regional district documents applicable to the jurisdiction for the project must also be followed, however provincial regulations take precedence.

Manual of Standard Traffic Signs & Pavement Markings (2000, BC MoT, Victoria) – Generally known as the BC Signs and Markings Manual. Mandatory requirements for all public roads, advisory requirement on all private property.

Electrical and Traffic Engineering Manual, Section 400, Signal Design (2003, BC MoT, Victoria) – Generally known as the *BC Signal Manual*. Mandatory requirements for all public roads, advisory requirement on all private property. (Other sections of this document relate to lighting and electrical designs in general).

Standard Specifications for Highway Construction (2005, BC MoT, Victoria, BC) – Standard construction specifications for work on BC MoT facilities, including driveways. See also later amendments and supplementary materials.

C.3.3 Access Management

These documents provide essential background and detailed implementation advice. The concepts outlined must be followed and applied appropriately to all roads based on their function and access class. Their application on municipal roads will be defined by the municipality for each project.

Access Management Manual (2003, TRB) – This is the prime reference to the development of access management strategies that define the best locations and types of access along a given corridor. The principals should be applied to all development projects, even if an approved Access Management Plan is not yet in place. This manual is based on this document.

A Guidebook for Including Access Management in Transportation Planning (2005, NCHRP 548) – This guidebook identifies how to establish a policy and planning basis for access management so that decisions are not made on a project-by-project or permit-by-permit basis. It further identifies how transportation planners can work to ensure that the land use planning and development review processes also address access management.

C.3.4 Geometric Design

These documents provide essential technical background and detailed implementation advice. The concepts outlined must be followed and applied appropriately to all roads based on their function and access class. Their application on municipal roads will be defined by the municipality for each project.

Geometric Design Guide for Canadian Roads (1999, 2007 revision, TAC) – Generally referred to as the TAC *Design Guide*. This is the basis of geometric design for all public roads in BC and should be used for all private roads.

BC Supplement to the TAC Geometric Design Guide (2007, BC MoT, Victoria) – Generally referred to as the *BC Supplement to the TAC Design Guide* (or simply *BC Supplement*). Modifies the TAC guidelines for application to BC MoT facilities. (Includes all Technical Bulletins and Technical Notes.)

Corridor Ambient Geometric Design Elements Guidelines (1999, BC MoT, Victoria) – Generally referred to as the *Ambient Guidelines*. Provides the process (used by BC MoT Staff) to define appropriate standards for upgrading a specific segment within a specific road corridor to an acceptable standard that is different to that called for by the TAC *Design Guide*.

Guidelines for the Preparation of the Ambient Condition Rationale (1999, BC MoT, Victoria, *BC Supplement*, Chapter 13).

Highway Functional Classification Study (1992, BC MoT, Victoria) – Defines the functional classification of major roads (BC MoT jurisdiction) in BC. Municipalities have similar information in their Major Road Network Plans (MRNPs) or Official Community Plans (OCPs).

Kansas Roundabout Guide (2003, Kansas DoT, Topeka, KS) – A supplement to FHWA's *Roundabouts: An Informational Guide* that is used as the prime source on roundabout design by the Ministry.

Roundabouts: An Informational Guide (2000, US DOT – FHWA, FHWA-RD-00-068) – Generally referred to as the *FHWA Roundabout Guide*. Basic information on the design of modern roundabouts for use in North America.

Enhancing Intersection Safety Through Roundabouts (2008, ITE, IR-123). Overview of safety improvements expected through construction of roundabouts and general background to a number of relevant design issues.

BC MoT Cycling Policy (2000, BC MoT Technical Circular t11-00) – Provides guidance to ministry staff on provision for cyclists. (See also the 2007 *BC Supplement to the TAC Design Guidelines.*)

C.3.5 Design and Analysis Guidelines for Development Projects

This manual is based in part on the following document which is a fundamental reference for the review of development impacts with some specific additions and changes.

Transportation Impact Analyses for Site Development (2006, ITE) – Generally known as the *ITE Impact Guidelines*. The basic reference for the overall procedures for planning, design and traffic analysis process.

C.4 Other Referenced Material

Reference material in this section is additional background material that is required to adequately analyze or design the transportation component of development projects.

C.4.1 Transportation Planning and Engineering

Transportation Planning Handbook (2009, ITE TB-011A, 2nd edition) – Basic introduction to transportation planning.

Traffic Engineering Handbook (2009, ITE, TB-010A, 5th edition) – Basic introduction to traffic engineering.

Manual of Transportation Engineering Studies (2000, ITE, TB-12) – Background on traffic counts, etc.

Transportation and Land Development (2000, ITE, TB-015, 2nd edition) – Basic introduction to planning and designing the transportation component of development projects.

C.4.2 Capacity Analysis

Highway Capacity Manual (2000, TRB) – Generally referred to as the *HCM 2000.* Provides the basis for capacity analysis for all facilities (except signalized corridors where signal progression is required), with a few noted exceptions these procedures must be followed for analysis of capacity on BC MoT facilities.

C.4.3 Ministry Approved Software

Highway Capacity Software (McTrans, University of Florida, Gainseville, FL) – Generally referred to as *HCS*. Only the current version is approved by BC MoT.

Synchro/SimTraffic (Trafficware, Sugar Land, TX,) – Generally referred to as "Synchro". Provides the basis for analysis and simulation of signalized corridors and other types of intersections. Only the current version is approved by BC MoT.

VISSIM, SIDRA and Rodel may also be acceptable for specific applications subject to BC MoT approval on a case-by-case basis.

C.4.4 Trip Generation and Parking Guidelines

Trip Generation Handbook (2004, ITE, RP – 028B) – Generally referred to collectively with the *Trip Generation* publication as the ITE *Trip Generation Guide*. This is the basic reference source for the application of trip generation rates.

Trip Generation (2008, ITE, 8th edition, 3 volumes) – Generally referred to collectively with the *Trip Generation Handbook* as the ITE *Trip Generation Guide*. This is the basic reference source for trip generation rates.

Parking Generation (2004 ITE, 3rd edition,) – Generally referred to as the ITE *Parking Generation Guide*. This is the basic reference source for parking generation rates.

Shared Parking (2005, Urban Land Institute (ULI), Washington, DC, 2nd edition) – A comprehensive guide to shared parking on multi-use sites (excluding traditional shopping centres).

Shared Parking Planning Guidelines (1995, ITE, Washington, DC, IR – 086) – A guide to planning shared facilities.

C.4.5 Parking Lot Design

Dimensions of Parking (2000, ULI, , 4th edition) – A comprehensive guide to the planning and design of parking lots (includes functional design, detailed design and operation of parking facilities).

Safety Design Guidelines for Parking Facilities (1998, Insurance Corp. of BC [ICBC], North Vancouver, BC) – A review of several safety related issues including parking stall and aisle dimensions.

Guidelines for Parking Facility Location and Design (1994, ITE, RP-022A).

C.4.6 Neighbourhood Traffic Management and Traffic Calming

Canadian Guide to Traffic Calming (1998, CITE/TAC) – This is the primary Canadian reference document.

Traffic Calming: State of the Practice (1999, ITE/US DOT) – Provides additional relevant material on the use of traffic calming devices in North America.

C.4.7 Transportation Demand Management

Mitigating Traffic Congestion: The Role of Demand Side Strategies (2004, Association for Commuter Transportation and FHWA, Washington, DC).

Commuter Choice Primer (undated, FHWA, Washington, DC) – An employer's guide to implementing effective commuter choice programs. This document is designed to assist employers that are considering implementing a Transportation Demand Management program with determining those measures that might work best for their particular situation

C.4.8 Bicycle, Pedestrian and Transit Guidelines

Accessible Public Rights-of-Way: Planning and Design for Alterations (2007, ITE) – An extensive guide to planning and designing accessible facilities during upgrades or for new construction.

C.5 Referenced Documents

These documents are referred to in the absence of equivalent BC legislation and design guidelines. They are not binding on projects in BC. The material is referred to as relevant to good quality design that meets the needs of this group of users. It is intended to be interpreted in the BC context.

Accessibility for Ontarians with Disabilities Act: Transportation Accessibility Standards ([Act] 2005, Ontario Queens Printer, Toronto, ON) – Initial proposed standards, May 2007 document for review only, addresses transit, etc., not pedestrian access.

Americans with Disabilities Act **(ADA)** and ***Architectural Barriers Act*** **(ABA)** ***Accessibility Guidelines for Buildings and Facilities*** (2005, U.S. Architectural and Transportation Barriers Compliance Board [Access Board], Washington, DC) – Generally referred to as the *ADA-ABA Guidelines*. In the absence of Canada-wide standards or recommendations on access for the mobility impaired, reference is made to these US documents, to be interpreted in the Canadian context, as a guide to the provision of appropriate facilities. It is not the intent of this reference to imply or require their strict application in BC.

Specific sections of interest include:

- 207 Accessible Means of Egress (Chapter 4)
- 208 Parking Spaces (Chapter 5)
- 209 Parking and Passenger Loading Areas (Chapter 5)
- 218 Transportation Facilities (generally transit terminals, airports, etc. (Chapter 8)
- 402 Accessible Routes (Chapter 4)
- 406 Curb Ramps (Chapter 4)

C.6 Other Materials

Municipal Standards, Guidelines and Regulations – These are not documented in this manual. Each municipality has different requirements. The appropriate documents must be obtained from all agencies having jurisdiction and used on the project.

Policy on Geometric Design of Highways and Streets, (2004, AASHTO, 5th Edition) – Generally referred to as the *AASHTO Green Book*. Available from ITE – the US equivalent to the TAC *Design Guide*.

Context Sensitive Solutions in Designing Major Urban Thoroughfares for Walkable Communities (2005, ITE, RP 036,) – A useful guide to ensuring developments have better non-motorised access and connectivity.

Design and Safety of Pedestrian Facilities (1998, ITE, Washington, RP 026A).

Designing Sidewalks and Trails for Access (2001, US DOT/FHWA) 2 volumes.

Geometric Design and Operational Considerations for Trucks (1992, ITE, Washington, IR 062).

Manual of Uniform Traffic Control Devices (Canada) (1998 , TAC) – Generally referred to as the *MUTCDC*. Note that the *BC MVA Regulations* as described in the BC MoT Sign, Signal and Pavement Markings manuals take precedence over this document.

Innovative Bicycle Treatments (2002, ITE, Washington, IR 114).

Guide for the Development of Bicycle Facilities (1999, AASHTO, 3rd edition).

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D

Appendix
Additional Materials

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This appendix contains additional detailed materials that are referred to in the main sections of the manual. Cross references back to the appropriate section in the manual are provided.

Sections

Other Appendices

D.1 Stakeholders (See **Sections 1.1.2**, **1.1.6**, **1.3.2**)

The recommendations of the Design Report may have an impact on many different groups or stakeholders who may have a direct interest in either the development of the site itself or the effects of the traffic generated by the development. The following list should be used as a guide to identifying potential stakeholders and their level of interest in a development project design.

a. **Ministry District Office** staff are the primary contact point for all development approvals. The developer's contact is always through this office unless indicated otherwise. District staff are responsible for the day-to-day operation of the highway and also for the review and approval of zoning and access applications and the review of subdivision applications. The District Office serves as the point of contact for developers with questions about proposed developments or requests for applications and may be contacted about design standards. The District Office coordinates all construction inspections and approvals.

b. **Ministry Regional Office** planning and traffic staff look at the long and short range needs of the highway system and identify deficiencies and improvements. They are responsible for the development of regional system plans and corridor plans which aid in determining the acceptability of development proposals and provide guidance for the protection of right-of-way and operational strategies. Ministry regional design staff review designs proposed by the developer for access to the highway and provide technical assistance to the District Offices for more complex initiatives. In addition, regional traffic staff work with design staff to determine compliance of the developer's design to ministry standards for elements such as laning, geometrics, signal progression and safety. Approving Officers have final approval authority over subdivisions under the *Land Title Act* and some developments under the *Condominium Act*.

c. **Municipal Engineering** staff will wish to ensure that municipal roads operate in a safe and efficient manner, that municipal design standards, land use and strategic planning requirements are met and that the impacts of new developments are mitigated.

d. **Municipal Planning** staff are responsible for ensuring that the development complies with Official Community Plan policies, development permit guidelines, zoning regulations, land development guidelines, municipal council needs and the general public interest within their municipal boundaries.

e. **Regional District** staff are responsible for ensuring that the proposed development complies with Official Community Plan policies, development permit guidelines, zoning regulations, land development guidelines, rural design guidelines and the general public interest in areas that are not incorporated and others like Metro Vancouver and the Capital Regional District (CRD).

f. **Property Owners, Business Operators and Developers** will be interested in how their development or business will be affected by study conclusions and recommendations. In addition, they will be required to implement the recommendations for off-site improvements resulting from the study.

g. **Property Owners, Residents, and Developers of Adjacent Lands** may be interested in the access treatments of a neighbouring property. They may also be concerned about the impact of a development on their property. A coordinated approach to development can provide benefits in terms of phasing, shared facilities and cost-sharing of studies and improvements.

h. **Traffic/Transportation Engineering Consultants** require a clear outline of the requirements for conducting the Integrated Transportation Design in order to adequately coordinate their recommendations for the developer, the local government and the Ministry. They are also interested in obtaining access to related planning studies, computer models, data and information about other developments in the area.

i. **Project Management Consultants, Architects or Planning Consultants** acting on behalf of the developer of the site require early information about standards, parking rates, bylaw requirements and review processes in order to determine their influence on the conceptual layout, schedule and the financial viability of the development. This group must also actively participate with the Transportation Engineering Consultant to insure integration of the transportation components in the design proposal at the most appropriate time.

j. **Provincial and Federal Agencies** have varying degrees of involvement with development reviews and require their processes to be linked with those of other stakeholders. For example, an agency may require an environmental assessment for a development which has environmental impacts.

k. **Residents' Associations** may be concerned about the impact of the additional traffic generated by the new development, both on the local neighbourhood roads and on "their" highways. They may also be interested in the accommodation of alternate modes including access for pedestrians and cyclists.

l. **Emergency Services** may require inputs to access location and design; and traffic calming devices, to minimize response times.

m. **Transit Agencies and Operators** will be interested in reviewing the impact of development on transit services and facilities.

n. **Road Users** will be interested on the impacts which developments and proposed road improvements have on their travel times and safety. Examples of road user associations include: the B.C. Trucking Association, Cycling B.C., the B.C. Automobile Association, Downtown Parking Associations, etc.

Technical Background

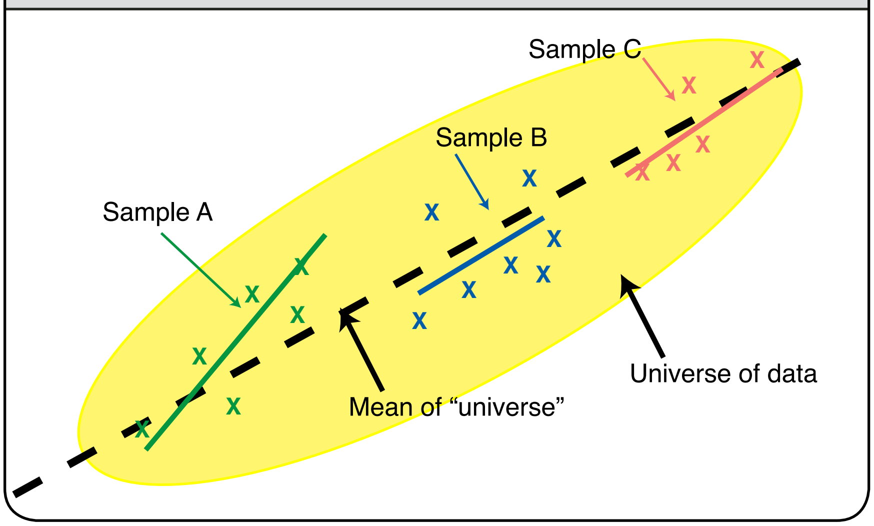
D.2 Sample Sizes (See Section 3.1.1)

It is tempting to conduct a survey to determine an appropriate trip or parking generation rate. However, statistically this only provides data for a sub-sample of the "universe" of such sites (see Section 3.1.1 – BC Rates). The data collected will almost certainly fall within the range of the "universe" (i.e., the ITE data) and will not have a high statistical significance unless a very large sample of sites is surveyed. Surveying another sub-sample hardly improves matters as it will have a different rate. If several sub-samples are collected, this can lead to a regression-to-the-mean issue (i.e., the regression line as calculated for the "universe" of data).

Keyword

Regression to the mean is a statistical term referring to the tendency of many sub-samples from a "universe" of data to tend towards the mean value. This is illustrated in Figure D.1.

Figure D.1 – Sample Size



In this example three sub-samples are taken, each has its own regression line. The universe of data lies within the shaded area and has a mean as shown (dotted line). If enough sub-samples are taken, their combined mean approaches the "mean of the universe". While each sub-sample has certain statistical properties, it is not representative of the "universe". (This diagram is simplified; in reality the sub-samples would contain more widely scattered data points.)

In reality, adding a new site may initially alter the calculated regression rate for pre-existing sites (e.g., at retail sites, as customers in a given area only have so much money spend on "widgets").

Sensitivity analysis can be used to address this situation. One analysis is carried out using the regression line rate. Further analyses are carried out for a higher and possibly a lower rate. The objective is to determine the conditions under which the design lane configuration has to be changed when acceptable changes in intersection control (e.g., signal timing plans) cannot provide the required level of service.

Since many land uses show a range in rates of approximately half to twice the regression line rate, if analysis of a doubling of the site-generated traffic shows that it can be accommodated, then a robust solution has been found.

> The determination of the higher (and if appropriate) lower rate limits to be analyzed is part of the Terms of Reference approval and must be done before the analysis is carried out.

This must be documented as part of the sensitivity analysis (see **Section 3.2.10**).

D.3 Principles of Parking and Trip Generation

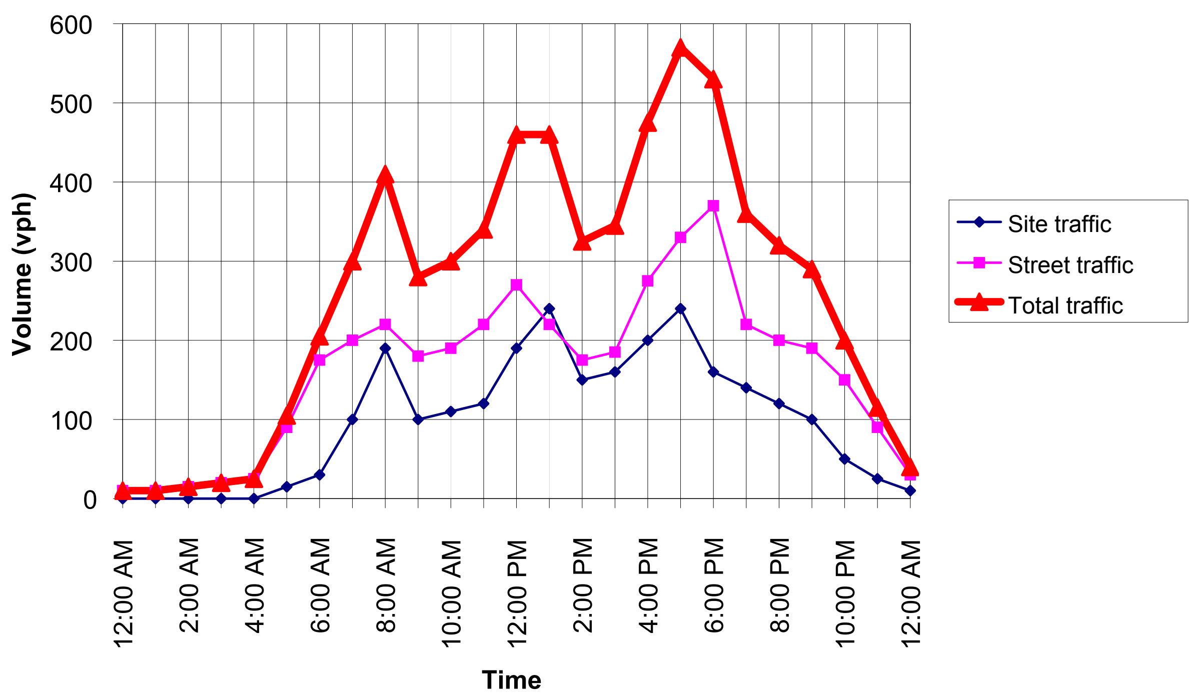
(See **Section 3.2.1**)

Site and Street Peak Periods

Both the site traffic volumes for the peak hour of the site and the peak hour of the adjacent street must be reviewed with their concurrent street/site volumes to determine which is the most critical case for each turning movement. The worst case combinations must be analyzed for each intersection or turning movement. (This means that if a specific turning movement has a peak time that differs from the others, both cases must be evaluated to determine which will give the lowest level of service or longest queue, etc., when analyzed in detail.)

The designer must evaluate the requirements for the design hour for the site and adjust the average trip generation rate accordingly. This must be addressed in the sensitivity analysis as discussed in **Section 3.2.10**.

Figure D.2 – Street and Site Traffic Peaks



In the example above, the site and street peaks are coincident for the a.m. peak. At noon, the street peak (magenta) precedes the site traffic peak (blue), but in the p.m. peak, the street peak follows the site peak.

In this case, the correct analysis is for the combined p.m. peak that is the street volume plus site volume at the time period of the site peak (5:00 p.m.) since this gives the highest combined volume. To take the site and street peaks and add them would overestimate the impact of the project in this case. This analysis must be considered for each approach as well as for the intersection as a whole. In exceptional cases it may also be required for an individual movement (i.e., a critical left-turn lane).

For some land uses, the peak hour of the site and of the adjacent street will be the same time period. Other uses may have different peak characteristics (e.g., some land uses will have higher peaks on weekend days than on weekdays or at different times of the day).

The estimates are then used to determine the impact caused by development traffic on the capacity and operation of the adjacent highway system (see **Section 4**) and any improvements that are required to maintain the safety and performance of the highway system at a certain level of service.

Failure to accurately forecast and design for the trip generation created by the development may result in an unexpected reduction in the roadway capacity and safety with consequent delays and congestion for other traffic.

The rate applicable to the peak hour of the adjacent street is used to determine the impact of a development on the road network. The rate corresponding to the site's peak hour of generation is used to determine the access, egress and circulation requirements of the development. For some land uses (e.g., offices and residential) these are the same, whereas for others (e.g., shopping centres and hotels), they are likely to be different.

Municipal Rates

Municipal bylaws generally establish the minimum parking requirements for different land uses. However, the purpose underlying municipal parking rates can differ significantly from the Ministry's objectives. While the Ministry seeks to ensure the safe and efficient movement of through-traffic on major roads, municipal parking requirements focus on the municipality's planning and development policies. For example, a municipality seeking to encourage development may establish low minimum parking requirements in order to minimize development costs and motivate investment. The limited availability of development land and the existence of abundant on-street parking are other reasons why a municipality may establish low minimum parking requirements.

Municipal and ministry parking requirements are therefore expected to differ because the objectives of mobility versus access are different. However, a developer who requests access to roads under the Ministry's jurisdiction must comply with the requirements outlined in this manual.

In summary, parking and trip generation rates are needed to maintain the integrity of the road system in order to provide mobility and safety for through-traffic. They are important tools used by the road authorities to protect their long-term investment in the highway system.

Where municipal and ministry rates differ, the higher rate must be used unless otherwise agreed upon in the Terms of Reference.

Highest and Best Use

Road authorities differ substantially in their ability to manage land use after a rezoning. The Ministry has the ability to specify conditions in an Access Permit that requires re-evaluation of traffic operations on a change-of-use from that specified in the permit. Municipalities, however, often use fairly broad categories of land use that encompass uses with quite different trip generation or parking demand characteristics. (Some municipalities, however, may use single-use zoning categories in certain situations.) Where there is joint jurisdiction, BC MoT will require either:

- Land use conditions in the Access Permit,
- That the highest and best use be analyzed,

  or
- That some other control be in place.

Where a municipality uses broad categories, it may require a project to be analyzed using the "highest and best use" concept even though the development application is for a specific current use with lower requirements. This ensures that a change-in-use that does not require rezoning can still provide adequate parking and not impose an undue load on the road system.

This may be addressed as a specific analysis or included in the sensitivity analysis component of the design process.

Average vs. Real Rates

Trip generation and parking rates given in the ITE handbooks are derived from data collected at multiple sites for each land use type. These rates may be presented based on one or more independent variables. The derivation is either a regression equation or, if there is insufficient data, an average rate. The range in rates is also given.

There is no reasonable way to predict exactly what generation rate a particular site will have. The design process therefore has to rely on sensitivity analysis and the "design domain" approach (see **Section 5**) where the domain is the range of rates appropriate for the size of the development.

To select an appropriate value from this domain is a complex task. A single rate cannot normally be identified in advance of the construction and opening of the development because there are too many unknowns that can't be reasonably quantified, including:

- Relative business success of the subject site versus other similar sites within the trading area (more successful = higher rate)
- Population of the trading area versus the floor area of the business (the less floor area per potential customer, the higher the rate)
- Quality of the access versus the access at competing businesses (better access = more customers)
- Location of the business in relation to the trading area boundaries and population centre (closer to more people = more customers)

These parameters, and thus trip and parking generation rates, change over time.

Impact of Rates on Developers

Parking and trip generation rates are also important to land developers. The parking rate determines the amount of parking that the developer must provide on the proposed development site. Many developers regard adequate parking as vital to the success of a development. However, providing adequate parking may also be quite expensive and may decrease the amount of land space available for the building component of the development. Some developers feel it is to their advantage to keep on-site parking to a minimum.

Similarly, trip generation rates determine the volume of traffic produced by the development. Any associated road improvements that are the responsibility of the developer represent an added cost to the developer. Some developers feel that the proposed trip generation rate is too high. At the same time, developers expect their sites to be successful compared to others, which implies that they will generate above-average traffic.

D.4 Elements of Parking and Trip Generation

(See **Section 3.2.2**)

A number of factors other than the size of a development influence the choice of parking and trip generation rates appropriate for an individual development.

When a "first principles" analysis is required (i.e., there is no existing data for a proposed land use, or the data does not refer to the required design hour), analysis of these factors is required to determine the appropriate rates.

These factors include the following elements.

Vehicle Arrival Pattern

The number of vehicles arriving at a development represents the attractiveness of the development. It is a function of many factors such as land use, development size, market area, population demographics and site accessibility.

The number of vehicle arrivals over a given time period represents the **arrival rate** for the time period. Arrival (and departure) rates must be measured over either 5- or 15-minute periods for as long a time-span as is required to clearly show that the peak has been captured. The highest 15-minute arrival rate is referred to as the **peak arrival rate**.

The peak hour is the highest four consecutive 15-minute time periods. The **peak hour factor** (PHF) is the ratio between the actual peak hour and four times the peak 15 minutes (PHF = peak hour/(4 x peak 15 minutes) and represents the variation in flows within that peak hour.

Arrival rates vary on an hourly, daily and seasonal basis, resulting in arrival patterns that differ for each type of land use.

For most land uses, the arrival rate determines the rate for the a.m. peak hour of the street (i.e., offices but not residential or sporting events). For some land uses (i.e., residential), the arrival rate determines the rate for the p.m. peak hour of the street.

Parking Duration

The **parking duration** is the time that a vehicle remains parked after arriving at the development. It is a function of the development's land use. The parking duration at a supermarket parking lot may be between 30 minutes and two hours, but the parking duration at an office building is more likely to be between seven and nine hours. The parking duration is a significant factor in determining the peak parking accumulation.

Vehicle Departure Pattern

Keyword

Vehicle departure occurs some time after vehicle arrival and the time difference between arrival and departure is the parking duration. The **vehicle departure pattern** may be similar to the arrival pattern (e.g., for offices) or different (e.g., at sporting events).

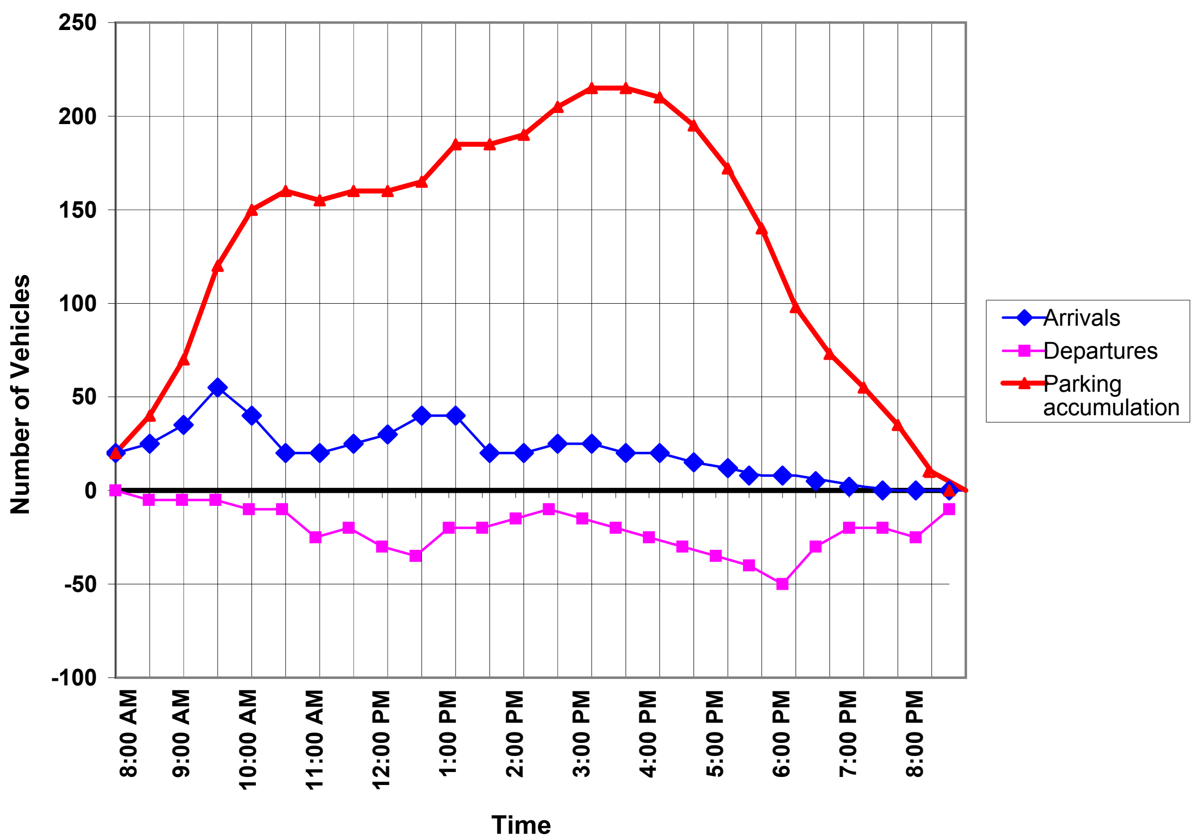
For most land uses, the departure rate determines the rate for the p.m. peak hour of the street (i.e., offices and retail, but not residential). For some land uses (i.e., residential) the departure rate determines the rate for the a.m. peak hour of the street.

Parking Accumulation Pattern

Keyword

The **parking accumulation pattern** is the difference between arrival and departure rates. When the arrival rate (blue line) exceeds the departure rate (magenta line) early in the day, the parking accumulation or demand (red line) is rising. Later when the departure rate is higher than the arrival rate, the demand is falling.

Figure D.3 – Parking Accumulation



During any given time period, the parking accumulation at a parking facility is a function of the vehicle arrivals and departures plus the total vehicle accumulation immediately before that period.

Keyword

The **peak accumulation** is the parking demand, provided that the parking lot is not full. (Once the lot is full, it is no longer possible to measure the demand by examining the accumulation pattern.)

The parking demand may have to be adjusted for daily and seasonal variations to correlate with the peak traffic characteristics of the adjacent road network. This would occur, for example, if the seasonal or daily use of the facility did not match the seasonal or daily peak of the adjacent roadways. In this case, two analyses would be required, one for each peak.

The parking accumulation pattern on multi-use sites determines the peak demand for which parking must be provided. It is the highest combined values of all the uses at any one time. Differences in the accumulation patterns between land uses allow shared parking to work (see **Section 3.2.4**).

Stall Occupancy, Turnover and Utilization Factors

Keyword

Stall occupancy (utilization) is the ratio of occupied (parking accumulation) to total available stalls. When occupancy exceeds 90%, a high level of circulation is required to find an available space and users generally regard the parking area as full.

Keyword

Stall turnover rate is another measure of parking duration. It measures the number of different vehicles using a parking space while the parking duration measures the parking time of a vehicle. If, during the course of an eight-hour day, a single parking stall is occupied by the same vehicle for the full eight hours, the parking duration is eight hours and the stall turnover rate is 1.0. However, if six different vehicles occupy the same stall during the course of the day, and the stall is vacant for only a negligible amount of time, the average parking duration is one hour and 20 minutes, and the stall turnover rate is 6.0. A high turnover rate signifies short parking durations and consequently a lower total parking accumulation for the same number of total daily arrivals.

Keyword

The amount of time that a parking space is used over a fixed time period is measured by the **utilization factor.** For example, suppose that during the course of an eight-hour day a parking stall is occupied by one vehicle for two hours, then is vacant for two hours, then is occupied by a second vehicle for four hours. The utilization factor is determined by dividing the total time during which the stall was occupied (six hours) by the total monitoring time (eight hours). In this case, the utilization factor is 0.75. During the time the stall was occupied, the average parking duration in this example is 3.0 hours and the turnover rate is 2.0.

> An average utilization factor approaching 1.0 for all the stalls at a parking facility indicates that the facility is always full and that additional parking is probably required and must be examined.

In some special cases, there may be user-specific requirements for parking. These may include shift changes (see below) or reserved parking for specific users at specific times of the day (see **Section 3.2.4 – Shared-Use Sites**).

Shift Changes

Shift changes pose two challenges: very peaked traffic volumes and, in some cases, the requirement for overlapping parking. With overlapping parking, the new shift has to arrive before the previous shift can leave. The outgoing shift spaces are then available for other uses after those users have left. These considerations may limit utilization if the spaces required for shift changes are not available at other times. This applies to hospitals (nursing staff) in particular, but may apply to other industrial uses as well.

D.5 Regional Characteristics (See Section 3.2.3)

Regional characteristics vary depending on local weather conditions, demographics, the extent of urbanization and local travel habits. The regional characteristics associated with parking and trip generation rates are discussed in this section.

Weather Conditions

Travellers in places with more severe winter weather conditions generally tend to rely more on personal vehicles than transit, walking or cycling. In these regions, it is unlikely that trip generation and parking demand will be significantly reduced through the use of alternative modes of travel. Difficult weather conditions also tend to encourage the use of larger, more powerful cars, pick-up trucks and SUVs which require larger parking stalls. Moderate weather conditions may encourage the use of smaller, compact cars. For example, in winter weather conditions, most residents of cities such as Terrace or Prince George may not use any mode of travel other than the personal vehicle, even on the shortest of trips.

Degree of Urbanization

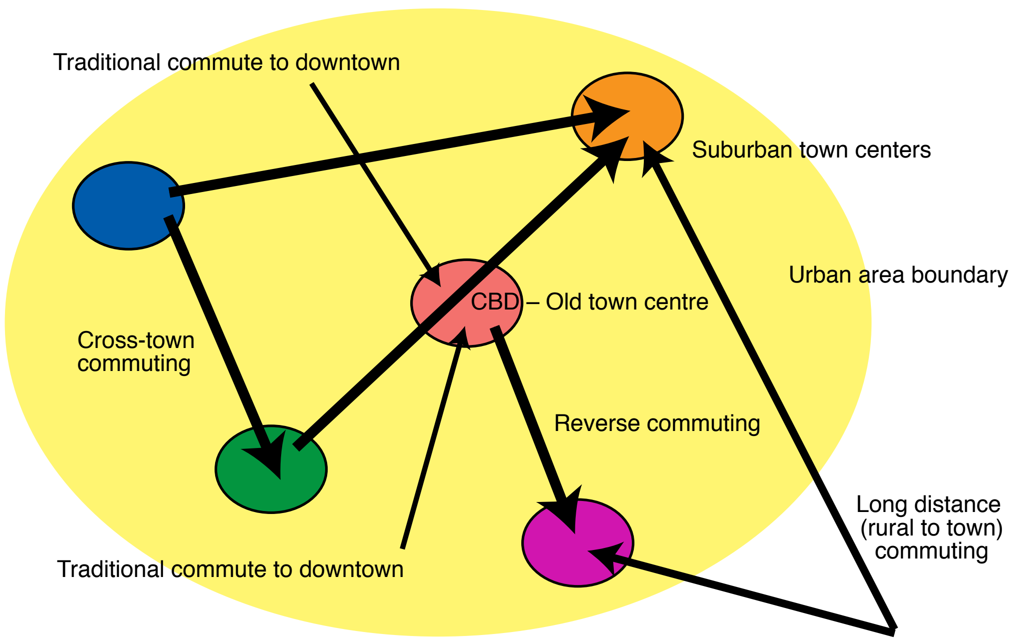
The spreading of urbanization and the clustering of developments tend to segregate residential and employment areas from each other, resulting in the formation of central business districts (CBDs) and residential suburbs.

Within a central business district, the clustering of developments encourages pedestrian and cycling activity, multi-destination trips, shared parking and ultimately the provision of transit services. However, between the central business district and the residential suburbs, the need for vehicular travel usually increases, resulting in the emergence of commuters and commuter routes.

The development of regional town centres, and increasing commercial and other employment nodes in suburban areas, has dramatically increased the amount of non-CBD orientated travel in both peak and off-peak hours. This has resulted in the increase of more complex cross-town travel patterns that lead to increased congestion where these routes cross or diverge from radial, downtown-orientated travel. However, well-designed centres that mix employment, retail and recreational uses with appropriate types of residential uses can reduce travel demand, but possibly at the expense of more concentrated access traffic volumes.

Changing development patterns are leading to higher suburban densities through development of suburban town centres and higher density mixed-use sites. These pose additional challenges that require careful analysis and adequate review of alternative scenarios. It should not automatically be assumed that increased density would bring reduced traffic impacts, or that established CBD-orientated travel will continue to predominate in the future.

Figure D.4 – Suburbanization: Town Centers



Local Economic Conditions

Local economic conditions tend to dictate a region's overall level of activity. In general, the more prosperous a region, the higher the level of travel activity and the greater the number of personal vehicle trips. In a vibrant economy, employment and consumer spending increase, resulting in more travel activity and increased construction of new developments. Retail, entertainment and recreational trips also increase.

The local economy can have an impact on vehicle classification. For example, an area with a resource-oriented economy is expected to have a higher percentage of pickup truck and SUV traffic, whereas an area with a tourism-oriented economy is expected to have a high percentage of recreational vehicle traffic.

It is important to consider long-term economic conditions and prospects rather than short-term fluctuations of market forces in addressing local economic conditions. This may be achieved by considering alternative growth rates for background traffic, or trip generation rates for site-specific traffic (see **Section 3.2.10 – Sensitivity Analysis**).

Local Habits and Lifestyles

Local habits and lifestyle may affect trip generation in terms of local inhabitants' dependence on motor vehicles or the propensity of travellers to use other modes.

Local habits and lifestyles are by-products of local weather, economic and demographic conditions. They must be taken into consideration when forecasting travel trends by making appropriate adjustments to trip generation, parking or background traffic growth rates.

> When a developer suggests that "local conditions" would change travel demand, or background growth rates, the reasons for this must be fully documented and approved by the road authority before use in the analysis.

D.6 Establishing Traffic Volumes (See Section 4.2.6)

Design Hour Volumes (DHV)

DHV is not the volume as counted on any random day. It is an adjusted set of volumes that represent the design criteria. This is typically the volume equivalent to the 30th highest hour. These are derived using appropriate day-of-week and month adjustments, and by comparing the volumes with the actual or estimated 30th hour volumes.

In some cases, the 30th hour is not the appropriate criterion. The intent is to identify a significant "break point" in the profile of ranked volumes such that the higher ranked volumes are rare and the lower ones are more common. Given 52 weeks in a year, the 30th hour represents about the 90th percentile of peak hour/peak direction volumes. It would be expected to occur roughly once every two weeks. DHVs are required for both the a.m. and p.m. peaks as well as any other periods to be analyzed.

Traffic Counts

Intersection turning movement counts must show the following data in an approved MS Excel spreadsheet format:

a. Location data, survey times, weather and road conditions, any special circumstances, intersection key plan showing laning and orientation, surveyor's names, etc. Orientation of movements must be consistent between intersections within the project.

b. Where classification data is collected (cars, trucks, bicycles, etc.), the top worksheet in the file must show "all vehicles." Subsequent worksheets must show the various vehicle classifications one per sheet (cars, trucks, etc.). Cells in lower sheets must be aligned with the top sheet and the worksheets must be named with the vehicle type.

c. Pedestrian data (if collected) must be shown on the top sheet.

d. Movements must be identified by vehicle travel direction consistent with the order for data entry used by the analysis program to be used (Synchro and HCS use E/B, W/B, N/B, S/B; Left, Thru, Right). Pedestrian data must also be displayed in the spreadsheet in the order in which it is entered into the software.

e. Approach and intersection totals for vehicles and pedestrians must be given for each 15-minute period.

f. A "running hour" total for vehicles must be given to identify the peak and other similar hours.

g. Where vehicle classification is given, the “all vehicles” sheet must show the peak hour and classification data for the “all vehicles” peak hour. Where more than one additional classification is used, the aggregate value for all vehicles classed as “trucks” must be displayed as well as the data for each individual classification. The individual vehicle classification sheets must show the peak hour for that vehicle type (which may be different to the “all vehicles” peak hour).

h. The peak hour factor (PHF) must be shown for the peak hour of each classification using the actual peak hour for that classification (“all vehicles” uses the peak hour for “all vehicles”) and using the highest 15-minute value within that peak hour for each individual turning movement, approach and the whole intersection (see discussion of PHF below).

Analysis of Count Data

In addition to adjustments for seasonality, day of week and 30th hour or other considerations, the analyst has to identify the worst combination of volumes from a traffic count, site traffic projection or combination thereof.

Design hour volumes (DHV) for the existing conditions (or any future projected conditions) are based on the set of concurrent one-hour traffic count volumes that represent the worst combination of turning and through-traffic at an intersection. “Worst combination” includes both capacity and queuing for each individual movement.

Unfortunately this is not necessarily the peak hour as expressed by the highest hourly volume through the intersection. Table D1 – Volume Combination Examples illustrates this.

Example 1 shows a conventional situation where the peak hour (running hour [each one-hour period of 4 consecutive 15-minute intervals], yellow), the peak 15 minutes (red), peak 15-minute conflicting, and peak-hour conflicting are within the same 60-minute band but are not concurrent. (In practice, the ideal case where they are concurrent may be infrequent.)

Example 2 shows a case where the peak hour (yellow) and the peak hour of conflicting traffic (red) are not the same (they overlap), and also where the peak 15-minute volumes, and the peak 15-minute conflicting volumes, do not lie within the peak hour (although they are concurrent).

Example 3 shows a more extreme case where none of the peak 15-minute volume, peak 15-minute conflicting volume, or peak hour conflicting volumes, lie within the peak hour of total volumes.

Table D 1 – Volume Combination Examples

	E/B				W/B				N/B				S/B							
	LT	Th	RT	Approach Total	LT	Th	RT	Approach Total	LT	Th	RT	Approach Total	LT	Th	RT	Approach Total	Intersection Total	Running Hour	Conflict	
																			15 min	Hr
Example 1	20	70	20	110	50	150	60	260	150	589	89	828	120	425	59	604	1802		1028	
	50	70	20	140	50	180	50	280	150	678	89	917	120	489	70	679	2016		1167	
	20	70	20	110	50	150	50	250	150	589	89	828	120	489	59	668	1856		1018	
	50	70	20	140	50	180	50	280	150	645	89	884	150	489	70	709	2013	7687	1164	4377
	60	90	20	170	70	190	50	310	100	589	89	778	150	489	90	729	1987	7872	1128	4477
	20	70	70	160	50	150	88	288	150	589	45	784	120	425	59	604	1836	7692	1012	4322
	20	90	20	130	70	200	50	320	100	589	89	778	120	489	90	699	1927	7763	1068	4372
	20	70	70	160	50	150	88	288	150	546	45	741	150	455	59	664	1853	7603	999	4207
	20	70	20	110	50	150	50	250	150	546	89	785	120	489	59	668	1813	7429	975	4054
	50	70	20	140	50	180	50	280	150	645	89	884	120	489	70	679	1983	7576	1134	4176
	20	90	20	130	70	150	90	310	100	589	89	778	150	489	90	729	1947	7596	1088	4196
	20	70	70	160	50	150	88	288	150	589	45	784	120	425	59	604	1836	7579	1012	4209
																Max =	2016	7872	1167	4477

	E/B				W/B				N/B				S/B							
	LT	Th	RT	Approach Total	LT	Th	RT	Approach Total	LT	Th	RT	Approach Total	LT	Th	RT	Approach Total	Intersection Total	Running Hour	Conflict	
																			15 min	Hr
Example 2	20	70	20	110	50	150	60	260	150	620	89	859	120	425	30	575	1804		1059	
	50	70	20	140	50	180	50	280	150	678	89	917	120	489	70	679	2016		1167	
	20	70	20	110	50	150	50	250	150	589	89	828	120	489	59	668	1856		1018	
	50	70	20	140	50	180	50	280	150	645	89	884	150	489	70	709	2013	7689	1164	4408
	20	90	20	130	70	150	50	270	100	589	89	778	120	489	90	699	1877	7762	1018	4367
	20	70	70	160	50	150	88	288	150	589	45	784	120	425	59	604	1836	7582	1012	4212
	20	90	20	130	70	200	50	320	100	589	89	778	120	489	90	699	1927	7653	1068	4262
	20	70	70	160	50	150	88	288	150	546	45	741	150	455	59	664	1853	7493	999	4097
	20	70	20	110	50	150	50	250	150	546	89	785	120	489	59	668	1813	7429	975	4054
	50	70	20	140	50	180	50	280	150	645	89	884	120	489	70	679	1983	7576	1134	4176
	20	90	20	130	70	200	90	360	100	640	89	829	150	489	90	729	2048	7697	1189	4297
	20	70	70	160	50	150	88	288	150	589	45	784	120	425	59	604	1836	7680	1012	4310
																Max =	2048	7762	1189	4408

	E/B				W/B				N/B				S/B							
	LT	Th	RT	Approach Total	LT	Th	RT	Approach Total	LT	Th	RT	Approach Total	LT	Th	RT	Approach Total	Intersection Total	Running Hour	Conflict	
																			15 min	Hr
Example 3	20	70	20	110	50	150	60	260	150	589	89	828	120	425	59	604	1802		1028	
	50	70	20	140	50	180	50	280	150	678	89	917	120	489	70	679	2016		1167	
	20	70	20	110	50	150	50	250	150	589	89	828	120	489	59	668	1856		1018	
	50	70	20	140	50	180	50	280	150	630	89	869	150	489	70	709	1998	7672	1149	4362
	20	90	20	130	89	**130**	50	269	100	**589**	89	778	**120**	***550***	90	760	1937	7807	998	4332
	20	70	70	160	50	150	88	288	150	589	45	784	120	475	59	654	1886	7677	1012	4177
	20	90	20	130	70	200	50	320	100	589	89	778	120	489	90	699	1927	7748	1068	4227
	20	70	31	121	50	150	72	272	150	546	45	741	150	455	59	664	1798	7548	983	4061
	20	70	20	110	50	150	50	250	150	546	89	785	120	489	59	668	1813	7424	975	4038
	50	70	20	140	50	180	50	280	120	645	89	854	120	489	70	679	1953	7491	1134	4160
	50	90	30	170	70	**250**	60	380	100	**640**	120	860	**150**	***525***	50	725	2135	7699	1270	4362
	20	70	70	160	50	150	88	288	150	540	45	735	120	425	59	604	1787	7688	963	4342
																Max =	2135	7807	1270	4362

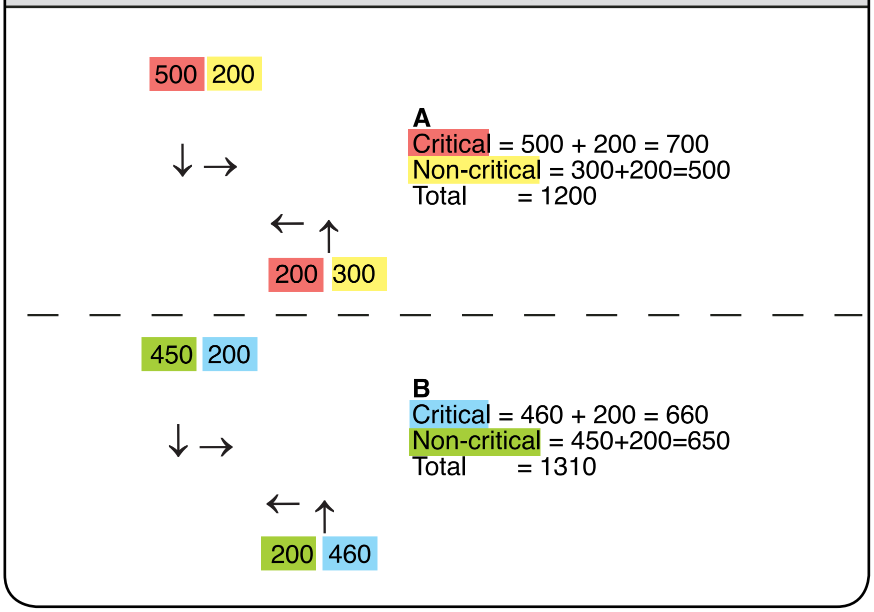
On the individual movement level, the peak 15 minutes for a movement may not coincide with that for the approach or the intersection as a whole.

Short duration peaks generally cause these deviations, such as from a shift change at a place of employment, or a development traffic peak that does not coincide with the peak of the street.

The problem "peak hour fails to identify peak conflicts" arises because the peak hour considers all vehicles while only certain movements conflict. If the movements that are non-critical in the peak hour are higher in a period where the total volume is below the peak value, this results in failure to identify the correct conflicting volumes.

This is illustrated in Figure D5 below. In "A" the critical conflicting volume (red) is higher, but in "B" the total volume is higher as a non-critical volume in "A" (yellow) has increased (blue) more than the other volumes (green) have decreased.

Figure D.5 – Conflicting Volumes



To assist the analyst in determining the required peaks for analysis, it is recommended that the spreadsheet also show the 15-minute conflicting movement and hourly conflicting movement totals. It is noted that only the generalized "LT + opposing (through + right turns)" combinations can be easily shown. However, this is the correct value unless the right turn is completely free flow with adequate right-turn lane length prior to the intersection to clear any queues, and adequate downstream merging distance.

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Peak Hour Factors

The peak hour factor is used to estimate a peak hour volume (vehicles per hour) that corresponds to a shorter-term peak within the "peak hour." Typically a 15-minute peak is used for this. The factor is calculated as:

PHF = Peak hour volume/ 4 x 15-minute peak volume

By definition, this value has to have a range of 0 <PHF < 1.0.

In any given count we can expect the peak 15-minute period for any movement to not be in the same time interval as the peak for the approach or intersection as a whole. This leads to some uncertainty in determining the design peak hour. Table D2 – PHF Examples, illustrates this.

In Example 1 (the same as in the previous table), the peak 15 minutes and peak 15-minute conflicts lie within the peak hour. The movement PHFs range from 0.75 to 1.0, the approach PHFs range from .82 to .96 and the intersection PHF is .98. Clearly, different results will be obtained depending on whether movement, approach or intersection values are used.

The volumes derived from movement PHFs (Example 1, blue numbers) give a total for the intersection of 8504 (4868 conflicting) vs. 7872 (4477 conflicts) for the "clock" peak hour, a difference of 8.7% for the intersection.

In Example 3 (the same as in the previous table), we have presented both the peak hour by volume (yellow) and the peak hour by conflicts (blue).

In the "Case Comparison" we show the differences between a conventional peak hour (Example 1); peak volumes, but not containing peak conflicts (Example 3, top data block, yellow); and peak conflicts (Example 3, lower data block, blue). Examining the top three rows of the comparison, it is clear that the conventional peak hour example would give quite different analysis results than the "Peak Conflicts" example. The latter shows higher side street and lower main street volumes. A signal designed for the conventional case may well fail to meet level of service expectations.

There are three options for applying the values:

a. Use the overall intersection value.

b. Use the approach values.

c. Use the movement values.

Table D 2 – PHF Examples

	E/B				W/B				N/B				S/B							
	LT	Th	RT	Approach Total	LT	Th	RT	Approach Total	LT	Th	RT	Approach Total	LT	Th	RT	Approach Total	Intersection Total	Running Hour	Conflict	
																			15 min	Hr
Example 1	20	70	20	110	50	150	60	260	150	589	89	828	120	425	59	604	1802		1028	
	50	70	20	140	50	180	50	280	150	678	89	917	120	489	70	679	2016		1167	
	20	70	20	110	50	150	50	250	150	589	89	828	120	489	59	668	1856		1018	
	50	70	20	140	50	180	50	280	150	645	89	884	150	489	70	709	2013	7687	1164	4377
	60	90	20	170	70	190	50	310	100	589	89	778	150	489	90	729	1987	7872	1128	4477
Peak 15	60	90	20	170	70	190	50	310	150	678	89	917	150	489	90	729	2016			
Peak 15 x 4	240	360	80	680	280	760	200	1240	600	2712	356	3668	600	1956	360	2916	8064			
PFH	**0.75**	0.83	1.00	0.82	0.79	0.92	1.00	0.90	0.92	0.92	1.00	0.93	0.90	1.00	0.80	0.96	0.98			
																		Peak Hour Conflicts		
Design Volume	240	360	80	680	280	760	200	1240	600	2712	356	3668	600	1956	360	2916	8504		4868	
Actual Pk Hr	180	300	80	560	220	700	200	1120	550	2501	356	3407	540	1956	289	2785	7872		4477	
														Peak Hr Design Vol			**0.93**		**8.73%**	

	E/B				W/B				N/B				S/B							
	LT	Th	RT	Approach Total	LT	Th	RT	Approach Total	LT	Th	RT	Approach Total	LT	Th	RT	Approach Total	Intersection Total	Running Hour	Conflict	
																			15 min	Hr
Example 3	20	70	20	110	50	150	60	260	150	589	89	828	120	425	59	604	1802		1028	
	50	70	20	140	50	180	50	280	150	678	89	917	120	489	70	679	2016		1167	
	20	70	20	110	50	150	50	250	150	589	89	828	120	489	59	668	1856		1018	
	50	70	20	140	50	180	50	280	150	630	89	869	150	489	70	709	1998	7672	1149	4362
	20	90	20	130	89	130	50	269	100	589	89	778	120	550	90	760	1937	7807	998	4332
Peak 15	50	90	20	140	89	180	50	280	150	678	89	917	150	550	90	760	2016			
Peak 15 x 4	200	360	80	560	356	720	200	1120	600	2712	356	3668	600	2200	360	3040	8064			
PFH	0.70	0.83	1.00	0.93	**0.67**	0.89	1.00	0.96	0.92	0.92	1.00	0.92	0.85	0.92	0.80	0.93	0.97			
Design Volume	200	360	80	640	356	720	200	1276	600	2712	356	3668	600	2200	360	3160	8744			
Actual Pk Hr	140	300	80	520	239	640	200	1079	550	2486	356	3392	510	2017	289	2816	7807			
														Peak Hr/Comp Peak			**0.89**			
	20	70	70	160	50	150	88	288	150	589	45	784	120	475	59	654	1886		1012	
	20	90	20	130	70	200	50	320	100	589	89	778	120	489	90	699	1927		1068	
	20	70	31	121	50	150	72	272	150	546	45	741	150	455	59	664	1798		983	
	20	70	20	110	50	150	50	250	150	546	89	785	120	489	59	668	1813	7424	975	4038
	50	70	20	140	50	180	50	280	120	645	89	854	120	489	70	679	1953	7491	1134	4160
	50	90	30	170	70	250	60	380	100	640	120	860	150	525	50	725	2135	7699	1270	4362
Peak 15	50	90	31	170	70	250	72	380	150	645	120	860	150	525	70	725	2135			
Peak 15 x 4	200	360	124	680	280	1000	288	1520	600	2580	480	3440	600	2100	280	2900	8540			
PFH	**0.70**	0.83	0.81	0.80	0.79	0.73	0.81	0.78	0.87	0.92	0.71	0.94	0.90	0.93	0.85	0.94	0.90			
Design Volume	200	360	124	684	280	1000	288	1568	600	2580	480	3660	600	2100	280	2980	8892			
Actual Pk Hr	140	300	101	541	220	730	232	1182	520	2377	343	3240	540	1958	238	2736	7699			
														Peak Hr/Comp Peak			**0.87**			
Case Comparision																				
Conventional Peak Hr	**240**	360	80	680	280	**760**	**200**	1240	600	**2712**	**356**	3668	**600**	1956	360	2916	8504		4868	
Peak Vol - NOT Conflicts	200	360	80	640	356	720	200	1276	600	2712	356	3668	600	2200	360	3160	8744		4788	
Peak Conflicts	**200**	360	124	684	280	**1000**	**288**	1568	600	**2580**	**480**	3660	**600**	2100	280	2980	8892		5148	
Maximum	240	360	124	684	356	1000	288	1568	600	2712	480	3668	600	2200	360	3160	8892			
Minimum	200	360	80	640	280	720	200	1240	600	2580	356	3660	600	1956	280	2916	8504			
Difference	40	0	44	44	76	280	88	328	0	132	124	8	0	244	80	244	388			
% of Minimum value	20%	0%	**55%**	7%	27%	39%	44%	**26%**	0%	5%	35%	0%	0%	12%	29%	8%	**5%**			

Using a. (overall intersection value) ignores any differences in movement or approach profiles; this is generally not appropriate.

Using b. (approach value) ignores movement variations; this may be appropriate if one movement has a very low volume where minor changes between periods give large percentage changes while the others do not.

Using c. (movement value) most closely reflects actual conditions.

For calculating the values the options are:

a. Use the 15-minute peak volume based on the 15-minute peak for the intersection (4 x peak 15 minutes).

b. Use the maximum of the peak hour 15-minute steps for each movement.

c. Use 4 x volume for the peak 15 minutes.

Using a. can give out-of-range results (PHF > 1.0) where the volume for that movement is not the highest in that time period. Even if it is not out of range, it does not always give an appropriate answer.

Using b. may give values that are not concurrent.

Using c. ignores the PHF calculation entirely, and uses the 4 times peak volume value for the peak 15-minute period for the intersection. This avoids the out-of-range and concurrency issues and models the peak 15 minutes explicitly. If the peak 15-minute conflicts are used, it also addresses that issue.

Real Data Example

Table D3 – PM Count Example uses data from a real traffic count as opposed to constructed data.

The original table (yellow data) used the 15-minute peak values (blue) to calculate the 4 times 15-minute value. The second block of data uses the maximum value in the peak hour. It is coincidental that the totals are the same even though the individual cells are different, which would give different analysis results.

Similar differences are noted comparing these with the lower block based on peak conflicting movements using the orange data.

Table D 3 – PM Count Example

Time From	To	E/B LT	E/B Th	E/B RT	E/B Approach	W/B LT	W/B Th	W/B RT	W/B Approach	N/B LT	N/B Th	N/B RT	N/B Approach	S/B LT	S/B Th	S/B RT	S/B Approach	Total Volume	Hourly Volume	Conflict 15 min	Conflict Hr
14:00	14:15	14	209	7	230	17	158	21	196	43	51	19	113	10	59	18	87	1165		353	
14:15	14:30	12	155	5	172	11	153	16	180	33	43	9	85	7	33	12	52	926		259	
14:30	14:45	18	147	9	174	11	126	10	147	29	42	10	81	5	35	6	46	850		237	
14:45	15:00	13	171	3	187	15	128	12	155	41	51	8	100	11	30	14	55	939	3880	274	1123
15:00	15:15	10	127	4	141	20	138	18	176	35	44	7	86	11	27	11	49	855	3570	239	1009
15:15	15:30	15	109	9	133	14	147	15	176	31	35	5	71	8	27	12	47	807	3451	247	997
15:30	15:45	13	143	4	160	12	142	12	166	29	51	11	91	21	29	8	58	892	3493	250	1010
15:45	16:00	15	136	8	159	13	127	10	150	37	37	10	84	5	26	14	45	831	3385	234	970
16:00	16:15	14	142	5	161	17	146	11	174	40	52	16	108	9	33	9	51	937	3467	253	984
16:15	16:30	15	149	9	173	16	151	12	179	36	47	14	97	10	34	16	60	958	3618	264	1001
16:30	16:45	9	179	5	193	9	180	7	196	36	48	16	100	19	24	9	52	1030	3756	279	1030
16:45	17:00	11	166	6	183	28	162	12	202	33	40	8	81	10	23	11	44	976	3901	267	1063
17:00	17:15	5	172	6	183	15	153	19	187	30	54	5	89	12	20	12	44	962	3926	264	1074
17:15	17:30	9	128	4	141	11	139	10	160	28	58	9	95	9	21	6	36	828	3796	234	1044
17:30	17:45	8	114	7	129	14	108	6	128	30	48	6	84	14	17	7	38	720	3486	203	968
17:45	18:00	10	120	5	135	16	100	4	120	26	52	8	86	12	15	5	32	714	3224	213	914
Total		**191**	**2367**	**96**	**2654**	**239**	**2258**	**195**	**2692**	**537**	**753**	**161**	**1451**	**173**	**453**	**170**	**796**	**14390**		**353**	**1123**
Peak Hr Volumes		40	666	26	732	68	646	50	764	135	189	43	367	51	101	48	200	3926			
PHF		0.67	0.93	0.72	0.95	0.61	0.90	0.66	0.95	0.94	0.88	0.67	0.92	0.67	0.74	0.75	0.83	0.95			
15 x 4		36	716	20	772	36	720	28	784	144	192	64	400	76	96	36	208	4120		1116	
Average Hour		48	592	24		60	565	49		134	188	40		43	113	43					

Note: In the above table, the PHF is calculated based on the maximum of the movement in the peak hour. However the 4 x 15 line is 4 x the peak 15 minutes of the intersection volume. This is inconsistent.

Based on True Peak in Peak Hour

Peak Hr Volumes	40	666	26	732	68	646	50	764	135	189	43	367	51	101	48	200	3926	
PHF	0.67	0.93	0.72	0.95	0.61	0.90	0.66	0.95	0.94	0.88	0.67	0.92	0.67	0.74	0.75	0.83	0.95	
15 x 4	60	716	36	772	112	720	76	808	144	216	64	400	76	136	64	240	4120	1220

Note: In this table the 4 x 15 line is calculated based on the maximum of the movement in the peak hour.

Based on Peak Conflicts

Peak Hr Volumes	57	682	24	763	54	565	59	678	146	187	46	379	33	157	50	240	3880	
PHF	0.79	0.82	0.67	0.83	0.79	0.89	0.70	0.86	0.85	0.92	0.61	0.84	0.75	0.67	0.69	0.69	0.83	
15 x 4	72	836	36	920	68	632	84	784	172	204	76	452	44	236	72	348	4660	1420

Note: In this table the 4 x 15 line is calculated based on the maximum of the movement in the peak hour for conflicts.

Summary

The combination of selecting the peak hour of conflicts (rather than peak hour for total volume), and the basis for calculation of the PHFs, is critical to determining the true design case. Again, the caveat is noted that both capacity and queue lengths must be evaluated. Once a design is done based on overall volumes, the proposed design must be checked for queue lengths (storage and blocking) for each lane group.

The objective is to produce a set of concurrent volumes that represents the design peak hour for capacity, and aids in checking for issues with short duration peaks outside the defined peak hours. In both cases, both capacity and queue lengths are issues.

The use of conflicts vs. total volumes is clear, conflicting volumes are the critical issue. The most appropriate approach seems to be to use the actual peak 15 minutes x 4 and ignore the PHF (=1) since we have that data. To calculate a total, determine a ratio and then go back and recalculate the "original" data is unnecessary.

In all cases, the analyst must confirm that using the identified time period(s) does in fact result in a worst case analysis for both capacity and queuing for each movement.

D.7 Traffic Projections (See Sections 4.2.7, 4.2.10)

Use of Trends or Growth Rate Method

This is one of the simplest approaches to use although it is prone to significant errors. The growth rate method is based on the assumption that recent traffic volume growth rates will continue to the horizon year(s) or will change predictably. Behind this are the underlying assumptions that:

- Variations in traffic volumes correspond to the economic climates that are experienced in British Columbia,

  and

- Development trends both within and external to the study area will continue at approximately the same rate as in the past.

If recent growth rates are not expected to continue, the growth rate should be adjusted to reflect these changes or another method of forecasting should be considered.

Peak hour, 30th hour, AADT and SADT traffic volumes and/or individual intersection turning movements should be used to develop the growth rates.

If data for turning movements for multiple years is available, that data should be used to develop growth rates for individual movements. Otherwise, the analyst must determine and document which is the most appropriate rate to use.

In congested conditions peak hour (and possibly 30th hour), growth may be limited by congestion. In this, case care must be used to ensure that the growth rate reflects the future continuation, or removal, of these constraints.

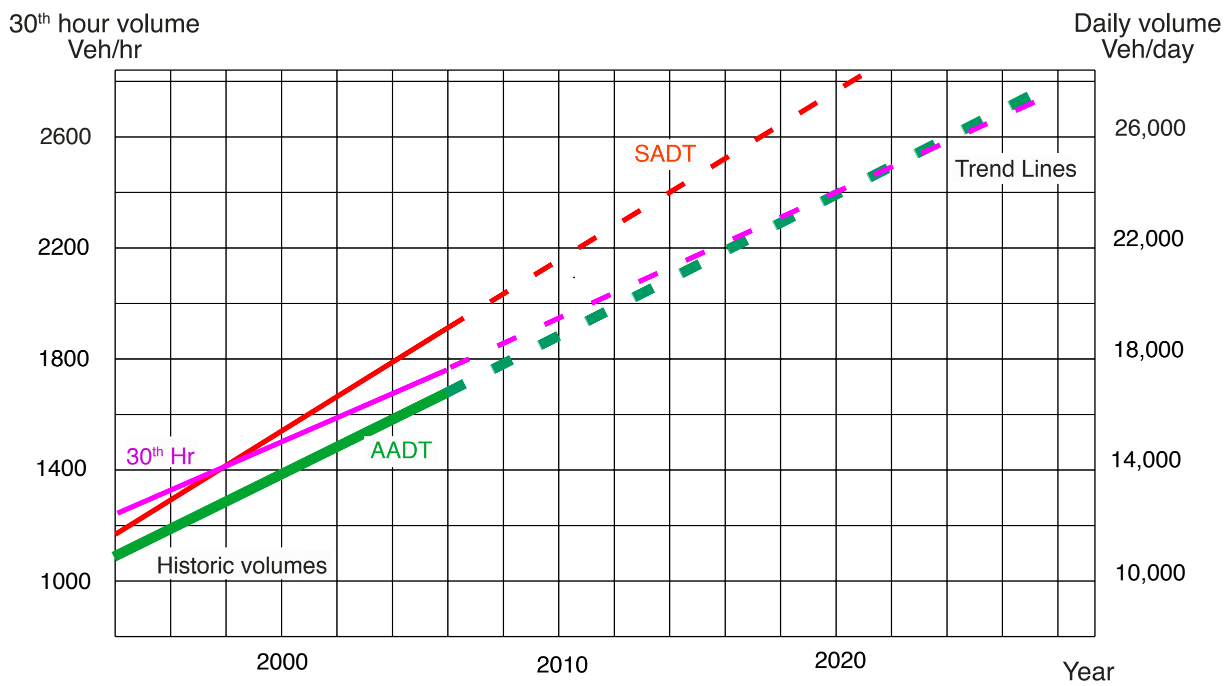
In some cases, such as in recreational areas, AAWDT and AAWET volumes should be considered separately as weekend traffic may be critical for some time periods. Seasonal variations in traffic volumes should also be considered.

> Growth rates must be based on traffic data taken over at least a ten-year period. The growth rate may then be determined by analysing the patterns of this data. The data must be presented graphically and include the trend line equation and R^2 values.

Caution should be exercised when using this method since it is often insensitive to localized changes. Other methods may be necessary in order to incorporate changes to the transportation network or other extensive nearby developments that have occurred or will occur during the study period.

In congested areas, AADT or SADT growth may exceed the measured peak hour traffic growth. This must be identified in the Design Report and addressed in the analysis.

Figure D.6 – Growth Rate Method



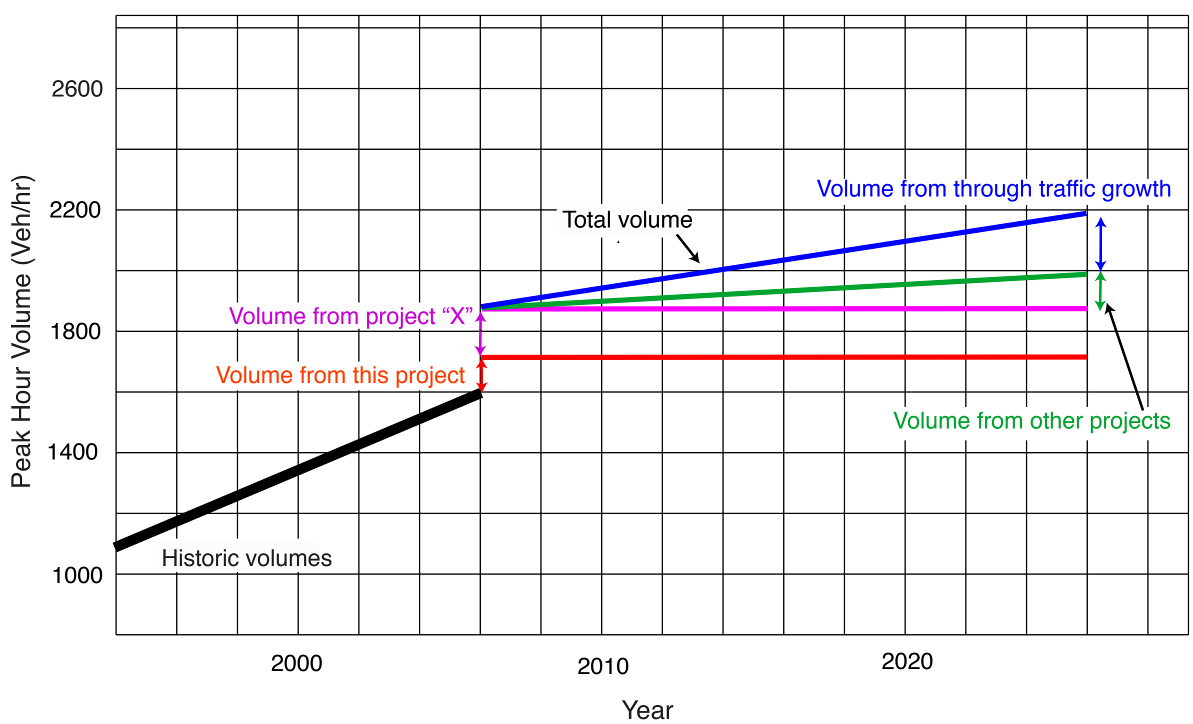
Ministry or municipal staff may already have determined the appropriate growth rate on the relevant roads in some cases. In such cases, these values will be provided and must be used. Where the growth rate is to be developed during the project design, the methodology and the rate must be approved by the Ministry and other reviewing agencies prior to use.

Use of the Build-Up Method

The build-up method is appropriate for study areas where one or more other projects are being developed during the same period as the proposed development. This technique can more accurately reflect local area traffic patterns that will change as a result of limited or moderate adjacent development or that are in an area where available traffic projections are not accurately known. The steps in using the build-up method are:

1. Determine existing traffic volumes.
2. Project peak hour traffic to be generated by approved and anticipated developments in the study area.
3. Assign the projected traffic to the proposed future street system.
4. Add any through-traffic that has both trip ends outside the study area. This may be obtained from a transportation model or external traffic volumes that have been scaled up by an appropriate growth factor (often the regional growth rate).

Figure D.7 – Build-up Method



Use of Area Transportation Plan or Modelled Volumes

Regional or sub-regional (including municipal) transportation plans and models usually project traffic volumes on major roads and highways for approximately 20 years into the future. Sometimes interim horizon year projections are also made. Projected traffic volumes from transportation plans or models are appropriate for the following types of studies:

- Very large projects with area-wide or regional impacts
- Situations where the traffic projections have local credibility (land use and demographic projections have been accepted by the Ministry and other reviewing agencies)

- The transportation model has a level of network detail that is required for site traffic analysis in the study area

Modelled information is used to determine the basic number of roadway lanes and right-of-way requirements. The transportation model can show changes in traffic patterns on area roads and the reassignment of adjacent traffic to alternative routes.

> Area-wide transportation models may only be used to review the impacts of network road issues and are not accurate to the level of detail needed for operational intersection analysis and individual access driveway requirements.

Sub-area models, with enhanced network descriptions and detailed zoning that represents individual land uses appropriately linked to roads, may provide more realistic turning movements for the specific traffic generation modelled if they are recalibrated to current local traffic volumes. This includes major driveways.

> Sensitivity analysis is required to evaluate the likely range of volumes projected.

It is more typical to use the transportation model to provide future forecasts of base traffic and the distribution pattern of trips generated by the development site or the zone that the site is in. Then other techniques can be used to carry out the assignment of generated trips for the specific site.

The impact of the availability of transportation model data on the selection of the horizon years was noted in **Section 4.2.7**.

Trip Distribution

The total trips generated by the development must be distributed and assigned to the road network. Trip distribution refers to the estimates of the origins and destinations of site-generated trips. (Trip assignment is discussed in **Section 4.2.10 – Assignment of Development Traffic**).

In trip distribution, it is important to consider the direction relative to the site as a whole, not just which specific road(s) will be used. In some cases, the direction and road may in fact be the same if there are limited routing choices. In other cases there may be choices; this is addressed in the next section.

The directions from which traffic will access the site can vary depending on many factors including:

- Size and type of proposed development
- Different areas, their land uses and population in the catchment area from which the development will attract traffic
- Competing developments (if applicable)
- Operating conditions on the surrounding street network

In carrying out a transportation design, the developer must clearly document the catchment area and the proportion of traffic from each part of it that is assumed for distributing the generated trips. The size of the catchment area can be based on:

- A reasonable maximum convenient travel time to the site
- Area boundaries that have been delineated based on the locations of competing developments
- Market studies or the known (from other sources) market catchment area

The three most commonly accepted methods for estimating trip distribution are discussed below. They are:

- Analogy method
- Trip distribution model
- Surrogate data

Whichever method is used, trip distribution should be estimated and analyzed for each horizon year since population levels change over time on an area-by-area basis. Consideration should also be given to whether inbound and outbound trips will have similar distributions. The derivation of trip distribution percentages must be fully documented in the Design Report

It is important that trip lengths be considered, particularly for large study areas and for land uses that have a regional significance, regardless of which method is used. For some types of land use, trips will be completed within a few kilometres of the site. Unless a gravity model is used to account for trip lengths, the analyst must develop a rationale based on population/employment distribution, a trip length frequency curve based on an origin-destination survey or other method documented in the Terms of Reference.

The Terms of Reference must state which trip distribution method is appropriate for the project. (See **Appendix A , item B4**.)

If the Ministry and other reviewing agencies agree that the proposed methodology is appropriate for the study area and the site, it will be approved by the road authority as part of the approved Terms of Reference.

Analogy Method

This method can be used to estimate the distribution of the proposed site traffic if a similar existing development is located near the proposed development. Data for the existing site can be collected by one or more of :

- Counting access and intersection turning movements
- Conducting a licence plate origin-destination or driver response survey

The trip distribution can then be estimated for the proposed site based on data collected from the similar site.

Trip Distribution Model

The gravity model or other locally acceptable trip distribution model can be used to estimate site trip distribution. Some municipalities have developed transportation models for use in projecting travel patterns on the street network system for future years. This data can, with caution, be adapted for use in developing site traffic distribution patterns. The model may only be used to review the overall impacts on the road network and should not be used directly to determine individual access driveway requirements.

Manual estimation based on the gravity model principle can often also be accomplished using experience, judgment and knowledge of local conditions. Specific information on locally available and applicable transportation planning models (e.g., Emme2, etc.) may be available from the Ministry or local governments.

Surrogate Data

The origins and distributions of destinations can be developed when an adequate socio-economic and/or demographic database of usable detail (by zones or other sub-areas) is available for the population or employment distribution representative of the study horizon year. In most cases: population can be used as the basis for estimating distribution of office, retail, and entertainment trips; employment can be used as a reasonable surrogate for residential trips; and other trips can be similarly distributed using surrogates that have similar characteristics.

D.8 Glossary of Terms

Abutting	Having a common boundary with or touching along a border.
Acceleration Lane	A speed-change lane, including taper areas, to enable a vehicle entering a roadway to increase its speed to that at which it can safely merge with through traffic. (See also Merge Area.)
Access	Includes any private driveway or other point of access such as a strata road or private road that connects to the public street system.
Access Management Plan (AMP)	A roadway design plan which designates access locations and their designs for the purpose of bringing those portions of the roadway included in the access management plan into conformance with their functional classification to the extent feasible.
ADA/ABA	*Americans with Disabilities Act/Architectural Barriers Act*, provide details for designing for users with disabilities and should be interpreted in the Canadian context in the absence of similar Canadian documents.
Arterial Highway	A designated ministry facility within a municipality. Usually numbered Highways.
Arterial Road	Roads with the primary purpose of carrying through traffic. Land access is not normally desirable. (See also Collector and Local Roads.)
Auxiliary Lane	Any additional special purpose lane such as speed-change lanes, climbing lanes and turning lanes.
Average Annual Daily Traffic (AADT)	The total volume passing a point or segment of a highway facility in both directions for one year, divided by the number of days in the year. (See also SADT, WDADT, WEADT.)
Average Travel Speed	The average speed of a traffic stream computed as the length of a highway segment divided by the average travel time of vehicles traversing the segment, in kilometres per hour.
Average Travel Time	The average time spent by vehicles traversing a highway segment of given length, including all stopped-time delay, in seconds per vehicle or minutes per vehicle.
Backage Road	See Service Road.
Bandwidth	The time in seconds, or the percent of traffic signal cycle length, between a pair or group of intersections which delineates a progressive movement on a time-space diagram. It is a quantitative measurement of the through-traffic capacity of a signal progression system. The greater the percentage of bandwidth, the higher the capacity on the arterial system.
Bike Lane	A portion of a roadway that has been designated by striping, signing and pavement markings for the preferential or exclusive use of bicycles.
Bike Path	A bikeway physically separated from motorized traffic by an open space or barrier, either within the highway right-of-way or within an independent right-of-way.

Capacity	The maximum rate of flow at which persons or vehicles can be reasonably expected to traverse a point or uniform segment of a lane or roadway during a specified time period under prevailing roadway, traffic and control conditions. Usually expressed as vehicles per hour or persons per hour.
Channelization	The separation and direction of traffic movements and pedestrian crossings at an at-grade intersection into defined paths through the use of geometric features, pavement markings and traffic control devices.
Collector Roads	Roads that connect local roads with arterial roads and provide access to individual properties.
Controlled Access Highways	Highways or portions of highways designated or designed for through traffic. Highways designated as such by an Order-in-Council enable BC MoT to restrict access onto the highway, to have special powers within controlled areas, - i.e. within an 800 metre radius of an intersection (notably approval powers over land use rezoning) - and to review subdivisions along the highway.
Corner Clearance	The distance between the near curb of a street intersection and the near edge of a driveway throat or public lane. (See also Intersection Functional Area.)
Critical Gap	The median time headway (in seconds) between vehicles in a traffic stream that will allow vehicles at a stop or yield controlled approach to cross through or merge with the traffic stream under prevailing traffic and roadway conditions.
Crosswalk	The marked crossing area for pedestrians crossing the street at an intersection or designated mid-block location.
Cycle	Any complete sequence of traffic signal indications.
Cycle Length	The total time for a traffic signal to complete one cycle.
Deceleration Lane	A speed-change lane, including tapered areas, to enable a vehicle that is leaving a roadway to slow to a safe turning speed after it has left the mainstream of faster-moving traffic.
Delay	Additional travel time experienced by a driver, passenger or pedestrian beyond what would reasonably be desired for a given trip.
Density	The number of vehicles occupying a given length of lane or roadway averaged over time. Usually expressed as vehicles per kilometre or vehicles per lane kilometre.
Design Domain	A range of limiting values for key design parameters.
Design Hour Volume (DHV)	The traffic volume (by direction and/or turning movement) determined for use in the geometric design of the access and adjacent road network. (See also Peak Hour Volume.)
Diverge Area	The area where a single lane (or more) of traffic splits to form two separate lanes without the aid of traffic signals or other right-of-way controls. Typically occurs at freeway or expressway exits.
Downstream	The direction in which traffic is flowing away from an intersection.
Driveway	An access that is not a public street, road or highway.
Frontage Road	See Service Road.

Functional Classification	A classification system that defines a public roadway standard according to its purposes and hierarchy in the local or provincial highway plans.
High Occupant Vehicle (HOV) Lane	A lane designated for the exclusive use of high occupancy vehicles, such as cars with two or more (as signed) occupants, buses and taxis.
General Street System	The interconnecting network of city streets and provincial roads and highways in an area.
Intersection Functional Area	The portion of roadway impacted by traffic operations (queueing, deceleration, acceleration, etc.) at an intersection on both the approach and exit legs.
ITE (CITE)	(Canadian) Institute of Transportation Engineers
Lane Balance	A condition at a diverge point where the number of lanes leaving the diverge is one more than the number of lanes approaching it
Left-Turn Lane (Single, Double, Triple)	One or more adjacent lanes intended for the exclusive use of vehicles about to turn left.
Level of Service	A qualitative measure describing operational conditions within a traffic stream. Generally described in terms of such factors as speed, delay, v/c ratio, freedom to maneuver, traffic interruptions, comfort and convenience, and safety.
Local Area Plan	A municipal or regional district plan developed under an OCP (see below) defining land use and transportation facilities in a local area in more detail than the OCP.
Local Government	A term referring to Regional Districts, the Islands Trust or municipalities.
Local Roads	Roads that provide access to individual properties and connect with collector roads.
Merge Area	Area where two separate lanes of traffic combine to form a single lane without the aid of traffic signals or other right-of-way controls. Typically occurs at freeway or expressway entrance ramps.
Multilane Highway	A highway with at least two lanes for the exclusive use of traffic in each direction, with no or partial control of access, that may have periodic interruptions to flow at signalized intersections.
Official Community Plan (OCP)	A community plan adopted under the *Local Government Act* section 875. An OCP is a statement of objectives and policies to guide decisions on planning and land use management within the area covered by the plan. All OCPs include a description of the transportation system (by mode).
Operational Analysis	The use of capacity analysis to determine the prevailing level of service on an existing or projected facility, with known or projected traffic, roadway and control conditions.
Parking Demand	Total spaces required for the development per unit of land use by type. (See *Parking Generation* manual.)
Pass-By Trips	The portion of trips generated by a development that are already on the road system but are diverted to the new land use before resuming travel in their original direction. Pass-by trips are not new trips generated by the development.

Peak Hour Factor	A measure of traffic demand fluctuation within the peak hour. The hourly volume during the maximum volume hour of the day divided by the peak 15-minute rate of flow within the peak hour (by turning movement).
Peak Hour Volume	The time period(s) that provide the highest cumulative directional traffic demands which are used to assess the impact of site traffic on the adjacent street system and to define the roadway configurations and traffic control measure changes needed in the study area.
Pedestrian	An individual travelling on foot.
Permissive Turn	Left or right turns at a signalized intersection that are made against an opposing or conflicting vehicular or pedestrian flow. (See also Protected Turns.)
Phase	The part of the signal cycle allocated to any combination of traffic movements receiving the right-of-way simultaneously during one or more intervals.
Planning Analysis	A use of capacity analysis procedures to estimate the number of lanes required by a facility in order to provide for a specified level of service based on approximate and general planning data in the early stages of project development.
Primary and Secondary Highways	Provincial highways that allow high-speed movement of inter- and intra-provincial traffic (see *Highway Functional Classification Policy*).
Protected Turn	Left or right turns at a signalized intersection made with no opposing or conflicting vehicular or pedestrian flow. (See also Permissive Turns.)
Protected/ Permissive Turn (P/P Turn)	A left or right turn phase that first shows the protected status, then shows permissive status for the remainder of the phase. (See also Protected Turn and Permitted Turn.)
Rate	A value-per-unit measure that specifies the requirements that need to be considered in evaluating a development. A parking generation rate specifies the parking requirements that should be provided for. A trip generation rate specifies the volume of traffic that should be accommodated.
Rate of Flow	The equivalent hourly rate at which vehicles or persons pass a point on a lane, roadway or other trafficway for a period of time other than one hour. Computed as the number of persons or vehicles passing the point, divided by the time interval in which they passed (in hours). Expressed as vehicles or persons per hour.
Recreational Vehicle	A vehicle generally operated by a private motorist and used for recreation. Examples include campers, mobile homes, boat or motorcycle trailers, etc.
Retrofit	The reconstruction of an existing street with geometric improvements to the existing design.
Right-Turn Lane	One or more adjacent lanes intended for the exclusive use of vehicles about to turn right.
Summer Average Daily Traffic (SADT)	The total volume passing a point or segment of a highway facility in both directions during the summer months, divided by the number of days in that time period. (See also AADT, WDADT, WEADT.)

Service (Frontage or Rear Access) Road	A roadway generally paralleling a controlled-access facility (freeway, expressway or major street) that is designed to intercept, collect and distribute traffic desiring to access or cross the major facility between interchanges or intersections. It provides access to property which otherwise would be isolated with no access to the road system.
Shared Parking	Parking space that can be used to serve two or more land uses over the course of a day or week or month. It is a method of optimizing the use of available parking space by sharing it among a group of users with different peak parking characteristics.
Sidewalk	Paved or gravel area designated for pedestrian use separated from the roadway by a raised curb or boulevard. (See also Walkway.)
Sight Distance	The distance visible to the driver of a passenger vehicle, measured along the normal path of a roadway from a designated location and to a specified height above the roadway when the view is unobstructed by traffic.
Sight Triangle	The triangle formed by the line-of-sight and the two sight distances of drivers in vehicles, cyclists or pedestrians approaching an intersection on two intersecting streets.
Signal Progression	The progressive movement of traffic through adjacent signalized intersections within a traffic signal system, travelling at a planned speed without stopping.
Speed	The rate of motion expressed as distance per unit time (kilometres per hour).
Speed-Change Lane	A separate lane for the purpose of enabling a vehicle entering or leaving a roadway to increase or decrease its speed to a rate at which it can more safely merge or diverge with through traffic. Acceleration and deceleration lanes are speed change lanes.
TAC	Transportation Association of Canada.
Taper	The widening of pavement to allow the redirection of vehicles around or into an auxiliary lane.
Throat Length	The provision of sufficient unobstructed on-site driveway length to prevent stopped vehicles from blocking the path of entering vehicles or vehicles travelling along the internal circulation roadways.
Transportation Demand Management (TDM)	A term used to describe measures designed to reduce the use of single-occupant vehicles or to shift travel time to non-peak conditions. TDM is usually directed at commuter travel in large population centres.
TRB	Transportation Research Board.
Trip	A single or one-direction vehicle movement with either the origin or the destination (exiting or entering) inside a study area.
Trip Generation	Total (two-way) vehicles per hour generated by a development per unit of land use by type during a given period. (See *Trip Generation* manual.)
Truck	A heavy vehicle engaged primarily in the transport of goods and materials or the delivery of services, other than a transit bus.
Two-Way Left-Turn Lane	The middle lane of a two-way undivided street intended for the exclusive use of vehicles about to turn left from either direction.

Upstream	The direction in which traffic is flowing towards an intersection.
Unsignalized Intersection	Any intersection not controlled by traffic signals.
Volume/Capacity (v/c) Ratio	The ratio of measured flow rate to capacity for a traffic facility.
Volume	The number of persons or vehicles passing a point on a lane, roadway or other trafficway during some time interval. Expressed in vehicles per hour.
Walkway	Paved or gravel area designated for pedestrian use provided on a separate right-of-way from the road.
Weaving Area	The length of roadway including an auxiliary lane where vehicles cross paths under free flow conditions. Normally formed between merge and diverge points, as well as between on-ramps and off-ramps on freeways. Weaving can also occur on non-grade-separated facilities. (See also Merging and Diverging Areas.)
Weaving Lane	A lane added to provide additional capacity and operational improvement in sections experiencing significant weaving volumes. A length of lane at one end of which two lanes merge and at the other end diverge.
Weekday Average Daily Traffic (WDADT)	The total volume passing a point or segment of a highway facility in both directions on weekdays only, for one year, divided by the number of such days in the year. (See also AADT, SADT, WEADT.)
Weekend Day Average Daily Traffic (WEADT)	The total volume passing a point or segment of a highway facility in both directions on weekend days only, for one year, divided by the number of such days in the year. (See also AADT, SADT, WDADT.)

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