THE CASE FOR MUNICIPAL FREIGHT AUDITS

Presented and Authored by:
W. J. Ford, C. Eng., M.I.C.E., P.Eng.
Manager,
Cansult Limited, Markham, Ontario.
(905) 470 2010

Co-author Julius Gorys, MCIP, PLE
Senior Planner
Ministry of Transportation, Downsview Ontario
(416) 235-3965

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1. CONTEXT

One of the two definitions found in the Canadian Oxford Dictionary of the word "audit" is:

> ***"A detailed examination or analysis, especially to assess strengths and weaknesses".***

Typically an "Audit" is a methodical examination, review of, or an assessment of the compliance with, a set of established rules, standards, conditions or situations often associated with financial issues.

In this case we will apply the formal definition above to Freight Movement.

To add to our difficulty in presenting the need for an audit of how well freight can move on a road system, rules, standards or accepted guidelines currently do not exist upon which to base an "Audit". Nor is there a definition of a "Freight Audit" in current use in the freight industry or for the use of its Municipal planning partners. There are no guidelines for Planners and Engineers, who play a major role in creating and establishing the various Master Transportation Plans governing Goods Movement in, through and between Municipal jurisdictions.

Within the context of a draft document being prepared for the Ministry of Transportation of Ontario on developing "Freight Supportive Land Use Planning Guidelines", it became all too obvious that there was a great need to come up with criteria to address challenges associated with the efficient transportation of goods using the road infrastructure system, hence this paper. Information in this paper is largely drawn from work prepared for the Ministry of Transportation on the subject matter.

The steady growth of truck traffic over the past decades has been associated with major delays to all modes of traffic at peak travel times, despite the fact that trucks attempt to avoid traditional rush hour periods. Truck growth between 1995 and 2000 has exceeded auto growth along Central Ontario's highway corridors (45% versus 35%) [I] . The tendency to use longer trailers is increasing as the incidence of "Cubing" out before "Weighing" out also increases. This has arisen due to the production and delivery needs of lighter, high value, time sensitive goods creating the situation where trucks reach their temporal payload well before their axle and registered weight capacity has been reached. This has resulted in the 53' trailer becoming the standard whereas 20 years ago the standard trailer length was 40' or 45' long.

The maximum length of a tractor/trailer combination traveling on Ontario roads, without obtaining a special permit, is 25 metres (82 feet); it can have a height not exceeding 4.15 metres (13.6 feet) and a width not exceeding 2.6 metres (8.5 feet) [II].

[I] MTO - Commercial Vehicle Survey Program, Transportation Planning Branch, 1995 - 2000
[II] MTO - Vehicle Weight and Dimension Limits - published in print and on-line by the Carrier Safety and Enforcement Branch (June 2001)

In order to assess the physical needs of such large vehicles a design designation has been developed which can apply to all vehicle sizes and is based upon a dimension from the front of the tractor to the middle of the rear axle set and in the case of semi-trailers, is preceded by the letters "WB". The "WB 20" design vehicle [III] has an overall length of 22.7 metres (74.5 feet) and a maximum allowable trailer length of 16.2 metres or 53 feet as mentioned above as the current commonly used standard for many trailers on the road.

All other vehicles, not requiring a special permit, are smaller and require less maneuvering space than the WB 20. The "**Freight Audit**" uses the WB 20 as the measure upon which assessments of compatibility are made.

The "**Freight Audit**" will also demonstrate to what extent the road system can accommodate larger vehicles requiring special permits, known as "Exceptional Load Vehicles". In Ontario, the Ministry of Transportation issues an annual average of 35,000 single trip permits for oversize and/or overweight loads [IV], thus demonstrating the need to accommodate the movement of such loads in, through and between Municipalities.

In order to improve a road system to respond to the needs of freight movement, the identified deficiencies must be corrected. This requires the inclusion of the remedial actions to be included within capital budgets. In many cases, the scope of the work may require allocation of funds over several years. In other situations the Municipality will have to wait for redevelopment of an area to implement changes and others might be able to be included in the current years' maintenance budgets. In all cases, a monitoring of the situation surrounding each improvement must be carried out and an update of an expected opportunity for implementation should be continuously reviewed.

2. OBJECTIVES

The objective of a **Municipal Freight Audit** is to identify impediments to the efficient transportation of goods and identify appropriate solutions which could lead to the allocation of resources for implementation.

Proper accommodation of goods movement and the efficiency of the freight movement system serving it, can improve the economic viability of existing businesses, encourage and attract new business and help Cities create an economic advantage or "edge" and maintain an appropriate balance of residential versus commercial tax revenues.

The economy of the region depends on the movement of goods to sustain and develop itself. Efficient goods movement is essential for economic growth and competitiveness.

3. DEFINITION OF "FREIGHT AUDIT"

Combining these thoughts and issues, the definition of a "**Freight Audit**" is:

> ***"A Freight Audit is a detailed examination and analysis of the capability of a Municipal road system to accommodate the needs of the movement of freight, in, through and between Municipal jurisdictions ".***

[III] TAC Geometric Design Guide for Canadian Roads Sept 1999 – Fig 1.2.4.6.
[IV] MTO – Permit Department 2002.

Based on the definition, key activities of a Freight Audit are to:

- Inventory the road system from a freight movement perspective,
- Document strengths and weaknesses,
- Identify specific initiatives that can be programmed and implemented.

4. ISSUES, METHODOLOGY AND PRACTICAL USES

Municipalities tend to ignore or undervalue the needs of goods movement in their transportation planning.

Municipal Freight Audits are a means to address the needs of freight movement in, through and between Municipalities and should therefore be an integral part of Municipal Transportation Master Plans. Ideally, the Master Plan should address the following issues related to freight movement:

- The establishment of a Municipal Truck Route Network
- The inclusion of potential truck by-pass routes where appropriate
- Acknowledgement of the needs of, and provision for, exceptional loads
- Recognition of the network of rail lines used on a regular basis for freight movement,
- Identification and protection of major rail classification and intermodal yards,
- Address Local/County/Regional/Provincial road access to ports, major airports, major truck and intermodal terminals,
- The collection and analysis of information highlighting the degree of freight movement, by mode, from principal attractors and generators within the Municipality,
- The collection of Dangerous Goods attraction, generation and transport information
- Development of a risk assessment of potential hazards related to Dangerous Goods,
- Development of Municipal response scenarios to comply with The Emergency Management Act, R.S.O., 1990, Chapter E9,
- Policies setting out processes for addressing goods movement needs and issues,
- Establish a consultative forum, comprised of key stakeholders, to periodically update the needs of the freight transportation industry and also update new information gathered,
- Review the appropriateness of area bylaws and establishment of new bylaws if necessary that recognize current freight movement operating conditions and global business practices, and
- Development and inclusion of any delivery generation rates measured against Land Use and its gross area, all to be added to a general database for future reference.

The inclusion of these within a Transportation Master Plan requires an understanding of the methodology, the reasoning and the practical use of the information behind the need for inclusion.

The following should provide the context for "what", "how" and the "why"…….
the "when" is always "yesterday".

Municipal Truck Route Network

Municipalities should recognize the critical role that their road networks, particularly the arterials, play in the overall freight network and in any Freight Strategy in the programming and prioritization of capital expenditures and should allocate those expenditures accordingly. Arterial roads are essential for freight movement, linking local streets to the Provincial highway system and to global markets

Municipalities should recognize that Provincial highways within their jurisdictions form an essential part of the broader regional freight network and that this role is reflected in their Official Plans. In addition, it should be acknowledged that these Provincial facilities periodically need to be upgraded and enhanced in response to the need for efficient goods movement and they should support their upgrading to sustain economic development.

The contribution of trucks in helping achieve economic vitality is often undervalued, and instead, their negative attributes emphasized. Municipalities should proactively plan to accommodate freight movements within their jurisdiction through the designation of a network of truck routes in their Official Plans and/or Transportation Master Plans. Ideally, the truck network should be the full arterial road network, designed for accommodation of all truck sizes and free of temporal restrictions. The Regional Municipality of York, for example, has adopted this approach [V]. An alternative approach would be the designation of an appropriate sub-set of the arterial network as 24 (hours)/7 (days a week) truck routes based on information obtained from the **freight audit**, and after appropriate consultation between freight stakeholders and local residents.

Municipalities should ensure that all such arterials connecting to the Provincial Highway network are part of the designated truck network. In addition, arterials or collectors serving freight terminals or major employment areas should also be part of the municipal truck route network. When selecting truck routes for designation it is also important to consider the functional characteristics of the roadway.

Generally, such roads in suburban and greenfield [VI] locations should have higher speeds; fewer intersections, traffic signals and entrances; and more favourable traffic signal phasings and timings. In more urban situations this is not possible. However, the provision of on-street parking, and freight loading facilities and enforcement practices would assist freight movements on those urban arterials that are municipal truck routes. (Ideally off-street parking and loading facilities should be provided) Municipalities should also commit to identify, prioritize and address any impediments to safe and efficient truck movement along those routes, including sub-standard geometrics, and sight distances, need for new traffic signals, and parking restrictions and related items.

[V] Regional Municipality of York Official Plan 2002.
[VI] Locations where urban development has not previously taken place.

Bypasses

In order to maintain the character of some communities, bypasses have sometimes been introduced to redirect through traffic.

A way to minimize vehicle noise, vibration and emissions emanating from all traffic, but particularly trucks, and enhance the character of residential communities and/or main street retail areas is to construct a by-pass around those areas, rather than impose a vehicular specific (i.e. trucks) or temporal restrictions.

This alternative can and has been introduced in both urban and rural settings, and it attempts to replace the vehicular capacity of the facility in question with one in close proximity, in order to expedite through traffic.

There are tradeoffs associated with bypassing commercial main streets (for example, lost business from through traffic). Municipalities should therefore carefully review the costs and benefits for all purpose or truck by-pass facilities around small communities and main streets. Where outcomes of such studies justify by-pass facilities, partnerships should be sought to expedite their implementation.

The Highway 10 by-pass of Orangeville is an example of a by-pass that expedites movement for all users and reduces truck traffic through the community while expediting through freight movements. The Unionville By-pass in Markham, Ontario, another successful deployment of this approach, has enabled the preservation and enhancement of Unionville's historic Main Street.

Signage

To assist the trucking industry, municipalities should appropriately sign municipal truck routes and exceptional load routes using a common format and identify key intermodal connections and provide more comprehensive information for drivers than a simple directional sign.

For most pick-ups and deliveries, trucks must rely on municipal roads. Municipal roads must be designed, operated and maintained with trucks in mind. Within the hierarchy of expressway/arterial/collector and local municipal roads, however, it is the expressway and arterial networks that are most important to trucks as they provide the critical connections to the Provincial highway network. Industrial collectors are also very important from a freight movement standpoint as they serve major truck traffic generators and therefore should accommodate large trucks and ideally exceptional loads. At the local end of the hierarchy, even residential streets must accommodate deliveries and pick-ups for mail, building materials, household goods, shop-at-home services, and household and yard waste; and therefore need to be designed and built with servicing needs in mind.

Principles for Development and Operation of Municipal Truck Route Networks

The following principles should be adopted by municipalities:

- several truck routes should be identified and designated by each municipality (a network for larger municipalities);

- freight movement needs should be considered on a network basis as part of Official Plan reviews, Transportation Master Plans, and municipal **freight audits**;
- municipal truck route networks should be comprised of:
    - highways and most major arterials;
    - municipal roads connecting major employment areas to Provincial highways;
    - major roads serving ports, major airports and other inter-modal and truck terminals,
    - municipal arterials that parallel Provincial highways.
- a small sub-set of the municipal truck route network should be designed for use by trucks carrying exceptional loads and these routes should be designed to a higher standard and be free of physical constraints;
- designated truck routes should be continuous across the municipality and should coincide at municipal boundaries with those designated by adjacent municipalities;
- adjacent land uses should be considered in selecting truck routes. Routes with sensitive adjacent land uses (e.g. schools and parks) should be avoided wherever possible;
- routes with high levels of transit service and/or busy bicycle usage should be avoided wherever possible;
- higher performance arterials should be prime candidates for designation as truck routes. These routes would generally have higher speed limits (60 kph and greater), lower frequency of traffic signals, higher incidence of exclusive turn lanes and railway grade separations, and more generous lane and right-of-way widths;
- designated truck routes should be signed appropriately; and
- designated truck routes and exceptional load routes should be mapped and made available to trucking companies, shippers, couriers, and the general public.

A reasonably dense municipal truck route network should be designated to provide good north-south and east-west circulation. In heavily urbanized areas, it is suggested that a 4 km. grid truck route network would be appropriate and in all circumstances it should be developed to provide freight mobility to all parts of communities and for through traffic.

Truck routes should connect to the Provincial highway network and serve ports and major employment areas that regularly generate substantial truck volumes.

In smaller, less urbanized municipalities or communities with a more radial (rather than grid) network, the truck network may be less dense and more heavily reliant on Provincial highways serving the area.

Discontinuity

Truck movements between municipalities should be seamless. Network discontinuities result in higher delivery costs, added congestion and more accidents.

Some truck and exceptional load routes available to freight movers are discontinuous either within municipalities or at their boundaries, or have restrictive turning movements where

jogs have not been eliminated. In addition to municipal boundaries, other barriers to truck route continuity include watercourses, railways, major utility corridors and freeways.

Discontinuities in the network of municipal truck routes increase the number of turning movements required, thus increasing truck travel times and delivery costs, overall levels of congestion and potential for accidents. In some cases, truck routes may appear to end (i.e. no alternative routes beyond a certain point), resulting in driver confusion and frustration, and unnecessary truck travel. Where the capability for direct continuity is not available or when restrictions exist on an otherwise suitable route, connecting links may be required.

As part of an integrated freight movement plan, continuous municipal truck routes should be provided. These routes should service desired destination points within the municipality, intersect Provincial highways, and connect adjacent municipalities. There should not be interchange access to roads with a truck restriction.

Cross boundary truck routes

Cross boundary truck routes add another degree of complexity since two municipal jurisdictions are involved. Liaison among relevant staff of adjacent municipalities is therefore essential. The frequency of continuous truck routes will depend upon the numbers of existing cross boundary roads. Cross boundary truck routes should be as direct as possible, compatible in design standards and be prime candidates for exceptional load routes.

Local Alternatives to Provincial Highways

Where Provincial highways form the “spine” of a local road network, parallel municipal roads should be developed to accommodate local trips, rather than having these trips impede intercity movements on Provincial highways.

Provincial highways perform a vital service linking communities with each other and with Ontario’s international and inter-provincial borders. For example, lack of arterials parallel to Hwy. 400 in Barrie results in increased usage of the freeway for local truck trips. The ability of these highways to expedite intercity travel can be compromised if they are used as collector lanes for primarily local traffic. In municipal transportation system planning, parallel municipal roads (service roads or otherwise) should be planned and implemented to serve local truck and auto trips

Continuous upgrading of truck routes

Route constraints impose additional costs to shippers and carriers, and ultimately the consumer.

Direct and efficient access to many destinations is hampered by local constraints which cause “out-of-way” travel. Additional distance and additional turns increase the time it takes to move from one stop to another, generates more wear and tear on truck braking and steering systems, and impedes the ability to carry out all pickup and deliveries in a given day, resulting in inefficient vehicle utilization and additional labour and fuel costs due to further vehicle kilometres traveled. For example, instead of one vehicle with two drivers (one daytime and one night-time), each performing an eight hour workday, time of day restrictions (typically twelve hours) force use of a second vehicle because 16 hours worth of work cannot be accomplished in 12 hours because of time taken loading and unloading products. Since this is particularly the case

for exceptional loads, it is important when planning local road/bridge improvements to check that exceptional load access is maintained or improved.

An inventory of the differing degrees of constraints for the effective movement of freight within the municipality/region should be part of a **freight audit**. The inventory can then be used as a basis for capital expenditure planning to remove such constraints and/or provide information to private industry related to the types and extent of the constraints for route planning and permit application purposes.

Removal of route constraints will involve:

- identifying the degree of constraints,
- documenting details for private industry use,
- creating an inventory of constraints as part of a "**freight audit**",
- developing a program of removal of constraints,
- integrating the constraint removal program with the municipalities' ongoing capital works programs.

Exceptional Load Routes

Part of the municipal truck route network should be capable of accommodating exceptionally large loads, such as construction material and equipment, on-site construction offices (trailers), mobile homes and even permanent houses. Since the size of load can vary significantly, it is not possible to define a single envelope which could be adopted by local municipal and provincial jurisdictions and issued as a standard. A range of recommended clearance dimensions is more appropriate to provide guidance to Planners and Engineers [VII] as shown on Figure 1.

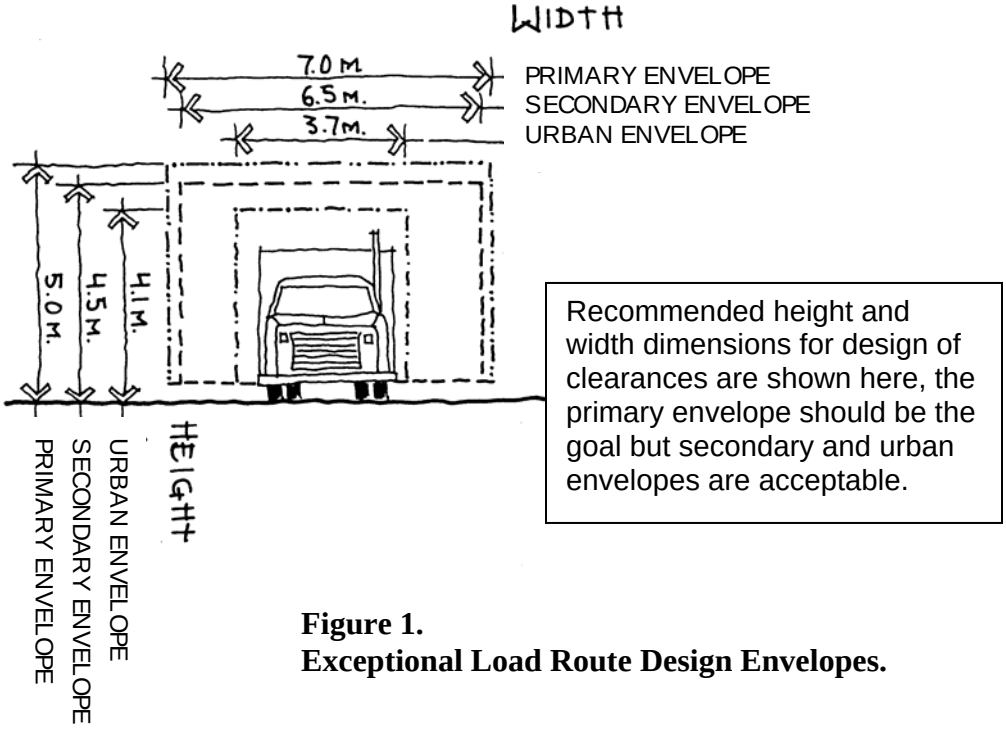

Figure 1.
Exceptional Load Route Design Envelopes.

[VII] Metro Toronto Exceptional Load Route Designation Study 1990.

Principles for Development of Exceptional Load Routes

The following principles could be adopted by municipalities:

- exceptional load route(s) should be a sub-set of the municipal truck route network;
- the identification of capability to carry exceptional loads should be based upon an hierarchy of routes using primary, secondary and minimal urban envelopes as identifiers as shown in the sketch above;
- an exceptional load route should connect to Provincial freeways and highways and should provide for continuous cross- boundary travel between adjacent municipalities where warranted;
- the network should serve any operating port and other identified generators and attractors of exceptionally large loads;
- municipalities should identify and map route constraints through conduct of a **freight audit** and periodic updates;
- municipalities should routinely consider removal of constraints in the context of ongoing capital work programs.

Through the conduct of municipal **freight audits**, generators and attractors of exceptional loads can be identified and mapped, thus providing an important input to the development of exceptional load routes. The **freight audit** should also include the identification and documentation of constraints along candidate routes. Once exceptional load routes have been established, an action plan should be developed to eliminate constraints over time, in conjunction with programmed roadway and bridge improvements or rehabilitation initiatives.

In 1997, following the transportation of some very heavy and large equipment, a new load designation was developed, and consequently the protocol for transporting a “superload” was put into place. Approximately 250 applicants per year [VIII] meet the criteria and obtain authorization to transport a “superload” in Ontario. “Superloads” in Ontario are:

- loads in excess of 6 m. in width traveling on 2-lane highways;
- loads in excess of 7 m. in width traveling on multi-lane highways;
- loads having a total gross vehicle weight of 120,000 kg. or more.

Truck Collector Roads

Collector roads in industrial employment areas should be of sufficient width for the amount of traffic generated and should incorporate gentler curves and run parallel to major arterial roads where possible. A grid pattern should be respected and discontinuous routes should be avoided to promote greater use of such roads, rather than have trucks compete with public transit and commuter traffic on major arterial roads. Intersection design should also be generous to accommodate wider turning radii. Discontinuous routes within industrial or commercial subdivisions should be avoided and planned for at the very initial stages of the planning process, if not, expensive retrofit solutions may be required.

[VIII] MTO – Permits Department 2002.

Truck Local Roads

A normal element of any residential or industrial subdivision is local roads that provide access to collector roads or major arterials. Depending on the role of the industrial area, landscape and proximity to other transportation corridors experience shows that streets, crescents and cul-de-sacs will be used by heavy vehicles.

Where possible, and with the exception of cul-de-sacs, access should be provided in more than one place, to permit a "back door" exit in the event of excess congestion on that higher order street

Signed Truck Routes

Appropriately signed routes provide clarity to drivers and ensure compliance with municipal restrictions. Designated truck routes should be signed as such, particularly in the vicinity of freeway interchanges, other Provincial highway intersections, ports, major airports and other inter-modal and truck terminals. This provides the best way-finding service for truckers, especially those who do not make regular pick-ups or deliveries in that area.

Similarly, arterials not specifically designated for trucks should be clearly signed with any truck restrictions (e.g. 7 p.m. – 7 a.m.).

Route Planning Assistance

With the advent of the internet, most municipalities have developed municipal websites. The websites would provide an excellent location for placing truck route maps and is an ideal vehicle for the dissemination of truck route information to trucking companies, shippers and couriers as well as the general public.

Municipal truck route networks, including exceptional load routes (with any specific constraints), could be mounted on the websites, thus providing easy and quick access to this information. This would facilitate route planning for truck trips including the identification of alternate routes.

Another approach would be to display such maps at prominent municipal freight gateway locations, prepare hard copy maps and distribute these to local industries and trucking companies, and keep them on hand at city halls and other key public buildings.

Operational issues

- Rationalize Design Standards

Horizontal road geometrics are governed by the characteristics of the design vehicle chosen which most closely fulfills the purpose of the task resulting in increased demand for the tractor trailer combination utilizing the 53ft trailer known as "design vehicle WB 20" which should be used as a basis for all freight related design considerations.

The WB 20 is a vehicle with an overall length of 22.7 metres (74'- 6") and a height of 4.15 metres (13'-7 ½") see Figure 2.

The current maximum width (without a special permit or allowance for rear viewing mirrors, etc.) for a vehicle on Ontario roads is 8'- 6" (2.6 metres) [IX].

Software programs are available to determine the subscribed areas for the WB 20 as well as other design vehicles for many different maneuvering requirements.

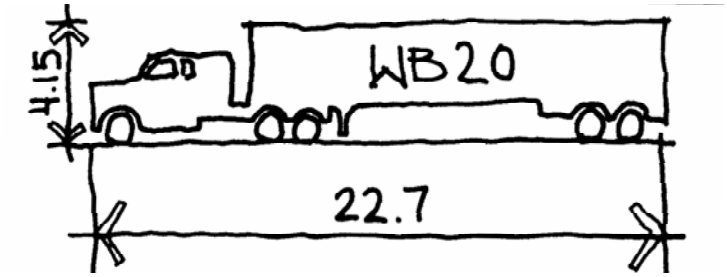

Figure 2. WB 20 - Basic Design Characteristics.

Areas where horizontal geometrics should be considered are:

- Left and right turns at intersections,
- Site and building entrances,
- Docking facilities,
- Areas with physical restrictions (walls, gatehouses, gates, columns etc...)
- When there is the need to reverse,
- Potential encroachment into oncoming traffic lanes to complete a maneuver,
- During temporary/interim road or access construction works (detours, restricted lane width, obstructions, road repairs etc…).

Left and Double Left Turn Lanes

Providing sufficient turning radii and signal phasing greatly enhances truck movements. Trucks subscribe a large area when making left turns and require substantial space to maneuver safely through an intersection. When gaining access to adjoining roads using double left turn lanes, an outside left turn maneuver will compromise the entire left turn movement for other users, thus prejudicing the safety of the intersection.

Turning from the near side left turn lane enables other vehicles to use the outside lane with safety and enables the truck to perform the maneuver without using the other lanes available for oncoming right turn traffic. It is therefore recommended that trucks be encouraged to use the near side left turn lane of a double left turn by installing appropriate signs well ahead

[IX] MTO - Vehicle Weight and Dimension Limits - published in print and on-line by the Carrier Safety and Enforcement Branch (June 2001)

of an intersection and at the intersection itself. An alternative solution would be to enact legislation/by-laws prohibiting large trucks from using the outside double left turn lane.

Right Turns

Right turns require properly designed curb radii to avoid riding curbs and potential damage to street furniture or utilities. The larger the curb radius, the easier it is for trucks to enter their correct lane on the intersecting roadway. Tight or inadequate radii will force trucks into an incorrect location on the adjoining roadway and in the case of a two way, two lane intersecting road, may force encroachment into the lanes used by oncoming vehicles.

Site Access

When trucks require access into a specific site the entrance radii will have to provide sufficient space for the WB20 design vehicle to make left and right turns into the entrance such that there is no encroachment on exiting vehicles. The same principles used for intersection design should be applied to entrances to sites. In many cases access into a site is gained from a two lane, two way local road, care should be exercised when designing entrances under these circumstances.

Vertical Geometrics

The vertical geometrics as applied to major road designs will normally provide for adequate ground clearances for most vehicles. Ground clearance is a function of length of wheelbase (axle spacing) and severity of roadway crest situation grade changes over short distances, except in the case of the freight mover which is designed specifically with little normal ground clearance (e.g. float trailer) to help load and enable tall cargoes to clear obstructions.

Moving vans also have reduced ground clearance due to the addition of storage compartments below the main body. There is also a difference in ground clearance between an unloaded and a fully loaded vehicle.

There are situations where attention to the vertical geometrics is essential:

- Railroad crossings,
- Raised intersections on narrow roads (usually a rural situation),
- Rural roads, culvert locations and bridges especially in undulating terrain,
- Detours,
- Speed bumps at a crest,
- Entrances with large positive to negative gradient differences.

Street Furniture and Roadway Clearances

Much of the existing infrastructure was originally designed to accommodate much smaller truck configuration than the newer WB 20 tractor-trailer combinations.

When making turns, the trailer's rear wheels move toward the centre of the curb radius or the pivot point of the turn. The traveled path of the rear wheels is not circular but closer to an ellipse. Thus, unless the physical curb is suitably matched to the minimum inside radius of the

subscribed truck turning template, "curb riding" will take place with the accompanying wheel load damage to the grass/asphalt/concrete boulevard area behind the curb. In some cases damage due to "curb riding" can be quite substantial and may cause damage to above and below ground street furniture or utilities. A clear visibility zone (Sight Triangle) is required at intersections which should include generous setbacks for such items as hydro poles, lighting poles, traffic signals and trees on corners [X]. The recommended minimum set back for street furniture in an urban environment is 0.4 m. between intersections [XI].

Locations prone to "curb riding" include:

- Restricted turns into 2 lane side roads,
- Where a raised median does not allow sufficient "out swing" to make a right turn,
- At entrances to car parking areas that are used for freight access to load or unload,
- Landscaped areas near docking facilities,
- Where no clear delineation exists between running surface and grassed/gravel areas.

Exceptional Loads

As stated earlier all vehicles traveling on Ontario roads must comply with regulations controlling their weight and dimensions. It is legally permitted to conduct business on Ontario roads with a semi trailer combination (tractor + trailer) whose dimensions do not exceed any one of the following limits:

- Length – 25 metres (82.02 feet),
- Height – 4.15 metres (13.6 feet),
- Width – 2.6 metres (8.5 feet).

The maximum length of a semi trailer is 16.2 metres (53.15 feet).

In Ontario, if the vehicle exceeds any one of the above dimensions, including the load, it is classified as an "Exceptional Load Vehicle" and requires a special permit to travel. Many exceptional loads require police escorts while traveling.

The Ministry of Transportation of Ontario's publication "Vehicle Weight and Dimension Limits" published in print and on-line by the Carrier Safety and Enforcement Branch (June 2001) provides comprehensive definitions of permitted freight vehicle sizes and weights.

An exceptional loads designation results from exceeding any one of the regulated dimensions for vehicles for weight, height, width or length as described above. To establish planning and design criteria for clearance envelopes for exceptional loads, three basic combinations of dimensions should be used to classify exceptional load routes. These classifications can form the basis of a **freight audit** database dealing with exceptional loads. The length criterion relates to horizontal design capabilities and the space required to perform

[X] TAC Urban Supplement to the Geometric Design Guide for Canadian Roads U.D.6 (b) April 1995.
[XI] TAC Geometric Design Guide for Canadian Roads Sept 1999 – Ch 3.3.2

turning movements without impacting upon such items as street furniture, utility poles or buildings close to the traveled way.

The three envelopes are:

- Primary Envelope – the largest clearances (H=5.0m, W=7.0m, L=36.5m),
- Secondary Envelope – intermediate clearances (H=4.5m, W=6.5m, L=30.5m),
- Urban Envelope – Urban minimums (H=4.15m, W=3.7m, L=24.5m).

Exceptional load routes should avoid the following characteristics:

- Abrupt changes in grades,
- Steep hills,
- Narrow lane widths,
- Two lane roads,
- Overhead utility services with less than 5m clearance,
- Sharp turns,
- Excessive "out-of-way" travel,
- Non continuous municipal boundary crossings.

Freight Friendly Interchange Configurations

Current standards for interchange designs in large part incorporate the needs for freight movement vehicles. Those designed many years ago may be substandard, but are gradually being updated. In some instances tighter geometry has been applied making it more problematic for trucks. Adjusting interchange configurations can provide direct access to large industrial areas or freight attractors and generators.

When a development is proposed, and where the interchange most likely to be adopted for use to access that development can be identified, planners should confirm that the interchange conforms to the latest design standards.

The intent of the latest design standards [XII] is to enable heavy vehicles to attain highway speeds for safe merging within the exit ramp length; the converse applies to slowing down in the deceleration ramp before using the interchange itself.

In the event that access to the highway system will be via an "older style" interchange the following design components should be reviewed with the Provincial Highway Authority:

- Adequacy of the ramp radii,
- Length of highway deceleration lane, especially if the approach ramp to the interchange is downhill,

[XII] MTO – Geometric Design Standards for Ontario Highways.

- Length of highway acceleration lane, especially if the exit ramp for the interchange is uphill,
- All weaving lengths,
- If ramps are super-elevated, for protection against overturning potential,
- Style of interchange

It is possible to retrofit interchanges to permit direct access into a large freight generating area (e.g. industrial subdivision or shopping centre) by adjusting the configuration to provide an at-grade link (typically the middle lane of a 3 lane intersection), or a grade separated link which is far more costly ($1-2 million) and should be the responsibility of the development interest, given directly attributable benefits.

Generally access to large industrial sites adjacent to highways and/or their interchanges is by major arterials and the closest local road intersections either side of the highway. Often access involves left turns, usually through the nearest signalized intersection.

Access directly from a freeway in and out of an adjacent industrial area would be the most efficient from a goods movement perspective. This can be achieved with much less impact at an interchange location rather than from a link between two interchanges where spacing and weave lengths could be problematic. Existing and planned interchanges can be modified or designed to accommodate the traffic moves required by checking horizontal and vertical geometrics. Typical elevation differences at interchange locations can provide opportunities to pass under a local arterial. Utilizing existing signals at ramp terminal points may involve raising the access road beyond the signals or designing the grading of the adjacent development to take advantage of the grade differences.

Such changes require approval from the highway authority and suggestions for new designs or retrofitting existing interchanges will be scrutinized to ensure that current/future operational functionality and level of service is within acceptable limits.

Non Typical Configurations

Direct access into industrial areas or shopping centre and outlet centre sites can also be provided at partial interchanges. While in some instances access is provided from the ramp itself into some sites, the practice is not preferred.

Effective Supporting Operational Measures

- Intersection Signalization and Optimization

When cross street traffic flow, accidents or traffic profile warrants, intersections should be signalized in the interests of efficiency and safety. Special attention should be paid to delays to traffic due to left turns especially on two lane roads where the opportunity to pass a waiting vehicle is minimal.

Left turn signal times should be lengthened to permit more than one truck to clear an intersection. It takes in the order of ten seconds for a tractor-trailer unit to successfully negotiate a left turn across a major road from a standing start, a little less if moving when starting the left turn.

- Speed Limits

The continuity and maintenance of effective speed limits on routes used by freight movers is an important variable in the timely and cost-effective delivery of goods. Firstly, journey times can be estimated with greater accuracy. Secondly, the constant changing of speed is a negative factor in the "wear and tear" aspects of maintenance costs of trucks. One way to maintain a higher rate of speed along a freight corridor is to limit the number of signalized intersections, where the lights are activated by loops. As much as 1 (one) minute of lost time per signalized intersection can accumulate if linking for through traffic is not present.

- Enforcement Practices

Enforcement of regulations related to illegal on-street parking will help with maintaining general traffic flow especially when one lane of traffic is obstructed. Automobiles are far more likely to cause such infractions. Similarly, illegal off-street parking infractions should be actively pursued particularly in service laneways and loading bays to avoid on going noise and safety issues related to truck parking on private property. Where designated and time specific parking has been allocated, enforcement of the uses permitted will discourage abuse of curbside parking/management schemes.

- Seasonal Load Restrictions and Designated Truck Routes

The need to impose seasonal load restrictions on commonly used truck routes to protect the road structure in the spring thaw period, is a good indicator of need for pavement upgrading and can be used for capital budgeting purposes as the economy of the area may well depend upon efficient year round access for freight movers. Seasonal load restrictions are most common in rural areas where the updating of the road system has not kept pace with the overall traffic demands of the area as a whole, especially for transportation of freight.

- Truck Climbing Lanes

Trucks have a disproportionate impact on traffic flow because of their size and operating characteristics. In general, trucks, because of their reduced performance capabilities and physical size, impede traffic flow. The effects of trucks tend to become greater as traffic volume increases and as roadway geometrics become more restrictive.

The effect of trucks on traffic flow has generally been addressed in theory and practice through the concept of a passenger car equivalent (PCE), i.e. a truck effectively "takes up the space", or is the operational equivalent, of several passenger cars. For example, as the grade of a highway increases, a given truck's PCE will increase (all things considered equal) as the truck slows down, and effectively takes the place of several passenger cars. This phenomenon is then reflected in the service flow rate that a roadway can accommodate at a given level of service.

Part of an overall supportive operational measure to assist trucks and reduce delays for other road users is the installation of truck climbing lanes. As a first indicator a truck climbing lane should be considered for inclines of 5% or more which are in excess of 1km in length, steeper grades would warrant shorter lengths. The PCE varies with three criteria, the gradient of the hill, the length of the gradient and the percent of trucks and/or buses in the traffic flow and can vary from 1.5 PCE's on a gradient of less than 2% over any length to 15 PCE's on a 6% gradient for a length of greater than 1 mile (1.6 km). For the example above 5% at 1 km length

and 6% trucks in the traffic stream, a truck will have a PCE of 6.0. Reference to detailed design criteria should be made for the actual design [XIII].

- Data Collection

Essential to all planning exercises is the collection of appropriate data upon which to base decisions. In the context of freight movement and the **freight audit** data should include:

- The degree of freight movement by route and mode from principal attractors and generators within the Municipality,
- Information related to the origin, destination and movement by route of dangerous goods, and
- Delivery and generation rates measured against Land Use.

5. SUMMARY AND CONCLUSIONS

Transportation Master Plans are comprehensive, multi-modal plans usually prepared to address the long term needs of entire municipalities.

Typically, Master Plan preparation involves preparing travel forecasts for a 20 or 30 year time horizon, developing, testing and evaluating alternative road, public transit and rail networks and then selecting the preferred networks based on a series of pre-determined criteria. While the focus of Master Plans is person travel, Master Plans should also deal with goods movement, since the latter will influence road and rail system requirements. In addition to defining networks, the preparation of Master Plans should also include transportation policy analysis and development, as Transportation Master Plans usually provide the basis for both transportation policies and networks to be included in municipal Official Plans. As such, Transportation Master Plans provide the ideal opportunity to deal with freight movement needs and policies in the context of the broader transportation network, which must accommodate the travel needs of both people and goods.

From a goods movement perspective, Transportation Master Plans should include a "**Freight Audit**" which:

- establishes a municipal truck route network including proposed by-pass routes (where appropriate) and designated routes for exceptional loads;
- recognizes the network of rail lines used on a regular basis for freight movement, including major classification yards;
- addresses access to ports, major airports and major truck and intermodal terminal via the municipal/county road or Provincial highway network;
- collects and analyzes information highlighting the degree of freight movement by mode from principal attractors and generators within the municipality;
- develops policies setting out processes for addressing goods movement needs and issues, including establishment of a consultative forum that includes a local freight stakeholder group and a requirement for periodic updates of the freight audit;

[XIII] TAC Geometric Design Guide for Canadian Roads Sept 1999 – Ch 2.1.8.3.

- review of the appropriateness of area bylaws and the establishment of new bylaws if necessary that recognize current operating conditions and global business practices; and
- should include any and all delivery generation rates measured against land use and areas to be added to a general database..

The degree of information in the audit will be a function of the amount of economic and logistics activity in the community and the sophistication of its planning and transportation departments.

Shown below on Figure 3 is the composition of a Transportation Master Plan and the relationship that a **Freight Audit** has within it.

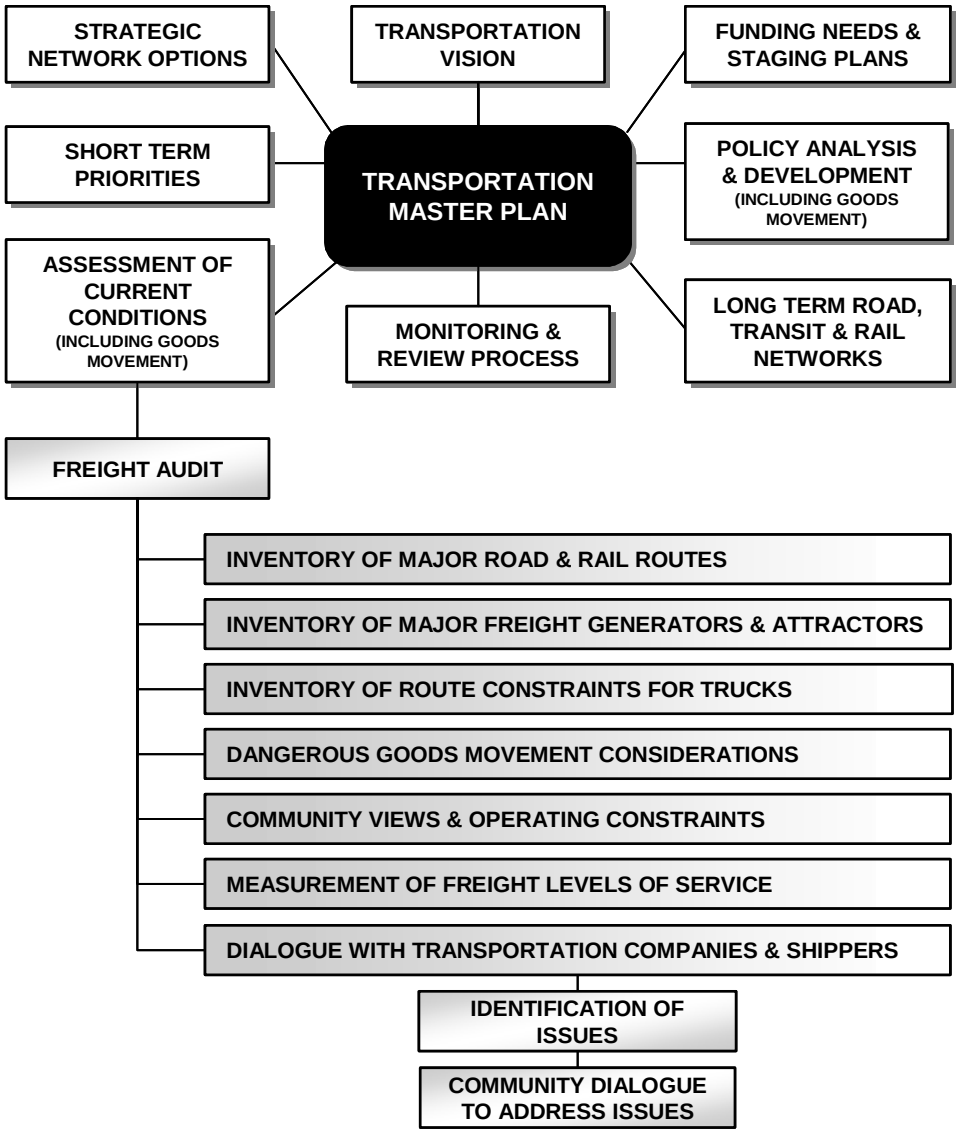

Figure 3.
Freight Audit Relationship to Transportation Master Plan.

Some municipalities may prefer to have more detailed goods movement related policies reside in their Transportation Master Plans rather than in their Official Plans. This is acceptable as long as the policies are supported by relevant Councils. The new Emergency Management Act, R.S.O., 1990, Chapter E9, requires municipalities to provide a risk assessment and an analysis of potential hazards within municipalities and to develop municipal response scenarios in the event of an incident involving dangerous goods. Dangerous goods information collected during a **freight audit** would be of great assistance to municipalities to meet such obligations. Information on the locations of generators and attractors of dangerous goods and the routes taken by carriers of such goods would be extremely valuable in assisting in the development of municipal emergency response measures.

In our modern society, the efficient movement of goods translates directly into economic advantages. **Freight Audits**, carried out and acted upon by Municipal Authorities will ensure the viability of tax bases and enable knowledgeable decisions to be made related to the distribution of tax dollars through capital budget planning over several years.

Gradual but purposeful investment in the roadway infrastructure focused on freight movement needs will provide substantial returns on investment and enable individual municipalities to keep and attract businesses that rely on the effectiveness of the freight movement industry.

A Freight Audit and its associated road system inventories which cover all the planning, physical and operational issues described in this paper will provide the basis for moving forward in an organized and transparent way. It is hoped that knowledge has been gained and this paper can be used for practical application in the “Real World” of goods movement.

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