Appendix D

Impacts of Front Yard Parking on Wet Weather Flow Management Issues

Scope of Appendix

Staff of Toronto Water's Infrastructure Management Asset Planning and Management – Stormwater Management group have considered the several requests to provide additional information on the effect of front yard parking and driveway widening on stormwater management.

This appendix:

a) Examines additional issues from Community Council and Works Committee requests concerning "the impacts of residential parking located at the front or beside a house on stormwater runoff, the Wet Weather Flow Management Plan, toxicity, and extrapolation City wide using the WWF Hydrological Model".

b) Summarizes the status of developing a methodology for evaluating various porous materials for front yard pads.

Impacts of Front Yard Parking on Stormwater Management

Effects of Front Yard Parking By Extrapolation of Wet Weather Flow Model

Toronto and East York Community Council (Paragraph (3)(a), Clause No. 25 of Report No. 5, adopted by City Council at its meeting of June 14, 15 and 16, 2005), requested "an extrapolation of the wet weather flow [WWF] hydrologic model for all existing licensed front yard parking pads and driveway widenings to determine the amount of additional stormwater that enters storm sewers as a result of these pads". In addition, Policy and Finance Committee (Paragraph (3)(a), Clause No. 2 of Report No. 3 of Policy and Finance Committee, adopted as amended by City Council at it special meeting of February 21, 22, 23, 24, 25, 28 and March 1, 2005) made requests to document the environmental impact of front yard parking and driveway widening. The environmental impact considered in this section is the additional volume of stormwater runoff generated if the parking pads are paved with asphalt or other hard surfaces.

To evaluate the amount of additional stormwater that enters storm sewers as a result of these pads, the following methodology was used. The WWF model was applied by considering the four categories of residential parking and the land use categories. The four basic categories of residential parking located at the front or beside a house, described in the Staff Report dated May 17, 2005 to all Community Councils, were used to characterize the number and size of parking pads.

The hydrological response of any lot is a function of land use categories, connectivity, and type of soils. The WWF model considers land use categories of low-density residential (range of 30%-50% imperviousness), medium-density residential (range of 50%-70% imperviousness), high-density residential (range of 70%-90% imperviousness), high rise residential, downtown commercial, big box commercial, strip mall commercial, and a set of industrial and open space categories (institutional, educational, parklands, hydro, golf, cemetery, valley lands, highway, prestige industrial, big box industrial, and agricultural). For purposes of this assessment, it was estimated that all residential parking pads are limited to low density and medium density land uses. The model uses 7 different types of connectivities (how rainwater is transported from the building, through overland flow, footing drains and downspouts) between the lot and the City conveyance system, and 3 major soil types (which influence infiltration); all 'connectivities' and soils across the City were considered in the assessment. The amount of imperviousness in each land use category includes all hard surfaces-roofs, sidewalks, driveways, roadways and parking lots, and as such includes existing front and side yard parking present at the time of digitizing the aerial photography of the City of Toronto (2000-2001 period).

The results from the WWF hydrological model are as follows. The 14,885 parking sites licensed as of December 31, 2004, contributes about 0.7% of stormwater runoff from low and medium density areas across the City of Toronto, assuming that these residential parking pads were included in the 2000 – 2001 digital information. Since 1002 sites were licensed in 2003 and 984 sites were licensed in 2004 (see May 17, 2005 Staff Report to the Community Councils), a scenario in which 1000 sites have been licensed per year for the 4 year period of 2001 to 2005 is calculated to have generated an additional stormwater volume of about 0.2% since the City mapping was last digitized.

Additional perspective is provided by examining the effect of parking on residential properties in general across Toronto. Considering estimates of about 356,000 residential driveways providing access to garages and other on-site parking areas, about 17% of stormwater runoff from low and medium-density residential areas in Toronto is due to these facilities.

It is concluded that, on a City wide basis, the residential licensed parking areas represent a very small portion of stormwater runoff across the whole City; parking sites licensed since 2001 represent an even smaller portion.

Toxicity Considerations

The Toronto and East York Community Council (Paragraph (3)(b) Clause No. 25 of Report No. 5, adopted by City Council at its meeting of June 14, 15 and 16, 2005), requested a report "on the wet weather flow management plan to include the toxicity and runoff to be applied to Front Yard Parking, Driveway Widenings, Residential Boulevard Parking and Disabled Parking. As there is not a definitive data-base to address this request, it is evaluated below by considering the toxicological properties of stormwater runoff, materials potentially used in parking pads, and the role of the parked automobile.

Comments have also been sought on the environment impact of water and wastewater runoff, with respect to the paving of backyards with material such as tar [assumed, by

City staff to be asphalt] concrete stone and brick and whether this is a sustainable practice and should continue (Paragraph (3)(a), Clause No. 2 of Report No. 3 of Policy and Finance Committee, adopted as amended by City Council at it special meeting of February 21, 22, 23, 24, 25, 28 and March 1, 2005). The information presented above indicates that the major impact is the increased volume of stormwater runoff. Water quality impacts associated with the leachability of materials used in parking pads are addressed in this sub-section while the sustainability issue is addressed in the next section.

<u>Toxicological properties of stormwater runoff</u>. The toxicity of stormwater runoff was assessed by an R &D partnership led by the Ontario Ministry of Environment, in the late 1990s of which the City of Toronto was a partner. The general findings are that stormwater runoff does not pose a toxicological risk to receiving waters when derived from residential areas but that stormwater runoff from roads with larger traffic volumes such as freeways may pose a concern and should be addressed through future research. On such roadways, two metals - copper and zinc plus road salt applied as a winter time deicing material were the main constituents of toxicological concern. Stormwater Best Management Practices can be used to address the metals copper and zinc while under the direction of Environment Canada's evaluation of road salt, the City of Toronto has developed and implemented a Salt Management Plan to address the potential effects of road salt on receiving waters as well as optimize the use of road salt to achieve deicing and road safety objectives. The City's Salt Management Plan meets the regulatory requirements proceeding from Environment Canada's designation of road salt as a material which has the potential to impair the environment.

<u>Toxicity of materials potentially used in parking pads</u>. In terms of asphalt, concrete, recycled asphalt pavement, and other materials incorporated into building roadbeds, an US National Academy of Science research project completed as a part of the National Co-operative Highway Research Program (NCHRP Project No 25-9) developed a methodology for examining the leachability and toxicological properties of leachates from various highway, roadway, and street construction and repair materials. The general findings are that for the variety of asphalt and concrete materials tested, the leachates were not toxic to either an algae or to a water flea (Daphnia magna) which were used as the test organisms following nationally used toxicity testing protocols. Some materials used in the roadway and street allowance pose a toxicological risk, such as wood preservatives (ACZA) used on pressure treated wood in certain American states.

<u>The role of the automobile.</u> In terms of front yard parking, the toxicological risk of stormwater runoff is associated with sources of metals such as copper and zinc. One source is wear and tear of the automobile while it is in operation. Other metals, such as iron which does not pose a toxicological risk, are leached from the automobile body by corrosion. Parked vehicles per se have a minimal contribution to toxicological risk of stormwater runoff, if the risk is generated by the active operation of the vehicle; if the risk is generated by rainwater hitting a parked vehicle and washing some of the metal off of the automobile body, a case could conceivably be made for concern about vehicles parked in front yard pads. Some research has been conducted on the issue - for example

washing individual automobiles under control conditions in the laboratory and spray irrigating cars driven on an interstate highway such as was carried out in Austin Texas in the mid 1990s. Unfortunately the research database does not permit a separation of the affects of parked vehicles relative to vehicles being driven. In addition, new materials used in automobiles to make them lighter in weight, reduce the amount of metal in automobile bodies, and reduce the mass of metal leached in the 2000 era, compared to the 1980s; again the research data that documents the reduction are evolving.

Even the effects of the number of vehicles on the concentration of contaminants and pollutants in highway stormwater runoff has been a matter of considerable debate over the past two to three decades. A synopsis of concentrations of constituents in highway runoff based on monitoring data from the early 1980s differentiated concentrations into two categories: roadways which have more than 30,000 vehicles per day in urban areas and highways which have more than 30,000 vehicles per day in urban areas. Unlike air quality where there is a direct quantitative link between the number of vehicles driven per day in an area and the impacts on air quality through the mass of air pollutants emitted, there is no similar clear quantitative link with the concentration of constituents in stormwater runoff, based on professional syntheses currently available in the literature.

<ins>Summary.</ins> A synthesis of available literature indicates that the toxicological risk of stormwater runoff from front yard parking pads in residential areas cannot be separated from the risk of stormwater runoff from the general streetscape. The constituents who generate toxicological risk are associated with automobiles and general urban dust fall, rather than the materials that are used to construct such pads. The City's requirements for materials used in parking pads ensure that they do not pose a toxicological risk.

Effects of Front Yard Parking on Stormwater Best Management Practices

The staff report dated May 17 2005, contrasted the size and cost of an end-of-pipe facility needed to treat stormwater runoff from front yard parking in areas such as Toronto and East York with driveway widening in other areas of Etobicoke, North York and Scarborough. Based on the examples provided there, the incremental cost related to front yard driveway where space confined techniques are required in Central Toronto is about $1 million dollars whereas the incremental cost related to driveway expansion in Etobicoke, North York and Scarborough is in the order of $150,000.00 per 50 ha sewershed.

The biggest effect of front yard parking on wet weather flow and on the WWFMMP is on a local scale - sub-watersheds, where the societal pressure for front-yard parking is the greatest. These are also the areas where space confined underground technologies would be needed to address stormwater quality.

<ins>Mitigation Through Downspout Disconnection and Porous Materials</ins>

The potential additional volume of stormwater runoff from front-yard parking pads can be off-set by variety of techniques. A qualitative rating of the effectiveness of all the techniques (over 100 techniques) considered in the WWFMMP Management and Operations Guide is provided in the appendix (D.1). Of these techniques, downspout disconnection where physical conditions permit, education, management of imperviousness, construction with permeable materials and soft landscaping are addressed in the section, as they are the most effective and directly applicable to mitigating the effects of front yard parking.

(i) Mitigation Through Downspout Disconnection

The Toronto and East York Community Council (Clause No. 33 of Report No. 2, adopted by Toronto City Council at its meeting of March 1, 2 and 3, 2004), requested "the Commissioner of Works and Emergency Services, in future reports, to include comments on the disconnection of downspouts and impacts on sewer and wastewater management".

In the past, staff provided all applicants with information on downspout disconnection and strongly encourage them to consider this measure and the benefits arising in conjunction with their applications. The proposed new code provisions will now make it a requirement of approval for front yard parking that downspouts must be disconnected, at the owner's expense, where physically feasible. In the downspout disconnection program, if a homeowner wants their downspouts to be disconnected, city staff inspect the property to determine that this measure will not physically impair the structural integrity of the dwelling. If it will impair the structural integrity, downspout disconnection is not carried out.

(ii) Education

Staff are examining the feasibility of providing information in the water bill of the negative effect on the water system due to FYP pads. (Clause No 14(a) of Scarborough Community Council, received by City Council at its meeting of June 14 – 16, 2005).

(iii) Management of Imperviousness

Comments have been sought as to whether paving of backyards, and by implication FYP pads, is a sustainable practice and should continue (Paragraph (3)(a), Clause No 2 of Report No 3 of Policy and Finance Committee, adopted as amended by City Council at it special meeting of February 21, 22, 23, 24, 25, 28 and March 1, 2005). The amount of imperviousness in a catchment is used in this section as an indicator for addressing the issue of sustainability.

The management of the amount of imperviousness in a watershed is being implemented in some jurisdictions as a technique to minimize the impacts of stormwater discharged from a site. Regulating the amount of imperviousness in a catchment has two opposite ends to the spectrum – minimizing the amount of imperviousness based on threshold values which minimize the impact of stormwater runoff on aquatic systems, and maximizing the degree of imperviousness in certain catchments.

At a sub-watershed scale, evolving research indicates that beyond a range of 10% to 15% imperviousness in a catchment, it is difficult to maintain the ecological integrity of receiving waters, without a substantial reduction in the volume of runoff from pavement through infiltration and evapotranspiration. In Ontario, imperviousness management has first been recognized for lands falling under the jurisdiction of the Oak Ridges Moraine Act, where a 10% imperviousness limit requirement has been established. Where planning policies encourage or mandate medium and high densities to promote efficient urban form and servicing, the amount of impervious surface in a watershed is in the range of 40%-60%. Due to the amount of impervious surface in those developed portions of *urban settlement* areas, and those areas of new *development*, it may be more efficient, and in some cases the only practical way, to compensate offsite for the inevitable adverse effects of excessive hard-surfacing on the *watershed's* important ground and surface water areas, water quality, and hydrological functions.

At a lot –level scale, because much of Toronto is already 40% impervious or larger, one or two additional front yard pads have a negligible effect on receiving water ecosystems, because the amount of impervious cover is already so far beyond a threshold which lies in the 10%-15% range. But on a cumulative basis, the focus of the WWFMMP Policy is on a hierarchy of controls (first source – lot level, then conveyance system, then end-of-pipe controls) which dictates that we need to decrease the amount of transport – connected imperviousness on a lot by lot basis, because every site, no matter how small, assists in achieving the bigger picture of creating a more sustainable human living space in urban areas.

Hence, the policy direction for FYP pads is to minimize the extent of imperviousness in the yard.

(iv) Mitigation Through Porous Materials

Comments have been sought on 'citywide standards WWF master plan objectives and materials that can be used for permeability' (Paragraph 4(b) of Clause 25 of Report No. 5, adopted by City Council at its meeting of June 14, 15 and 16, 2005). Clause No. 51(a) of North York Community Council, adopted by City Council at the June 14, 15, and 16 2005 meeting, in paragraph (2)(a) requested the Acting General Manager of Transportation Services, to report on 'proposed policy to require permeable surfacing on all front yard parking and driveway widening, and in paragraph (3) 'requested the Acting General Manager Transportation Services, to report on other materials besides asphalt and interlocking brick and the appropriate bylaws that that should be adopted to permit these materials, instead of asphalt or interlocking brick'.

<u>Description of Alternative Materials.</u> Porous pavement materials allow some of the rain to pass through, collecting in the void space of the base course, and ultimately drain away by natural infiltration, but the amount of evapotranspiration is smaller than with grassed areas. There is a spectrum of porous materials used in driveway reconstruction, some better than others in ensuring infiltration. Materials such as clear stone gravel without fines have superior infiltration properties but require maintenance through surcharging with additional material. This will also impact on street cleanliness and aesthetics.

Porous materials partially mitigate the hydrological effect of conversion of front yard grassed areas to parking pads.

Four different types of porous pavements have been identified: 1. porous asphalt pavement (PAP), 2. porous concrete pavement (PCP), 3. modular interlocking concrete block (MICB) of the internal drainage cell type (MICBIC), and 4. modular interlocking concrete block with external drainage cells (MICBEC). PAP, like conventional asphalt pavement, is composed of stone aggregate and an asphalt binder, but differs from conventional asphalt pavement in that it contains very little fine aggregates (dust or sand), allowing stormwater to infiltrate into the substructure. PCP is constructed, similar to other concretes, from aggregate and a portland cement binder. Similar to PAP, the porosity of PCP is provided by the omission of the fine aggregates. PCP density is generally about 70 to 80 percent of that of other conventional portland cement concretes and is dependent on the aggregate source and degree of compaction.

Different MICBEC and MICBEC pavers are illustrated in Figure 2.1 (Figure 2.1 is embedded in diagram from Kresin, 1996). Figure 2.1a depicts the external drainage cells from a specific manufacturer, when three concrete pavers are placed together as well as a single paver. Figures 2.1b and 2.1c show two typical lattice style MICBIC system pavements.

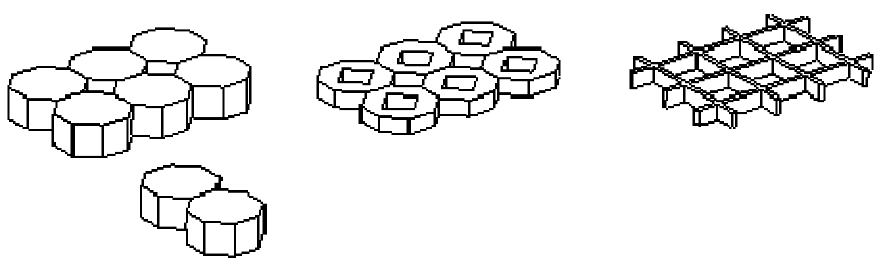

Fig 2.1 a   Figure 2.1 b   Figure 2.1 c

Figure 2.1 MICBEC and MICBIC Systems (Kresin, 1996)

Permeable pavement attempts to reproduce the pre-development hydrologic regime that was present before urbanization. The main purpose of this type of stormwater management practice is to reduce the volume of runoff that will reach receiving waters.

There have been various investigations into the performance of permeable pavement installations. One example of a rating system is provided in Table D1. A wide variety of

Table D.1 Pavement Thickness and Materials Used and Amount of Runoff generated from different parking materials

	Asphalt		Cement Paver		Manufacturer "X Product"		Manufacturer "Y Product"	
	Thickness (mm)	Material (mm)	Thickness (mm)	Material	Thickness (mm)	Material	Thickness (mm)	Material
Surface	75	Hl8	60	Concrete	80	Concrete	80	Concrete
Base	90	Gran "A"	75	Gran "A"	100	C.L.S.S.	75	C.L.S.
Sub-base	400	Gran "A"	400	Gran "A"	400	Gran "A"	400	Gran "A"
Runoff as Percentage of Rainfall	100 %		80 %		61 %		38 %	

Note:
C.L.S. - clear washed stone
C.L.S.S.- clear washed stone and sand
Gran "A"- Granular "A"

values have been established in the professional scientific / engineering literature, ranging from 10%-20% infiltration up to 80%-90% infiltration. It is a function of many factors including: under-bedding and drainage design, (the pads need both a surface material as well as a sub-surface material); age of structure (amount of infiltration declines with age); how recent was the last rainfall and how much fell; whether testing is carried out in the laboratory or outdoors; and the performance testing protocol used. Table D.1 very clearly shows the effect of material type and base on infiltration performance.

Status of Policy Development. The front yard parking and driveway widening by-law requires that permeable materials be used for the parking pad.

In terms of citywide standards for WWFMMP objectives and materials that can be used for permeability, city staff are in the midst of extracting a quantitative rating for all the WWF techniques listed in Appendix D.1 from the WWF model, both in terms of water quality improvement and in terms of reduction of volume of stormwater discharged. As a part of this effort, a methodology for assessing permeability for different materials is being developed. This work has the following implications. Of the alternative methodologies, one approach is to assign functional values to different permeable materials filed with General Manager of Transportation, while another is to use field measurements of the permeability of the FYP after it is built. Because field measurement protocols are in a state of infancy in Ontario, a performance standard together with a consistent method for assigning function values of permeability for different designs will be established. In the interim, front yard pads which provide the equivalent permeable properties to that displayed in Figure 2.1b or 2.1c will be accepted by the City.

(v) Mitigation with Soft Landscaping

Soft landscaping (i.e. vegetation) reduces stormwater runoff by evaporating water and promoting infiltration by assisting in maintaining a porous soil structure in the root zone.

Compared to paved areas, the WWF model indicates that soft landscaping can decrease the volume of stormwater discharged by 30% to 200% dependent on the soils, slope of the front yard, and length of the flow path

Landscaping requirements provided in the proposed Code Chapter provide stormwater benefits, as well as aesthetics and reduce the heat island effect.

Summary of Findings Concerning Mitigating Measures

To off-set the hydrological effects of front-yard parking and to reduce the environmental impact, the following three methods are the most effective and will be used in application of the FYP Bylaw:

- Downspout disconnection
- Permeable / porous materials
- Soft [vegetated] landscaping

Educational efforts will be used to further assist with reducing the environmental effects.

Appendix D.1. Qualitative Rating of Effectiveness of all Management Techniques Considered in the WWF Study

In the technical guide for Wet Weather Flow Management Master Plan (WWFMMP) Study, there are a variety of documented methods which can be used to offset the effect of imperviousness, whether it includes roofs, sidewalks, streets, or front yard parking pads. The measures and general functional hydrological benefits provided are as follows:

1. The following measures have some degree of benefit, with respect to reduction in stormwater discharge from an urban area.

    i. Roof Restrictors
    ii. Lot level storage [page 1-44, 'Control Alternatives' report]
    iii. Redirect Parking runoff [R.O].
    iv. Trees & Bushes [page 1-70, 'Control Alternatives' report]
    v. Regrade Parking Area
    vi. Rooftop Gardens [page 1-67, 'Control Alternatives' report]
    vii. Pervious Pavement/ porous pavement [3 types; page 1-50, 'Control Alternatives' report]
    viii. Infiltrate Roof R.O.
    ix. Underground Storage
    x. Bio-filtration in Parking Lot
    xi. Soak-away pits [page 1-52, 'Control Alternatives' report]
    xii. Roof leader disconnection [page 1-40, 'Control Alternatives' report]
    xiii. Foundation drain disconnection [page 1-42, 'Control Alternatives' report]
    xiv. Back-yard swale [page 1-55, 'Control Alternatives' report]
    xv. Vegetative filter strip [page 1-58, 'Control Alternatives' report]
    xvi. Stream and valley corridor buffer strips [page 1-61, 'Control Alternatives' report]
    xvii. Bioretention areas [page 1-64, 'Control Alternatives' report]
    xviii. Roof-top storage [page 1-67, 'Control Alternatives' report]
    xix. Roof-top Green roof
    xx. Enhanced yard vegetation [page 1-70, 'Control Alternatives' report]
    xxi. Rain/storm garden [page 1-70, 'Control Alternatives' report]
    xxii. Urban forest [page 1-73 'Control Alternatives' report]
    xxiii. Rainwater harvesting.

2. The following measures may or may not have a significant effect on volume of stormwater discharged:

    i. Lot grading [page 1-46, 'Control Alternatives' report]
    ii. Water conservation [page 1-15, 'Control Alternatives' report]

3. The following options/techniques/operations and maintenance practices listed in the WWFMMP Management and Operations Guide, have no effect on the volume of stormwater discharged:

   i. Storm drain flushing [page 1-1, ‘Control Alternatives’ report]
   ii. Catch basin cleaning [page 1-3, ‘Control Alternatives’ report]
   iii. Street cleaning [page 1-5, ‘Control Alternatives’ report]
   iv. Control of road deicers [page 1-8, ‘Control Alternatives’ report]
   v. Control of fertilizers and pesticides [page 1-10, ‘Control Alternatives’ report]
   vi. Enforcement of anti-litter and discharge bylaw [page 1-12, ‘Control Alternatives’ report]
   vii. Erosion and sediment control [page 1-18, ‘Control Alternatives’ report]
   viii. Used oil recycling [page 1-20, ‘Control Alternatives’ report]
   ix. Household hazardous waste collection [page 1-22, ‘Control Alternatives’ report]
   x. Safer alternative products [page 1-24, ‘Control Alternatives’ report]
   xi. Materials Storage Controls [page 1-26, ‘Control Alternatives’ report]
   xii. Vehicle use reduction [page 1-28, ‘Control Alternatives’ report]
   xiii. Pool Drainage [page 1-30, ‘Control Alternatives’ report]
   xiv. Spills Control [page 1-32, ‘Control Alternatives’ report]
   xv. Leaf clearing and removal [page 1-34, ‘Control Alternatives’ report]
   xvi. Modifying Engineering Standards [page 1-36, ‘Control Alternatives’ report]
   xvii. Cross- connection Control Program [page 1-38, ‘Control Alternatives’ report]
   xviii. Catch basin restrictors / inlet controls [page 1-48, ‘Control Alternatives’ report]
   xix. Oil Grit separators [page 1-76, ‘Control Alternatives’ report]
   xx. Super-pipes [page 1-79, ‘Control Alternatives’ report]
   xxi. Physio-chemical and biochemical treatment techniques [page 1-81 to I-118, ‘Control Alternatives’ report]