MODELLING PROCEDURES AND CALIBRATION

Procedure for Developing P.M. Peak Hour Matrix

The a.m. peak hour trip matrix from the 2001 model was converted to a p.m. peak hour trip matrix. The procedure entailed transposing the a.m. peak hour matrix. For example, if 25 trips travel from Hamilton to Toronto in the a.m. peak hour it is implied that the same 25 trips travel from Toronto to Hamilton in the p.m. peak hour. Discretionary trips (non-work and non-school trips), which are calculated separately, were increased by 33 percent to account for under-estimating of these types of trips. The rationale for this adjustment was documented in a report by the Data Management Group *(Report #97 DMG (2003). 2001 Transportation Tomorrow Survey: Data Validation. Data Management Group, Joint Program in Transportation, University of Toronto. http://www.jpint.utoronto.ca/PDF/validation2001.pdf)*

The p.m. peak hour trip matrix developed by the aforementioned procedure was compared with the trips from Toronto Tomorrow Survey (TTS) (*Source: The Data Management Group, Joint Program in Transportation, University of Toronto*). The 2001 TTS adjusted matrix was underestimated by less than 1,000 trips from over 37,000 total trips or by 2.5 percent. The percent differences for various trip interchanges were also within acceptable ranges.

A more detailed analysis of the projected p.m. peak hour travel shows auto volumes crossing screenlines within the study area. It compares 2001 p.m. peak hour model volumes to existing p.m. peak hour counts.

The results of the analysis are shown in **Figure 9C.1**. The following summarizes the results of the comparison:

- When comparing the total p.m. peak hour 2001 model volumes to 2001 p.m. peak hour counts, the differences range from 6 to 28 percent for east/west screenlines and 2 to 44 percent for north/south screenlines.
- Overall, the peak direction (northbound/westbound) over-predicts by 16 percent while the off-peak direction (southbound/eastbound) under-predicts by 12 percent.
- These comparisons are considered within acceptable limits for data from a regional model such as the City's GTA Model.

Some discrepancies can be attributed to a combination of the procedure used and to the fact that the count data represents differing years between 2000 to 2003, and varying seasons.

Figure 9C.1: PM Peak Hour Auto Driver Flows

North of Rogers Rd. Screenline

			Southbound								Northbound			
Road	SB Tag	2001 Model Volume	Count Volume	Model +/- Trips	Model +/- %	2021 Model Volume	% Change 2021 - 2001	NB Tag	2001 Model Volume	Count Volume	Model +/- Trips	Model +/- %	2021 Model Volume	% Change 2021 - 2001
Weston	101	1680	1445	235	16.3%	2042	21.5%	2101	2354	1649	705	42.8%	2777	17.97%
Keele	102	1092	950	142	14.9%	1068	-2.2%	2102	1054	850	204	24.0%	1030	-2.26%
Caledonia	103	471	555	-84	-15.2%	862	83.1%	2103	537	621	-84	-13.6%	920	71.50%
Dufferin	104	1339	1135	204	18.0%	1161	-13.3%	2104	1514	947	567	59.9%	1314	-13.22%
Oakwood	105	638	744	-106	-14.2%	794	24.4%	2105	786	814	-28	-3.4%	933	18.66%
Total		**5220**	**4829**	**391**	**8.1%**	**5927**	13.5%		**6245**	**4881**	**1364**	**28.0%**	**6974**	11.68%

North of St. Clair Screenline

			Southbound								Northbound			
Road	SB Tag	2001 Model Volume	Count Volume	Model +/- Trips	Model +/- %	2021 Model Volume	% Change 2021 - 2001	NB Tag	2001 Model Volume	Count Volume	Model +/- Trips	Model +/- %	2021 Model Volume	% Change 2021 - 2001
Runnymede	201	630	456	174	38.1%	473	-24.9%	2201	847	310	537	173.3%	732	-13.59%
Weston	202	1367	1288	79	6.1%	1560	14.1%	2202	1598	1242	356	28.7%	1898	18.76%
Old Weston	203	866	572	294	51.3%	888	2.6%	2203	1146	691	455	65.8%	1135	-0.99%
Caledonia	204	263	624	-361	-57.8%	561	113.2%	2204	426	815	-389	-47.7%	860	101.67%
Dufferin	205	1078	1080	-2	-0.2%	906	-15.9%	2205	1568	892	676	75.8%	1331	-15.09%
Oakwood	206	362	655	-293	-44.8%	589	62.9%	2206	981	900	81	9.0%	1210	23.34%
Vaughan	207	165	307	-142	-46.4%	220	33.4%	2207	437	503	-66	-13.1%	472	8.08%
Bathurst	208	1181	1237	-56	-4.5%	1050	-11.1%	2208	1815	1061	754	71.0%	1514	-16.57%
Spadina	209	329	485	-156	-32.2%	463	40.6%	2209	625	685	-60	-8.7%	729	16.50%
Avenue	210	794	1062	-268	-25.3%	1292	62.8%	2210	1402	2005	-603	-30.1%	1781	27.01%
Yonge	211	947	752	195	25.9%	1042	10.1%	2211	1570	1142	428	37.5%	1445	-7.98%
Total		**7980**	**8518**	**-538**	**-6.3%**	**9044**	13.3%		**12416**	**10246**	**2170**	**21.2%**	**13107**	5.56%

South of Dupont / Dundas Screenline

			Southbound								Northbound			
Road	SB Tag	2001 Model Volume	Count Volume	Model +/- Trips	Model +/- %	2021 Model Volume	% Change 2021 - 2001	NB Tag	2001 Model Volume	Count Volume	Model +/- Trips	Model +/- %	2021 Model Volume	% Change 2021 - 2001
Runnymede	301	454	369	85	23.1%	480	5.7%	2301	437	311	126	40.6%	502	14.86%
Keele	303	876	1237	-361	-29.2%	985	12.5%	2303	991	765	226	29.5%	1171	18.13%
Dundas	304	631	542	89	16.5%	721	14.2%	2304	915	684	231	33.7%	960	5.00%
Lansdowne	306	243	541	-298	-55.1%	321	32.4%	2306	380	863	-483	-56.0%	453	19.31%
Dufferin	307	969	903	66	7.3%	879	-9.3%	2307	1046	714	332	46.5%	1071	2.38%
Dovercourt	308	120	396	-276	-69.6%	176	46.5%	2308	545	555	-10	-1.8%	613	12.50%
Ossington	309	198	423	-225	-53.1%	244	23.1%	2309	696	710	-14	-1.9%	682	-2.05%
Christie	310	134	398	-264	-66.2%	242	79.8%	2310	644	493	151	30.6%	723	12.34%
Bathurst	311	750	838	-88	-10.5%	668	-10.9%	2311	1192	1091	101	9.3%	1020	-14.46%
Spadina	312	305	490	-185	-37.7%	547	79.0%	2312	1023	963	60	6.2%	1115	8.96%
Total		**4681**	**6137**	**-1456**	**-23.7%**	**5263**	12.4%		**7868**	**7149**	**719**	**10.1%**	**8310**	5.61%

West of Runnymede Screenline

			Eastbound								Westbound			
Road	EB Tag	2001 Model Volume	Count Volume	Model +/- Trips	Model +/- %	2021 Model Volume	% Change 2021 - 2001	WB Tag	2001 Model Volume	Count Volume	Model +/- Trips	Model +/- %	2021 Model Volume	% Change 2021 - 2001
St. Clair	401	799	785	14	1.8%	1080	35.2%	2401	1283	1331	-48	-3.6%	1482	15.50%
Dundas	402	625	490	135	27.6%	700	11.9%	2402	961	779	182	23.4%	1009	5.00%
Total		**1424**	**1275**	**149**	**11.7%**	**1780**	25.0%		**2244**	**2110**	**134**	**6.4%**	**2491**	11.00%

West of Dufferin Screenline

			Eastbound								Westbound			
Road	EB Tag	2001 Model Volume	Count Volume	Model +/- Trips	Model +/- %	2021 Model Volume	% Change 2021 - 2001	WB Tag	2001 Model Volume	Count Volume	Model +/- Trips	Model +/- %	2021 Model Volume	% Change 2021 - 2001
Rogers	801	298	383	-85	-22.3%	512	72.0%	2801	746	429	317	73.9%	872	16.94%
St. Clair	802	998	892	106	11.9%	1031	3.3%	2802	1392	1118	274	24.5%	1585	13.82%
Davenport	803	332	531	-199	-37.4%	435	30.8%	2803	873	690	183	26.6%	1028	17.74%
Dupont	804	521	850	-329	-38.7%	924	77.3%	2804	1099	1009	90	8.9%	1294	17.80%
Total		**2149**	**2656**	**-507**	**-19.1%**	**2902**	35.0%		**4110**	**3246**	**864**	**26.6%**	**4779**	16.28%

West of Spadina Screenline

			Eastbound								Westbound			
Road	EB Tag	2001 Model Volume	Count Volume	Model +/- Trips	Model +/- %	2021 Model Volume	% Change 2021 - 2001	WB Tag	2001 Model Volume	Count Volume	Model +/- Trips	Model +/- %	2021 Model Volume	% Change 2021 - 2001
St. Clair	1101	887	971	-84	-8.7%	919	3.7%	3101	1542	1312	230	17.5%	1582	2.63%
Davenport	1102	293	630	-337	-53.5%	319	8.9%	3102	909	1095	-186	-17.0%	976	7.32%
Dupont	1103	148	754	-606	-80.4%	674	355.1%	3103	1135	1103	32	2.9%	1293	13.88%
Total		**1328**	**2355**	**-1027**	**-43.6%**	**1912**	44.0%		**3586**	**3510**	**76**	**2.2%**	**3851**	7.38%

East of Yonge Screenline

			Eastbound								Westbound			
Road	EB Tag	2001 Model Volume	Count Volume	Model +/- Trips	Model +/- %	2021 Model Volume	% Change 2021 - 2001	WB Tag	2001 Model Volume	Count Volume	Model +/- Trips	Model +/- %	2021 Model Volume	% Change 2021 - 2001
St Clair	1301	888	1035	-147	**-14.2%**	1011	13.8%	3301	515	872	-357	**-40.9%**	657	27.54%

Counts: Adjusted counts from City of Toronto; (yellow) = adjusted by MMM; (green) = adjusted by Intellican

TOTALS	23671	26805	-3134	-11.7%	27838	17.6%	36986	32014	4972	15.5%	40169	8.6%

J:\2003jobs\16-03107.rkw (TTC St Clair EA)\reports\Final Report\5.0 Future Conditions\Figures\EMME2 Model Results (Table 5.3.1.1).xls

This same procedure was used to develop the future year 2021 matrices that were converted to the Paramics model to assess changes in travel flows and their impact on the network under various design/operational scenarios for St. Clair Avenue.

Simulation Methodology

The Paramics model was developed for the p.m. peak hour, to reflect the commercial activity along St. Clair during that time. The following steps were followed during the course of the model development:

- Coding the geometry of the status quo;
- Acquisition and coding of signal timing plans for the status quo;
- Acquisition of vehicle trip origin-destination matrix from the City's EMME/2 Greater Toronto Area model. This morning peak period based trip matrix was transposed and further adjusted to reflect the p.m. peak hour demands in the St. Clair area;
- Acquisition of turning volume counts from the City of Toronto. The volume counts were 'consistency checked' and smoothed for any seasonal and 'different day' variations. These counts were used to calibrate the base model network;
- Estimation of the travel demand in the network. This was performed using Transportation Tomorrow Survey (TTS) data, but were adjusted to be consistent with selected road counts. A detailed travel demand estimation is documented later in the Appendix as "**Estimation of Travel Demand – Draft Technical Memorandum**"
- Acquisition of streetcar travel data, namely boarding, offloading and travel time information. This information was also used to calibrate the base model network
- Calibration and refinement of network geometry by extensive visualization of traffic operations in the model. This includes identification of potentially problematic locations, followed by implementation of remedial changes;
- Calibration of the model parameters using an extensive and elaborate Genetic Algorithms approach to minimize discrepancies between simulation model output and field observations;
- Identification of the key Measures of Effectiveness (MOEs) to be used for all comparisons;
- Acquisition of the alternative concept plans in order to code the geometry of alternative concepts;
- Preliminary runs of the three models;
- Final fixes of any discrepancies in the models and fine-tuning. The performances of the alternative networks were assessed relative to each other and to the base case do-nothing network. Numerous simulation runs per plan were conducted under varying conditions, to feed into the analysis of results.

Measures of Effectiveness

The following measures of effectiveness (MOE) were agreed upon by the Project Team for the traffic simulation model analysis and subsequent comparison of the alternative concepts. The final MOEs are:

1. Total auto travel time (for all vehicle trips in the network);
2. Average auto travel time (for all vehicle trips in the network);
3. Average Speed (for all vehicle trips in the network);
4. Average auto travel time between Runnymede Road and Avoca Avenue on St. Clair Avenue;
5. Average sectional auto travel time on St. Clair Avenue between
   - Gunns Road and Dufferin Street
   - Dufferin Street and Bathurst Street
   - Bathurst Street and Avoca Avenue;
6. Average of streetcar route travel time on St. Clair Avenue;
7. Average number of streetcar trips completed on the peak hour on St. Clair Avenue;
8. Vehicle-kilometres travelled on the north-south side streets and the east-west side streets in the secondary study area (the area bounded by Bloor Street on the south, Eglinton Avenue on the north, Gunns Road on the west and Avoca Avenue on the east). These were recorded in the same sections noted under point 5.

Calibration of the Model

This is an iterative model refinement procedure where several parameters are fine-tuned in order for the model to replicate the actual scenario. The difference between the model results and actual conditions in terms of several MOEs determines the accuracy of the model. Given the size and complexity of the network, the calibration was a lengthy process. The calibration process involved improvements ranging from local corrections to network-wide parameter adjustments. The network was calibrated according to the following basic sequence:

1. Geometric refinement: The lane geometry was initially developed to closely follow the existing scenario. This was further modified in order to achieve realistic traffic flow patterns. The initial network was ‘run’ a number of times and looking for any unusual behaviour or results. This was done visually as well as by checking statistical outputs.

2. Node and link refinement: Upon observation of the vehicles travelling through the network, various vehicle input and output node locations were adjusted in order to

attain a smooth flow of traffic. Link attributes, stop lines and intersection curb radius were also adjusted in order to attain smooth follow of traffic through the intersection, and/or assist with correct choice of lanes. Vehicle turn movement decision points were also adjusted by relocating mid block nodes.

3. Traffic signal refinement: Signal phases, co-ordinated signal offsets and actuated signal algorithms were adjusted to ensure correct operations. Information from the actual signal operations helped to improve the model reliability in a number of locations.

4. Traffic zones and travel demand: Zone boundaries and travel demand were reviewed to identify errors and improve model operations. The internal zone boundaries were adjusted in a few locations to better reflect traffic flow patterns. For example, unrealistically heavy left-turn demand was rectified at a few intersections by slightly adjusting adjacent zone boundaries.

5. Time Step Detail: The discrete time step frequency with which calculations are updated affects the final results of the model. This is the minimum unit of temporal resolution for the model. The default value is two time steps per second. If the time step detail is increased traffic can flow more smoothly at given values of speed and density. However, increasing the time step detail has a significant effect on simulation performance. After a significant amount of testing, a 6 time steps per second was found to be an appropriate compromise between computational efficiency and simulation accuracy.

6. Demand Profile: A dynamic feedback assignment was employed in the model in order to reflect the real scenario. The dynamic feedback can make the network volatile where, if congestion develops suddenly, a large percentage of driver shifts to a new route based on 'updated route costs'. If the new route is unable to handle a huge volume of traffic, the traffic is re-routed again. Specific links connecting the alternate routes could become highly congested reducing overall route capacity. This was overcome by gradually increasing the demand loaded on the network, thereby allowing the congestion to develop slowly. A half-hour 'warm up' period was provided to network where a demand profile was applied, so that 100% demand was reached gradually.

7. Genetic parameter calibration: A number of driver related parameters can be adjusted in order to closely emulate the existing conditions. The main parameters are mean headway and mean reaction time, feedback interval (affecting how drivers react to congestion), perturbation (random error in travel time perception by the users, affecting stochastic assignment amongst alternate routes), and familiarity (the

percentage of drivers familiar with the network). These parameters were adjusted by a genetic algorithm based optimization model. After attaining convergence, the calibrated parameters values were as follows:

- Mean Headway: 1 sec.
- Mean Reaction Time: 1 sec.
- Familiarity: 60 %
- Perturbation: 5 %
- Feedback: 5 min.

Accommodation of Travel Demands and Turn Restrictions

The calibrated existing model network was modified to accommodate the proposed design concepts. The modifications included the geometric changes, turn restrictions and traffic signal timing optimizations. The Paramics simulator reroutes traffic based on 'least route cost' for a network wide optimization of travel. Travel demand was further accommodated through restructuring the on-street parking restrictions to allow an extra travel lane where required.

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Estimation of Travel Demand – Draft Technical Memorandum

The estimation of travel demand in the St. Clair Study Area was necessary to develop a realistic simulation of traffic at the micro level. A three-step procedure was used to develop estimates of travel demand for the PM peak hour that are based on Transportation Tomorrow Survey (TTS) data, but that are adjusted to be consistent with selected road counts.

The three steps undertaken are as follows:

1. Run a static equilibrium assignment for the Greater Toronto Area (GTA)
2. Estimate seed origin-destination (O-D) demands using cordons around the St. Clair study area
3. Adjust the seed O-D demands to reflect actual link counts by applying a gradient O-D adjustment procedure

Each of these three steps is further discussed below.

Static equilibrium assignment for the Greater Toronto Area (GTA)

PM Peak period (3:30 p.m. to 6:29 p.m.) travel demand was obtained for the GTA based on data from the 2001 Transportation Tomorrow Survey (TTS), a trip diary survey of approximately 5% of households in the GTA. It has been noted that there is a tendency of TTS survey respondents to under-report non-work, non-school trips (DMG 2003). Hence, a factor of 1.33 is applied to all trips that are not work- or school-based, as recommended by the Data Management Group (Dalton 1999). A peak hour factor was then applied to the peak period travel demand to result in peak hour trip tables.

To determine the appropriate PM peak hour factor (i.e. trips in the peak hour / trips in the 3-hour peak period), TTS auto drive trips for the GTA were assessed in 30-minute intervals. Hourly total trips were then generated to determine when the maximum hour occurred within the 3-hour peak period. The appropriate peak hour factor for the PM peak period was found to be 37.6% and the peak hour was found to occur from 4:30-5:29 PM. To be certain that this factor was appropriate for the study area, the peak hour factor was also checked for trips originating in the area bounded by the Humber River, Highway 401, The Don River and the Toronto Waterfront (i.e. Planning Districts 1-4). The peak hour factor for these trips was found to be very similar to that of the entire GTA (37.2%), although the peak hour was found to be slightly later (5:00 – 5:59 PM).

A static equilibrium assignment was then run in EMME/2 on the Greater Toronto Area road network for the PM peak hour. It was necessary to review the portion of the EMME/2 GTA network in the St. Clair study area in detail to ensure that local level traffic was assigned with a good degree of accuracy.

The following modifications were made to the St. Clair Study Area within the EMME/2 network to result in a traffic assignment that was reasonably consistent with road counts provided by the City of Toronto:

First, lane capacity and speeds were reduced for north-south arterial roads whose traffic was over-assigned. This resulted in a shift of traffic to parallel (under-assigned) roadways:

a) Reduced the lane capacity of Yonge St. from 700 vph to 600 vph from Bloor Street to Eglinton Ave.
b) Reduced the lane capacity of Bathurst St. and Dufferin St. from 700 vph to 600 vph from Bloor St. to St. Clair Ave, and from 700 vph to 500 vph from St. Clair Ave. to Eglinton Ave.
c) Reduced lane capacity of Old Weston Rd./ Keele St. from 700 vph to 500 vph from St. Clair Ave to Eglinton Ave.
d) Reduced lane capacity of Runnymede Rd., Castleton Ave., Rockcliffe Blvd., Alliance Ave., Lambton Ave., and Guestville Ave. from 700vph to 500 vph and the speed from 50 km/h to 40 km/h from St. Clair Avenue to Eglinton Ave.

Lane capacity and speeds of some other roads were increased to reflect road counts that were greater than roadway capacity originally coded in the EMME/2 model. This resulted in a shift of traffic from other parallel roadways:

a) Increased lane capacity of Caledonia Road from 500 vph to 800 vph from Davenport Rd. to Eglinton Ave.
b) Increased lane capacity of Avenue Road from 700 vph to 800 vph from St. Clair Ave. to Eglinton Ave.
c) Increased lane capacity of Annette St./Dupont St. from 500 vph to 600 vph and the EB speed from 40 km/h to 50 km/h from Jane Street to Avenue Road.

Finally, 60 second turn penalties were incorporated into the EMME/2 model for all banned turning movements at intersections within the study area. A full ban was not applied in EMME/2 to allow for "effective turns" made via detours on minor roads not included in the EMME/2 network model.

Estimation of seed origin-destination (O-D) demands using cordons around the St. Clair Study Area

The St. Clair Study Area for the traffic microsimulation is approximately defined by cordons that are located north of Rogers Rd./Vaughan Rd./Claxton Blvd./Burton Rd./Kilbarry Rd., east of Yonge Street, south of Dundas St. W./Dupont St./Davenport Rd., and west of Runnymede.

Each major roadway crossing the study area boundary is considered to be a gateway zone to the study area. Gateway zones are also included where significant traffic crosses the boundary on "local" roads[1]. A total of 53 gateways are included in the EMME/2 model, of which 33 represent major roadways and 20 represent local roads. The gateways to the study area and the study area boundary are shown in **Table 1** and **Figure 1**, respectively.

The seed O-D demands are determined from the GTA EMME/2 model by capturing traffic entering, exiting or travelling within the study area. The O-D demands take the form of a study area trip table that includes internal zones and external gateways (this trip table is referred to as a "traversal matrix" in EMME/2). Thus, the seed O-D demand matrix represents a "cut out" of the

[1] In EMME/2 "local" roads are represented by zone connectors. Where a zone connector with significant traffic volume crosses the screenline and does represent existing "local roads", a gateway is added.

GTA-wide demand that either originates in, is destined for, or simply passes through the study area.

A study area EMME/2 road network was also “cut out” from the GTA regional road network on which additional modifications could be made to better approximate travel demand in the St. Clair area. The resulting traffic volumes from a static equilibrium assignment of “unadjusted” seed O-D demand to the study area EMME/2 road network are shown in **Table 2** for the PM peak hour. A summary of the “unadjusted” seed O-D demand matrix is shown in **Table 3**.

Adjustment of the Seed O-D Demands to Reflect Actual Link Counts

It is clear that the there are a number of unavoidable deficiencies in the use of TTS data to estimate total vehicular demand within the St. Clair study area. The following shortcomings must be addressed to result in an accurate assessment of peak hour demand.

- The seed O-D matrix is based on data from a 5% survey sample. The expansion of such a 5% sample results in a matrix that is not as well distributed as would be the case with a 100% sample.
- The seed matrix is developed from a regional scale model which is not intended to reproduce individual road volumes with a high degree of precision.
- The seed matrix does not include commercial vehicle traffic.
- “Intrazonal” traffic (i.e. trips whose origin and destination are in the same traffic zone) is ignored in an EMME/2 traffic assignment.
- There is a recognized non-reporting rate inherent in the TTS data, especially for non-work, non-school trips. In the survey, a single household member is asked to report on the entire household’s travel, all of which the respondent may not even be aware, or willing to report. (DMG 2003)

The most direct method for addressing all of these concerns is to adjust the seed O-D demand matrix to reflect observed road counts. The gradient approach, a set of EMME/2 macros developed by Heinz Spiess (1990), is a computationally efficient method that modifies O-D demand to reflect road counts while making the least necessary change to the seed O-D demand matrix. This is important because it is desirable to maintain as much valuable information from all data sources as possible.

Road counts were obtained from the City of Toronto for the adjustment of the seed O-D demand matrix. The gradient approach converges most successfully when the majority of trips cross only a small number of links at which road count adjustments are applied. Therefore, road counts were assembled for a limited set of screenlines at and within the limits of the study area. The screenline locations used for the gradient adjustment procedure are shown in **Figure 2**. All count locations used for the gradient adjustment procedure of the seed O-D demand are also shown in **Figure 2**. The road counts applied in the procedure were collected on weekdays in the years 2000 to 2003 and included commercial as well as personal vehicles[2].

Because the traffic counts were collected in different years, at different times of year, on different days of the week, and at slightly different times of day, some inconsistencies were found in traffic counts at adjacent intersections. Therefore, some traffic counts that appeared to be significantly different than the adjacent intersections were "smoothed" such that traffic counts were reasonably consistent between intersections. Traffic counts that have been "smoothed" are identified on each of the screenline summaries that follow.

The gradient adjustment procedure resulted in an EMME/2 traffic assignment that closely reflects the available road counts. **Table 4** shows a comparison of the adjusted screenline traffic volumes to the available road counts for the PM peak hour. At screenlines used in the gradient adjustment procedure, model screenline volumes are within +/- 5% of road counts. Individual link volumes display a greater variation from the count volumes, however, the differences are considered to be acceptable given the "planning nature" of the EMME/2 modelling software.

The overall adjustments made to the seed O-D demand matrices are shown in **Table 5** for the PM peak hour. The gradient adjustment procedure results in an overall increase of approximately 1100 trips (2.9%) to an adjusted total of 38,650 trips. The greatest percentage increases were for southbound trips destined south of St. Clair (+8.4%), trips in the east end of

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[2] One exception was the count available at the intersection of Lansdowne and Dupont, which was collected in 1996. 1996 traffic at this location was found to be reasonably consistent with more recent counts at adjacent intersections.

the study area (+8.9%), and for trips with either origin, or destination in the study area (+7.7% and +9.2%, respectively). The adjustment procedure resulted in decreases in trips internal to the study area (-6.4%), trips travelling in areas north of St. Clair (-6.8%) and for trips travelling to areas from east to west of Oakwood/ Dovercourt (-4.1%). Overall, these adjustments are considered to be minor, and reflect the good quality of the original "unadjusted" matrix.

It is to be emphasized that the purpose of the EMME/2 traffic assignment is to produce the best possible demand inputs to the microsimulation model. The dynamic traffic assignment capabilities of the microsimulation model are superior to those of a static user equilibrium assignment. Therefore, small link-level deficiencies in EMME/2 assignment results are not of great concern, provided the overall O-D demand matrix prepared for the microsimulation analysis is the best possible given the available data. Overall the final adjusted O-D demand matrix developed as input to the microsimulation model based on the above analysis is considered to be within an acceptable degree of accuracy.

References

Dalton, Peter (1999). *1996 Transportation Tomorrow Survey Discretionary Travel*. Data Management Group, Joint Program in Transportation, University of Toronto. Report # 63.

DMG (2003). *2001 Transportation Tomorrow Survey: Data Validation.* Data Management Group, Joint Program in Transportation, University of Toronto. Report #97.

Spiess, Heinz (1990). *A Gradient Approach for the O-D Matrix Adjustment Problem*. EMME/2 Support Centre. Aegerten, Switzerland. (available at http://www.spiess.ch/emme2/demadj/demadj.html)

Table 1 – Gateways to the Study Area

Gateway Zone	Street	Location	Zone Connector?
2800	St. Clair Ave. W.	W of Runnymede	N
2801	Runnymede Rd.	N. of St. Clair Ave. W.	N
2802	Avon Cr., Seneca Ave., Cayuga Ave.	W. of Weston Rd.	132
2803	Weston Rd.	N. of Rogers Rd.	N
2804	Forbes Ave., Bicknell Ave.	N. of Rogers Rd.	137
2805	Keele St.	N. of Rogers Rd.	N
2806	Scott Rd. to Blackthorn Ave.	N. of Rogers Rd.	139
2807	Caledonia Rd.	N. of Rogers Rd.	N
2808	Harvie Ave. to Sellers Ave.	N. of Rogers Rd.	115
2809	Dufferin St.	N. of Rogers Rd.	N
2810	Westmount Ave. to Blandford St.	N. of Rogers Rd.	117
2811	Hanson Ave. to Vaughan Rd.	W. of Oakwood Ave.	117
2812	Oakwood Ave.	N. of Vaughan Rd.	N
2813	Glenora Ave. to Arlington Ave.	N. of Vaughan Rd.	118
2814	Bathurst St.	N. of Burton Rd.	N
2815	Spadina Rd.	N. of Burton Rd.	N
2816	Avenue Rd.	South of Chaplin Cr.	N
2817	Yonge St.	S. of Chaplin Cr./Davisville Ave.	N
2818	St. Clair Ave. E.	W. of Mt. Pleasant Rd.	N
2819	Avoca Ave. to Shaftsbury Ave.	S. of St. Claire / E. of Yonge St.	199
2820	Crescent Rd.	W. of Mt. Pleasant Rd.	N
2821	Aylmer Ave.	E. of Yonge St.	N
2822	Church St.	E. of Yonge St.	N
2823	Yonge St.	S. of Church St.	N
2824	Yonge St., Bay St.	S. of Church St./Davenport Rd.	194
2825	Bay St.	S. of Church St./Davenport Rd.	N
2826	Hazleton Ave., Avenue Rd.	S. of Davenport Rd.	194
2827	Avenue Rd.	S. of Davenport Rd.	N
2828	Bedford Rd.	S. of Davenport Rd.	N
2829	Admiral Rd. to Madison Ave.	S. of Dupont St.	188
2830	Spadina Rd.	S. of Dupont St.	N
2831	Walmer Rd. to Albany Ave.	S. of Dupont St.	187
2832	Bathurst St.	S. of Dupont St.	N
2833	Palmerston Ave.to Clinton St.	S. of Dupont St.	182
2834	Christie St.	S. of Dupont St.	N
2835	Ossington Ave.	S. of Dupont St.	N
2836	Concorde Ave. to Delaware Ave.	S. of Dupont St.	180
2837	Dovercourt Rd.	S. of Dupont St.	N
2838	Westmoreland Ave.to Gladstone Ave.	S. of Dupont St.	174
2839	Dufferin St.	S. of Dupont St.	N
2840	Wallace Emerson CC to St. Clarens Ave.	S. of Dupont St.	173
2841	Lansdowne Ave.	S. of Dupont St.	N
2842	Symington Ave.	S. of Dupont St.	N
2843	Campbell Ave. to Edwin Ave.	S. of Dupont St.	172
2844	Dundas St. W.	S. of Dupont St.	N
2845	Annette St.	W. of Dundas St. W.	N
2846	Indian Rd. Cr. to Indian Gr.	S. of Dundas St. W.	168
2847	Keele St.	S. of Dundas St. W.	N
2848	Maverty St. to Pacific Ave.	S. of Dundas St. W.	141
2849	High Park Ave.	S. of Dundas St. W.	N
2850	Quebec Ave. to Fisken Ave.	S. of Dundas St. W.	140
2851	Runnymede Rd.	S. of Dundas St. W.	N
2852	Dundas St. W.	W. of Runnymede Rd.	N

Table 2 - Assignment of "Unadjusted" Seed O-D Demand – PM Peak Hour

East-West Screenlines

Road	Southbound Model Volume	Southbound Count Volume	Southbound Model +/- Trips	Southbound Model +/- %	Northbound Model Volume	Northbound Count Volume	Northbound Model +/- Trips	Northbound Model +/- %
North of Rogers Rd. Screenline								
Weston	1769	1445	324	22.5%	1937	1649	288	17.5%
Keele	860	950	-90	-9.4%	890	850	40	4.7%
Caledonia	725	555	170	30.6%	772	621	151	24.2%
Dufferin	1006	1135	-129	-11.3%	1100	947	153	16.2%
Oakwood	665	744	-79	-10.6%	740	814	-74	-9.0%
Total	**5026**	**4829**	**197**	**4.1%**	**5439**	**4881**	**558**	**11.4%**
North of St. Clair Screenline								
Runnymede	413	456	-43	-9.5%	519	310	209	67.4%
Weston	1359	1288	71	5.5%	1465	1242	223	17.9%
Old Weston	817	572	245	42.9%	819	691	128	18.5%
Caledonia	582	624	-42	-6.7%	837	815	22	2.7%
Dufferin	884	1080	-196	-18.2%	1130	892	238	26.7%
Oakwood	516	655	-139	-21.3%	882	900	-18	-2.0%
Vaughan	253	307	-54	-17.5%	458	503	-45	-9.0%
Bathurst	1038	1237	-199	-16.1%	1271	1061	210	19.8%
Spadina	420	485	-65	-13.4%	628	685	-57	-8.3%
Avenue	1143	1062	81	7.6%	1579	2005	-426	-21.2%
Yonge	882	752	130	17.3%	1394	1142	252	22.1%
Total	**8307**	**8518**	**-211**	**-2.5%**	**10982**	**10246**	**736**	**7.2%**
South of Dupont / Dundas Screenline								
Runnymede	412	369	43	11.5%	324.585	311	14	4.4%
Keele	1107	1237	-130	-10.5%	725.455	765	-40	-5.2%
Dundas	656	542	114	21.0%	784.511	684	101	14.7%
Lansdowne	184	541	-357	-65.9%	199.666	863	-663	-76.9%
Dufferin	834	903	-69	-7.6%	825.257	714	111	15.6%
Dovercourt	92	396	-304	-76.8%	447.723	555	-107	-19.3%
Ossington	235	423	-188	-44.3%	703.061	710	-7	-1.0%
Christie	114	398	-284	-71.4%	621.527	493	129	26.1%
Bathurst	630	838	-208	-24.8%	971.034	1091	-120	-11.0%
Spadina	535	490	45	9.2%	872.004	963	-91	-9.4%
Avenue	957	923	34	3.7%	1570.71	2061	-490	-23.8%
Bay	139	382	-243	-63.7%	405.413	913	-508	-55.6%
Yonge	596	790	-194	-24.6%	1084.15	715	369	51.6%
Total	**6492**	**8232**	**-1740**	**-21.1%**	**9535**	**10838**	**-1303**	**-12.0%**

North-South Screenlines

Road	Eastbound Model Volume	Eastbound Count Volume	Eastbound Model +/- Trips	Eastbound Model +/- %	Westbound Model Volume	Westbound Count Volume	Westbound Model +/- Trips	Westbound Model +/- %
West of Runnymede Screenline								
St. Clair	845	785	60	7.6%	1137	1331	-194	-14.5%
Dundas	664	490	174	35.6%	952	779	173	22.2%
Total	**1509**	**1275**	**234**	**18.3%**	**2089**	**2110**	**-21**	**-1.0%**
West of Dufferin Screenline								
Rogers	449	383	66	17.4%	544	429	115	26.7%
St. Clair	829	892	-63	-7.1%	1155	1118	37	3.3%
Davenport	359	531	-172	-32.5%	865	690	175	25.3%
Dupont	898	850	48	5.7%	1128	1009	119	11.8%
Total	**2535**	**2656**	**-121**	**-4.5%**	**3691**	**3246**	**445**	**13.7%**
West of Spadina Screenline								
St. Clair	1175	971	204	21.0%	1478	1312	166	12.6%
Davenport	345	630	-285	-45.2%	921	1095	-174	-15.9%
Dupont	790	754	36	4.7%	1091	1103	-12	-1.1%
Total	**2310**	**2355**	**-45**	**-1.9%**	**3490**	**3510**	**-20**	**-0.6%**
East of Yonge Screenline								
St Clair	891	1035	-144	-13.9%	691	872	-181	-20.8%
Total	**891**	**1035**	**-144**	**-13.9%**	**691**	**872**	**-181**	**-20.8%**

(yellow) = count adjusted by MMM

(green) = count adjusted by Intellican

Table 3 – Summary of "Unadjusted" Seed O-D Travel Demand – PM Peak Hour

Internal / External Trips

To From	To Study Area	To External	Total
From Study Area	1859	6744	8603
From External	7984	20974	28958
Total	9843	27718	37561

North of St. Clair / South of St. Clair

To From	To North of St. Clair	To South of St. Clair	Total
From N. of St. Clair	5530	9336	14866
From S. of St. Clair	13172	9523	22695
Total	18702	18859	37561

West of Oakwood-Dovercourt / East of Oakwood-Dovercourt

To From	To W. of Oakwood Dovercourt	To E. of Oakwood Dovercourt	Total
From W. of Oakwood Dovercourt	13674	2863	16537
From E. of Oakwood Dovercourt	4464	16560	21024
Total	18138	19423	37561

Table 4 – Comparison of Model to Observed Screenline Traffic – PM peak hour

East-West Screenlines

Road	Southbound Model Volume	Southbound Count Volume	Southbound Model +/- Trips	Southbound Model +/- %	Northbound Model Volume	Northbound Count Volume	Northbound Model +/- Trips	Northbound Model +/- %
North of Rogers Rd. Screenline								
Weston	1412	1445	-33	-2.3%	1658	1649	9	0.6%
Keele	923	950	-27	-2.8%	809	850	-41	-4.8%
Caledonia	630	555	75	13.6%	675	621	54	8.8%
Dufferin	1154	1135	19	1.7%	929	947	-18	-1.9%
Oakwood	763	744	19	2.5%	822	814	8	1.0%
Total	**4883**	**4829**	**54**	**1.1%**	**4894**	**4881**	**13**	**0.3%**
North of St. Clair Screenline								
Runnymede	449	456	-7	-1.5%	316	310	6	1.9%
Weston	1280	1288	-8	-0.6%	1134	1242	-108	-8.7%
Old Weston	589	572	17	2.9%	974	691	283	41.0%
Caledonia	574	624	-50	-8.1%	662	815	-153	-18.8%
Dufferin	1046	1080	-34	-3.2%	969	892	77	8.6%
Oakwood	694	655	39	5.9%	843	900	-57	-6.3%
Vaughan	278	307	-29	-9.6%	465	503	-38	-7.5%
Bathurst	1250	1237	13	1.0%	1066	1061	5	0.5%
Spadina	485	485	0	0.0%	699	685	14	2.1%
Avenue	1063	1062	1	0.1%	2060	2005	55	2.7%
Yonge	755	752	3	0.4%	1151	1142	9	0.8%
Total	**8462**	**8518**	**-56**	**-0.7%**	**10339**	**10246**	**93**	**0.9%**
South of Dupont / Dundas Screenline								
Runnymede	375	369	6	1.6%	309	311	-2	-0.6%
Keele	1243	1237	6	0.4%	776	765	11	1.4%
Dundas	544	542	2	0.4%	688	684	4	0.6%
Lansdowne	530	541	-11	-2.0%	858	863	-5	-0.5%
Dufferin	926	903	23	2.6%	698	714	-16	-2.3%
Dovercourt	321	396	-75	-18.8%	524	555	-31	-5.6%
Ossington	389	423	-34	-8.1%	690	710	-20	-2.8%
Christie	344	398	-54	-13.5%	479	493	-14	-2.8%
Bathurst	829	838	-9	-1.1%	1093	1091	2	0.2%
Spadina	490	490	0	0.0%	972	963	9	1.0%
Avenue	931	923	8	0.9%	2124	2061	63	3.1%
Bay	389	382	7	1.7%	920	913	7	0.8%
Yonge	788	790	-2	-0.3%	716	715	1	0.2%
Total	**8099**	**8232**	**-133**	**-1.6%**	**10848**	**10838**	**10**	**0.1%**

North-South Screenlines

Road	Eastbound Model Volume	Eastbound Count Volume	Eastbound Model +/- Trips	Eastbound Model +/- %	Westbound Model Volume	Westbound Count Volume	Westbound Model +/- Trips	Westbound Model +/- %
West of Runnymede Screenline								
St. Clair	785	785	0	0.0%	1340	1331	9	0.7%
Dundas	480	490	-10	-2.0%	776	779	-3	-0.3%
Total	**1265**	**1275**	**-10**	**-0.8%**	**2117**	**2110**	**7**	**0.3%**
West of Dufferin Screenline								
Rogers	369	383	-14	-3.6%	428	429	-1	-0.1%
St. Clair	873	892	-19	-2.1%	1125	1118	7	0.6%
Davenport	492	531	-39	-7.3%	683	690	-7	-1.0%
Dupont	879	850	29	3.4%	1036	1009	27	2.6%
Total	**2613**	**2656**	**-43**	**-1.6%**	**3272**	**3246**	**26**	**0.8%**
West of Spadina Screenline								
St. Clair	1116	971	145	14.9%	1562	1312	250	19.0%
Davenport	551	630	-79	-12.6%	940	1095	-155	-14.2%
Dupont	811	754	57	7.5%	1190	1103	87	7.9%
Total	**2477**	**2355**	**122**	**5.2%**	**3692**	**3510**	**182**	**5.2%**
East of Yonge Screenline								
St Clair	1030	1035	-5	-0.5%	871	872	-1	-0.1%
Total	**1030**	**1035**	**-5**	**-0.5%**	**871**	**872**	**-1**	**-0.1%**

[yellow] = count adjusted by MMM

[green] = count adjusted by Intellican

Table 5 – Adjusted O-D Travel Demand (% change over seed O-D demand) – PM peak hour

Internal / External Trips

To From	To Study Area	To External	Total
From Study Area	1739 (-6.4%)	7260 (+7.7%)	9000 (+4.6%)
From External	8720 (+9.2%)	20931 (-0.2%)	29651 (+2.4%)
Total	10460 (+6.3%)	28191 (+1.7%)	38651 (+2.9%)

North of St. Clair / South of St. Clair

To From	To North of St. Clair	To South of St. Clair	Total
From N. of St. Clair	5154 (-6.8%)	9973 (+6.8%)	15127 (+1.8%)
From S. of St. Clair	13062 (-0.8%)	10463 (+9.9%)	23524 (+3.7%)
Total	18216 (-2.6%)	20435 (+8.4%)	38651 (+2.9%)

West of Oakwood-Dovercourt / East of Oakwood-Dovercourt

To From	To W. of Oakwood Dovercourt	To E. of Oakwood Dovercourt	Total
From W. of Oakwood Dovercourt	13479 (-1.4%)	2852 (-0.4%)	16330 (-1.3%)
From E. of Oakwood Dovercourt	4279 (-4.1%)	18042 (+8.9%)	22321 (+6.2%)
Total	17758 (-2.1%)	20893 (+7.6%)	38651 (+2.9%)

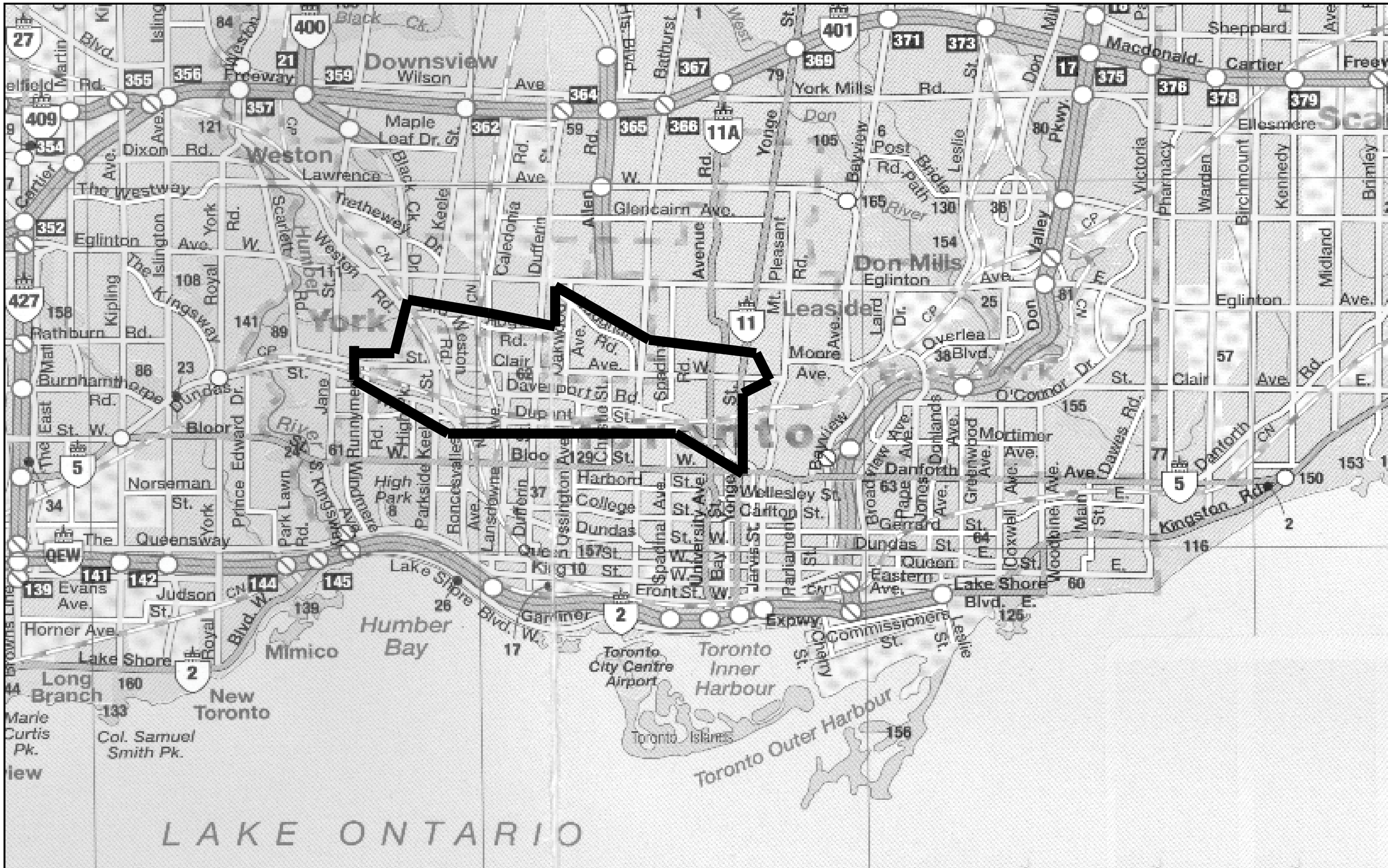

Figure 1 – Study Area Boundary

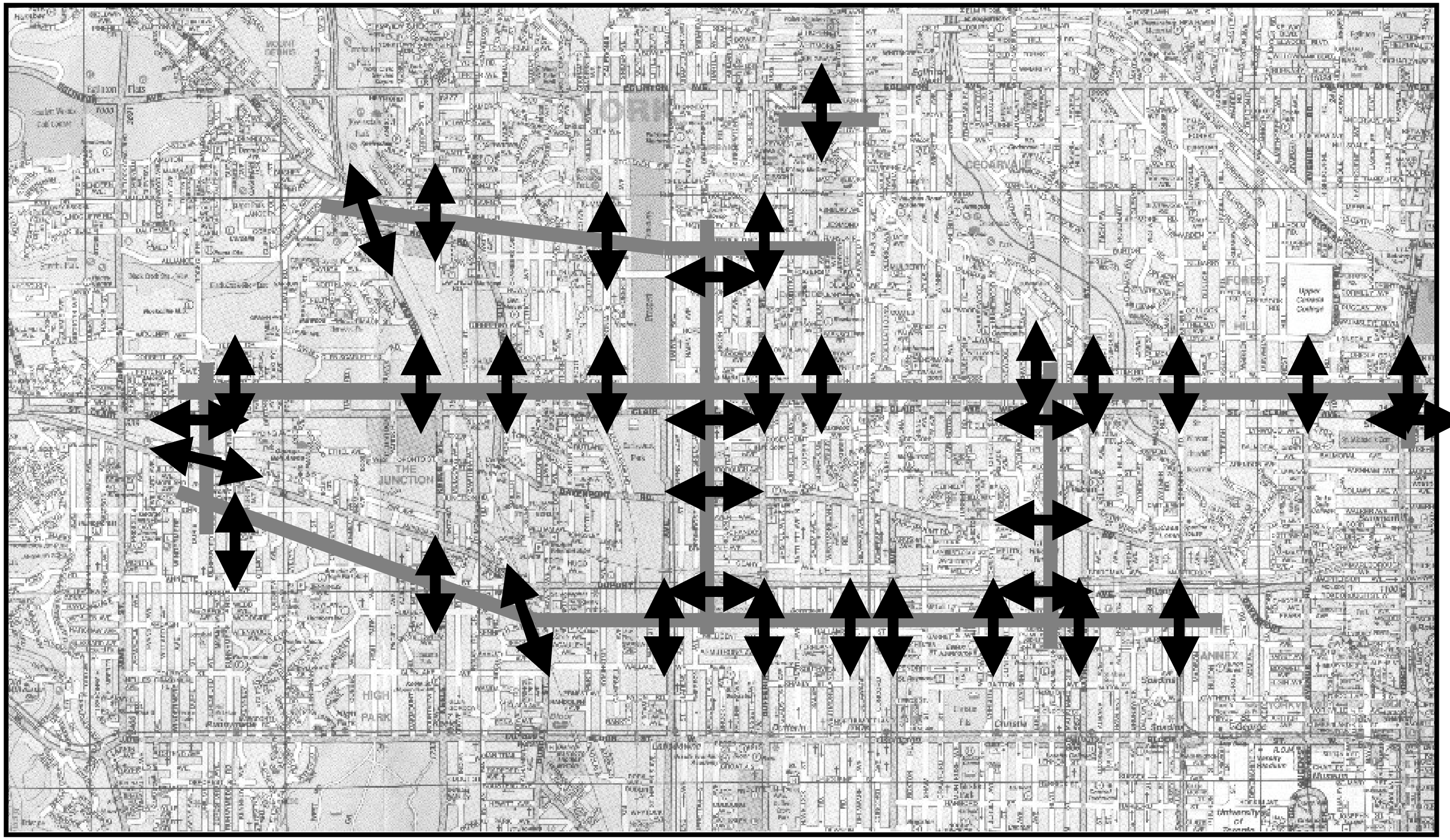

Figure 2 – PM Peak Hour – Adjustment Count Locations and Evaluation Screenlines

Legend

2-way count location

Evaluation screenline