

# ANNUAL REPORT, 2021-22

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#### 1. INTRODUCTION

This document describes the activities of the Travel Modelling Group (TMG) during its 11<sup>th</sup> year of operation, 2021-22 (April 1, 2020 through March 31, 2022).

Section 2 summarizes and comments on TMG activities and outcomes during the reporting period. In a few instances, tasks discussed in the 2021-22 work plan could not be completed to due major TMG staff turnover, combined with unanticipated needs to address other emergent priorities activities. Nevertheless,2021-22 has been a very productive year, with a number of milestone accomplishments, despite on-going COVID-19 restrictions. Section 3 then describes the TMG budget and resources that enabled these activities.

### 2. **2021-22 Projects & Activities**

Table 1 presents the 2021-22 work plan as approved by the TMG Steering Committee. As indicated in this figure, the work plan tasks divided into 15 primary tasks. TMG activities in each of these areas are discussed in the following Sections 2.1 through 2.15, inclusive.

тмо	5 2021-22 Work Plan	MONT	-											Davs A	llocated	
No.	таяк	Apr	Mav	June	Julv	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Total <sup>1</sup>	%	
1	GTAModel "C19" Version Development	4	3	3	3	3	1	1	1	1				80	16.7%	
2	2 Large-Scale Model System Calibration	0.5														
3	Volume-Delay Function (VDF) Evaluation & Calibration <sup>2</sup>	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	24	5.0%	
4	Implementing Standard Accessibility Calculations <sup>3</sup>		0.5	0.5	0.5	0.5								8	1.7%	
5	Updated 2021 network coding standard		0.5	0.5	0.5	0.5								8	1.7%	
6	Development of a network repository		0.5	0.5	0.5	0.5	2	2	2	2	0.5	0.5	0.5	46	9.6%	
	Development of Standard/Base Future Year Networks						1.5	1.5	1.5	1.5	1.5	1.5	1.5	42	8.8%	
8	Improved Non-Work/School Destination Choice Models <sup>4</sup>										1	1	1	12	2.5%	
ç	Freight model improvements										2	2	2	24	5.0%	51.0%
10	GTAModel Maintenance & V4.3 Development	1	1	1	1	1	1	1	1	1	1	1	1	48	10.0%	
11	TMG Aimsun & Emme Toolbox Development & Maintenance	1	1	1	1	1	1	1	1	1	0.5	0.5	0.5	42	8.8%	
12	2 XTMF: Upgrades/ Maintenance & V2.0 Development	2	2	2	2	2	2	2	2	2	2	2	2	96	20.1%	
13	B Documentation of TMG products	1	1	1	1	1	1	1	1	1	1	1	1	48	10.0%	49.0%
14	Outreach & Training (4 workshops)		W1	W2			W3				W4			478	Total	100.0%
15	Meetings: TMGSC (2) & TMGTAC (5)	TAC				TAC		TAC	SC	TAC		TAC	SC			
	TMG Staff Average Weekly Time Allocation (Days) <sup>5</sup>	10	10	10	10	10	10	10	10	10	10	10	10	10.0		
Sug	gested Workshops <sup>6</sup>															
W1	GTAModel "C19"	]														
W2	Network Repository / Coding Standard															
W3	Accessibility Measurement															
W4	XTMF 2.0 Prototype															
Lege	end															
n	Lighter, on-going effort	n = app	roximate	e, averag	e numbe	er of TM	G days p	er week	for this t	ask						
n	Heavy, focussed effort															
	"Research" activity	-														
	"Maintenance & support" activity	-														
Not	es:															
1	Estimated total days of staff time allocated to the task, assuming 48 work	ing week	s per yea	ar (staff	take 2 w	eeks vac	ation an	nd the Ur	niversity	closes						
	for 2 weeks/year during the Christmas Break).															
2 A MASc student (Amin Abedini) will work full-time on this task for his MASc thesis. TMG staff time assisting Mr. Abedini shown in the schedule.																
3	An undergraduate summer research assistant will work full-time on this ta	sk. TMG	staff tim	e assisti	ng the st	udent sh	iown in t	he scheo	dule.							
4	Ur. Gozde Uzonder will lead the work on this task, assisted by TMG staff.															
	5 days/week for Brendan Reilly & Luna Xi. Student & postdoc time not inc	luded in	tnis table	e. James	Vaughai	n time al	so not a	llocated	in this ta	ble.						
6	Provisional. Topics and timing may change.															

#### Table 1: 2020-21 Work Plan

#### 2.1 GTAModel "C19" Version Development

In response to the major COVID-19 pandemic impacts on travel behaviour in the GTHA a modified version of GTAModel that supports various pandemic recovery scenario testing. The

C19 modules are compatible with Versions 4.0.4, 4.1 and 4.2. The basic design idea is to create a model system in which various assumptions concerning travel behaviour changes (working from home rates, propensity to use transit, etc.) and policy scenarios (transit service levels, etc.) could be tested by "pivoting off" a base, non-pandemic V4.2 model system run. This revised model system has been dubbed "GTAModel C19".

Key steps in developing the C19 model system included:

- Gathering road and transit count data for both 2019 and 2020 pre-pandemic and pandemic conditions.
- Constructing 2019 and 2020 Emme networks so that pre- and during-pandemic conditions can be simulated.
- Coding the C19 system.
- Testing the C19 system and recalibrating it, as best as possible given limited data, so that it is useful for modelling during/post-pandemic conditions.
- Running various policy and scenario tests using the developed model.

Work on C19 began in the fall of 2020, but only limited progress was made due to pre-existing TMG staff workloads and commitments. This work continued through 2021-22, but was further delayed by TMG staff turnover and competing demands for staff time. C19 has, however, been completed and documented. It is now being used by TMG to test a range of pandemic recovery scenarios

#### 2.2 Large-Scale Model System Calibration Guidance

Calibrating a large-scale regional travel demand model system such as GTAModel or GGHM4 is a non-trivial and very time-consuming task. It is much an "art" as a "science", despite decades of experience among planning agencies and modelling consultants worldwide. Global, systematic/automated model system wide optimization of parameters is not a feasible proposition at this time, despite research efforts aimed at this objective.<sup>1</sup> Nevertheless, more systematic procedures and guidance for the calibration of a model system such as GTAModel V4 are required in order to ensure that operational implementations are as robust and credible as possible.

As a hold-over task from 2020-21, a TMG report providing this calibration guidance has been prepared and posted to the TMG website.

#### 2.3 Volume-Delay Function (VDF) Evaluation & Calibration

The VDFs used in our road network models have never been properly validated, despite their obvious importance to overall model system performance. The key challenge with respect to developing improved VDFs is what data are available to use, which historically was largely lacking. A second issue is the need to work within the static, deterministic and aggregate user equilibrium structure of the Emme road assignment algorithm, which imposes limitations on how volume-delay relationships can be specified. In recent years, however, many GTHA agencies

<sup>&</sup>lt;sup>1</sup> Najmi, A., T.H. Rashidi, J. Vaughan and E.J. Miller, "Calibration of Large-Scale Transportation Planning Models: A Systematic Approach", *Transportation*, 2019. DOI: 10.1007/s11116-019-10018-6.



have obtained access to improved speed and/or volume data from a variety of sources, thereby raising the possibility that improved VDFs can, indeed, be developed.

MASc student Mohammad Amin Abedini has worked on this task for his MASc thesis. He has reviewed data availability within the GTHA as well as the literature to identify best practice. He is using data from Streetlight Data<sup>2</sup> for the GTHA for this task. This work will be completed sometime in the spring, at which time a summary of his thesis will be prepared for submission to TMGTAC. The thesis will also be available for anyone interested in it.

#### 2.4 Implementing Standard Accessibility Calculations

GTAModel outputs are increasingly being used to support accessibility measure calculations for a variety of applications. In early 2020, UTTRI completed a study for the City of Toronto documenting the state of art/practice in accessibility measurement and associated software.<sup>3</sup> The report made a number of recommendations concerning how accessibility calculations could be incorporated as a standard output from GTAModel. Perhaps largely due to the onslaught of the pandemic, these recommendations have not been acted upon. In this task, a first cut at implementing a set of simple but useful accessibility measurements that can be readily constructed from GTAModel outputs (and/or TTS data undertaken by an undergraduate summer research student (Andre Li) under the supervision of the TMG Research Director and assisted by TMG staff. Isochrone employment accessibility measure calculations, as well as "logsum" employment accessibility measures using the GTAModel Place-of-Resident-Place-of-Work (PoRPoW) were implemented in XTMF, in both cases disaggregated by occupation category and employment status (full- and part-time). In the case of the PoRPoW logsum accessibilities, the scaling method developed by Luna Xi for her MASc thesis was also implemented,<sup>4</sup> which permits the accessibilities for different occupation groups to be directly compared. This work has been documented in a technical report that is available on the TMG website.

#### 2.5 Updated 2022 Network Coding Standard (NCS22)

Network coding needs have continued to evolve as agencies' modelling efforts have progressed. The current 2016 Network Coding Standard (NCS2016)<sup>5</sup> has been updated to reflect these changes, as well as emerging and anticipated network modelling needs as we look ahead to working with TTS 2022 data in the coming years. NCS2022 has been developed through extensive consultation with TMG agencies and regional consultants who have experience in working with TMG-based networks. A major objective of this work was to bring GTAModel and

<sup>&</sup>lt;sup>2</sup> https://www.streetlightdata.com/

<sup>&</sup>lt;sup>3</sup> Higgins, C., A. DeJohn, S. Farber, M. Palm, J. Vaughan, M. Widener, Y. Xi and E.J. Miller, *Transportation Accessibility Advice, Final Report*, prepared for the City of Toronto Planning Department, Toronto: University of Toronto Transportation Research Institute, February, 2020, 35 pages.

https://uttri.utoronto.ca/files/2020/07/UTTRI-Report-Transit-Accessibility-Advice-Final-Higgins-2020-1.pdf <sup>4</sup> Xi, Y. (2019), *Logit-Based Accessibility Measures: A Destination-Mode Choice Model for Morning-Peak Commuting in the GTHA*, MASc thesis, Toronto: Department of Civil & Mineral Engineering.

In addition, see: Miller, E.J. (2019), *Measuring Accessibility: Methods & Issues*, International Transport Forum Discussion Paper, Paris: OECD.

<sup>&</sup>lt;sup>5</sup> https://tmg.utoronto.ca/files/coding\_standards/2016\_Network\_Coding\_Standard.pdf



GGH Model (GGHM) coding conventions in to aligned, which has been accomplished. The new NCS22 report is posted on the TMG website.

#### 2.6 Network Repository Development

With expansion of TMG network modelling support to include Aimsun (and possibly other software in the future, such as MATSim), it is arguable that the need exists to develop a generic base network that can be readily imported into all supported packages. To be operationally practical, this requires developing a software repository system within which standard networks can be stored and routinely exported as needed by member agencies and TMG staff. Extending this repository to include storing "base" future year networks (Task 7), this would include developing software for "stitching together" network components into an overall network scenario for the region.

After carefully considering the software design requirements for such a repository, and considering the limited available TMG staff resources (and other priorities for their time) it became clear that this task simply could not be feasibly/successfully undertaken with the 2021-22 work year. In particular, a clear, well-defined set of software specifications proved very difficult to establish. Thus, this task has been "shelved" for possible future consideration for when a more explicit set of specifications might be articulated and TMG staff resources and priorities might feasibly support such an activity.

#### 2.7 Development of Standard/Base Future Year Networks

The idea of developing "standard" or "base" future year networks for general use by member agencies has been discussed several times in the past. While there has been some agreement that this is a "good idea", general agreement among all agencies has never been achieved to actually share the information needed to do this. Given the abandoning of the network repository, as well as, again, a lack of "crisp" specifications for these "base" future year networks and TMG staff limitations (notably the major staff turnover that occurred in the middle of the 2021-22 work year), this task was also abandoned in favour of more pressing and feasible tasks.

#### 2.8 Improved Non-Work/School (NWS) Destination Choice Models

NWS destination choice models are always a relatively under-developed component of travel demand model systems, despite NWS trips representing an important component of overall travel in the GTHA. This task was intended to explore options for developing improved destination choice models. The intention was for TMG postdoctoral fellow Dr. Gozde Ozonder to lead this task. Unfortunately, Dr. Ozonder also left the TMG in September, 2021 to take a position in the private sector. Combined with the TMG staff turnover occurring at the same time, it meant that this task could not be undertaken in the 2021-22 work year. It has been "pushed" into the 2022-23 work plan, when we are expecting Dr. Ozonder's replacement (Sanjana Hossein, currently completing his PhD under the supervision of Prof. Nurul Habib) to pick up this work.

#### 2.9 Freight Model Improvements

An improved freight (truck movement) model was implemented in GTAModel V4.2. This involved updating the model's base year from 2011 to 2016, to be consistent with the rest of V4.2.

#### 2.10 GTAModel V4 Maintenance & Updates

Various versions of GTAModel V4 are now being used or are in the process of being adopted by the Cities of Toronto, Mississauga, Brampton and Vaughan and by the Regions of Durham, Halton and Peel. During 2021-22 new implementations were also begun to apply the model system to the Region of Niagara and the Town of Bradford (Simcoe County). As usage of the model system increases, so does the need for TMG staff to provide technical support to the agencies and their consultants using the software and to continuously update/fine-tune the software as usage identifies weaknesses in the code that can be incrementally improved. Considerable TMG staff time over the past year has gone into providing this on-going support to our member agencies and their consulting support teams.

The major milestone for GTAModel during the 2021-22 work year was the release of GTAModel V4.2, containing a number of important upgrades from V4.1. These upgrades included an updated 2016 truck model, airport model, improved NWS location choice formula, and a parking policy module.

#### 2.11 TMG Aimsun & Emme Toolbox Development & Maintenance

A primary rationale for the TMG is to develop standard tools, procedures and templates for general use by member agencies. Historically, these tools have been primarily of two types: XTMF-based modules and Emme/4 Modeller procedures. One of the most time-consuming tasks undertaken in 2021-22 was the development of an Aimsun Toolbox to enable GTAModel to interface with Aimsun in support of the Region of Peel's on-going GTAModel implementation. This involved considerable support to Peel and its consultants in transferring the TMG's 2016 base road and transit network into Aimsun, in additional to the Aimsun Toolbox (and various associated XMTF extensions) development. The primary challenges in the network conversion task were: (1) the very different data structures of Emme and Aimsun, and (2) the need to support mesoscopic (DTA) road assignments in Aimsun, which require much higher fidelity data relative to Emme. TMG's component of the network transfer is completed, and an operational, documented Aimsun toolbox has also been completed and is available for use by Peel, or any other TMG partners interested in using Aimsun.

#### 2.12 XTMF Upgrades/Maintenance & V2.0 Development

Similarly, XTMF, as a primary software system for TMG work, is constantly being upgraded, it needs to be maintained, and technical support needs to be provided for its use by member agencies, their consultants, etc. Incremental additions and improvements (and associated updating of documentation) occurs continuously as needed, and as they are generated by continuing development of the TMG Toolbox and other TMG modules and models. V1.9 is the most recent release of XTMF, becoming available in February, 2022.

As time has permitted, work has continued on developing a significantly upgraded and redesigned XTMF V2. In addition to a major refactoring of the XTMF design, this new version will include a major rewrite of major TASHA components that are at the core of GTAModel. V2.0 is also essential to support the expected major upgrade of GTAModel to V5.0 (a similarly major upgrade and redesign of the model system), which, as discussed in detail in the TMG 2022-23 work plan, will commence in terms of preliminary investigations in 20222-3, in preparation for the full-scale development of V5.0 in the latter part of 2023 once TTS 2022 begins to become available.

#### 2.13 Documentation of Software & Models

Up-to-date documentation of GTAModel V4.2, XTMF and Emme Toolbox modules is available on the TMG website. Website improvements and updating are on-going tasks.

#### 2.14 Outreach & Training

A critical component of TMG activities in all phases of its work must be training, technology transfer and outreach. In order to succeed, TMG must be responsive to its collaborating partners' needs. It must also get the tools that it is developing into the hands of its partners for their use. The TMG's role is intended to be one of tool developer, not to be the user of these tools on behalf of its partners in operational applications (except in special cases). In addition to Task 13 documentation and website maintenance activities, 2021-22 activities included:

- Eight meetings were held with TMGTAC to discuss work in progress, next steps in the work plan and to disseminate work plan results.
- Due to both COVID restrictions and the evolution of actual TMG activities (as documented above), only one workshop was held during the 2021-22 reporting period to present and discuss in detail the newly released GTAModel V4.2. The workshop presentations are available on the TMG website.

#### 2.15 Steering Committee Meetings

In addition to the TMGTAC meetings discussed in Section 2.11, two meetings with the TMG Steering Committee (TMGSC) were held (on Nov. 3/21 and March 2/22) to discuss work plan progress, budget, overall TMG directions for work and other administrative and supervisory matters.

## 3. 2021-22 BUDGET & REVENUES

Table 2 presents the 2021-22 TMG expenditures and revenues. This budget supported two fulltime technical staff persons (initially, Luna Xi and Brendan Reilly, replaced upon their resignations to take other positions with Williams Diogu and Amit Sandhel), and, in whole or in part, five undergraduate summer student research assistants (Ethan Baron, Nadia Mohsin, Lisa Guseva, Andre Li and Ryan Ahdab).



### Table 2: 2021-22 Expenditures & Revenues

TMG Budget Projections, 2021-2026					
TMG Budget	2021-22				
Expenses	Amount				
Salaries <sup>1</sup>	\$184,081.77				
Supplies, Misc. Expenses	\$250.00				
Emme & Aimsun Licences	\$6,000.00				
Contingency	\$0.00				
Overhead (@40%)	\$76,857.14				
Total Expenses	\$267,188.91				
Percent increase in expenses over previous year					
Revenues	2021-22				
Member Contributions	Amount				
Metrolinx	\$66,000.00				
МТО	\$34,000.00				
City of Toronto	\$34,000.00				
City of Hamilton	\$21,000.00				
Region of Durham	\$21,000.00				
Region of Halton	\$21,000.00				
Region of Peel	\$21,000.00				
Region of York	\$21,000.00				
City of Brampton	\$7,500.00				
City of Mississauga	\$7,500.00				
City of Vaughan	\$7,500.00				
Toronto Transit Commission	\$7,500.00				
Total Member Contributions	\$269,000.00				
Carry-Forward from Previous Year <sup>3</sup>	\$0.00				
Additional Revenue (UofT Subsidy)	\$0.00				
Total Revenues <sup>2</sup>	\$269,000.00				
Percent Increase in contributions over previous year	0.0%				
Total Revenues-Total Expenses	\$1.811.09				
Contributions-Actual Expenses	\$1.811.09				
Notos					
1 2 full time TMC staff salaries + henefits + 1 undergra	duata summor ra		arch accistant		
1. 2 full-time five start salaries + benefits + 1 undergra		sea	arch assistant	aach waar	
2 "Total Bayanuas" include carry forward from the pro-	vious voor	ann		each year.	
2. Total Revenues include carry-forward from the pre	evious year.				
University of Toronto In-Kind Contributions					
Principal Investigator Time	\$50,000.00				
Co-Investigators' Time	\$0.00				
Post-Doctoral Fellow Time	\$15,000.00				
Graduate Research Assistants Time	\$20,000.00				
Office Space & telephones	\$6,194.26				
Total	\$91,194.26				
This excludes other UofT in-kind contributions to TMG	that are very diff	icul	t to quantify. Th	nese include:	
Data Management Group support of TMG					
Internet access					
University of Toronto library access					
Administrative support					
TMG computers & software					