July 8th, 2013
Extreme Rainfall Event
Summary & Analysis Report

F I N A L

Submitted to:

TRCA
Toronto, Ontario

Submitted by:

AMEC Environment & Infrastructure

A Division AMEC Americas Limited
3215 North Service Road
Burlington, ON L7N 3G2

Tel: 905-335-2353
Fax: 905-335-1414

December 2014

December 17, 2014
AMEC Project TP114045-10

Toronto and Region Conservation Authority
5 Shoreham Drive
Downsview, ON M3N 1S4

ATTENTION: Mr. Jamie Duncan, Project Manager, Flood Risk Management

Dear Sir:

RE: July 8th, 2013 Extreme Rainfall Storm Event
Summary and Analysis Report
Final Report, Toronto and Region Conservation Authority

AMEC Environment & Infrastructure is pleased to submit the Final Report for the July 8th, 2013 Extreme Rainfall Storm Event, Summary and Analysis.

We acknowledge and appreciate the co-operation and input from Toronto and Region Conservation Authority staff during the preparation of this report.

It is envisioned that the report and its directions can ultimately become a template for analyzing and reporting future extreme events.

Yours truly,

AMEC ENVIRONMENT & INFRASTRUCTURE
a division of AMEC Americas Limited

Per: Ron Scheckenberger, M.Eng., P.Eng.
Principal Consultant

Per: Vahid Taleban, M.Sc., P. Eng
Water Resources Engineer

RBS/VT/ll

AMEC Environment & Infrastructure
A Division of AMEC Americas Limited
3215 North Service Road
Burlington, Ontario
CANADA L7N 3G2
Tel + 1 (905) 335-2353
Fax + 1 (905) 335-1414
www.amec.com

EXECUTIVE SUMMARY

AMEC Environment & Infrastructure has been retained by TRCA to study the background and associated impacts of the July 8th, 2013 extreme rainfall event which hit the TRCA watersheds. Rainfall data have been obtained and analyzed from 135 rain gauges operated by several municipalities, provincial and federal agencies located in and around the TRCA jurisdiction. Water level and stream flow data from 58 stream gauges operated by TRCA and Water Survey Canada have also been obtained and analyzed. In addition to measured rainfall and flow data, radar rainfall data sets have been obtained from the King City and Buffalo radar stations and assessed for further analysis.

The July 8th, 2013 extreme rainfall event had a maximum duration of 10 hours and a maximum total observed rainfall of 138 mm (Martin Grove gauge located east of Toronto Pearson International Airport). The maximum hourly rainfall was observed to be 79 mm also at the Martin Grove gauge. The maximum short term rainfall was 21.6 mm (TRCA gauge HY025 located on Etobicoke Creek at QEW) recorded over 5 minutes, equivalent to an intensity of 259.2 mm/hr. A review of the common Canadian and US numerical weather prediction models has indicated that these models did not accurately predict the severity, timing, or location of the extreme rainfall event over the TRCA watersheds on July 8th, 2013.

The four (4) TRCA watersheds affected, Humber River, Don River, Etobicoke Creek and Mimico Creek received the highest amount of rainfall. The maximum total rainfall during the storm occurred in the Mimico Creek watershed with an average of 94.6 mm of rain across the watershed. To-date, the total estimated cost of damages, due to the July 8th, 2013 storm event has reached 932 million Canadian Dollars. Radar data sets obtained from King City and Buffalo radar stations have been found to accurately depict the shape and total average depth of the storm over the TRCA watersheds with a strong agreement; however the adjusted King City Radar data, using ground-truthing techniques, seems to have overestimated the maximum observed total depth of rainfall, when compared to Buffalo radar data and point gauge data.

Observed stream water levels and high water marks have been compared with the modelled 100 year and Regional Storm flooding limits in order to identify locations where water levels exceeded Regulatory flood lines. Based on this assessment, it has been found that observed water levels have exceeded the 100 year storm flooding limits at 5 stations operated by TRCA and 2 stations operated by Water Survey Canada. Additionally, observed peak flows have been compared with modelled frequency flows at each gauge to determine where observed flows would fall in terms of estimated return period. This assessment indicated that at two locations, Etobicoke Creek near QEW and Humber River at Weston Road, the observed peak flows exceeded low frequency flows with a return period of 500 years.

The comparison of the July 8th, 2013 extreme storm event with major historic storm events in Ontario indicated that while the duration of this storm was shorter than most, the maximum observed rainfall for durations up to 3 hours exceeded the values reported for Hurricane Hazel, as well as the Timmins Storm and Harrow Storms. However the July 2013 storm was found to be smaller than the Toronto August 2005 storm for all durations. The maximum total rainfall during the July 2013 storm event was also been found to be smaller than all other major historic storm events reviewed as part of this assessment. When compared with historic storm events

from other jurisdictions reviewed as part of this assessment, the July 8th, 2013 storm event had a shorter duration but comparable estimated cost of flood damages.

This report used a number of analytical techniques to assess the storm and its runoff response. These techniques have been documented into a Methods Appendix for the benefit of TRCA to standardize the analysis, reporting, and graphics associated with extreme storm events.

TABLE OF CONTENTS

PAGE

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1.0 INTRODUCTION

Conservation Authorities were created in 1946 by an Act of the Ontario legislature and are mandated to ensure the conservation, restoration and responsible management of Ontario's water, land and natural habitats, through programs that balance human, environmental and economic needs.

Through this Act, a principal mandate of Toronto and Region Conservation Authority (TRCA) is to reduce the risk to life and damage to property caused by flooding. TRCA does this by providing local agencies and the public with notice, information and advice so that they can respond during severe rainfall events with the potential to cause flooding, and during flood related emergencies. TRCA's Flood Management Service (FMS) was developed in order to prepare and respond to a changing environment, the increasing needs of municipal partners, and the health and well-being of the living city.

It is important to recognize the different types of flooding. Riverine flooding is the responsibility of Conservation Authorities and occurs when water levels of rivers rise and overflow their banks. Urban flooding is the responsibility of municipalities, consisting of street flooding, basement flooding, and flooding of other low lying urban areas, due to a lack of major overland flow routes or the limited capacity of existing drainage systems.

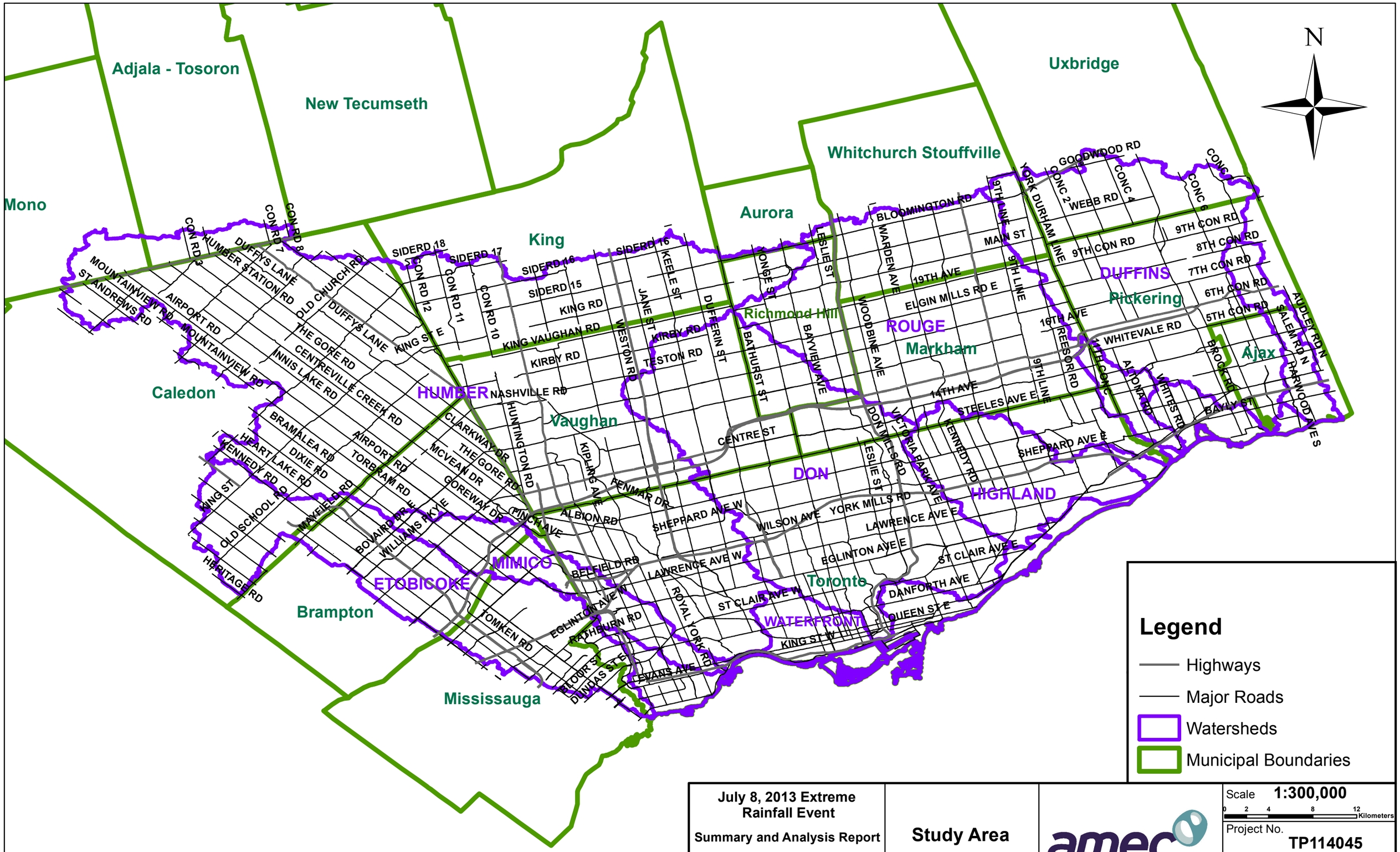
On July 8th, 2013, parts of the Greater Toronto Area (GTA) were hit by an extreme rainfall event which caused widespread power outages and disrupted the evening rush hour traffic, stranding many commuters. The magnitude of the damages caused by flooding due to this extreme rainfall event has prompted the Toronto and Region Conservation Authority (TRCA) to initiate a study to assess the climatological and hydrologic observations from the July 8th, 2013 storm event. This report outlines the hydrologic observations from the July 8th, 2013 extreme rainfall event, by reviewing measured rainfall depths from various rain gauges across the study area, as well as water level and stream flow measurements from available stream flow gauges. In addition to measured rainfall and stream flow data at various ground-based gauges, further analysis has been conducted using radar rainfall data sets acquired from King City and Buffalo New York radar stations for comparison purposes.

Figure 1-1: Flooding in Don Valley Parkway on July 8, 2013 (Craig Robertson/QMI Agency)

The area under study includes all watersheds within TRCA's jurisdiction, as presented in Figure 1-2, which extends to Winston Churchill Blvd. on the west, Lake Ridge Road North on the east, Highway 9 on the north and Lake Ontario on the south. Sixteen (16) municipalities within Dufferin, Durham, Peel, Simcoe, Toronto and York Regions are covered by the study area.

The content of this report has been guided by the original Terms of Reference (November 27, 2013), input from TRCA staff. A Method's Appendix which outlines some standardized aspects of the extreme event analyses, has been developed over the course of the study.

TRCA has separately contracted a Climatological Study (also prepared by AMEC) which is a companion initiative to this Summary and Analysis report (ref. July 8th, 2013 Extreme Rainfall Event - Climatological Report, 2014, AMEC Environment & Infrastructure).



July 8, 2013 Extreme Rainfall Event **Summary and Analysis Report** **Toronto and Region Conservation Authority**	**Study Area**	amec	Scale **1:300,000** 0 2 4 8 12 Kilometers Project No. **TP114045** Figure No. **1-2**

2.0 BACKGROUND DATA / INFORMATION

Monitoring data including rainfall, stream flow and water level measurements, as well as hydraulic modelling and floodplain mapping have been collected from several municipal, provincial and federal organizations for use in this assessment. In addition to monitoring data, radar rainfall data sets for the total storm duration have also been acquired from the Buffalo New York and King City Radar stations. The data sets are described in detail in the following:

2.1 Rainfall

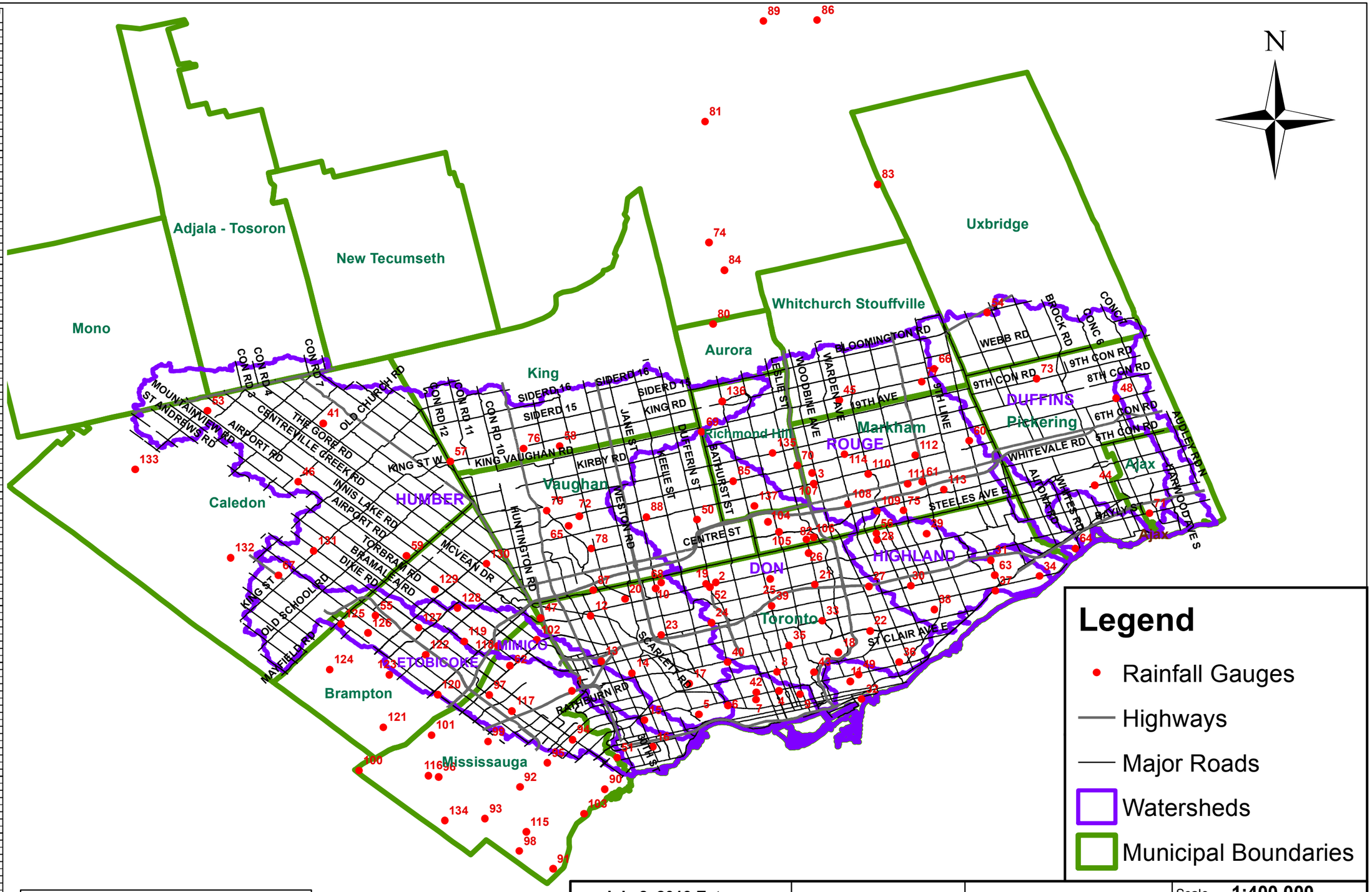
Rainfall data measured at all rain gauges operated by the Toronto and Region Conservation Authority have been obtained for use in this assessment. In addition, supplemental rainfall data from 7 other sources have been collected. Rainfall data providers, as well as the total number of available gauges and the time interval for collected data from each provider are presented in Table 2-1. All available gauges as well as their spatial distribution are presented in Figure 2-1. Station information for all gauges is also presented in Appendix D.

Table 2-1: Characteristics of Available Rainfall data from all Sources

Data	Provider	No. of Gauges	Time Interval
Rainfall	TRCA	30	5 min
		3	15 min
Rainfall	City of Toronto	36	5 min
Rainfall	City of Mississauga	14	5 min
Rainfall	Peel Region	20	15, 60 min
Rainfall	York Region	16	5 min
Rainfall	Environment Canada	3	0.2 mm tips
		1	15 min
Rainfall	City of Markham	11	5 min
Rainfall	Town of Richmond Hill	3	5 min
Total		**137**	

All rainfall data sets have been thoroughly reviewed to identify any potential spatial and temporal gaps. The review process has resulted in identifying two gauges with missing rainfall data. The Ashbridges Bay rain gauge operated by the City of Toronto did not have any reported rainfall depth values in the data set provided and the Fairbank Middle Public School rain gauge also operated by the City of Toronto had no rainfall records beyond the early hours of July 7th, 2013. As such, both gauges have been excluded from further analysis.

ID	Gauge Name	Source	Total Rainfall (mm)
1	Toronto Pearson Int'l. A	Environment Canada	114.6
2	Toronto North York	Environment Canada	67.2
3	Toronto Buttonville A	Environment Canada	14.2
4	Toronto City	Environment Canada	96.4
5	Swansea	City of Toronto	56.75
6	Howard	City of Toronto	57
7	Central	City of Toronto	87.25
8	Brown	City of Toronto	85
9	Church	City of Toronto	92.25
10	Lane	City of Toronto	53.5
11	Greenwood	City of Toronto	52.5
12	Albion	City of Toronto	86.25
13	Martin Grove	City of Toronto	138
14	Richview	City of Toronto	121
15	Bering	City of Toronto	83.5
16	Kipling	City of Toronto	37.75
17	Castlefield	City of Toronto	72.5
18	Thomcliffe	City of Toronto	62.5
19	Finch Yard	City of Toronto	68
20	Emery Yard	City of Toronto	55.75
21	Fire Station 116	City of Toronto	49
22	Bermondsey Yard	City of Toronto	49.75
23	Wilson	City of Toronto	96.25
24	Ancaster	City of Toronto	70.5
25	Mitchell Field	City of Toronto	62.324
26	Cummer	City of Toronto	32.5
27	Pharmacy/401	City of Toronto	18.25
28	Liamoreaux	City of Toronto	10.5
29	Nashdene Yard	City of Toronto	8.75
30	Ellesmere Yard	City of Toronto	10.25
31	Morningside Yard	City of Toronto	9.75
32	Ashbridges Bay	City of Toronto	Missing
33	Edwards Gardens	City of Toronto	48
34	Fire Station 215	City of Toronto	7.75
35	Mount Pleasant	City of Toronto	78
36	Denton	City of Toronto	40.25
37	Poplar	City of Toronto	7.25
38	Seminole	City of Toronto	11
39	Fire Station 121	City of Toronto	61.25
40	Fairbank Middle Public School	City of Toronto	Missing
41	Albion Hills	TRCA	43.6
42	Alex Duff Memorial Pool	TRCA	88.6
43	Brickworks	TRCA	69.4
44	Brock West Landfill	TRCA	6
45	Bruces Mill CA	TRCA	15.4
46	Caledon Pumping Station	TRCA	37
47	Claireville Dam	TRCA	85.2
48	Claremont Shop	TRCA	4
49	Dainforth and Coxwell	TRCA	50.2
50	Dufferin Reservoir	TRCA	40.7
51	Etobicoke at QEW	TRCA	78.4
52	G Ross Dam	TRCA	67.6
53	Glen Haffy	TRCA	22.6
54	Goodwood Pumping Station	TRCA	2.4
55	Heart Lake CA	TRCA	81.8
56	Kennedy Pump Station	TRCA	9.8
57	King and Albion-Vaughan	TRCA	57.8
58	East Humber at Mill Road	TRCA	73
59	Ladaw Bus Depot	TRCA	51.2
60	Little Rouge at 16th	TRCA	6.8
61	Milne Dam	TRCA	10.2
62	Mississauga Works Yard	TRCA	109.4
63	Morningside Works Yard	TRCA	8.6
64	Pettapiece CA	TRCA	9
65	Restoration Services	TRCA	79
66	Stouffville Dam	TRCA	5.7
67	Sue Grange Farm	TRCA	35
68	TRCA Head Office	TRCA	72.6
69	York Pumping Station	TRCA	25.4
70	York Region Works Yard	TRCA	20
71	Early and Church	TRCA	7.4
72	Kortright	TRCA	94
73	Transport Canada	TRCA	3.2
74	R_ET_HL01	York Region	47.8
75	R_ET_MA03	York Region	7.8
76	R_ET_NO01	York Region	106
77	R_ET_ST02	York Region	6.8
78	R_ET_VA01	York Region	75
79	R_ET_VA02	York Region	111.4
80	R_YR_AU02	York Region	29.4
81	R_YR_KE01	York Region	5.6
82	R_YR_MA03	York Region	44.6
83	R_YR_MO01	York Region	3
84	R_YR_NE01	York Region	31.6
85	R_YR_RH01	York Region	47.2
86	R_YR_SU01	York Region	2.4
87	R_YR_VA03	York Region	100.8
88	R_YR_VA04	York Region	60.4
89	R_YR_WB01	York Region	2.8
90	STN 01 - Third St.	Mississauga	81.4
91	STN 02 - Clarkson	Mississauga	5.6
92	STN 03 - Wolfedale	Mississauga	50.2
93	STN 04 - South Common	Mississauga	2.75
94	STN 05 - Winding Trail	Mississauga	88.4
95	STN 06 - Mississauga Valley	Mississauga	71
96	STN 07 - Britannia	Mississauga	20.4
97	STN 08 - Terriken	Mississauga	56.4
98	STN 09 - Truscott	Mississauga	4
99	STN 10 - Fallbourne	Mississauga	56.8
100	STN 11 - Garry Morden FTC	Mississauga	14.2
101	STN 12 - CVC	Mississauga	46.6
102	STN 13 - Goreway	Mississauga	87.8
103	STN 14 - Port Credit	Mississauga	59.4
104	Stornoway P.S.	Markham	56.8
105	Thornhill C.C.	Markham	49.63
106	German Mills P.S.	Markham	39
107	Lincoln Alexander P.S.	Markham	20
108	8100 Warden Ave	Markham	13.6
109	Milliken Mills C.C.	Markham	9.25
110	Fire Hall #94	Markham	12.5
111	Roy H Crosby P.S.	Markham	10
112	Markham Museum	Markham	9.4
113	Rouge River C.C.	Markham	11
114	Angus Glen C.C.	Markham	12
115	RG03	Peel Region	3.75
116	RG11	Peel Region	9.75
117	RG16	Peel Region	61.25
118	RG20	Peel Region	109.75
119	RG22	Peel Region	74.75
120	RG23	Peel Region	19.25
121	RG24	Peel Region	42.5
122	RG25	Peel Region	81.75
123	RG26	Peel Region	24
124	RG27	Peel Region	52
125	RG28	Peel Region	74.25
126	RG29	Peel Region	97.5
127	RG31	Peel Region	67.25
128	RG32	Peel Region	86.75
129	RG33	Peel Region	63.75
130	RG34	Peel Region	36.5
131	RG36	Peel Region	44.25
132	RG39	Peel Region	47.75
133	RG42	Peel Region	17.75
134	RG44	Peel Region	9.75
135	Discovery	RichmondHill	56.6
136	Oak Ridges	RichmondHill	29.6
137	Operations	RichmondHill	32.6



Note: Total Precipitation presented has been calculated from 14:00 on July 8, 2013 until 02:00 on July 9, 2013

July 8, 2013 Extreme Rainfall Event

Summary and Analysis Report

Toronto and Region Conservation Authority

Rainfall Gauge Locations

amec

Scale 1:400,000

0 2.5 5 10 15 Kilometers

Project No. TP114045

Figure No. 2-1

The NEXRAD level III Digital Storm Total Precipitation data set from the Buffalo New York radar station has been obtained from the National Oceanic and Atmospheric Administration (NOAA) data archives for analysis. Additionally, data sets from King City Ontario radar station have been obtained for analysis.

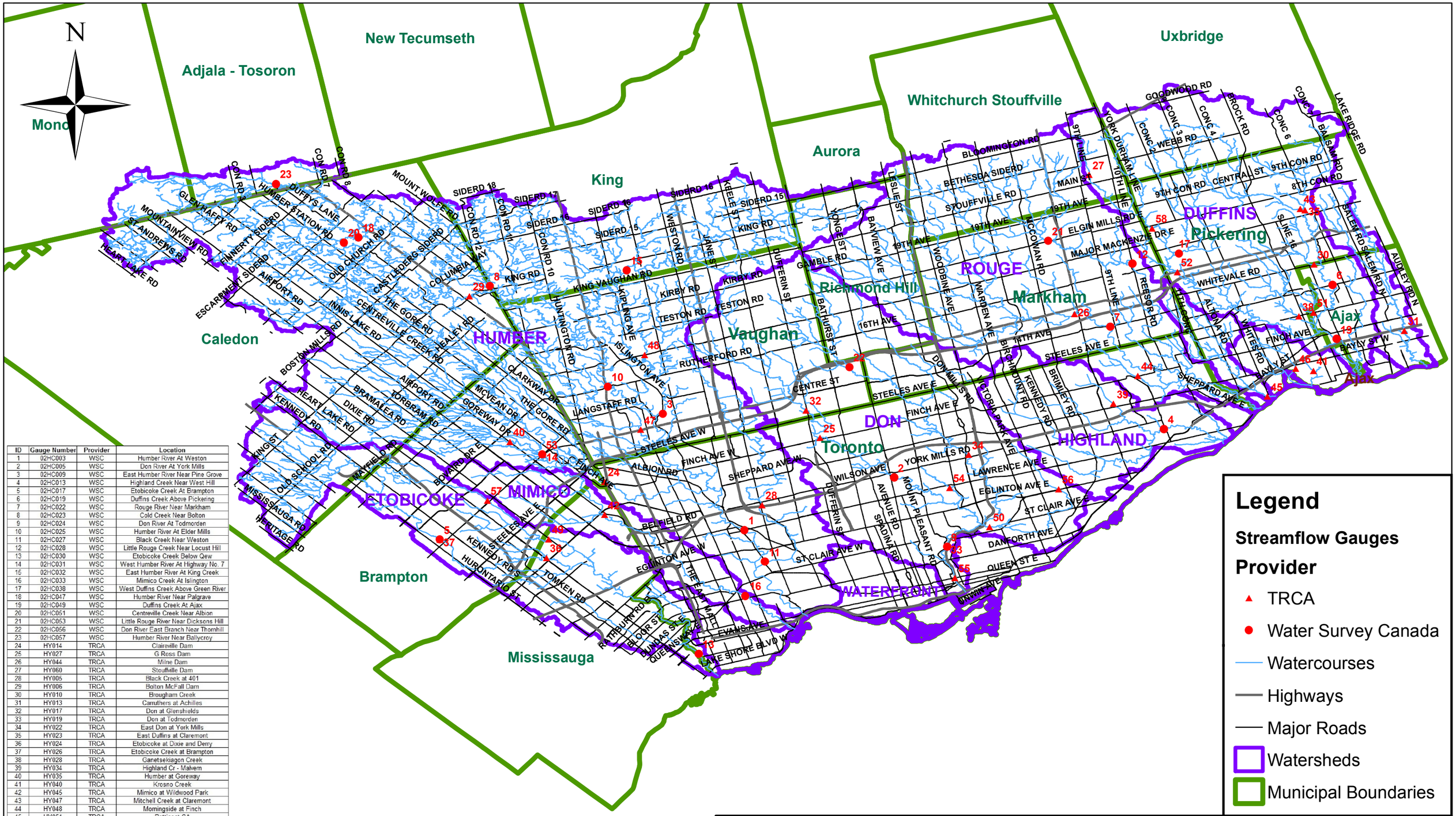
2.2 Streamflow/Water Level

Streamflow and water level data have been provided for all flow gauges operated by TRCA. In addition to these data sets, streamflow and water level data for all gauges operated by Water Survey Canada, within the TRCA jurisdiction, have been obtained to be used for analysis. The characteristics of the streamflow and water level data have been presented in Table 2-2. Locations of the gauges with available streamflow and water level data have also been depicted in Figure 2-2. Station information for all gauges is also presented in Appendix D.

Table 2-2: Characteristics of Streamflow and Water Level Data from All Sources

Data	Provider	No. of Gauges	Time Interval
Water Level	TRCA	31	15 min
Stream Flow		22	15 min
Water Level at Dams		4	15 min
Water Level	Water Survey Canada	1	5 min
		12	15 min
		10	30 min
Stream Flow		1	5 min
		12	15 min
		9	30 min
Total	**Water Level**	**58**	
	Stream Flow	**44**	

A review has been conducted on the streamflow and water level data for all available gauges to identify any temporal and spatial gaps. The results of this assessment have been presented in Table 2-3. Further consultation with TRCA (ref. Technical Memorandum, Lucero-Scheckenberger, June 27th, 2014) has indicated that two (2) gauges, HY005 on Black Creek and 401 and HY081 on Spring Creek North, were inundated during the storm event and therefore data are missing for these gauges. The remaining gauges, including HY024, HY035, HY045, HY053, HY054, HY059 and HY062 have recorded water levels outside of the range of their corresponding rating curves and therefore it has not been possible to accurately estimate stream flow for these gauges during the July 2013 storm event. A review of the data provided by WSC also indicated that Gauge 02HC057 is missing stream flow data, while water level data is available for this gauge. Six (6) other gauges, as listed in Table 2-3, have temporal gaps in recorded stream flows which are similarly due to rating curve exceedance at these gauges.



ID	Gauge Number	Provider	Location
1	02HC003	WSC	Humber River At Weston
2	02HC005	WSC	Don River At York Mills
3	02HC009	WSC	East Humber River Near Pine Grove
4	02HC013	WSC	Highland Creek Near West Hill
5	02HC017	WSC	Etobicoke Creek At Brampton
6	02HC019	WSC	Duffins Creek Above Pickering
7	02HC022	WSC	Rouge River Near Markham
8	02HC023	WSC	Cold Creek Near Bolton
9	02HC024	WSC	Don River At Todmorden
10	02HC025	WSC	Humber River At Elder Mills
11	02HC027	WSC	Black Creek Near Weston
12	02HC028	WSC	Little Rouge Creek Near Locust Hill
13	02HC030	WSC	Etobicoke Creek Below Qew
14	02HC031	WSC	West Humber River At Highway No. 7
15	02HC032	WSC	East Humber River At King Creek
16	02HC033	WSC	Mimico Creek At Islington
17	02HC038	WSC	West Duffins Creek Above Green River
18	02HC047	WSC	Humber River Near Palgrave
19	02HC049	WSC	Duffins Creek At Ajax
20	02HC051	WSC	Centreville Creek Near Albion
21	02HC053	WSC	Little Rouge River Near Dicksons Hill
22	02HC056	WSC	Don River East Branch Near Thornhill
23	02HC057	WSC	Humber River Near Ballycroy
24	HY014	TRCA	Claireville Dam
25	HY027	TRCA	G Ross Dam
26	HY044	TRCA	Milne Dam
27	HY060	TRCA	Stouffville Dam
28	HY005	TRCA	Black Creek at 401
29	HY006	TRCA	Bolton McFall Dam
30	HY010	TRCA	Brougham Creek
31	HY013	TRCA	Carruthers at Achilles
32	HY017	TRCA	Don at Glenshields
33	HY019	TRCA	Don at Todmorden
34	HY022	TRCA	East Don at York Mills
35	HY023	TRCA	East Duffins at Claremont
36	HY024	TRCA	Etobicoke at Dixie and Derry
37	HY026	TRCA	Etobicoke Creek at Brampton
38	HY028	TRCA	Ganetsekiagon Creek
39	HY034	TRCA	Highland Cr - Malvern
40	HY035	TRCA	Humber at Goreway
41	HY040	TRCA	Krosno Creek
42	HY045	TRCA	Mimico at Wildwood Park
43	HY047	TRCA	Mitchell Creek at Claremont
44	HY048	TRCA	Morningside at Finch
45	HY051	TRCA	Petticoat CA
46	HY052	TRCA	Pine Creek
47	HY053	TRCA	Plunkett Creek
48	HY054	TRCA	Purpleville Creek
49	HY059	TRCA	Spring Creek
50	HY062	TRCA	Taylor Creek South
51	HY065	TRCA	Urfe Creek
52	HY066	TRCA	West Duffins at Hwy7
53	HY067	TRCA	West Humber at Hwy7
54	HY068	TRCA	Willket Creek
55	HY079	TRCA	Don at Dundas
56	HY080	TRCA	Taylor Creek North
57	HY081	TRCA	Spring Creek North
58	HY082	TRCA	Reesors Creek

Legend

Streamflow Gauges

Provider

- TRCA
- Water Survey Canada
- Watercourses
- Highways
- Major Roads
- Watersheds
- Municipal Boundaries

July 8, 2013 Extreme Rainfall Event

Summary and Analysis Report

Toronto and Region Conservation Authority

Streamflow Gauge Locations

amec

Scale **1:300,000**

0 2 4 8 12 Kilometers

Project No. **TP114045**

Figure No. **2-2**

Table 2-3: Identified Gaps for Streamflow and Water Level Data

Data	Provider	Time Interval	Gauges	Number of Gaps	Gap Start	Gap End	Total Time Steps Missing	Notes
Water Level	TRCA	15 min	HY005	1	08/07/2013 17:45	10/07/2013 0:00	121	Missing gauge data continues to July 15th.
		15 min	HY081	1	08/07/2013 20:30	09/07/2013 00:45	17	Gap filled by TRCA using Aquarius®Software Modelling Tool
Stream Flow		15 min	HY024	3	08/07/2013 19:15	08/07/2013 20:00	2	
					08/07/2013 20:45	09/07/2013 3:15	25	
					09/07/2013 9:15	09/07/2013 12:45	13	
		15 min	HY035	2	07/07/2013 17:45	07/07/2013 21:30	14	
		15 min			08/07/2013 17:45	09/07/2013 9:15	61	
		15 min	HY045	1	08/07/2013 17:15	08/07/2013 18:15	3	
		15 min	HY053	1	08/07/2013 16:45	09/07/2013 6:30	54	
		15 min	HY054	1	08/07/2013 17:00	10/07/2013 0:00	124	
		15 min	HY059	2	07/07/2013 15:45	07/07/2013 20:30	18	
					08/07/2013 16:30	09/07/2013 5:30	51	
		15 min	HY062	2	07/07/2013 17:00	07/07/2013 17:45	2	
					08/07/2013 16:15	08/07/2013 18:00	6	
		15 min	HY065	*Data Quality*	*N/A*	*N/A*	*N/A*	Data for this gauge are given either a grade of 1 or 7, indicative of preliminary and unverified data
		15 min	HY081	1	08/07/2013 19:00	09/07/2013 0:45	22	Data for this gauge are given either a grade of 1 or 7, indicative of preliminary and unverified data
Water Level	WSC	15 min	02HC030	1	08/07/2013 17:15	09/07/2013 02:00	37	Marked as unusable by WSC
Stream Flow		15 min	02HC056	1	08/07/2013 16:45	08/07/2013 17:45	3	
		15 min	02HC033	1	08/07/2013 11:00	09/07/2013 17:45	51	
		15 min	02HC030	2	08/07/2013 17:30	08/07/2013 18:00	1	
		15 min			08/07/2013 18:00	09/07/2013 1:30	29	
		15 min	02HC027	1	08/07/2013 17:30	08/07/2013 20:15	10	
		15 min	02HC005	1	08/07/2013 16:30	08/07/2013 17:30	3	
		30 min	02HC057	*missing*	*N/A*	*N/A*	*N/A*	Gauge data are missing.
		30 min	02HC009	1	08/07/2013 22:00	01/07/2013 1:00	5	
Total	**Water Level**			**3**			**175**	Not including missing gauges
	Stream Flow			**20**			**497**	Not including missing gauges

2.3 Modelling

HEC-RAS hydraulics models have been provided by TRCA for the Etobicoke Creek, Mimico Creek, Humber River and Don River Watersheds within the TRCA jurisdiction, where the flooding impacts due to the extreme rainfall event on July 8th, 2013 have been significant. The models are understood to be the currently approved models used to develop the current Regulatory floodplain mapping for these watersheds by TRCA.

2.4 Mapping

Several drawings and maps have been provided and reviewed for this study which include:

i) AutoCAD™ drawings depicting the Regulatory and 100 year flood inundation mapping for the four (4) watersheds of Etobicoke Creek, Mimico Creek, Humber River and Don River.
ii) AutoCAD™ drawings for survey High Water Marks for the Don River, Etobicoke Creek, Mimico Creek and Humber River following the July 8th. 2013 storm event, depicting the location of collected field data by TRCA staff.

In addition to the foregoing drawings, several layers in GIS format have been provided including:

i) TRCA watersheds and subwatersheds
ii) TRCA watercourses
iii) Pearson International Airport boundary
iv) Municipal boundaries within TRCA jurisdiction
v) Highways and major roads in the study area

2.5 Reports

Reports for major historic storm events have been obtained and reviewed in order to conduct a comparison between reporting methodologies and relative matrices for other extreme storm events as compared to the July 8th, 2013 storm event. The subject reports include:

Ontario

- The Storm and Floods of October 1954 in Southern Ontario; D.V. Anderson and J.P. Bruce, 1958
- Storm of October 15, 1954; National Oceanic and Atmospheric Administration, November 1954
- Hurricane Hazel in Ontario, Transport Canada Report; Meteorological Division/Department of Transport Canada, January 1955
- Hurricane Hazel and Extreme Rainfall in Southern Ontario; Cumming Cockburn Limited for the Institute of Catastrophic Loss Reduction (ICLR), November 2000
- Harrow Storm and Flood Study; M.M. Dillon Limited for Ministry of Natural Resources, March 1990

- Extreme Rainfall in Ontario: The summer 2004 Storms Study – Peterborough; Environment Canada, 2006
- Timmins Flood August 31 – September 1, 1961, A Design Storm for Ontario; Meteorological Branch/Department of Transport Canada, October 1962
- Summary of Rainfall Analysis Completed for the August 19th, 2005 Storm Event, Clarifica Inc., June 2006.

Other Jurisdictions

- Floods of July 1986 in West Central Alberta, Environment Canada, June 1988.
- Flood of June 1964 in the Oldman and Milk River Basins, Alberta, Environment Canada, 1973.
- Flood of June 1975 In the Oldman River Basin, Alberta, Environment Canada, October 1982.
- Floods of July and August 1982 In The Smoky River Basin, Alberta, Environment Canada, March 1988.
- Report On Big Thompson Flood 1977, Colorado State University, September 1977.
- The Big Thompson River Flood of July 21-August 1, 1976, U.S. Geological Survey and Colorado Water Conservation Board, 1976.
- Colorado Flooding: Echoes of Alberta, Dayna Vettese, September 2013,.
- Overview of Heavy Rainfall Events in Quebec, Environment Canada, July 1999.
- The Floods of 2005 in Switzerland - Synthesis Report on the Event Analysis, Federal Department for the Environment, Transport , Energy and Communications (DETEC), 2008.
- Analysis of the January 2011 Extreme Precipitation Event in the Brisbane River Basin, CLIMsystems Ltd., 2011.

3.0 STORM OVERVIEW

This section describes the meteorological situation and the general evolution of the weather systems that produced this extreme rainfall event. [Note: for additional detail on the Climatological aspects of this event, refer to the July 8, 2013 Extreme Rainfall event Climatological Report to be submitted to TRCA 2015.]

3.1 Chronology of Events

This section provides a chronology of events covering the July 8th, 2013 extreme rainfall event including: TRCA messages, and messages issued by Environment Canada including; Public Forecasts, Special Weather Statements, Severe Thunderstorm Warnings, and select observations at the Toronto Pearson Airport station. The chronology of key events is summarized in Table 3-1.

While not generally known to personnel outside the meteorology and aviation realms, Meteorological Terminal Aviation Routine Weather Reports (METAR) provide valuable observational documentation of weather across the world. Most airports have weather instrumentation that generate automated METARs, and these provide documentation of weather conditions at the site that goes beyond mere measurements of meteorological variables. The complete listing of all the METAR and Special Meteorological Reports at Toronto Pearson International Airport (CYYZ) on July 7 and 8, 2013 is included in Appendix E.

The complete listing of all the Weather Forecasts Issued by Environment Canada from 5 am July 7, 2013 to 5 am July 9, 2013 is included in Appendix F.

The complete listing of all the Special Weather Statements, Weather Alerts, Advisories, Watches, and Warnings Issued by Environment Canada from 1:31 pm July 8, 2013 to 10:55 pm on July 8, 2013 is included in Appendix G.

The typical public forecast for the days preceding the event for the City of Toronto, issued at 11 am EDT (15:00 UTC) on Sunday July 7th, 2013, is given in Table 3-1. The key feature was the 60% chance of showers and a risk of a thunderstorm on Sunday and Monday evening.

The updated forecast issued by Environment Canada at 8:11 am EDT (12:11 UTC) on Monday, July 8th, 2013 was as follows: A 40% chance of evening showers with a risk of a thunderstorm in the afternoon and early evening.

A special weather statement was issued by Environment Canada at 1:31 pm EDT (17:31 UTC) on Monday July 8th, 2013 advising of “local heavy downpours giving 30 to 40 mm of rain in less than one hour are likely”. Although it did not include the City of Toronto at that time, it did cover a wide area and provided an alert to the general public of the possibilities for heavy rainfall.

The updated weather forecast issued by Environment Canada at 5:14 pm EDT (21:14 UTC) on Monday, July 8th, 2013 was the first weather forecast that alerted the public to “showers at times heavy with thunderstorms this evening”.

A severe thunderstorm warning was issued at 2:40 pm EDT (18:40 UTC) July 8th, 2013. It is important to note that the criteria for issuing such a warning is: "Greater than or equal to 50 mm of rain in 1 hr is expected". The areas covered by the warning were Innisfil, New Tecumseth, Angus, Barrie, Collingwood, and Hillsdale. The warning was issued in response to a report by a weather watcher in the Angus area who received 50 mm of rain in 30 minutes. The complete original message is shown in Table 3-1.

The first severe thunderstorm warning to include the City of Toronto was issued at 5:51 pm EDT (21:51 UTC) July 8th, 2013. The regions mentioned in the new storm warning included the City of Toronto, Vaughan, Richmond Hill, Markham, Mississauga and Brampton.

An alert message summary was issued at 6:10 pm EDT (22:10 UTC) that included an important description about the tracking of severe thunderstorms, moving slowly, capable of producing localized flooding, with total rainfall amounts possible between 50 to 75 mm.

The weather conditions reported at station CYYZ (Toronto Pearson International Airport) at 4 pm EDT (20:00 UTC) consisted of scattered towering-cumulus (TCU) clouds, the temperature was 28 degrees Celsius, and the dew point temperature was 21 degrees Celsius, the winds were from the southeast (from 160 degrees) at 13 knots. The light rain showers (-SHRA) began at 4:23 pm EDT (20:23 UTC), becoming a heavy shower (+SHRA) at 4:32 pm EDT (20:32 UTC), and a heavy Thunderstorm (+TSRA) at 4:40 pm EDT (20:40 UTC).

The first report that indicated the extreme nature of the event was issued at 5:37 pm EDT (21:37 UTC) when the visibility was reported to be ¼ SM (statute mile) and the report included a remark that the rain shower was very heavy (+SHRA VRY HVY). The magnitude of the rainfall was quantified at 6 pm EDT (22:00 UTC) when the remarks section of the report indicated that 90 mm of rain had accumulated within the previous hour. The rainfall accumulation remark increased to 94 mm at 7 pm EDT (23:00 UTC) and 106 mm at 8 pm EDT (00:00 UTC). At 8:43 pm EDT (00:43 UTC), the weather observation had decreased the intensity to a rain shower, signifying an end to the high intensity rainfall.

Table 3-1: A chronological list of significant published forecasts, weather statements, warnings, alerts and observations during the extreme rainfall event on July 8th, 2013

Date and Time	Type	Description
Sunday, 7 July 2013 at 10:30am EDT	TRCA issued Watershed Conditions Statement	TRCA issued a Watershed Conditions Statement for Water Safety on Sunday, July 7th, 2013 at 10:30am that would be in effect through Tuesday, July 9th, 2013, to inform the public of higher flows in the rivers.
SUNDAY 7 JULY 2013: 11.00 AM EDT	Public Forecast issued by Environment Canada	CITY OF TORONTO. TODAY..MAINLY CLOUDY WITH 60 PERCENT CHANCE OF SHOWERS. RISK OF A THUNDERSTORM THIS AFTERNOON. WIND BECOMING SOUTHWEST 20 KM/H THIS AFTERNOON. HIGH 28. UV INDEX 6 OR HIGH.TONIGHT..PARTLY CLOUDY. 60 PERCENT CHANCE OF SHOWERS EARLY THIS EVENING WITH RISK OF A THUNDERSTORM. WIND SOUTHWEST 20 KM/H BECOMING LIGHT THIS EVENING. LOW 22. MONDAY..MAINLY CLOUDY. 60 PERCENT CHANCE OF SHOWERS IN THE AFTERNOON AND EVENING WITH RISK OF A THUNDERSTORM. HIGH 27
MONDAY 8 JULY 2013: 8.11 AM EDT	Updated Forecast issued by Environment Canada	CITY OF TORONTO. TODAY..INCREASING CLOUDINESS. A FEW SHOWERS BEGINNING THIS AFTERNOON. RISK OF THUNDERSTORMS THIS AFTERNOON. HIGH 28. UV INDEX 5 OR MODERATE. TONIGHT..A FEW SHOWERS ENDING THIS EVENING THEN MAINLY CLOUDY WITH 40 PERCENT CHANCE OF SHOWERS. RISK OF THUNDERSTORMS EARLY THIS EVENING. LOW 21.
MONDAY 8 JULY 2013: 1:31 PM EDT	SPECIAL WEATHER STATEMENT issued by Environment Canada	SPECIAL WEATHER STATEMENT FOR: =NEW= CALEDON =NEW= YORK - DURHAM =NEW= MOUNT FOREST - ARTHUR - NORTHERN WELLINGTON COUNTY =NEW= DUFFERIN - INNISFIL =NEW= HANOVER - DUNDALK - SOUTHERN GREY COUNTY =NEW= OWEN SOUND - BLUE MOUNTAINS - NORTHERN GREY COUNTY =NEW= BARRIE - ORILLIA - MIDLAND =NEW= BELLEVILLE - QUINTE -

Table 3-1: A chronological list of significant published forecasts, weather statements, warnings, alerts and observations during the extreme rainfall event on July 8th, 2013

Date and Time	Type	Description
		NORTHUMBERLAND =NEW= KINGSTON - PRINCE EDWARD =NEW= PETERBOROUGH - KAWARTHA LAKES =NEW= STIRLING - TWEED - SOUTH FRONTENAC. LOCAL HEAVY DOWNPOURS THIS AFTERNOON. ==DISCUSSION== LOCAL HEAVY DOWNPOURS GIVING **30 TO 40 MILLIMETRES** OF RAIN IN LESS THAN ONE HOUR ARE LIKELY IN THE ABOVE REGIONS. THESE HEAVY SHOWERS MAY OR MAY NOT BE ASSOCIATED WITH THUNDERSTORMS AND MAY OCCUR SUDDENLY. REDUCED VISIBILITY IN HEAVY RAIN IS ALSO POSSIBLE. TRAVELLERS SHOULD USE CAUTION IN AREAS OF HEAVY RAIN THIS EVENING. END
MONDAY 8 JULY 2013: 2:16 PM EDT	SPECIAL WEATHER STATEMENT issued by Environment Canada	SPECIAL WEATHER STATEMENT FOR: **=NEW= CITY OF TORONTO** ==DISCUSSION== LOCAL HEAVY DOWNPOURS GIVING **30 TO 40 MILLIMETRES** OF RAIN IN LESS THAN ONE HOUR
MONDAY 8 JULY 2013: 2:34 PM EDT	SEVERE THUNDERSTORM WARNING issued by Environment Canada	=NEW= INNISFIL - NEW TECUMSETH - ANGUS =NEW= BARRIE - COLLINGWOOD - HILLSDALE. AT 2:30 PM EDT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF SEVERE THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING LOCALIZED FLOODING. COMMUNITIES IN THE PATH INCLUDE: ANGUS AND BARRIE **A WEATHER WATCHER REPORTED 50 MM OF RAIN IN 30 MINUTES IN THE ANGUS AREA**
MONDAY 8 JULY 2013: 4:23 TO	Meteorological Terminal Aviation	Light rain shower begins at Toronto Pearson Airport at 4:23

Table 3-1: A chronological list of significant published forecasts, weather statements, warnings, alerts and observations during the extreme rainfall event on July 8th, 2013

Date and Time	Type	Description
4:54 PM EDT	Routine Weather Reports (METAR) issued by Environment Canada	pm. Details of report: CYYZ 082023Z 15009KT **4SM -SHRA** BKN038TCU BKN150 27/21 Heavy rain shower begins at Toronto Pearson Airport at 2:32 pm. Details of reports: CYYZ 082032Z 22016KT 150V220 **2 1/2SM +SHRA** OVC025TCU 25/20 CYYZ 082037Z 27010G20KT 170V270 **3/4SM +SHRA** OVC015TCU 23/20 Heavy thunderstorm begins at Toronto Pearson Airport at 2:40 pm. Details of reports: CYYZ 082040Z 26008G20KT 200V270 **1SM +TSRA** OVC024CB 23/19 CYYZ 082054Z 05011G16KT **1SM +TSRA** BKN008 OVC020CB 22/21
MONDAY 8 JULY 2013: 5:00 TO 5:45 PM EDT	Meteorological Terminal Aviation Routine Weather Reports (METAR) issued by Environment Canada	Heavy thunderstorm at Toronto Pearson Airport at 5:00 pm. Accumulated 16 mm of rain within the past hour. Very heavy thunderstorm at Toronto Pearson Airport reported at 5:27, 5:37, and 5:45 pm. Details of reports: CYYZ 082100Z 06018KT **3/4SM +TSRA** VV006 22/21 RMK /R16/ CYYZ 082127Z 01023KT **1/2SM +TSRA** VV005 22/21 RMK CB EMBD LTGIC **+SHRA VRY HVY** CYYZ 082137Z 05020G26KT **1/4SM +TSRA** VV003 21/20 RMK CB+LTNG OVRHD **+SHRA VRY HVY** CYYZ 082145Z 06010G26KT **3/4SM**

Table 3-1: A chronological list of significant published forecasts, weather statements, warnings, alerts and observations during the extreme rainfall event on July 8th, 2013

Date and Time	Type	Description
		+TSRA VV005 21/20 RMK CB EMBD LTNG OVRHD **+SHRA VRY HVY**
MONDAY 8 JULY 2013: 5.14 PM EDT	Updated Forecast issued by Environment Canada	CITY OF TORONTO VAUGHAN - RICHMOND HILL - MARKHAM. TONIGHT..SHOWERS AT TIMES HEAVY WITH THUNDERSTORMS ENDING THIS EVENING THEN MAINLY CLOUDY WITH 40 PERCENT CHANCE OF SHOWERS. LOW 20.
MONDAY 8 JULY 2013: 5:30 PM EDT	Flood watch notification issued by TRCA	With the Water Safety Statement still in effect on Monday July 8th, the TRCA Flood Duty Officer (FDO) upgraded the conditions, and issued a Flood Watch message at 5:30 pm.
MONDAY 8 JULY 2013: 5:51 PM EDT	SEVERE THUNDERSTORM WARNING issued by Environment Canada	SEVERE THUNDERSTORM WARNING FOR: =NEW= VAUGHAN - RICHMOND HILL - MARKHAM **=NEW= CITY OF TORONTO** =NEW= MISSISSAUGA - BRAMPTON.
MONDAY 8 JULY 2013: 6:00 PM EDT	Meteorological Terminal Aviation Routine Weather Reports (METAR) issued by Environment Canada	Heavy thunderstorm at Toronto Pearson Airport at 6:00 pm. Accumulated 90 mm of rain within the past two hours. Details of report: CYYZ 082200Z CCA 32021G32KT **3/4SM +TSRA** VV005 21/20 RMK **/R90**/ OCNL LTGIC CB EMBD **+SHRA VRY HVY** WSHFT
MONDAY 8 JULY 2013: 6:10 PM EDT	ACTIVE ALERT MESSAGE issued by Environment Canada	AT 6:00 PM EDT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING LOCALIZED FLOODING. AFFECTED COMMUNITIES IN THE PATH INCLUDE: MARKDALE, FLESHERTON, DUNDALK, SHELBURNE. SEVERE THUNDERSTORM WARNING - UPDATED AT 5:51 PM EDT MONDAY 8 JULY 2013 FOR: VAUGHAN - RICHMOND HILL - MARKHAM CITY OF TORONTO MISSISSAUGA - BRAMPTON.

Table 3-1: A chronological list of significant published forecasts, weather statements, warnings, alerts and observations during the extreme rainfall event on July 8th, 2013

Date and Time	Type	Description
		AT 5:45DT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING LOCALIZED FLASH FLOODING. THE THUNDERSTORMS ARE OVER THE MISSISSAUGA AND BRAMPTON REGIONS AND MOVING SLOWLY EASTWARD TOWARD MARKHAM, RICHMOND HILL AND TORONTO. THESE THUNDERSTORMS WILL PASS OVER AREAS WHICH HAVE ALREADY RECEIVED OVER 30 MM OF RAIN FROM PREVIOUS STORMS. **TOTAL RAINFALL AMOUNTS COULD LOCALLY REACH 50 TO 75 MM.**
MONDAY 8 JULY 2013: 7:00 PM EDT	Meteorological Terminal Aviation Routine Weather Reports (METAR) issued by Environment Canada	Heavy thunderstorm at Toronto Pearson Airport at 7:00 pm. Accumulated 94 mm of rain within the past three hours. Details of report: CYYZ 082300Z 08007KT **6SM -SHRA** OVC020 21/20 RMK **/R94/**
MONDAY 8 JULY 2013: 7:20 PM EDT	Flood warning issued by TRCA	TRCA issued a Flood Warning message to alert that flooding was occurring in low lying areas of TRCA watersheds.
MONDAY 8 JULY 2013: 8:00 PM EDT	Meteorological Terminal Aviation Routine Weather Reports (METAR) issued by Environment Canada	Heavy thunderstorm at Toronto Pearson Airport at 8:00 pm. Accumulated 106 mm of rain within the past four hours. Details of report: CYYZ 090000Z 36010KT **6SM TSRA** OVC015 23/20 RMK **/R106/**
TUESDAY 9 JULY 2013: 7:30 AM EDT	TRCA Flood Outlook Statement	TRCA downgraded the Flood Warning message to a Flood Outlook Statement when the watercourse levels had receded back to safe levels.

3.2 TRCA Flood Messages

It is part of TRCA's mandate to provide local agencies and the public with notice, information and advice during flood related emergencies. This is done through formal flood messages that are distributed to school boards, municipalities, police, emergency services, media as well as other local conservation authorities. The flood messages have different levels of urgency and state pertinent information relating to weather forecasts, potential impacts and what actions should be taken from the public. Figure 3-1 summarizes the different types of messages that TRCA may release.

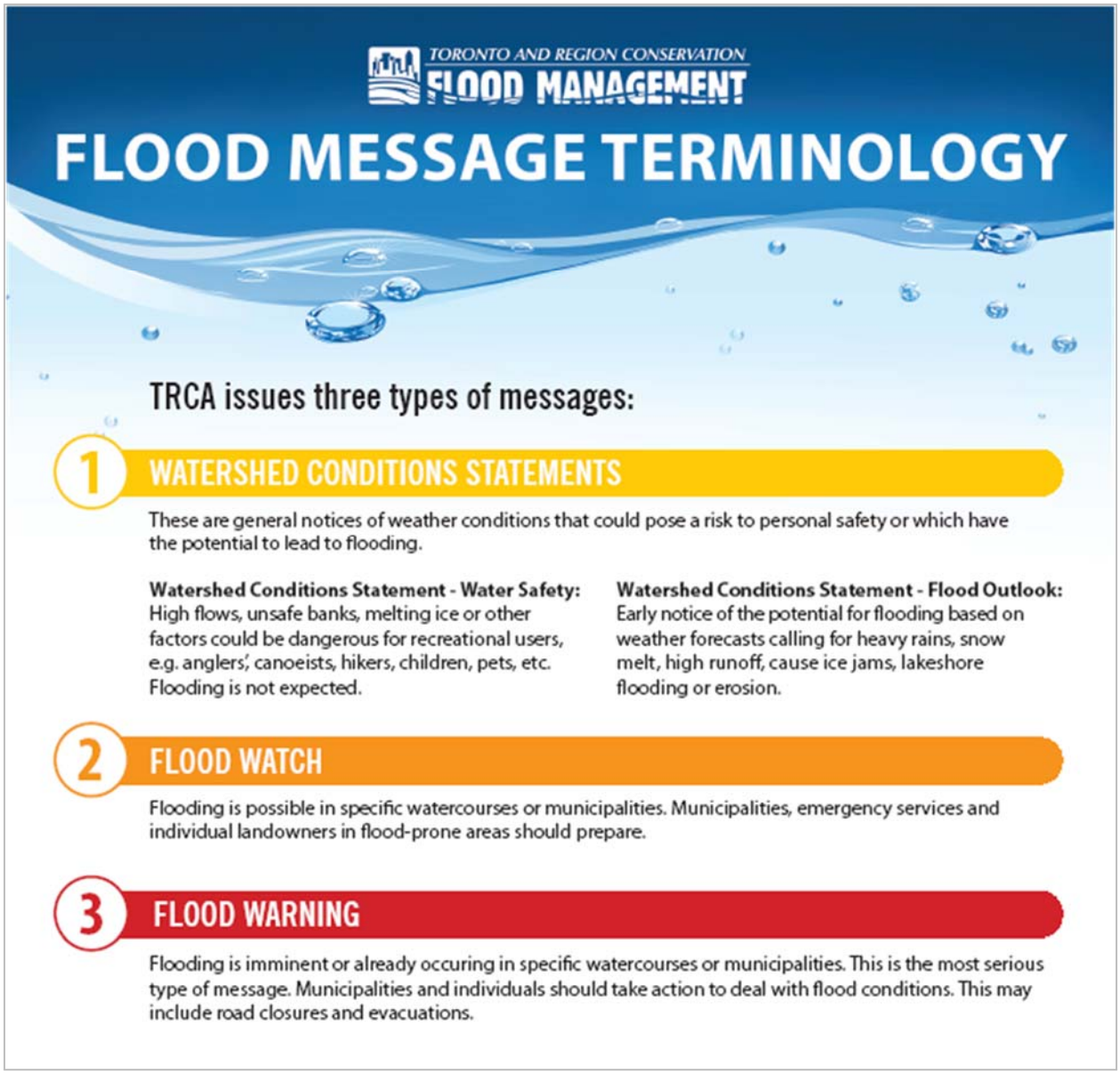


Figure 3-1: Flood message terminology for TRCA which includes statements, watches and warning similar to Environment Canada's public weather messages

Preceding the July 8th, 2013 storm, there had been a significant amount of rainfall, with upwards of 30 mm falling through the afternoon and evening of July 7th, 2013. In response to this rainfall,

TRCA had issued a Watershed Conditions Statement for Water Safety on Sunday, July 7th, 2013 at 10:30 a.m. that would be in effect through Tuesday, July 9th, 2013, to inform the public of higher flows in the rivers.

With the Water Safety Statement still in effect on Monday July 8th, 2013 the TRCA Flood Duty Officer (FDO) upgraded the conditions, and issued a Flood Watch message at 5:30 pm. This watch was in effect until midnight Tuesday, July 9th, 2013, in order to prepare for the potential of flooding in flood-prone areas. The message included details of forecasted slow moving heavy showers that may give 30 to 40 mm of rain in less than one hour.

At 7:20 pm TRCA issued a Flood Warning message to alert that flooding was occurring in low lying areas of TRCA watersheds. The flood warning message was prompted by the amounts of rainfall already on the ground as well as additional amounts still forecasted to come.

The next morning at 7:30 am on July 9th, 2013, TRCA downgraded the Flood Warning message to a Flood Outlook Statement when the watercourse levels had receded back to safe levels. Since there was still possibility of thunderstorms in the forecast for the next two days and the ground was already saturated due to the record rainfall, this statement would be in effect through Thursday, July 11th, 2013.

No additional rainfall fell in the days after the July 8th, 2013 storm, therefore no other messages were issued by TRCA and the Flood Outlook Statement was cancelled by Thursday July 11th, 2013. All issued TRCA messages can be found in Appendix H.

Other Conservation Authorities also sent out flood messages for the weather systems associated with the July 8th, 2013 event including TRCA's neighboring Conservation Authorities, Lake Simcoe Region (LSRCA) to the north, and Credit Valley Conservation (CVC), Conservation Halton and Grand River Conservation Authority (GRCA) to the west.

3.3 Meteorological Situation Overview

The 500 mb chart (approximate height 6 km MSL) is generally used to illustrate the mid-atmosphere flow patterns and identify regions with strong dynamics and vorticity (local spinning motion) caused by wind speed and directional changes with respect to height. The 500 mb weather chart produced by the North American Meso-scale forecast system (NAM), valid at 2 pm EDT (18 UTC) on the afternoon of July 8, 2013 is shown in Figure 3-2. The key feature in Figure 3-2 is the low pressure trough (highlighted by the black circle), which was passing to the south of a ridge of high pressure extending northward towards Hudson Bay. This Low had originated in the Gulf of Mexico several days previously, between the two large sub-tropical High pressure systems located over the southwest US and off the east coast (extension of the Bermuda High). The Low tracked northeastward, bringing significant moisture from the Gulf, and its moist, unstable air mass caused the rain showers over southern Ontario on July 7th 2013. The clockwise flow around the Bermuda High is often referred as a "conveyor belt" of heat and moisture from the Gulf of Mexico into the Great Lakes region and southern Ontario. These are key ingredients for convective storms. The Low did not have strong winds associated with it and would be classified as a relatively weak Low with respect to its dynamics.

Two vorticity centers are shown in yellow within the black circle in Figure 3-2. The vorticity center southeast of Lake Ontario was the dynamic weather system that caused the rain showers on the afternoon of July 7th. The second vorticity center within the black circle, and located west of Toronto, was associated with a cold frontal system approaching southern Ontario from the west, that was traveling with the prevailing westerly winds and had originated in the Pacific Ocean and had crossed the continent along the US-Canada border. This second vorticity center and associated cold front is what helped to trigger the heavy thunderstorms and extreme rainfall over Toronto on the afternoon of July 8th. The motion and evolution of two relatively benign looking and separate Low pressure systems of distinctly different origins resulted in their interaction over southern Ontario on the afternoon and evening of July 8th, 2013 causing the extreme rainfall event.

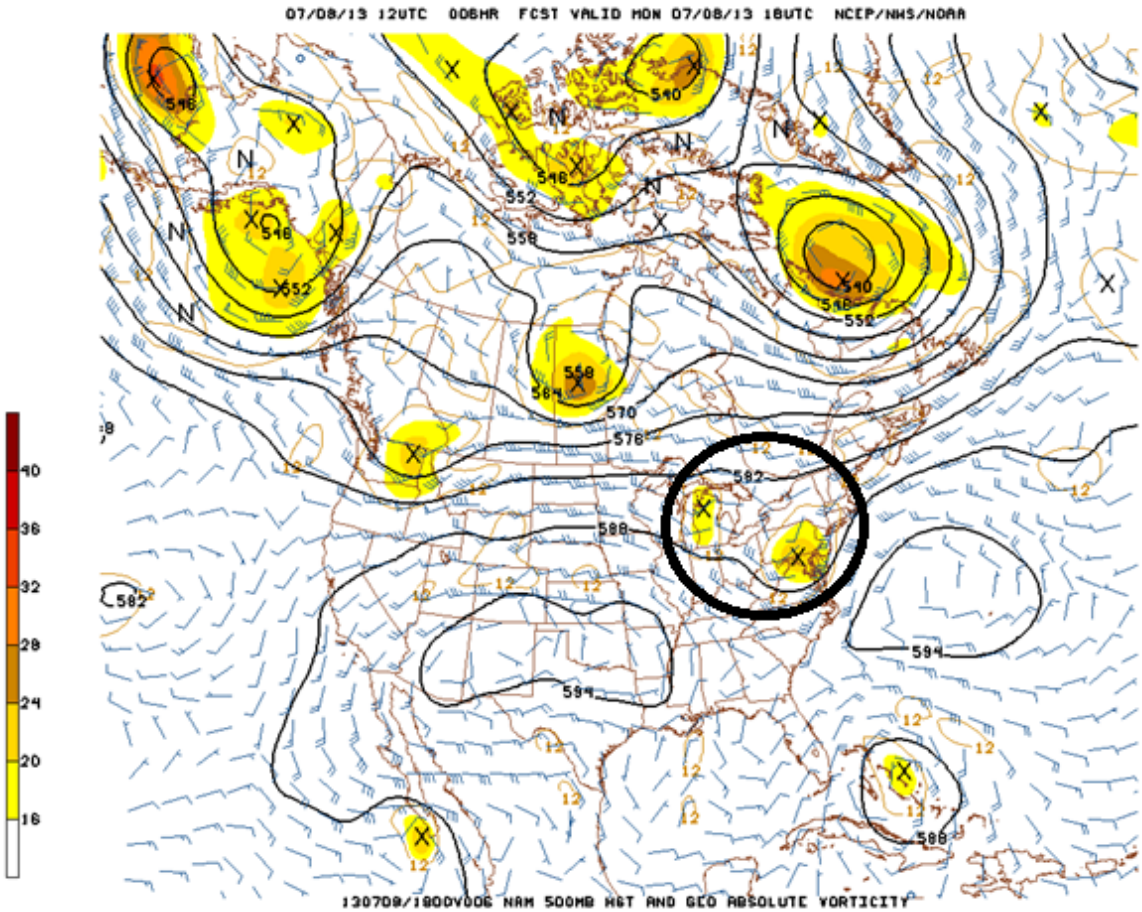


Figure 3-2: The 500 mb chart (approximate height 6 km MSL) produced by the NAM model 6 hr forecast valid at 18 UTC (2 pm EDT) on July 8th, 2013. The black circle highlights the low pressure trough passing over the Toronto area, and two regions of positive vorticity (counter clockwise rotation) shown in yellow and centers shown with an "X".

The surface chart and IR satellite image including radar echoes at 5:30 pm EDT (21:30 UTC) on the afternoon of July 8th, 2013 is shown in Figure 3-3. The yellow circle shows the relatively intense thunderstorms over Lake Huron and the western part of Lake Erie, plus the radar echoes associated with the thunderstorms over Toronto Pearson Airport at this time.

Areas that are forecast (by the US National Weather Service) to potentially experience extreme weather and heavy rainfall are indicated in Figure 3-3 with “yellow outlined boxes”. There were no severe weather warning boxes identified in the southern Ontario region. The only areas that were forecast to expect extreme weather were located in Montana and South Dakota.

The satellite and radar images at 5:30 pm EDT (21:30 UTC) on July 8th, 2013 (Figure 3-3) show a significant line of relatively intense thunderstorms over Lake Huron and the western part of Lake Erie, plus the thunderstorms over the Toronto area. The surface analysis does not show a cold front associated with the showers and cloud mass along the line of thunderstorms over Lake Huron. The thunderstorms over Toronto formed in the “warm sector” region (shown within the yellow circle in Figure 3-3) in advance of the approaching cold front and Low pressure system centered in Wisconsin.

There was not a sufficiently well defined Low and cold front in Southern Ontario, indicative of the relatively weak dynamics associated with this system, and further explains why weather forecasters were surprised by the severity of the thunderstorms and extreme rainfall generated over the GTA by this system. Forecasters were actually expecting more severe thunderstorms in the Windsor area (ref: personal communication, A. Ashton, Environment Canada).

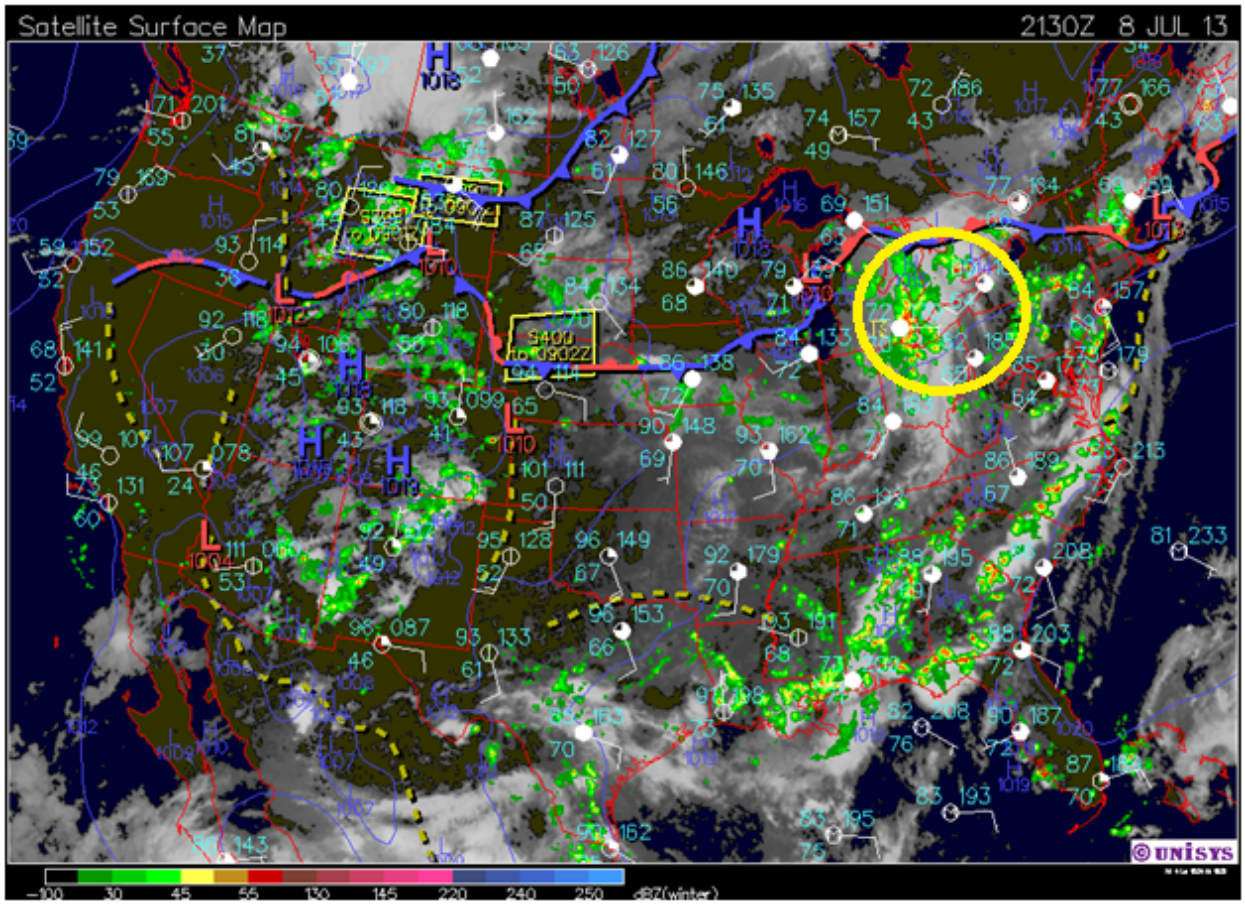


Figure 3-3: Satellite image with radar echoes and surface features at 2130Z (5:30 pm EDT) on July 8th, 2013. Station temperatures and dew points (upper and lower numbers on the left side of station markers) are given in degrees Fahrenheit. The yellow circle highlights the rain showers and thunderstorms occurring at this time over southern Ontario and the GTA.

3.4 Representative Atmospheric Sounding

Thermodynamic diagrams are commonly used in weather analysis and forecasting because the diagrams display the vertical profiles of temperature, dew point, and wind derived from radiosonde data or numerical models, and allow calculations of convective instability and convective available potential energy (CAPE). The Skew-T Log-P diagram is the standard thermodynamic chart in use in the United States. The NAM model forecast thermodynamic vertical profile for Toronto Lester B. Pearson Airport station CYYZ at 5 pm EDT (21 UTC) on July 8th, 2013 is shown in Figure 3-4.

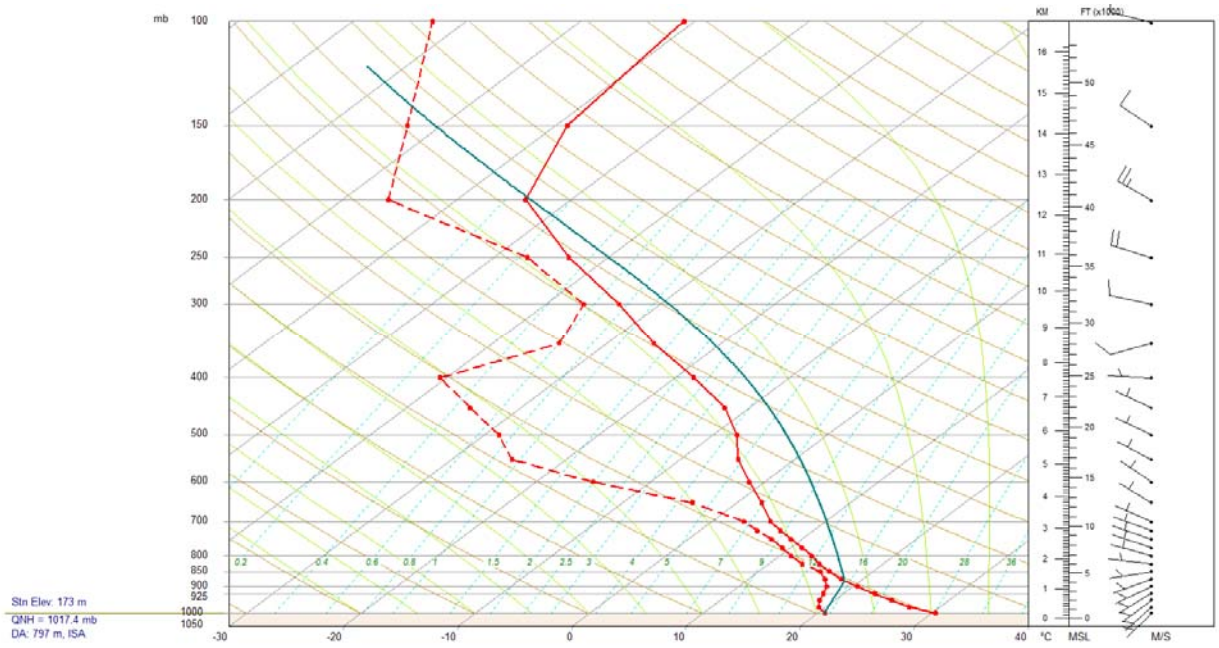


Figure 3-4: The NAM model 21 hr forecast Skew-T thermodynamic vertical profile for Toronto Lester B. Pearson Airport station CYYZ valid at 21UTC (5 pm EDT) on July 8th, 2013. The profile for a lifted air parcel from the surface is shown, with a CAPE of 1680 J/kg.

The forecast sounding profile for Toronto Pearson Airport was extremely unstable, with a Convective Available Potential Energy (CAPE) of 1680 J/kg. Therefore, thunderstorms were extremely likely. The weak wind speeds (typically <10 m/s) through the layer from the surface to 10 km MSL are also worth noting, since these winds would result in slow moving storms. The predicted storm motion for Toronto, based on these winds, was from the southwest (from 321 degrees) at 7 knots. Therefore, slow moving thunderstorms were highly likely and it stands to reason that if the thunderstorms move slow, local precipitation amounts would be greater.

3.5 Spatial and Temporal Analysis

Weather radar imagery provides the most detailed information regarding the general evolution of a rain storm, its convective cell structure, trajectory, size and intensity as a function of time.

3.5.1 King City Radar storm tracking

Radar images from the Environment Canada weather radar at King City are shown in Appendix I.

The thunderstorms that formed in the Barrie to GTA region on July 8th occurred in the hot and humid air mass or "warm sector" on the east side of the cold front approaching from the west, and south of the quasi-stationary warm front located to the north (shown in Figure 3-3 satellite image with surface features).

On July 8th, 2013 at 2:00 pm EDT (18:00 UTC, ref. Figure I-1 in Appendix I), King City radar showed thunderstorm cells with >50 mm/hr cores in the Barrie-Angus area. At 2:30 pm EDT (18:30 UTC Environment Canada reported a severe thunderstorm warning capable of producing localized flooding, and a comment that a "weather watcher reported 50 mm of rain in 30 min in the Angus area". This was the first documented report of localized heavy rainfall associated with this convective weather system.

At 3:10 pm EDT (19:10 UTC, ref. Figure I-2 in Appendix I), the line of thunderstorm cells formed a west-east line of moderate thundershowers in the Newmarket area north of Toronto. There also appeared to be the first signs of a flanking line of weaker echo clouds towards the southwest between Newmarket and Brampton, which appeared to be forming along a lake breeze boundary, a common phenomenon observed in this area.

The radar image at 3:40 pm EDT (19:40 UTC, ref. Figure I-3 in Appendix I) shows an intensification of the cells in the Newmarket area, and the flanking line of echo extending southwest of the main cell was clearly associated with a meso-scale, thunderstorm outflow boundary, likely interacting with a lake-breeze convergence line, that began propagating with the storm towards the southeast.

At 4:30 pm EDT (20:30 UTC, ref. Figure I-4 in Appendix I), the line of thunderstorm cells approaching Toronto from the northwest had expanded and intensified along the outflow boundary, and a larger region composed of three cells was producing a larger area of heavy rainfall associated with the higher radar reflectivities. Also of note, was a second organized line of thunderstorms located approximately 40 km further to the northwest, moving in the same direction towards the southeast and setting the stage for a second wave of precipitation over the TRCA watershed.

At 4:50 pm EDT (20:50 UTC, ref. Figure I-5 in Appendix I), the radar shows a convective complex of at least three thunderstorm cells located over the western TRCA jurisdiction, organized in a west-east line, and slowly moving towards the southeast. This time coincides with the heaviest rainfall being recorded at the Martin Grove gauge site (74.75 mm in 1 hr reported at 5:00 pm EDT (21:00 UTC). The King City radar image at 5:00 pm EDT (21:00 UTC, ref. Figure 3-5) is shown for comparison purposes. It deserves to be mentioned that the Buffalo radar images showed cells with greater intensity than the King City radar image at this time. The lower intensity radar values from the King City radar are speculated to be a result of attenuation of the signal due to the wet radome at King City (ref. personal communication by Dave Hudak, Environment Canada). Furthermore, the King City radar is a C-band radar (5-cm

wavelength) which inherently suffers from greater signal attenuation by heavy precipitation compared to the S-band (10-cm wavelength) Buffalo radar.

The King City radar image at 5:30 pm EDT (21:30 UTC, ref. Figure I-7 in Appendix I) shows the convective complex of slowly moving thunderstorm cells covering west Toronto. The cores of high reflectivity and heaviest rainfall are relatively small (approximately 5 km in diameter), however, these are speculated to have been attenuated and as a result they were actually more intense than displayed in the image. These thunderstorm cells produced the 67 mm of rainfall in one hour reported at the Lester B. Pearson Airport gauge at 6:00 pm EDT (22 UTC).

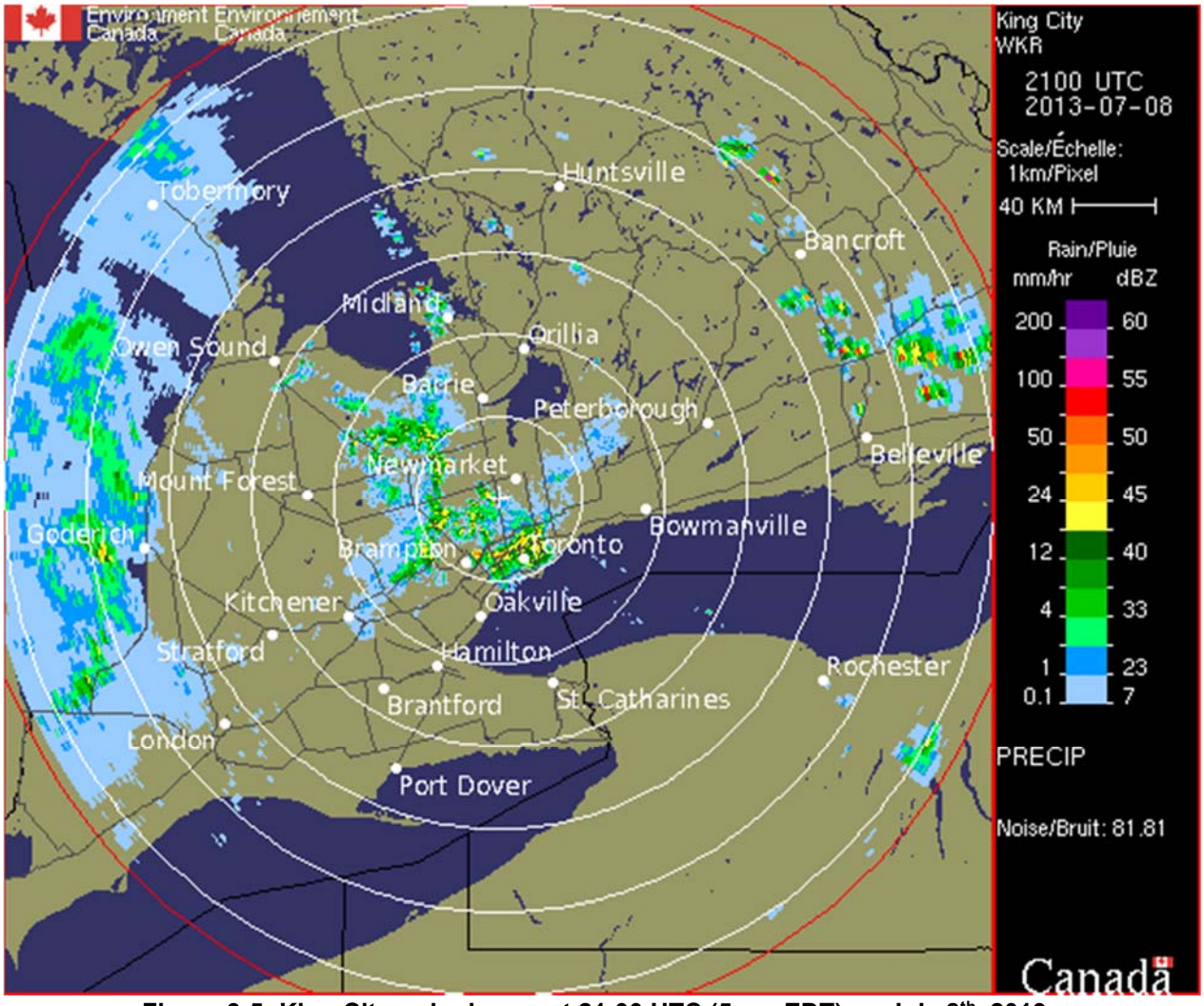


Figure 3-5: King City radar image at 21:00 UTC (5 pm EDT) on July 8th, 2013

By 6:00 pm EDT (22:00 UTC, ref. Figure I-8 in Appendix I), the radar echoes over the GTA appeared as a larger meso-scale convective complex of thundershowers, producing moderate rainfall over the entire GTA.

3.6 Satellite Image Analysis

The following sections show several key infrared and visible satellite images of the clouds that produced the extreme rainfall on July 8th, 2013.

3.6.1 Infrared Satellite Image

The infrared satellite image at 4:45 pm EDT (20:45 UTC) on July 8th, 2013 is shown in Figure 3-6. Heavy thunderstorms were just starting to be reported at Toronto Pearson Airport. The broad band of cloud, oriented north-south across Lake Huron and the Detroit-Windsor area was associated with the approaching cold front and Low pressure system that had originated in the west. A number of thunderstorms (deep blue cloud tops) and rain showers are indicated over the Barrie region extending southward to the GTA (shown within the black circle in Figure 15). Thunderstorms and rain showers are also shown in the Detroit-Windsor area. These rain showers and thunderstorms were located in advance of the approaching cold frontal and were located mostly in the warm, moist sector, but appeared to be “triggered” by the approaching cold front.

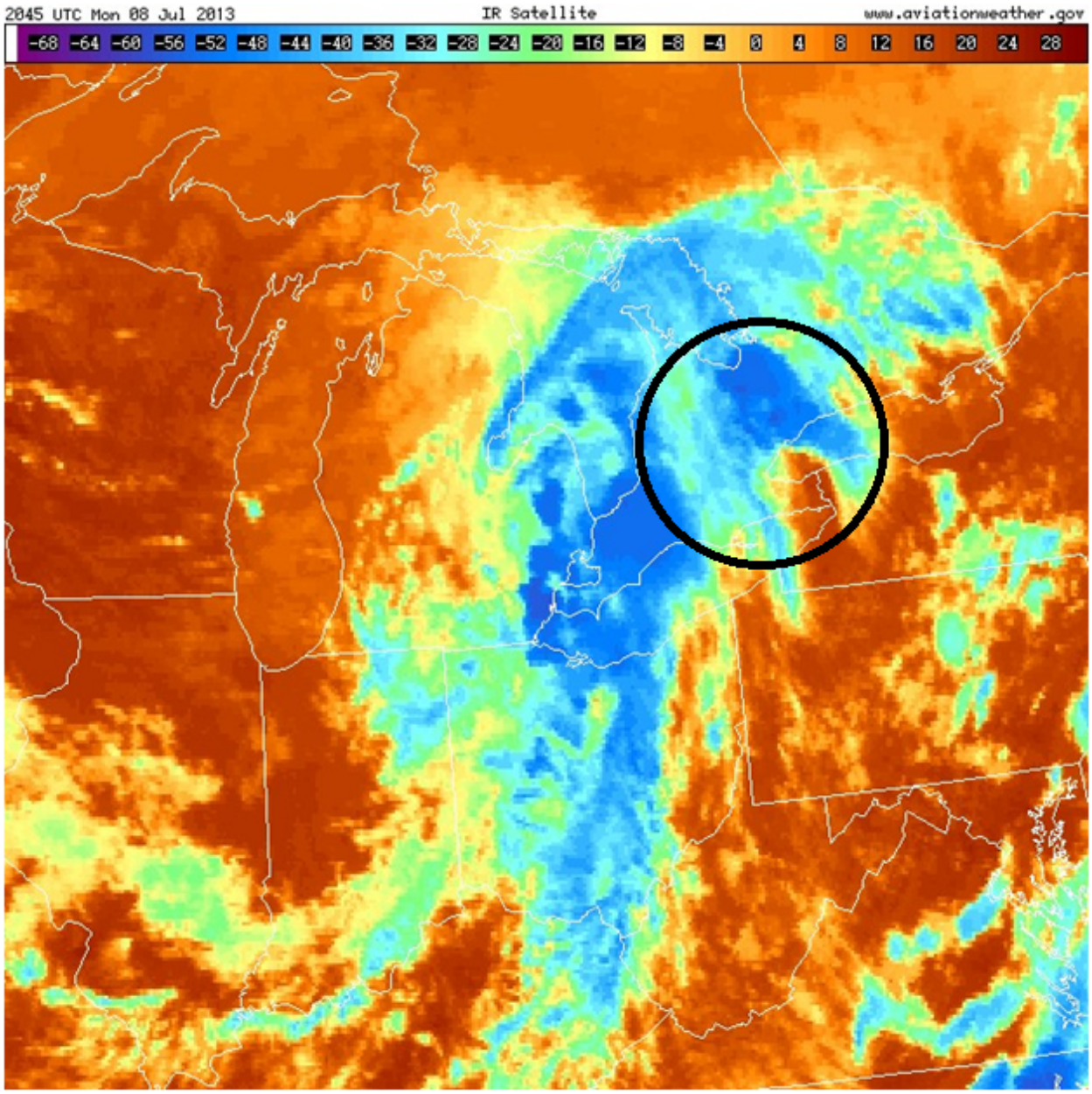


Figure 3-6: Infrared satellite image at 20:45 UTC (4:45 pm EDT) on July 8th, 2013.

3.6.2 Visible Satellite Images

Visible satellite images covering the extreme rainfall event on July 8th are presented in Appendix J. The visible satellite image at 2:45 pm EDT (18:45 UTC) July 8th, 2013 is shown in Figure J-1 in Appendix J. The thunderstorms in the Barrie area are shown (within the black circle). In addition to the west, a long line of thunderstorms, oriented north-south across the Detroit-Windsor area, was associated with the approaching cold front, even though the front was not shown in most analyses, due to its relatively weak pressure gradients.

The visible satellite image at 4:15 pm EDT (20:15 UTC) July 8th, 2013 is shown in Figure J-2 in Appendix J. The thunderstorms in the Barrie area had expanded and covered a larger area and

were moving toward the TRCA watershed (shown within the black circle in Figure J-2 in Appendix J). The cold front approaching from the West was now approaching London, ON.

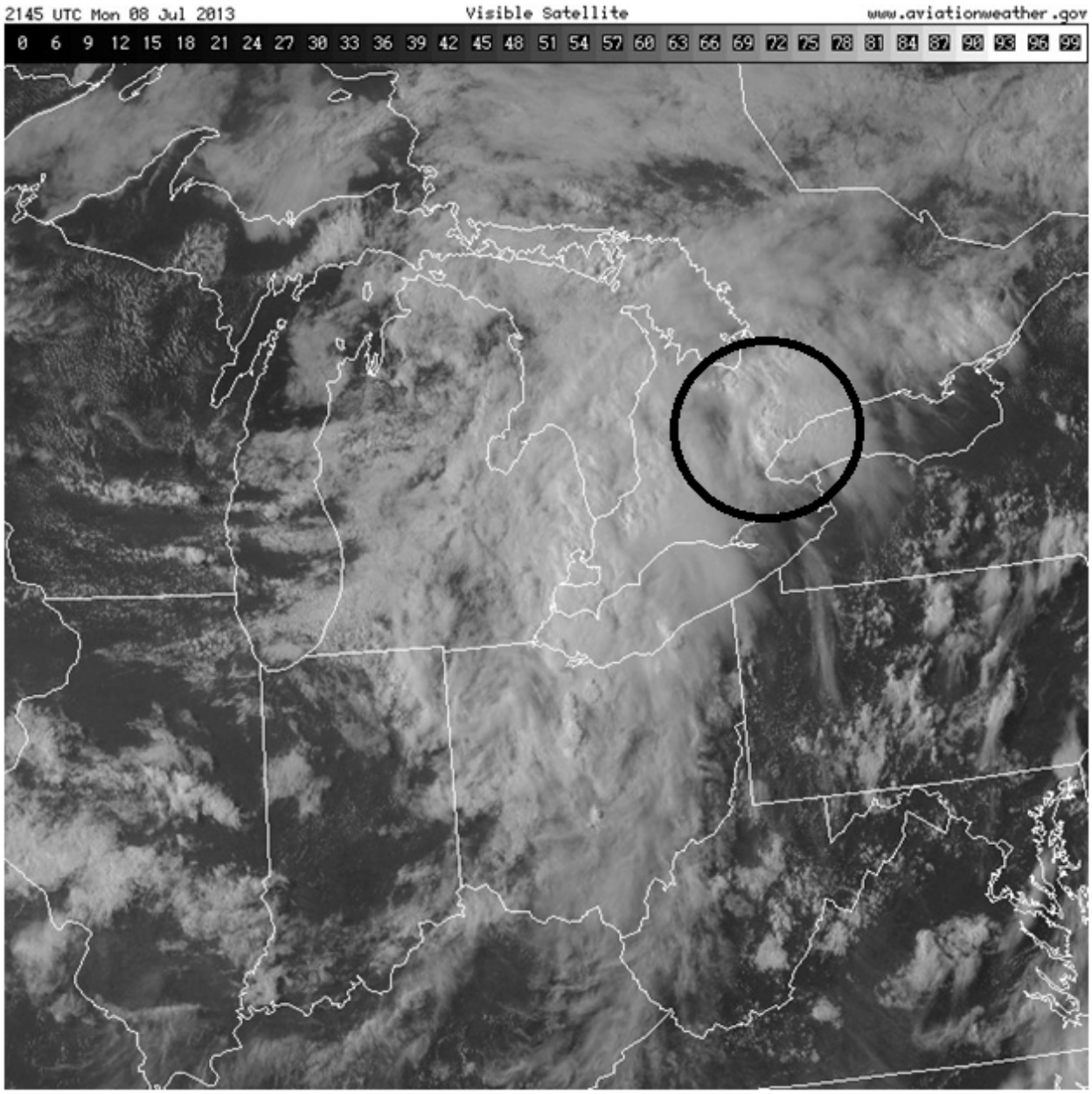


Figure 3-7: Visible satellite image at 21:45 UTC (5:45 pm EDT) on July 8th, 2013.

The visible satellite image at 5:15 pm EDT (21:15 UTC) July 8th, 2013 is shown in Figure J-3 in Appendix J. At 5:00 pm EDT (21:00 UTC) Toronto Pearson Airport reported having received 16 mm of rain, and reported having received a total of 90 mm of rain at 6:00 pm EDT (22:00 UTC), therefore, this image shows the early stages of the thunderstorms that produced the heaviest rainfall. A line of thunderstorms, oriented west-east, is visible over the TRCA watershed. The visible satellite image at 5:45 pm EDT (2145 UTC) July 8th, 2013 is shown in Figure 3-7 and Figure J-3 in Appendix J. The thunderstorms over the GTA now appeared as a large meso-

scale complex of multiple thunderstorms (within the black circle) and convective showers, and coincided with the time of maximum precipitation rates over the TRCA watershed.

3.7 Numerical Model Forecasts

Current weather forecasting operations are dominated by Numerical Weather Prediction (NWP). This section briefly outlines the predictions and performance of the latest generation of NWP computer models most commonly used in Canada and the United States.

The Global Environmental Multi-scale Model (GEM) is an integrated forecasting and data assimilation system developed by the Canadian Meteorological Centre (CMC), and is one of the predominant synoptic scale models in general use. The GEM model has been developed to meet the operational weather forecasting needs of Canada for medium-range and short-range regional forecasting purposes.

The Canadian GEM Regional, high resolution model forecast 3 hr total rainfall, valid at 24 UTC (8 pm EDT), July 8th, 2013 is shown in Figure 3-8. The model correctly predicted rain showers over the GTA, however, the predicted amounts were in the 10 to 15 mm range, and considerably less than what was observed.

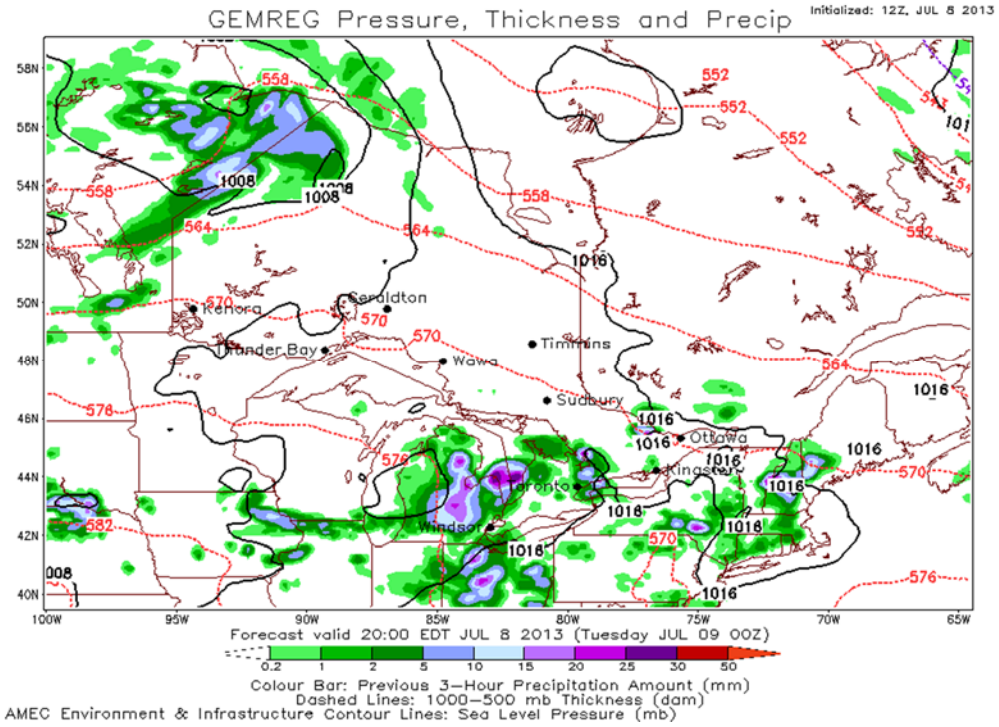


Figure 3-8: The Canadian GEM Regional model forecast 3 hr total rainfall valid at 24 UTC (8 pm EDT), on July 8th, 2013.

The Canadian GEM Regional high-resolution, limited-area-model (LAM) forecast 24 hr total rainfall ending at 24 UTC (8 pm EDT), July 8th, 2013 is shown in Figure 3-9. The latest GEM Regional LAM model correctly forecasted a region of high rainfall over western Toronto (highlighted by the black circle), west of the station marked YTZ (Billy Bishop Toronto City

Airport). The maximum rainfall value, however, was in the range 40 to 50 mm, approximately half of what was observed. The model predicted greater rainfall in the area between northern Lake Michigan and Lake Huron and immediately west of Windsor ON.

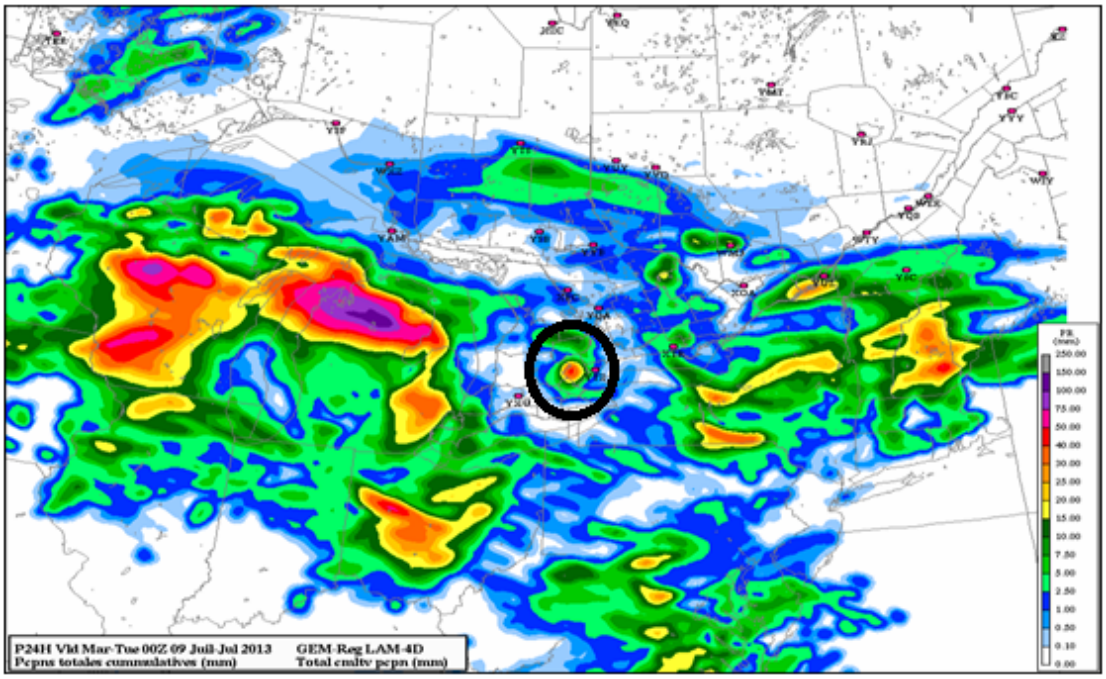


Figure 3-9: The Canadian GEM Regional high-resolution, limited-area model (LAM) forecast 24 hr total rainfall ending at 00Z (8 pm EDT), on July 8th, 2013.

In order to illustrate the large variability and inconsistency of the NWP quantitative precipitation forecasts, two meteograms for CYYZ (Toronto Lester B. Pearson Airport) of predicted hourly precipitation by three of the most popular US models (GFS, NAM, and RAP models), over this storm period of interest, are shown in Figures 3-10 and 3-11.

On the day before the event (July 7th, 2013), the greatest rainfall accumulation predicted for CYYZ over the next 4 days was <0.8 inches (< 20 mm). The NAM model run at 12 UTC (8 am EDT) on the morning of July 8th, 2013 predicted the most rainfall for CYYZ, with a rapid accumulation of 1.4 inches (38 mm) in less than 6 hrs. Although this likely alerted forecasters to the possibility of a heavy thundershower, the total expected rainfall and intensity were still considerably less than the criteria for issuing a rainfall warning which is >50 mm of rain in one hour.

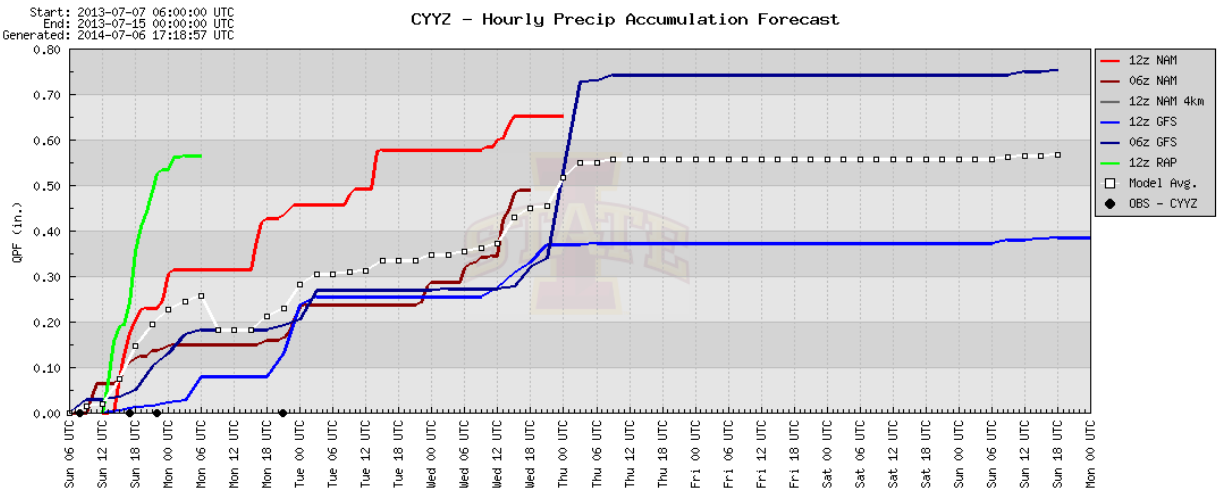


Figure 3-10: Forecast precipitation accumulation for CYYZ for the NAM, GFS, and RAP models starting on July 7th, 2013.

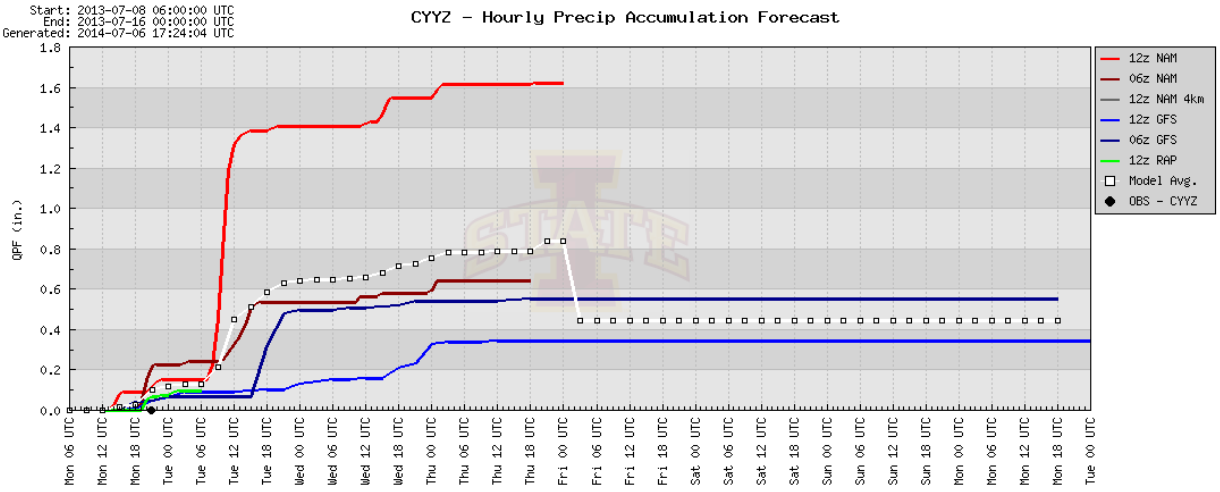


Figure 3-11: Forecast precipitation accumulation for CYYZ for the NAM, GFS, and RAP models starting on July 8th, 2013.

3.7.1 Summary of Model Quantitative Precipitation Forecasts

Forecast models did not accurately predict the timing, magnitude and exact location of heavy rainfall that caused the flooding over the GTA on July 8th, 2013. All NWP forecast rainfall accumulations underestimated the observed accumulations (and the rainfall patterns). The heavy rainfall observed was convective in nature, generated by relatively small clusters of multi-cellular storms, associated with some “back-building” or “training” and moving over the same locations. This has been found to be a common process by which summertime flash floods are generated, and remains extremely challenging for NWP models and forecasters.

3.8 Summary of Meteorological Situation and Precipitation Forecasts

The extreme rainfall event on July 8th 2013 was the result of the motion and evolution of two relatively modest looking weather systems of distinctly different origins. The clockwise circulation around the Bermuda High had created a "conveyor belt" transport of heat and moisture from the Gulf of Mexico into southern Ontario in the days leading up to July 8th, 2013. A relatively weak Low that originated near the Saskatchewan-Montana border, tracked eastward, and its associated cold front moved into southern Ontario and triggered the thunderstorms that caused the extreme rainfall event over the GTA in the late afternoon of July 8th, 2013.

The public weather forecasts did not give any indication to the extreme nature of the July 8th, 2013 event. The official weather forecast on the morning of July 8th, 2013 called for a 40% chance of evening showers with a risk of a thunderstorm in the afternoon and early evening. A special weather statement was issued by Environment Canada at 1:31 pm EDT on Monday July 8th 2013, and should have provided an alert to the general public of the possibilities for local heavy downpours later in the afternoon for nearby areas. The special weather statement was extended to include the City of Toronto at 2:16 pm EDT, advising of local heavy downpours giving 30 to 40 mm of rain in less than one hour.

The first significant severe thunderstorm warning was issued at 2:34 pm EDT for the Angus and Barrie regions, after a weather watcher reported 50 mm of rain in 30 min. This was the earliest Indication of the extreme nature of the event in the region. The first severe thunderstorm warning to include the City of Toronto was issued at 5:51 pm EDT. The regions mentioned in the updated severe storm warning also included Vaughan, Richmond Hill, Markham, Mississauga and Brampton.

The updated weather forecast issued by Environment Canada at 5:14 pm EDT on Monday, July 8th, 2013 was the first weather forecast that alerted the public to "showers at times heavy with thunderstorms this evening".

Weather radar images showed a series of thunderstorm cells over the western part of the GTA between 4:30 and 4:50 pm EDT. Rain gauges within the western GTA reported >70 mm/hr at 5:00 pm EDT and >60 mm/hr at 6:00 pm EDT. The Lester B. Pearson Airport station (CYYZ) reported 90 mm of accumulated rain in its 6:00 pm EDT observation report. The eastern GTA reported >40 mm/hr at 4:00 pm and 5:00 pm EDT. In essence, the official warning by Environment Canada occurred after the most intense rainfall rates occurred; therefore, there was no advance warning of the extreme event for planning purposes.

Severe thunderstorms have produced all of Ontario's extreme rainfall record amounts. At the same time they are among the most difficult to forecast accurately. The common Canadian and US numerical weather prediction models did not accurately predict the severity, timing, or location of the extreme rainfall event over the TRCA watershed on July 8th, 2013. In spite of the new generation of very high resolution models with advanced physics parameterizations, local thunderstorms still present a huge challenge with respect to quantitative precipitation prediction. A number of meteorological processes interact on multiple scales of motion to eventually define the exact region and timing of extreme convective rainfall. With respect to numerical modelling

of precipitation, small errors in defining the intial state of the atmopshere have been shown to result in large differences in the forecast, especially for extreme events, since the faulty initialization is often amplified when advected downstream. Furthermore, a common known weakness of numerical models is that they tend to move certain features (e.g. Low pressure systems) along too fast. This fact implies that numerical models have a tendency to move fronts and warm, moist conveyor belt type occlusions, that often create extreme heavy rain events, along too fast. It stands to reason that if the thunderstorms and precipitation band moves slower, local precipitation amounts will be greater.

Precipitation from mesoscale convective systems is very difficult to predict. In summer, flash flooding may occur due to a mesoscale system or even occur from a single storm that remains quasi-stationary and has intense rainfall rates. Forecasting extreme rainfall events often involves recognition and an understanding of a combination of ingredients involving atmospheric moisture, instability, and motion that can lead to high rainfall rates for an extended period.

At shorter time ranges, closely monitoring satellite and radar imagery, combined with high resolution, mesoscale analysis, and satellite and radar cell tracking extrapolation are likely the best tools for identifying when and where an extreme rainfall event is most likely to occur.

3.9 Antecedent Conditions

The spring and early summer of 2013 were wetter than normal periods. A comparison between the total precipitation in the months of April, May and June of 2013, as reported by Environment Canada, for the two (2) rain gauges at Toronto International Pearson Airport and Toronto Buttonville Airport with 1981-2010 climate normals has been presented in Table 3-2.

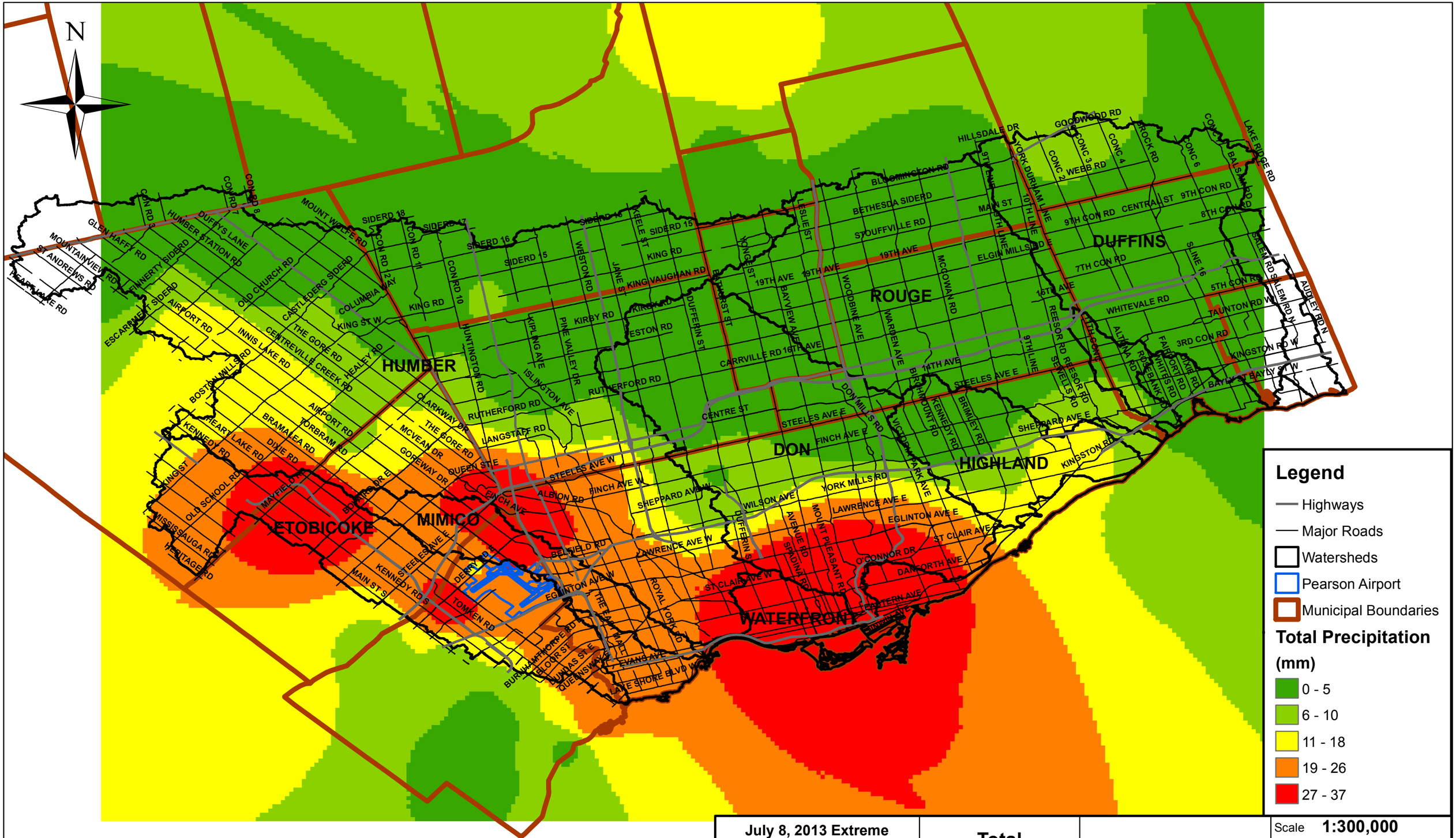
Table 3-2: Antecedent Total Precipitation based on Environment Canada Rain gauges (mm)

Gauge	Year	April	May	June
Toronto Pearson Airport	2013	110.4	76.2	100.6
	1981-2010 Climate Normals	68.5	74.3	71.5
Toronto Buttonville Airport	2013	99	80.9	166.6
	1981-2010 Climate Normals	74.1	79.6	82.8

The results presented in Table 3-2 indicate that at both gauges, total precipitation for all months were greater than the long term normals. The reported total precipitation at Toronto Buttonville Airport in June 2013 was more than double the long term normals.

In order to examine the period leading up to the July 8th, 2013 storm event, both on a short term and a long term basis, total rainfall measured at all rain gauges used for this assessment have been determined for three antecedent periods including 1 day (24 hours), 2 days (48 hours) and 7 days (168 hours) prior to the storm event and have been presented in a thematic format in Figures 3-12 to 3-14, respectively. The results presented in these three (3) figures indicate that the Etobicoke and Mimico Creek watersheds, as well as the lower half of Don and Humber River watersheds had received a range of total rain of 6 mm to 37 mm during the prior 24 hours, 11 mm to 43 mm during the prior 48 hours and 25 mm to 82 mm during the 7 days prior to the July 8th, 2013 storm event.

In order to put the antecedent conditions into context for this event, a frequency analysis has been conducted using maximum daily rainfall measurements recorded at the Environment Canada rain gauge located at Pearson International Airport (ref. Table 3- 3). The comparison of the maximum recorded antecedent rainfall depths with the frequency analysis results indicates that the maximum 1 day and 2 day antecedent rainfall depths prior to the July 8th, 2013 storm event had a return period of 1.25 to 2 years, while the maximum 7 day rainfall prior to the event has had a return period of 2 to 5 years.



July 8, 2013 Extreme Rainfall Event **Summary and Analysis Report** **Toronto and Region Conservation Authority**	**Total Antecedent Precipitation 24 hr Prior**	amec	Scale **1:300,000** 0 2 4 8 12 Kilometers Project No. **TP114045** Figure No. **3-12**

N

HUMBER
ROUGE
DUFFINS
DON
HIGHLAND
ETOBICOKE
MIMICO
WATERFRONT

Legend

- Highways
- Major Roads
- Watersheds
- Pearson Airport
- Municipal Boundaries

Total Precipitation (mm)

- 0 - 10
- 11 - 15
- 16 - 22
- 23 - 30
- 31 - 43

July 8, 2013 Extreme Rainfall Event

Summary and Analysis Report

Toronto and Region Conservation Authority

Total Antecedent Precipitation 48 hr Prior

amec

Scale 1:300,000

0 2 4 8 12 Kilometers

Project No. TP114045

Figure No. 3-13

N

HUMBER
ETOBICOKE
MIMICO
DON
ROUGE
DUFFINS
HIGHLAND
WATERFRONT

Legend

- Highways
- Major Roads
- Watersheds
- Pearson Airport
- Municipal Boundaries

Total Precipitation (mm)

- 0 - 24
- 25 - 32
- 33 - 42
- 43 - 53
- 54 - 82

July 8, 2013 Extreme Rainfall Event

Summary and Analysis Report

Toronto and Region Conservation Authority

Total Antecedent Precipitation 168 hr Prior

amec

Scale 1:300,000

0 2 4 8 12 Kilometers

Project No. TP114045

Figure No. 3-14

Table 3-3: Frequency Analysis Results for Maximum Daily Rainfall measured at Pearson Airport

Return Period (Year)	Maximum rainfall (mm)		
	1 Day	2 Day	7 Day
1.01	19.6	29.1	39.8
1.05	24.3	32.9	47.1
1.11	27.3	35.4	51.6
1.25	31.4	39.0	57.6
2	40.9	48.2	71.3
5	53.4	62.0	88.4
10	61.3	71.9	98.9
20	68.8	81.9	108.6
50	78.3	95.8	120.7
100	85.3	107.0	129.5
200	92.3	118.8	138.2
500	101.5	135.7	149.5

Antecedent moisture classes (AMC) based on the Soil Conservation Services (SCS) method of rainfall abstractions indicate that during the growing season, total 5-day antecedent rainfall less than 1.4 inches (35.6 mm) would correspond to the AMC I (dry) condition, with 1.4 to 2.1 inches (35.6 to 53.3 mm) corresponding to AMC II condition (normal) and total 5-day antecedent rainfall greater than 2.1 inches (53.3 mm) corresponding to AMC III condition (wet). The distribution of antecedent moisture classes based on 5-day antecedent rainfall has also been determined using this classification system and presented in Figure 3-15. The spatial distribution of AMC conditions throughout the TRCA watersheds is presented in Table 3-4.

Table 3-4: Distribution of Antecedent Moisture Classes in TRCA Watersheds based on 5 day antecedent Rainfall (% by class)

Watershed	Antecedent Moisture Class		
	AMC I	AMC II	AMC III
Carruthers	100	0	0
Don	64	35	1
Duffins	100	0	0
Etobicoke	0	62	38
Frenchmans bay	100	0	0
Highland	98	2	0
Humber	76	18	6
Mimico	0	53	47
Petticoat	100	0	0
Rouge	100	0	0

Based on results presented in Table 3-4, the lower half of Etobicoke and Mimico Creek and a small portion of the Humber River watershed experienced AMC III, or wetter than normal conditions. Clearly these antecedent rainfall conditions were significant and undoubtedly contributed to higher rates of runoff. These antecedent conditions would have contributed to saturated soil conditions across the watersheds, reducing infiltration capacity, increasing water levels in stormwater management infrastructure and consequently, contributed to more runoff generation during the storm event.

N

HUMBER

ETOBICOKE

MIMICO

DON

ROUGE

DUFFINS

HIGHLAND

WATERFRONT

Legend

- Highways
- Major Roads
- Watersheds
- Pearson Airport
- Municipal Boundaries

Antecedent Moisture Class

(5 Day Rainfal)

- AMC I (< 35.56 mm)
- AMC II (35.56 - 53.34 mm)
- AMC III (> 53.34 mm)

July 8, 2013 Extreme Rainfall Event **Summary and Analysis Report** **Toronto and Region Conservation Authority**	**Antecedent Moisture Classes**	amec	Scale **1:300,000** 0 2 4 8 12 Kilometers Project No. **TP114045** Figure No. **3-15**

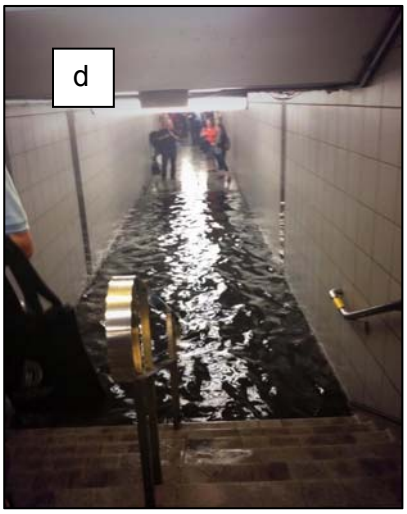
3.10 Reported Storm Impacts

The July 8 th, 2013 rainfall event which resulted in widespread flooding, was the most expensive natural disaster in Ontario history, to date, according to the Insurance Bureau of Canada[1] (IBC). As reported by the IBC, on August 14, 2013, the preliminary estimate of insured property damage caused by this event was more than $850 million. By comparison, the August 19, 2005 and July 24-28, 2009 storms resulted in $671 million and $228 million in insured damages.

http://www.greenpoweraction.com/blog/wp-content/uploads/2013/07/hi-toronto-flood-cp-0470032.jpg

http://i.cbc.ca/1.430986.1378570691!/httpImage/image.jpg_gen/derivatives/16x9_620/image.jpg

http://wpmedia.o.canada.com/2013/07/wea_ont_storms_20130708_topix_27633753.jpg



http://livenews.thestar.com/Event/Severe_thunderstorms_in_Toronto?Page=1

Figure 3-16: Flooding in Toronto During July 8, 2013 Storm Event: a) Don Valley Parkway, b) Don Valley Parkway , c) Go Train Stranded at Bayview and Pottery Road, d) TTC Queen's Park Station

Initial media reports provided by various online news outlets generally described the impacts from the storm as flooded basements, power outages, downed trees, major disruptions to transportation including surface routes, subways, railways and airlines and disruption to water and sewer services. It should be noted that these information have not been confirmed by AMEC or TRCA. Power outages resulting from the storm affected about 300,000 Toronto

[1]http://www.ibc.ca/en/Media_Centre/News_Releases/2013/Preliminary_insured_losses_released_in_the_most_expensive_natural_disaster_in_Ontario_history.asp

residents and some reports indicated that about seventy per cent (70%) of Mississauga lost power. The resultant flooding also stranded about 1,400 passengers for hours on a GO commuter train that filled with water. Square One and Sherway Mall were both reported as having been evacuated due to the storm.

The City of Toronto staff report (ref. Impacts of the July 8th, 2013 Storm Event on the City of Toronto, City of Toronto, 2013) summarized the impacts from the storm as follows:

- The City of Toronto estimated initial impact costs from the storm event as $65.6 million comprised of $10.1 million for operating costs and $55.5 million for capital requirements ($31.3 million of which related to TRCA requirements). It was also noted that the City expects cost recovery through insurance totalling approximately $4.9 million.
- Toronto Water reported occurrences of sink holes, damage to portions of sanitary sewers, storm sewers, outfall pipes, storm inlets and stream erosion, as well as damage to various electrical systems at pumping stations.
- Toronto Parks, Forestry and Recreation reported flood related damage to a works yard and community centre, artificial turf in stadiums, and damages to bridges and significant flood related erosion throughout the parks system.
- The City received 4,759 basement flooding calls resulting from the storm with 991 from North York, 56 from Scarborough, 607 from Toronto and East York and 3,105 from Etobicoke and York.

As part of this study, AMEC has contacted seventeen (17) agencies (ref. Table 3-5) and media outlets for whom it was expected had direct knowledge of, or experienced direct impacts from, the storm event and could possibly provide details on specific impacts, information relative to their service or jurisdiction. A summary of the contacted agencies and provided estimates have been presented in this section. Detailed information has been presented in Appendix K.

Table 3-5: Summary of Agencies Contacted and Estimated Cost of Damages due to July 8th, 2013 Storm Event

Organization / Agency Contacted	Organization / Agency Responded	Cost of Estimated Damage in Millions
Bell	No	N/A
CBC	No	N/A
City News	No	N/A
City of Brampton	No	N/A
City of Mississauga	Yes	$1.217M
City of Toronto	Yes	$70.1M
Enbridge Gas	No	N/A
Enersource	Yes	N/A
Global TV	No	N/A
GO / Metrolinx	Yes	$8.352M
Insurance Bureau of Canada	Yes	$850M
Hydro One Networks Inc.	Yes	N/A
MTO	Yes	N/A
Region of Peel	Yes	$1.5M
Toronto Hydro	Yes	$1.410M
Toronto Police	No	$114.610K
Toronto Transit Commission	No	$1.318M

These organizations have been engaged via email or telephone. Through this data summarization exercise it has also been identified that there is typically no clear single point of direct contact within these organizations to access this type of information. In some cases no information was provided to AMEC. It should be noted that the groups contacted is not considered comprehensive, in the context of all groups potentially affected by the storm, however simply reflects major points of contact for information relating to the storm event.

It is noted that the manner in which impact data are compiled by these organizations ranges from organized to ad hoc. As such, amalgamating the information from the various sources into a consistent framework requires significant effort. Also, even though almost a year has passed since this event occurred, the information regarding the impacts outlined in this summary should be considered preliminary, as data are still being compiled and vetted by those who were contacted.

The following information and comments were provided to AMEC from the organizations noted in Table 3-5. Overall general impacts were classified as physical effects and costs:

- The majority of the storm impacts relate to municipal and private infrastructure, utility networks and lost time due to travel disruption.
- No information was provided to indicate the number of vehicles damaged, though the number is assumed to be in the thousands.
- Deficiencies in the existing systems led to the majority of damages and the majority of future estimated costs arise from requirements and upgrades to infrastructure in order to mitigate future damage.

Municipal impacts included:

- City of Toronto: Approximately 500,000 homes and businesses (ref. 14-12-23 Global News), including Sherway Mall (ref.14-07-22 Toronto Hydro Bruckmueller) were directly affected by the power outage caused by the event.
- City of Toronto: Flooding of 4759 homes.
- Region of Peel: Incurred significant costs related to removal of approximately 200,000 tons of flood related waste from 2,500 flooded homes and other sources and haulage to waste management centers (14-05-08-rc-agenda p.105).
- Region of Peel: Two (2) road underpasses suffered damage
- Region of Peel: Flooding at the GE Booth Wastewater treatment facility causing phosphorous loads in its effluent for the month of July 2013 to be 1.02 mg/L, marginally higher than the allowable limit of 1.0 mg/L (p.4 13-08-24 Report_-_PW-C1_Update).
- City of Mississauga: Reported widespread watercourse erosion along Cooksville, Serson, Cawthra, Applewood, Mimico, Little Etobicoke and Etobicoke Creeks, trail damage, flooding at City facilities, evacuation of an apartment building and structural damage to a house (p.4 13-08-26 Corp Report).
- City of Mississauga: Reported that five (5) roads were impassible or closed (email 14-07-28 Mississauga Holmes).

Utility impacts included:

- The power outage resulted from equipment failure due to flooding at two (2) transformer stations and one (1) operations building at Hydro One's Richview and Manby Transformer Stations (13-07-08 Toronto Flood Summary Report).
- The Hydro One power outage also affected six (6) local distribution companies who receive their supply from Hydro One, including Toronto Hydro, Hydro One Brampton, Enersource, Oakville Hydro, PowerStream, and Veridian. Also four (4) transmission connected customers were directly affected: Ontario Power Generation Kipling Complex, Ford Oakville, IBM and Kinetrics HV Lab.

Transportation impacts from Metrolinx/GO Transit included:

- Services were disrupted including the GO Train line in the Don Valley, stranding 1,400 passengers for more than seven hours (13-09-06 Staff Report Sewer and SW) and damaging ten (10) passenger cars and 1 locomotive (Telecon July 10/2014).
- Reported that the GO Train concourse at Union Station flooded (AAR).
- Reported track washout damage occurred at four (4) locations along its (owned) transit corridors.
- Bala Subdivision, the track bed eroded to a depth of approximately 1.2 m along the shoulder from the end of track ties during the flood (ref. email correspondence: Stone-Dawydiuk-14-07-23).

Bell, CBC, City News, the City of Brampton, Enbridge Gas, Global TV, and the Ontario Ministry of Transportation (MTO) have also been contacted, however to-date[2], no information has been provided from these agencies. Through the interaction with these groups, it is clear that most of those affected understand that major preventative and mitigative measures are required to reduce the amount of damage in the future from similar events. These costs are presently estimated to reach into the hundreds of millions of dollars (Insurance Bureau of Canada (IBC).

[2] As of August 8, 2014.

4.0 RAINFALL ANALYSIS

Rainfall data for the entire duration of the extreme event on July 8th, 2013 have been obtained for 135 gauges, as previously noted under Section 2.1. These gauges belong to several municipalities and organizations and are spread across all TRCA watersheds. 109 of these gauges are located within the TRCA boundaries and the remaining 26 gauges are located outside of the boundaries of TRCA, mostly in north and south west regions.

This section discusses the results of the analysis using these rainfall data sets. Data from all these gauges have been analyzed to determine the spatial coverage of the storm event, as well as the intensity and duration of the rainfall. The probability of the occurrence of the extreme rainfall storm of July 8th, 2013 has also been compared to available Intensity-Duration-Frequency (IDF) relationships for Environment Canada gauges within the study area and surrounding regions. Finally, a comparison has been performed between the measured rainfall depths at all gauges and spatial coverage mapping based on these values and radar rainfall data sets obtained from different sources including the NEXRAD Buffalo Radar and King City Radar.

4.1 Isohyets

Total rainfall depths measured at all gauges presented in Figure 2-1 have been used to develop thematic mapping depicting the spatial coverage of the total storm across the study area. In order to prepare the thematic mapping, it has been required to use interpolation techniques to spatially interpolate the total storm depth measured at each gauge location over the study area and assemble a spatial coverage map. Several interpolation techniques are available within the ESRI™ ArcGIS package version 10.0, which has been used to conduct this assessment. These techniques include Inverse Distance Weighted (IDW), Kriging, Natural Neighbour and Spline techniques.

Prior to conducting the interpolation assessment, it has been necessary to determine which methodology would result in the most accurate simulation of the spatial coverage of the rainfall. For this purpose, an evaluation process has been conducted using the three methods of IDW, Kriging and Spline, which are the three most commonly used interpolation techniques applied for determination of spatial coverage of rainfall. Descriptions of these three methods are summarized in Appendix L. A verification assessment has been conducted A subset of rain gauges and statistical agreement indexes, including regression correlation coefficients, Root Mean Square Error and Nash-Sutcliff coefficient, have been used to determine the most appropriate interpolation technique. The Results of this assessment have been presented in Table 4-1. The verification assessment has been explained in further detail in Appendix A. The methods of comparison along with sample calculations have been explained in further detail in Appendix M.

Table 4-1: Results of the Verification Assessment for Different Interpolation Methods

Gauge Name	Source	AMEC ID	Total Observed Rainfall (mm)	Predicted Rainfall (mm)							
				IDW (P=2)	Kriging (Ordinary)	Spline	IDW (P=1)	IDW P=1.5)	IDW (P=2.5)	IDW (P=3)	Kriging (Universal)
Oak Ridges	Richmond Hill	136	29.60	32.44	34.23	47.30	33.76	33.22	31.47	30.40	33.23
Toronto North York	Environment Canada	2	67.20	67.77	62.44	66.78	66.26	67.36	67.90	67.94	66.45
Emery Yard	City of Toronto	20	55.75	84.20	85.96	49.03	85.48	84.89	83.48	82.82	86.94
Castlefield	City of Toronto	17	72.50	75.99	82.02	90.31	79.47	77.83	74.01	71.95	81.72
Central	City of Toronto	7	87.25	86.89	71.73	89.49	80.84	84.68	87.90	88.32	70.35
Edwards Gardens	City of Toronto	33	48.00	58.50	59.42	71.75	58.73	58.56	58.54	58.64	55.26
Fire Station 121	City of Toronto	39	61.25	61.24	63.60	62.82	62.67	62.02	60.36	59.41	65.60
R_YR_KE01	York Region	81	5.60	20.17	23.66	36.53	21.54	20.74	19.84	19.69	24.64
R_YR_NE01	York Region	84	31.60	39.88	25.78	40.31	32.15	36.35	42.34	43.92	35.57
R_ET_VA01	York Region	78	75.00	81.92	74.63	87.35	78.54	80.37	83.10	83.88	74.37
R_ET_ST02	York Region	77	6.80	6.70	9.50	6.19	8.34	7.47	6.20	5.93	7.95
Fire Hall #94	Markham	110	12.50	11.42	11.83	11.44	11.58	11.49	11.38	11.36	12.37
Thornhill C.C.	Markham	105	49.53	46.52	40.59	64.88	42.68	44.47	48.56	50.40	43.29
German Mills P.S.	Markham	106	39.00	40.22	29.47	38.45	34.59	37.71	41.89	42.89	31.46
Lincoln Alexander P.S.	Markham	107	20.00	19.55	29.56	10.89	24.64	21.81	18.03	17.09	26.25
STN 06 - Mississauga Valley	Mississauga	95	71.00	64.33	59.27	67.63	62.00	63.24	65.23	65.95	63.02
STN 08 - Tomken	Mississauga	97	56.40	72.27	72.18	58.93	72.32	72.34	72.09	71.78	70.38
STN 13 - Goreway	Mississauga	102	87.80	95.46	93.66	104.26	95.30	95.61	94.90	94.04	89.00
HY008	TRCA	43	69.40	74.97	64.13	75.21	70.65	73.09	76.39	77.48	67.54
HY012	TRCA	46	37.00	47.02	52.54	37.94	49.74	48.33	45.87	44.93	41.35
HY016	TRCA	49	50.20	53.84	53.76	49.39	54.98	54.53	53.28	52.93	59.04
HY033	TRCA	55	81.80	77.48	56.43	95.75	65.99	71.74	82.65	86.86	56.73
HY036	TRCA	56	9.80	11.26	19.06	10.66	14.38	12.42	10.75	10.56	15.82
HY039	TRCA	72	94.00	82.41	75.11	65.32	80.18	81.87	82.10	81.46	76.69
HY043	TRCA	60	6.80	8.55	7.94	8.43	8.21	8.37	8.73	8.92	6.88
HY044	TRCA	61	10.20	10.00	10.54	10.08	10.13	10.04	10.01	10.03	9.86
HY050	TRCA	63	8.60	8.64	12.71	8.38	10.16	9.20	8.36	8.21	10.04
HY051	TRCA	64	9.00	7.68	7.85	7.99	7.78	7.72	7.64	7.61	7.65
RG03	Peel Region	115	3.75	18.39	38.82	19.99	29.10	23.57	14.09	10.83	21.20
RG24	Peel Region	121	42.50	36.97	46.98	-7.17	41.58	39.14	35.10	33.53	32.98
RG32	Peel Region	128	86.75	69.16	68.36	62.50	69.13	69.23	68.95	68.67	69.28
RG36	Peel Region	131	44.25	52.37	57.99	36.89	56.12	54.48	49.94	47.39	51.03
RSQ				**0.9142**	**0.7937**	**0.7588**	**0.8733**	**0.8998**	**0.9198**	**0.9200**	**0.8504**
RMSE				**8.95**	**13.28**	**15.28**	**10.62**	**9.57**	**8.68**	**8.66**	**11.21**
Nash Sutcliff Coefficient				**0.904**	**0.788**	**0.719**	**0.864**	**0.890**	**0.909**	**0.910**	**0.849**

The results presented in Table 4-1 indicate that the Inverse Distance Weighted interpolation technique using a power value of 3 will result in the highest correlation coefficient, lowest level of RMSE error and highest Nash-Sutcliff coefficient, which are all indicative of a strong fit to observed data. As such, this method has been selected for interpolation of rainfall depths for this assessment. The total rainfall depth during the storm has therefore been interpolated using IDW with P=3 using the total measured depth at all 135 gauges; the resultant thematic mapping depicting the isohyets has been presented in Figure 4-1.

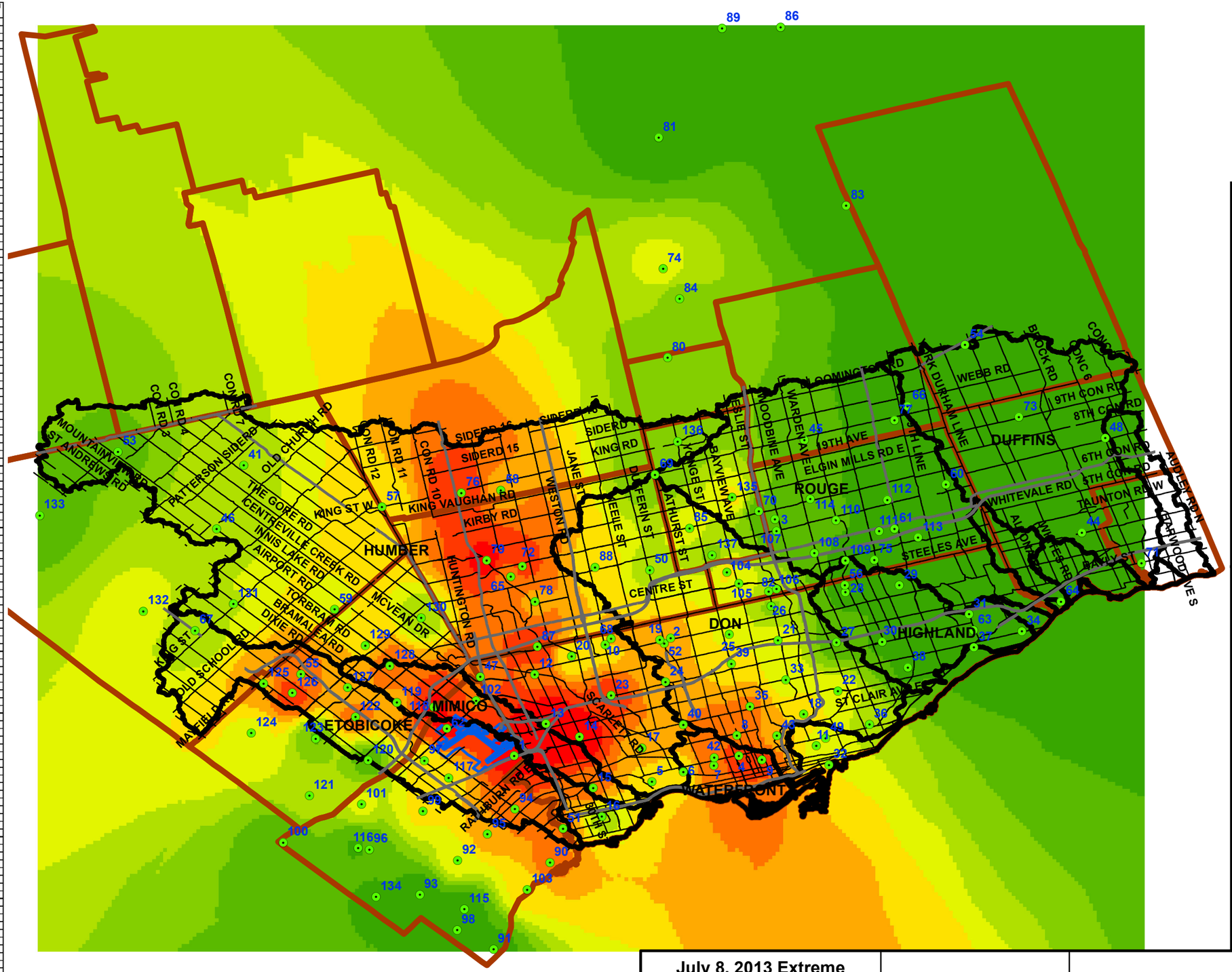
The results presented in Figure 4-1 indicate that the watersheds located in the western part of TRCA's jurisdiction received a significant amount of rainfall during the extreme storm event of July 8th, 2013, with a rainfall range of 45 mm to 138 mm; these watersheds include Don River, Humber River, Mimico Creek and Etobicoke Creek. The highest amount of rainfall has been observed in areas immediately east of Toronto Pearson International Airport which ranges between 107 mm to 138 mm. The average total rainfall spatially weighted received by each watershed has been calculated using the TRCA's watershed boundaries and the spatial coverage of the total storm depth presented in Figure 4-1. The results of this assessment are presented in Table 4-2.

Table 4-2: Average Total Storm Depth in TRCA Watersheds

TRCA Watersheds	Spatially Averaged Storm Depth (mm)
Mimico	94.6
Etobicoke	69.9
Humber	62.0
Don	52.3
Rouge	15.8
Highland	10.6
Petticoat	8.3
Frenchmans Bay	7.6
Duffins	5.0
Carruthers	4.2

The results presented in Table 4-2 Indicate that the Mimico watershed received the highest amount of rain with a spatially-averaged depth of 94.6 mm of rainfall, while the Carruthers watershed received the lowest amount of rainfall with a spatially-averaged rainfall depth of 4.2 mm during the extreme storm event of July 8th, 2013.

ID	Gauge Name	Source	Total Rainfall (mm)
1	Toronto Pearson Int'L A	Environment Canada	114.6
2	Toronto North York	Environment Canada	67.2
3	Toronto Buttonville A	Environment Canada	14.2
4	Toronto City	Environment Canada	96.4
5	Swansea	City of Toronto	56.75
6	Howard	City of Toronto	57
7	Central	City of Toronto	87.25
8	Brown	City of Toronto	85
9	Church	City of Toronto	92.25
10	Lans	City of Toronto	53.5
11	Greenwood	City of Toronto	52.5
12	Albion	City of Toronto	86.25
13	Martin Grove	City of Toronto	138
14	Richview	City of Toronto	121
15	Bering	City of Toronto	83.5
16	Kipling	City of Toronto	37.75
17	Castlefield	City of Toronto	72.5
18	Thorncliffe	City of Toronto	62.5
19	Finch Yard	City of Toronto	68
20	Emery Yard	City of Toronto	55.75
21	Fire Station 116	City of Toronto	49
22	Bermondsey Yard	City of Toronto	49.75
23	Wilson	City of Toronto	96.25
24	Ancaster	City of Toronto	70.5
25	Mitchell Field	City of Toronto	52.304
26	Cummer	City of Toronto	92.5
27	Pharmacy/401	City of Toronto	18.25
28	Lawrence Heights	City of Toronto	10.5
29	Nashdene Yard	City of Toronto	8.75
30	Ellesmere Yard	City of Toronto	10.25
31	Morningside Yard	City of Toronto	9.75
32	Ashbridges Bay	City of Toronto	Missing
33	Edwards Gardens	City of Toronto	48
34	Fire Station 215	City of Toronto	7.75
35	Mount Pleasant	City of Toronto	78
36	Denton	City of Toronto	40.25
37	Poplar	City of Toronto	7.25
38	Saminda	City of Toronto	11
39	Fire Station 121	City of Toronto	61.25
40	Fairbank Middle Public School	City of Toronto	Missing
41	Albion Hills	TRCA	43.6
42	Alex Duff Memorial Pool	TRCA	88.6
43	Bridgworks	TRCA	69.4
44	Brock West Landfill	TRCA	6
45	Bruces Mill CA	TRCA	15.4
46	Caledon Pumping Station	TRCA	37
47	Claireville Dam	TRCA	85.2
48	Claremont Shop	TRCA	4
49	Danforth and Coxwell	TRCA	50.2
50	Dufferin Reservoir	TRCA	40.7
51	Etobicoke at QEW	TRCA	78.4
52	G Ross Dam	TRCA	67.6
53	Glen Haffy	TRCA	22.6
54	Goodwood Pumping Station	TRCA	2.4
55	Heart Lake CA	TRCA	81.8
56	Kennedy Pump Station	TRCA	9.8
57	King and Albion-Vaughan	TRCA	57.8
58	East Humber at Mill Road	TRCA	73
59	Ladaw Bus Depot	TRCA	51.2
60	Little Rouge at 16th	TRCA	6.6
61	Milne Dam	TRCA	10.2
62	Mississauga Works Yard	TRCA	109.4
63	Morningside Works Yard	TRCA	8.6
64	Pefferlaw GA	TRCA	9
65	Restoration Services	TRCA	79
66	Stouffville Dam	TRCA	5.7
67	Sue Grange Farm	TRCA	35
68	TRCA Head Office	TRCA	72.6
69	York Pumping Station	TRCA	25.4
70	York Region Works Yard	TRCA	20
71	Bayly and Church	TRCA	7.4
72	Kortright	TRCA	94
73	Transport Canada	TRCA	3.2
74	R_ET_HL01	York Region	47.8
75	R_ET_MA03	York Region	7.6
76	R_ET_NO01	York Region	102
77	R_ET_ST02	York Region	6.8
78	R_ET_VA01	York Region	75
79	R_ET_VA02	York Region	111.4
80	R_YR_AU02	York Region	29.4
81	R_YR_KE01	York Region	5.6
82	R_YR_MA03	York Region	44.6
83	R_YR_MO01	York Region	3
84	R_YR_NE01	York Region	31.6
85	R_YR_RH01	York Region	47.2
86	R_YR_SU01	York Region	2.4
87	R_YR_VA03	York Region	100.8
88	R_YR_VA04	York Region	60.4
89	R_YR_WB01	York Region	2.8
90	STN 01 - Third St.	Mississauga	81.4
91	STN 02 - Clarkson	Mississauga	6.6
92	STN 03 - Wolfedale	Mississauga	59.2
93	STN 04 - South Common	Mississauga	2.75
94	STN 05 - Winding Trail	Mississauga	86.4
95	STN 06 - Mississauga Valley	Mississauga	71
96	STN 07 - Britannia	Mississauga	20.4
97	STN 08 - Tomken	Mississauga	56.4
98	STN 09 - Trusott	Mississauga	4
99	STN 10 - Falbourne	Mississauga	56.8
100	STN 11 - Garry Morden FTC	Mississauga	14.2
101	STN 12 - CVC	Mississauga	46.6
102	STN 13 - Gorway	Mississauga	87.8
103	STN 14 - Port Credit	Mississauga	59.4
104	Stornoway P.S.	Markham	56.8
105	Thornhill C.C.	Markham	49.63
106	Germen Mills P.S.	Markham	39
107	Lincoln Alexander P.S.	Markham	20
108	8100 Warden Ave	Markham	13.6
109	Milliken Mills C.C.	Markham	9.25
110	Fire Hall #94	Markham	12.5
111	Roy H Crosby P.S.	Markham	10
112	Markham Museum	Markham	9.4
113	Rouge Fever C.C.	Markham	11
114	Angus Glen C.C.	Markham	12
115	RG03	Peel Region	3.75
116	RG11	Peel Region	9.75
117	RG16	Peel Region	61.25
118	RG20	Peel Region	109.75
119	RG22	Peel Region	74.75
120	RG23	Peel Region	19.25
121	RG24	Peel Region	42.5
122	RG25	Peel Region	81.75
123	RG26	Peel Region	94
124	RG27	Peel Region	52
125	RG28	Peel Region	74.25
126	RG29	Peel Region	97.5
127	RG31	Peel Region	67.25
128	RG32	Peel Region	86.75
129	RG33	Peel Region	63.75
130	RG34	Peel Region	36.5
131	RG36	Peel Region	44.25
132	RG39	Peel Region	47.75
133	RG42	Peel Region	17.75
134	RG44	Peel Region	9.75
135	Discovery	Richmond Hill	58.6
136	Oak Ridges	Richmond Hill	29.6
137	Operations	Richmond Hill	32.6



4.2 Intensities

Rainfall depth has been recorded at the gauges used for this assessment with a recording frequency of 5 minutes for 111 gauges and 15 minutes for 24 gauges. Using these measurements, maximum rainfall intensities for durations of 5, 10, 15 and 30 minutes, as well as 1, 2, 6 and 12 hours for each gauge has been calculated and the results have been interpolated in order to develop thematic mapping depicting the spatial coverage of maximum rainfall intensity for various durations within the study area. The results of this assessment have been presented in Figure 4-2 to Figure 4-9. It should be noted that the 5 and 10 minute maximum intensities presented in Figure 4-2 and Figure 4-3 have been determined using data from 111 gauges with available 5 minute measurements and therefore these two (2) figures provide coverage for a slightly smaller extent, compared to the balance of the figures.

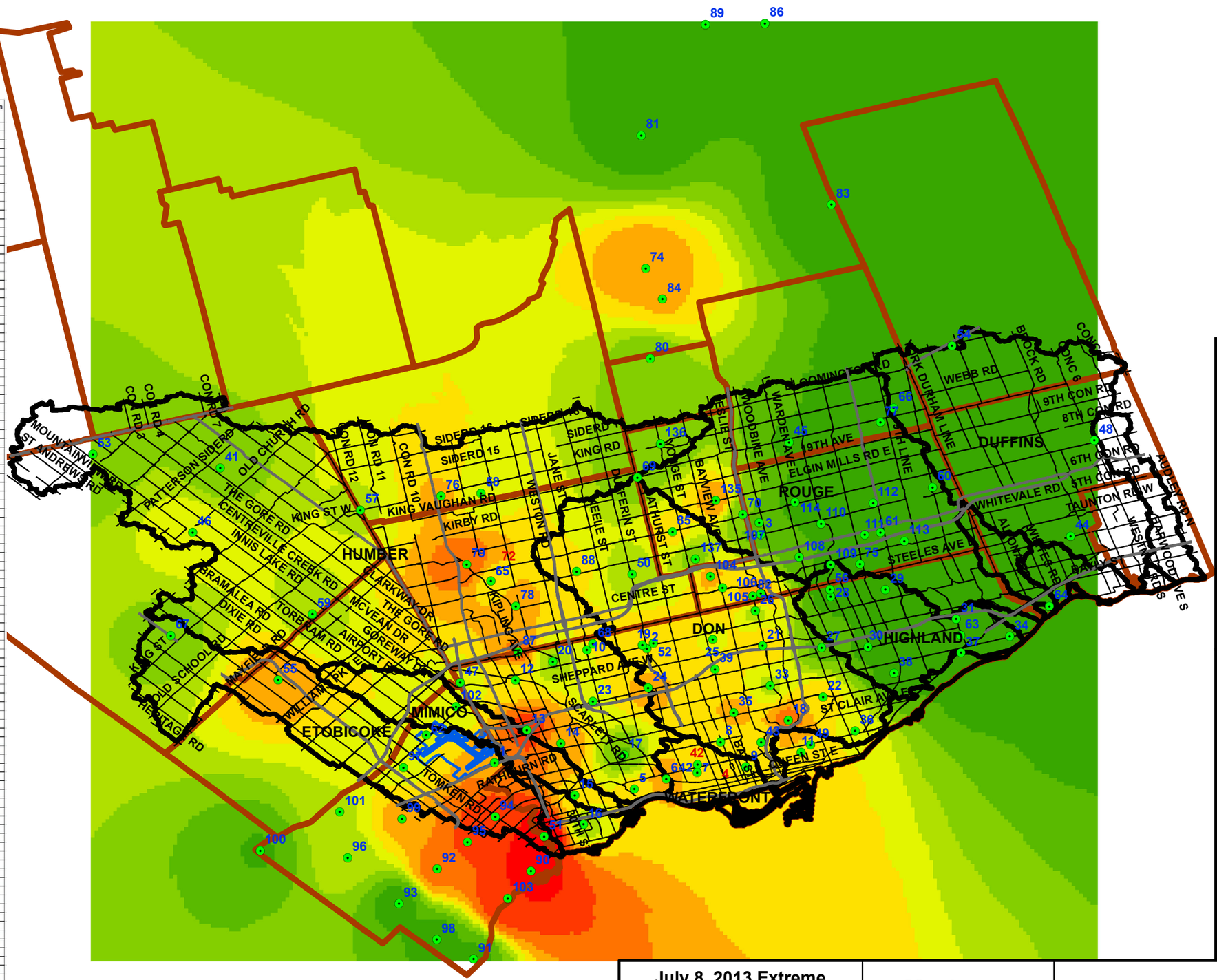
Maximum rainfall intensity for each TRCA watershed has also been calculated using the spatial coverage of rainfall intensities for all durations and the results have been presented in Table 4-3.

Table 4-3: Maximum Rainfall Intensity for All Durations for TRCA Watersheds

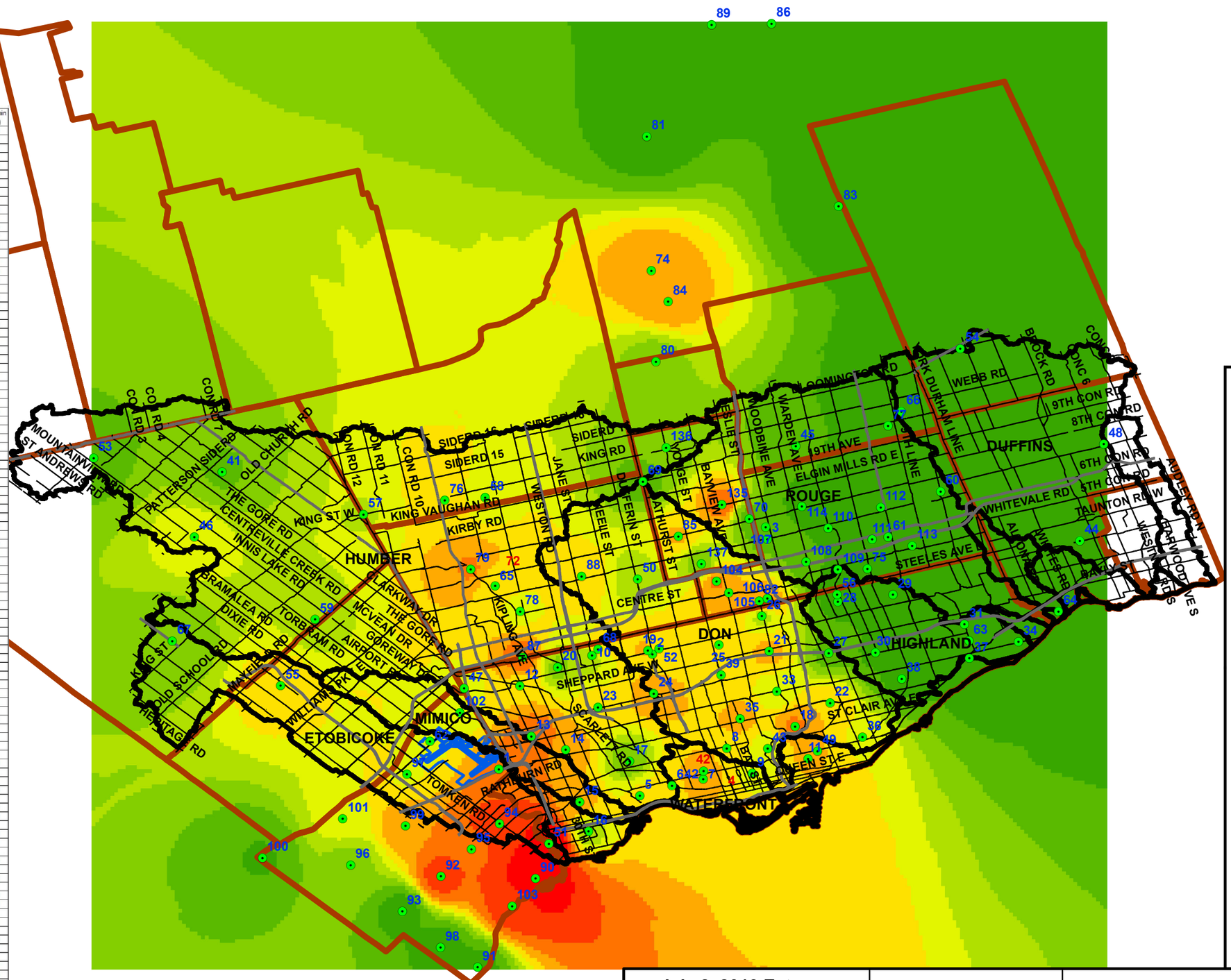
TRCA Watersheds	Maximum 5 Min Intensity (mm/hr)	Maximum 10 Min Intensity (mm/hr)	Maximum 15 Min Intensity (mm/hr)	Maximum 30 Min Intensity (mm/hr)	Maximum 1 Hour Intensity (mm/hr)	Maximum 2 Hour Intensity (mm/hr)	Maximum 6 Hour Intensity (mm/hr)	Maximum 12 Hour Intensity (mm/hr)
Carruthers	4.82	4.81	4.69	3.39	2.53	1.94	0.73	0.43
Don	143.99	121.19	109.00	84.99	54.12	41.18	15.12	7.64
Duffins	8.55	7.63	6.80	5.69	4.60	3.10	1.24	0.68
Etobicoke	259.16	205.17	162.34	117.20	70.00	46.10	18.87	9.55
Frenchman's Bay	9.59	8.39	7.98	6.79	5.99	3.79	1.46	0.75
Highland	60.67	53.41	47.21	30.79	16.64	9.30	3.94	2.06
Humber	180.00	135.00	116.00	91.00	78.75	56.75	22.87	11.50
Mimico	179.44	134.75	110.19	90.83	78.53	56.57	22.80	11.47
Petticoat	9.60	8.40	8.00	6.80	6.00	3.80	1.47	0.75
Rouge	131.93	129.52	117.54	84.35	46.18	24.49	9.20	4.73

The results provided in Table 4-3 indicate that for rainfall with a duration of 30 minutes or shorter, the Etobicoke Creek watershed received the largest rainfall intensity. For 1 hour duration and longer, the Humber River and Mimico Creek watersheds received the highest intensities. The maximum rainfall intensity was observed to be equal to 259.2 mm/hour, occurring in the Etobicoke Creek watershed, with 21.6 mm of rainfall depth over a period of 5 minutes. This rainfall intensity was recorded at gauge HY025, located on Etobicoke Creek at QEW which is operated by TRCA. The maximum one hour precipitation observed within the TRCA jurisdiction was 78.75 mm, observed in the Humber River watershed. This rainfall intensity was recorded at the Martin Grove gauge, located at 947 Martin Grove Road, operated by the City of Toronto.

ID	Gauge Name	Source	Max 5 min (mm/hr)
1	Toronto Lester B. Pearson Int'L A	Environment Canada	129.60
2	Toronto North York	Environment Canada	103.20
3	Toronto Buttonville A	Environment Canada	38.40
5	Swansea	City of Toronto	105.00
6	Howard	City of Toronto	129.00
7	Central	City of Toronto	105.00
8	Brown	City of Toronto	99.00
9	Church	City of Toronto	99.00
10	Jane	City of Toronto	93.00
11	Greenwood	City of Toronto	114.00
12	Albion	City of Toronto	99.00
13	Martin Grove	City of Toronto	180.00
14	Richview	City of Toronto	132.00
15	Bering	City of Toronto	111.00
16	Kipling	City of Toronto	72.00
17	Castlefield	City of Toronto	45.00
18	Thorncliffe	City of Toronto	144.00
19	Finch Yard	City of Toronto	108.00
20	Emery Yard	City of Toronto	66.00
21	Fire Station 116	City of Toronto	114.00
22	Bermondsey Yard	City of Toronto	108.00
23	Wilson	City of Toronto	96.00
24	Ancaster	City of Toronto	123.90
25	Mitchell Field	City of Toronto	97.54
26	Cummer	City of Toronto	75.00
27	Pharmacy/401	City of Toronto	42.00
28	Lismoreaux	City of Toronto	21.00
29	Nashdene Yard	City of Toronto	9.00
30	Ellesmere Yard	City of Toronto	18.00
31	Morningside Yard	City of Toronto	6.00
33	Edwards Gardens	City of Toronto	81.00
34	Fire Station 215	City of Toronto	9.00
35	Mount Pleasant	City of Toronto	120.00
36	Denton	City of Toronto	93.00
37	Poplar	City of Toronto	6.00
38	Seminole	City of Toronto	15.00
39	Fire Station 121	City of Toronto	102.00
41	HY002	TRCA	57.60
42	HY003	TRCA	112.80
43	HY008	TRCA	108.00
44	HY009	TRCA	7.20
45	HY011	TRCA	21.60
46	HY012	TRCA	96.00
47	HY014	TRCA	91.20
48	HY015	TRCA	4.80
49	HY016	TRCA	115.20
50	HY021	TRCA	70.80
51	HY025	TRCA	259.20
52	HY027	TRCA	110.40
53	HY030	TRCA	55.20
54	HY031	TRCA	4.80
55	HY033	TRCA	129.60
56	HY036	TRCA	12.00
57	HY037	TRCA	81.60
58	HY038	TRCA	86.40
59	HY041	TRCA	76.80
60	HY043	TRCA	7.20
61	HY044	TRCA	9.60
62	HY046	TRCA	98.40
63	HY050	TRCA	7.20
64	HY051	TRCA	9.60
65	HY055	TRCA	105.60
66	HY060	TRCA	6.00
67	HY061	TRCA	62.40
68	HY064	TRCA	110.40
69	HY069	TRCA	57.60
70	HY070	TRCA	48.00
74	R_ET_HL01	York Region	134.40
75	R_ET_MA03	York Region	7.20
76	R_ET_NO01	York Region	117.60
77	R_ET_ST02	York Region	7.20
78	R_ET_VA01	York Region	122.40
79	R_ET_VA02	York Region	158.40
80	R_YR_AU02	York Region	52.80
81	R_YR_KE01	York Region	9.60
82	R_YR_MA03	York Region	127.20
83	R_YR_MO01	York Region	4.80
84	R_YR_NE01	York Region	117.60
85	R_YR_RH01	York Region	108.00
86	R_YR_SU01	York Region	4.80
87	R_YR_VA03	York Region	141.60
88	R_YR_VA04	York Region	100.80
89	R_YR_WB01	York Region	7.20
90	STN 01 - Third St.	Mississauga	220.80
91	STN 02 - Clarkson	Mississauga	16.80
92	STN 03 - Wolfedale	Mississauga	148.80
93	STN 04 - South Common	Mississauga	9.00
94	STN 05 - Winding Trail	Mississauga	172.80
95	STN 06 - Mississauga Valley	Mississauga	165.60
96	STN 07 - Britannia	Mississauga	74.40
97	STN 08 - Tomken	Mississauga	93.60
98	STN 09 - Truscott	Mississauga	7.20
99	STN 10 - Falbourne	Mississauga	122.40
100	STN 11 - Garry Morden FTC	Mississauga	21.60
101	STN 12 - CVC	Mississauga	81.60
102	STN 13 - Goreway	Mississauga	84.00
103	STN 14 - Port Credit	Mississauga	196.80
104	Stornoway P.S.	Markham	124.80
105	Thornhill C.C.	Markham	109.73
106	German Mills P.S.	Markham	124.80
107	Lincoln Alexander P.S.	Markham	40.80
108	8100 Warden Ave	Markham	33.60
109	Milliken Mills C.C.	Markham	9.00
110	Fire Hall #94	Markham	15.00
111	Roy H Crosby P.S.	Markham	9.60
112	Markham Museum	Markham	12.00
113	Rouge River C.C.	Markham	12.00
114	Angus Glen C.C.	Markham	15.00
135	Discovery	RichmondHill	132.00
136	Oak Ridges	RichmondHill	50.40
137	Operations	RichmondHill	55.20



ID	Gauge Name	Source	Max 10 min (mm/hr)
1	Toronto Lester B. Pearson Int'L A	Environment Canada	121.20
2	Toronto North York	Environment Canada	94.80
3	Toronto Buttonville A	Environment Canada	33.60
5	Swansea	City of Toronto	98.50
6	Howard	City of Toronto	100.50
7	Central	City of Toronto	103.50
8	Brown	City of Toronto	99.00
9	Church	City of Toronto	82.50
10	Jane	City of Toronto	57.00
11	Greenwood	City of Toronto	102.00
12	Albion	City of Toronto	96.00
13	Martin Grove	City of Toronto	135.00
14	Richview	City of Toronto	114.00
15	Bering	City of Toronto	105.00
16	Kipling	City of Toronto	64.50
17	Castlefield	City of Toronto	45.00
18	Thorncliffe	City of Toronto	120.00
19	Finch Yard	City of Toronto	106.50
20	Emery Yard	City of Toronto	54.00
21	Fire Station 116	City of Toronto	105.00
22	Bermondsey Yard	City of Toronto	100.50
23	Wilson	City of Toronto	91.50
24	Ancaster	City of Toronto	112.50
25	Mitchell Field	City of Toronto	91.44
26	Cummer	City of Toronto	66.00
27	Pharmacy/401	City of Toronto	36.00
28	Liamoreaux	City of Toronto	15.00
29	Nashdene Yard	City of Toronto	7.50
30	Ellesmere Yard	City of Toronto	15.00
31	Morningside Yard	City of Toronto	6.00
33	Edwards Gardens	City of Toronto	73.50
34	Fire Station 215	City of Toronto	7.50
35	Mount Pleasant	City of Toronto	105.00
36	Denton	City of Toronto	84.00
37	Poplar	City of Toronto	4.50
38	Seminole	City of Toronto	13.50
39	Fire Station 121	City of Toronto	91.50
41	HY002	TRCA	39.60
42	HY003	TRCA	104.40
43	HY008	TRCA	75.60
44	HY009	TRCA	6.00
45	HY011	TRCA	21.60
46	HY012	TRCA	81.60
47	HY014	TRCA	81.60
48	HY015	TRCA	4.80
49	HY016	TRCA	100.80
50	HY021	TRCA	60.60
51	HY025	TRCA	205.20
52	HY027	TRCA	86.40
53	HY030	TRCA	36.00
54	HY031	TRCA	2.40
55	HY033	TRCA	97.20
56	HY036	TRCA	12.00
57	HY037	TRCA	72.00
58	HY038	TRCA	79.20
59	HY041	TRCA	66.00
60	HY043	TRCA	7.20
61	HY044	TRCA	8.40
62	HY046	TRCA	82.80
63	HY050	TRCA	7.20
64	HY051	TRCA	8.40
65	HY055	TRCA	90.00
66	HY060	TRCA	4.20
67	HY061	TRCA	45.60
68	HY064	TRCA	99.60
69	HY069	TRCA	33.60
70	HY070	TRCA	33.60
74	R_ET_HL01	York Region	112.80
75	R_ET_MA03	York Region	6.00
76	R_ET_NO01	York Region	98.40
77	R_ET_ST02	York Region	7.20
78	R_ET_VA01	York Region	82.80
79	R_ET_VA02	York Region	118.80
80	R_YR_AU02	York Region	48.00
81	R_YR_KE01	York Region	9.40
82	R_YR_MA03	York Region	110.40
83	R_YR_MO01	York Region	2.40
84	R_YR_NE01	York Region	114.00
85	R_YR_RH01	York Region	102.00
86	R_YR_SU01	York Region	3.60
87	R_YR_VA03	York Region	130.80
88	R_YR_VA04	York Region	98.40
89	R_YR_WB01	York Region	4.80
90	STN 01 - Third St.	Mississauga	214.80
91	STN 02 - Clarkson	Mississauga	10.80
92	STN 03 - Wolfedale	Mississauga	148.80
93	STN 04 - South Common	Mississauga	7.50
94	STN 05 - Winding Trail	Mississauga	148.80
95	STN 06 - Mississauga Valley	Mississauga	134.40
96	STN 07 - Britannia	Mississauga	49.20
97	STN 08 - Tomken	Mississauga	85.20
98	STN 09 - Truscott	Mississauga	4.80
99	STN 10 - Falbourne	Mississauga	114.00
100	STN 11 - Garry Morden FTC	Mississauga	18.00
101	STN 12 - CVC	Mississauga	90.40
102	STN 13 - Goreway	Mississauga	76.80
103	STN 14 - Port Credit	Mississauga	153.60
104	Stornoway P.S.	Markham	121.20
105	Thornhill C.C.	Markham	106.68
106	German Mills P.S.	Markham	110.40
107	Lincoln Alexander P.S.	Markham	31.20
108	8100 Warden Ave	Markham	31.20
109	Milliken Mills C.C.	Markham	7.50
110	Fire Hall #94	Markham	12.00
111	Roy H Crosby P.S.	Markham	7.20
112	Markham Museum	Markham	8.40
113	Rouge River C.C.	Markham	10.50
114	Angus Glen C.C.	Markham	10.50
135	Discovery	RichmondHill	129.60
136	Oak Ridges	RichmondHill	48.00
137	Operations	RichmondHill	44.40



July 8, 2013 Extreme Rainfall Event

Summary and Analysis Report

Toronto and Region Conservation Authority

Maximum 10 Minute Rainfall Intensity

amec

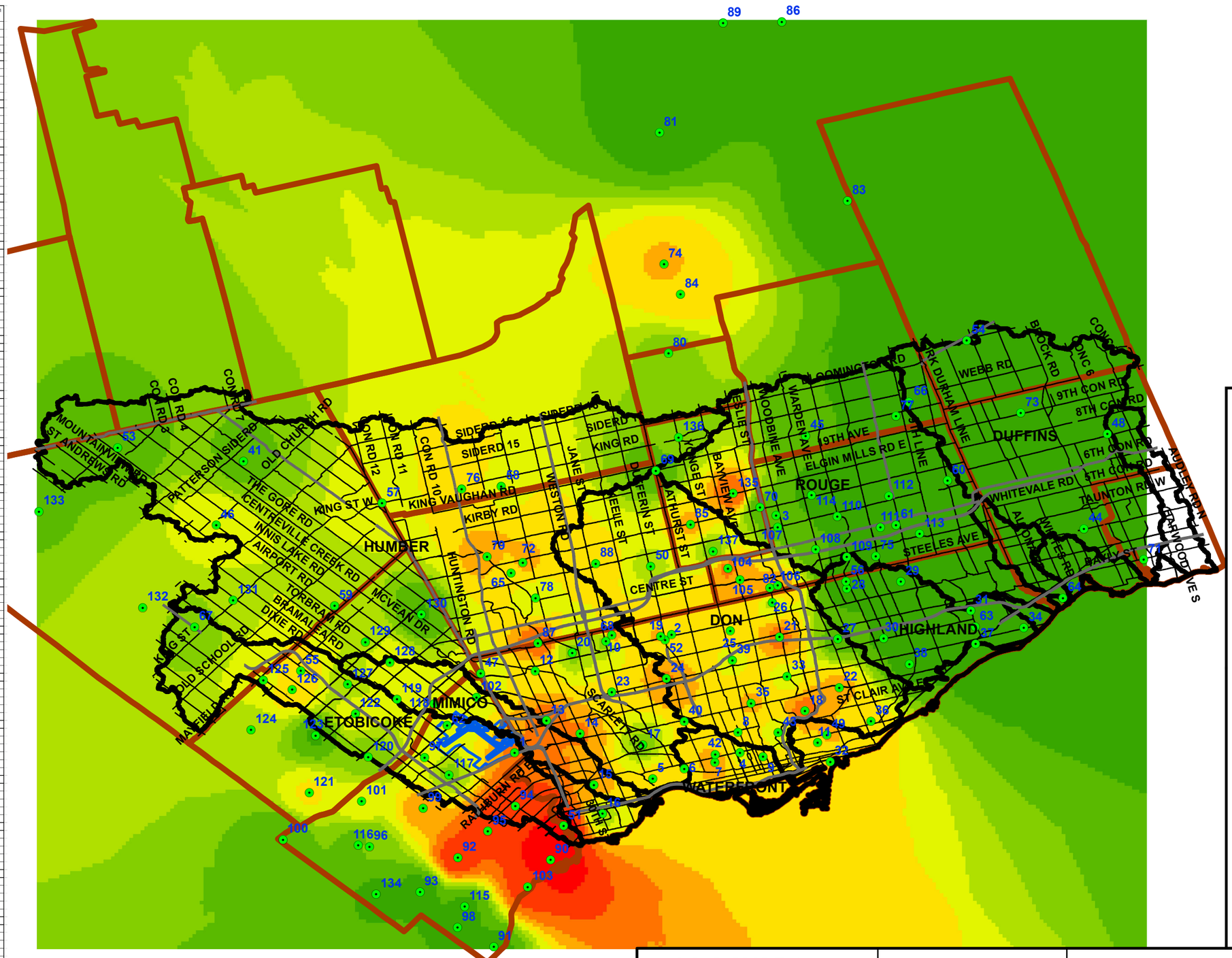
Scale 1:400,000

0 2.5 5 10 15 Kilometers

Project No. TP114045

Figure No. 4-3

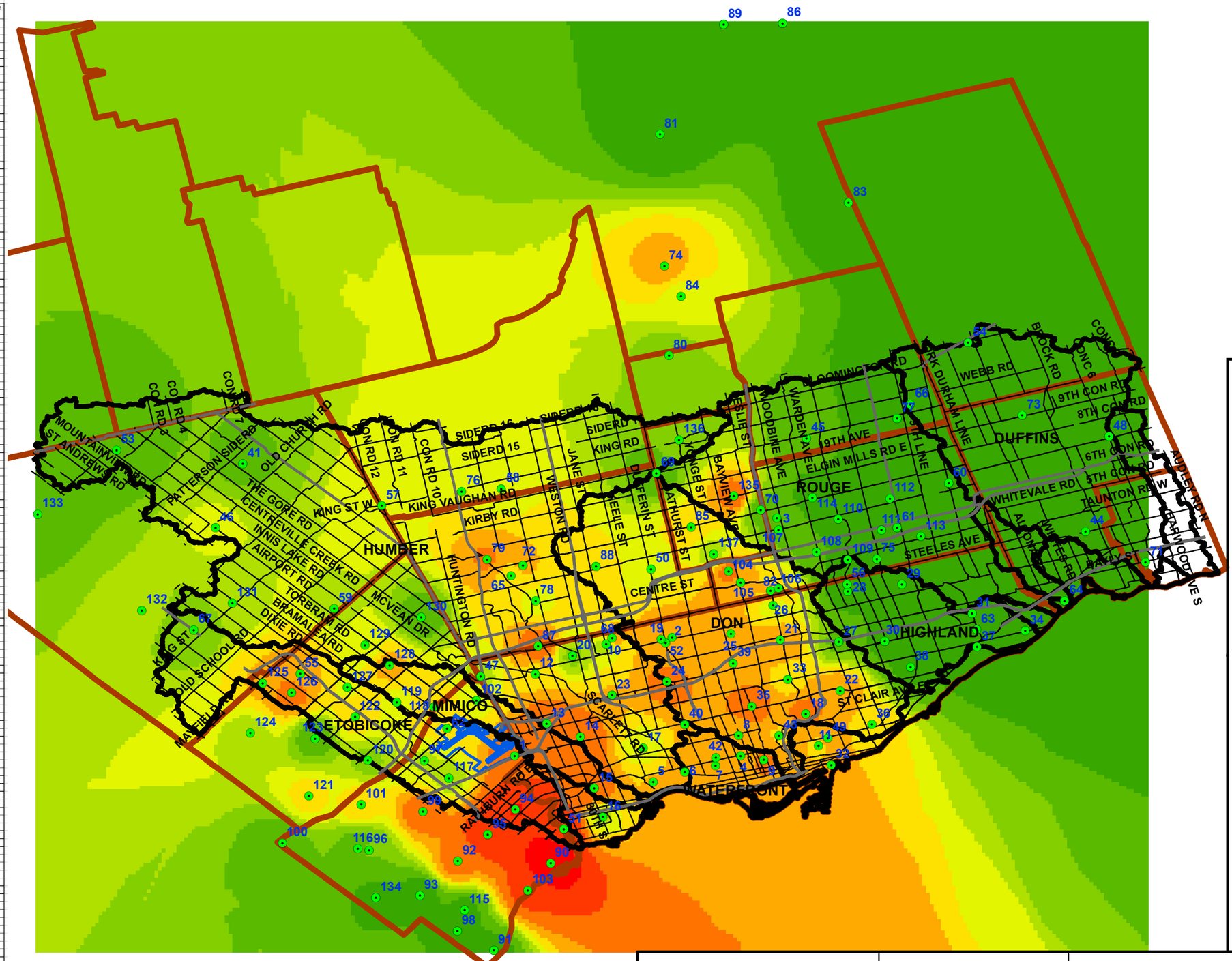
ID	Gauge Name	Source	Max 15 min (mm/hr)
1	Toronto Lester B. Pearson Int'L A	Environment Canada	104.00
2	Toronto North York	Environment Canada	75.20
3	Toronto Buttonville A	Environment Canada	28.00
4	Toronto City	Environment Canada	69.20
5	Swansea	City of Toronto	80.00
6	Howard	City of Toronto	85.00
7	Central	City of Toronto	94.00
8	Brown	City of Toronto	88.00
9	Church	City of Toronto	80.00
10	Jane	City of Toronto	41.00
11	Greenwood	City of Toronto	87.00
12	Albion	City of Toronto	81.00
13	Martin Grove	City of Toronto	110.00
14	Richview	City of Toronto	104.00
15	Bering	City of Toronto	99.00
16	Kipling	City of Toronto	55.00
17	Castlefield	City of Toronto	45.00
18	Thorncliffe	City of Toronto	109.00
19	Finch Yard	City of Toronto	94.00
20	Emery Yard	City of Toronto	46.00
21	Fire Station 116	City of Toronto	107.00
22	Bermondsey Yard	City of Toronto	94.00
23	Wilson	City of Toronto	77.00
24	Ancaster	City of Toronto	104.00
25	Mitchell Field	City of Toronto	80.26
26	Cummer	City of Toronto	58.00
27	Pharmacy/401	City of Toronto	29.00
28	Lawrence Ave	City of Toronto	11.00
29	Nashdene Yard	City of Toronto	6.00
30	Ellesmere Yard	City of Toronto	13.00
31	Morningside Yard	City of Toronto	6.00
33	Edwards Gardens	City of Toronto	69.00
34	Fire Station 215	City of Toronto	6.00
35	Mount Pleasant	City of Toronto	90.00
36	Denton	City of Toronto	80.00
37	Poplar	City of Toronto	4.00
38	Seminole	City of Toronto	12.00
39	Fire Station 121	City of Toronto	72.00
41	HY002	TRCA	30.80
42	HY003	TRCA	88.80
43	HY008	TRCA	66.40
44	HY009	TRCA	5.60
45	HY011	TRCA	19.20
46	HY012	TRCA	72.80
47	HY014	TRCA	60.80
48	HY015	TRCA	4.00
49	HY016	TRCA	89.60
50	HY021	TRCA	56.80
51	HY025	TRCA	161.60
52	HY027	TRCA	76.00
53	HY030	TRCA	26.40
54	HY031	TRCA	2.40
55	HY033	TRCA	83.20
56	HY036	TRCA	8.80
57	HY037	TRCA	65.60
58	HY038	TRCA	70.40
59	HY041	TRCA	54.40
60	HY043	TRCA	6.40
61	HY044	TRCA	7.20
62	HY045	TRCA	68.00
63	HY050	TRCA	5.60
64	HY051	TRCA	8.00
65	HY055	TRCA	74.40
66	HY060	TRCA	4.00
67	HY061	TRCA	36.80
68	HY064	TRCA	100.80
69	HY069	TRCA	24.00
70	HY070	TRCA	28.00
71	HY004	TRCA	5.60
72	HY039	TRCA	94.40
73	HY063	TRCA	3.20
74	R_ET_HL01	York Region	90.40
75	R_ET_MA03	York Region	5.60
76	R_ET_NO01	York Region	86.40
77	R_ET_ST02	York Region	5.60
78	R_ET_VA01	York Region	63.20
79	R_ET_VA02	York Region	97.60
80	R_YR_AU02	York Region	42.40
81	R_YR_KE01	York Region	6.40
82	R_YR_MA03	York Region	96.80
83	R_YR_MO01	York Region	2.40
84	R_YR_NE01	York Region	87.20
85	R_YR_RH01	York Region	91.20
86	R_YR_SU01	York Region	2.40
87	R_YR_VA03	York Region	116.00
88	R_YR_VA04	York Region	84.80
89	R_YR_WB01	York Region	4.00
90	STN 01 - Third St.	Mississauga	194.40
91	STN 02 - Clarkson	Mississauga	10.40
92	STN 03 - Wolfedale	Mississauga	139.20
93	STN 04 - South Common	Mississauga	6.00
94	STN 06 - Winding Trail	Mississauga	145.60
95	STN 06 - Mississauga Valley	Mississauga	134.40
96	STN 07 - Britannia	Mississauga	38.40
97	STN 08 - Tomken	Mississauga	64.00
98	STN 09 - Truscott	Mississauga	5.60
99	STN 10 - Falbourne	Mississauga	100.00
100	STN 11 - Garry Morden FTC	Mississauga	16.80
101	STN 12 - CVC	Mississauga	74.40
102	STN 13 - Goreway	Mississauga	69.60
103	STN 14 - Port Credit	Mississauga	136.00
104	Stornoway P.S.	Markham	107.20
105	Thornhill C.C.	Markham	96.52
106	German Mills P.S.	Markham	96.00
107	Lincoln Alexander P.S.	Markham	27.20
108	8100 Warden Ave	Markham	22.40
109	Milliken Mills C.C.	Markham	6.00
110	Fire Hall #94	Markham	10.00
111	Roy H Crosby P.S.	Markham	7.20
112	Markham Museum	Markham	8.80
113	Rouge River C.C.	Markham	10.00
114	Angus Glen C.C.	Markham	9.00
115	RG03	Peel Region	12.00
116	RG11	Peel Region	27.00
117	RG16	Peel Region	46.00
118	RG20	Peel Region	71.00
119	RG22	Peel Region	61.00
120	RG23	Peel Region	35.00
121	RG24	Peel Region	77.00
122	RG25	Peel Region	71.00
123	RG26	Peel Region	15.00
124	RG27	Peel Region	50.00
125	RG28	Peel Region	67.00
126	RG29	Peel Region	89.00
127	RG31	Peel Region	51.00
128	RG32	Peel Region	71.00
129	RG33	Peel Region	58.00
130	RG34	Peel Region	16.00
131	RG36	Peel Region	58.00
132	RG39	Peel Region	56.00
133	RG42	Peel Region	33.00
134	RG44	Peel Region	12.00
135	Discovery	RichmondHill	117.60
136	Oak Ridges	RichmondHill	42.40
137	Operations	RichmondHill	41.60



Page 50

July 8, 2013 Extreme Rainfall Event **Summary and Analysis Report** **Toronto and Region Conservation Authority**	**Maximum 15 Minute Rainfall Intensity**	amec	Scale **1:400,000** 0 2.5 5 10 15 Kilometers Project No. **TP114045** Figure No. **4-4**

ID	Gauge Name	Source	Max 30 min (mm/hr)
1	Toronto Lester B. Pearson Intl A	Environment Canada	85.20
2	Toronto North York	Environment Canada	72.90
3	Toronto Buttonville A	Environment Canada	19.40
4	Toronto City	Environment Canada	64.40
5	Swansea	City of Toronto	62.00
6	Howard	City of Toronto	66.00
7	Central	City of Toronto	74.50
8	Brown	City of Toronto	67.50
9	Church	City of Toronto	77.00
10	Jane	City of Toronto	35.00
11	Greenwood	City of Toronto	60.50
12	Albion	City of Toronto	58.50
13	Martin Grove	City of Toronto	91.00
14	Richview	City of Toronto	90.00
15	Bering	City of Toronto	87.50
16	Kipling	City of Toronto	40.50
17	Castlefield	City of Toronto	42.00
18	Thorncliffe	City of Toronto	81.50
19	Finch Yard	City of Toronto	64.00
20	Emery Yard	City of Toronto	31.00
21	Fire Station 116	City of Toronto	73.50
22	Bermondsey Yard	City of Toronto	74.50
23	Wilson	City of Toronto	62.00
24	Ancaster	City of Toronto	81.50
25	Mitchell Field	City of Toronto	66.04
26	Cummer	City of Toronto	42.50
27	Pharmacy/401	City of Toronto	21.50
28	Liamoreaux	City of Toronto	6.50
29	Nashdene Yard	City of Toronto	6.00
30	Ellesmere Yard	City of Toronto	7.00
31	Morningside Yard	City of Toronto	5.50
32	Edwards Gardens	City of Toronto	56.00
33	Fire Station 215	City of Toronto	5.50
34	Mount Pleasant	City of Toronto	85.00
35	Denton	City of Toronto	57.50
36	Poplar	City of Toronto	3.50
37	Seminole	City of Toronto	8.00
38	Fire Station 121	City of Toronto	66.00
39	HY002	TRCA	21.00
41	HY003	TRCA	71.60
42	HY008	TRCA	60.80
43	HY009	TRCA	4.40
44	HY011	TRCA	15.60
45	HY012	TRCA	44.40
46	HY014	TRCA	39.20
47	HY015	TRCA	2.40
48	HY016	TRCA	64.00
49	HY021	TRCA	43.00
51	HY025	TRCA	114.00
52	HY027	TRCA	64.00
53	HY030	TRCA	13.20
54	HY031	TRCA	1.60
55	HY033	TRCA	66.00
56	HY036	TRCA	5.80
57	HY037	TRCA	45.00
58	HY038	TRCA	43.20
59	HY041	TRCA	38.80
60	HY043	TRCA	5.20
61	HY044	TRCA	6.80
62	HY046	TRCA	55.60
63	HY050	TRCA	4.80
64	HY051	TRCA	6.80
65	HY056	TRCA	57.20
66	HY060	TRCA	3.40
67	HY061	TRCA	23.60
68	HY064	TRCA	70.00
69	HY069	TRCA	16.40
70	HY070	TRCA	18.40
71	HY004	TRCA	5.20
72	HY039	TRCA	63.60
73	HY063	TRCA	2.00
74	R_ET_HL01	York Region	67.60
75	R_ET_MA03	York Region	4.40
76	R_ET_NO01	York Region	50.80
77	R_ET_ST02	York Region	4.40
78	R_ET_VA01	York Region	47.20
79	R_ET_VA02	York Region	76.40
80	R_YR_AU02	York Region	28.40
81	R_YR_KE01	York Region	4.40
82	R_YR_MA03	York Region	64.40
83	R_YR_MO01	York Region	1.20
84	R_YR_NE01	York Region	47.20
85	R_YR_RH01	York Region	59.20
86	R_YR_SU01	York Region	2.00
87	R_YR_VA03	York Region	86.80
88	R_YR_VA04	York Region	54.00
89	R_YR_WD01	York Region	2.80
90	STN 01 - Third St.	Mississauga	139.20
91	STN 02 - Clarkson	Mississauga	6.00
92	STN 03 - Wolfedale	Mississauga	82.80
93	STN 04 - South Common	Mississauga	4.00
94	STN 05 - Winding Trail	Mississauga	117.20
95	STN 06 - Mississauga Valley	Mississauga	111.60
96	STN 07 - Britannia	Mississauga	24.00
97	STN 08 - Tomken	Mississauga	40.80
98	STN 09 - Truscott	Mississauga	3.60
99	STN 10 - Malbourne	Mississauga	87.20
100	STN 11 - Garry Morden FTC	Mississauga	12.40
101	STN 12 - CYC	Mississauga	60.00
102	STN 13 - Goreway	Mississauga	48.00
103	STN 14 - Port Credit	Mississauga	100.40
104	Stornoway P.S.	Markham	80.00
105	Thornhill C.C.	Markham	70.61
106	German Mills P.S.	Markham	57.20
107	Lincoln Alexander P.S.	Markham	17.20
108	8100 Warden Ave	Markham	12.40
109	Milliken Mills C.C.	Markham	5.00
110	Fire Hall #94	Markham	6.50
111	Roy H Crosby P.S.	Markham	6.40
112	Markham Museum	Markham	7.20
113	Rouge River C.C.	Markham	8.00
114	Angus Glen C.C.	Markham	5.50
115	RG03	Peel Region	7.50
116	RG11	Peel Region	16.00
117	RG16	Peel Region	35.50
118	RG20	Peel Region	60.00
119	RG22	Peel Region	48.50
120	RG23	Peel Region	30.00
121	RG24	Peel Region	55.00
122	RG25	Peel Region	57.50
123	RG26	Peel Region	14.50
124	RG27	Peel Region	38.00
125	RG28	Peel Region	63.00
126	RG29	Peel Region	84.50
127	RG31	Peel Region	50.00
128	RG32	Peel Region	67.00
129	RG33	Peel Region	42.50
130	RG34	Peel Region	16.00
131	RG36	Peel Region	35.00
132	RG39	Peel Region	36.00
133	RG42	Peel Region	17.50
134	RG44	Peel Region	7.50
135	Discovery	RichmondHill	84.40
136	Oak Ridges	RichmondHill	27.60
137	Operations	RichmondHill	34.80



Legend

- Rainfall Gauges
- Highways
- Major Roads
- Watersheds
- Municipal Boundaries
- Pearson Airport

Maximum 30 min Intensity (mm/hr)

- 1 - 11
- 12 - 23
- 24 - 33
- 34 - 42
- 43 - 51
- 52 - 62
- 63 - 75
- 76 - 94
- 95 - 117
- 118 - 139

July 8, 2013 Extreme Rainfall Event

Summary and Analysis Report

Toronto and Region Conservation Authority

Maximum 30 Minute Rainfall Intensity

amec

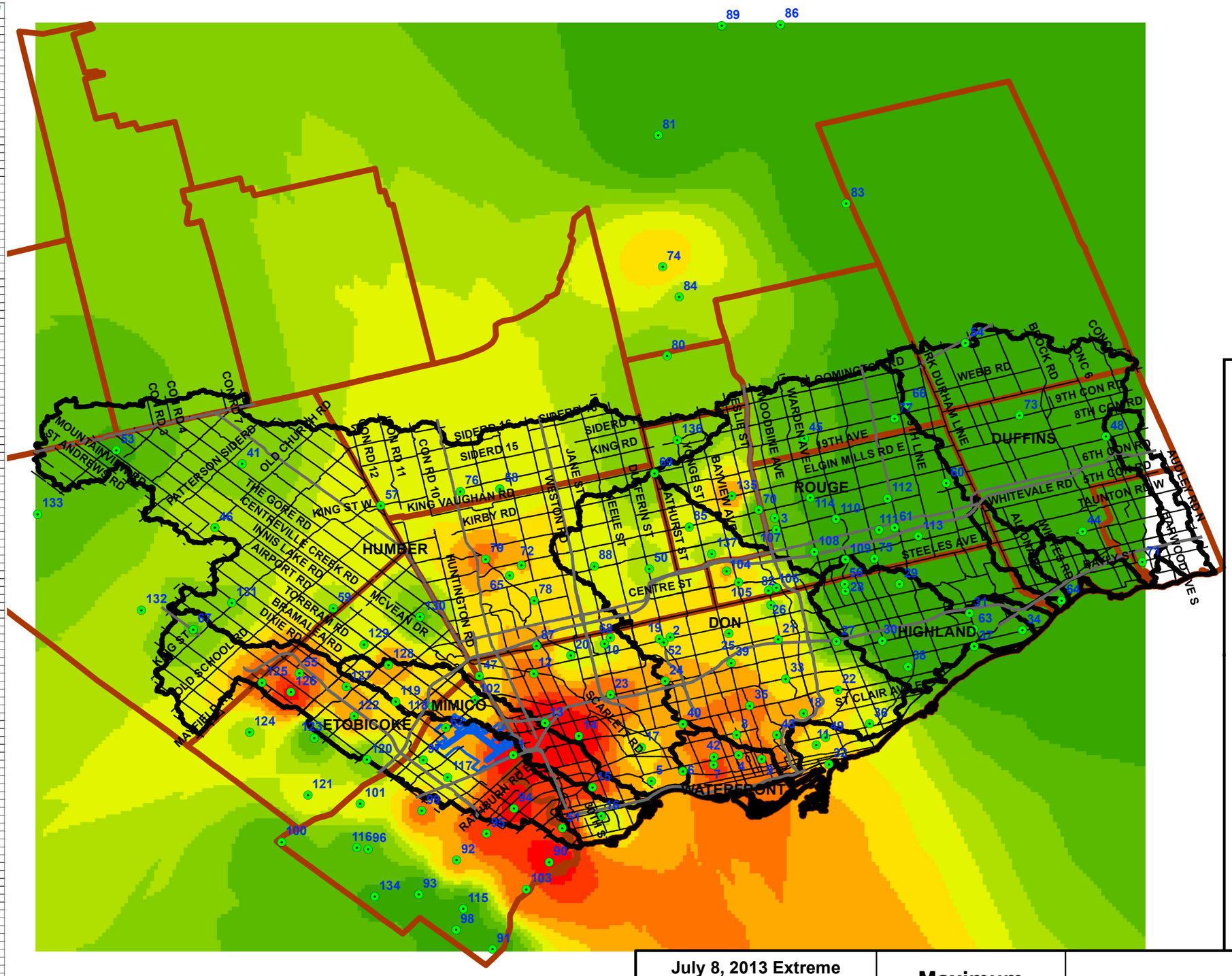
Scale 1:400,000

0 2.5 5 10 15 Kilometers

Project No. TP114045

Figure No. 4-5

ID	Gauge Name	Source	Max 1 hour (mm/hr)
1	Toronto Lester B. Pearson Int'L A	Environment Canada	70.00
2	Toronto North York	Environment Canada	42.00
3	Toronto Buttonville A	Environment Canada	10.60
4	Toronto City	Environment Canada	51.20
5	Swansea	City of Toronto	41.25
6	Howard	City of Toronto	44.25
7	Central	City of Toronto	59.50
8	Brown	City of Toronto	46.00
9	Church	City of Toronto	55.75
10	Jane	City of Toronto	22.00
11	Greenwood	City of Toronto	38.00
12	Albion	City of Toronto	51.75
13	Martin Grove	City of Toronto	78.75
14	Richview	City of Toronto	73.00
15	Bering	City of Toronto	62.00
16	Kipling	City of Toronto	25.50
17	Castlefield	City of Toronto	37.75
18	Thorncliffe	City of Toronto	46.00
19	Finch Yard	City of Toronto	39.60
20	Emery Yard	City of Toronto	29.25
21	Fire Station 116	City of Toronto	41.60
22	Bermondsey Yard	City of Toronto	40.25
23	Wilson	City of Toronto	55.25
24	Ancaster	City of Toronto	46.00
25	Mitchell Field	City of Toronto	39.37
26	Cummer	City of Toronto	23.00
27	Pharmacy/401	City of Toronto	11.50
28	Llamoreaux	City of Toronto	3.75
29	Nashdene Yard	City of Toronto	4.25
30	Ellesmere Yard	City of Toronto	4.25
31	Morningside Yard	City of Toronto	5.00
33	Edwards Gardens	City of Toronto	35.25
34	Fire Station 215	City of Toronto	4.50
35	Mount Pleasant	City of Toronto	51.00
36	Denton	City of Toronto	31.00
37	Poplar	City of Toronto	3.25
38	Seminole	City of Toronto	4.50
39	Fire Station 121	City of Toronto	41.50
41	HY002	TRCA	16.90
42	HY003	TRCA	54.20
43	HY006	TRCA	45.60
44	HY009	TRCA	3.80
45	HY011	TRCA	8.60
46	HY012	TRCA	24.40
47	HY014	TRCA	35.20
48	HY015	TRCA	1.40
49	HY016	TRCA	35.00
50	HY021	TRCA	24.40
51	HY025	TRCA	63.00
52	HY027	TRCA	38.40
53	HY030	TRCA	6.60
54	HY031	TRCA	0.80
55	HY033	TRCA	54.40
56	HY036	TRCA	3.40
57	HY037	TRCA	31.60
58	HY038	TRCA	28.20
59	HY041	TRCA	25.20
60	HY043	TRCA	3.60
61	HY044	TRCA	5.40
62	HY046	TRCA	47.60
63	HY050	TRCA	4.40
64	HY051	TRCA	6.00
65	HY055	TRCA	41.00
66	HY060	TRCA	2.90
67	HY061	TRCA	13.60
68	HY064	TRCA	42.20
69	HY069	TRCA	14.00
70	HY070	TRCA	11.00
71	HY004	TRCA	4.60
72	HY039	TRCA	41.60
73	HY063	TRCA	1.20
74	R_ET_HL01	York Region	39.00
75	R_ET_MA03	York Region	3.00
76	R_ET_NO01	York Region	31.20
77	R_ET_ST02	York Region	3.00
78	R_ET_VA01	York Region	36.20
79	R_ET_VA02	York Region	49.60
80	R_YR_AU02	York Region	16.40
81	R_YR_KE01	York Region	2.20
82	R_YR_MA03	York Region	34.20
83	R_YR_MO01	York Region	1.00
84	R_YR_NE01	York Region	24.80
85	R_YR_RH01	York Region	31.60
86	R_YR_SU01	York Region	1.20
87	R_YR_VA03	York Region	46.40
88	R_YR_VA04	York Region	29.00
89	R_YR_WE01	York Region	1.60
90	STN 01 - Third St.	Mississauga	74.20
91	STN 02 - Clarkson	Mississauga	3.00
92	STN 03 - Wolfedale	Mississauga	43.60
93	STN 04 - South Common	Mississauga	2.25
94	STN 05 - Winding Trail	Mississauga	66.80
95	STN 06 - Mississauga Valley	Mississauga	62.40
96	STN 07 - Britannia	Mississauga	13.80
97	STN 08 - Tomken	Mississauga	27.40
98	STN 09 - Truscott	Mississauga	2.20
99	STN 10 - Falbourne	Mississauga	49.80
100	STN 11 - Garry Morden FTC	Mississauga	7.40
101	STN 12 - CVC	Mississauga	32.60
102	STN 13 - Goreway	Mississauga	34.20
103	STN 14 - Port Credit	Mississauga	54.00
104	Stornoway P.S.	Markham	43.20
105	Thornhill C.C.	Markham	39.61
106	German Mills P.S.	Markham	29.80
107	Lincoln Alexander P.S.	Markham	9.80
108	8100 Warden Ave	Markham	6.60
109	Milliken Mills C.C.	Markham	3.50
110	Fire Hall #94	Markham	4.50
111	Roy H Crosby P.S.	Markham	5.00
112	Markham Museum	Markham	5.00
113	Rouge River C.C.	Markham	6.00
114	Angus Glen C.C.	Markham	5.00
115	RG03	Peel Region	3.75
116	RG11	Peel Region	9.25
117	RG16	Peel Region	27.75
118	RG20	Peel Region	42.75
119	RG22	Peel Region	35.25
120	RG23	Peel Region	17.00
121	RG24	Peel Region	30.00
122	RG25	Peel Region	46.00
123	RG26	Peel Region	9.50
124	RG27	Peel Region	25.00
125	RG28	Peel Region	49.75
126	RG29	Peel Region	67.00
127	RG31	Peel Region	41.50
128	RG32	Peel Region	47.75
129	RG33	Peel Region	27.75
130	RG34	Peel Region	13.50
131	RG36	Peel Region	20.25
132	RG39	Peel Region	21.25
133	RG42	Peel Region	9.75
134	RG44	Peel Region	6.00
135	Discovery	RichmondHill	46.20
136	Oak Ridges	RichmondHill	14.80
137	Operations	RichmondHill	21.80



July 8, 2013 Extreme Rainfall Event

Summary and Analysis Report

Toronto and Region Conservation Authority

Maximum 1 Hour Rainfall Intensity

amec

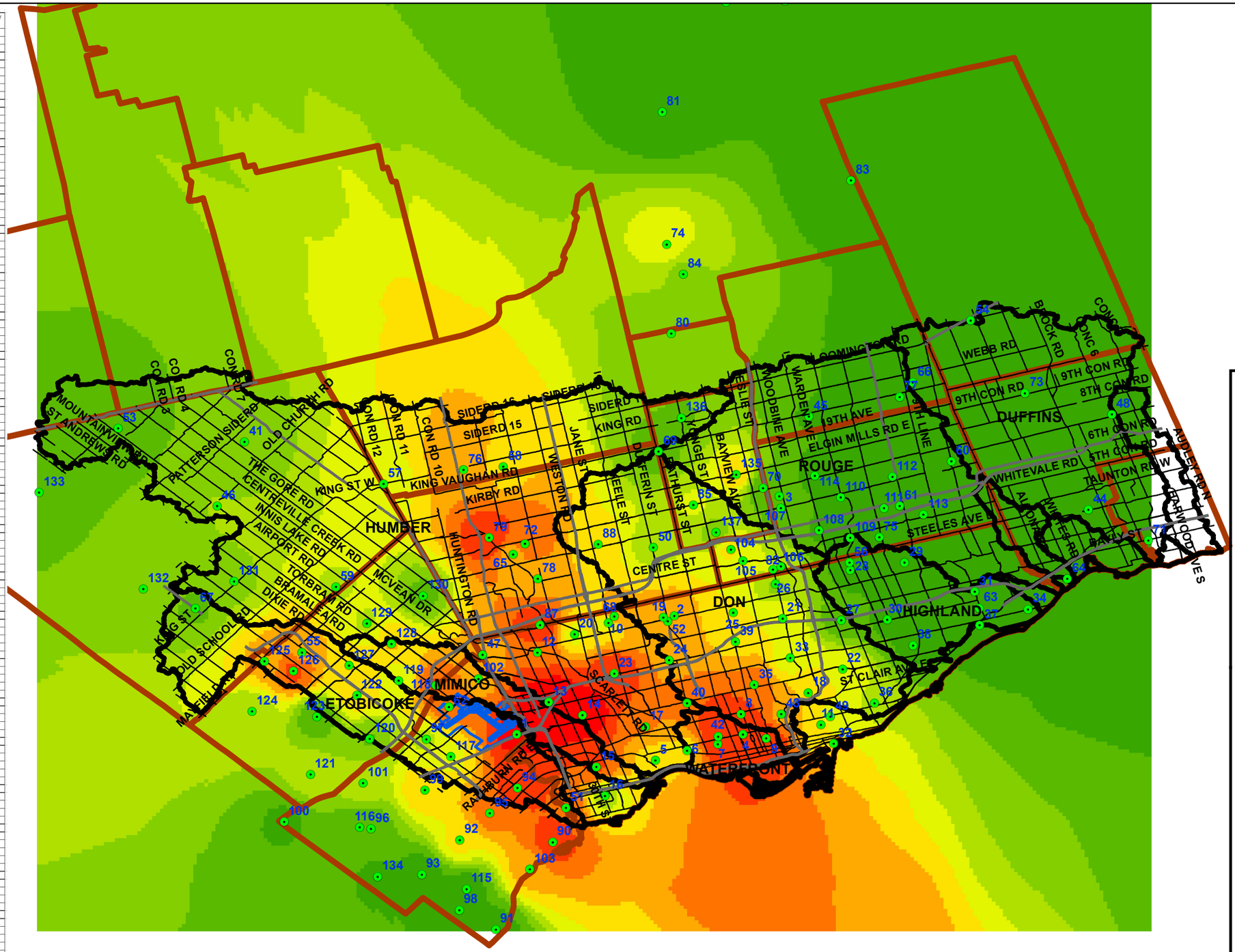
Scale 1:400,000

0 2.5 5 10 15 Kilometers

Project No. TP114045

Figure No. 4-6

ID	Gauge Name	Source	Max 2 hour (mm/hr)
1	Toronto Lester B. Pearson Int'L A	Environment Canada	46.10
2	Toronto North York	Environment Canada	28.10
3	Toronto Buttonville A	Environment Canada	6.00
4	Toronto City	Environment Canada	43.85
5	Swansea	City of Toronto	23.13
6	Howard	City of Toronto	24.38
7	Central	City of Toronto	39.50
8	Brown	City of Toronto	37.38
9	Church	City of Toronto	41.75
10	Jane	City of Toronto	19.75
11	Greenwood	City of Toronto	22.13
12	Albion	City of Toronto	34.25
13	Martin Grove	City of Toronto	56.75
14	Richview	City of Toronto	51.25
15	Bering	City of Toronto	36.25
16	Kipling	City of Toronto	15.75
17	Castlefield	City of Toronto	30.88
18	Thorncliffe	City of Toronto	25.75
19	Finch Yard	City of Toronto	28.63
20	Emery Yard	City of Toronto	20.50
21	Fire Station 116	City of Toronto	21.63
22	Bermondsey Yard	City of Toronto	20.75
23	Wilson	City of Toronto	41.50
24	Ancaster	City of Toronto	30.38
25	Mitchell Field	City of Toronto	21.84
26	Cummer	City of Toronto	12.38
27	Pharmacy/401	City of Toronto	6.63
28	Liamoreaux	City of Toronto	3.25
29	Nashdene Yard	City of Toronto	2.88
30	Ellesmere Yard	City of Toronto	3.38
31	Morningside Yard	City of Toronto	3.63
33	Edwards Gardens	City of Toronto	19.13
34	Fire Station 215	City of Toronto	3.13
35	Mount Pleasant	City of Toronto	33.00
36	Denton	City of Toronto	16.50
37	Poplar	City of Toronto	2.63
38	Seminole	City of Toronto	3.38
39	Fire Station 121	City of Toronto	25.50
41	HY002	TRCA	11.75
42	HY003	TRCA	39.50
43	HY008	TRCA	29.70
44	HY009	TRCA	2.40
45	HY011	TRCA	4.40
46	HY012	TRCA	13.30
47	HY014	TRCA	26.70
48	HY015	TRCA	1.40
49	HY016	TRCA	20.20
50	HY021	TRCA	14.85
51	HY025	TRCA	35.50
52	HY027	TRCA	28.30
53	HY030	TRCA	6.10
54	HY031	TRCA	0.50
55	HY033	TRCA	30.00
56	HY036	TRCA	2.90
57	HY037	TRCA	19.20
58	HY038	TRCA	24.40
59	HY041	TRCA	16.90
60	HY043	TRCA	2.20
61	HY044	TRCA	3.40
62	HY046	TRCA	35.20
63	HY050	TRCA	3.30
64	HY051	TRCA	3.80
65	HY055	TRCA	28.00
66	HY060	TRCA	1.65
67	HY061	TRCA	8.60
68	HY064	TRCA	30.70
69	HY069	TRCA	7.50
70	HY070	TRCA	6.30
71	HY004	TRCA	3.10
72	HY039	TRCA	35.80
73	HY063	TRCA	0.80
74	R_ET_HL01	York Region	19.70
75	R_ET_MA03	York Region	2.40
76	R_ET_NO01	York Region	30.10
77	R_ET_ST02	York Region	1.70
78	R_ET_VA01	York Region	27.10
79	R_ET_VA02	York Region	41.40
80	R_YR_AU02	York Region	9.60
81	R_YR_KE01	York Region	1.40
82	R_YR_MA03	York Region	18.00
83	R_YR_MO01	York Region	0.90
84	R_YR_NE01	York Region	12.60
85	R_YR_RH01	York Region	17.60
86	R_YR_SU01	York Region	0.60
87	R_YR_VA03	York Region	41.40
88	R_YR_VA04	York Region	23.00
89	R_YR_WB01	York Region	0.90
90	STN 01 - Third St.	Mississauga	38.80
91	STN 02 - Clarkson	Mississauga	1.50
92	STN 03 - Wolfedale	Mississauga	23.00
93	STN 04 - South Common	Mississauga	1.13
94	STN 06 - Winding Trail	Mississauga	38.30
95	STN 06 - Mississauga Valley	Mississauga	32.40
96	STN 07 - Britannia	Mississauga	7.30
97	STN 08 - Tomken	Mississauga	16.50
98	STN 09 - Truscott	Mississauga	1.20
99	STN 10 - Falbourne	Mississauga	26.30
100	STN 11 - Garry Morden FTC	Mississauga	3.70
101	STN 12 - CVC	Mississauga	17.10
102	STN 13 - Goreway	Mississauga	28.90
103	STN 14 - Port Credit	Mississauga	28.50
104	Stornoway P.S.	Markham	22.90
105	Thornhill C.C.	Markham	20.19
106	German Mills P.S.	Markham	15.60
107	Lincoln Alexander P.S.	Markham	5.70
108	8100 Warden Ave	Markham	4.20
109	Milliken Mills C.C.	Markham	2.50
110	Fire Hall #94	Markham	3.38
111	Roy H Crosby P.S.	Markham	3.20
112	Markham Museum	Markham	3.00
113	Rouge River C.C.	Markham	3.88
114	Angus Glen C.C.	Markham	3.38
115	RG03	Peel Region	1.88
116	RG11	Peel Region	4.63
117	RG16	Peel Region	20.50
118	RG20	Peel Region	35.13
119	RG22	Peel Region	19.13
120	RG23	Peel Region	9.00
121	RG24	Peel Region	15.50
122	RG25	Peel Region	24.38
123	RG26	Peel Region	5.25
124	RG27	Peel Region	13.75
125	RG28	Peel Region	27.50
126	RG29	Peel Region	37.00
127	RG31	Peel Region	23.63
128	RG32	Peel Region	26.38
129	RG33	Peel Region	16.75
130	RG34	Peel Region	8.00
131	RG36	Peel Region	12.38
132	RG39	Peel Region	12.63
133	RG42	Peel Region	5.13
134	RG44	Peel Region	3.88
135	Discovery	RichmondHill	24.50
136	Oak Ridges	RichmondHill	9.00
137	Operations	RichmondHill	11.59



July 8, 2013 Extreme Rainfall Event

Summary and Analysis Report

Toronto and Region Conservation Authority

Maximum 2 Hour Rainfall Intensity

amec

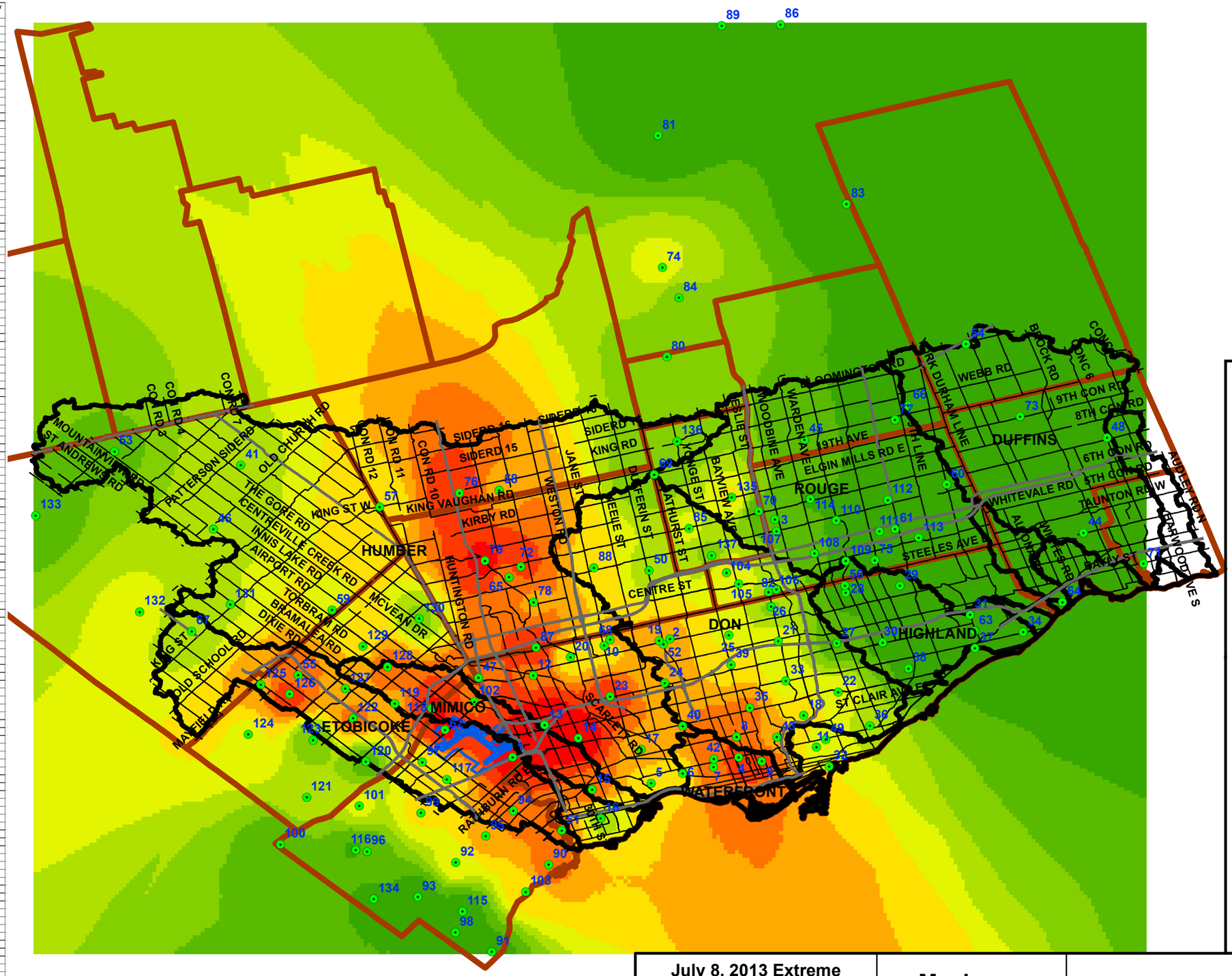
Scale 1:400,000

0 2.5 5 10 15 Kilometers

Project No. TP114045

Figure No. 4-7

ID	Gauge Name	Source	Max 6 hour (mm/hr)
1	Toronto Lester B. Pearson Int'L A.	Environment Canada	18.87
2	Toronto North York	Environment Canada	11.03
3	Toronto Buttonville A	Environment Canada	3.23
4	Toronto City	Environment Canada	15.92
5	Swansea	City of Toronto	9.38
6	Howard	City of Toronto	9.46
7	Central	City of Toronto	14.42
8	Brown	City of Toronto	14.00
9	Church	City of Toronto	15.25
10	Jane	City of Toronto	8.75
11	Greenwood	City of Toronto	8.58
12	Albion	City of Toronto	14.29
13	Martin Grove	City of Toronto	22.88
14	Richview	City of Toronto	20.00
15	Bering	City of Toronto	13.88
16	Kipling	City of Toronto	6.25
17	Castlefield	City of Toronto	11.96
18	Thorncliffe	City of Toronto	10.17
19	Finch Yard	City of Toronto	11.21
20	Emery Yard	City of Toronto	9.21
21	Fire Station 116	City of Toronto	8.04
22	Bermondsey Yard	City of Toronto	8.13
23	Willson	City of Toronto	16.00
24	Ancaster	City of Toronto	11.67
25	Mitchell Field	City of Toronto	8.59
26	Cummer	City of Toronto	5.25
27	Pharmacy/401	City of Toronto	2.92
28	Liamoreaux	City of Toronto	1.63
29	Nashdene Yard	City of Toronto	1.38
30	Ellesmere Yard	City of Toronto	1.58
31	Morningside Yard	City of Toronto	1.50
33	Edwards Gardens	City of Toronto	7.88
34	Fire Station 215	City of Toronto	1.21
35	Mount Pleasant	City of Toronto	12.83
36	Denton	City of Toronto	6.50
37	Poplar	City of Toronto	1.13
38	Seminole	City of Toronto	1.71
39	Fire Station 121	City of Toronto	10.13
41	HY002	TRCA	7.07
42	HY003	TRCA	14.70
43	HY008	TRCA	11.49
44	HY009	TRCA	0.90
45	HY011	TRCA	2.33
46	HY012	TRCA	5.63
47	HY014	TRCA	14.10
48	HY015	TRCA	0.50
49	HY016	TRCA	8.10
50	HY021	TRCA	6.53
51	HY025	TRCA	13.00
52	HY027	TRCA	11.10
53	HY030	TRCA	3.67
54	HY031	TRCA	0.27
55	HY033	TRCA	13.83
56	HY036	TRCA	1.50
57	HY037	TRCA	9.47
58	HY038	TRCA	11.99
59	HY041	TRCA	8.40
60	HY043	TRCA	1.00
61	HY044	TRCA	1.57
62	HY046	TRCA	17.97
63	HY050	TRCA	1.33
64	HY051	TRCA	1.47
65	HY055	TRCA	13.03
66	HY060	TRCA	0.78
67	HY061	TRCA	5.77
68	HY064	TRCA	11.90
69	HY069	TRCA	3.93
70	HY070	TRCA	3.13
71	HY004	TRCA	1.17
72	HY039	TRCA	15.60
73	HY063	TRCA	0.43
74	R_ET_HL01	York Region	7.63
75	R_ET_MA03	York Region	1.23
76	R_ET_NO01	York Region	16.83
77	R_ET_ST02	York Region	0.93
78	R_ET_VA01	York Region	12.40
79	R_ET_VA02	York Region	18.47
80	R_YR_AU02	York Region	4.67
81	R_YR_KE01	York Region	0.50
82	R_YR_MA03	York Region	7.27
83	R_YR_MO01	York Region	0.43
84	R_YR_NE01	York Region	5.17
85	R_YR_RH01	York Region	7.47
86	R_YR_SU01	York Region	0.37
87	R_YR_VA03	York Region	16.73
88	R_YR_VA04	York Region	9.63
89	R_YR_WB01	York Region	0.43
90	STN 01 - Third St.	Mississauga	13.57
91	STN 02 - Clarkson	Mississauga	1.10
92	STN 03 - Wolfedale	Mississauga	8.57
93	STN 04 - South Common	Mississauga	0.46
94	STN 05 - Winding Trail	Mississauga	14.20
95	STN 06 - Mississauga Valley	Mississauga	11.67
96	STN 07 - Britannia	Mississauga	3.37
97	STN 08 - Tomken	Mississauga	9.00
98	STN 09 - Truscott	Mississauga	0.63
99	STN 10 - Fallbourne	Mississauga	9.30
100	STN 11 - Garry Morden FTC	Mississauga	2.33
101	STN 12 - CVC	Mississauga	7.63
102	STN 13 - Goreway	Mississauga	14.43
103	STN 14 - Port Credit	Mississauga	9.67
104	Stornoway P.S.	Markham	9.27
105	Thornhill C.C.	Markham	8.00
106	German Mills P.S.	Markham	6.33
107	Lincoln Alexander P.S.	Markham	3.10
108	9100 Warden Ave	Markham	2.13
109	Milliken Mills C.C.	Markham	1.42
110	Fire Hall #54	Markham	1.52
111	Roy H Crosby P.S.	Markham	1.57
112	Markham Museum	Markham	1.43
113	Rouge River C.C.	Markham	1.71
114	Angus Glen C.C.	Markham	1.69
115	RG03	Peel Region	0.63
116	RG11	Peel Region	1.63
117	RG15	Peel Region	9.79
118	RG20	Peel Region	18.04
119	RG22	Peel Region	12.17
120	RG23	Peel Region	3.17
121	RG24	Peel Region	6.96
122	RG25	Peel Region	13.33
123	RG26	Peel Region	3.96
124	RG27	Peel Region	8.67
125	RG28	Peel Region	12.29
126	RG29	Peel Region	16.21
127	RG31	Peel Region	11.17
128	RG32	Peel Region	14.13
129	RG33	Peel Region	10.29
130	RG34	Peel Region	5.38
131	RG35	Peel Region	7.17
132	RG39	Peel Region	7.71
133	RG42	Peel Region	2.88
134	RG44	Peel Region	1.63
135	Discovery	RichmondHill	9.20
136	Oak Ridges	RichmondHill	4.67
137	Operations	RichmondHill	5.13



Legend

- Rainfall Gauges
- Highways
- Major Roads
- Watersheds
- Municipal Boundaries
- Pearson Airport

Maximum 6 Hour Intensity (mm/hr)

- 0 - 2
- 3 - 4
- 5 - 6
- 7 - 7
- 8 - 9
- 10 - 11
- 12 - 13
- 14 - 15
- 16 - 18
- 19 - 23

July 8, 2013 Extreme Rainfall Event

Summary and Analysis Report

Toronto and Region Conservation Authority

Maximum 6 Hour Rainfall Intensity

amec

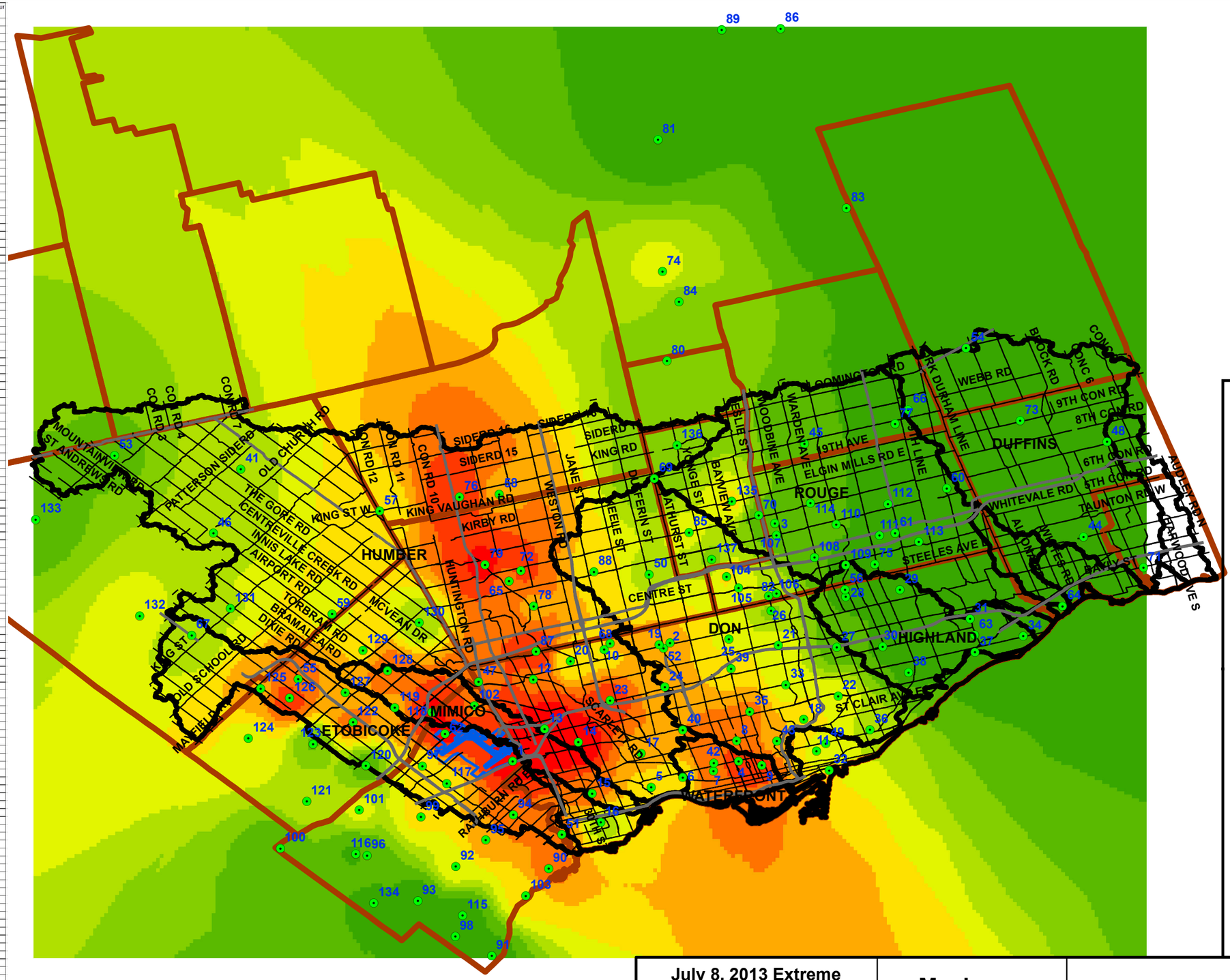
Scale **1:400,000**

0 2.5 5 10 15 Kilometers

Project No. **TP114045**

Figure No. **4-8**

ID	Gauge Name	Source	Max 12 Hour (mm/hr)
1	Toronto Lester B. Pearson Int'l A	Environment Canada	9.55
2	Toronto North York	Environment Canada	5.60
3	Toronto Buttonville A	Environment Canada	1.72
4	Toronto City	Environment Canada	6.03
5	Swansea	City of Toronto	4.75
6	Howard	City of Toronto	4.75
7	Central	City of Toronto	7.27
8	Brown	City of Toronto	7.08
9	Church	City of Toronto	7.69
10	Jane	City of Toronto	4.46
11	Greenwood	City of Toronto	4.38
12	Albion	City of Toronto	7.23
13	Martin Grove	City of Toronto	11.59
14	Richview	City of Toronto	10.08
15	Bering	City of Toronto	6.96
16	Kipling	City of Toronto	3.15
17	Castlefield	City of Toronto	6.04
18	Thorncliffe	City of Toronto	5.29
19	Finch Yard	City of Toronto	5.71
20	Emery Yard	City of Toronto	4.65
21	Fire Station 116	City of Toronto	4.13
22	Bermondsey Yard	City of Toronto	4.15
23	Wilson	City of Toronto	8.02
24	Ancaster	City of Toronto	5.88
25	Mitchell Field	City of Toronto	4.36
26	Cummer	City of Toronto	2.71
27	Pharmacy/401	City of Toronto	1.52
28	Lawrence Yard	City of Toronto	0.54
29	Nashdene Yard	City of Toronto	0.73
30	Ellesmere Yard	City of Toronto	0.85
31	Morningside Yard	City of Toronto	0.81
33	Edwards Gardens	City of Toronto	4.00
34	Fire Station 215	City of Toronto	0.65
35	Mount Pleasant	City of Toronto	6.62
36	Denton	City of Toronto	3.42
37	Poplar	City of Toronto	0.60
38	Seminole	City of Toronto	0.52
39	Fire Station 121	City of Toronto	5.10
41	HY002	TRCA	3.63
42	HY003	TRCA	7.38
43	HY008	TRCA	5.78
44	HY009	TRCA	0.50
45	HY011	TRCA	1.28
46	HY012	TRCA	3.08
47	HY014	TRCA	7.10
48	HY015	TRCA	0.33
49	HY016	TRCA	4.18
50	HY021	TRCA	3.39
51	HY025	TRCA	6.55
52	HY027	TRCA	6.63
53	HY030	TRCA	1.88
54	HY031	TRCA	0.22
55	HY033	TRCA	6.83
56	HY036	TRCA	0.62
57	HY037	TRCA	4.82
58	HY038	TRCA	6.08
59	HY041	TRCA	4.27
60	HY043	TRCA	0.57
61	HY044	TRCA	0.85
62	HY046	TRCA	9.13
63	HY050	TRCA	0.72
64	HY051	TRCA	0.75
65	HY055	TRCA	6.58
66	HY060	TRCA	0.48
67	HY061	TRCA	2.93
68	HY064	TRCA	6.05
69	HY069	TRCA	2.12
70	HY070	TRCA	1.67
71	HY004	TRCA	0.62
72	HY039	TRCA	7.83
73	HY063	TRCA	0.27
74	R_ET_HL01	York Region	3.98
75	R_ET_MA03	York Region	0.65
76	R_ET_NO01	York Region	8.52
77	R_ET_ST02	York Region	0.57
78	R_ET_VA01	York Region	6.25
79	R_ET_VA02	York Region	9.28
80	R_YR_AU02	York Region	2.45
81	R_YR_KE01	York Region	0.47
82	R_YR_MA03	York Region	3.73
83	R_YR_MO01	York Region	0.27
84	R_YR_NE01	York Region	2.63
85	R_YR_RH01	York Region	3.93
86	R_YR_SU01	York Region	0.22
87	R_YR_VA03	York Region	8.40
88	R_YR_VA04	York Region	6.03
89	R_YR_WI01	York Region	0.28
90	STN 01 - Third St.	Mississauga	6.78
91	STN 02 - Clarkson	Mississauga	0.55
92	STN 03 - Wolfedale	Mississauga	4.18
93	STN 04 - South Common	Mississauga	0.31
94	STN 05 - Winding Trail	Mississauga	7.20
95	STN 06 - Mississauga Valley	Mississauga	5.92
96	STN 07 - Britannia	Mississauga	1.70
97	STN 08 - Tomken	Mississauga	4.70
98	STN 09 - Truscott	Mississauga	0.33
99	STN 10 - Fallbourne	Mississauga	4.73
100	STN 11 - Garry Morden FTC	Mississauga	1.20
101	STN 12 - CVC	Mississauga	3.88
102	STN 13 - Goreway	Mississauga	7.32
103	STN 14 - Port Credit	Mississauga	4.95
104	Stornoway P.S.	Markham	4.73
105	Thornhill C.C.	Markham	4.13
106	German Mills P.S.	Markham	3.25
107	Lincoln Alexander P.S.	Markham	1.67
108	8100 Warden Ave	Markham	1.13
109	Milliken Mills C.C.	Markham	0.77
110	Fire Hall #94	Markham	1.04
111	Roy H Crosby P.S.	Markham	0.83
112	Markham Museum	Markham	0.85
113	Rouge River C.C.	Markham	0.92
114	Angus Glen C.C.	Markham	1.02
115	RG03	Peel Region	0.31
116	RG11	Peel Region	0.81
117	RG16	Peel Region	5.10
118	RG20	Peel Region	9.15
119	RG22	Peel Region	6.23
120	RG23	Peel Region	1.60
121	RG24	Peel Region	3.54
122	RG25	Peel Region	6.81
123	RG26	Peel Region	2.60
124	RG27	Peel Region	4.33
125	RG28	Peel Region	6.19
126	RG29	Peel Region	8.13
127	RG31	Peel Region	5.60
128	RG32	Peel Region	7.23
129	RG33	Peel Region	5.31
130	RG34	Peel Region	3.04
131	RG36	Peel Region	3.69
132	RG39	Peel Region	3.58
133	RG42	Peel Region	1.48
134	RG44	Peel Region	0.81
135	Discovery	RichmondHill	4.73
136	Oak Ridges	RichmondHill	2.47
137	Operations	RichmondHill	2.72



Page 55

July 8, 2013 Extreme Rainfall Event **Summary and Analysis Report** **Toronto and Region Conservation Authority**	**Maximum 12 Hour Rainfall Intensity**	amec	Scale **1:400,000** 0 2.5 5 10 15 Kilometers Project No. **TP114045** Figure No. **4-9**

4.3 Duration

The total storm duration has been determined for all gauges using the rainfall measurements from the onset of the event to its termination. The temporal distribution of the July 8th, 2013 storm event for all gauges has been presented in Figure 4-10. For the purposes of this report, all time references are reported in Eastern Standard Time and do not account for Daylight Savings Time (DST). The rainfall time series with an interval of 15 minutes have been presented in Figure 4-10 for each gauge and the time steps when precipitation was recorded have been colour coded using a green colour. When establishing rainfall duration for each gauge, single time steps with reported rainfall with a time difference of more than one hour from the previous time step (for termination of the storm) or following time step (for onset of the storm) with rainfall, have been excluded. For example, Rain Gauge Edwards Garden operated by City of Toronto (AMEC ID 33) reported 0.3 mm of rainfall on July 9th, 2013 at 01:45 AM which is more than one hour after the last recorded rainfall and as such this time step has been excluded and the storm has been considered to have ended at 23:00 pm on July 8th, 2013 for this gauge. The results of this assessment have been used to develop a spatial grid depicting the spatial variation of storm duration across the study area, which have been presented in Figure 4-11.

The results presented in Figure 4-10 indicate that the July 8th, 2013 storm event started at around 14:00 EST on the afternoon of July 8th, 2013 and ended at around midnight. The minimum and maximum storm duration ranged between 5.5 and 9.5 hours within TRCA jurisdiction which were observed at RG31 and RG34 respectively, both operated by Peel Region. Gauge RG31 is located south of the Bovaird Drive, west of Dixie Road and Gauge RG34 is located south of the Castlemore Road, east of the Gore Road.

The results presented in Figure 4-11 indicate that majority of the study area experienced a storm event with a duration of 7 to 8 hours. The north-center parts of the TRCA, including Northern parts of Don and Rouge River Watersheds, as well as central and north western parts of the Humber River watersheds experienced a storm event with a duration of longer than 8 hours. Rainfall duration has also been estimated for all TRCA watershed using the spatial coverage of storm duration for July 8th, 2013 extreme storm event. The results of this analysis have been presented in Table 4-4.

Table 4-4: Storm Duration Statistics for All TRCA Watersheds (Hours)

Watershed	Mean	MIN	MAX	STD
Rouge	7.7	6.8	8.7	0.5
Don	7.6	6.5	8.7	0.4
Humber	7.4	6.2	9.5	0.5
Carruthers	7.2	7.0	7.2	0.1
Duffins	7.2	6.3	8.2	0.4
Highland	7.2	6.8	7.7	0.2
Mimico	7.0	5.6	7.6	0.5
Petticoat	6.9	6.7	7.6	0.2
Etobicoke	6.7	5.5	8.2	0.4
Frenchmans Bay	6.6	6.3	6.8	0.2

The results presented in Table 4-4 indicate that Rouge, Don and Humber River watersheds experienced the longest rainfall duration among TRCA watersheds during the July 8th, 2013 storm.

AMEC ID		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Source		EC				City of Toronto															
Date/Gauge		Pearson	North York	Buttonville	Toronto City	Swansea	Howard	Central	Brown	Church	Jane	Greenwood	Albion	Martin Grove	Richview	Bering	Kipling	Castlefield	Thorncliffe	Finch Yard	Emery Yard
08/07/2013	14:00-14:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	14:15-14:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	14:30-14:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	14:45-14:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	15:00-15:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	15:15-15:30	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	15:30-15:45	7.2	12.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	9.5	0.0	12.5	5.0	0.0	0.0	0.0	0.0	0.0	5.3	7.0
08/07/2013	15:45-15:00	10.2	18.4	0.2	0.0	0.3	0.0	0.0	0.0	0.0	3.5	0.0	16.8	16.8	14.5	0.0	0.0	3.3	1.0	18.0	0.5
08/07/2013	16:00-16:15	11.6	8.6	0.2	12.6	0.8	0.5	9.8	9.8	15.0	4.8	18.5	1.5	16.5	10.0	2.8	0.0	11.3	27.3	10.5	3.5
08/07/2013	16:15-16:30	18.2	2.6	0.2	17.3	2.0	1.5	16.5	16.5	18.3	0.3	11.8	18.3	18.0	10.3	6.5	3.0	9.8	13.5	3.5	3.5
08/07/2013	16:30-16:45	24.4	3.2	0.2	14.9	6.3	6.3	5.8	9.3	16.3	7.3	2.8	6.0	27.5	25.0	15.3	1.8	8.8	2.0	5.0	9.0
08/07/2013	16:45-16:00	12.8	8.8	0.2	4.7	15.8	11.5	13.8	5.3	5.5	7.3	5.0	6.5	12.8	19.3	22.8	5.8	7.5	3.0	12.5	3.8
08/07/2013	17:00-17:15	6.6	1.4	0.4	14.3	15.3	20.3	23.5	12.0	10.5	3.5	1.3	6.0	14.5	18.5	17.5	12.0	7.5	0.8	2.0	11.5
08/07/2013	17:15-17:30	1.0	0.8	0.2	15.6	3.8	6.3	6.5	18.5	14.8	3.0	2.0	1.0	1.8	4.0	4.5	6.0	8.0	1.0	0.5	2.3
08/07/2013	17:30-17:45	1.0	0.4	0.0	7.5	1.5	1.5	2.5	2.0	2.8	1.3	2.5	1.3	1.3	1.0	2.0	0.8	5.5	2.0	0.8	0.8
08/07/2013	17:45-17:00	1.0	1.4	0.6	0.8	0.5	0.3	0.5	1.3	0.5	2.0	0.5	1.0	1.3	1.3	0.8	1.0	0.8	1.0	1.3	1.8
08/07/2013	18:00-18:15	0.4	1.6	1.4	1.0	1.3	1.3	1.0	1.3	1.0	1.0	0.8	0.5	0.5	1.0	1.3	1.3	1.0	1.3	1.5	0.8
08/07/2013	18:15-18:30	0.2	0.4	3.2	1.7	0.8	1.0	1.5	1.5	1.8	0.5	1.3	0.8	0.8	0.5	0.5	0.5	1.3	1.3	0.0	0.8
08/07/2013	18:30-18:45	0.0	0.8	2.4	0.4	0.5	0.3	0.3	0.5	0.5	0.8	0.8	0.8	0.3	0.5	0.3	0.0	0.5	0.5	0.8	0.8
08/07/2013	18:45-18:00	0.6	0.4	1.2	0.0	0.0	0.0	0.0	0.3	0.3	0.5	0.3	3.0	2.8	1.0	0.0	0.3	0.3	0.5	0.3	1.5
08/07/2013	19:00-19:15	0.4	0.2	0.4	0.2	1.0	0.3	0.3	0.3	0.0	1.0	0.0	2.5	2.5	1.5	2.8	2.0	0.3	0.3	0.3	1.3
08/07/2013	19:15-19:30	8.2	0.6	0.6	0.4	1.3	1.5	0.8	0.8	0.5	0.5	0.8	2.5	5.0	0.8	0.3	0.0	0.5	1.0	0.8	1.5
08/07/2013	19:30-19:45	4.4	0.2	0.0	0.9	0.5	0.3	0.8	1.0	1.0	0.5	0.8	0.5	6.0	6.0	0.5	0.0	0.3	0.8	0.3	0.5
08/07/2013	19:45-19:00	0.8	0.8	0.4	0.7	1.0	0.8	0.5	0.5	0.8	1.3	0.8	0.8	0.5	0.8	0.5	0.0	1.8	1.0	1.3	1.0
08/07/2013	20:00-20:15	0.4	1.0	0.0	1.0	1.0	1.0	1.0	1.3	0.8	1.5	0.8	1.0	1.0	0.8	0.5	0.0	1.0	0.5	0.8	1.3
08/07/2013	20:15-20:30	0.6	0.8	0.2	0.5	0.3	0.3	0.3	0.5	0.5	1.0	0.5	0.8	0.5	0.8	0.3	0.3	1.0	0.8	1.0	0.8
08/07/2013	20:30-20:45	0.6	0.4	0.0	0.0	0.5	0.3	0.3	0.5	0.0	0.5	0.0	0.3	0.5	0.5	1.0	0.3	0.5	0.5	0.3	0.5
08/07/2013	20:45-20:00	0.8	0.2	0.2	0.4	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.5	0.5	0.8	0.8	0.3	0.3	0.3	0.3	0.3
08/07/2013	21:00-21:15	0.8	0.4	0.2	0.0	0.3	0.3	0.3	0.3	0.3	0.5	0.0	0.8	0.5	0.5	0.5	0.8	0.5	0.5	0.5	0.5
08/07/2013	21:15-21:30	1.0	0.4	0.2	0.4	0.8	0.5	0.3	0.3	0.0	0.5	0.3	0.3	0.5	0.8	0.8	0.8	0.3	0.3	0.3	0.5
08/07/2013	21:30-21:45	0.6	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.0	0.3	0.5	0.3	1.0	0.5	0.3	0.0	0.3	0.3
08/07/2013	21:45-21:00	0.4	0.2	0.2	0.0	0.8	0.5	0.3	0.3	0.3	0.0	0.3	0.0	0.3	0.5	0.5	0.5	0.3	0.5	0.0	0.0
08/07/2013	22:00-22:15	0.0	0.2	0.2	0.6	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.0	0.0	0.3	0.3	0.0	0.3	0.3	0.3	0.0
08/07/2013	22:15-22:30	0.0	0.0	0.2	0.3	0.0	0.3	0.3	0.5	0.3	0.0	0.3	0.3	0.3	0.0	0.0	0.0	0.3	0.3	0.0	0.3
08/07/2013	22:30-22:45	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0
08/07/2013	22:45-22:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
08/07/2013	23:00-23:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
08/07/2013	23:15-23:30	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	23:30-23:45	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	23:45-23:00	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
09/07/2013	0:00-0:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:15-0:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:30-0:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:45-0:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:00-1:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:15-1:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:30-1:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:45-2:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	2:00-2:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total		114.6	67.2	14.2	96.4	56.8	57.0	87.3	85.0	92.3	53.5	52.5	86.3	138.0	121.0	83.5	37.8	72.5	62.5	68.0	55.8

AMEC ID		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Source		City of Toronto																			
Date/Gauge		Fire Station 116	Bermondsey Yard	Wilson	Ancaster	Mitchell Field	Cummer	Pharmacy/401	Liamoreaux	Nashdene Yard	Ellesmere Yard	Morningsidede Yard	Ashbridges Bay	Edwards Gardens	Fire Station 215	Mount Pleasant	Denton	Poplar	Seminole	Fire Station 121	Fairbank Middle Public School
08/07/2013	14:00-14:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
08/07/2013	14:15-14:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
08/07/2013	14:30-14:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
08/07/2013	14:45-14:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
08/07/2013	15:00-15:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
08/07/2013	15:15-15:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
08/07/2013	15:30-15:45	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	2.5	
08/07/2013	15:45-15:00	21.3	6.8	17.3	18.3	20.1	14.0	0.0	0.0	0.0	0.0	0.0		11.0	0.0	8.5	0.0	0.0	0.0	18.0	
08/07/2013	16:00-16:15	15.5	22.3	13.0	22.5	13.0	7.3	6.8	2.0	0.0	0.0	0.0		16.3	0.0	21.0	14.3	0.0	0.0	15.0	
08/07/2013	16:15-16:30	4.3	9.8	10.8	1.3	1.5	1.5	4.0	1.0	1.0	2.5	0.0		7.3	0.0	13.3	12.5	0.0	1.3	4.8	
08/07/2013	16:30-16:45	0.5	1.5	13.8	6.0	1.0	0.3	0.8	0.3	0.3	1.0	1.3		0.8	0.3	4.3	3.8	0.3	2.8	2.3	
08/07/2013	16:45-16:00	0.5	0.0	14.3	3.5	1.5	0.5	0.0	0.3	0.3	0.0	0.3		0.3	0.0	5.0	0.5	0.8	0.3	6.0	
08/07/2013	17:00-17:15	0.5	0.5	8.8	5.8	1.8	0.3	0.5	0.8	0.3	0.8	0.0		1.0	0.3	3.5	0.0	0.0	0.3	1.0	
08/07/2013	17:15-17:30	0.5	0.3	3.8	2.0	0.3	0.8	0.3	0.3	1.0	0.5	0.8		1.0	0.5	7.3	0.5	0.5	0.3	1.3	
08/07/2013	17:30-17:45	0.3	0.5	1.5	1.5	0.3	0.3	0.8	0.8	0.5	0.8	1.0		0.8	1.0	2.8	0.8	0.8	0.5	0.3	
08/07/2013	17:45-17:00	0.3	0.3	1.5	1.0	1.0	0.8	0.3	0.8	0.8	0.5	1.5		0.5	1.5	0.8	0.8	1.0	0.5	1.0	
08/07/2013	18:00-18:15	0.5	0.8	1.3	1.5	1.3	1.3	0.8	1.3	1.3	0.5	1.3		1.0	1.0	2.0	0.5	0.8	0.5	1.5	
08/07/2013	18:15-18:30	0.8	1.3	0.8	0.8	1.0	0.5	0.8	0.5	1.5	0.8	1.3		1.0	0.5	1.5	1.3	0.8	1.0	1.0	
08/07/2013	18:30-18:45	0.5	0.3	0.5	0.5	0.8	0.3	0.0	0.0	0.3	0.5	0.5		0.5	1.3	0.3	0.8	0.8	0.5	0.5	
08/07/2013	18:45-18:00	0.5	0.3	0.5	0.3	1.0	0.8	0.3	0.3	0.0	0.0	0.0		0.5	0.3	0.5	0.0	0.0	0.3	0.5	
08/07/2013	19:00-19:15	0.3	0.0	1.0	0.5	0.3	0.5	0.5	0.3	0.0	0.3	0.3		0.3	0.0	0.3	0.3	0.0	0.0	0.0	
08/07/2013	19:15-19:30	0.0	0.5	1.0	0.5	0.5	0.0	0.0	0.3	0.3	0.0	0.0		0.8	0.3	0.8	0.0	0.3	0.3	0.8	
08/07/2013	19:30-19:45	0.3	0.8	2.3	0.3	0.5	0.3	0.3	0.0	0.0	0.0	0.0		0.8	0.0	1.0	0.5	0.0	0.0	0.5	
08/07/2013	19:45-19:00	0.8	0.5	0.8	0.5	0.3	0.5	0.0	0.0	0.0	0.3	0.0		0.8	0.0	0.5	0.5	0.0	0.3	1.0	
08/07/2013	20:00-20:15	0.0	1.0	1.0	1.0	0.0	0.5	0.5	0.0	0.0	0.0	0.0		1.0	0.0	1.0	0.8	0.0	0.3	1.0	
08/07/2013	20:15-20:30	0.5	0.5	0.8	1.0	0.3	0.0	0.3	0.3	0.3	0.3	0.0		0.5	0.0	1.0	0.5	0.0	0.3	0.8	
08/07/2013	20:30-20:45	0.0	0.3	0.5	0.3	0.5	0.5	0.3	0.0	0.0	0.3	0.3		0.3	0.0	0.8	0.3	0.3	0.3	0.3	
08/07/2013	20:45-20:00	0.3	0.3	0.0	0.3	0.3	0.3	0.0	0.3	0.0	0.0	0.0		0.5	0.0	0.3	0.3	0.3	0.5	0.3	
08/07/2013	21:00-21:15	0.0	0.5	0.5	0.5	0.0	0.3	0.3	0.3	0.3	0.3	0.3		0.3	0.3	0.3	0.3	0.0	0.3	0.3	
08/07/2013	21:15-21:30	0.5	0.0	0.5	0.3	0.3	0.3	0.3	0.0	0.0	0.3	0.0		0.3	0.0	0.3	0.0	0.3	0.0	0.3	
08/07/2013	21:30-21:45	0.0	0.3	0.3	0.3	0.0	0.3	0.3	0.3	0.0	0.0	0.3		0.3	0.0	0.3	0.3	0.0	0.3	0.3	
08/07/2013	21:45-21:00	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.3	0.3	0.3	0.0		0.0	0.3	0.3	0.0	0.0	0.0	0.0	
08/07/2013	22:00-22:15	0.5	0.0	0.0	0.3	0.0	0.3	0.3	0.0	0.3	0.0	0.3		0.3	0.0	0.3	0.3	0.0	0.0	0.0	
08/07/2013	22:15-22:30	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3	0.0		0.0	0.0	0.5	0.3	0.3	0.0	0.3	
08/07/2013	22:30-22:45	0.0	0.3	0.0	0.3	0.0	0.3	0.3	0.0	0.3	0.0	0.3		0.0	0.3	0.3	0.3	0.0	0.3	0.0	
08/07/2013	22:45-22:00	0.0	0.0	0.0	0.0	0.5	0.0	0.3	0.3	0.0	0.3	0.0		0.0	0.0	0.0	0.3	0.3	0.3	0.0	
08/07/2013	23:00-23:15	0.0	0.3	0.3	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.3		0.3	0.0	0.0	0.0	0.0	0.0	0.3	
08/07/2013	23:15-23:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3	0.0		0.0	0.3	0.0	0.0	0.0	0.3	0.0	
08/07/2013	23:30-23:45	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.3	0.0	0.0	
08/07/2013	23:45-23:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.3	0.0	0.0	0.0	
09/07/2013	0:00-0:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
09/07/2013	0:15-0:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
09/07/2013	0:30-0:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
09/07/2013	0:45-0:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
09/07/2013	1:00-1:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
09/07/2013	1:15-1:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
09/07/2013	1:30-1:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
09/07/2013	1:45-2:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.3	0.0	0.0	0.0	0.0	0.0	0.0	
09/07/2013	2:00-2:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Total		49.0	49.8	96.3	70.5	52.3	32.5	18.3	10.5	8.8	10.3	9.8	0.0	48.0	7.8	78.0	40.3	7.3	11.0	61.3	0.0

AMEC ID		41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57
Source		TRCA																
Date/Gauge		HY002	HY003	HY008	HY009	HY011	HY012	HY014	HY015	HY016	HY021	HY025	HY027	HY030	HY031	HY033	HY036	HY037
08/07/2013	14:00-14:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	14:15-14:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	14:30-14:45	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	14:45-14:00	0.2	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.8
08/07/2013	15:00-15:15	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	0.0	0.0	0.0	1.2
08/07/2013	15:15-15:30	4.8	0.0	0.0	0.0	0.4	2.0	2.6	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	3.2
08/07/2013	15:30-15:45	4.0	0.0	0.0	0.0	4.6	0.0	11.4	0.0	0.0	6.3	0.0	4.8	0.0	0.0	0.0	0.0	0.2
08/07/2013	15:45-15:00	5.4	0.0	0.0	0.0	3.2	0.0	6.6	0.0	0.0	13.8	0.0	14.0	0.0	0.0	0.0	0.0	2.4
08/07/2013	16:00-16:15	0.6	12.6	13.8	0.0	0.4	5.8	1.6	0.0	13.0	3.3	2.8	15.0	4.2	0.2	0.0	1.0	13.2
08/07/2013	16:15-16:30	2.0	18.2	16.6	0.0	0.0	16.4	14.8	0.0	16.4	0.3	2.6	3.8	0.2	0.4	0.0	1.4	9.8
08/07/2013	16:30-16:45	3.5	8.0	8.6	0.0	0.0	1.4	2.4	0.0	3.8	0.5	2.0	3.4	1.0	0.2	11.0	0.6	5.0
08/07/2013	16:45-16:00	1.5	8.0	6.4	0.0	0.2	0.8	11.6	0.6	1.2	1.3	24.8	11.8	0.2	0.0	3.2	0.0	2.6
08/07/2013	17:00-17:15	1.1	17.0	2.8	0.0	0.0	0.0	1.8	0.6	1.4	2.1	26.2	3.0	0.0	0.0	1.0	0.8	1.2
08/07/2013	17:15-17:30	0.6	10.6	5.4	0.2	0.2	0.2	1.6	0.0	1.0	1.7	9.2	0.6	0.4	0.0	1.6	0.2	1.8
08/07/2013	17:30-17:45	1.3	3.6	5.4	0.4	1.0	1.0	1.0	0.2	2.8	0.9	1.0	0.4	0.4	0.0	0.6	0.4	0.2
08/07/2013	17:45-17:00	6.7	0.8	0.4	1.0	1.0	0.4	0.6	0.0	0.4	1.5	1.6	1.4	1.2	0.0	0.4	0.6	2.0
08/07/2013	18:00-18:15	1.2	0.8	1.0	1.2	0.4	0.0	1.0	0.4	0.8	1.3	2.2	1.6	2.2	0.0	0.4	1.2	7.0
08/07/2013	18:15-18:30	2.4	1.6	1.6	1.0	1.0	0.0	1.0	0.6	1.2	0.9	0.6	0.4	0.6	0.0	10.4	0.8	2.0
08/07/2013	18:30-18:45	1.0	0.6	0.6	0.6	0.2	0.0	3.6	0.2	1.0	0.9	0.0	0.6	0.0	0.2	17.6	0.2	1.6
08/07/2013	18:45-18:00	0.2	0.0	0.4	0.4	0.2	0.0	5.8	0.2	0.2	0.5	0.2	0.6	0.0	0.0	15.2	0.0	0.2
08/07/2013	19:00-19:15	0.0	0.2	0.2	0.0	0.6	0.0	8.2	0.0	0.4	0.6	0.0	0.2	0.0	0.0	9.6	0.4	0.0
08/07/2013	19:15-19:30	0.1	0.8	0.4	0.0	0.0	0.4	5.8	0.0	0.4	0.3	0.0	0.8	0.4	0.0	5.2	0.2	0.0
08/07/2013	19:30-19:45	0.1	1.0	1.0	0.0	0.2	1.0	0.4	0.0	1.2	0.2	0.0	0.0	0.4	0.4	0.8	0.0	0.0
08/07/2013	19:45-19:00	0.3	0.8	1.0	0.0	0.2	0.8	0.4	0.0	0.4	0.3	0.0	1.0	0.8	0.0	0.2	0.0	0.0
08/07/2013	20:00-20:15	1.2	1.2	0.6	0.0	0.0	0.8	0.4	0.0	1.2	0.1	0.0	1.0	1.2	0.0	0.4	0.2	0.4
08/07/2013	20:15-20:30	1.1	0.4	0.8	0.0	0.0	1.2	0.6	0.0	0.4	0.5	0.0	0.6	1.0	0.0	0.4	0.0	0.8
08/07/2013	20:30-20:45	1.0	0.4	0.4	0.0	0.0	1.6	0.2	0.0	0.4	0.3	0.6	0.6	1.0	0.0	0.6	0.0	0.8
08/07/2013	20:45-20:00	0.6	0.2	0.0	0.0	0.0	1.0	0.6	0.0	0.2	0.2	0.2	0.2	0.2	0.0	0.8	0.2	0.6
08/07/2013	21:00-21:15	0.3	0.2	0.2	0.0	0.2	0.2	0.6	0.0	0.0	0.4	1.2	0.2	0.2	0.0	1.0	0.4	0.4
08/07/2013	21:15-21:30	0.1	0.4	0.4	0.0	0.0	0.2	0.2	0.0	0.2	0.4	0.8	0.6	0.2	0.0	0.6	0.0	0.2
08/07/2013	21:30-21:45	0.1	0.2	0.2	0.0	0.2	0.0	0.2	0.0	0.4	0.6	1.2	0.2	0.0	0.0	0.6	0.0	0.0
08/07/2013	21:45-21:00	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.8	0.0	0.0	0.0	0.2	0.2	0.0
08/07/2013	22:00-22:15	0.0	0.6	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.3	0.0	0.2	0.2	0.2	0.0	0.2	0.0
08/07/2013	22:15-22:30	0.2	0.2	0.4	0.0	0.2	0.0	0.2	0.2	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.0
08/07/2013	22:30-22:45	0.1	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.2	0.0	0.2	0.0	0.0	0.2
08/07/2013	22:45-22:00	0.0	0.0	0.0	0.2	0.4	0.0	0.0	0.2	0.0	0.2	0.0	0.0	0.0	0.2	0.0	0.4	0.0
08/07/2013	23:00-23:15	0.0	0.0	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	23:15-23:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.2	0.0	0.0	0.4	0.0	0.0	0.0
08/07/2013	23:30-23:45	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.2	0.0
08/07/2013	23:45-23:00	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:00-0:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:15-0:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:30-0:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:45-0:00	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:00-1:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:15-1:30	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:30-1:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:45-2:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	2:00-2:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total		43.6	88.6	69.4	6.0	15.4	37.0	85.2	4.0	50.2	40.7	78.4	67.6	22.6	2.4	81.8	9.8	57.8

AMEC ID		58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73
Source		TRCA															
Date/Gauge		HY038	HY041	HY043	HY044	HY046	HY050	HY051	HY055	HY060	HY061	HY064	HY069	HY070	HY004	HY039	HY063
08/07/2013	14:00-14:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	14:15-14:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	14:30-14:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	14:45-14:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.4	0.0	0.0	0.0	0.0
08/07/2013	15:00-15:15	3.4	3.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	5.6	0.0	0.0	0.0	0.0
08/07/2013	15:15-15:30	10.0	0.2	0.0	0.0	1.6	0.0	0.0	5.4	0.0	0.2	0.2	2.6	0.0	0.0	0.0	0.0
08/07/2013	15:30-15:45	2.0	0.0	0.0	0.0	12.6	0.0	0.0	8.8	0.0	0.0	3.8	5.4	1.4	0.0	23.6	0.0
08/07/2013	15:45-15:00	0.2	0.4	0.0	0.0	5.2	0.0	0.0	0.4	0.7	0.0	25.2	0.4	7.0	0.0	5.2	0.0
08/07/2013	16:00-16:15	1.6	2.2	0.0	0.8	7.6	0.0	0.0	0.0	0.4	0.0	6.8	0.0	2.2	0.0	0.6	0.0
08/07/2013	16:15-16:30	0.8	5.6	0.0	0.4	11.2	0.0	0.0	3.4	0.3	7.6	0.2	0.2	0.4	0.0	0.6	0.0
08/07/2013	16:30-16:45	4.0	13.6	0.0	0.2	13.8	0.0	0.0	8.8	0.0	3.8	10.0	0.2	0.4	0.0	3.6	0.4
08/07/2013	16:45-16:00	4.0	3.6	0.0	0.2	14.0	1.0	0.0	18.0	0.0	1.2	8.4	0.4	0.4	0.0	15.8	0.0
08/07/2013	17:00-17:15	17.6	1.0	0.0	0.6	3.8	0.0	0.0	10.6	0.0	1.0	3.4	0.4	0.2	0.0	16.0	0.2
08/07/2013	17:15-17:30	2.4	1.6	0.4	0.2	1.6	0.4	0.0	1.4	0.0	0.8	3.0	1.6	0.6	0.0	6.2	0.0
08/07/2013	17:30-17:45	1.6	0.8	0.4	0.8	1.2	1.2	1.6	1.0	0.0	0.6	1.2	1.2	0.4	0.2	1.2	0.0
08/07/2013	17:45-17:00	3.4	4.8	0.6	1.6	0.6	1.2	1.6	0.4	0.9	0.0	0.6	0.6	0.8	1.0	1.2	0.0
08/07/2013	18:00-18:15	3.0	0.8	0.2	1.6	0.4	0.8	1.0	3.0	0.8	0.0	1.6	1.0	1.2	1.4	0.6	0.8
08/07/2013	18:15-18:30	9.6	2.4	0.0	1.2	0.2	1.0	1.4	8.0	0.7	0.0	0.2	0.6	1.0	1.2	6.2	0.2
08/07/2013	18:30-18:45	6.2	2.6	0.0	0.6	0.6	1.0	1.6	2.2	0.5	2.2	0.6	0.8	0.2	1.0	6.4	0.0
08/07/2013	18:45-18:00	0.2	1.6	0.4	0.0	4.8	0.0	0.4	2.2	0.4	7.8	0.6	0.6	0.6	1.0	1.6	0.2
08/07/2013	19:00-19:15	0.2	0.6	1.6	0.0	10.4	0.4	0.0	1.6	0.0	2.0	0.4	0.6	0.8	0.2	1.0	0.0
08/07/2013	19:15-19:30	0.0	0.2	1.0	0.2	12.4	0.0	0.0	0.2	0.0	1.0	0.6	0.0	0.2	0.2	0.6	0.4
08/07/2013	19:30-19:45	0.0	0.8	0.6	0.0	2.6	0.0	0.0	0.6	0.0	1.0	0.4	0.0	0.2	0.0	0.2	0.0
08/07/2013	19:45-19:00	0.4	0.6	0.0	0.0	0.4	0.0	0.0	0.4	0.0	0.6	0.8	0.4	0.0	0.0	0.2	0.0
08/07/2013	20:00-20:15	0.0	0.8	0.0	0.0	0.4	0.0	0.2	0.2	0.0	1.0	1.2	0.2	0.0	0.0	0.4	0.0
08/07/2013	20:15-20:30	0.2	0.4	0.0	0.2	0.4	0.2	0.0	0.4	0.0	1.2	0.6	0.0	0.2	0.0	0.2	0.0
08/07/2013	20:30-20:45	0.2	0.8	0.0	0.0	0.6	0.0	0.0	0.4	0.0	0.8	0.6	0.0	0.0	0.0	0.6	0.0
08/07/2013	20:45-20:00	0.4	1.4	0.0	0.0	0.4	0.2	0.0	0.4	0.0	0.8	0.2	0.4	0.4	0.0	0.2	0.0
08/07/2013	21:00-21:15	0.4	0.8	0.0	0.4	0.6	0.0	0.0	0.4	0.0	0.8	0.6	0.4	0.0	0.0	0.6	0.0
08/07/2013	21:15-21:30	0.6	0.0	0.0	0.0	1.0	0.4	0.2	0.4	0.0	0.2	0.2	0.2	0.2	0.0	0.8	0.0
08/07/2013	21:30-21:45	0.0	0.0	0.0	0.2	0.8	0.0	0.0	0.2	0.0	0.2	0.2	0.2	0.2	0.0	0.2	0.0
08/07/2013	21:45-21:00	0.2	0.0	0.2	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.2	0.2	0.2	0.0	0.0	0.0
08/07/2013	22:00-22:15	0.0	0.0	0.0	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.0
08/07/2013	22:15-22:30	0.0	0.2	0.0	0.2	0.0	0.0	0.2	0.0	0.1	0.0	0.2	0.0	0.2	0.2	0.0	0.0
08/07/2013	22:30-22:45	0.0	0.0	0.4	0.2	0.0	0.0	0.2	0.0	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.2
08/07/2013	22:45-22:00	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.2	0.0	0.2	0.0	0.2
08/07/2013	23:00-23:15	0.0	0.0	0.2	0.0	0.0	0.0	0.2	0.0	0.3	0.0	0.0	0.0	0.2	0.4	0.2	0.0
08/07/2013	23:15-23:30	0.0	0.0	0.0	0.4	0.0	0.4	0.0	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.0	0.6
08/07/2013	23:30-23:45	0.4	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
08/07/2013	23:45-23:00	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:00-0:15	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:15-0:30	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:30-0:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
09/07/2013	0:45-0:00	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:00-1:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:15-1:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:30-1:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:45-2:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	2:00-2:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total		73.0	51.2	6.8	10.2	109.4	8.6	9.0	79.0	5.7	35.0	72.6	25.4	20.0	7.4	94.0	3.2

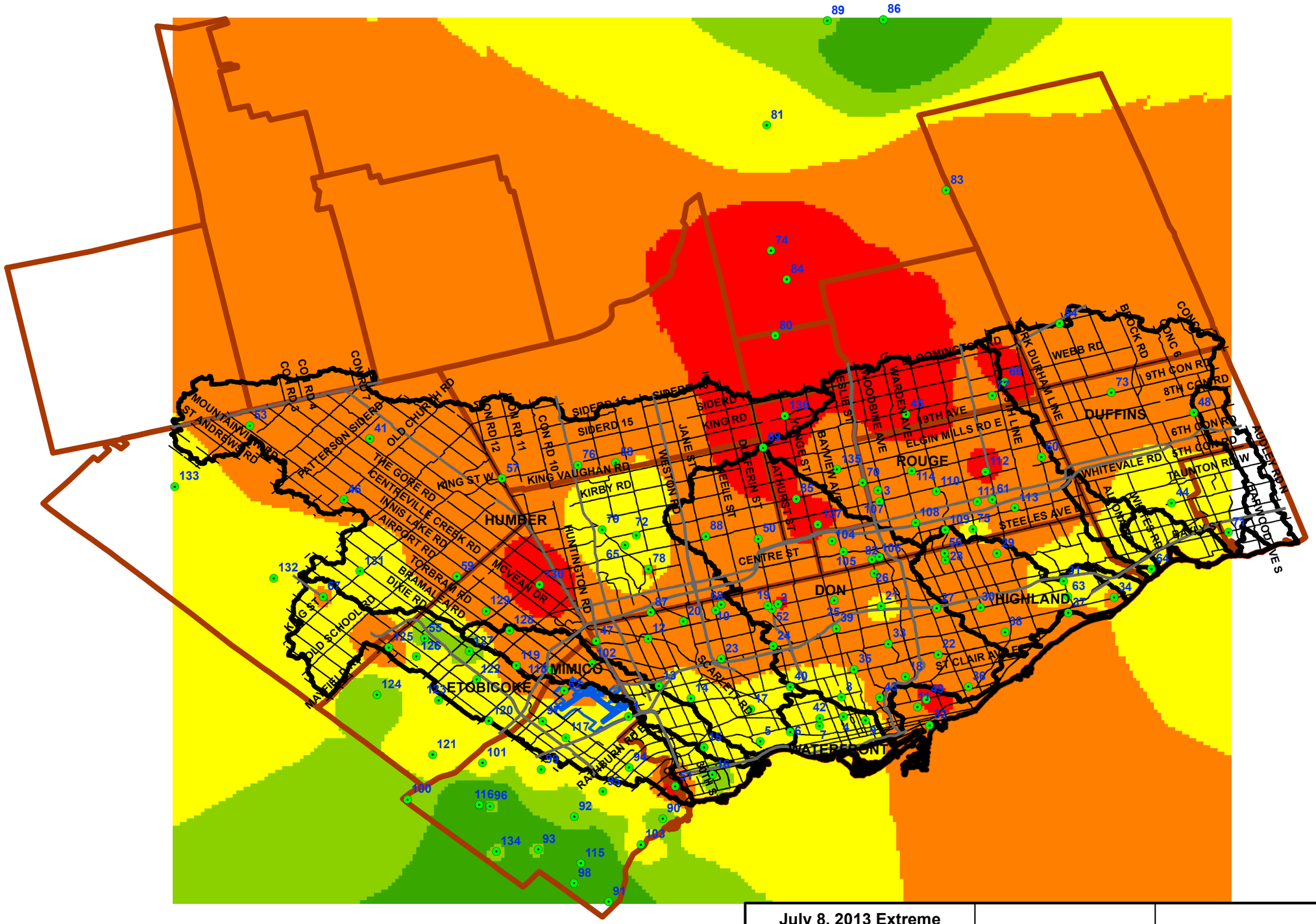
AMEC ID		74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89
Source		York Region															
Date/Gauge		R_ET_HL01	R_ET_MA03	R_ET_NO01	R_ET_ST02	R_ET_VA01	R_ET_VA02	R_YR_AU02	R_YR_KE01	R_YR_MA03	R_YR_MO01	R_YR_NE01	R_YR_RH01	R_YR_SU01	R_YR_VA03	R_YR_VA04	R_YR_WB01
08/07/2013	14:00-14:15	0.0	0.0	0.0	0.2	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	14:15-14:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.2
08/07/2013	14:30-14:45	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	19.0	0.8	0.0	0.0	0.0	0.0
08/07/2013	14:45-14:00	0.2	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	4.4	0.8	0.4	0.0	0.0	0.2
08/07/2013	15:00-15:15	0.0	0.0	0.0	0.0	0.0	0.0	2.6	0.2	0.0	0.2	1.2	0.0	0.2	0.0	0.0	0.0
08/07/2013	15:15-15:30	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.4	0.0	0.0	0.0	11.0	0.4	6.8	3.8	0.4
08/07/2013	15:30-15:45	20.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	3.6	0.6	0.4	18.0	0.0	29.0	21.2	0.0
08/07/2013	15:45-15:00	11.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.2	0.0	0.0	1.8	0.0	7.8	3.4	0.0
08/07/2013	16:00-16:15	6.6	0.0	7.2	0.0	0.0	0.0	0.0	0.0	4.8	0.0	0.0	0.6	0.0	0.2	0.6	0.0
08/07/2013	16:15-16:30	0.6	0.0	16.0	0.0	0.0	10.2	0.0	0.0	1.6	0.0	0.0	0.6	0.0	6.4	1.4	0.0
08/07/2013	16:30-16:45	0.2	0.0	2.8	0.0	15.8	21.6	0.0	0.0	0.0	0.0	0.0	0.6	0.0	11.4	3.4	0.0
08/07/2013	16:45-16:00	0.0	0.0	3.4	1.2	0.6	0.8	0.2	0.0	0.6	0.0	0.0	1.2	0.0	13.8	6.0	0.0
08/07/2013	17:00-17:15	0.0	0.0	2.4	0.4	0.0	0.4	1.8	0.0	0.4	0.0	0.8	1.4	0.0	7.0	4.8	0.0
08/07/2013	17:15-17:30	0.0	1.0	4.4	0.4	2.2	5.8	10.6	0.2	0.6	0.0	1.0	0.6	0.0	0.8	3.0	1.0
08/07/2013	17:30-17:45	0.0	0.4	10.6	0.0	7.8	10.4	2.8	0.6	0.2	0.0	0.6	0.8	0.6	1.4	1.6	0.2
08/07/2013	17:45-17:00	0.0	0.2	9.8	0.0	7.4	22.6	1.2	0.4	1.4	0.0	0.8	1.4	0.2	0.8	1.0	0.4
08/07/2013	18:00-18:15	0.0	0.6	5.8	0.0	14.0	10.6	0.8	0.4	1.4	0.0	0.2	0.6	0.4	0.8	0.8	0.0
08/07/2013	18:15-18:30	0.4	0.4	2.4	0.0	6.4	0.6	0.2	0.0	0.4	0.4	0.2	1.2	0.0	0.4	1.2	0.0
08/07/2013	18:30-18:45	1.2	0.4	4.6	0.0	0.6	1.0	0.6	0.2	0.6	0.0	0.6	1.8	0.0	1.6	1.8	0.0
08/07/2013	18:45-18:00	2.8	0.4	0.8	0.6	1.2	0.6	1.2	0.6	0.8	0.2	0.8	0.4	0.0	4.4	1.0	0.0
08/07/2013	19:00-19:15	0.2	1.4	6.4	1.2	0.6	8.2	0.6	0.2	0.2	0.4	0.6	0.6	0.0	1.8	1.2	0.2
08/07/2013	19:15-19:30	0.2	0.8	18.4	1.0	2.0	11.2	0.2	0.0	0.0	0.0	0.0	0.2	0.0	1.6	0.2	0.0
08/07/2013	19:30-19:45	0.4	0.2	3.4	0.2	1.2	3.2	0.0	0.0	0.4	0.2	0.2	0.0	0.0	0.4	0.2	0.0
08/07/2013	19:45-19:00	1.2	0.0	0.8	0.4	1.0	0.8	0.0	0.0	0.4	0.2	0.0	0.0	0.0	0.4	0.4	0.0
08/07/2013	20:00-20:15	0.8	0.0	0.0	0.0	7.8	0.2	0.4	0.0	0.4	0.4	0.0	0.2	0.0	1.2	0.4	0.0
08/07/2013	20:15-20:30	0.0	0.4	0.0	0.0	1.2	0.2	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.8	0.4	0.0
08/07/2013	20:30-20:45	0.4	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.2	0.0	0.0	0.2	0.0	0.2	0.4	0.0
08/07/2013	20:45-20:00	0.0	0.0	0.4	0.0	0.8	0.0	0.2	0.0	0.4	0.0	0.0	0.4	0.0	0.6	0.2	0.0
08/07/2013	21:00-21:15	0.0	0.0	0.0	0.0	1.0	0.4	0.0	0.0	0.2	0.2	0.0	0.2	0.0	0.4	0.6	0.0
08/07/2013	21:15-21:30	0.2	0.2	0.2	0.0	0.6	0.2	0.0	0.0	0.2	0.0	0.2	0.4	0.0	0.4	0.6	0.0
08/07/2013	21:30-21:45	0.0	0.0	0.6	0.0	0.6	0.6	0.0	0.0	0.6	0.0	0.0	0.4	0.0	0.0	0.2	0.0
08/07/2013	21:45-21:00	0.0	0.2	0.4	0.2	0.2	0.2	0.4	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.2	0.0
08/07/2013	22:00-22:15	0.0	0.0	0.6	0.0	0.6	0.8	0.2	0.0	0.2	0.0	0.0	0.2	0.0	0.2	0.2	0.2
08/07/2013	22:15-22:30	0.0	0.0	0.2	0.0	0.4	0.2	0.0	0.0	0.4	0.0	0.2	0.2	0.0	0.0	0.0	0.0
08/07/2013	22:30-22:45	0.0	0.4	0.0	0.0	0.2	0.4	0.2	0.0	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.0
08/07/2013	22:45-22:00	0.2	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.0
08/07/2013	23:00-23:15	0.4	0.4	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	23:15-23:30	0.0	0.0	0.0	0.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
08/07/2013	23:30-23:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	23:45-23:00	0.0	0.4	0.0	0.4	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:00-0:15	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:15-0:30	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0
09/07/2013	0:30-0:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:45-0:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:00-1:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:15-1:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:30-1:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:45-2:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	2:00-2:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total		47.8	7.8	102.0	6.8	75.0	111.4	29.4	5.6	44.6	3.0	31.6	47.2	2.4	100.8	60.4	2.8

AMEC ID		90	91	92	93	94	95	96	97	98	99	100	101	102	103
Source		Mississauga													
Date/Gauge		STN 01 - Third St.	STN 02 - Clarkson	STN 03 - Wolfedale	STN 04 - South Common	STN 05 - Winding Trail	STN 06 - Mississauga Valley	STN 07 - Britannia	STN 08 - Tomken	STN 09 - Truscott	STN 10 - Falbourne	STN 11 - Garry Morden FTC	STN 12 - CVC	STN 13 - Goreway	STN 14 - Port Credit
08/07/2013	14:00-14:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	14:15-14:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	14:30-14:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	14:45-14:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	15:00-15:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	15:15-15:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.4	0.0	2.2	0.0	0.6	14.2	0.0
08/07/2013	15:30-15:45	0.0	0.0	0.0	0.0	1.6	1.0	0.0	0.0	0.0	0.4	0.0	0.0	9.8	0.0
08/07/2013	15:45-15:00	0.0	0.0	0.0	0.0	3.2	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.4	0.0
08/07/2013	16:00-16:15	0.0	0.0	0.0	0.0	3.8	0.2	0.0	0.8	0.0	0.2	0.0	0.0	9.8	0.0
08/07/2013	16:15-16:30	0.6	0.0	0.0	0.0	0.8	0.0	0.0	4.8	0.0	3.0	1.2	0.0	3.8	0.0
08/07/2013	16:30-16:45	0.0	0.0	10.0	0.0	24.2	7.8	9.4	15.0	0.0	19.4	4.2	14.8	4.8	0.0
08/07/2013	16:45-16:00	36.8	0.0	28.8	0.0	32.2	33.6	2.6	4.6	0.0	20.0	1.2	15.2	13.6	27.2
08/07/2013	17:00-17:15	29.6	0.0	3.4	0.5	7.0	19.6	1.4	3.0	0.8	7.4	0.6	1.8	1.4	22.4
08/07/2013	17:15-17:30	6.0	0.2	0.8	0.0	3.4	1.2	0.4	0.8	0.8	0.0	0.2	1.0	1.2	3.6
08/07/2013	17:30-17:45	1.8	2.0	0.8	0.0	1.0	0.8	0.6	1.8	0.4	0.0	0.0	1.2	1.0	0.8
08/07/2013	17:45-17:00	1.4	0.4	1.4	0.0	1.4	1.2	0.0	0.6	0.2	0.0	0.0	0.2	0.4	1.0
08/07/2013	18:00-18:15	1.4	0.0	0.6	0.0	1.2	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.4	1.6
08/07/2013	18:15-18:30	0.6	0.0	0.2	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.4
08/07/2013	18:30-18:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	6.2	0.0
08/07/2013	18:45-18:00	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	5.6	0.0
08/07/2013	19:00-19:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	0.0	0.0	0.0	0.0	5.4	0.0
08/07/2013	19:15-19:30	0.0	1.4	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.2	4.2	0.0
08/07/2013	19:30-19:45	0.0	1.6	0.0	0.0	0.6	0.0	0.0	4.0	0.0	0.2	0.0	0.0	1.0	0.0
08/07/2013	19:45-19:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.2	1.0	5.8	0.0	0.0
08/07/2013	20:00-20:15	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.4	0.0	1.0	0.2	0.6	0.4	0.0
08/07/2013	20:15-20:30	0.0	0.0	0.4	0.0	0.6	0.6	0.4	0.4	0.0	0.2	0.6	0.6	0.6	0.0
08/07/2013	20:30-20:45	0.0	0.0	0.2	0.0	1.0	0.4	1.8	0.8	0.0	0.4	2.8	0.8	0.6	0.2
08/07/2013	20:45-20:00	0.6	0.2	1.0	0.0	0.6	0.8	1.0	1.2	0.4	0.6	0.6	1.2	0.6	0.4
08/07/2013	21:00-21:15	0.6	0.2	0.8	0.0	1.2	1.0	1.0	1.0	0.2	0.4	0.2	0.8	0.6	0.4
08/07/2013	21:15-21:30	0.4	0.2	0.8	0.5	0.8	0.8	0.6	1.6	0.4	0.6	0.8	1.0	0.4	0.4
08/07/2013	21:30-21:45	1.0	0.2	1.0	1.5	1.2	1.0	0.6	1.0	0.2	0.4	0.4	0.6	0.4	0.4
08/07/2013	21:45-21:00	0.4	0.0	0.0	0.3	0.4	0.2	0.0	0.4	0.2	0.0	0.0	0.0	0.2	0.4
08/07/2013	22:00-22:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	22:15-22:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	22:30-22:45	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.2	0.0
08/07/2013	22:45-22:00	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.2	0.0	0.2	0.0	0.2
08/07/2013	23:00-23:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	23:15-23:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	23:30-23:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	23:45-23:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:00-0:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:15-0:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:30-0:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:45-0:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:00-1:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:15-1:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:30-1:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:45-2:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	2:00-2:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0
Total		81.4	6.6	50.2	2.8	86.4	71.0	20.4	56.4	4.0	56.8	14.2	46.6	87.8	59.4

AMEC ID		104	105	106	107	108	109	110	111	112	113	114
Source		Markham										
Date/Gauge		Rain Gauge 1 (mm)	Rain Gauge 2 (mm)	Rain Gauge 3 (mm)	Rain Gauge 4 (mm)	Rain Gauge 5 (mm)	Rain Gauge 6 (mm)	Rain Gauge 7 (mm)	Rain Gauge 8 (mm)	Rain Gauge 9 (mm)	Rain Gauge 10 (mm)	Rain Gauge 11 (mm)
08/07/2013	14:00-14:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	14:15-14:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	14:30-14:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	14:45-14:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0
08/07/2013	15:00-15:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
08/07/2013	15:15-15:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	15:30-15:45	21.0	12.4	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	15:45-15:00	19.0	21.3	18.6	6.8	2.8	0.0	0.8	0.0	0.0	0.0	1.8
08/07/2013	16:00-16:15	3.0	3.6	9.8	1.4	3.0	1.3	2.0	1.0	0.8	0.3	0.5
08/07/2013	16:15-16:30	0.2	1.3	1.2	0.8	0.6	0.8	0.5	0.6	0.2	0.8	0.5
08/07/2013	16:30-16:45	0.4	0.3	0.2	0.2	0.0	0.3	0.3	0.2	0.2	0.3	0.3
08/07/2013	16:45-16:00	0.4	0.3	0.2	0.2	0.4	0.3	0.0	0.2	0.2	0.3	0.3
08/07/2013	17:00-17:15	1.0	0.8	0.6	0.8	0.2	0.5	0.8	0.2	0.2	0.3	0.5
08/07/2013	17:15-17:30	0.8	0.5	0.4	0.4	0.4	0.0	1.0	0.6	0.2	0.8	0.8
08/07/2013	17:30-17:45	0.2	0.3	0.2	0.6	0.4	0.5	0.8	0.6	0.8	0.8	1.0
08/07/2013	17:45-17:00	0.8	1.0	0.8	1.2	0.8	1.0	1.0	1.6	1.2	1.8	1.0
08/07/2013	18:00-18:15	0.2	1.0	1.2	1.4	1.2	1.3	1.8	1.4	2.2	2.3	1.8
08/07/2013	18:15-18:30	0.0	0.5	0.8	1.0	0.8	0.8	1.0	1.4	0.8	1.3	1.0
08/07/2013	18:30-18:45	0.0	0.8	0.4	0.4	0.2	0.0	0.3	0.4	0.4	0.3	0.5
08/07/2013	18:45-18:00	0.0	1.0	0.4	0.4	0.2	0.3	0.0	0.0	0.0	0.3	0.0
08/07/2013	19:00-19:15	0.0	0.3	0.6	0.8	0.4	0.5	0.3	0.0	0.0	0.0	0.3
08/07/2013	19:15-19:30	0.0	0.0	0.2	0.2	0.2	0.0	0.3	0.2	0.0	0.0	0.3
08/07/2013	19:30-19:45	0.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	19:45-19:00	0.0	0.5	0.4	0.2	0.0	0.0	0.0	0.0	0.2	0.3	0.0
08/07/2013	20:00-20:15	2.2	0.0	0.2	0.0	0.2	0.3	0.0	0.2	0.0	0.0	0.0
08/07/2013	20:15-20:30	1.2	0.5	0.2	0.2	0.0	0.0	0.3	0.0	0.0	0.3	0.3
08/07/2013	20:30-20:45	2.4	0.5	0.4	0.0	0.0	0.3	0.0	0.2	0.2	0.0	0.0
08/07/2013	20:45-20:00	1.0	0.0	0.4	0.2	0.4	0.0	0.0	0.2	0.0	0.0	0.3
08/07/2013	21:00-21:15	0.8	0.3	0.0	0.2	0.2	0.3	0.3	0.0	0.0	0.0	0.0
08/07/2013	21:15-21:30	0.6	0.5	0.2	0.4	0.0	0.0	0.0	0.0	0.0	0.3	0.3
08/07/2013	21:30-21:45	0.4	0.5	0.6	0.4	0.2	0.3	0.3	0.0	0.2	0.0	0.3
08/07/2013	21:45-21:00	0.2	0.3	0.2	0.2	0.2	0.3	0.3	0.2	0.2	0.3	0.3
08/07/2013	22:00-22:15	0.0	0.0	0.0	0.2	0.2	0.3	0.3	0.4	0.2	0.3	0.3
08/07/2013	22:15-22:30	0.4	0.3	0.4	0.4	0.0	0.0	0.3	0.0	0.2	0.3	0.0
08/07/2013	22:30-22:45	0.0	0.0	0.0	0.0	0.2	0.3	0.3	0.2	0.0	0.0	0.0
08/07/2013	22:45-22:00	0.2	0.3	0.2	0.2	0.0	0.0	0.0	0.0	0.4	0.3	0.3
08/07/2013	23:00-23:15	0.0	0.0	0.2	0.0	0.0	0.3	0.0	0.2	0.0	0.0	0.0
08/07/2013	23:15-23:30	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	23:30-23:45	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
08/07/2013	23:45-23:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:00-0:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:15-0:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0
09/07/2013	0:30-0:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:45-0:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:00-1:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:15-1:30	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:30-1:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:45-2:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	2:00-2:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total		56.8	49.5	39.0	20.0	13.6	9.3	12.5	10.0	9.4	11.0	12.0

AMEC ID		115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137
Source		Peel Region																				Richmond Hill		
Date/Gauge		RG3	RG11	RG16	RG20	RG22	RG23	RG24	RG25	RG26	RG27	RG28	RG29	RG31	RG32	RG33	RG34	RG36	RG39	RG42	RG44	Discovery	Oak	Oper
08/07/2013	14:00-14:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	14:15-14:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	14:30-14:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	4.0	0.0	1.3	0.0	0.0	0.0	0.0	0.0
08/07/2013	14:45-14:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	15:00-15:15	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.3	0.3	0.0	4.8	0.3	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.4
08/07/2013	15:15-15:30	0.0	0.0	11.5	17.8	4.0	0.0	0.5	1.5	0.0	0.0	0.0	0.0	0.0	1.8	0.3	0.0	0.0	0.0	0.0	0.0	0.0	8.8	3.2
08/07/2013	15:30-15:45	0.0	0.0	1.3	12.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.3	0.0	0.0	0.0	0.0	23.4	5.0	8.0
08/07/2013	15:45-15:00	0.0	0.0	0.5	0.5	0.3	0.0	0.0	0.3	0.5	0.0	0.0	0.0	0.0	0.3	0.3	1.8	1.8	0.3	8.3	0.0	18.8	1.0	9.4
08/07/2013	16:00-16:15	0.0	0.0	0.0	12.3	8.8	1.8	0.0	9.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.5	3.0	4.8	0.5	0.0	3.4	0.0	0.8
08/07/2013	16:15-16:30	0.0	0.0	6.8	4.8	1.5	0.3	8.3	0.3	0.5	6.5	7.8	3.8	0.0	0.5	2.3	1.0	14.5	7.8	0.5	0.0	0.6	0.0	0.2
08/07/2013	16:30-16:45	0.0	6.8	11.0	6.0	7.3	8.8	19.3	9.8	3.8	12.5	3.5	9.8	9.8	13.3	14.5	4.0	1.0	1.0	0.5	0.0	0.4	0.0	0.6
08/07/2013	16:45-16:00	0.8	1.3	6.8	17.0	6.8	6.3	2.0	3.8	3.5	1.5	0.8	0.8	2.8	5.3	2.5	1.0	1.0	1.0	0.3	0.0	0.2	0.6	0.2
08/07/2013	17:00-17:15	3.0	1.0	3.3	1.8	1.0	1.0	0.5	1.0	1.0	0.8	0.5	1.3	0.8	1.5	1.3	0.5	1.3	0.8	0.3	0.3	1.4	2.6	0.2
08/07/2013	17:15-17:30	0.0	0.3	0.5	1.5	0.8	0.0	0.8	1.3	1.3	0.5	1.3	1.8	1.5	1.8	1.8	0.3	1.5	0.5	0.0	1.0	0.8	1.8	0.4
08/07/2013	17:30-17:45	0.0	0.0	1.3	1.3	1.0	0.0	0.3	0.5	0.0	0.0	0.3	0.0	0.5	0.3	0.5	0.5	0.8	0.0	0.0	0.8	0.6	2.0	0.8
08/07/2013	17:45-17:00	0.0	0.0	1.3	0.5	0.3	0.0	0.0	0.3	0.0	0.0	0.0	0.3	0.3	0.8	2.0	0.3	0.0	0.0	0.0	0.0	0.8	0.8	1.0
08/07/2013	18:00-18:15	0.0	0.0	0.0	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.5	1.0	0.0	1.8	2.5	0.8	0.5	0.0	0.0	0.0	1.2	0.8	1.0
08/07/2013	18:15-18:30	0.0	0.0	0.3	0.8	1.0	0.0	0.0	0.5	0.0	0.0	12.8	12.0	8.3	6.0	4.0	0.8	6.3	2.3	0.0	0.0	0.6	0.8	1.2
08/07/2013	18:30-18:45	0.0	0.0	0.0	7.8	7.3	0.0	0.0	7.0	0.0	0.0	5.5	20.0	12.8	15.8	9.3	1.0	3.0	14.0	0.3	0.0	0.8	0.4	0.8
08/07/2013	18:45-18:00	0.0	0.0	0.0	7.0	9.0	0.0	0.0	10.3	0.0	0.0	16.8	22.3	12.3	17.8	12.0	3.5	1.5	4.0	0.3	0.0	0.2	0.6	0.8
08/07/2013	19:00-19:15	0.0	0.0	2.0	6.8	15.3	0.0	0.0	17.8	2.0	9.3	14.8	12.8	8.3	8.3	1.5	0.5	0.3	1.0	0.5	0.0	0.6	1.0	0.8
08/07/2013	19:15-19:30	0.0	0.0	4.5	5.3	3.8	0.0	0.3	11.0	3.0	8.8	3.3	3.8	4.5	1.5	1.3	0.5	1.0	0.5	1.0	0.0	0.0	0.4	0.2
08/07/2013	19:30-19:45	0.0	0.0	3.3	1.3	1.5	0.0	0.5	1.8	2.8	5.8	1.0	2.0	0.8	1.0	0.8	0.8	0.3	0.8	0.5	0.0	0.4	0.0	0.0
08/07/2013	19:45-19:00	0.0	0.0	1.3	0.0	0.3	0.0	2.3	0.5	0.3	1.3	0.5	0.3	0.3	0.3	0.3	0.5	0.5	1.5	1.3	0.0	0.0	0.2	0.0
08/07/2013	20:00-20:15	0.0	0.0	0.8	0.5	0.3	0.0	0.8	0.0	0.3	0.5	0.3	0.5	0.3	0.3	0.5	0.5	1.0	1.3	0.8	0.0	0.2	0.0	0.2
08/07/2013	20:15-20:30	0.0	0.0	0.8	0.8	0.3	0.0	3.3	0.5	0.5	0.8	0.8	0.8	0.5	0.5	0.3	0.3	1.3	1.3	0.5	0.8	0.0	0.0	0.0
08/07/2013	20:30-20:45	0.0	0.0	0.3	0.8	1.0	0.0	0.5	0.5	0.3	0.5	0.8	0.8	0.8	1.0	1.3	0.8	0.8	1.3	1.5	0.8	0.2	0.4	0.4
08/07/2013	20:45-20:00	0.0	0.0	0.8	0.8	0.5	0.0	1.3	1.0	1.0	0.8	0.8	1.0	1.0	0.5	1.3	0.8	1.0	2.0	0.3	3.0	0.0	0.4	0.2
08/07/2013	21:00-21:15	0.0	0.0	1.0	0.8	1.0	0.0	0.5	1.3	1.5	1.3	1.0	1.3	0.8	1.0	1.0	0.8	0.8	0.5	0.3	0.5	0.4	0.4	0.2
08/07/2013	21:15-21:30	0.0	0.0	1.5	0.5	0.8	0.5	1.3	1.3	1.3	1.3	0.8	1.0	0.5	0.5	0.5	0.3	0.3	0.0	0.0	1.8	0.2	0.2	0.0
08/07/2013	21:30-21:45	0.0	0.5	0.8	0.5	0.5	0.5	0.3	0.8	0.5	0.3	0.5	0.3	0.5	0.0	0.0	0.3	0.0	0.0	0.0	0.8	0.6	0.4	0.4
08/07/2013	21:45-21:00	0.0	0.0	0.3	0.3	0.3	0.0	0.0	0.3	0.3	0.0	0.0	0.3	0.3	0.3	0.3	0.3	0.0	0.0	0.3	0.3	0.2	0.4	0.2
08/07/2013	22:00-22:15	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.2
08/07/2013	22:15-22:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.0	0.4	0.0	0.4
08/07/2013	22:30-22:45	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.4	0.2
08/07/2013	22:45-22:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
08/07/2013	23:00-23:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
08/07/2013	23:15-23:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.2
08/07/2013	23:30-23:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
08/07/2013	23:45-23:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:00-0:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:15-0:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:30-0:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	0:45-0:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:00-1:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:15-1:30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:30-1:45	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	1:45-2:00	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
09/07/2013	2:00-2:15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total		3.8	9.8	61.3	109.8	74.8	19.3	42.5	81.8	24.0	52.0	74.3	97.5	67.3	86.8	63.8	36.5	44.3	47.8	17.8	9.8	56.6	29.6	32.6

Figure 4-10: Temporal Distribution of July 8th 2013 Extreme Rainfall Event



July 8, 2013 Extreme Rainfall Event **Summary and Analysis Report** **Toronto and Region Conservation Authority**	**Total Storm Duration**	amec	Scale **1:400,000** 0 2.5 5 10 15 Kilometers Project No. **TP114045** Figure No. **4-11**

4.4 Return Period

Environment Canada has a number of gauges in and around the study area which have established Intensity-Duration-Frequency (IDF) relationships. In order to establish an estimate of the return period of the July 8th, 2013 extreme storm event, a comparison has been performed between the observed maximum rainfall intensities, based on moving duration totals, determined at each gauge and the rainfall intensities for the Environment Canada IDF stations. The Environment Canada IDF stations used for this assessment, as well as rainfall intensities for all durations at each station with 100 and 50 year return periods have been presented in Tables 4-5 and 4-6.

Table 4-5: Rainfall Intensity with 100 Year Return Period for All Durations Based on Environment Canada IDF Stations (mm/hr)

Gauge	Available Period	Rainfall Duration							
		5 min	10 min	15 min	30 min	1 h	2 h	6 h	12 h
Toronto City	1940-2007	268.8	171.6	148.8	97	56.8	31.55	12.77	7.21
Toronto Lester B. Pearson Int'L Airport	1950-2007	224.4	163.8	137.2	91	51.3	30.8	14.07	8.26
Maple	1960-1975	Missing	Missing	Missing	Missing	55.6	38.15	13.1	6.83
Greenwood Mtrca	1960-1988	178.8	116.4	98.8	80.4	52.1	29.7	12.68	6.85
Stouffville Wpcp	1961-1989	Missing	Missing	Missing	Missing	61.8	42.15	15.02	9.33
Heart Lake	1962-1974	Missing	Missing	Missing	Missing	59.1	35.75	13.28	7.98
Toronto North York	1964-2007	282	223.2	208.8	140.8	87	50.85	19.75	10.63
Toronto Etobicoke	1964-1980	206.4	123	104.8	81.2	53	30.3	13.42	7.68
Oakville Southeast Wpcp	1965-1976	198	138.6	97.2	66.8	43.4	28.45	14.45	7.84
Lindsay Filtration Plant	1965-1989	217.2	151.2	118	85.6	58.8	34.7	14.95	7.51
Toronto Greenwood	1966-1981	226.8	170.4	142.4	94	58.1	30.15	10.63	5.53
Toronto Met Res Stn	1966-1987	247.2	166.2	132.4	89.8	51.4	30.7	14.92	7.72
Toronto Old Weston Rd	1966-1990	219.6	153.6	130	89.6	51.4	32.4	12.55	6.89
Toronto Booth	1966-1992	223.2	165.6	149.6	97.8	62.5	35.8	14.35	7.33
Toronto Ellesmere	1966-1994	187.2	139.8	120.8	83.8	53	33.35	12.43	6.25
Burketon Mclaughlin	1969-2001	192	138.6	124.4	78.2	47.5	32.4	13.98	7.58
Oshawa Wpcp	1970-2006	193.2	136.8	110	71.2	46	28.65	12.12	9.37
Toronto Island A	1971-1994	262.8	178.8	150	98	62	32.75	12.7	6.84
Toronto Seneca Hill	1973-1986	288	222.6	197.6	115.2	61.7	33.2	15.12	7.82
Toronto York Mills	1973-1986	212.4	180	163.6	122.4	68.5	34.05	13.1	6.68
Toronto Leslie Eglinton	1973-1987	181.2	134.4	110.4	89.4	56.9	30.9	12.47	6.56
Grand Valley Wpcp	1976-1991	205.2	138	110.8	76.6	45.9	30.65	14.68	8.07
Toronto Buttonville A	1986-2007	218.4	153.6	126	90.8	57.7	29.65	11.98	6.74
Egbert Cs	1989-2007	204	148.2	122.4	68.8	51.4	30.1	11.92	6.23
Orangeville MOE	1993-2007	200.4	176.4	149.6	93	48.6	25.8	9.82	Missing

Table 4-6: Rainfall Intensity with 50 Year Return Period for All Durations Based on Environment Canada IDF Stations (mm/hr)

Gauge	Available Period	Rainfall Duration							
		5 min	10 min	15 min	30 min	1 h	2 h	6 h	12 h
Toronto City	1940-2007	242.4	155.4	134.4	87.4	51.4	28.65	11.62	6.58
Toronto Lester B. Pearson Int'L Airport	1950-2007	204	148.8	124.4	82.6	46.6	27.9	12.72	7.46
Maple	1960-1975	Missing	Missing	Missing	Missing	49.7	34.15	11.92	6.24
Greenwood Mtrca	1960-1988	164.4	108	91.2	73	47.1	26.9	11.47	6.21
Stouffville Wpcp	1961-1989	Missing	Missing	Missing	Missing	55.4	37.6	13.6	8.38
Heart Lake	1962-1974	Missing	Missing	Missing	Missing	53.1	32.25	12.18	7.31
Toronto North York	1964-2007	253.2	199.8	185.2	124.6	76.9	44.9	17.52	9.45
Toronto Etobicoke	1964-1980	188.4	113.4	96	73.4	48	27.65	12.2	6.99
Oakville Southeast Wpcp	1965-1976	181.2	126.6	90	61.6	40	26.1	13.07	7.15
Lindsay Filtration Plant	1965-1989	198	138.6	108.4	78	53.1	31.3	13.48	6.82
Toronto Greenwood	1966-1981	204	153.6	128	84.6	52.1	27.25	9.77	5.13
Toronto Met Res Stn	1966-1987	225.6	151.8	121.6	82	47	28	13.47	6.99
Toronto Old Weston Rd	1966-1990	200.4	140.4	118.4	81.4	46.7	29.35	11.45	6.3
Toronto Booth	1966-1992	202.8	150	134.8	88	55.9	32.15	12.95	6.66
Toronto Ellesmere	1966-1994	171.6	127.8	109.6	75.8	47.8	29.95	11.32	5.74
Burketon Mclaughlin	1969-2001	176.4	127.2	113.2	71.6	43.6	29.45	12.72	6.9
Oshawa Wpcp	1970-2006	176.4	124.8	100.4	65	41.8	26	11.03	8.36
Toronto Island A	1971-1994	235.2	161.4	135.6	88.4	55.9	29.75	11.6	6.27
Toronto Seneca Hill	1973-1986	260.4	201	178	104.4	56.1	30.35	13.65	7.05
Toronto York Mills	1973-1986	193.2	162	146.8	109.4	61.3	30.7	11.82	6.04
Toronto Leslie Eglinton	1973-1987	166.8	123	101.6	80.8	51.5	28.05	11.33	5.99
Grand Valley Wpcp	1976-1991	187.2	127.2	102	70	41.9	27.9	13.27	7.31
Toronto Buttonville A	1986-2007	200.4	140.4	115.2	81.8	51.7	26.7	10.92	6.15
Egbert Cs	1989-2007	186	135	111.2	63.2	46.5	27.25	10.82	5.68
Orangeville Moe	1993-2007	182.4	157.8	133.2	83	43.6	23.35	9.03	Missing

The rainfall intensities for all IDF stations presented in Tables 4-5 and 4-6 have been used to develop a spatial grid depicting the spatial distribution of rainfall intensities with 50 and 100 year return periods for each rainfall duration. The resultant spatial grids have been compared to the spatial grid depicting the maximum rainfall intensity recorded at all of the rain gauges for each rainfall duration and the areas where the recorded maximum intensity exceeded the intensity coverage established based on IDF stations for all rainfall durations with 50 and 100 year return period. The results of this assessment have been presented in Figure 4-12 to Figure 4-19. The interpolation method used for these figures has been the IDW method with a power of 3.

Based on the results presented in these figures, portions of the Etobicoke Creek and Mimico Creek watersheds, mostly located on the south-eastern parts of the watershed received rainfall with a return period exceeding 100 years for storm durations of 5 minutes to 60 minutes. For rainfall durations longer than 1 hour, in addition to these two watersheds, a smaller portion of the Don River watershed located in the south west, as well as southern and central parts of the Humber River watershed also received rainfall with a return period in excess of 100 years.

These results also indicate that Mimico Creek, parts of Etobicoke Creek and the south/central part of the Humber River watershed received rainfall in excess of a 50 year rainfall event.

ID	Gauge Name	Source	Max 5 min (mm/hr)
1	Toronto Lester B. Pearson Int'L A	Environment Canada	129.60
2	Toronto North York	Environment Canada	103.20
3	Toronto Buttonville A	Environment Canada	38.40
5	Swansea	City of Toronto	105.00
6	Howard	City of Toronto	129.00
7	Central	City of Toronto	105.00
8	Brown	City of Toronto	99.00
9	Church	City of Toronto	99.00
10	Jane	City of Toronto	93.00
11	Greenwood	City of Toronto	114.00
12	Albion	City of Toronto	99.00
13	Martin Grove	City of Toronto	180.00
14	Richview	City of Toronto	132.00
15	Bering	City of Toronto	111.00
16	Kipling	City of Toronto	72.00
17	Castlefield	City of Toronto	45.00
18	Thorncliffe	City of Toronto	144.00
19	Finch Yard	City of Toronto	108.00
20	Emery Yard	City of Toronto	66.00
21	Fire Station 116	City of Toronto	114.00
22	Bermondsey Yard	City of Toronto	108.00
23	Wilson	City of Toronto	96.00
24	Ancaster	City of Toronto	123.00
25	Mitchell Field	City of Toronto	97.54
26	Cummer	City of Toronto	75.00
27	Pharmacy/401	City of Toronto	42.00
28	Lismoreaux	City of Toronto	21.00
29	Nashdene Yard	City of Toronto	9.00
30	Ellesmere Yard	City of Toronto	18.00
31	Morningside Yard	City of Toronto	6.00
33	Edwards Gardens	City of Toronto	81.00
34	Fire Station 215	City of Toronto	9.00
35	Mount Pleasant	City of Toronto	120.00
36	Denton	City of Toronto	93.00
37	Poplar	City of Toronto	6.00
38	Seminole	City of Toronto	15.00
39	Fire Station 121	City of Toronto	102.00
41	HY002	TRCA	57.60
42	HY003	TRCA	112.80
43	HY008	TRCA	108.00
44	HY009	TRCA	7.20
45	HY011	TRCA	21.60
46	HY012	TRCA	96.00
47	HY014	TRCA	91.20
48	HY015	TRCA	4.80
49	HY016	TRCA	115.20
50	HY021	TRCA	70.80
51	HY025	TRCA	259.20
52	HY027	TRCA	110.40
53	HY030	TRCA	55.20
54	HY031	TRCA	4.80
55	HY033	TRCA	129.60
56	HY036	TRCA	12.00
57	HY037	TRCA	81.60
58	HY038	TRCA	86.40
59	HY041	TRCA	76.80
60	HY043	TRCA	7.20
61	HY044	TRCA	9.60
62	HY046	TRCA	98.40
63	HY050	TRCA	7.20
64	HY051	TRCA	9.60
65	HY055	TRCA	105.60
66	HY060	TRCA	6.00
67	HY061	TRCA	62.40
68	HY064	TRCA	110.40
69	HY069	TRCA	57.60
70	HY070	TRCA	48.00
74	R_ET_HL01	York Region	134.40
75	R_ET_MA03	York Region	7.20
76	R_ET_NO01	York Region	117.60
77	R_ET_ST02	York Region	7.20
78	R_ET_VA01	York Region	122.40
79	R_ET_VA02	York Region	158.40
80	R_YR_AU02	York Region	52.80
81	R_YR_KE01	York Region	9.60
82	R_YR_MA03	York Region	127.20
83	R_YR_MO01	York Region	4.80
84	R_YR_NE01	York Region	117.60
85	R_YR_RH01	York Region	108.00
86	R_YR_SU01	York Region	4.80
87	R_YR_VA03	York Region	141.60
88	R_YR_VA04	York Region	100.80
89	R_YR_WB01	York Region	7.20
90	STN 01 - Third St.	Mississauga	220.80
91	STN 02 - Clarkson	Mississauga	16.80
92	STN 03 - Wolfedale	Mississauga	148.80
93	STN 04 - South Common	Mississauga	9.00
94	STN 05 - Winding Trail	Mississauga	172.80
95	STN 06 - Mississauga Valley	Mississauga	165.60
96	STN 07 - Britannia	Mississauga	74.40
97	STN 08 - Tomken	Mississauga	93.60
98	STN 09 - Truscott	Mississauga	7.20
99	STN 10 - Falbourne	Mississauga	122.40
100	STN 11 - Garry Morden FTC	Mississauga	21.60
101	STN 12 - CVC	Mississauga	81.60
102	STN 13 - Goreway	Mississauga	84.00
103	STN 14 - Port Credit	Mississauga	196.80
104	Stornoway P.S.	Markham	124.80
105	Thornhill C.C.	Markham	109.73
106	German Mills P.S.	Markham	124.80
107	Lincoln Alexander P.S.	Markham	40.80
108	8100 Warden Ave	Markham	33.60
109	Milliken Mills C.C.	Markham	9.00
110	Fire Hall #94	Markham	15.00
111	Roy H Crosby P.S.	Markham	9.60
112	Markham Museum	Markham	12.00
113	Rouge River C.C.	Markham	12.00
114	Angus Glen C.C.	Markham	15.00
135	Discovery	RichmondHill	132.00
136	Oak Ridges	RichmondHill	50.40
137	Operations	RichmondHill	55.20

N

Legend

- Rainfall Gauges
- Highways
- Major Roads
- Rainfall > 100 Year
- Rainfall >50 Year
- Watersheds
- Pearson Airport
- Municipal Boundaries

Maximum 5 min Intensity (mm/hr)

- 5 - 23
- 24 - 47
- 48 - 68
- 69 - 84
- 85 - 100
- 101 - 116
- 117 - 135
- 136 - 162
- 163 - 199
- 200 - 259

July 8, 2013 Extreme Rainfall Event

Summary and Analysis Report

Toronto and Region Conservation Authority

Maximum 5 Minute Rainfall Intensity IDF Comparison

amec

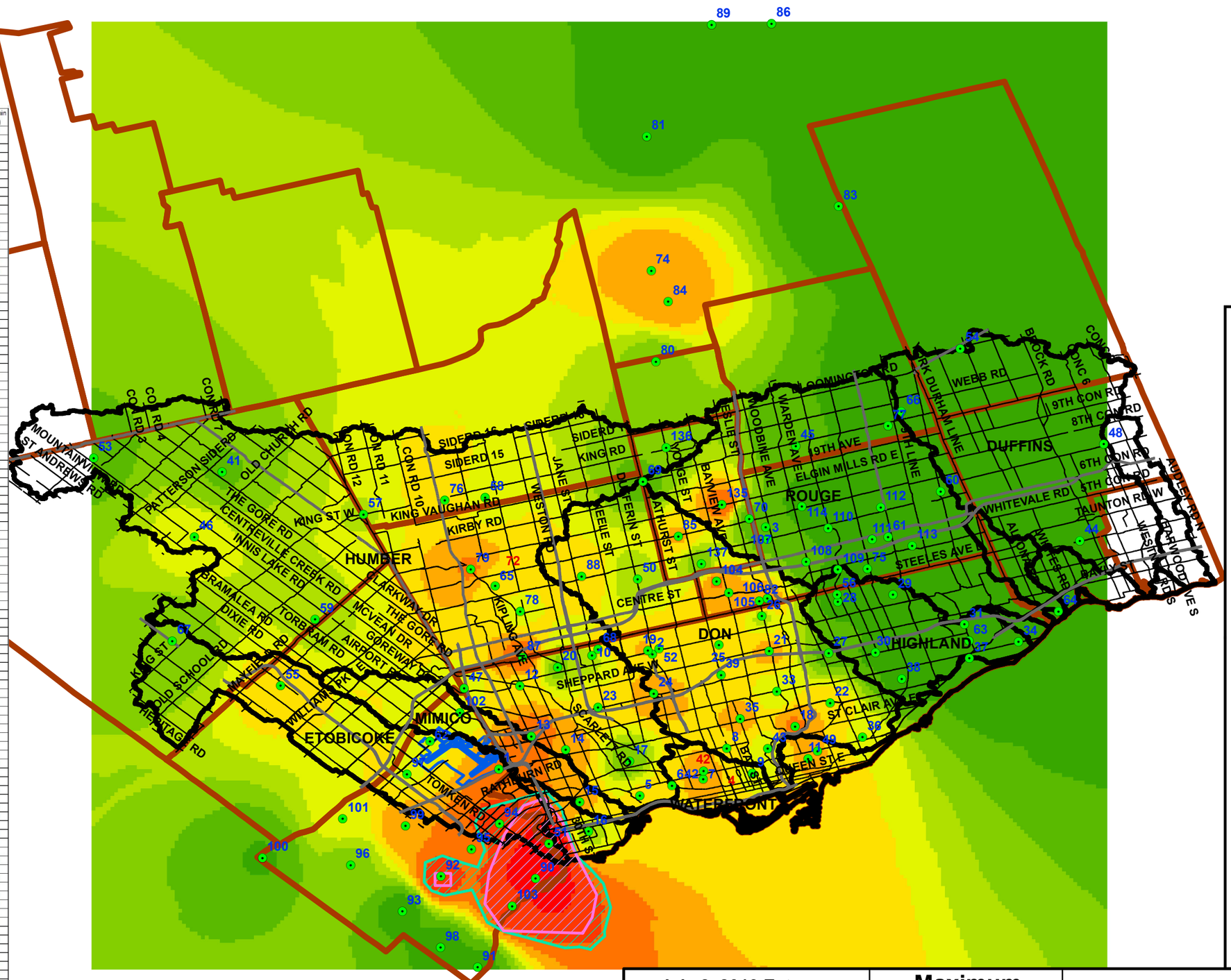
Scale 1:400,000

0 2.5 5 10 15 Kilometers

Project No. TP114045

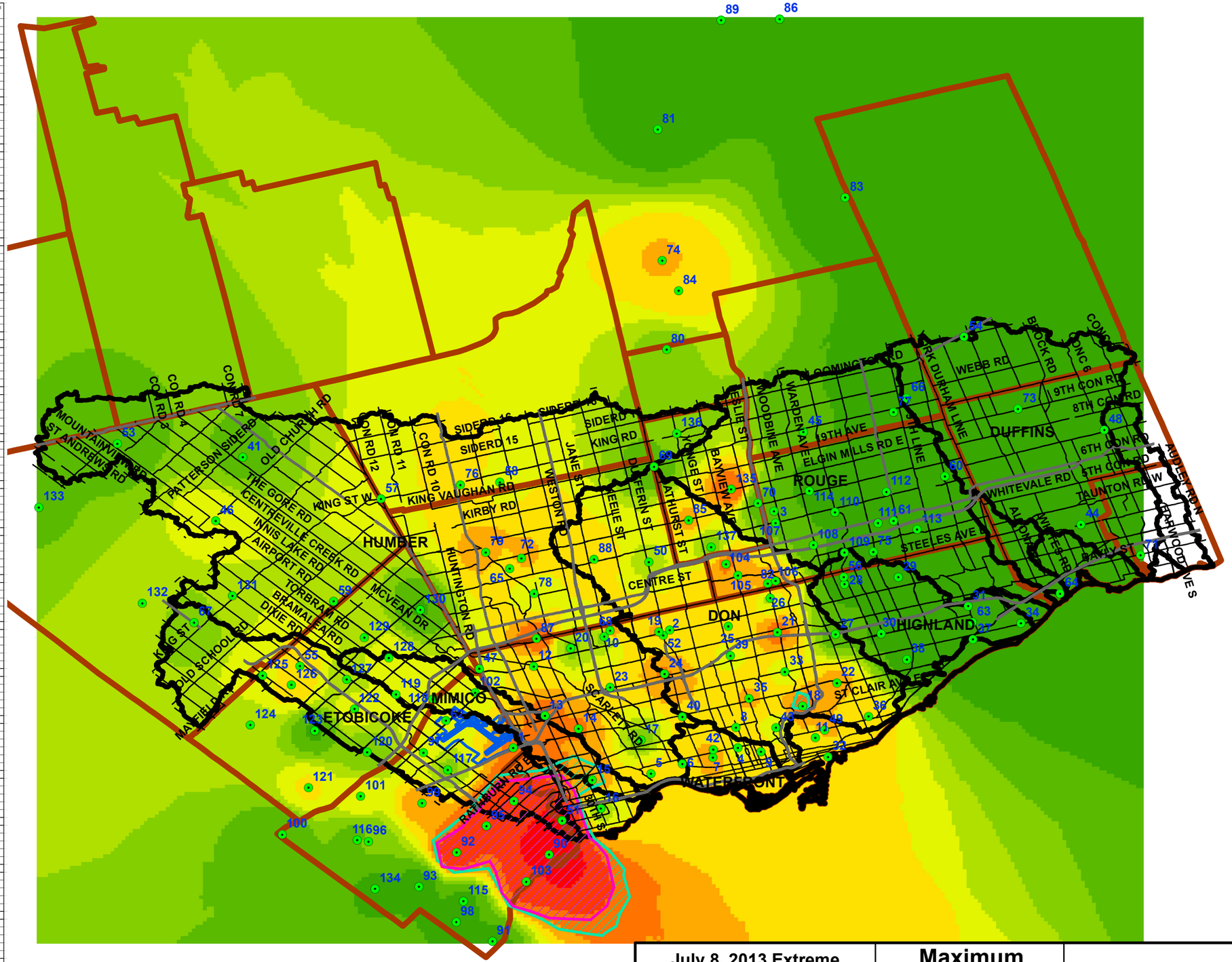
Figure No. 4-12

ID	Gauge Name	Source	Max 10 min (mm/hr)
1	Toronto Lester B. Pearson Int'L A	Environment Canada	121.20
2	Toronto North York	Environment Canada	94.80
3	Toronto Buttonville A	Environment Canada	33.60
5	Swansea	City of Toronto	98.50
6	Howard	City of Toronto	100.50
7	Central	City of Toronto	103.50
8	Brown	City of Toronto	99.00
9	Church	City of Toronto	82.50
10	Jane	City of Toronto	57.00
11	Greenwood	City of Toronto	102.00
12	Albion	City of Toronto	96.00
13	Martin Grove	City of Toronto	135.00
14	Richview	City of Toronto	114.00
15	Bering	City of Toronto	105.00
16	Kipling	City of Toronto	64.50
17	Castlefield	City of Toronto	45.00
18	Thorncliffe	City of Toronto	120.00
19	Finch Yard	City of Toronto	106.50
20	Emery Yard	City of Toronto	54.00
21	Fire Station 116	City of Toronto	105.00
22	Bermondsey Yard	City of Toronto	100.50
23	Wilson	City of Toronto	91.50
24	Ancaster	City of Toronto	112.50
25	Mitchell Field	City of Toronto	91.44
26	Cummer	City of Toronto	66.00
27	Pharmacy/401	City of Toronto	36.00
28	Liamoreaux	City of Toronto	15.00
29	Nashdene Yard	City of Toronto	7.50
30	Ellesmere Yard	City of Toronto	15.00
31	Morningside Yard	City of Toronto	6.00
33	Edwards Gardens	City of Toronto	73.50
34	Fire Station 215	City of Toronto	7.50
35	Mount Pleasant	City of Toronto	105.00
36	Denton	City of Toronto	84.00
37	Poplar	City of Toronto	4.50
38	Semmole	City of Toronto	13.50
39	Fire Station 121	City of Toronto	91.50
41	HY002	TRCA	39.60
42	HY003	TRCA	104.40
43	HY008	TRCA	75.60
44	HY009	TRCA	6.00
45	HY011	TRCA	21.60
46	HY012	TRCA	81.60
47	HY014	TRCA	81.60
48	HY015	TRCA	4.80
49	HY016	TRCA	100.80
50	HY021	TRCA	60.60
51	HY025	TRCA	205.20
52	HY027	TRCA	86.40
53	HY030	TRCA	36.00
54	HY031	TRCA	2.40
55	HY033	TRCA	97.20
56	HY036	TRCA	12.00
57	HY037	TRCA	72.00
58	HY038	TRCA	79.20
59	HY041	TRCA	66.00
60	HY043	TRCA	7.20
61	HY044	TRCA	8.40
62	HY046	TRCA	82.80
63	HY050	TRCA	7.20
64	HY051	TRCA	8.40
65	HY055	TRCA	90.00
66	HY060	TRCA	4.20
67	HY061	TRCA	45.60
68	HY064	TRCA	99.60
69	HY069	TRCA	33.60
70	HY070	TRCA	33.60
74	R_ET_HL01	York Region	112.80
75	R_ET_MA03	York Region	6.00
76	R_ET_NO01	York Region	98.40
77	R_ET_ST02	York Region	7.20
78	R_ET_VA01	York Region	82.80
79	R_ET_VA02	York Region	118.80
80	R_YR_AU02	York Region	48.00
81	R_YR_KE01	York Region	9.40
82	R_YR_MA03	York Region	110.40
83	R_YR_MO01	York Region	2.40
84	R_YR_NE01	York Region	114.00
85	R_YR_RH01	York Region	102.00
86	R_YR_SU01	York Region	3.60
87	R_YR_VA03	York Region	130.80
88	R_YR_VA04	York Region	98.40
89	R_YR_WB01	York Region	4.80
90	STN 01 - Third St.	Mississauga	214.80
91	STN 02 - Clarkson	Mississauga	10.80
92	STN 03 - Wolfedale	Mississauga	148.80
93	STN 04 - South Common	Mississauga	7.50
94	STN 05 - Winding Trail	Mississauga	148.80
95	STN 06 - Mississauga Valley	Mississauga	134.40
96	STN 07 - Britannia	Mississauga	49.20
97	STN 08 - Tomken	Mississauga	85.20
98	STN 09 - Truscott	Mississauga	4.80
99	STN 10 - Falbourne	Mississauga	114.00
100	STN 11 - Garry Morden FTC	Mississauga	18.00
101	STN 12 - CVC	Mississauga	80.40
102	STN 13 - Goreway	Mississauga	76.80
103	STN 14 - Port Credit	Mississauga	153.60
104	Stornoway P.S.	Markham	121.20
105	Thornhill C.C.	Markham	106.68
106	German Mills P.S.	Markham	110.40
107	Lincoln Alexander P.S.	Markham	31.20
108	8100 Warden Ave	Markham	31.20
109	Milliken Mills C.C.	Markham	7.50
110	Fire Hall #94	Markham	12.00
111	Roy H Crosby P.S.	Markham	7.20
112	Markham Museum	Markham	8.40
113	Rouge River C.C.	Markham	10.50
114	Angus Glen C.C.	Markham	10.50
135	Discovery	RichmondHill	129.60
136	Oak Ridges	RichmondHill	48.00
137	Operations	RichmondHill	44.40



July 8, 2013 Extreme Rainfall Event Summary and Analysis Report Toronto and Region Conservation Authority	Maximum 10 Minute Rainfall Intensity IDF Comparison	amec	Scale 1:400,000 0 2.5 5 10 15 Kilometers Project No. TP114045 Figure No. 4-13

ID	Gauge Name	Source	Max 15 min (mm/hr)
1	Toronto Lester B. Pearson Int'L A	Environment Canada	104.00
2	Toronto North York	Environment Canada	75.20
3	Toronto Buttonville A	Environment Canada	28.00
4	Toronto City	Environment Canada	69.20
5	Swansea	City of Toronto	80.00
6	Howard	City of Toronto	85.00
7	Central	City of Toronto	94.00
8	Brown	City of Toronto	88.00
9	Church	City of Toronto	80.00
10	Jane	City of Toronto	41.00
11	Greenwood	City of Toronto	87.00
12	Albion	City of Toronto	81.00
13	Martin Grove	City of Toronto	110.00
14	Richview	City of Toronto	104.00
15	Bering	City of Toronto	99.00
16	Kipling	City of Toronto	55.00
17	Castlefield	City of Toronto	45.00
18	Thorncliffe	City of Toronto	109.00
19	Finch Yard	City of Toronto	94.00
20	Emery Yard	City of Toronto	46.00
21	Fire Station 116	City of Toronto	107.00
22	Bermondsey Yard	City of Toronto	94.00
23	Wilson	City of Toronto	77.00
24	Ancaster	City of Toronto	104.00
25	Mitchell Field	City of Toronto	80.26
26	Cummer	City of Toronto	58.00
27	Pharmacy401	City of Toronto	29.00
28	Lawrence Ave	City of Toronto	11.00
29	Nashdene Yard	City of Toronto	6.00
30	Ellesmere Yard	City of Toronto	13.00
31	Morningside Yard	City of Toronto	6.00
33	Edwards Gardens	City of Toronto	69.00
34	Fire Station 215	City of Toronto	6.00
35	Mount Pleasant	City of Toronto	90.00
36	Denton	City of Toronto	80.00
37	Poplar	City of Toronto	4.00
38	Seminole	City of Toronto	12.00
39	Fire Station 121	City of Toronto	72.00
41	HY002	TRCA	30.80
42	HY003	TRCA	88.80
43	HY008	TRCA	66.40
44	HY009	TRCA	5.60
45	HY011	TRCA	19.20
46	HY012	TRCA	72.80
47	HY014	TRCA	60.80
48	HY015	TRCA	4.00
49	HY016	TRCA	89.60
50	HY021	TRCA	56.80
51	HY025	TRCA	161.60
52	HY027	TRCA	76.00
53	HY030	TRCA	26.40
54	HY031	TRCA	2.40
55	HY033	TRCA	83.20
56	HY036	TRCA	8.80
57	HY037	TRCA	65.60
58	HY038	TRCA	70.40
59	HY041	TRCA	54.40
60	HY043	TRCA	6.40
61	HY044	TRCA	7.20
62	HY045	TRCA	68.00
63	HY050	TRCA	5.60
64	HY051	TRCA	8.00
65	HY055	TRCA	74.40
66	HY060	TRCA	4.00
67	HY061	TRCA	36.80
68	HY064	TRCA	100.80
69	HY069	TRCA	24.00
70	HY070	TRCA	28.00
71	HY004	TRCA	5.60
72	HY039	TRCA	94.40
73	HY063	TRCA	3.20
74	R_ET_HL01	York Region	90.40
75	R_ET_MA03	York Region	5.60
76	R_ET_NO01	York Region	86.40
77	R_ET_ST02	York Region	5.60
78	R_ET_VA01	York Region	63.20
79	R_ET_VA02	York Region	97.60
80	R_YR_AU02	York Region	42.40
81	R_YR_KE01	York Region	6.40
82	R_YR_MA03	York Region	96.80
83	R_YR_MO01	York Region	2.40
84	R_YR_NE01	York Region	87.20
85	R_YR_RH01	York Region	91.20
86	R_YR_SU01	York Region	2.40
87	R_YR_VA03	York Region	116.00
88	R_YR_VA04	York Region	84.80
89	R_YR_WB01	York Region	4.00
90	STN 01 - Third St.	Mississauga	194.40
91	STN 02 - Clarkson	Mississauga	10.40
92	STN 03 - Wolfedale	Mississauga	139.20
93	STN 04 - South Common	Mississauga	6.00
94	STN 05 - Winding Trail	Mississauga	145.60
95	STN 06 - Mississauga Valley	Mississauga	134.40
96	STN 07 - Britannia	Mississauga	38.40
97	STN 08 - Tomken	Mississauga	64.00
98	STN 09 - Truscott	Mississauga	5.60
99	STN 10 - Falbourne	Mississauga	100.00
100	STN 11 - Garry Morden FTC	Mississauga	16.80
101	STN 12 - CVC	Mississauga	74.40
102	STN 13 - Goreway	Mississauga	69.60
103	STN 14 - Port Credit	Mississauga	136.00
104	Stornoway P.S.	Markham	107.20
105	Thornhill C.C.	Markham	96.52
106	German Mills P.S.	Markham	96.00
107	Lincoln Alexander P.S.	Markham	27.20
108	9100 Warden Ave	Markham	22.40
109	Milliken Mills C.C.	Markham	9.00
110	Fire Hall #54	Markham	10.00
111	Roy H Crosby P.S.	Markham	7.20
112	Markham Museum	Markham	8.80
113	Rouge River C.C.	Markham	10.00
114	Angus Glen C.C.	Markham	9.00
115	RG09	Peel Region	12.00
116	RG11	Peel Region	27.00
117	RG16	Peel Region	46.00
118	RG20	Peel Region	71.00
119	RG22	Peel Region	51.00
120	RG23	Peel Region	35.00
121	RG24	Peel Region	77.00
122	RG25	Peel Region	71.00
123	RG26	Peel Region	15.00
124	RG27	Peel Region	50.00
125	RG28	Peel Region	67.00
126	RG29	Peel Region	89.00
127	RG31	Peel Region	51.00
128	RG32	Peel Region	71.00
129	RG33	Peel Region	58.00
130	RG34	Peel Region	16.00
131	RG36	Peel Region	58.00
132	RG39	Peel Region	55.00
133	RG42	Peel Region	33.00
134	RG44	Peel Region	12.00
135	Discovery	RichmondHill	117.60
136	Oak Ridges	RichmondHill	42.40
137	Operations	RichmondHill	41.60



July 8, 2013 Extreme Rainfall Event

Summary and Analysis Report

Toronto and Region Conservation Authority

Maximum 15 Minute Rainfall Intensity IDF Comparison

amec

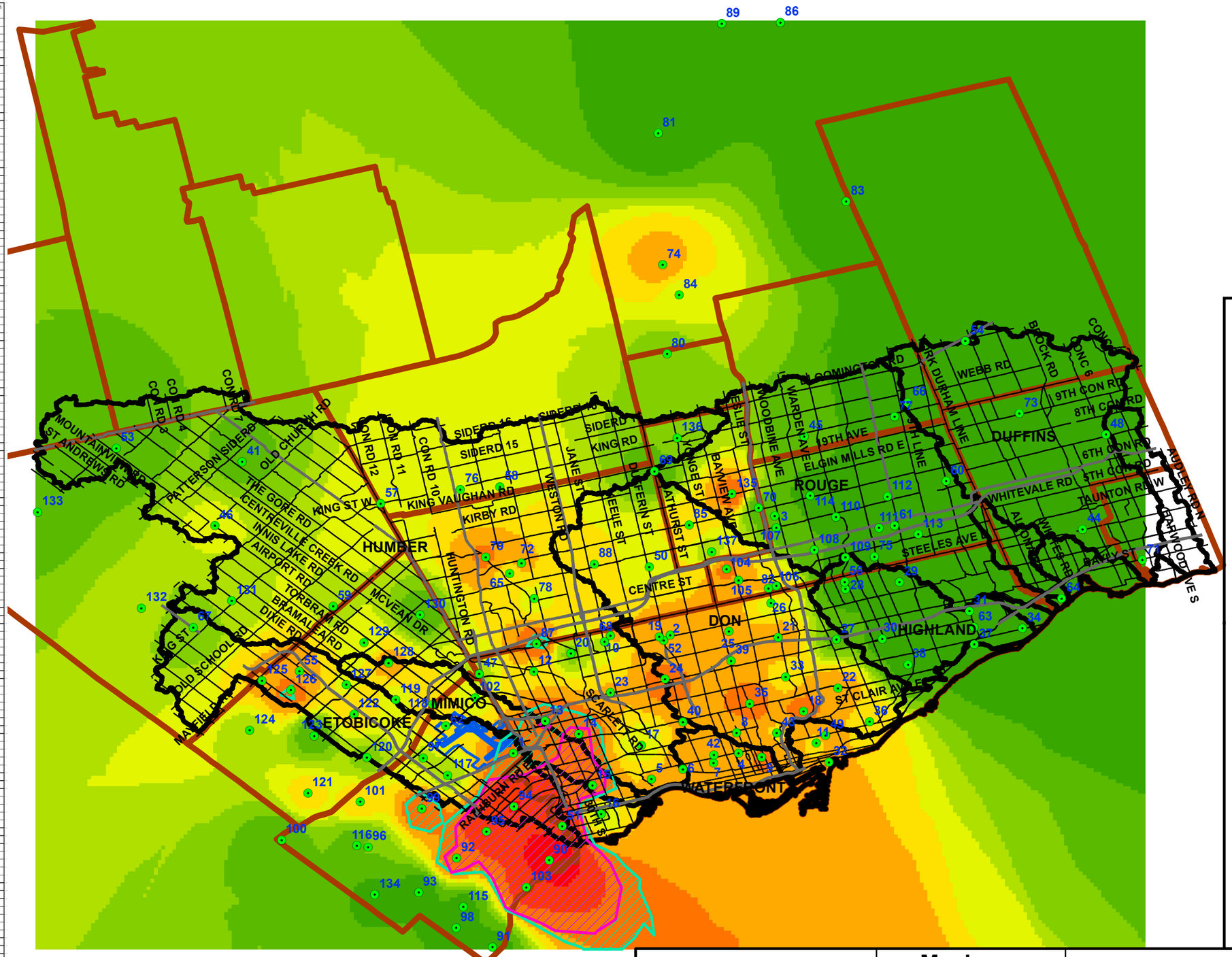
Scale 1:400,000

0 2.5 5 10 15 Kilometers

Project No. TP114045

Figure No. 4-14

ID	Gauge Name	Source	Max 30 min (mm/hr)
1	Toronto Lester B. Pearson Int'L A	Environment Canada	85.20
2	Toronto North York	Environment Canada	72.90
3	Toronto Buttonville A	Environment Canada	19.40
4	Toronto City	Environment Canada	64.40
5	Swansea	City of Toronto	62.00
6	Howard	City of Toronto	66.00
7	Central	City of Toronto	74.50
8	Brown	City of Toronto	67.50
9	Church	City of Toronto	77.00
10	Jane	City of Toronto	35.00
11	Greenwood	City of Toronto	60.50
12	Albion	City of Toronto	58.50
13	Martin Grove	City of Toronto	91.00
14	Richview	City of Toronto	90.00
15	Bering	City of Toronto	87.50
16	Kipling	City of Toronto	40.50
17	Castlefield	City of Toronto	42.00
18	Thorncliffe	City of Toronto	81.50
19	Finch Yard	City of Toronto	64.00
20	Emery Yard	City of Toronto	31.00
21	Fire Station 116	City of Toronto	73.50
22	Bermondsey Yard	City of Toronto	74.50
23	Wilson	City of Toronto	62.00
24	Ancaster	City of Toronto	81.50
25	Mitchell Field	City of Toronto	66.04
26	Dunmer	City of Toronto	42.50
27	Pharmacy/401	City of Toronto	21.50
28	Liamoreaux	City of Toronto	6.50
29	Nashdene Yard	City of Toronto	6.00
30	Ellesmere Yard	City of Toronto	7.00
31	Morningside Yard	City of Toronto	5.50
32	Edwards Gardens	City of Toronto	56.00
34	Fire Station 215	City of Toronto	5.50
35	Mount Pleasant	City of Toronto	85.00
36	Denton	City of Toronto	57.50
37	Poplar	City of Toronto	3.50
38	Seminole	City of Toronto	8.00
39	Fire Station 121	City of Toronto	66.00
41	HY002	TRCA	21.00
42	HY003	TRCA	71.60
43	HY008	TRCA	60.80
44	HY009	TRCA	4.40
45	HY011	TRCA	15.60
46	HY012	TRCA	44.40
47	HY014	TRCA	39.20
48	HY015	TRCA	2.40
49	HY016	TRCA	64.00
50	HY021	TRCA	43.00
51	HY025	TRCA	114.00
52	HY027	TRCA	64.00
53	HY030	TRCA	13.20
54	HY031	TRCA	1.60
55	HY033	TRCA	66.00
56	HY036	TRCA	5.80
57	HY037	TRCA	45.00
58	HY038	TRCA	43.20
59	HY041	TRCA	38.80
60	HY043	TRCA	5.20
61	HY044	TRCA	6.80
62	HY046	TRCA	55.60
63	HY050	TRCA	4.80
64	HY051	TRCA	6.80
65	HY056	TRCA	57.20
66	HY060	TRCA	3.40
67	HY061	TRCA	23.60
68	HY064	TRCA	70.00
69	HY069	TRCA	16.40
70	HY070	TRCA	18.40
71	HY004	TRCA	5.20
72	HY039	TRCA	63.60
73	HY063	TRCA	2.00
74	R_ET_HL01	York Region	67.60
75	R_ET_MA03	York Region	4.40
76	R_ET_NO01	York Region	50.80
77	R_ET_ST02	York Region	4.40
78	R_ET_VA01	York Region	47.20
79	R_ET_VA02	York Region	76.40
80	R_YR_AU02	York Region	28.40
81	R_YR_KE01	York Region	4.40
82	R_YR_MA03	York Region	64.40
83	R_YR_MO01	York Region	1.20
84	R_YR_NE01	York Region	47.20
85	R_YR_RH01	York Region	59.20
86	R_YR_SU01	York Region	2.00
87	R_YR_VA03	York Region	66.80
88	R_YR_VA04	York Region	54.00
89	R_YR_WB01	York Region	2.80
90	STN 01 - Third St.	Mississauga	139.20
91	STN 02 - Clarkson	Mississauga	6.00
92	STN 03 - Wolfedale	Mississauga	82.80
93	STN 04 - South Common	Mississauga	4.00
94	STN 05 - Winding Trail	Mississauga	117.20
95	STN 06 - Mississauga Valley	Mississauga	111.60
96	STN 07 - Britannia	Mississauga	24.00
97	STN 08 - Tomken	Mississauga	40.80
98	STN 09 - Truscott	Mississauga	3.80
99	STN 10 - Fallbourne	Mississauga	87.20
100	STN 11 - Garry Morden FTC	Mississauga	12.40
101	STN 12 - CVC	Mississauga	60.00
102	STN 13 - Goreway	Mississauga	48.00
103	STN 14 - Port Credit	Mississauga	100.40
104	Stornoway P.S.	Markham	80.00
105	Thornhill C.C.	Markham	70.61
106	German Mills P.S.	Markham	57.20
107	Lincoln Alexander P.S.	Markham	17.20
108	8100 Warden Ave	Markham	12.40
109	Milliken Mills C.C.	Markham	5.00
110	Fire Hall #24	Markham	6.50
111	Roy H Crosby P.S.	Markham	6.40
112	Markham Museum	Markham	7.20
113	Rouge River C.C.	Markham	8.00
114	Angus Glen C.C.	Markham	5.50
115	RG03	Peel Region	7.50
116	RG11	Peel Region	16.00
117	RG16	Peel Region	35.50
118	RG20	Peel Region	60.00
119	RG22	Peel Region	48.50
120	RG23	Peel Region	30.00
121	RG24	Peel Region	55.00
122	RG25	Peel Region	57.50
123	RG26	Peel Region	14.50
124	RG27	Peel Region	38.00
125	RG28	Peel Region	63.00
126	RG29	Peel Region	84.50
127	RG31	Peel Region	50.00
128	RG32	Peel Region	67.00
129	RG33	Peel Region	42.50
130	RG34	Peel Region	16.00
131	RG36	Peel Region	35.00
132	RG39	Peel Region	36.00
133	RG42	Peel Region	17.50
134	RG44	Peel Region	7.50
135	Discovery	RichmondHill	84.40
136	Oak Ridges	RichmondHill	27.60
137	Operations	RichmondHill	34.80



July 8, 2013 Extreme Rainfall Event

Summary and Analysis Report

Toronto and Region Conservation Authority

Maximum 30 Minute Rainfall Intensity IDF Comparison

amec

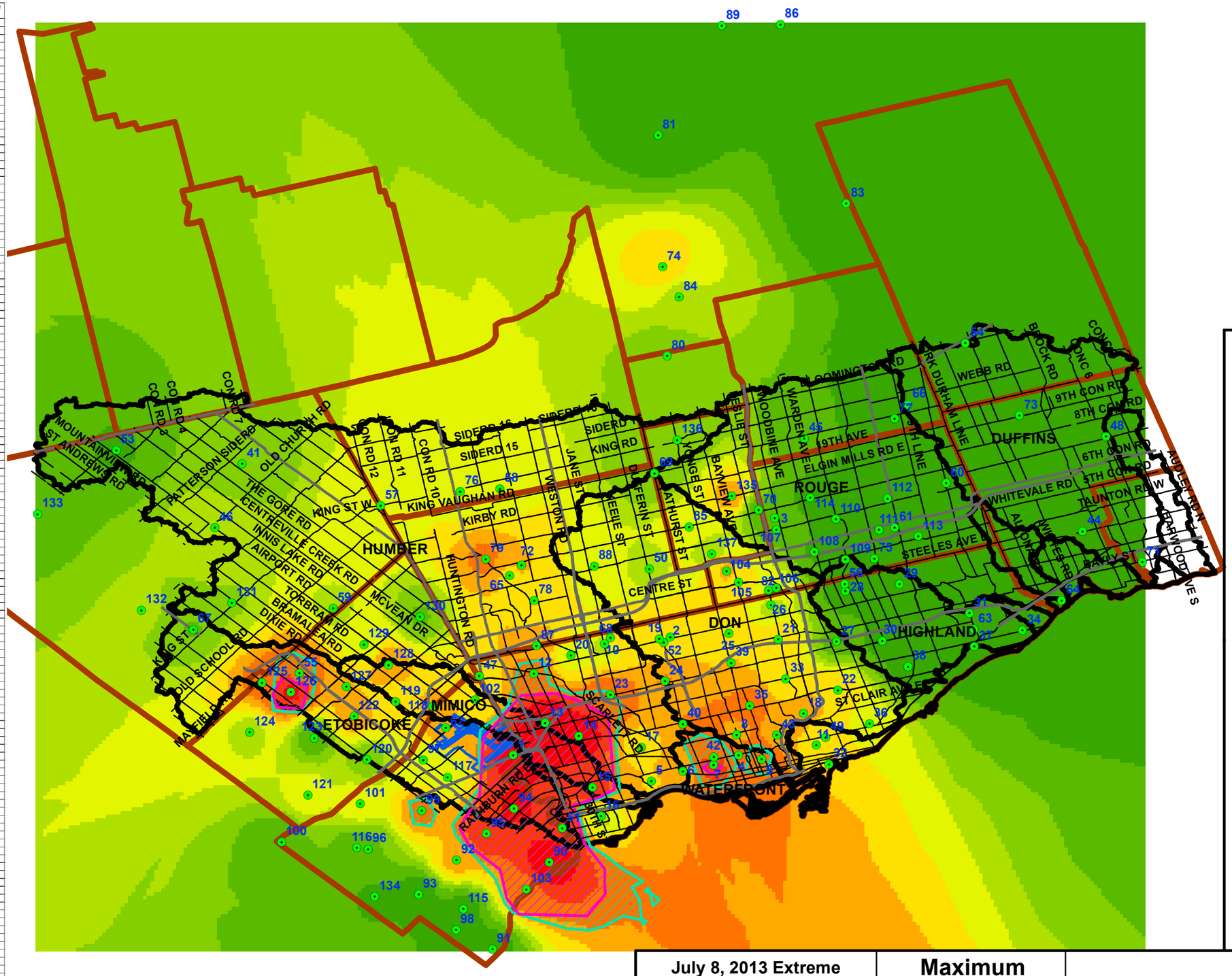
Scale 1:400,000

0 2.5 5 10 15 Kilometers

Project No. TP114045

Figure No. 4-15

ID	Gauge Name	Source	Max 1 hour (mm/hr)
1	Toronto Lester B. Pearson Int'L A	Environment Canada	70.00
2	Toronto North York	Environment Canada	42.00
3	Toronto Buttonville A	Environment Canada	10.60
4	Toronto City	Environment Canada	51.20
5	Swansea	City of Toronto	41.25
6	Howard	City of Toronto	44.25
7	Central	City of Toronto	59.50
8	Brown	City of Toronto	46.00
9	Church	City of Toronto	55.75
10	Jane	City of Toronto	22.00
11	Greenwood	City of Toronto	38.00
12	Albion	City of Toronto	51.75
13	Martin Grove	City of Toronto	78.75
14	Richview	City of Toronto	73.00
15	Bering	City of Toronto	62.00
16	Kipling	City of Toronto	25.50
17	Castlefield	City of Toronto	37.75
18	Thorncliffe	City of Toronto	46.00
19	Finch Yard	City of Toronto	39.60
20	Emery Yard	City of Toronto	29.25
21	Fire Station 116	City of Toronto	41.60
22	Bermondsey Yard	City of Toronto	40.25
23	Wilson	City of Toronto	55.25
24	Ancaster	City of Toronto	46.00
25	Mitchell Field	City of Toronto	39.37
26	Cummer	City of Toronto	23.00
27	Pharmacy/401	City of Toronto	11.50
28	Llamoreaux	City of Toronto	3.75
29	Nashdene Yard	City of Toronto	4.25
30	Ellesmere Yard	City of Toronto	4.25
31	Morningside Yard	City of Toronto	5.00
33	Edwards Gardens	City of Toronto	35.25
34	Fire Station 215	City of Toronto	4.50
35	Mount Pleasant	City of Toronto	51.00
36	Denton	City of Toronto	31.00
37	Poplar	City of Toronto	3.25
38	Seminole	City of Toronto	4.50
39	Fire Station 121	City of Toronto	41.50
41	HY002	TRCA	15.90
42	HY003	TRCA	54.20
43	HY006	TRCA	45.60
44	HY009	TRCA	3.80
45	HY011	TRCA	8.60
46	HY012	TRCA	24.40
47	HY014	TRCA	35.20
48	HY015	TRCA	1.40
49	HY016	TRCA	35.00
50	HY021	TRCA	24.40
51	HY025	TRCA	63.00
52	HY027	TRCA	38.40
53	HY030	TRCA	6.60
54	HY031	TRCA	0.80
55	HY033	TRCA	54.40
56	HY036	TRCA	3.40
57	HY037	TRCA	31.60
58	HY038	TRCA	28.20
59	HY041	TRCA	25.20
60	HY043	TRCA	3.60
61	HY044	TRCA	5.40
62	HY046	TRCA	47.60
63	HY050	TRCA	4.40
64	HY051	TRCA	6.00
65	HY055	TRCA	41.00
66	HY060	TRCA	2.90
67	HY061	TRCA	13.60
68	HY064	TRCA	42.20
69	HY069	TRCA	14.00
70	HY070	TRCA	11.00
71	HY004	TRCA	4.60
72	HY039	TRCA	41.60
73	HY063	TRCA	1.20
74	R_ET_HL01	York Region	39.00
75	R_ET_MA03	York Region	3.00
76	R_ET_NO01	York Region	31.20
77	R_ET_ST02	York Region	3.00
78	R_ET_VA01	York Region	36.20
79	R_ET_VA02	York Region	49.60
80	R_YR_AU02	York Region	16.40
81	R_YR_KE01	York Region	2.20
82	R_YR_MA03	York Region	34.20
83	R_YR_MO01	York Region	1.00
84	R_YR_NE01	York Region	24.80
85	R_YR_RH01	York Region	31.60
86	R_YR_SU01	York Region	1.20
87	R_YR_VA03	York Region	46.40
88	R_YR_VA04	York Region	29.00
89	R_YR_WE01	York Region	1.60
90	STN 01 - Third St.	Mississauga	74.20
91	STN 02 - Clarkson	Mississauga	3.00
92	STN 03 - Wolfedale	Mississauga	43.60
93	STN 04 - South Common	Mississauga	2.25
94	STN 05 - Winding Trail	Mississauga	66.80
95	STN 06 - Mississauga Valley	Mississauga	62.40
96	STN 07 - Britannia	Mississauga	13.80
97	STN 08 - Tomken	Mississauga	27.40
98	STN 09 - Truscott	Mississauga	2.20
99	STN 10 - Falbourne	Mississauga	49.80
100	STN 11 - Garry Morden FTC	Mississauga	7.40
101	STN 12 - CVC	Mississauga	32.60
102	STN 13 - Goreway	Mississauga	34.20
103	STN 14 - Port Credit	Mississauga	54.00
104	Stornoway P.S.	Markham	43.20
105	Thornhill C.C.	Markham	39.61
106	German Mills P.S.	Markham	29.80
107	Lincoln Alexander P.S.	Markham	9.80
108	8100 Warden Ave	Markham	6.60
109	Milliken Mills C.C.	Markham	3.50
110	Fire Hall #94	Markham	4.50
111	Roy H Crosby P.S.	Markham	5.00
112	Markham Museum	Markham	5.00
113	Rouge River C.C.	Markham	6.00
114	Angus Glen C.C.	Markham	5.00
115	RG03	Peel Region	3.75
116	RG11	Peel Region	9.25
117	RG16	Peel Region	27.75
118	RG20	Peel Region	42.75
119	RG22	Peel Region	35.25
120	RG23	Peel Region	17.00
121	RG24	Peel Region	30.00
122	RG25	Peel Region	46.00
123	RG26	Peel Region	9.50
124	RG27	Peel Region	25.00
125	RG28	Peel Region	49.75
126	RG29	Peel Region	67.00
127	RG31	Peel Region	41.50
128	RG32	Peel Region	47.75
129	RG33	Peel Region	27.75
130	RG34	Peel Region	13.50
131	RG36	Peel Region	20.25
132	RG39	Peel Region	21.25
133	RG42	Peel Region	9.75
134	RG44	Peel Region	6.00
135	Discovery	RichmondHill	46.20
136	Oak Ridges	RichmondHill	14.80
137	Operations	RichmondHill	21.80



July 8, 2013 Extreme Rainfall Event

Summary and Analysis Report

Toronto and Region Conservation Authority

Maximum 1 Hour Rainfall Intensity IDF Comparison

amec

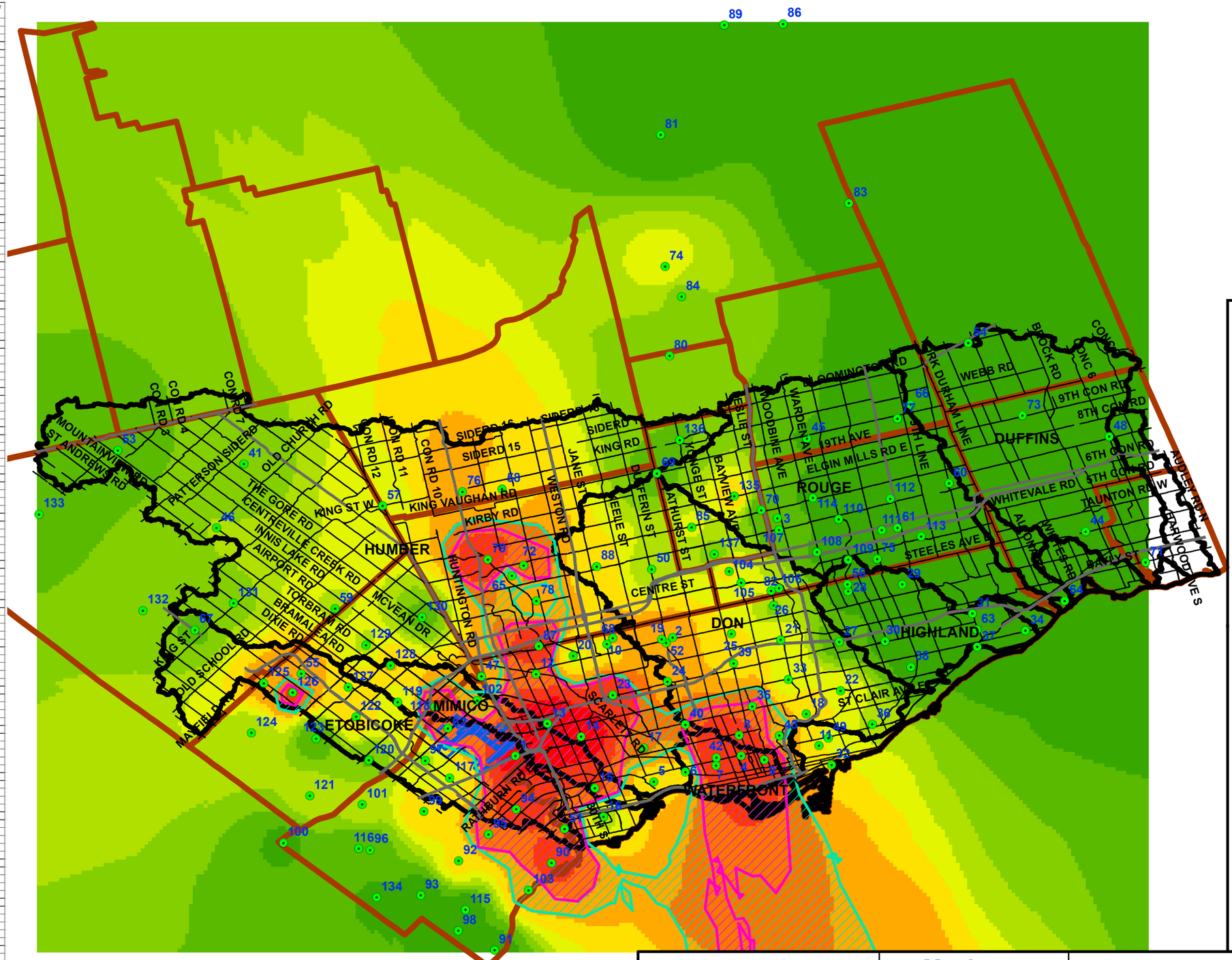
Scale 1:400,000

0 2.5 5 10 15 Kilometers

Project No. TP114045

Figure No. 4-16

ID	Gauge Name	Source	Max 2 hour (mm/hr)
1	Toronto Lester B. Pearson Int'L A	Environment Canada	46.10
2	Toronto North York	Environment Canada	28.10
3	Toronto Buttonville A	Environment Canada	6.00
4	Toronto City	Environment Canada	43.85
5	Swansea	City of Toronto	23.13
6	Howard	City of Toronto	24.38
7	Central	City of Toronto	39.50
8	Brown	City of Toronto	37.38
9	Church	City of Toronto	41.75
10	Jane	City of Toronto	19.75
11	Greenwood	City of Toronto	22.13
12	Albion	City of Toronto	34.25
13	Martin Grove	City of Toronto	56.75
14	Richview	City of Toronto	51.25
15	Bering	City of Toronto	36.25
16	Kipling	City of Toronto	15.75
17	Castlefield	City of Toronto	30.88
18	Thorncliffe	City of Toronto	25.75
19	Finch Yard	City of Toronto	28.63
20	Emery Yard	City of Toronto	20.50
21	Fire Station 116	City of Toronto	21.63
22	Bermondsey Yard	City of Toronto	20.75
23	Wilson	City of Toronto	41.50
24	Ancaster	City of Toronto	30.38
25	Mitchell Field	City of Toronto	21.84
26	Cummer	City of Toronto	12.38
27	Pharmacy/401	City of Toronto	6.63
28	Liamoreaux	City of Toronto	3.25
29	Nashdene Yard	City of Toronto	2.88
30	Ellesmere Yard	City of Toronto	3.38
31	Morningside Yard	City of Toronto	3.63
33	Edwards Gardens	City of Toronto	19.13
34	Fire Station 215	City of Toronto	3.13
35	Mount Pleasant	City of Toronto	33.00
36	Denton	City of Toronto	16.50
37	Poplar	City of Toronto	2.63
38	Seminole	City of Toronto	3.38
39	Fire Station 121	City of Toronto	25.50
41	HY002	TRCA	11.75
42	HY003	TRCA	39.50
43	HY008	TRCA	29.70
44	HY009	TRCA	2.40
45	HY011	TRCA	4.40
46	HY012	TRCA	13.30
47	HY014	TRCA	26.70
48	HY015	TRCA	1.40
49	HY016	TRCA	20.20
50	HY021	TRCA	14.85
51	HY025	TRCA	35.50
52	HY027	TRCA	28.30
53	HY030	TRCA	6.10
54	HY031	TRCA	0.50
55	HY033	TRCA	30.00
56	HY036	TRCA	2.90
57	HY037	TRCA	19.20
58	HY038	TRCA	24.40
59	HY041	TRCA	16.90
60	HY043	TRCA	2.20
61	HY044	TRCA	3.40
62	HY046	TRCA	35.20
63	HY050	TRCA	3.30
64	HY051	TRCA	3.80
65	HY055	TRCA	28.00
66	HY060	TRCA	1.55
67	HY061	TRCA	8.60
68	HY064	TRCA	30.70
69	HY069	TRCA	7.50
70	HY070	TRCA	6.30
71	HY004	TRCA	3.10
72	HY039	TRCA	35.80
73	HY063	TRCA	0.80
74	R_ET_HL01	York Region	19.70
75	R_ET_MA03	York Region	2.40
76	R_ET_NO01	York Region	30.10
77	R_ET_ST02	York Region	1.70
78	R_ET_VA01	York Region	27.10
79	R_ET_VA02	York Region	41.40
80	R_YR_AU02	York Region	9.60
81	R_YR_KE01	York Region	1.40
82	R_YR_MA03	York Region	18.00
83	R_YR_MO01	York Region	0.90
84	R_YR_NE01	York Region	12.60
85	R_YR_RH01	York Region	17.60
86	R_YR_SU01	York Region	0.60
87	R_YR_VA03	York Region	41.40
88	R_YR_VA04	York Region	23.00
89	R_YR_WB01	York Region	0.90
90	STN 01 - Third St.	Mississauga	38.00
91	STN 02 - Clarkson	Mississauga	1.50
92	STN 03 - Wolfedale	Mississauga	23.00
93	STN 04 - South Common	Mississauga	1.13
94	STN 06 - Winding Trail	Mississauga	38.30
95	STN 06 - Mississauga Valley	Mississauga	32.40
96	STN 07 - Britannia	Mississauga	7.30
97	STN 08 - Temiken	Mississauga	16.50
98	STN 09 - Truscott	Mississauga	1.20
99	STN 10 - Falbourne	Mississauga	26.30
100	STN 11 - Garry Morden FTC	Mississauga	3.70
101	STN 12 - CVC	Mississauga	17.10
102	STN 13 - Goreway	Mississauga	28.90
103	STN 14 - Port Credit	Mississauga	28.50
104	Stornoway P.S.	Markham	22.90
105	Thornhill C.C.	Markham	20.19
106	German Mills P.S.	Markham	15.60
107	Lincoln Alexander P.S.	Markham	5.70
108	8100 Warden Ave	Markham	4.20
109	Milliken Mills C.C.	Markham	2.50
110	Fire Hall #94	Markham	3.38
111	Roy H Crosby P.S.	Markham	3.20
112	Markham Museum	Markham	3.00
113	Rouge River C.C.	Markham	3.88
114	Angus Glen C.C.	Markham	3.38
115	RG03	Peel Region	1.88
116	RG11	Peel Region	4.63
117	RG16	Peel Region	20.50
118	RG20	Peel Region	36.13
119	RG22	Peel Region	19.13
120	RG23	Peel Region	9.00
121	RG24	Peel Region	15.50
122	RG25	Peel Region	24.38
123	RG26	Peel Region	5.25
124	RG27	Peel Region	13.75
125	RG28	Peel Region	27.50
126	RG29	Peel Region	37.00
127	RG31	Peel Region	23.63
128	RG32	Peel Region	26.38
129	RG33	Peel Region	16.75
130	RG34	Peel Region	8.00
131	RG36	Peel Region	12.38
132	RG39	Peel Region	12.63
133	RG42	Peel Region	5.13
134	RG44	Peel Region	3.88
135	Discovery	RichmondHill	24.50
136	Oak Ridges	RichmondHill	9.00
137	Operations	RichmondHill	11.50



Legend

- Rainfall Gauges
- Highways
- Major Roads
- Rainfall > 100 Year
- Rainfall > 50 Year
- Watersheds
- Pearson Airport
- Municipal Boundaries

Maximum 2 Hour Intensity (mm/hr)

- 1 - 4
- 5 - 9
- 10 - 13
- 14 - 17
- 18 - 22
- 23 - 26
- 27 - 31
- 32 - 36
- 37 - 44
- 45 - 57

July 8, 2013 Extreme Rainfall Event

Summary and Analysis Report

Toronto and Region Conservation Authority

Maximum 2 Hour Rainfall Intensity IDF Comparison

amec

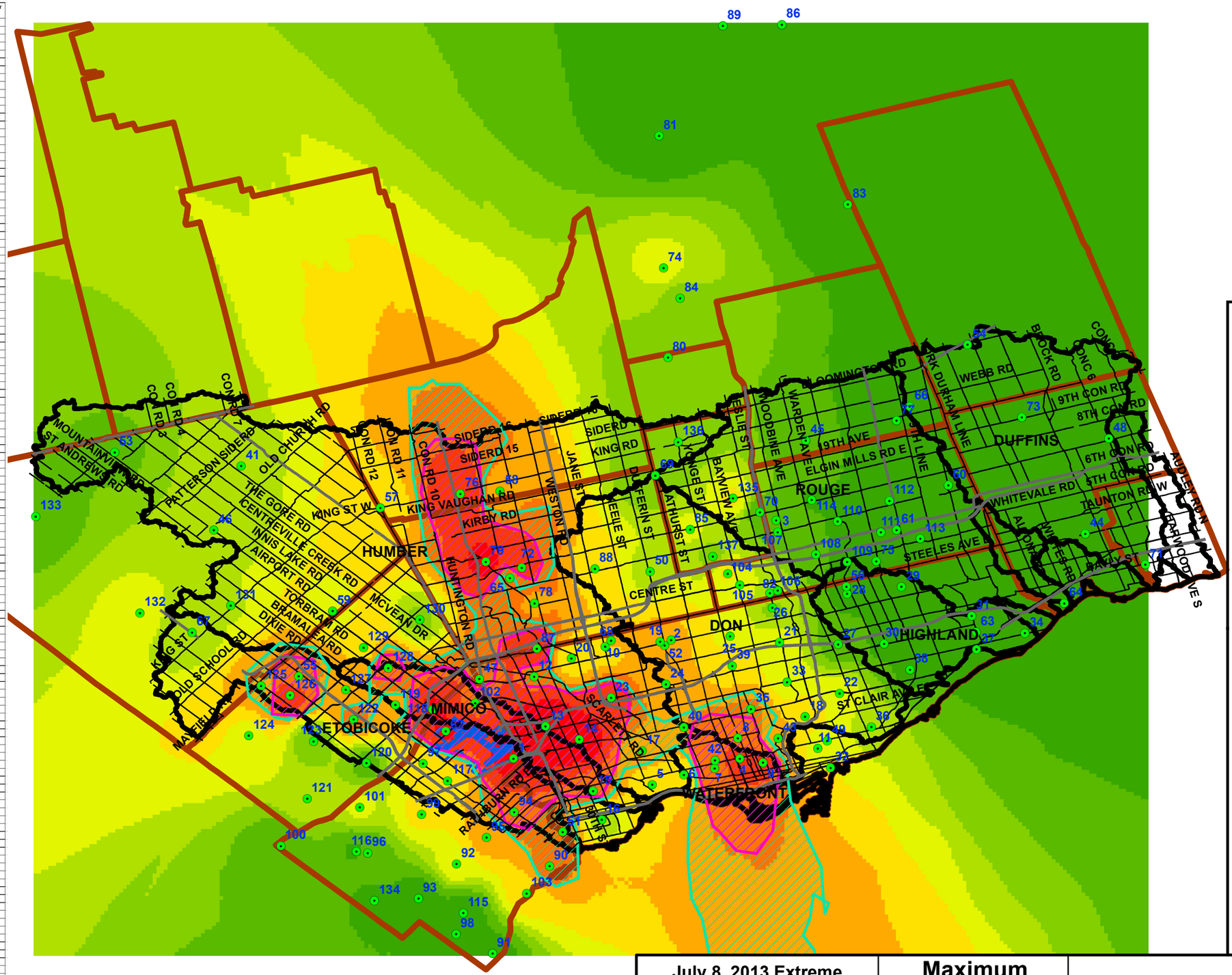
Scale 1:400,000

0 2.5 5 10 15 Kilometers

Project No. TP114045

Figure No. 4-17

ID	Gauge Name	Source	Max 6 hour (mm/hr)
1	Toronto Lester B. Pearson Int'L A.	Environment Canada	18.87
2	Toronto North York	Environment Canada	11.03
3	Toronto Buttonville A	Environment Canada	3.23
4	Toronto City	Environment Canada	15.92
5	Swansea	City of Toronto	9.38
6	Howard	City of Toronto	9.46
7	Central	City of Toronto	14.42
8	Brown	City of Toronto	14.00
9	Church	City of Toronto	15.25
10	Jane	City of Toronto	8.75
11	Greenwood	City of Toronto	8.58
12	Albion	City of Toronto	14.29
13	Martin Grove	City of Toronto	22.88
14	Richview	City of Toronto	20.00
15	Bering	City of Toronto	13.88
16	Kipling	City of Toronto	6.25
17	Castlefield	City of Toronto	11.96
18	Thorncliffe	City of Toronto	10.17
19	Finch Yard	City of Toronto	11.21
20	Emery Yard	City of Toronto	9.21
21	Fire Station 116	City of Toronto	8.04
22	Bermondsey Yard	City of Toronto	8.13
23	Wilson	City of Toronto	16.00
24	Ancaster	City of Toronto	11.67
25	Mitchell Field	City of Toronto	8.59
26	Cummer	City of Toronto	5.25
27	Pharmacy/401	City of Toronto	2.92
28	Liamoreaux	City of Toronto	1.63
29	Nashdene Yard	City of Toronto	1.38
30	Ellesmere Yard	City of Toronto	1.58
31	Morningside Yard	City of Toronto	1.50
33	Edwards Gardens	City of Toronto	7.88
34	Fire Station 215	City of Toronto	1.21
35	Mount Pleasant	City of Toronto	12.83
36	Denton	City of Toronto	6.50
37	Poplar	City of Toronto	1.13
38	Seminole	City of Toronto	1.71
39	Fire Station 121	City of Toronto	10.13
41	HY002	TRCA	7.07
42	HY003	TRCA	14.70
43	HY008	TRCA	11.49
44	HY009	TRCA	0.90
45	HY011	TRCA	2.33
46	HY012	TRCA	5.63
47	HY014	TRCA	14.10
48	HY015	TRCA	0.50
49	HY016	TRCA	8.10
50	HY021	TRCA	6.53
51	HY025	TRCA	13.00
52	HY027	TRCA	11.10
53	HY030	TRCA	3.67
54	HY031	TRCA	0.27
55	HY033	TRCA	13.83
56	HY036	TRCA	1.50
57	HY037	TRCA	9.47
58	HY038	TRCA	11.90
59	HY041	TRCA	8.40
60	HY043	TRCA	1.00
61	HY044	TRCA	1.57
62	HY046	TRCA	17.97
63	HY050	TRCA	1.33
64	HY051	TRCA	1.47
65	HY055	TRCA	13.03
66	HY060	TRCA	0.78
67	HY061	TRCA	5.77
68	HY064	TRCA	11.90
69	HY069	TRCA	3.93
70	HY070	TRCA	3.13
71	HY004	TRCA	1.17
72	HY039	TRCA	15.60
73	HY063	TRCA	0.43
74	R_ET_HL01	York Region	7.63
75	R_ET_MA03	York Region	1.23
76	R_ET_NO01	York Region	16.83
77	R_ET_ST02	York Region	0.93
78	R_ET_VA01	York Region	12.40
79	R_ET_VA02	York Region	18.47
80	R_YR_AU02	York Region	4.67
81	R_YR_KE01	York Region	0.90
82	R_YR_MA03	York Region	7.27
83	R_YR_MO01	York Region	0.43
84	R_YR_NE01	York Region	5.17
85	R_YR_RH01	York Region	7.47
86	R_YR_SU01	York Region	0.37
87	R_YR_VA03	York Region	16.73
88	R_YR_VA04	York Region	9.63
89	R_YR_WB01	York Region	0.43
90	STN 01 - Third St.	Mississauga	13.57
91	STN 02 - Clarkson	Mississauga	1.10
92	STN 03 - Wolfedale	Mississauga	8.37
93	STN 04 - South Common	Mississauga	0.46
94	STN 05 - Winding Trail	Mississauga	14.20
95	STN 06 - Mississauga Valley	Mississauga	11.67
96	STN 07 - Britannia	Mississauga	3.37
97	STN 08 - Tomken	Mississauga	9.00
98	STN 09 - Truscott	Mississauga	0.63
99	STN 10 - Fairbourne	Mississauga	9.30
100	STN 11 - Garry Morden FTC	Mississauga	2.33
101	STN 12 - CVC	Mississauga	7.63
102	STN 13 - Goreway	Mississauga	14.43
103	STN 14 - Port Credit	Mississauga	9.67
104	Stornoway P.S.	Markham	9.27
105	Thornhill C.C.	Markham	8.00
106	German Mills P.S.	Markham	6.33
107	Lincoln Alexander P.S.	Markham	3.10
108	8100 Warden Ave	Markham	2.13
109	Milliken Mills C.C.	Markham	1.42
110	Fire Hall #94	Markham	1.92
111	Roy H Crosby P.S.	Markham	1.57
112	Markham Museum	Markham	1.43
113	Rouge River C.C.	Markham	1.71
114	Angus Glen C.C.	Markham	1.88
115	RG03	Peel Region	0.63
116	RG11	Peel Region	1.63
117	RG16	Peel Region	9.79
118	RG20	Peel Region	18.04
119	RG22	Peel Region	12.17
120	RG23	Peel Region	3.17
121	RG24	Peel Region	6.96
122	RG25	Peel Region	13.33
123	RG26	Peel Region	3.96
124	RG27	Peel Region	8.67
125	RG28	Peel Region	12.29
126	RG29	Peel Region	16.21
127	RG31	Peel Region	11.17
128	RG32	Peel Region	14.13
129	RG33	Peel Region	10.29
130	RG34	Peel Region	5.38
131	RG36	Peel Region	7.17
132	RG39	Peel Region	7.71
133	RG42	Peel Region	2.88
134	RG44	Peel Region	1.63
135	Discovery	RichmondHill	9.20
136	Oak Ridges	RichmondHill	4.67
137	Operations	RichmondHill	5.13



Legend

- Rainfall Gauges
- Highways
- Major Roads
- Rainfall > 100 Year
- Rainfall > 50 Year
- Watersheds
- Pearson Airport
- Municipal Boundaries

Maximum 6 Hour Intensity (mm/hr)

- 0 - 2
- 3 - 4
- 5 - 6
- 7 - 7
- 8 - 9
- 10 - 11
- 12 - 13
- 14 - 15
- 16 - 18
- 19 - 23

July 8, 2013 Extreme Rainfall Event

Summary and Analysis Report

Toronto and Region Conservation Authority

Maximum 6 Hour Rainfall Intensity IDF Comparison

amec

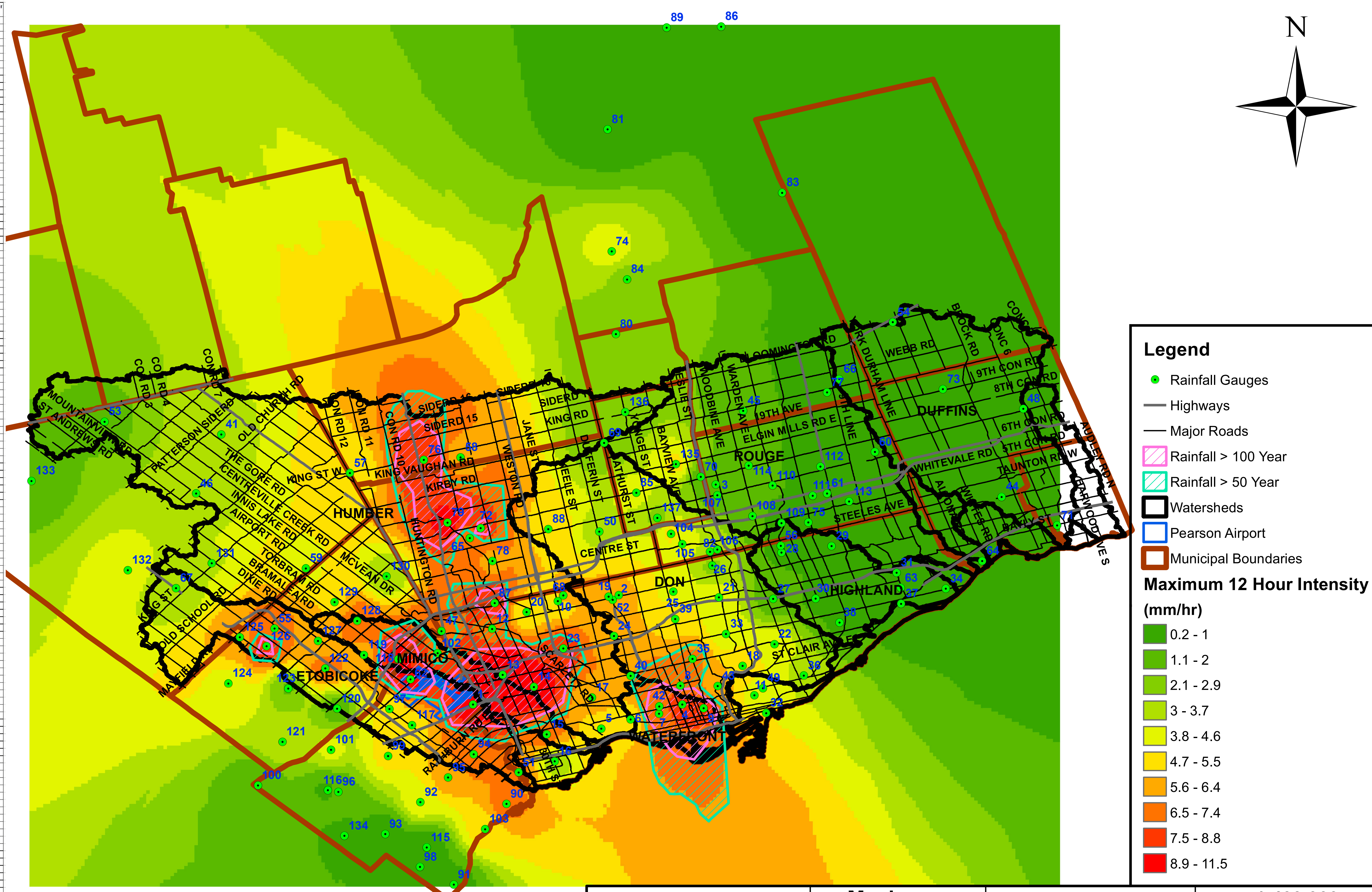
Scale 1:400,000

0 2.5 5 10 15 Kilometers

Project No. TP114045

Figure No. 4-18

ID	Gauge Name	Source	Max 12 Hour (mm/hr)
1	Toronto Lester B. Pearson Int'L A	Environment Canada	9.55
2	Toronto North York	Environment Canada	5.60
3	Toronto Buttonville A	Environment Canada	1.72
4	Toronto City	Environment Canada	8.03
5	Swansea	City of Toronto	4.75
6	Howard	City of Toronto	4.75
7	Central	City of Toronto	7.27
8	Brown	City of Toronto	7.08
9	Church	City of Toronto	7.69
10	Jane	City of Toronto	4.46
11	Greenwood	City of Toronto	4.38
12	Albion	City of Toronto	7.23
13	Martin Grove	City of Toronto	11.50
14	Richview	City of Toronto	10.08
15	Bering	City of Toronto	6.96
16	Kipling	City of Toronto	3.15
17	Castlefield	City of Toronto	6.04
18	Thorncliffe	City of Toronto	5.29
19	Finch Yard	City of Toronto	5.71
20	Emery Yard	City of Toronto	4.65
21	Fire Station 116	City of Toronto	4.13
22	Bermondsey Yard	City of Toronto	4.15
23	Wilson	City of Toronto	8.02
24	Ancaster	City of Toronto	5.88
25	Mitchell Field	City of Toronto	4.36
26	Cummer	City of Toronto	2.71
27	Pharmacy/401	City of Toronto	1.52
28	Liamoreaux	City of Toronto	0.94
29	Nashdene Yard	City of Toronto	0.73
30	Ellesmere Yard	City of Toronto	0.85
31	Morningsidede Yard	City of Toronto	0.81
33	Edwards Gardens	City of Toronto	4.00
34	Fire Station 215	City of Toronto	0.65
35	Mount Pleasant	City of Toronto	6.52
36	Denton	City of Toronto	3.42
37	Poplar	City of Toronto	0.60
38	Seminole	City of Toronto	0.92
39	Fire Station 121	City of Toronto	5.10
41	HY002	TRCA	3.63
42	HY003	TRCA	7.38
43	HY008	TRCA	5.78
44	HY009	TRCA	0.50
45	HY011	TRCA	1.28
46	HY012	TRCA	3.08
47	HY014	TRCA	7.10
48	HY015	TRCA	0.33
49	HY016	TRCA	4.18
50	HY021	TRCA	3.39
51	HY025	TRCA	6.55
52	HY027	TRCA	5.63
53	HY030	TRCA	1.88
54	HY031	TRCA	0.22
55	HY033	TRCA	6.83
56	HY036	TRCA	0.82
57	HY037	TRCA	4.82
58	HY038	TRCA	6.08
59	HY041	TRCA	4.27
60	HY043	TRCA	0.57
61	HY044	TRCA	0.85
62	HY046	TRCA	9.13
63	HY050	TRCA	0.72
64	HY051	TRCA	0.75
65	HY055	TRCA	6.58
66	HY060	TRCA	0.48
67	HY061	TRCA	2.93
68	HY064	TRCA	6.05
69	HY069	TRCA	2.12
70	HY070	TRCA	1.67
71	HY004	TRCA	0.62
72	HY039	TRCA	7.83
73	HY063	TRCA	0.27
74	R_ET_HL01	York Region	3.98
75	R_ET_MA03	York Region	0.65
76	R_ET_NO01	York Region	8.52
77	R_ET_ST02	York Region	0.57
78	R_ET_VA01	York Region	6.25
79	R_ET_VA02	York Region	9.28
80	R_YR_AU02	York Region	2.45
81	R_YR_KE01	York Region	0.47
82	R_YR_MA03	York Region	3.73
83	R_YR_MO01	York Region	0.27
84	R_YR_NE01	York Region	2.63
85	R_YR_RH01	York Region	3.93
86	R_YR_SU01	York Region	0.22
87	R_YR_VA03	York Region	8.40
88	R_YR_VA04	York Region	5.03
89	R_YR_WB01	York Region	0.28
90	STN 01 - Third St.	Mississauga	6.78
91	STN 02 - Clarkson	Mississauga	0.55
92	STN 03 - Wolfedale	Mississauga	4.18
93	STN 04 - South Common	Mississauga	0.31
94	STN 05 - Winding Trail	Mississauga	7.20
95	STN 06 - Mississauga Valley	Mississauga	5.92
96	STN 07 - Britannia	Mississauga	1.70
97	STN 08 - Tomken	Mississauga	4.70
98	STN 09 - Truscott	Mississauga	0.33
99	STN 10 - Falbourne	Mississauga	4.73
100	STN 11 - Garry Morden FTC	Mississauga	1.20
101	STN 12 - CVC	Mississauga	3.88
102	STN 13 - Goreway	Mississauga	7.32
103	STN 14 - Port Credit	Mississauga	4.95
104	Stornoway P.S.	Markham	4.73
105	Thornhill C.C.	Markham	4.13
106	German Mills P.S.	Markham	3.25
107	Lincoln Alexander P.S.	Markham	1.67
108	8100 Warden Ave	Markham	1.13
109	Milliken Mills C.C.	Markham	0.77
110	Fire Hall #94	Markham	1.04
111	Roy H Crosby P.S.	Markham	0.83
112	Markham Museum	Markham	0.85
113	Rouge River C.C.	Markham	0.92
114	Angus Glen C.C.	Markham	1.02
115	RG03	Peel Region	0.31
116	RG11	Peel Region	0.81
117	RG16	Peel Region	5.10
118	RG20	Peel Region	9.15
119	RG22	Peel Region	6.23
120	RG23	Peel Region	1.60
121	RG24	Peel Region	3.54
122	RG25	Peel Region	6.81
123	RG26	Peel Region	2.00
124	RG27	Peel Region	4.33
125	RG28	Peel Region	6.19
126	RG29	Peel Region	8.13
127	RG31	Peel Region	5.60
128	RG32	Peel Region	7.23
129	RG33	Peel Region	5.31
130	RG34	Peel Region	3.04
131	RG36	Peel Region	3.69
132	RG39	Peel Region	3.98
133	RG42	Peel Region	1.48
134	RG44	Peel Region	0.81
135	Discovery	RichmondHill	4.73
136	Oak Ridges	RichmondHill	2.47
137	Operations	RichmondHill	2.72



July 8, 2013 Extreme Rainfall Event

Summary and Analysis Report

Toronto and Region Conservation Authority

Maximum 12 Hour Rainfall Intensity IDF Comparison

amec

Scale 1:400,000

0 2.5 5 10 15 Kilometers

Project No. TP114045

Figure No. 4-19

4.5 Radar Based Assessment

In addition to measured rainfall depths from available rain gauges within the study area, radar rainfall data sets have also been obtained from the two sources with available data for the study area, specifically the King City and NEXRAD Buffalo radar stations. The radar-based assessment for each station is discussed in this section.

4.5.1 Buffalo Radar

The Next Generation Radar (NEXRAD) Level III data set for the station located in Buffalo, New York, United States has been obtained from National Climatic Data Center (NCDC) of National Oceanic and Atmospheric Administration (NOAA). The Buffalo Radar Station has a maximum range of 230 km according to NOAA which provides full coverage for the area under study. The coverage extent of the Buffalo radar station has been presented in Figure 4-20.

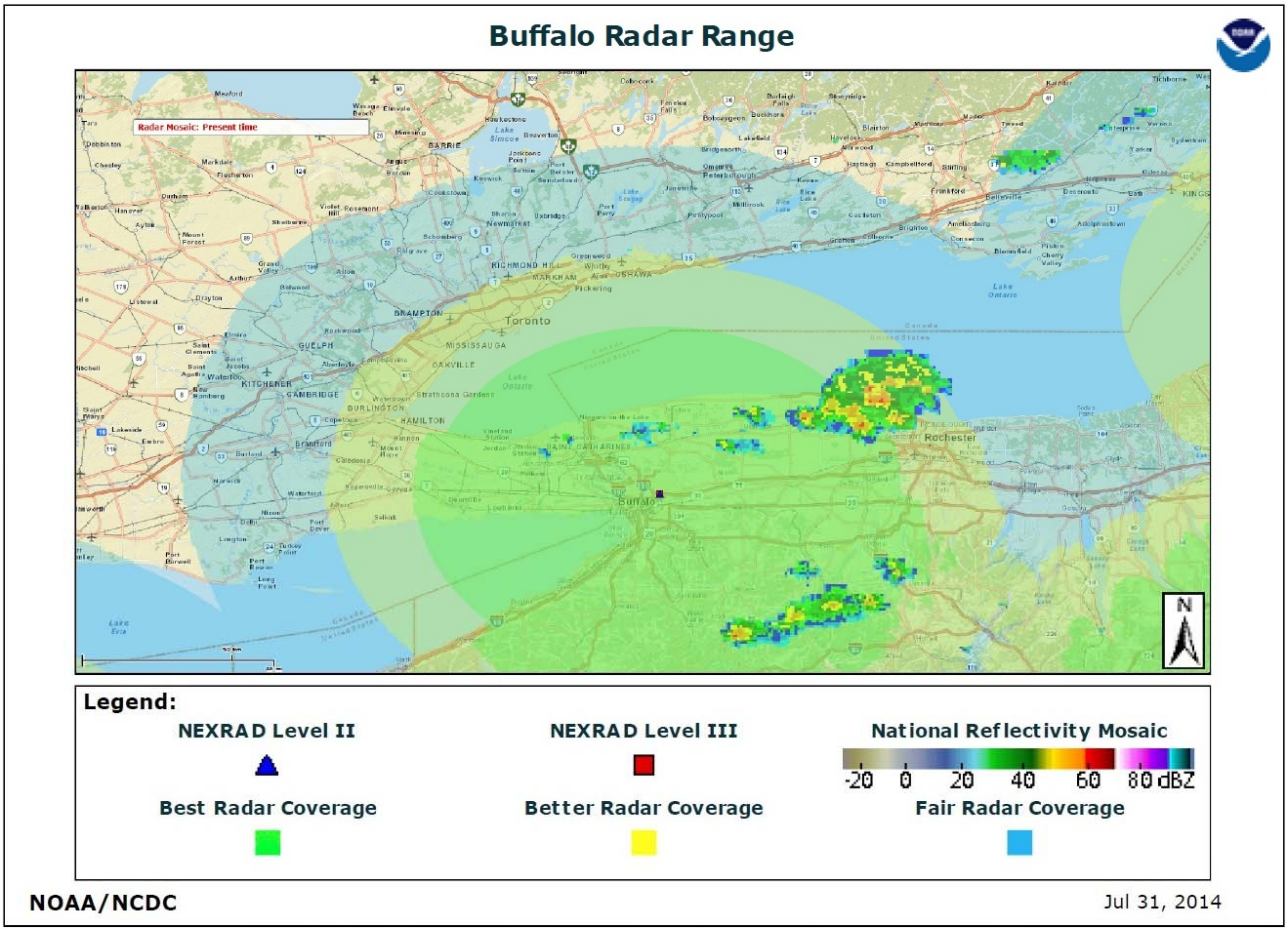


Figure 4-20: Buffalo Radar Effective Range

The product used for this assessment has been the Digital Storm Total Precipitation which provides total accumulated storm depth from the onset of the storm with 12 measurements per hour. The total storm depth based on Buffalo Station radar data has been presented in Figure 4-21. The results presented in this Figure demonstrate a very similar trend in spatial

distribution of rainfall with the results based on rain gauge measurements, as presented in Figure 4-1.

A comparison was conducted between the total storm volume measured at each rain gauge and the corresponding rain fall depth based on the Buffalo radar station. The results of this comparison have been presented in Figure 4-22 for all gauges. Summary statistics of the absolute difference between measured rainfall volumes at gauges and radar rainfall depths at gauge locations have also been presented in Table 4-7.

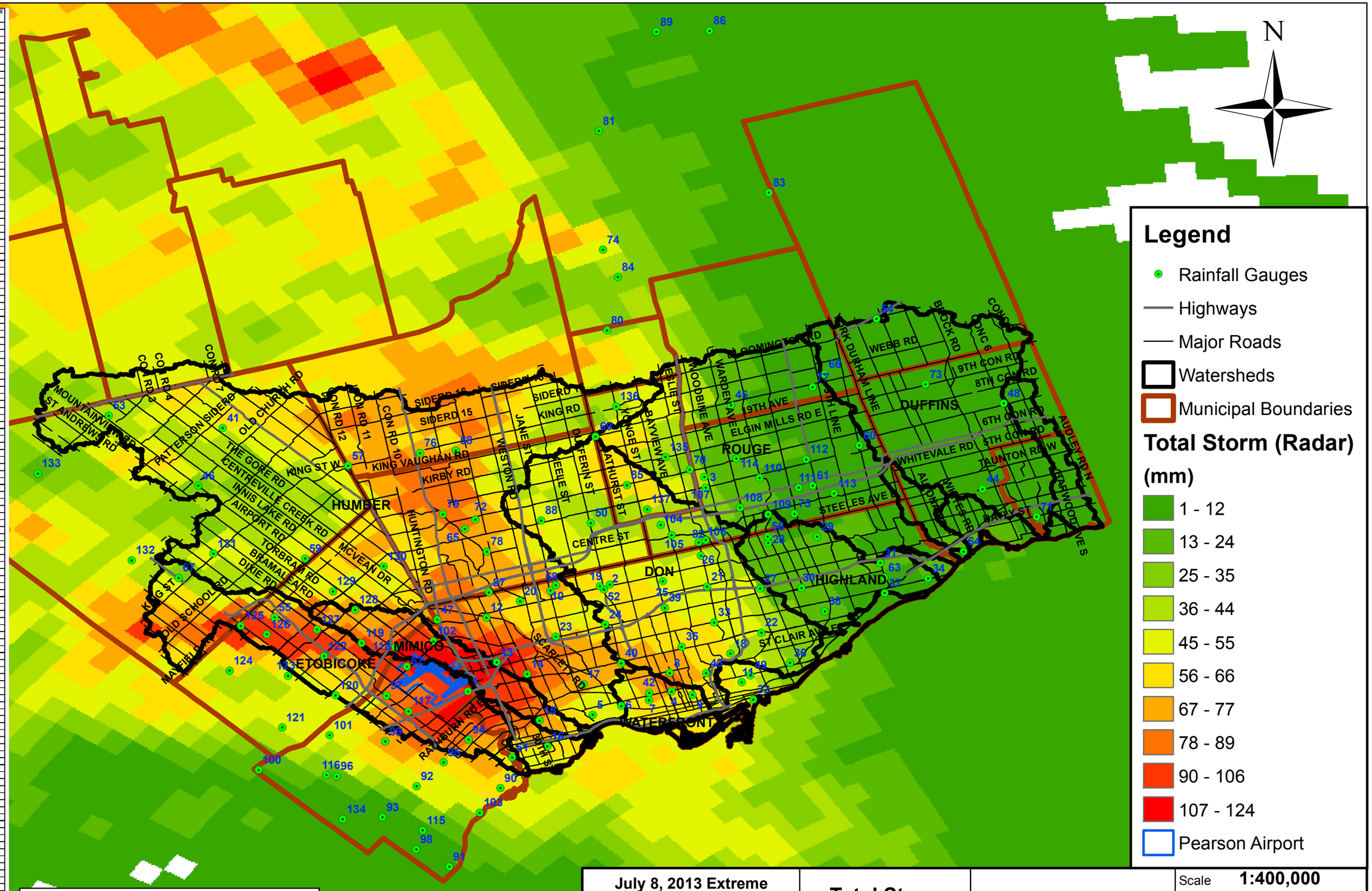
The results presented in Figure 4-22 indicate that the difference between radar rainfall depth and rain gauge measured values was smaller where the gauge received a large amount of rainfall during the July 8th, 2013 storm event. This observation is consistent with general characteristics of radar rainfall estimation which is expected to be more accurate during larger storm events, compared to smaller storms.

Table 4-7: Summary Statistics of absolute difference between Buffalo Radar Rainfall and Rain Gauge Values

Statistical Parameter	Value (mm)	% error
Minimum	0.09	0.18
Maximum	32.51	149
Mean	9.06	27
Standard Deviation	8.51	30

The results presented in Table 4-7 are indicative of a relatively strong agreement between the measured rainfall depths and radar rainfall values at gauge locations with a mean absolute difference of 9.06 mm and a standard deviation of 8.51 mm. Minimum and maximum absolute differences are 0.09 mm and 32.51 mm, respectively. Mean percentage error has been estimated to be 27%.

ID	Gauge Name	Source	Total Rainfall (mm)
1	Toronto Pearson Int'L A	Environment Canada	114.6
2	Toronto North York	Environment Canada	67.2
3	Toronto Buttonville A	Environment Canada	14.2
4	Toronto City	Environment Canada	96.4
5	Swansea	City of Toronto	56.75
6	Howard	City of Toronto	57
7	Central	City of Toronto	87.25
8	Brown	City of Toronto	85
9	Church	City of Toronto	92.25
10	Lans	City of Toronto	53.5
11	Greenwood	City of Toronto	52.5
12	Albion	City of Toronto	86.25
13	Martin Grove	City of Toronto	138
14	Richview	City of Toronto	121
15	Bering	City of Toronto	83.5
16	Kipling	City of Toronto	97.75
17	Castlefield	City of Toronto	72.5
18	Thorncliffe	City of Toronto	62.5
19	Finch Yard	City of Toronto	68
20	Emery Yard	City of Toronto	66.75
21	Fire Station 116	City of Toronto	49
22	Bermondsey Yard	City of Toronto	49.75
23	Wilson	City of Toronto	96.25
24	Ancaster	City of Toronto	70.5
25	Mitchell Field	City of Toronto	52.304
26	Dunmer	City of Toronto	92.5
27	Pharmacy/401	City of Toronto	18.25
28	Liamoreaux	City of Toronto	10.5
29	Nashdene Yard	City of Toronto	8.75
30	Ellesmere Yard	City of Toronto	10.25
31	Morningside Yard	City of Toronto	9.75
32	Ashbridges Bay	City of Toronto	Missing
33	Edwards Gardens	City of Toronto	48
34	Fire Station 215	City of Toronto	7.75
35	Mount Pleasant	City of Toronto	78
36	Denton	City of Toronto	40.25
37	Poplar	City of Toronto	7.25
38	Saminole	City of Toronto	11
39	Fire Station 121	City of Toronto	61.25
40	Fairbank Middle Public School	City of Toronto	Missing
41	Albion Hills	TRCA	43.6
42	Alex Duff Memorial Pool	TRCA	88.6
43	Brickworks	TRCA	69.4
44	Brock West Landfill	TRCA	6
45	Bruces Mill CA	TRCA	15.4
46	Caledon Pumping Station	TRCA	37
47	Claireville Dam	TRCA	85.2
48	Clairemont Shop	TRCA	4
49	Danforth and Coxwell	TRCA	50.2
50	Dufferin Reservoir	TRCA	40.7
51	Erobicoke at QEW	TRCA	78.4
52	G Ross Dam	TRCA	67.6
53	Glen Haffy	TRCA	22.6
54	Goodwood Pumping Station	TRCA	2.4
55	Heart Lake CA	TRCA	81.8
56	Kennedy Pump Station	TRCA	9.8
57	King and Albion-Vaughan	TRCA	57.8
58	East Humber at Mill Road	TRCA	73
59	Ladaw Bus Depot	TRCA	51.2
60	Little Rouge at 16th	TRCA	6.6
61	Milne Dam	TRCA	10.2
62	Mississauga Works Yard	TRCA	109.4
63	Morningside Works Yard	TRCA	8.6
64	Pettiocat CA	TRCA	9
65	Restoration Services	TRCA	79
66	Stouffville Dam	TRCA	5.7
67	Sue Grange Farm	TRCA	35
68	TRCA Head Office	TRCA	72.6
69	York Pumping Station	TRCA	25.4
70	York Region Works Yard	TRCA	20
71	Bayly and Church	TRCA	7.4
72	Kortright	TRCA	94
73	Transport Canada	TRCA	3.2
74	R_ET_HL01	York Region	47.8
75	R_ET_MA03	York Region	7.8
76	R_ET_NO01	York Region	102
77	R_ET_ST02	York Region	6.8
78	R_ET_VA01	York Region	75
79	R_ET_VA02	York Region	111.4
80	R_YR_AU02	York Region	29.4
81	R_YR_KE01	York Region	5.6
82	R_YR_MA03	York Region	44.6
83	R_YR_MO01	York Region	3
84	R_YR_NE01	York Region	31.6
85	R_YR_RH01	York Region	47.2
86	R_YR_SU01	York Region	2.4
87	R_YR_VA03	York Region	100.8
88	R_YR_VA04	York Region	60.4
89	R_YR_WB01	York Region	2.6
90	STN 01 - Third St.	Mississauga	81.4
91	STN 02 - Clarkson	Mississauga	6.6
92	STN 03 - Wolfedale	Mississauga	50.2
93	STN 04 - South Common	Mississauga	2.75
94	STN 05 - Winding Trail	Mississauga	86.4
95	STN 06 - Mississauga Valley	Mississauga	71
96	STN 07 - Britannia	Mississauga	20.4
97	STN 08 - Tomken	Mississauga	56.4
98	STN 09 - Truscott	Mississauga	4
99	STN 10 - Fallbourne	Mississauga	56.8
100	STN 11 - Garry Morden FTC	Mississauga	14.2
101	STN 12 - CVC	Mississauga	46.6
102	STN 13 - Goreway	Mississauga	87.8
103	STN 14 - Port Credit	Mississauga	59.4
104	Stornoway P.S.	Markham	56.8
105	Thornhill C.C.	Markham	49.63
106	Germen Mills P.S.	Markham	39
107	Lincoln Alexander P.S.	Markham	20
108	8100 Warden Ave	Markham	13.6
109	Milliken Mills C.C.	Markham	9.25
110	Fire Hall #94	Markham	12.5
111	Roy H Crosby P.S.	Markham	10
112	Markham Museum	Markham	9.4
113	Rouge River C.C.	Markham	11
114	Angus Glen C.C.	Markham	12
115	RG03	Peel Region	3.75
116	RG11	Peel Region	9.75
117	RG16	Peel Region	61.25
118	RG20	Peel Region	109.75
119	RG22	Peel Region	74.75
120	RG23	Peel Region	19.25
121	RG24	Peel Region	42.5
122	RG25	Peel Region	91.75
123	RG26	Peel Region	24
124	RG27	Peel Region	52
125	RG28	Peel Region	74.25
126	RG29	Peel Region	97.5
127	RG31	Peel Region	67.25
128	RG32	Peel Region	86.75
129	RG33	Peel Region	63.75
130	RG34	Peel Region	36.5
131	RG36	Peel Region	44.25
132	RG39	Peel Region	47.75
133	RG42	Peel Region	17.75
134	RG44	Peel Region	9.75
135	Discovery	RichmondHill	56.6
136	Oak Ridges	RichmondHill	29.6
137	Operations	RichmondHill	32.6



July 8, 2013 Extreme Rainfall Event

Summary and Analysis Report

Toronto and Region Conservation Authority

Total Storm Depth Based on Buffalo Radar

amec

Scale 1:400,000

0 2.5 5 10 15 Kilometers

Project No. TP114045

Figure No. 4-21

N

Legend

- 69
- Rainfall Based on Gauge
- Difference with Radar
- Highways
- Major Roads
- Watersheds
- Municipal Boundaries
- Pearson Airport

July 8, 2013 Extreme Rainfall Event **Summary and Analysis Report** **Toronto and Region Conservation Authority**	**Total Storm Comparison Rain Gauge vs Buffalo Radar**	amec	Scale **1:350,000** 0 2 4 8 12 Kilometers Project No. **TP114045** Figure No. **4-22**

4.5.2 King City Radar

The King City radar (43.963889°N, 79.573889°W) is a dual-polarized radar and part of the Environment Canada radar network. It scans every 10 minutes and produces a 26 level conventional reflectivity volume scan and 4 single level Doppler scans at different elevation angles. The convention reflectivity scans have a theoretical maximum range of 256 km and the Doppler scans 112.5 km. The King City radar is the closest radar to the City of Toronto and the Doppler scans easily cover the entire area.

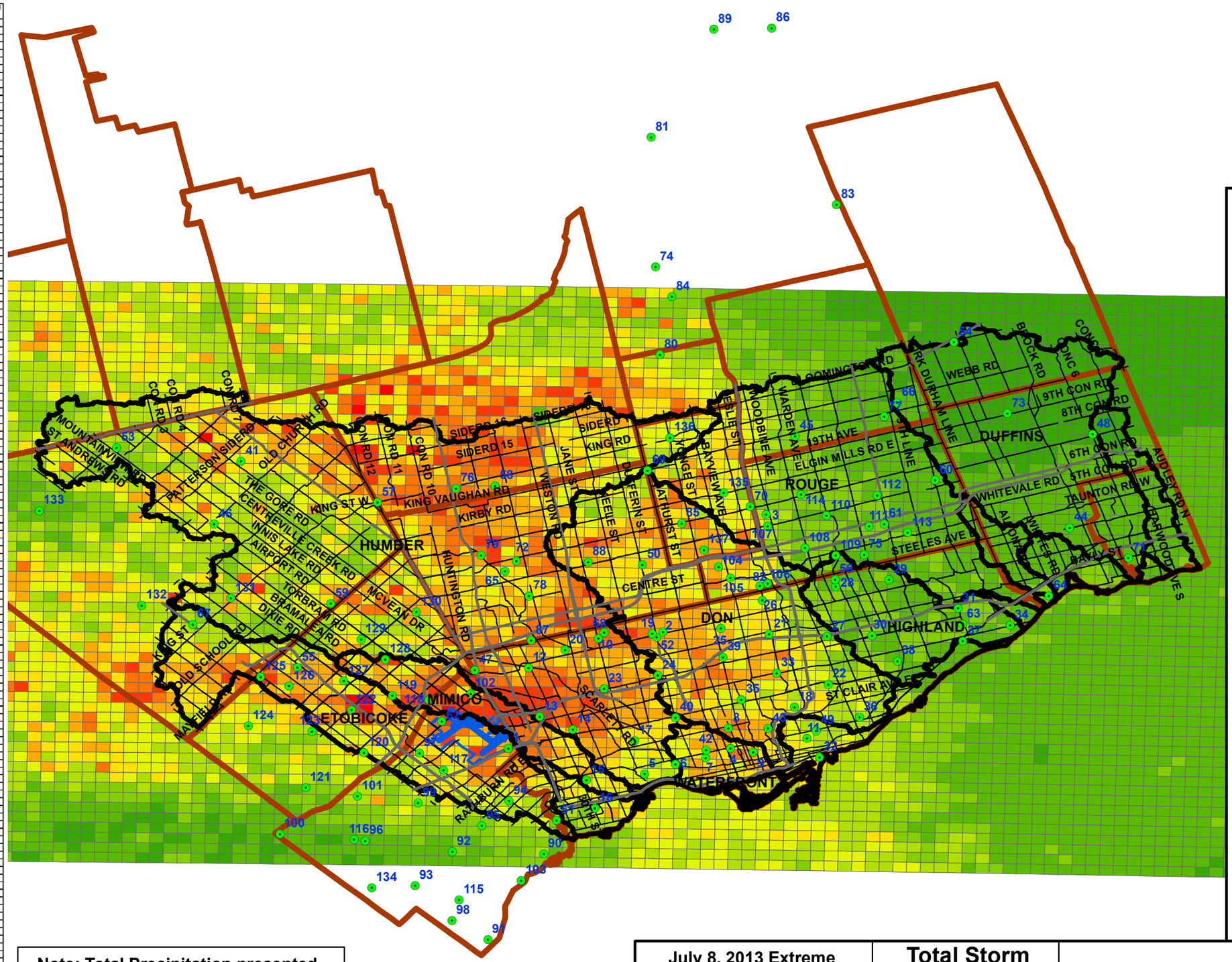
Raw radar data has been provided for King City Radar station and has been processed in order to perform ground-truthing and obtain total rainfall accumulation for the July 8th, 2013 extreme storm event. The processing procedure has been explained in detail in Appendix N.

Once all the radar files have been processed, two types of Mean Field Bias (MFB) analyses have been performed. The first has been to sum across all the rain gauge and radar estimates to arrive at two total estimates of rainfall. From these values, the MFB scale factor has been calculated which has then been applied to the radar data as a whole, effectively scaling all the data up or down. By applying an MFB scale factor in this way, residuals or differences between the scaled radar data and rain gauge data can be calculated. The results of this assessment have been presented in Figure 4-23.

The second approach has been to determine the “area of influence” for each rain gauge, calculate an MFB scale factor for each “area of influence” defined using Thiessen polygons and then scale only the radar data within that area. This has been done for all rain gauges and means that the radar data as a whole is affected by a patch work of scale factors. By applying individual MFB scale factors to each “area of influence” then the residuals or differences between scaled radar data and rain gauge data will always be zero. The results of this assessment have been presented in Figure 4-24.

A comparison of the results between the two adjustment methodologies for raw data at King City radar illustrates a similar trend and shape for the two methods, however the MFB adjustment, based on Thiessen polygons seems to have higher estimates of rainfall in the area hit by the eye of the storm, compared to MFB adjustment based on all gauges. The shape of the rainfall distribution as determined using the King City radar data has a very similar trend to that of Buffalo radar data and interpolated spatial grid developed using rain gauge measurements as well.

ID	Gauge Name	Source	Total Rainfall (mm)
1	Toronto Pearson Int'L A	Environment Canada	114.6
2	Toronto North York	Environment Canada	67.2
3	Toronto Buttonville A	Environment Canada	14.2
4	Toronto City	Environment Canada	96.4
5	Swansea	City of Toronto	56.75
6	Howard	City of Toronto	57
7	Central	City of Toronto	87.25
8	Brown	City of Toronto	85
9	Church	City of Toronto	92.25
10	Lans	City of Toronto	53.5
11	Greenwood	City of Toronto	52.5
12	Albion	City of Toronto	86.25
13	Martin Grove	City of Toronto	138
14	Richview	City of Toronto	121
15	Bering	City of Toronto	83.5
16	Kipling	City of Toronto	37.75
17	Castlefield	City of Toronto	72.5
18	Thorncliffe	City of Toronto	62.5
19	Finch Yard	City of Toronto	68
20	Emery Yard	City of Toronto	65.75
21	Fire Station 116	City of Toronto	49
22	Bermondsey Yard	City of Toronto	49.75
23	Wilson	City of Toronto	96.25
24	Ancaster	City of Toronto	70.5
25	Mitchell Field	City of Toronto	52.304
26	Cummer	City of Toronto	92.5
27	Pharmacy/401	City of Toronto	18.25
28	Lawrence Yard	City of Toronto	10.5
29	Nashdene Yard	City of Toronto	8.75
30	Ellesmere Yard	City of Toronto	10.25
31	Morningside Yard	City of Toronto	9.75
32	Ashbridges Bay	City of Toronto	Missing
33	Edwards Gardens	City of Toronto	48
34	Fire Station 215	City of Toronto	7.75
35	Mount Pleasant	City of Toronto	78
36	Denton	City of Toronto	40.25
37	Poplar	City of Toronto	7.25
38	Saminda	City of Toronto	11
39	Fire Station 121	City of Toronto	61.25
40	Fairbank Middle Public School	City of Toronto	Missing
41	Albion Hills	TRCA	43.6
42	Alex Duff Memorial Pool	TRCA	88.6
43	Bridgworks	TRCA	69.4
44	Brock West Landfill	TRCA	6
45	Bruces Mill CA	TRCA	15.4
46	Caledon Pumping Station	TRCA	37
47	Claireville Dam	TRCA	85.2
48	Claremont Shop	TRCA	4
49	Danforth and Coxwell	TRCA	50.2
50	Dufferin Reservoir	TRCA	40.7
51	Etobicoke at QEW	TRCA	78.4
52	G Ross Dam	TRCA	67.6
53	Glen Haffy	TRCA	22.6
54	Goodwood Pumping Station	TRCA	2.4
55	Heart Lake CA	TRCA	81.8
56	Kennedy Pump Station	TRCA	9.8
57	King and Albion-Vaughan	TRCA	57.8
58	East Humber at Mill Road	TRCA	73
59	Maw Bus Depot	TRCA	51.2
60	Little Rouge at 16th	TRCA	6.6
61	Milne Dam	TRCA	10.2
62	Mississauga Works Yard	TRCA	109.4
63	Morningside Works Yard	TRCA	8.6
64	Pettycoat CA	TRCA	9
65	Restoration Services	TRCA	79
66	Stouffville Dam	TRCA	5.7
67	Sue Grange Farm	TRCA	35
68	TRCA Head Office	TRCA	72.6
69	York Pumping Station	TRCA	25.4
70	York Region Works Yard	TRCA	20
71	Bayly and Church	TRCA	7.4
72	Kortright	TRCA	94
73	Transport Canada	TRCA	3.2
74	R_ET_ML01	York Region	47.8
75	R_ET_MA03	York Region	7.6
76	R_ET_NO01	York Region	102
77	R_ET_ST02	York Region	6.8
78	R_ET_VA01	York Region	75
79	R_ET_VA02	York Region	111.4
80	R_YR_AU02	York Region	29.4
81	R_YR_KE01	York Region	5.6
82	R_YR_MA03	York Region	44.6
83	R_YR_MO01	York Region	3
84	R_YR_NE01	York Region	31.6
85	R_YR_RI-01	York Region	47.2
86	R_YR_SU01	York Region	2.4
87	R_YR_VA03	York Region	100.8
88	R_YR_VA04	York Region	60.4
89	R_YR_WB01	York Region	2.6
90	STN 01 - Third St.	Mississauga	81.4
91	STN 02 - Clarkson	Mississauga	6.6
92	STN 03 - Wolfedale	Mississauga	50.2
93	STN 04 - South Common	Mississauga	2.75
94	STN 05 - Winding Trail	Mississauga	86.4
95	STN 06 - Mississauga Valley	Mississauga	71
96	STN 07 - Britannia	Mississauga	20.4
97	STN 08 - Tomken	Mississauga	56.4
98	STN 09 - Truscott	Mississauga	4
99	STN 10 - Falbourne	Mississauga	56.8
100	STN 11 - Garry Morden FTC	Mississauga	14.2
101	STN 12 - CVC	Mississauga	46.6
102	STN 13 - Goreway	Mississauga	87.8
103	STN 14 - Port Credit	Mississauga	59.4
104	Stomoway P.S.	Markham	56.8
105	Thornhill C.C.	Markham	49.63
106	German Mills P.S.	Markham	39
107	Lincoln Alexander P.S.	Markham	20
108	8100 Warden Ave.	Markham	13.6
109	Milliken Mills C.C.	Markham	9.25
110	Fire Hall #94	Markham	12.5
111	Roy H Crosby P.S.	Markham	10
112	Markham Museum	Markham	9.4
113	Rouge River C.C.	Markham	11
114	Angus Glen C.C.	Markham	12
115	RG03	Peel Region	3.75
116	RG11	Peel Region	9.75
117	RG16	Peel Region	61.95
118	RG20	Peel Region	109.75
119	RG22	Peel Region	74.75
120	RG23	Peel Region	19.25
121	RG24	Peel Region	42.5
122	RG25	Peel Region	81.75
123	RG26	Peel Region	24
124	RG27	Peel Region	52
125	RG28	Peel Region	74.25
126	RG29	Peel Region	97.5
127	RG31	Peel Region	67.25
128	RG32	Peel Region	86.75
129	RG33	Peel Region	83.75
130	RG34	Peel Region	36.5
131	RG36	Peel Region	44.25
132	RG39	Peel Region	47.75
133	RG42	Peel Region	17.75
134	RG44	Peel Region	9.75
135	Discovery	Richmond Hill	56.6
136	Oak Ridges	Richmond Hill	29.6
137	Operations	Richmond Hill	32.6



July 8, 2013 Extreme Rainfall Event

Summary and Analysis Report

Toronto and Region Conservation Authority

Total Storm Volume Based on King City Radar-Adjusted to All Gauges

amec

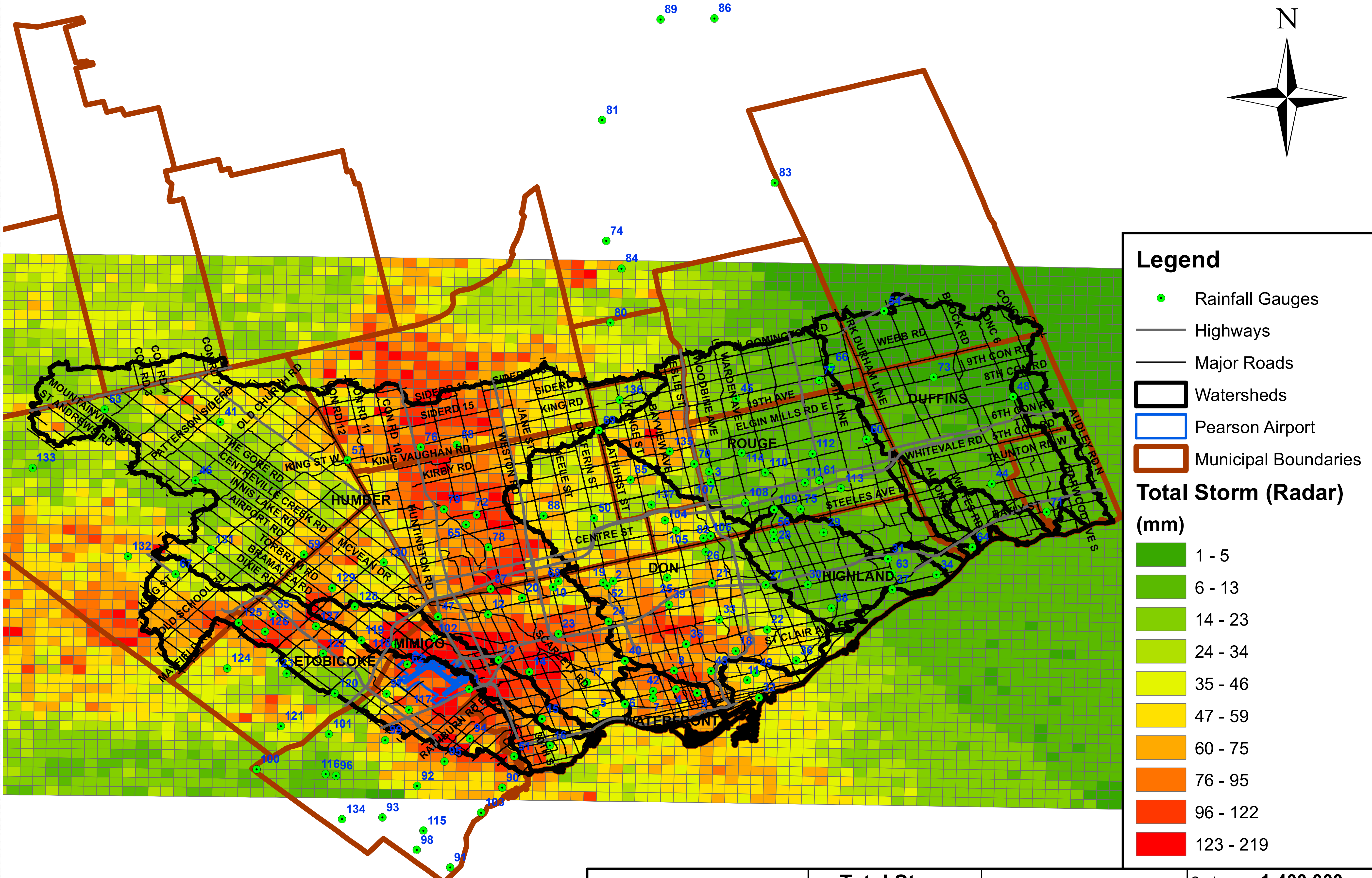
Scale 1:400,000

0 2.5 5 10 15 Kilometers

Project No. TP114045

Figure No. 4-23

ID	Gauge Name	Source	Total Rainfall (mm)
1	Toronto Pearson Int'L A	Environment Canada	114.6
2	Toronto North York	Environment Canada	67.2
3	Toronto Buttonville A	Environment Canada	14.2
4	Toronto City	Environment Canada	96.4
5	Swansea	City of Toronto	56.75
6	Howard	City of Toronto	57
7	Central	City of Toronto	87.25
8	Brown	City of Toronto	85
9	Church	City of Toronto	92.25
10	Jane	City of Toronto	53.5
11	Greenwood	City of Toronto	52.5
12	Albion	City of Toronto	86.25
13	Martin Grove	City of Toronto	138
14	Richview	City of Toronto	121
15	Bering	City of Toronto	83.5
16	Kipling	City of Toronto	37.75
17	Castlefield	City of Toronto	72.5
18	Thorncliffe	City of Toronto	62.5
19	Finch Yard	City of Toronto	68
20	Emery Yard	City of Toronto	55.75
21	Fire Station 116	City of Toronto	49
22	Bermondsey Yard	City of Toronto	49.75
23	Wilson	City of Toronto	96.25
24	Ancaster	City of Toronto	70.5
25	Mitchell Field	City of Toronto	52.324
26	Cummer	City of Toronto	32.5
27	Pharmacy/401	City of Toronto	18.25
28	Liamoreaux	City of Toronto	10.5
29	Nashdene Yard	City of Toronto	8.75
30	Ellesmere Yard	City of Toronto	10.25
31	Morningsidede Yard	City of Toronto	9.75
32	Ashbridges Bay	City of Toronto	Missing
33	Edwards Gardens	City of Toronto	48
34	Fire Station 215	City of Toronto	7.75
35	Mount Pleasant	City of Toronto	78
36	Denton	City of Toronto	40.25
37	Poplar	City of Toronto	7.25
38	Seminole	City of Toronto	11
39	Fire Station 121	City of Toronto	61.25
40	Fairbank Middle Public School	City of Toronto	Missing
41	Albion Hills	TRCA	43.6
42	Alex Duff Memorial Pool	TRCA	88.6
43	Brickworks	TRCA	69.4
44	Brock West Landfill	TRCA	6
45	Bruces Mill CA	TRCA	15.4
46	Caledon Pumping Station	TRCA	37
47	Claireville Dam	TRCA	85.2
48	Claremont Shop	TRCA	4
49	Danforth and Coxwell	TRCA	50.2
50	Dufferin Reservoir	TRCA	40.7
51	Etobicoke at QEW	TRCA	78.4
52	G Ross Dam	TRCA	67.6
53	Glen Haffy	TRCA	22.6
54	Goodwood Pumping Station	TRCA	2.4
55	Heart Lake CA	TRCA	81.8
56	Kennedy Pump Station	TRCA	9.8
57	King and Albion-Vaughan	TRCA	57.8
58	East Humber at Mill Road	TRCA	73
59	Laidlaw Bus Depot	TRCA	51.2
60	Little Rouge at 16th	TRCA	6.8
61	Milne Dam	TRCA	10.2
62	Missisauga Works Yard	TRCA	109.4
63	Morningside Works Yard	TRCA	8.6
64	Petticoat CA	TRCA	9
65	Restoration Services	TRCA	79
66	Stouffville Dam	TRCA	5.7
67	Sue Grange Farm	TRCA	35
68	TRCA Head Office	TRCA	72.6
69	York Pumping Station	TRCA	25.4
70	York Region Works Yard	TRCA	20
71	Bayly and Church	TRCA	7.4
72	Kortright	TRCA	94
73	Transport Canada	TRCA	3.2
74	R_ET_HL01	York Region	47.8
75	R_ET_MA03	York Region	7.8
76	R_ET_NO01	York Region	102
77	R_ET_ST02	York Region	6.8
78	R_ET_VA01	York Region	75
79	R_ET_VA02	York Region	111.4
80	R_YR_AU02	York Region	29.4
81	R_YR_KE01	York Region	5.6
82	R_YR_MA03	York Region	44.6
83	R_YR_MO01	York Region	3
84	R_YR_NE01	York Region	31.6
85	R_YR_RH01	York Region	47.2
86	R_YR_SU01	York Region	2.4
87	R_YR_VA03	York Region	100.8
88	R_YR_VA04	York Region	60.4
89	R_YR_WB01	York Region	2.8
90	STN 01 - Third St.	Mississauga	81.4
91	STN 02 - Clarkson	Mississauga	6.6
92	STN 03 - Wolfedale	Mississauga	50.2
93	STN 04 - South Common	Mississauga	2.75
94	STN 05 - Winding Trail	Mississauga	86.4
95	STN 06 - Mississauga Valley	Mississauga	71
96	STN 07 - Britannia	Mississauga	20.4
97	STN 08 - Tomken	Mississauga	56.4
98	STN 09 - Truscott	Mississauga	4
99	STN 10 - Falbourne	Mississauga	56.8
100	STN 11 - Garry Morden FTC	Mississauga	14.2
101	STN 12 - CVC	Mississauga	46.6
102	STN 13 - Goreway	Mississauga	87.8
103	STN 14 - Port Credit	Mississauga	59.4
104	Stornoway P.S.	Markham	56.8
105	Thornhill C.C.	Markham	49.53
106	German Mills P.S.	Markham	39
107	Lincoln Alexander P.S.	Markham	20
108	8100 Warden Ave	Markham	13.6
109	Milliken Mills C.C.	Markham	9.25
110	Fire Hall #94	Markham	12.5
111	Roy H Crosby P.S.	Markham	10
112	Markham Museum	Markham	9.4
113	Rouge River C.C.	Markham	11
114	Angus Glen C.C.	Markham	12
115	RG03	Peel Region	3.75
116	RG11	Peel Region	9.75
117	RG16	Peel Region	61.25
118	RG20	Peel Region	109.75
119	RG22	Peel Region	74.75
120	RG23	Peel Region	19.25
121	RG24	Peel Region	42.5
122	RG25	Peel Region	81.75
123	RG26	Peel Region	24
124	RG27	Peel Region	52
125	RG28	Peel Region	74.25
126	RG29	Peel Region	97.5
127	RG31	Peel Region	67.25
128	RG32	Peel Region	86.75
129	RG33	Peel Region	63.75
130	RG34	Peel Region	36.5
131	RG36	Peel Region	44.25
132	RG39	Peel Region	47.75
133	RG42	Peel Region	17.75
134	RG44	Peel Region	9.75
135	Discovery	RichmondHill	56.6
136	Oak Ridges	RichmondHill	29.6
137	Operations	RichmondHill	32.6



Note: Total Precipitation presented has been calculated from 14:00 on July 8, 2013 until 02:00 on July 9, 2013

July 8, 2013 Extreme Rainfall Event
Summary and Analysis Report
Toronto and Region Conservation Authority

Total Storm Depth Based on King City Radar-Adjusted to Thiessens

Scale 1:400,000
0 2.5 5 10 15 Kilometers

Project No. TP114045

Figure No. 4-24

4.6 Comparison of Rainfall Data Sets

Spatial coverage of the July 8th, 2013 extreme storm event has been determined using measured rainfall depths based on 135 rain gauges within the study area, as well as radar rainfall datasets obtained from the Buffalo and King City radar stations. A comparison has been performed between the summary statistics of estimated rainfall during the July 8th, 2013 storm event for all TRCA watersheds using the three (3) methodologies. The results of the comparison have been presented in Table 4-8.

Based on the results presented in Table 4-8, Buffalo Radar estimates of maximum rainfall depth during the July 8th, 2013 storm event have been similar to values determined using the interpolation of measured rainfall depths at all rain gauges. The King City Radar datasets tend to overestimate the maximum rainfall depths. Both Buffalo radar datasets and King City radar adjusted using MFB values based on Thiessen polygons have relatively similar average rainfall depths for all watersheds, compared to levels estimated using interpolated rain gauge rainfall depths.

Table 4-8: Comparison of Estimated Total Storm Depth for TRCA Watersheds Using Rain Gauge and Radar Datasets													
Rainfall Type		**Statistics**	**Carruthers**	**Don**	**Duffins**	**Etobicoke**	**Frenchman's Bay**	**Highland**	**Humber**	**Mimico**	**Petticoat**	**Rouge**	**Waterfront**
Rain Gauge Interpolation	IDW	MIN	4.00	13.67	2.40	19.29	6.07	7.25	19.54	55.30	6.93	5.73	7.26
		MAX	5.15	91.63	8.09	114.59	8.99	24.42	138.00	137.58	9.00	56.57	108.65
		MEAN	4.18	52.26	4.98	69.95	7.56	10.58	61.95	94.65	8.31	15.81	58.20
		STD	0.22	15.17	1.36	20.62	0.71	2.54	22.98	17.60	0.49	10.58	27.28
Radar Rainfall Data	Buffalo	MIN	3.81	14.48	1.52	34.29	7.62	9.14	28.96	56.39	7.62	4.57	9.14
		MAX	10.67	79.25	11.43	123.44	12.95	32.77	119.63	123.44	12.19	62.48	99.06
		MEAN	8.68	48.85	5.68	79.01	11.12	13.97	58.21	92.03	10.04	19.39	46.83
		STD	1.90	11.50	2.36	18.94	1.08	3.93	16.63	17.83	1.40	14.24	20.98
	King City MFB All Gauges	MIN	5.15	22.41	3.05	24.59	14.56	13.01	12.58	41.21	13.45	9.50	15.54
		MAX	20.58	100.78	18.69	207.27	23.67	35.35	158.77	164.32	21.90	91.83	81.98
		MEAN	13.59	56.74	10.01	61.35	18.68	20.46	60.15	79.56	17.15	26.74	45.04
		STD	4.27	14.57	3.83	23.07	2.58	3.15	22.00	24.35	2.27	14.17	16.37
	King City MFB Thiessens	MIN	2.09	12.43	1.11	14.21	5.87	5.75	11.63	37.58	5.74	4.75	6.26
		MAX	8.33	127.11	8.83	160.84	9.99	20.84	200.00	219.02	13.37	123.61	125.30
		MEAN	5.51	52.33	4.52	75.40	7.75	10.17	59.65	102.40	8.65	17.97	56.48
		STD	1.73	21.40	1.70	33.02	1.15	2.27	32.07	37.63	2.15	17.38	29.39

5.0 STREAMFLOW AND WATER LEVELS

This section focuses on interpreting the data associated with runoff and related flooding responses of impacted TRCA watersheds during this extreme storm event. For this purpose, measured stream flow data and water levels have been obtained for 58 stream flow gauges operated by TRCA and Water Survey Canada.

In following sections, comparisons have been performed between observed peak water levels and documented flood plain elevations and also between observed peak flows during the extreme storm event with frequency flows at each corresponding gauges. Finally, the observed high water marks have been compared with current flood lines in order to identify locations where observed water levels exceeded the 100 year and Regulatory flood limits.

5.1 Peak Flows and Water Levels

Data provided for all stream flow gauges have been reviewed in order to conduct a comparison between the maximum observed water surface elevations at all stream flow gauges on July 8th, 2013 and the 100 year and Regulatory event flooding depths. As noted in Section 2.2, two of the TRCA flow gauges had instrumentation failure during the July 8th, 2013 storm event and therefore did not perform for the whole event. These two stations are station HY005 at Black Creek at Highway 401 and HY081 at Spring Creek North.

Further communication with TRCA (ref. Technical Memorandum, Lucero-Scheckenberger, June 27th, 2014) has indicated that HY005 had been inundated during the storm event and had stopped recording at 17:45 on July 8th, 2013. HY081 had also been inundated during the extreme storm event of July 8th, 2013 and had stopped recording data at 20:30 on July 8th, 2013. Water level gaps at this station have been filled by TRCA, based on a nearby downstream stream gauge of HY059-Spring Creek South, however gauge HY059 has had observed water levels during the July 8th, 2013 storm event beyond the available range of the existing rating curve for this gauge and therefore, it has not been possible to fill all available gaps for steam flow at gauge HY081, based on observed stream flows at gauge HY059.

A similar methodology using the relationship developed between water level at these two gauges has been applied by AMEC in order to fill the gaps at TRCA flow gauge HY005 at Black Creek near Highway 401 by relating the observed water levels at this gauge to a downstream gauge, operated by Water Survey Canada and the peak water level during the July 8th, 2013 storm event has been estimated.

In the next step, a comparison has been conducted between the maximum observed water level at each gauge and the 100 year and Regulatory flooding depths from TRCA. The results of this assessment have been presented in Table 5-1.

Table 5-1: Comparison of Maximum Observed Water Surface Elevations at Streamflow Gauges on July 8th, 2013 with Provided Flooding Elevation (m)

Watershed	Station	Station Name	100 Year Storm	July 8, 2013 Storm	Difference	Time of Peak
TRCA Gauge Stations						
Carruthers	HY013	Carruthers at Achilles	*	82.34	-	8th 00:30
Don	HY017	Don at Glenshields	NA	182.51	-	8th 23:45
	HY019	Don at Todmorden	NA	80.72	-	8th 20:30
	HY022	East Don at York Mills	NA	119.62	-	8th 18:45
	HY062	Taylor Creek South	NA	91.05	-	8th 17:00
	HY068	Wilket Creek	NA	122.93	-	8th 17:15
	HY079	Don at Dundas	79.52	77.56	-1.96	8th 21:30
	HY080	Taylor Creek North	156.61	151.92	-4.69	8th 18:00
Duffins	HY010	Brougham Creek	*	120.43	-	8th 20:30
	HY023	East Duffins at Claremont	*	9.00 [1]	-	8th 00:00
	HY028	Ganetsekiagon Creek	*	10.97 [1]	-	8th 21:30
	HY047	Mitchell Creek at Claremont	*	7.86 [1]	-	9th 03:45
	HY065	Urfe Creek	*	88.71	-	8th 21:45
	HY066	West Duffins at Hwy 7	*	177.73	-	8th 00:00
	HY082	Reesors Creek	*	7.23 [1]	-	8th 23:30
Etobicoke	HY024	Etobicoke at Dixie and Derry	172.49	171.83	-0.66	9th 00:30
	HY026 [2]	Etobicoke Creek at Brampton	212.35	***3.76*** [1]	-	8th 22:45
	HY059	Spring Creek	175.47	174.60	-0.87	8th 20:45
	HY081 [3]	Spring Creek North	211.22	***212.18***	0.96	8th 21:45
Frenchman's Bay	HY040	Krosno Creek	*	75.88	-	8th 19:00
	HY052	Pine Creek	*	77.08	-	8th 19:00
Highland	HY034	Highland Cr - Malvern	*	155.02	-	8th 19:00
Humber	HY005 [4]	Black Creek at 401	126.59	***124.52***	-2.07	8th 17:45
	HY005 GF [4]	Black Creek at 401	126.59	125.01	-1.58	8th 19:00
	HY006	Bolton McFall Dam	214.17	213.26	-0.91	9th 04:30
	HY035	Humber at Goreway	183.36	***183.49***	0.13	8th 20:45
	HY053	Plunkett Creek	NA	154.33	-	8th 19:30
	HY054	Purpleville Creek	NA	18.47 [1]	-	8th 20:00
	HY067	West Humber at Hwy 7	169.46	168.85	-0.61	8th 22:45
Mimico	HY045	Mimico at Wildwood Park	161.4	***162.12***	0.72	8th 17:45
Petticoat	HY051	Petticoat CA	*	77.88	-	9th 01:30
Rouge	HY048	Morningside at Finch	*	145.59	-	9th 04:00

Table 5-1: Comparison of Maximum Observed Water Surface Elevations at Streamflow Gauges on July 8th, 2013 with Provided Flooding Elevation (m)

Watershed	Station	Station Name	100 Year Storm	July 8, 2013 Storm	Difference	Time of Peak
Water Survey Canada Gauge Stations						
Don	02HC005	Don River at York Mills	NA	124.92	-	8th 17:00
	02HC024	Don River at Todmorden	NA	80.57	-	8th 18:40
	02HC056	Don River East Branch near Thornhill	165.91	3.50 [1]	-	8th 17:15
Duffins	02HC019	Duffins Creek above Pickering	*	1.77 [1]	-	8th 00:00
	02HC038	West Duffins Creek above Green River	*	185.83	-	8th 00:00
	02HC049	Duffins Creek at Ajax	*	0.86 [1]	-	8th 19:10
Etobicoke	02HC017 [2]	Etobicoke Creek at Brampton	212.35	***3.62*** [1]	-	8th 21:30
	02HC030 [5]	Etobicoke Creek Below QEW	92.47	91.91	-0.56	8th 21:30
Highland	02HC013	Highland Creek Near West Hill	*	6.84 [1]	-	8th 19:45
Humber	02HC003	Humber River at Weston	115.54	113.97	-1.57	9th 06:50
	02HC009	East Humber River near Pine Grove	NA	145.04	-	8th 23:15
	02HC023	Cold Creek near Bolton	209.99	***210.13***	0.14	8th 21:35
	02HC025	Humber River at Elder Mills	NA	159.55	-	8th 23:30
	02HC027	Black Creek near Weston	100.22	98.29	-1.93	8th 19:00
	02HC031	West Humber River at Hwy 7	169.46	168.86	-0.60	8th 21:40
	02HC032	East Humber River at King Creek	NA	227.98	-	8th 22:20
	02HC047	Humber River near Palgrave	NA	254.96	-	8th 17:50
	02HC051	Centreville Creek near Albion	NA	7.18 [1]	-	9th 06:00
	02HC057	Humber River near Ballycroy	NA	3.46 [1]	-	8th 22:50
Mimico	02HC033	Mimico Creek at Islington	114.41	**115.23**	0.82	8th 19:20
Rouge	02HC022	Rouge River near Markham	*	153.33	-	9th 11:10
	02HC028	Little Rouge Creek near Locust Hill	*	179.34	-	9th 08:55
	02HC053	Little Rouge River near Dicksons Hall	*	5.16 [1]	-	9th 04:15

* No floodline mapping provided
** Values highlighted in red color indicate that water level has exceeded estimated 100 year flood elevation
*** Rows with a blue background color indicate that the station missed the peak of the storm
1. Assumed datum, no geodetic conversion provided.
2. Stations HY026 and 02HC017 have an assumed datum, high water mark (AMEC ID 15 in Table 5-6) located approximately 225 m downstream of the station indicates that the 100 year storm was exceeded by approximately 0.40 meters
3. Station HY081 stopped recording at 20:00 on July 8th, 2013 missing the peak of the storm, the data was gap filled by TRCA using stream gauge HY059
4. Station HY005 stopped recording at 17:45 on July 8th, 2013 missing the peak of the storm, the data was gap filled as HY005 GF using nearby WSC gauge 02HC027
5. Station 02HC030 data during peak of the storm is identified as unusable by Water Survey Canada grading
NA Only Regional Storm water surface elevation included in mapping
Overlapping Stations: HY067 & 02HC031
Overlapping Stations: HY019 & 02HC024
Overlapping Stations: HY026 & 02HC017
Note: All design storm values interpolated from mapping except stations HY006, HY026, 02HC003, 02HC009, 02HC025, 02HC047, 02HC051

The results presented in Table 5-1 indicate that observed water levels at all of the stream flow gauges used for this study did not exceed the estimated flood elevation associated with Regional Storm event. However the observed water levels (highlighted in red) did exceed the 100 year storm event flood limits at 7 gauges. These gauges are HY026 (Etobicoke at Brampton), HY035 (Humber at Goreway), HY045 (Mimico at Wildwood Park), HY005 (Black Creek at Hwy 401) and HY081 (Spring Creek North) all operated by TRCA and 02HC023 (Cold Creek near Bolton) and 02HC033 (Mimico Creek at Islington) operated by Water Survey Canada.

The gauges HY026 and 02HC017 (Etobicoke at Brampton) are overlapping stations with an assumed datum. The nearest high water mark (AMEC ID 15 in Table 5-6) to the stream gauge was located 225 m downstream and was surveyed at 211.90 meters in a channel with a 100 year flood elevation of 211.45 meters. Therefore HY026 and 02HC017 have been identified as a gauge location where the peak water level has potentially exceeded 100 year flood elevation.

TRCA gauge HY005 (Black Creek at 401) became inundated during the storm at 17:45 on July 8th, 2013 and missed the peak of the storm; however, the nearest high water mark (AMEC ID 51 in Table 5-6) located in the immediate vicinity of the stream gauge, was surveyed at 127.81 m at a location with a 100 year flood elevation of 125.30 meters, suggesting that peak water levels at the location of this gauge have exceeded 100 year flood lines. As such, this gauge has been highlighted in red as well.

5.2 Flood Frequency

The streamflow gauges operated by Water Survey Canada generally have had data collected for a long period of time. Using the maximum instantaneous peak flows recorded at all these gauges, a single station frequency analysis has been conducted and observed peak flows at each flow gauge have been compared with estimated frequency flows, in order to determine where the July 8th, 2013 peak flow would fall in terms of return period. The peak instantaneous peak flows for all gauges operated by Water Survey Canada have been obtained from the latest version of the HYDAT database from Environment Canada, published on April 15, 2014. Annual peak flows for all gauges have been reviewed in order to identify gaps before conducting the single station frequency analysis. All gauges have been found to have missing peak annual flows for several years during their operational period. The missing annual peak flows have been estimated using the relationship between annual Instantaneous peak flows and maximum daily flows for each gauge, subject to a strong correlation. The results of the gap filling assessment have been presented in Table 5-2.

Table 5-2: Streamflow Gauges Used in Single Station Frequency Analysis					
Station	**Number of Years Operational**	**Number of Years with Available Annual Instantaneous Peak Flow**	**Number of Years with Missing Data**	**Number of Gaps Filled**	**Regression Correlation Coefficient**
02HC003	67	53	14	11	0.8504
02HC005	66	37	29	0	0.3387
02HC009	59	41	18	17	0.6228
02HC013	55	35	20	0	0.4211
02HC017	46	29	17	0	0.4269
02HC019	46	37	9	9	0.5622
02HC022	51	44	7	6	0.9057
02HC023	50	36	14	3	0.8249
02HC024	50	49	1	0	0.0479
02HC025	50	34	16	11	0.7758
02HC027	46	43	3	0	0.1816
02HC028	49	37	12	11	0.7883
02HC030	46	42	4	0	0.3624
02HC031	47	35	12	7	0.5558
02HC032	46	33	13	3	0.8133
02HC033	48	45	3	2	0.5087
02HC038	38	16	22	0	0.4975
02HC047	32	16	16	4	0.6834
02HC048	-	-	-	-	-
02HC049	23	21	2	1	0.7543
02HC051	10	6	4	0	0.4507
02HC053	10	3	7	0	-0.127
02HC056	6	3	3	0	0.7405
02HC057	7	5	2	0	0.6763

Single station frequency analysis has been conducted using the U.S. Army Corps of Engineers statistical software package to estimate flows with return periods of 2, 5, 10, 20, 50, 100, 200 and 500 years for each individual stream flow gauge. The single station frequency analysis for all gauges has been conducted using the Log Pearson Type III distribution. A summary of the single station frequency analysis results for all gauges have been presented in Appendix O. Frequency flows estimated for each gauge have been compared to observed peak flows at each gauge and the results of this assessment have been presented in Table 5-3. It should be noted that for stream flow gauges with gaps in observed peak flows during the storm event due to the observed water levels being beyond their rating curves, comparison has been conducted using the maximum observed peak flow (ref. footnote Table 5-3), which is a guaranteed underestimation of the peak flow during the extreme storm event, and therefore the estimated bounding return periods have been underestimated.

The results presented in Table 5-3 indicate that for the gauges located in the east of the study area, where rainfall was not significant, the flow response was not significant either and observed peak flows are generally below the flows with a return period of 2 years or less. On the other hand, observed peak flows for gauges located in the west of the study area demonstrated a significant response. Gauge 02HC030 located on Etobicoke Creek near the

QEW had a peak observed flow of 253.3 m^3/s before the observed water levels exceeded the available rating curve which is greater than the estimated peak flow for a 500 year return period. This gauge has 42 years of available data which increases the confidence in estimated frequency flows, however gauges 02HC051, 02HC053, 02HC056 and 02HC057 have data available for only 10 years or less and therefore the estimated frequency flows should not be used for comparison purposes due to low confidence levels. Gauge 02HC003 located in the lower Humber River near Weston Rd, has 63 years of data and the observed peak flow of 362.8 m^3/s exceeded the 500 year return period. Observed peak flows at gauge 02HC027 located on Black Creek also near Weston Rd. exceeded the estimated 100 year frequency flow.

Table 5-3: Comparison between Single Station Frequency Analysis Results and Observed Peak Flows During July 8th, 2013 Extreme Storm Event for WSC Flow Gauges

Watershed	Station	Number of Years Sampled	Frequency (years)												Lower Return Period	Observed Peak Flow During July 8, 2013 Storm (m^3/s)			Upper Return Period
			1.01	1.05	1.11	1.25	2	5	10	20	50	100	200	500					
Don	02HC005 *	37	7.71	10.71	12.79	15.90	24.31	37.54	47.32	57.41	71.53	82.93	95.06	112.29	20	<	57.650	<	50
	02HC024	49	44.08	59.97	70.02	83.77	115.12	153.25	175.82	195.72	219.41	235.90	251.42	270.74	20	<	198.057	<	50
	02HC056 *	3	5.44	6.56	7.35	8.56	11.99	17.89	22.64	27.89	35.82	42.73	50.54	62.49	10	<	24.557	<	20
Duffins	02HC019	46	4.93	9.05	12.26	17.39	32.12	55.34	71.60	87.41	107.89	123.16	138.25	157.96		<	1.059	<	1.01
	02HC038	16	4.61	6.24	7.30	8.79	12.39	17.20	20.29	23.19	26.86	29.57	32.24	35.75		<	0.545	<	1.01
	02HC049	22	12.85	21.08	26.82	35.16	55.50	81.17	96.23	109.22	124.16	134.16	143.23	154.04		<	2.586	<	1.01
Etobicoke	02HC017	29	9.74	13.95	16.72	20.63	29.95	41.96	49.35	56.04	64.18	69.96	75.48	82.46	2	<	41.833	<	5
	02HC030 *	42	36.95	47.28	53.91	63.15	85.36	115.20	134.66	153.12	176.88	194.70	212.54	236.32	500	<	253.277	<	
Highland	02HC013	35	8.03	16.42	23.26	34.40	66.51	115.06	147.02	176.39	212.07	237.00	260.33	288.91	1.05	<	21.342	<	1.11
Humber	02HC003	63	40.57	59.54	71.93	89.20	129.19	177.67	205.81	230.14	258.36	277.48	295.07	316.37	500	<	362.767	<	
	02HC009 *	57	6.19	10.11	12.89	17.01	27.48	41.70	50.62	58.71	68.51	75.41	81.93	90.05	50	<	69.908	<	100
	02HC023	39	3.97	5.55	6.61	8.14	11.99	17.42	21.06	24.56	29.12	32.56	36.01	40.64	2	<	16.975	<	5
	02HC025	45	10.58	14.99	17.97	22.26	33.10	48.35	58.53	68.30	80.94	90.45	99.97	112.65	2	<	46.709	<	5
	02HC027 *	43	24.82	31.08	35.23	41.22	56.59	79.39	95.60	111.98	134.47	152.39	171.23	197.76	100	<	156.128	<	200
	02HC031	42	15.39	21.68	25.89	31.93	46.98	67.76	81.43	94.41	111.03	123.41	135.71	151.94	10	<	85.982	<	20
	02HC032	36	3.87	5.92	7.29	9.26	13.96	19.89	23.43	26.54	30.20	32.72	35.05	37.91	1.25	<	13.058	<	2
	02HC047	20	8.48	10.00	11.01	12.47	16.18	21.70	25.64	29.63	35.16	39.58	44.27	50.91		<	6.262	<	1.01
	02HC051	6	1.89	2.20	2.39	2.65	3.28	4.12	4.67	5.20	5.89	6.42	6.96	7.68		<	0.935	<	1.01
	02HC057 *	5	3.79	3.84	3.89	3.98	4.31	4.92	5.42	5.94	6.70	7.33	8.02	9.01			NA		
Mimico	02HC033 *	47	15.79	19.45	21.86	25.30	34.01	46.69	55.58	64.48	76.58	86.15	96.14	110.11	5	<	49.716	<	10
Rouge	02HC022	50	8.51	13.95	17.83	23.57	38.21	58.08	70.54	81.82	95.48	105.07	114.12	125.39	1.05	<	17.585	<	1.11
	02HC028	48	8.58	11.51	13.37	15.93	21.87	29.31	33.84	37.92	42.90	46.43	49.83	54.13		<	1.063	<	1.01
	02HC053	3	2.72	5.79	8.33	12.48	24.45	42.14	53.45	63.58	75.52	83.63	91.03	99.84		<	0.744	<	1.01

* Flow gauge has gaps in data during the peak of the July 8, 2013 storm. Recorded peak flow is the higher of the last recorded flow prior to the peak or the first recorded flow after the peak.

A summary of the results presented in Table 5-3 have been presented in Table 5-4 which provides the number of gauges where observed peak flows during the July 8th, 2013 storm event have exceeded each frequency flow.

Based on the results presented in Table 5-4, the Humber River watershed, which has the highest number of flow gauges operated by Water Survey Canada, experienced flows in excess of a 10 year return period at 4 gauge locations, including one gauge exceeding the 500 year peak flow. One gauge in Etobicoke Creek operated by Water Survey Canada also recorded flows in excess of the 500 year peak flow.

Table 5-4: Number of Gauges where Observed Peak Flows During The July 8th, 2013 Storm Event Exceeded Single Station Frequency Analysis Results

Watershed	Total Number Of Gauges	Frequency (years)											
		1.01	1.05	1.11	1.25	2	5	10	20	50	100	200	500
Don	3							1	2				
Duffins	3												
Etobicoke	2					1							1
Highland	1		1										
Humber	10				1	2		1		1	1		1
Mimico	1						1						
Rouge	3		1										

Streamflow hydrographs are presented in Figure 4-25, where Water Survey Canada storm discharge values are compared to the calculated flood frequency flows for corresponding gauge stations. Streamflow gauges, located nearest to the watershed outlet, are highlighted in the hydrographs from the Etobicoke and Mimico Creeks, and the Don and Humber Rivers. The largest observed discharge was recorded in the Main Humber gauge at Weston Rd with 363 m^3/s (or 21,780m^3/min) which is enough water to fill over 8 Olympic sized swimming pools in one minute.

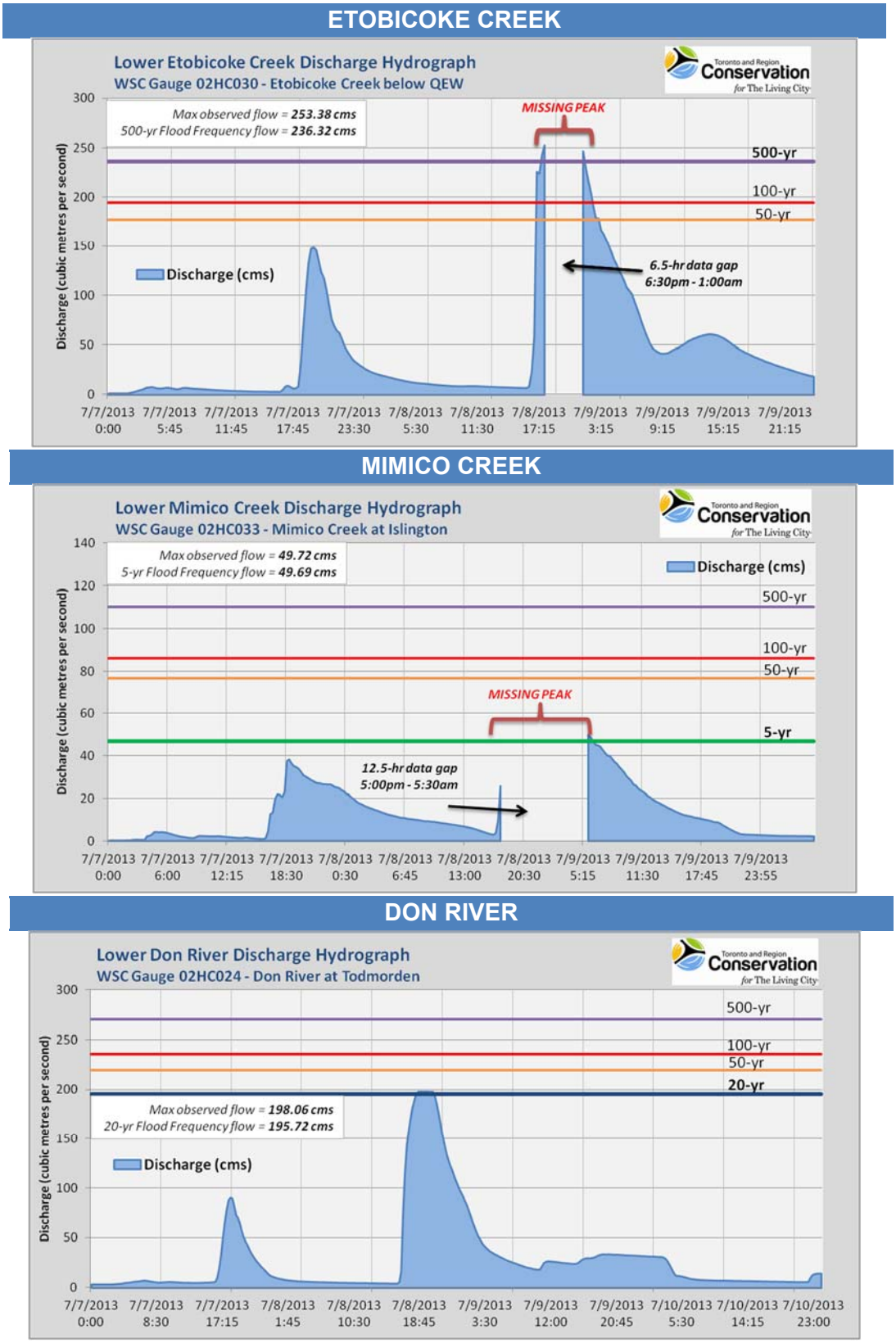


Figure 4-25: Stream discharge hydrographs for July 8th, 2013 storm from western TRCA watersheds including flood frequency flows in years.

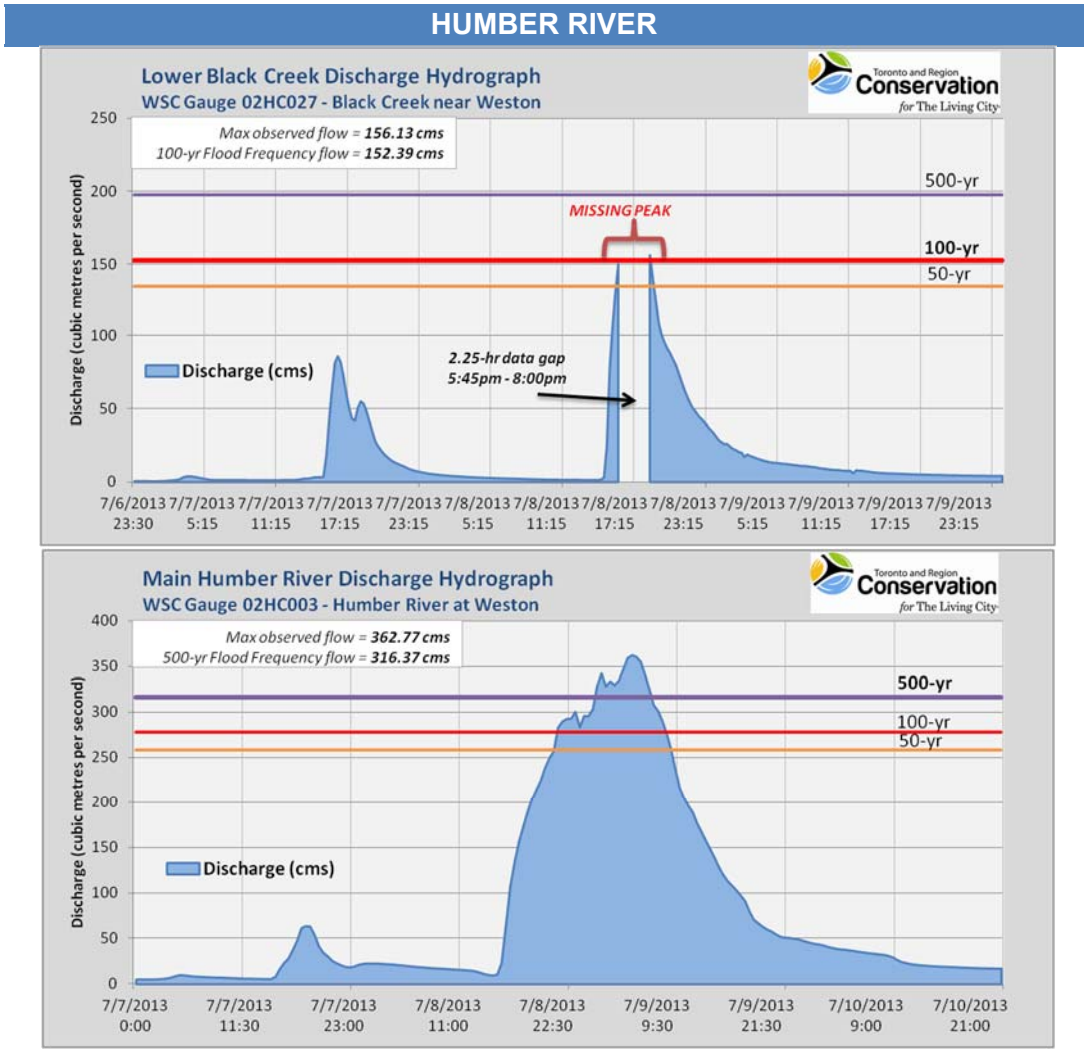


Figure 4-25: Stream discharge hydrographs for July 8th, 2013 storm from western TRCA watersheds including flood frequency flows in years (continued).

An important consideration when comparing observed flow and water level data with Regulatory flooding elevations is the fact that hydrologic modelling practice in Ontario does not account for storage upstream of man-made structures resulting in higher simulated peak flows, whereas observed peak flows take this effect into account inherently. In order to demonstrate the impact of storage upstream of man-made structures on modelled peak flows, an assessment has been conducted using a calibrated hydrologic model for Black Creek in the Humber River watershed. The peak flows at the location of stream flow gauge HY005 near Highway 401, have been estimated using the hydrologic model for two conditions: with and without storage upstream of man-made structures. The peak flows for two consecutive nodes located near Highway 401 on Black Creek during design storm events with low frequency and a duration of 12 hours have been presented in Table 5-5.

Table 5-5: Peak Flows at Black Creek near Highway 401 During 12 Hour Design Storms (m^3/s)				
Frequency	Node 1		Node 2	
	With Structures	Without Structures	With Structures	Without Structures
25 year	46.60	52.33	43.88	49.28
50 year	53.22	63.70	48.99	61.17
100 year	59.58	92.66	55.66	79.47

The results presented in Table 5-5 indicate that when attenuation upstream of man-made structures is taken into consideration, peak flows may decrease up to 36% which would have a significant impact on delineated flooding limits and elevations. This impact been observed in the current extreme storm assessment by comparing the results presented in Table 5-1 to those presented in Table 5-3. For example, the comparison between observed water levels at gauge 02HC003 (Humber River at Weston) and the floodplain mapping as presented in Table 5-1, indicates that the maximum observed water level has been found to be below the floodlines associated with 100 year storm event, however the observed peak flow presented in Table 5-3, has exceeded the frequency flow with a 500 year return period, . Similarly, there are numerous locations whereby the observed water levels and peak flows suggest a less extreme/severe event than would have been expected. As such, would be more meaningful and accurate to conduct a comparison for a dataset which takes into account the attenuation behind man-made structures.

5.3 Observed Flood Elevations

High water marks during the July 8th, 2013 extreme storm event have been recorded by TRCA field staff at 111 different locations. A comparison has been conducted between the recorded high water marks and 100 year and Regional Storm event flood lines provided by TRCA in order to determine if the observed water marks exceeded the flooding limits associated with the 100 year and Regional Storm events. The results of this assessment have been presented in Table 5-6 and Figure 5-1.

A colour coding system has been used and locations where the observed high water mark elevations exceeded the elevations associated with Regional Storm event, flood elevations have been presented using a red colour. These areas are generally located near the outlets of Etobicoke Creek and Mimico Creek watersheds. Observed high water marks in several other areas have also exceeded the 100 year storm flood elevations which have been highlighted using a yellow color. These areas are mostly spread across the Humber River, Mimico Creek and Etobicoke Creek watersheds.

Table 5-6: Comparison of Surveyed High Water Marks with 100 Year and Regional Storm Flood Elevations

AMEC ID	Easting	Northing	Elevation	Field Notes ID	Site #	Description	Note	High Water Mark
Etobicoke Creek Watershed								
1	617304.288	4827314.221	78.7895	no id	83	HWM at Water Quality Control Station North of Bridge at Marie Curtis Park		Below 100 Year Storm Elevation
2	617364.0831	4827241.909	78.091	no id	83	HWM at SE Bridge abutment of Bridge at Marie Curtis Park		Below 100 Year Storm Elevation
3	617385.4859	4827214.128	77.8002	no id	83	HWNM at Rescue Station SE of Bridge at Marie Curtis Park		Below 100 Year Storm Elevation
4	615829.2736	4831263.553	114.3355	N/A	84	HWM on tree NW of bridge		Between 100 Year Storm Elevation and Regional Storm Elevation
5	615851.8053	4831203.955	114.3567	N/A	84	HWM on tree SW of bridge		Between 100 Year Storm Elevation and Regional Storm Elevation
6	614023.2075	4832419.846	127.6435	N/A	85	HWM on fence post NW of bridge		Between 100 Year Storm Elevation and Regional Storm Elevation
7	614063.5177	4832380.269	127.2866	N/A	85	HWM SW abutment		Between 100 Year Storm Elevation and Regional Storm Elevation
8	614183.5997	4829872.644	127.3345	N/A	86	HWM Fence		Above Regional Storm Elevation
9	611905.2802	4830517.318	138.84747	N/A	87	HWM on tree N of Bridge		Above Regional Storm Elevation
10	611904.1855	4830502.568	138.93726	N/A	87	HWM NE abutment		Above Regional Storm Elevation
11	611940.6433	4830483.425	138.92303	N/A	87	HWM SE abutment		Above Regional Storm Elevation
12	611962.6922	4830490.738	139.10215	N/A	87	HWM SE Trail		Above Regional Storm Elevation
13	598597.139	4839281.402	219.686	no id	91	HWM on trail north side Williams Parkway		Below 100 Year Storm Elevation
14	598633.728	4839227.429	219.133	no id	91	HWM on trail south side Williams Parkway		Between 100 Year Storm Elevation and Regional Storm Elevation
15	600177.02	4838261.68	211.896	no id	90	HWM on concrete channel d/s Church St bridge		Between 100 Year Storm Elevation and Regional Storm Elevation
16	600286.435	4838201.872	211.899	no id	89	HWM on concrete channel north of Queen Street bridge		Between 100 Year Storm Elevation and Regional Storm Elevation
17	600308.613	4838185.245	211.703	no id	89	HWM on concrete channel south of Queen Street bridge		Between 100 Year Storm Elevation and Regional Storm Elevation
18	600794.885	4836871.713	205.746	no id	88	HWM nail on abutment		Below 100 Year Storm Elevation
19	600828.283	4836884.157	205.642	no id	88	HWM nail on bottom gabion wall		Below 100 Year Storm Elevation
20	600208.5638	4843170.893	232.727	no id	94	HWM nail on north wall of water structure at Dixie and Bovaird		No floodplain mapping received for reach.
21	600391.1005	4843106.173	230.7915	no id	94	HWM nail on south wall of culvert at Dixie and Bovaird		Between 100 Year Storm Elevation and Regional Storm Elevation
22	605075.8747	4839418.923	187.5652	no id	92 & 93	HWM on fence post at Steeles and Bramalea	Draft Floodplain Mapping	Below 100 Year Storm Elevation
23	604889.4336	4839597.402	189.625	no id	Etob 6	HWM on fence post SW bank	Draft Floodplain Mapping	Below 100 Year Storm Elevation
24	604903.2531	4839633.644	189.605	no id	Etob 6	HWM u/s east bank - hydro pole	Draft Floodplain Mapping	Below 100 Year Storm Elevation
25	604938.1929	4839578.62	189.6511	no id	Etob 6	HWM d/s east bank - fence post	Draft Floodplain Mapping	Below 100 Year Storm Elevation
26	605439.2105	4839006.224	183.69054	no id	Etob 6	HWM d/s west bank - mark on wing wall	Draft Floodplain Mapping	Below 100 Year Storm Elevation
27	605429.4027	4839033.111	183.97389	no id	Etob 6	HWM u/s west bank - on wing wall	Draft Floodplain Mapping	Below 100 Year Storm Elevation
Mimico Creek Watershed								
28	609145.2341	4839851.697	165.8361	040, 041	100	HWM on tree SW side of bridge at Airport Rd & Ironstone Crt		Below 100 Year Storm Elevation
29	609191.8706	4839874.758	165.6028	42	100	HWM on tree NE side of bridge at Airport RD & Ironstone Crt		Below 100 Year Storm Elevation
30	609169.2055	4839877.471	165.5101	43, 044	100	HWM debris line marked with flagging on tree NE of bridge		Below 100 Year Storm Elevation

Table 5-6: Comparison of Surveyed High Water Marks with 100 Year and Regional Storm Flood Elevations

AMEC ID	Easting	Northing	Elevation	Field Notes ID	Site #	Description	Note	High Water Mark
31	609781.2961	4840421.424	163.73868	057, 058	100	HWM on tree NW side of bridge 100m NW of Derry Rd		Between 100 Year Storm Elevation and Regional Storm Elevation
32	609717.8938	4840416.546	163.42565	059, 060	100	HWM top of stake in field at tree line, 110m NW of Derry Rd		Between 100 Year Storm Elevation and Regional Storm Elevation
33	609752.7876	4840454.231	163.38273	061, 062	100	HWM on tree 100m north of Derry Rd		Between 100 Year Storm Elevation and Regional Storm Elevation
34	609819.4702	4840476.406	163.87752	065, 066	100	HWM on tree 20m NE of Derry Rd		Between 100 Year Storm Elevation and Regional Storm Elevation
35	610125.5396	4840874.735	162.93068	045-047	100	HWM on tree NE side of bridge at Goreway Dr & Derry Rd		Between 100 Year Storm Elevation and Regional Storm Elevation
36	610107.9054	4840832.909	162.96247	050-052	100	HWM - paintmark NW side of abutment		Between 100 Year Storm Elevation and Regional Storm Elevation
37	610086.9624	4840819.734	162.71514	053-055	100	HWM on tree NW of bridge		Between 100 Year Storm Elevation and Regional Storm Elevation
38	621659.1603	4831464.368	84.94974	17	96 - Mimico Creek	Top stk SS Queensway Bridge		Above Regional Storm Elevation
39	621659.1363	4831464.385	84.74839	17	96 - Mimico Creek	Bot stk SS Queensway Bridge		Above Regional Storm Elevation
40	621602.6263	4831487.061	85.5048	6	96 - Mimico Creek	HWM SE abutment Queensway Bridge		Above Regional Storm Elevation
41	621557.6364	4831500.464	86.0217	9	96 - Mimico Creek	HWM NW abutment Queensway Bridge		Between 100 Year Storm Elevation and Regional Storm Elevation
42	617304.288	4827314.221	78.7895		96 - Mimico Creek	HWM at TRCA WQC Stat North		Below 100 Year Storm Elevation
43	617385.4859	4827214.128	77.8002		96 - Mimico Creek	HWM at Rest Stat SE Bridge		Below 100 Year Storm Elevation
44	617364.0831	4827241.909	78.091		96 - Mimico Creek	HWM on abutment SE Bridge		Below 100 Year Storm Elevation
45	618865.8194	4833925.934	118.244	72	97	HWM on tree SE of intersection Facing West		Between 100 Year Storm Elevation and Regional Storm Elevation
46	618915.3932	4833885.686	118.69171	75	97	HWM on Bridge East Corner of bridge S of Dundas		Between 100 Year Storm Elevation and Regional Storm Elevation
47	618995.7385	4833759.18	117.837	78	97	Debris on fence		Between 100 Year Storm Elevation and Regional Storm Elevation
48	618760.834	4833967.563	116.113	79	97	HWM Bolt on Guardrail on river bank		Below 100 Year Storm Elevation
49	618983.196	4833840.611	115.283	67	97	Fence removed		Below 100 Year Storm Elevation
50	620267.7808	4832883.899	106.7878	22	97	HWM on Tree SE bridge		Above Regional Storm Elevation
Humber River Watershed								
51	620270.5235	4841493.987	127.80672	N/A	17	HWM on NW bridge abutment		Between 100 Year Storm Elevation and Regional Storm Elevation
52	616532.9167	4842642.62	126.59481	N/A	30	HWM on stk d/s east of Albion Bridge		Between 100 Year Storm Elevation and Regional Storm Elevation
53	617358.0325	4841506.3	123.95271	N/A	HUM3	HWM on stk d/s footbridge east bank		Below 100 Year Storm Elevation
54	617355.8863	4841513.321	124.4489	N/A	HUM3	HWM on tree d/s footbridge east bank		Below 100 Year Storm Elevation
55	614953.8365	4843613.18	145.75039	N/A	31	HWM on stk NW Albion Creek Bridge		Above Regional Storm Elevation
56	614963.3844	4843599.801	145.09887	N/A	31	HWM in culvert u/s at Albion Creek		Above Regional Storm Elevation
57	614953.7987	4843563.36	144.94308	N/A	31	HWM in culvert d/s at Albion Creek		Above Regional Storm Elevation
58	614956.7769	4843538.165	143.9678	N/A	31	HWM on tree d/s Albion Creek		Above Regional Storm Elevation
59	614958.9096	4843537.186	143.23631	N/A	31	HWM on gabion bask d/s Albion Creek		Above Regional Storm Elevation
60	618729.6017	4849765.145	197.3004	799798	no id	HWM on stake, d/s of driveway south of hwy 7, west side of channel		Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)
61	618723.7878	4849807.274	197.4225	800, 801 802	no id	HWM on stake, u/s driveway, south of hwy 7, west side of channel		Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)
62	618710.2079	4849919.875	198.0862	803 804	no id	HWM on hydro pole base north of hwy 7, west side of channel		Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)

Table 5-6: Comparison of Surveyed High Water Marks with 100 Year and Regional Storm Flood Elevations

AMEC ID	Easting	Northing	Elevation	Field Notes ID	Site #	Description	Note	High Water Mark
63	617789.9515	4850849.5	201.9381	797 795 796	no id	survey based on debris line from SW side of culvert at Edgeley blvd and Pennsylvania Ave	No HWM provided due to fence condition	Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)
64	623008.3075	4832162.042	75.7689	1	unknown	HWM sprayed ground surface NE Queensway		Below 100 Year Storm Elevation
65	623024.4492	4832149.21	75.962	82	unknown	HWM trashline SE Queensway	no evidence	Below 100 Year Storm Elevation
66	623025.4617	4832061.381	76.0394	088, 002	unknown	HWM on bike trail NW railway		Below 100 Year Storm Elevation
67	603057.5872	4846655.033	197.767	30	No ID	Stake next to bridge NW side gacing east	Bottom STK	Between 100 Year Storm Elevation and Regional Storm Elevation
68	603122.9827	4846661.777	197.69101	032-033	No ID	nail on fence post SE of bridge		Between 100 Year Storm Elevation and Regional Storm Elevation
69	622423.9822	4837435.541	104.74725	NO I.D.		HWM on Fence west side of Humber Blvd S	FENCE 1	Below 100 Year Storm Elevation
70	622375.8869	4837337.125	104.67465	NO I.D.		HWM on Fence west side of Humber Blvd S	FENCE 2	Below 100 Year Storm Elevation
71	622335.7618	4837254.987	104.5708	NO I.D.		HWM on Fence west side of Humber Blvd S	FENCE 3	Below 100 Year Storm Elevation
72	622291.7345	4837164.936	104.4225	NO I.D.		HWM on Fence west side of Humber Blvd S	FENCE 4	Below 100 Year Storm Elevation
73	622271.2085	4837028.915	103.78585	NO I.D.		HWM on Fence west side of Humber Blvd S	FENCE 5	Below 100 Year Storm Elevation
74	622175.3101	4836833.333	103.5037	NO I.D.		HWM on Fench south side of Black Creek channel, north of Rockcliffe Crt	FENCE 6	Below 100 Year Storm Elevation
75	622088.8874	4836791.204	103.638	NO I.D.		HWM on Fench south side of Black Creek channel, north of Rockcliffe Crt	FENCE 7	Below 100 Year Storm Elevation
76	622342.8445	4836734.236	103.1413	NO I.D.		HWM on tree along creek, west of Hilldale Road and north of Orman Ave	TREE	Below 100 Year Storm Elevation
77	614012.6747	4851073.215	155.56	787	SG25	HWM on rip rap NW Langstaff Bridge		Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)
78	614011.8698	4851045.521	155.375	788-792	SG25	HWM on Stick SW Langstaff Bridge		Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)
79	619193.8253	4839268.301	113.8589	N/A	SG8	HWM SE of Lawrence Bridge		Below 100 Year Storm Elevation
80	620555.0699	4836547.015	98.5531	N/A	SG9	HWM on water gauge	no evidence of debris @ time of inspection	Between 100 Year Storm Elevation and Regional Storm Elevation
81	621848.8861	4836695.716	103.46702	N/A	17	HWM @ SE Bridge		Below 100 Year Storm Elevation
82	621807.7068	4836692.832	102.78832	N/A	17	HWM on SW bridge abutments		Below 100 Year Storm Elevation
83	621789.3726	4836670.867	103.1139	N/A	17	HWM on trees SW of bridge		Below 100 Year Storm Elevation
84	621813.3244	4836676.444	103.08067	N/A	17	HWM SW of bridge	no evidence	Below 100 Year Storm Elevation
85	620333.3978	4837059.415	97.5684	no id	16	HWM on wall, u/s Scarlett Road Bridge		Below 100 Year Storm Elevation
86	620313.5521	4837013.988	97.5571	no id	16	HWM on tree, d/s Scarlett Road Bridge		Below 100 Year Storm Elevation
87	612390.8051	4848373.819	156	785, 786	SG71	HWM debris u/s footbridge East side		Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)
88	612402.8232	4848254.259	155.458	782, 783	SG71	HWM debris d/s of footbridge		Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)
89	612426.2471	4848222.024	154.924	780, 781	SG71	HWM debris line d/s of footbridge		Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)
90	612300.7519	4848477.123	157.357	778, 779	SG71	HWM debris line marked with sprayed stick & flagging		Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)
91	612369.3687	4848379.412	155.892	777	SG71	HWM - flagging in tree		Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)
92	612399.4375	4848461.62	157.213	775, 776	SG71	HWM - Robinson - South side of trib near outfall ditch		Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)
93	610865.2139	4848220.597	169.10786	772-774	27	HWM at SE of highway 27 bridge		Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)

Table 5-6: Comparison of Surveyed High Water Marks with 100 Year and Regional Storm Flood Elevations

AMEC ID	Easting	Northing	Elevation	Field Notes ID	Site #	Description	Note	High Water Mark
Don River Watershed								
94	631997.6609	4838355.377	81.69884	88	60	HWM on wall NE of pottery brdg		Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)
95	632017.824	4838368.237	81.57434	92	60	HWM on tree US of Pottery brdg		Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)
96	631983.2591	4838345.402	81.47472	95	60	HWM on wall SE Pottery brdg		Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)
97	630414.4511	4842902.856	113.5558	N/A	64	HWM on NE pedbrdg at Bayview & Lawrence	Paint mark on tree gone due to trunk got cut off	Below Regional Storm Elevation (100 Year Storm Elevation not provided)
98	630373.2569	4842919.199	114.6283	N/A	64	HWM on tree 15m SB Bayview brdg		Below Regional Storm Elevation (100 Year Storm Elevation not provided)
99	630371.1929	4842925.676	114.4496	N/A	64	HWM on tree 10m SB Bayview brdg		Below Regional Storm Elevation (100 Year Storm Elevation not provided)
100	627677.4805	4852746.144	154.72	N/A	East Don #64	HWM on tree NE u/s of Henderson culvert		Below 100 Year Storm Elevation
101	628134.8842	4844404.936	127.74671	N/A	N/A	HWM on gabion @ Wilson Ave bridge		Below Regional Storm Elevation (100 Year Storm Elevation not provided)
102	628128.5959	4844401.143	127.989	N/A	N/A	HWM on tree @ Wilson Ave bridge		Below Regional Storm Elevation (100 Year Storm Elevation not provided)
103	631857.7081	4837877.115	80.2344		No ID	HWM at Brickworks, NE corner of building B		Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)
104	632732.0108	4841455.326	100.85594	60-62	58	HWM on catch basin under Eglinton bridge		Above Regional Storm Elevation
105	632722.2533	4841428.455	98.92149	67-72	58	HWM on hydro pole ds from Eglinton bridge		Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)
106	632695.1674	4841467.035	97.01198	73-74	58	Shot on CSP us Eglinton bridge	No evident markings	Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)
107	632688.8042	4841480.867	99.30508	N/A	58	HWM on tree us from Eglinton bridge		Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)
108	639215.0027	4841369.066	141.23197	94-98	56	HWM 5m ds of Birchmount Rd and St. Clair Ave culvert		Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)
109	639224.6955	4841371.708	141.22947	94-98	56	HWM 15m ds Birchmount Rd and St Clair Ave culvert		Below Regional Storm Elevation (100 Year Storm Elevation not provided for reach)
110	638968.5893	4843221.377	152.59911	99-105	57	HWM US NE face of culvert at Rosemount DR and Eglinton Ave E		Below 100 Year Storm Elevation
111	639026.2863	4843178.368	152.18021	106-108	57	HWM on bridge abutment ds at Rosemount De and Eglinton Ave E		Below 100 Year Storm Elevation

HIGHWAY 9
HIGHWAY 50
HIGHWAY 27
HIGHWAY 400
HIGHWAY 404
HUMBER RIVER
HIGHWAY 50
DON RIVER
HIGHWAY 7
HIGHWAY 407
DON VALLEY PKWY
HIGHWAY 401
MIMICO CREEK
ETOBICOKE CREEK
HIGHWAY 410
LESTER B. PEARSON AIRPORT
GARDINER EXPRESSWAY
HIGHWAY 403

N

LEGEND

- WATERCOURSE
- MUNICIPAL BOUNDARY
- WATERSHED BOUNDARY
- CROSS SECTION LOCATION
- FLOODPLAIN
- NO FLOODPLAIN MAPPING
- BELOW 100 YEAR STORM ELEVATION
- BELOW REGIONAL STORM ELEVATION (100 YEAR STORM NOT INCLUDED IN MAPPING)
- BETWEEN 100 YEAR STORM ELEVATION AND REGIONAL STORM ELEVATION
- ABOVE REGIONAL STORM ELEVATION

Path: P:\Work\TP114045\Water\dwg\Jul2014\Figure5-1 Floodlevels.dwg
Plotted By: richard.bartolo
Last Saved By: richard.bartolo
Plotted: 2014-10-02
Last Saved: 2014-10-02

SCALE VALID ONLY FOR 24"x36" VERSION

JULY 8, 2013 EXTREME RAINFALL EVENT
SUMMARY AND ANALYSIS REPORT
TORONTO AND REGION CONSERVATION AUTHORITY

COMPARISON BETWEEN OBSERVED HIGH WATER MARKS AND FLOODLINES

amec

Scale 1:100000
0 1000 2000 4000

Consultant File No.
TP114045

Figure No.
5-1

6.0 COMPARISON TO MAJOR STORM EVENTS

Many areas in Ontario have been hit by major storm events in the past decade and the frequency of the occurrence of such storms has been increasing. It is therefore beneficial to compare the July 8th, 2013 storm event with the other major historic storm events observed in Ontario and also with historic storm events in other jurisdictions. This section provides a qualitative and quantitative comparison between such extreme storm events, to the extent possible, based on available existing reports and studies published for extreme storm events in Ontario and in areas located in other jurisdictions.

6.1 Ontario

A literature review has been performed on major storm events in Ontario. The review has consisted of five historic major storm events across the province. The results of the review have been presented in Table 6-1 and Table 6-2. The reviewed storms include Hurricane Hazel of 1954, the Timmins Storm of 1962, the Harrow Storm of 1989, the Peterborough Storm of 2004 and the Toronto Storm of 2005. The Timmins Storm and Hurricane Hazel are storms which covered large areas of Ontario. The Harrow Storm, Peterborough Storm and Toronto August 2005 storm affected relatively smaller areas in comparison. Table 6-1 presents general information on the storms.

Table 6-1: Comparison of Major Historical Storm Events in Ontario - General Information

Storm	Year	Storm Type	Location of Centre	Area (km^2)	Duration (hours)	Antecedent Precipitation Description (Likely AMC condition)	Estimated Damages ($)	Loss of Life
Hurricane Hazel	1954	Hurricane	Brampton	30,000	48	Wetter than average (AMCIII)	640* million	80
Timmins Storm	1962	Convective	Timmins	24,000	12	Not reported	Thousands	5
Harrow Storm	1989	Convective	Harrow	700	30	Near drought conditions (AMCI)	50 million	0
Peterborough Storm	2004	Convective	Peterborough	Not Reported	41	Wetter than average (AMCIII)	125 million	0
Toronto August 19th Storm	2005	Convective	Toronto	Not Reported	15.5	Not Reported	671 million	Not Reported
Toronto July 8th Storm	2013	Convective	Toronto	25,000**	10	Wetter than average (AMCIII)	932 million	0

*Estimated Damage Costs are per year 2000 Currency and have not been adjusted based on inflation rates
**Estimated using King City Radar data

Table 6-2 presents rainfall data obtained for all of the historic storms. Rainfall depths for Hurricane Hazel and the Timmins Storm are best estimates from tipping bucket sampling performed after the storm. The values presented for Hurricane Hazel were recorded in Snelgrove, located northeast of Brampton. Official gauges for the Harrow Storm did not capture the centre of the storm where the rainfall was greatest. The values presented for the Harrow Storm have been derived from unofficial gauges operating near the centre of the storm and confirmed by radar.

The values presented for the Peterborough storm were recorded at Trent University located in the northeast area of the City of Peterborough. The values presented in Table 6-2 were the largest values recorded at the centre of the storm.

Table 6-2: Comparison of Major Historical Storm Events in Ontario - Rainfall Information

Storm	Maximum Rainfall Depth Over Given Time Period (mm)											Maximum Hourly Rainfall (mm)
	5 min	10 min	15 min	30 min	1 Hour	2 Hour	3 Hour	6 Hour	12 Hour	24 Hour	48 Hour	
Hurricane Hazel-1954					53	91	104	153	212	230	285	52.5
Timmins Storm-1962					43	63		132	203.2			
Harrow Storm-1989					50*	80*		187	240	425	450	20.8
Peterborough Storm-2004					87	150				240	250	87
August 19th 2005	21.6	39.7	61	93	115	133.8	137.3	139.8	152.4	153.4		116.6
July 8th, 2013	21.6	35.8	48.6	69.6	78.8	113.5	116.5	137.2	138			78.8

*Based on values recoded at a nearby gauge not located in the center of the storm

Hurricane Hazel affected a large area of Ontario, with the largest rainfall centered on Brampton, northwest of Toronto and totaling 285 mm in 48 hours. Hurricane Hazel is representative of a long duration, high intensity storm affecting a large area.

The Timmins Storm was reported as a 12 hour storm with 203.2 mm of rainfall at its centre. The area of the Timmins Storm was reported as 24,000 square kilometers that received more than 50 mm of rainfall. The Timmins Storm is an example of a large storm event affecting a large area in Northern Ontario.

The area affected by Harrow Storm has been reported as 700 km^2 but an area of 10 km^2 which represents the centre of the storm, was recorded to receive up to 450 mm of rainfall. The Harrow Storm occurred as two events separated by a five hour pause. The first event occurred over 9 hours with a maximum total rainfall of 150 mm and the second event occurred over 5 hours with a maximum total rainfall of 104 mm. Prior to the Harrow Storm the area had no rain (except for a 0.6 mm day) for three weeks. The soil condition was likely very dry for the first event, and saturated for the second event. The Harrow Storm is representative of a short duration, high intensity storm affecting a small area.

The Peterborough Storm had its centre at Trent University in the northeast of the City of Peterborough. A total storm rainfall of over 250 mm was recorded at Trent University during 41 hours on July 14-15 of 2004. The antecedent rainfall conditions were reported as generally more wet than average for the time of year. The Peterborough Storm was a short duration, very high intensity storm.

The August 2005 Storm had its centre located on the north border of the City of Toronto, between Vaughan and Richmond Hill. Rainfall depths and intensities were analyzed from 93 gauges across the TRCA watersheds. The Highland Creek watershed received the largest rainfall depth and highest intensities with more than half of the watershed receiving at least

130 mm of rainfall within approximately 2.5 hours. No information regarding antecedent rainfall or moisture conditions were reported. The Toronto August 19th, 2005 storm was also a short duration, very high intensity storm.

The results presented in Table 6-2 indicate that the July 8th, 2013 storm event was greater than Hurricane Hazel and Harrow Storm when comparing maximum observed hourly rainfall depths and also total rainfall depths for durations up to and including 3 hours; however, the rainfall depth for all short and long durations for the July 8th, 2013 were smaller than the August 19th, 2005 extreme storm event. The total storm depth was also smaller than all historic major storms considered in this assessment; however the storm duration was also shorter than all of the reviewed storms.

A graphical comparison of total rainfall for the major historic storm events in Ontario has also been presented in Figure 6-1.

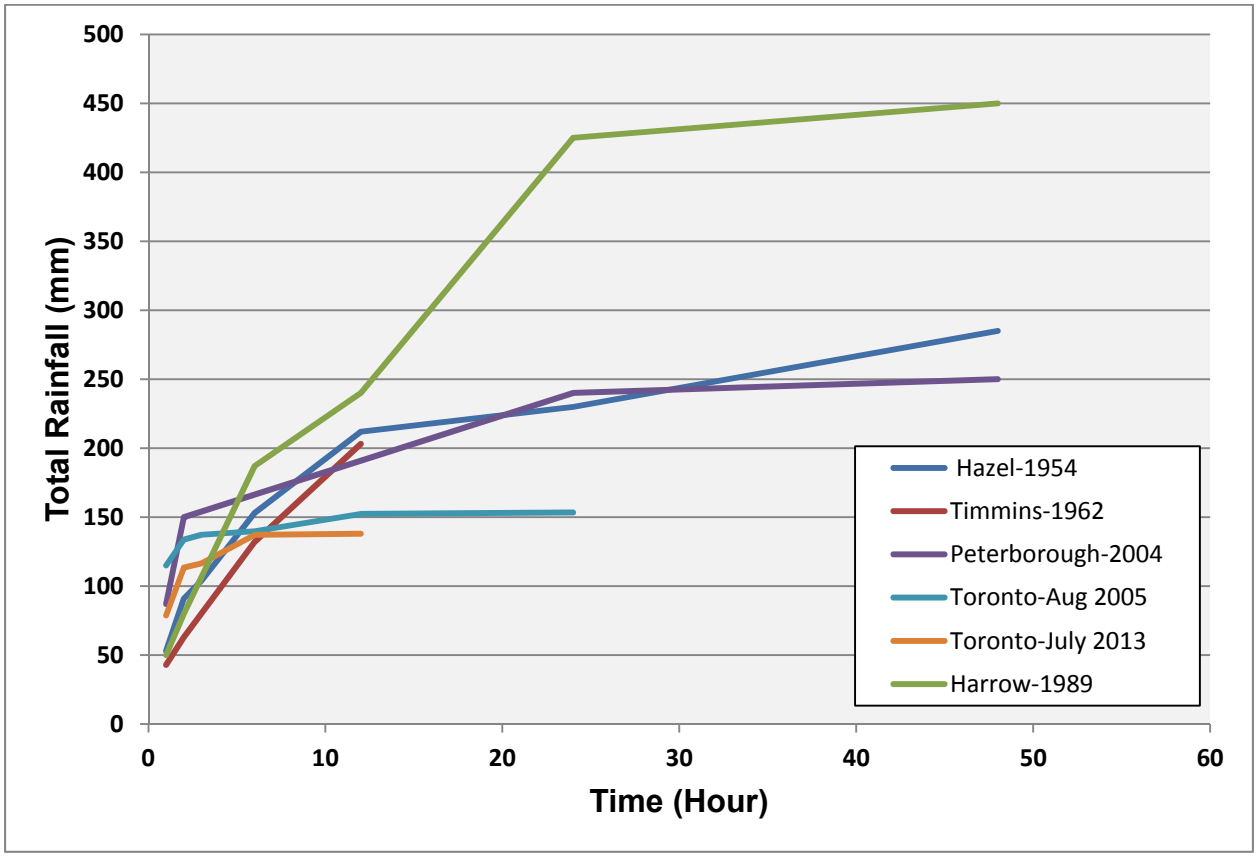


Figure 6-1: Comparison of Total Rainfall for Major Historic Storm Events in Ontario

6.2 Other Jurisdictions

In addition to the major historic storm events in Ontario, as part of this study AMEC has reviewed major historic storm events that occurred in other parts of Canada and the Globe. Included in this review are nine (9) historic major storms that occurred outside of Ontario (ref. Table 6-3). The storms transpired in Alberta, Colorado, Australia, Quebec, and Switzerland.

Reported damages from these storms range from $5.6 M to $2.8 billion Canadian dollars. These estimated damages have not been adjusted based on inflation rates.

Table 6-3: Comparison of Major Historical Storm Events in Other Jurisdictions - General Information

Storm	Year	Location			Duration	Antecedent Precipitation Description (Likely AMC condition)	Estimated Damages** (CND $)	Loss of Life	Maximum Rainfall Depth Over Given Time Period (mm)	
		Location of Centre	Province /State	Country	(hours)				24 Hour	48 Hour
July 8th Toronto	2013	Toronto	ON	CA	~10	AMCIII	932 million	0	138	-
Alberta Storm of 1964	1964	Waterton Red Rock	AB	CA	~48	NR*	NR*	NR*	121.2	225.81
Brisbane River Basin Flood	1974	Mount Glorious	QLD	AUS	~120	AMCIII	NR*	NR*	462.9	-
Alberta Storm of 1975	1975	Waterton Red Rock	AB	CA	~96	AMCII	NR*	NR*	224	310
Big Thompson Storm	1976	Glen Haven	CO	US	~24	AMCII	46 million	139	305	-
Smoky River Basin Storm	1982	Nose Mountain Lookout	AB	CA	~48	NR*	5.6 million	NR*	138.9	166.8
West Central Alberta Storm	1986	Carrot Creek	AB	CA	~72	AMCIII	NR*	NR*	104.5	-
Saguenay Valley Flood	1996	Jonquière-Chicoutimi-La Baie	QC	CA	~48	NR*	700 million	0	152	231
2005 European Floods	2005	Meiringen	BE	CH	~48	AMCIII	2.8 billion	6	-	205
Colorado Storm	2013	Boulder	CO	US	~96	NR*	2 billion	8	231	-

*Not Reported (NR) in literature cited
**Estimated Damages are in Canadian dollars at the time of the storm event and have not been adjusted based on inflation rates

The most costly precipitation event, monetarily, in this review occurred in 2005 in Switzerland. This storm was the cause of the 2005 European floods, and in addition to costing Switzerland $2.8 Billion, it also claimed the lives of 6 people. Soil moisture conditions were likely conducive to the catastrophic floods that resulted on the 21st and 22nd of August 2005, due to the fact that there had already been moderate rainfall in areas of northern Switzerland during the days leading up to the storm. The torrential downpours of this storm event were due to a low pressure system that had accumulated significant moisture from the Mediterranean Sea before being pushed up the northern edge of the Alps in Switzerland. This resulted in a very high intensity storm.

Four of the storms included in this review occurred in Alberta, the largest of these being the Alberta Storm of 1975 where over 300 mm of rain fell at the Red Rock site in Waterton. The Storm of 1975 lasted approximately 96 hours, and resulted in up to 360 mm of rain in some areas. This precipitation event resulted mainly from the convection of unstable air in a northwesterly flow. This consequently resulted in a long duration storm with moderate to high intensity precipitation.

The information presented in Table 6-3 indicates that the July 8th, 2013 storm event had a shorter duration compared to other major historic storm events reviewed as part of this assessment in other jurisdictions, however this extreme storm resulted in comparable estimated damages which is predominantly due to the high intensity of the rainfall during this event as well as the location and infrastructure it affected.

7.0 SUMMARY

The July 8th, 2013 extreme rainfall event covered a large area of the GTA and resulted in severe flooding in parts of Etobicoke Creek, Mimico Creek, Humber River and Don River watersheds within the TRCA's Jurisdiction with over $932 million of estimated damages. Measured rainfall and stream flow data from 135 rain gauges and 58 stream flow gauges operated by several municipal, provincial and federal agencies have been obtained and analyzed to study the hydrologic impacts of this extreme rainfall event. Radar rainfall data sets have also been obtained from the King City and Buffalo radar stations and have been analyzed and compared with ground measurements. This section discusses the findings and conclusions based on the assessment conducted as part of this study and provides recommendations based on these findings.

7.1 Conclusions

The following has been concluded from the assessment conducted for the available data for the July 8th, 2013 extreme storm event:

i) Antecedent Conditions

When compared to the 30 year climate normals from Environment Canada, the spring and early summer of 2013 were found to be wetter than normal in terms of total precipitation. The rainfall analysis has demonstrated that the GTA had received up to 82 mm of rainfall during the 7 day period leading up to the July 8th, 2013 extreme storm event. This falls between a return period of 2 to 5 years when compared with frequency analysis results of maximum 7 day rainfall at Pearson International Airport station. Nearly half of the Mimico and Etobicoke Creek watersheds experienced AMC III conditions based on a comparison with SCS Antecedent Moisture Conditions criteria for the 5 day total precipitation prior to the July 8th, 2013 storm event.

ii) Event Forecasting

A review of the common Canadian and US numerical weather prediction models has indicated that these models have not accurately predicted the severity, timing, or location of the extreme rainfall event that occurred in the GTA on July 8th, 2013.

iii) Storm Impacts

To-date, the estimated cost of damages obtained from several municipal, provincial and fegeral agencies has been over $932 million (Canadian) with some 7,300 homes reporting basement flooding and over 500,000 homes and businesses being without power.

iv) Storm Characteristics

The rainfall analysis has indicated the July 8th, 2013 storm event had a maximum duration of 9.5 to 10 hours with the majority of the area under study receiving rainfall for a duration of 7 to 8 hours. The maximum total rainfall depth observed during this storm event was 138 mm recorded at the Martin Grove gauge, operated by City of Toronto, located east of Toronto

Pearson International Airport. The maximum one-hour rainfall was 79 mm. The maximum short term rainfall was 21.6 mm which was recorded over 5 minutes and is equivalent to an intensity of 259.2 mm/hr. A comparison of total rainfall for all TRCA watersheds has indicated that the Mimico Creek watershed received the highest rainfall among all TRCA watersheds with an average total rainfall of ~95 mm during the July 8th, 2013 storm event.

v) Storm Severity/Frequency Analysis

Comparison between the observed rainfall and available IDF information from Environment Canada for stations within and near the study area, has indicated that the western part of TRCA's jurisdiction, including the Humber River, Don River, Mimico Creek and Etobicoke Creek watersheds received rainfall in excess of a 50 year storm event. Additionally, smaller portions of the Humber River, Don River, Etobicoke Creek and Mimico Creek watersheds have received rainfall in excess of a 100 year storm event, particularly for events with a duration longer than 1 hour.

vi) Radar Data Analysis

Radar data sets used as part of this study have predicted the total storm depth with an acceptable agreement with measured ground-based rainfall data sets. Both the Buffalo and King City radar data have provided similar spatial distribution for the July 8th, 2013 extreme rainfall event, when compared to the spatial distribution as per ground gauges. The King City radar has been found to overestimate the maximum depth of rainfall for the July 8th, 2013 extreme event, while the Total Storm Precipitation estimated by the Buffalo radar station has shown a stronger agreement with observed ground-based rainfall values.

vii) Streamflows/Water Levels

Water levels and stream flow data measured at 58 gauges operated by TRCA and Water Survey Canada have been analyzed in this assessment. A comparison of observed water levels at all gauges with previously calculated flooding elevations as provided by TRCA has indicated that at 5 stations operated by TRCA and 2 stations operated by Water Survey Canada, the observed water levels from the July 8th, 2013 storm exceeded the provided flooding elevations associated with a 100 year storm event. The observed water levels were not found to have exceeded the Regional Storm flooding elevations at any stream flow gauge location.

Maximum observed peak flows at each station operated by Water Survey Canada have also been compared with frequency flows calculated for each gauge based on historic maximum instantaneous peak flows, in order to determine where the observed peak flows during the July 8th, 2013 storm event would fall in terms of return period. The results of this assessment have indicated that for gauges located in south western part of TRCA jurisdiction, observed flows during the July 8th, 2013 storm event exceeded flows with 20 year return period at 2 locations, flows with 50 year return period at 1 location and flows with 100 year return period in 1 location. At two other locations, a gauge on Etobicoke Creek near QEW (02HC030) and a gauge on Humber River at Weston (02HC003) the observed peak flows during the July 8th, 2013 storm event exceeded an estimated flow with a 500 year return period.

An important consideration when comparing observed water levels and peak flows to simulated water levels and peak flows relates to the methodology applied by Conservation Authorities in the Province of Ontario, whereby the attenuative effects of storage upstream of man-made structures is not taken into account. This Provincial criterion has its basis in the fact that man-made storage upstream of structures such as bridges and culverts cannot be relied upon to decrease flows during major storms as the structure may fail (i.e. ref. Finch Avenue during August 2005 storm). Similarly, if man-made storage is used to reduce flows, all structures would need to remain the same size and none could ever be made larger. Hence, for this study interpreting the recorded water levels and peak flows and comparing them to simulated water levels and peak flows has been confounded by the Provincial methodology described in the foregoing. Thus, it is expected that the runoff return periods (expressed in both level and peak flows) would be higher than determined in this study.

viii) Historic Storm Comparison

A comparison of the July 8th, 2013 extreme storm event with major historic storm events in Ontario indicates that while the duration of this storm was shorter, the maximum observed rainfall for durations up to 3 hours exceeded the values reported for Hurricane Hazel, Timmins Storm and Harrow Storms, however the July 2013 storm has been found to have intensities smaller than the Toronto August 2005 storm for all durations. The maximum total rainfall during the July 2013 storm event has also been found to be smaller than all other major historic storm events reviewed as part of this assessment. When compared with historic storm events from other jurisdictions outside of Ontario, the July 8th, 2013 storm event has a shorter duration but comparable estimated cost of damages.

7.2 Recommendations

Based upon the assessment conducted for the July 8th, 2013 extreme storm, the following recommendations are advanced for consideration of TRCA and its partners:

i) A common platform should be developed in the form of a GIS geodatabase to compile rainfall measurements from all gauges operated by municipalities, provincial and federal agencies. The objective would be to achieve a consistent quality of rainfall data and facilitate analyses of potential future extreme rainfall events.

ii) A standard measurement protocol should be developed and implemented in order to maintain consistency among different agencies operating rain gauges in the GTA. Rainfall measurements at all gauges should be conducted using consistent time steps, preferably 5 minutes, in a uniform time format (i.e. Eastern Standard Time vs. Daylight Saving Time vs. Greenwich Mean Time)

iii) The spatial distribution of all rain gauges used for the current assessment suggests that the concentration of available rain gauges in the western part of Humber River watershed and Duffins and Caruthers watersheds is less than other watersheds. It is therefore recommended to install additional rain gauges in these watersheds in order to better capture the spatial distribution of rainfall within TRCA's jurisdiction.

iv) A verification assessment has been conducted in order to identify the most appropriate interpolation technique for determination of the spatial distribution of the July 8th, 2013 storm event. The results of that assessment have indicated that the Inverse Distance Weighting interpolation method had the strongest agreement with observed rainfall depths. It is recommended to conduct similar assessments using data from different storm events and further verify the findings of this study and from this establish a standard interpolation method for rainfall in TRCA's jurisdiction.

v) When comparing maximum observed rainfall intensities with IDF relationships developed by Environment Canada, it is evident that several stations have short periods of available data and no stations have had IDF relationships updated beyond 2007. It is therefore recommended to update these analyses, once the IDF relationships developed by Environment Canada have been updated using more recent rainfall data, in order to conduct the comparison with more confidence, particularly in light of changing weather patterns.

vi) Several gauges operated by both TRCA and Water Survey Canada experienced observed water levels above the last ordinate on their rating curves which resulted in gaps in estimated peak flows during the July 8th, 2013 storm event at these stations. As such, the rating curves for these stations should continue to be extended in order to facilitate the estimation of peak flows during extreme events with lower frequency.

vii) Peak flows during the July 8th, 2013 storm event, for gauges which were inundated during the extreme storm event and for the gauges where the maximum observed water levels exceeded their rating curves, are missing. It is recommended to estimate the peak flows for these gauges using a thorough survey at the gauge location and the approved HEC-RAS models used for flood line delineation.

viii) Hydrologic modelling practice in Ontario does not account for storage upstream of man-made structures for predicting peak flows used for Regulatory purposes, whereas observed peak flows take this into account inherently. Hence it is recommended when conducting hydrologic studies either for flood impact or Regulatory purposes, that an additional scenario be developed which accounts for major storage upstream of man-made structures in order to properly interpret peak flow flood frequency derivations for flood event assessments.

8.0 References

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APPENDIX A

Methods

APPENDIX A
METHODS APPENDIX

This Appendix provides a summary of the common and appropriate analysis methods for reporting extreme events to a variety of audiences including a list of stakeholders as identified by Toronto and Region Conservation Authority (TRCA), specifically:

- Partners/Stakeholders
- Private Sector
- General Public
- Internal (TRCA) Staff

This Appendix outlines the techniques used per the Terms of Reference for this Study, along with other companion techniques and enhancements derived over the course of the study, as well as research from other jurisdictions. This Methods Appendix also summarizes the interpretation of the data analyses related to the extreme storm, as well as associated limitations of the data or findings.

1. Background Data/Information

Background data and related extreme event information are required to be obtained in order to conduct an assessment of the extreme rainfall event. These data/information include:

1. Rainfall Measurements
2. Water level measurements
3. Estimated stream flows

These data and information should be obtained for rain gauges and stream flow gauges operated by TRCA, as well as rainfall and stream flow gauges operated by regions and municipalities within TRCA's jurisdiction, Environment Canada and Water Survey Canada, to the finest possible temporal resolution. The data need to be reviewed for quality and completeness in order to identify any potential temporal and spatial gaps. A standardized procedure to obtain, record, and log 3rd party data from others, is important in order to facilitate timely and effective data transfer.

In addition, other important event data which will be necessary to support TRCA's reporting role for extreme events will need to come from others as storm characterization data, including:

- damages (value, type, and location)
- infrastructure impacts (service disruptions, cost of repair, location) including:
  - utilities
  - municipal services
  - provincial services
- other related information

Further, there are other in-house TRCA databases which need to be made available to these assessments in order for the analyses to be appropriately conducted including:

- GIS Layers (geo-referenced)
  - TRCA watersheds and subwatersheds
  - TRCA watercourses
  - Municipal boundaries within TRCA jurisdiction
  - Highways and major roads in the study area
  - Location of all gauges
- Streamflow Rating Curves
- Regulated Watercourses
  - flood elevations (by nodes coordinated with gauges)
  - peak flows (by nodes coordinated with gauges)

2. Storm Overview

2.1 Weather Forecasts

A summary of the relevant weather forecasts for the extreme rainfall event under study should be obtained and placed into context for the users of the report. This summary should review all forecasts, plus any special measures or warnings established by TRCA as follows:

1. Public forecasts
2. Special weather statements
3. Severe thunderstorm warnings
4. Numerical model forecasts

Other information which can optimally be gathered for documentation of the extreme event's climatological conditions includes:

i) Documentation of the Weather Situation
  - Synoptic environment
    - Upper Levels
      - 300 mb analysis and/or 500 mb analysis (pressure patterns)
      - Jet streams and Positive Vorticity Advection (vertical velocities)
    - Low Levels
      - 700 mb analysis and/or 850 mb analysis (pressure patterns)
      - Moisture: amount, sources, and transport paths
    - Surface Analysis: MSL pressure and winds, fronts identified
  - Thermodynamics
    - Key atmospheric soundings: profiles of temperature, humidity, winds.
    - Instability and wind shear.

ii) Observations
  - Key Surface weather reports.
    - Precipitation amounts and intensities
  - Visible satellite imagery
  - Infrared satellite and/or Water Vapour satellite imagery

- Weather Radar imagery
  - Radar rainfall estimates
  - Doppler and Severe Storm parameters if relevant

2.2 Antecedent Conditions

Knowledge of how wet it has been prior to the extreme storm is important information since users, particularly the public, are often surprised that comparatively smaller storm events can cause significant flooding. As such, a review of the antecedent conditions should be conducted for any extreme event. Long term rainfall depths for monthly and/or seasonal periods measured at available ground gauges within the study area should be compared with long term climate normals, as provided by Environment Canada (it is important to ensure that the most recent data are used). In addition, the short term rainfall depths for all gauges available within the study area for durations of 24, 48 and 168 hours (one week) prior to the storm event should be determined and used to prepare thematic mapping, in order to depict the spatial distribution of antecedent rainfall conditions for the three (3) short term periods cited. The objective here would be to demonstrate that antecedent conditions are not uniform across the watershed and could answer questions about varying flood impacts which may differ from rainfall.

Another method for presenting the significance of Antecedent Moisture Conditions is to compare the 5 day total rainfall prior to the extreme rainfall event with the SCS method of rainfall abstractions. This method indicates that during the growing season, total 5-day antecedent rainfall less than 1.4 inches (35.56 mm) corresponds to the AMC I condition, 1.4 to 2.1 inches (35.56 to 53.34 mm) corresponds to the AMC II condition and total 5-day antecedent rainfall greater than 2.1 inches (53.34 mm) corresponds to the AMC III condition

There are no particular data limitations for those data (based on ground rainfall stations) used to define antecedent conditions; that said, it is difficult to convey these data to non-technical users, hence return period or percentage likelihood as offered for the July 8th, 2013 storm may be beneficial.

2.3 Reported Storm Impacts

As noted under Section 1, a comprehensive list of government agencies, utilities, and municipalities who would be expected to have direct knowledge of, or experienced direct impacts from, the extreme storm event, should be developed and maintained. This group should have a standard form or questionnaire to complete with standard data requests, in order to streamline communications. Early determination of storm impact lead personnel at each jurisdiction will benefit the data organizer by having a base for the initial contact and evolving roles and responsibilities. Initial collaboration may be best achieved through a form letter combined with the suggested data requests provided below, with information gathered, based on such communications compiled in a tabular format, including:

- Direct damage to residential properties
- Number of properties experiencing power outages
- Number of businesses closed
- Potential roads/highways closures and damages
- Public transportation disruptures

- Drainage and stormwater management infrastructure failure and cost of repair
- Estimated total cost of damages due to the extreme storm event
- Others as appropriate

While this information is not specifically under TRCA's management, it does provide users with a framework to semi-quantitatively establish a sense of storm event severity.

3. Rainfall Analysis

Rainfall Data are the first and most widely reported information, hence need to be collected in a fulsome and accurate manner; important initial information will relate to:

- duration
- total depth
- intensities by temporal period
- spatial coverage/size

Since no storm is uniform, attention to spatial and temporal variation is critical in communicating information about the event.

Initial data/information will need to be analysed to interpret the storm event in terms of return period/frequency/percent likelihood of occurrence relative to historical data. The whole concept of reporting storms on annualized return period is moving into disfavour hence further dialogue is required with TRCA on communication preferences. Also, the all important spatial and temporal variabilities associated with return period/frequency/percent likelihood of occurrence also needs to be considered. The average lay person does not understand many of these concepts, hence there may need to be separate forms of communication for the public and politicians versus other practitioners/users of the data.

3.1 Storm Duration

The onset of the event to its termination should be examined using the data from the rain gauge network of TRCA and supplemental rain gauges obtained for the assessment from others. Rules need to be set up in order to accurately identify the onset and termination of the extreme storm event. One approach, which has been used in this analysis is to set the onset of the storm at a time when no rainfall has occurred for at least one hour prior to that time step and therefore exclude single time steps with reported rainfall with a time difference of more than one hour from the following time step. The same rule can be applied for the termination of the storm and rainfall occurring more than one hour after the last time step of the time series. For example, Rain Gauge Edwards Garden operated by City of Toronto (AMEC ID 33) reported 0.3 mm of rainfall on July 9th, 2013 at 01:45 AM which is more than one hour after the last recorded rainfall and as such this time step has been excluded and the storm has been considered to have ended at 23:00 pm on July 8th, 2013 for this gaugeThis will show any variation in the overall duration of the event across the watershed and should be used to prepare a thematic spatial grid depicting the storm duration across the study area using GIS techniques. Once this spatial grid has been prepared, the spatial analyst extension of ArcGIS software can be used to determine the average, maximum and minimum storm duration for each TRCA watershed.

While there are no direct data limitations, standard procedures and criteria for when an event is deemed to have started versus ended should be adopted. Working criteria have been adopted for the July 8th, 2013 Event analysis and should be reviewed by TRCA.

3.2 Rainfall Totals Including Isohyet Mapping

Total event rainfall depth for each rain gauge for the entire duration of the storm should be determined. The results of this assessment should be used to prepare a thematic mapping depicting the spatial distribution of the total storm depth across the study area using preferred GIS interpolation techniques. An assessment of the preferred interpolation approach has been conducted for the July 8th, 2013 event and 103 rainfall gauges (out of the total 135) with available data have been selected for the evaluation of the interpolation techniques. The gauges have been selected so that they provide a relatively uniform distribution across the study area and represent all available sources. The total rainfall depth for the July 8th, 2013 storm event has been interpolated using the three methods of IDW, Kriging and Spline. These methods are the three most commonly used interpolation techniques applied for the determination of spatial coverage of rainfall. Thematic mapping has been prepared using the spatial analyst function of ArcGIS software for each methodology. The resultant raster grids have been compared with the measured rainfall depth for all 32 gauges selected for verification of the interpolation assessments.

The results of the predicted rainfall for all verification gauges, using each interpolation technique, have been compared to the observed total rainfall depths using two quantitative statistical methods, specifically the correlation coefficient of the linear regression between the two datasets, as well as the Root Mean Square Error (RMSE) of the estimate. An index of agreement, Nash-Sutcliff coefficient, generally used for comparison of observed versus predicted values in hydrology, has also been used to compare the predicted rainfall values to observed depths

This methodology should likely be tested on 2 or 3 other extreme storm events in TRCA's jurisdiction to ensure that it continues to provide the 'best' interpolation.

The spatial grid developed as part of the July 8th, 2013 assessment should also be used to determine the spatially averaged total storm depth for all TRCA watersheds. In order to determine the statistics of the extreme event, including minimum, maximum and mean rainfall for each watershed, the resultant raster can be analyzed using the spatial analyst extension within ArcGIS software. This information will provide a comparison between watersheds and will reinforce to all users of the data the spatial variability of rainfall while concurrently providing a basis for interpreting streamflow/level data.

3.3 Rainfall Intensities

Based on the measured rainfall depths during the entire duration of the extreme storm event, maximum rainfall intensities for various industry-standard rainfall durations of 5, 15, 30 and 60 minutes as well as 1, 2, 6 and 12 hours should be determined. The calculated maximum intensities should be determined for moving durations on the available time series, rather than fixed time steps. The results should be used to prepare a thematic spatial grid depicting the maximum observed rainfall intensity for each duration across the study area. The same

interpolation technique identified to be the most accurate method as part of section 3.2 should be used for this assessment.

When selecting the appropriate intensity-duration for TRCA watersheds during any extreme storm event, it should be considered that due to large variations between TRCA watersheds physiographic characteristics including total contributing drainage area, stream channel characteristics and level of development (i.e, percent imperviousness) and different nature of potential extreme storm events (i.e. storm type) it is not possible to select one specific intensity-duration for TRCA watersheds. Parameters such as time to peak may be estimated for each watershed and used as an indicator of the critical storm duration-intensity, however there is no consideration of the extreme storm characteristics when such physiographic parameters are calculated.

The issue with this information and process though is that it will result in up to eight (8) separate maps of intensities which while useful for practitioners, will be potentially cumbersome and difficult to understand for the public and politicians. As such, it is considered unlikely that more than one or two of these maps would ever be shared with a broader audience; further discussion is required with TRCA.

3.4 Return Period/Probability of Occurrence

All rainfall gauges operated by Environment Canada have established Intensity-Duration-Frequency (IDF) relationships. Based on these IDF relationships (for each Environment Canada station), a spatial grid should be developed by interpolation of rainfall intensity at each station for different return periods. The same interpolation technique identified as to be the most appropriate and used for prior analysis, should be used for this assessment. These results should be compared with spatial grids developed as part of Section 3.1.3 of the July 8th, 2013 assessment, in order to determine locations where rainfall intensity has exceeded certain return periods. This assessment can be conducted using the spatial analyst extension of ArcGIS software. and should at least be conducted for the 50 and 100 year return periods but could also be prepared for other return periods or probability of occurrences.

At issue though is the same matter related to duration; spatial variation is inherently covered off in this exercise but the size and location of the area affected will vary by duration. Perhaps the two (2) most severe (largest area of coverage) can be selected for reporting purposes, as doing more will undoubtedly result in confusion for the report audience.

3.5 Radar Based Assessments

Watersheds in TRCA's jurisdiction are covered by two radar stations, King City radar station located in Ontario and Buffalo radar station located in Buffalo, New York. In addition to the determination of the spatial distribution of the extreme rainfall event using ground gauge values, the spatial coverage of the storm for its entire duration could be determined using radar rainfall data sets obtained from either or both of the Buffalo and King City radar stations and compared with the spatial grid developed as part of Section 3.1.2 of the July 8th, 2013 Extreme event report. The methodology to process raw radar data and conduct ground-thruthing assessment has been discussed in detail in Appendix I.

At issue though is that use of radar data will inherently introduce more data and more variability which will be difficult for most users to clearly understand. Besides the radar data being different than ground data, it will also be different based on source (King City versus Buffalo). Other issues relate to the differing methods (and frequency) of ground truthing radar data; further discussion is hence required with TRCA.

4. Streamflow and Water Levels

Rainfall is the driving function and streamflows/water levels are the outcome/response. Clearly the interpretation of these outcomes is even more complex than rainfall due to a number of influences including:

- spatial variability of rainfall
- antecedent conditions
- man-made storage
  - formal (stormwater)
  - informal (embankments)
- blockages at culverts/bridges/channels

As such, the data again need to be carefully analyzed and assessed to convey meaningful information to the users. The format and interpretation of this information is important so that the respective users can best understand results of the analyses.

4.1 Peak Flows and Water Levels

Peak flows and water levels provided by TRCA stream flow gauges and Water Survey Canada stations should be reviewed to identify any spatial and temporal gaps. If found, these gaps should be filled using available rating curves for each station as possible depending on the availability of surrogate or adjacent data. In the case of stream flow gauges being inundated or water levels exceeding the available rating curves, other available gap filling techniques should be used, for example developing relationships for observed water levels and peak flows between gauges located on same reaches, or gap filling with other information such as high water level observations. Other more complex techniques such as hydrologic modelling with temporally and spatially variable rainfall is also possible, however this may not be worth the effort due to cost and time involved.

From the available data, maximum observed water levels at each station (flow or water level) should be compared with floodline information (i.e. Flood Elevation or Peak Flows), in order to identify stations where observed water levels exceeded water levels of a prescribed frequency.

Clearly though, as outlined in the July 8th, 2013 Extreme event report, the data associated with simulated water levels needs to be interpreted with care, since this information typically does not take into account the influence of man-made storage upstream of culverts/bridges. As such, the observed water level will typically be lower than the simulated water level for the same flow rate. It is for this reason that AMEC suggests that TRCA consider for future floodplain mapping studies, preparation of two (2) sets of data: one including the influence of man-made storage and the other not, in accordance with MNRF protocols.

Other data limitations obviously relate to the rating curves used to translate the gauge water level to a flow rate, as typical observations and points on the curve are well below the extreme event flood levels resulting in considerable potential for error. As such, it has been recommended to enhance rating curves with a variety of techniques to improve on overall accuracy and reduce the potential for errors.

4.2 Flood Frequency

Where single site gauges have been in-place for a sufficient time period, generally 20 years or longer, a single station flood frequency analysis should be conducted and frequency flows for each gauge should be determined and compared with maximum observed peak flow during the extreme storm event; this would allow for the determination of where the extreme event under study would fall in terms of return period. These single site frequency analyses should be periodically updated and maintained, thereby reducing variability and allowing for direct access to this information following the extreme storm event.

The Hydrologic Engineering Center of U.S Army Corps of Engineers has developed a Statistical Software Package (HEC-SSP) which can be used to conduct statistical analyses of hydrologic data. This software package has a graphical user interface which facilitates the use of the software, while maintaining a high level of efficiency. The statistical analysis components of this software package include Flow Frequency Analysis (ref. Bulletin 17B, which implements procedures in Bulletin 17B, “Guidelines for Determining Flood Frequency” by the Interagency Committee on Water Data), General Frequency Analysis, Volume Frequency Analysis, Duration Analysis, Coincidental Frequency Analysis and Curve Combination Analysis. General Frequency Analyses, which have been conducted under the current study, can be performed using Normal, Pearson, 3 Parameter Log Normal and Log Pearson III distributions.

4.3 Observed Flood Extents

Based upon the availability of observed flood extents, related in part to the surveyed high water marks during the extreme rainfall event, a comparison could be conducted between simulated floodlines (associated with a particular frequency) and the maximum observed high water marks and/or flood limit, in order to determine where the observed flood extents fit in terms of return period or probabilities.

In order to be most effective, this assessment would involve “mapping” of the estimated limit for the observed flood in particular locations of interest and comparing this to the limits associated with an event of a known return period/probability. Due to the effort involved and the discrete level of mapping required, it is unlikely that this exercise would be warranted for all areas and only selected areas hit by the worst portions of the storm would be demarqued. One critical data limitation would relate to the influence of blockages.

5. Comparison to Major Storm Events

Most often when communicating the severity of the storm event, there is an inevitable requirement for a comparison to be conducted between the extreme rainfall event and other major historic storm events, usually others from Ontario. Historic storm events considered in the July 8th, 2013 extreme storm assessment included:

1. Hurricane Hazel, 1954
2. Timmins Storm, 1952
3. Harrow Storm, 1989
4. Peterborough Storm, 2004
5. Toronto August 19th, Storm, 2005
6. Toronto July 8th, Storm, 2013

Clearly a database should be generated and continually updated and populated with new data on extreme events as it is received.

The comparison should include such parameters as: the area influenced by the storm, storm duration, antecedent precipitation conditions, estimated damages, loss of life and other storm characteristics such as maximum rainfall depth over given time periods ranging from 5 minutes to 48 hours.

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APPENDIX B

Summary of Documentation

Memo

To: **Rita Lucera** File no: TP114045-26

From: Ron Scheckenberger

Date: June 24, 2014

c.c.: Terry Krauss/Vahid Taleban

Subject: Progress Update and Data Gap Summary
July 8th 2013 Extreme Rainfall Event
For : *Summary and Analysis Report*
Climatological Report

Further to your recent request, we hereby provide you with a status update on these projects. In brief, we are advancing well and generally aligned with the updated schedule.

A. Summary and Analysis Report

Task 1: Data Collection and Review

Subtask 1.1: Collection of Supplemental Rainfall and Streamflow/Water Level Data

- *Complete: See attached for summary of data received from available sources.*

Subtask 1.2: Review of Available Data and Identification of Gaps

- *Complete: Some minor gaps have been identified as related to data and mapping as noted on the attached*.
- *In addition, some information cited in the May 23, 2014 minutes has yet to be received or actioned including:*
  - *Ref. Item 3 (vi) and 3 (viii) – TRCA*
  - *Ref. Item 4 (ii) – AMEC*
  - *Ref. Item 4 (iii) - TRCA*

Task 2: Provide General Storm Overview Analysis...

Subtask 2.1: Summery of Relevant Weather Forecasts

- *Complete; all data received and processed*

Subtask 2.2: Summary Discussion

- *50% Complete; text only (issue with Environment Canada report)*

Subtask 2.3: Assessment of Antecedent Conditions

- *Ongoing*

Subtask 2.4: Reported Storm Impacts

- *Note: Michael Heralall was to provide some ideas and contacts hence we have not yet initiated this task*

AMEC Environment & Infrastructure
A division of AMEC Americas Limited
3215 North Service Road
Burlington, Ontario L7N 3G2
Tel +(905) 335-2353
Fax +(905) 335-1414
www.amec.com

Tasks 3, 4, 5

- *Yet to be initiated*.

Task 6: Meetings

Subtask 6.1: Start up Meeting

- *Held May 23, 2014.*

B. Climatological Report

Task 1: Data Collection and Review

Subtask 1.1: Collect Weather Forecast Data

- *All model data received and processed*

Subtask 1.2: Collect Radar and Satellite Imagery

- *Minimal satellite data at this time*

Subtask 1.3: Collect Supplemental Rainfall Information

- *Complete*

Task 2: Prepare Primer on Prevalent Warm Weather Systems in the GTA

Subtask 2.1: Discuss Synoptic, meso scale and local factors

- *Local effects almost done*

Subtask 2.2: Discuss changes to weather patterns over period of record

- *On-going*

Subtask 2.3: Discuss Meso scale convective systems related to severe thunderstorms

- *Compiling references*

Subtask 2.4: Discuss Urban heat island effects related to convective activity

- *Part of local effects in progress*

Subtask 2.5: Review topographic/geological features in/around GTA influencing storms

- *Local effects almost done.*

Task 3: Discuss Climatological Aspects of July 8, 2013 Storm

Subtask 3.1: Summary of forecast data

- *Text only; no Environment Canada report*

Subtask 3.2: Discussion of Numerical Model Forecasts

- *Numerical analysis complete.*

Subtask 3.3: Review of weather conditions preceding July 8 , 2013

- *Continue collecting maps etc.*

Subtask 3.4: Discuss Evolution of weather conditions during July 8, 2013
- *On-going.*

Subtask 3.5: Comparison of available forecast data with observed conditions for July 8, 2013
- *Initial examination complete.*

Subtask 3.6: Derive high-res radar rainfall and compare with observations for July 8, 2013
- *Buffalo complete. King City being initiated.*

Task 4: Assessment of Guidance Offered During July 8, 2013 Storm

Subtask 4.1: Identify Best Guidance
- *Pending*

Subtask 4.2: Identify when Guidance appropriate
- *First look says no guidance ahead of time; on-going.*

Subtask 4.3: Compile and assess public warnings
- *Compiled from AMEC archive; nothing received from Environment Canada.*

Subtask 4.4: Provide Opinion on Prediction Capabilities
- *First look rates prediction as very poor; on-going.*

Subtask 4.5: Identify best data sources for decision-making by TRCA
- *First looks show radar is the best nowcasting tool; on-going.*

Subtask 4.6: Assess Advance Guidance
- *Models did a poor job in general; on-going.*

Task 5: Characterization of July 8, 2013 Storm

Subtask 5.1: Meteorological Classification
- *Compiling references*

Subtask 5.2: Comparison to other similar storms
- *TBD*

Task 6: Discuss Implications for Future Management of Flood Risk

Subtask 6.1: Discuss likelihood of future similar storms
- *TBD*

Subtask 6.2: Provide Assessment on likelihood of similar storm in the GTA
- *TBD*

Subtask 6.3: Identify Sources of information for future decision making
- *TBD*

Task 7: Meetings and 8: Reporting - Pending

Task 9: Provide General Storm Overview Analysis and Reporting

Subtask 9.1: Provide General Storm Overview Analysis and Reporting
- *Data compiled.*

Subtask 9.2: Summary of Relevant Weather Forecasts
- *On-going*

Subtask 9.3: Summary Discussion
- *TBD*

Subtask 9.4: Assessment of Antecedent Conditions
- *Compiled most maps leading up to the event.*

The targeted date for the next meeting was the week of July 7 – 11, 2014. If possible and if convenient could we hold the meeting the week after? Week of July 14th?

RS/bk

/attach

July 8th 2013 Storm Event Summary Analysis and Climatologic Report, TRCA
DATA TRACKING SCHEDULE

DATA CATEGORY				STATUS			COMMENTS/RELEVANCE
Item	**Description**	**Type**	**Format**	**Details of Data Request**	**Status**	**Date Received**	
1. Monitoring Data	TRCA Precip Data	spreadsheet	.xlsx	Date Requested: 23/05/2014	Received	23-May-14	5-minute data from 30 stations and 15 min data from 3 stations - station metadata provided - Toronto Pearson Airport Rainfall from 4:00 pm on July 8th to 2:00 am on July 9th also provided
	TRCA stream data	spreadsheet	.xlsx	Date Requested: 23/05/2014	Received	23-May-14	Water elevations for 31 gauges - calculated discharge for 22 gauges - dam locations for 4 locations- all data with 15 min intervals - station metadata provided
	TRCA climate data	spreadsheet	.xlsx	Date Requested: 23/05/2014	Received	23-May-14	Climate data from 5 weather stations - air temperature, soil moisture, atmospheric pressure, wind measurements including speed, gust speed and direction - station metadata provided
	TRCA Rating Tables	text files	.txt	Date Requested: 23/05/2014	Received	23-May-14	Rating Tables for 23 stations for TRCA
	York Region Rainfall Data	spreadsheet	.xlsx	Date Requested: 23/05/2014	Received	23-May-14	Rainfall data with 5 min interval for 16 gauges starting from July 1st until July 15th of 2013 - Station metadata included as well.
	City of Mississauga Rainfall Data	spreadsheet	.xlsx	Date Requested: 23/05/2014	Received	23-May-14	Rainfall data with 5 min interval for 14 gauges starting from July 1st until July 15th of 2013 - Station metadata included as well.
	IDF Google™ App	text file and google map application	.txt and .html	Date Requested: 23/05/2014	Received	23-May-14	An application using Google™ map to show EC IDF station locations and generated IDF for stations across Canada
	Environment Canada Precipitation Data	spreadsheet	.xlsx	Date Requested: 26/05/2014	Received	27-May-14	15 min and hourly rainfall value for Toronto City station and raw tipping bucket data for Buttonville, Toronto North York and Toronto Pearson A stations
	Water Survey Canada Stream flow/Water level Data	spreadsheet	.xlsx	Date Requested: 27/05/2014	Received	04-Nov-14	Water level and Stream flow data for 24 flow Gauges belonging to Water Survey Canada in TRCA jurisdiction with hourly, 15 min and 5 min intervals
	City of Toronto Rainfall Data	spreadsheet	.xlsx	Date Requested: 27/05/2014	Received	03-Jun-14	Rainfall Data for 36 Gauges belonging to City of Toronto with 5 min interval
	City of Markham Rainfall Data	spreadsheet	.xlsx	Date Requested: 30/05/2014	Received	04-Jun-14	Rainfall Data for 11 gauges belonging to City of Markham with 5 min interval - shape file for gauge locations provided as well
	Peel Region Rainfall Data	spreadsheet	.xlsx	Date Requested: 30/05/2014	Received	04-Jun-14	Rainfall Data for 20 gauges belonging to Peel Region. Station metadata has not been sent and therefore the location of gauges is difficult to determine accurately -
	Town of RichmondHill Rainfall Data	spreadsheet	.xlsx	Date Requested: 02/06/2014	Received	10-Jun-14	Rainfall Data for all 3 gauges belonging to Town of RichmondHill - no station metadata provided but street address has been included
2. Mapping/ Drawings	Highways	Digital Vector Data	.shp	Date Requested: 23/05/2014	Received	26-May-14	
	Major Roads	Digital Vector Data	.shp	Date Requested: 23/05/2014	Received	26-May-14	
	Municipal Boundaries	Digital Vector Data	.shp	Date Requested: 23/05/2014	Received	26-May-14	
	Pearson Airport	Digital Vector Data	.shp	Date Requested: 23/05/2014	Received	26-May-14	

July 8th 2013 Storm Event Summary Analysis and Climatologic Report, TRCA
DATA TRACKING SCHEDULE

DATA CATEGORY				STATUS			COMMENTS/RELEVANCE
Item	**Description**	**Type**	**Format**	**Details of Data Request**	**Status**	**Date Received**	
	TRCA watercourses	Digital Vector Data	.shp	Date Requested: 23/05/2014	Received	26-May-14	
	TRCA watersheds	Digital Vector Data	.shp	Date Requested: 23/05/2014	Received	26-May-14	
	TRCA Subwatersheds	Digital Vector Data	.shp	Date Requested: 23/05/2014	Received	26-May-14	Jamie Duncan stated that the provided layer for subwatershed is not the intended one and alternative layer will be provided
	TRCA High Water Mark Data - Survey Results for 4 TRCA Watersheds	Digital Data	.dwg	Date Requested: 23/05/2014	Received	23-May-14	CAD drawings for survey results for Don River, Etobicoke, Mimico and Humber River High Water Marks during July 8th storm event
	TRCA High Water Mark Data - Field Notes for 4 TRCA Watersheds	Digital Document	.pdf	Date Requested: 23/05/2014	Received	23-May-14	documents depicting location of collected field data by TRCA staff following the July 8th 2013 storm for Don River, Etobicoke, Mimico and Humber River
	Floodplain Maps for 4 TRCA Watersheds	Digital Data	.dwg .pdf	Date Requested: 23/05/2014	Received	23-May-14	Floodplain Maps for Etobicoke Creek, Mimico Creek, Humber River and Don River Watersheds
3. Reporting	TRCA August 19 2005 Storm Event - Final Report	Report	.pdf	Date Requested: 23/05/2014	Received	23-May-14	Prepared by Clarifica Inc. for TRCA - 2006
	Dillon_Harrow_Storm_July-19-20-1989	Report	.pdf	Date Requested: 23/05/2014	Received	23-May-14	Prepared by M.M. Dillon Limited for MNR
	The storm and Floods of October 1954 in Southern Ontario	Report	.pdf	Date Requested: 23/05/2014	Received	23-May-14	Paper prepared by D.V. Anderson and J.P. Bruce
	The storm of October 15, 1954	Report	.pdf	Date Requested: 23/05/2014	Received	23-May-14	Prepared by National Oceanic and Atmospheric Administration
	Hurrican Hazel in Ontario - Transport Canada Report 1955	Report	.pdf	Date Requested: 23/05/2014	Received	23-May-14	Prepared by Meteorological Division - Department of Transport - Canada
	The Summer 2004 Storm Study - Peterborough	Report	.pdf	Date Requested: 23/05/2014	Received	23-May-14	Prepared by Environment Canada
	EC report to TRCA on July 8th event	Report		Date Requested: 10/06/2014			
4. Models	HEC-RAS Model for 4 TRCA Watersheds	Digital model		Date Requested: 23/05/2014	Received	23-May-14	HEC-RAS model for Etobicoke Creek, Mimico Creek, Humber River and Don River Watersheds

Data Gap Analysis

Data	Provider	Time Interval	Gauges	Number of Gaps	Gap Start	Gap End	Total Sampling Periods Missing	Notes
Rainfall	City of Toronto	5 min	Ashbridges Bay	*missing*	*N/A*	*N/A*	*N/A*	Gauge data are missing.
		5 min	Fairbank Middle Public School	*missing*	*N/A*	*N/A*	*N/A*	Gauge data are missing.
Total				**2**			***N/A***	Not including missing gauges
Water Level	TRCA	15 min	HY005	1	08/07/2013 17:45	10/07/2013 0:00	121	Missing gauge data continues to July 15th.
Stream Flow		15 min	HY024	2	08/07/2013 19:15	08/07/2013 20:00	2	
Stream Flow					08/07/2013 20:45	09/07/2013 3:15	25	
Stream Flow		15 min	HY035	1	08/07/2013 17:45	09/07/2013 9:15	61	
Stream Flow		15 min	HY045	1	08/07/2013 17:15	08/07/2013 18:15	3	
Stream Flow		15 min	HY053	1	08/07/2013 16:45	09/07/2013 6:30	54	
Stream Flow		15 min	HY054	1	08/07/2013 17:00	10/07/2013 0:00	124	
Stream Flow		15 min	HY059	1	08/07/2013 16:30	09/07/2013 5:30	51	
Stream Flow		15 min	HY062	1	08/07/2013 16:15	08/07/2013 18:00	6	
Stream Flow		15 min	HY065	*Data Quality*	*N/A*	*N/A*	*N/A*	Data for this gauge are given either a grade of 1 or 7. Descriptions of these codes can be seen in the GradeCodes worksheet.
Stream Flow		15 min	HY081	1	08/07/2013 19:00	09/07/2013 0:45	22	Data for this gauge are given either a grade of 1 or 7. Descriptions of these codes can be seen in the GradeCodes worksheet.
Stream Flow	Water Survey of Canada	15 min	02HC056	1	08/07/2013 16:45	08/07/2013 17:45	3	
		15 min	02HC033	1	08/07/2013 11:00	09/07/2013 17:45	51	
		15 min	02HC030	2	08/07/2013 17:30	08/07/2013 18:00	1	
		15 min			08/07/2013 18:00	09/07/2013 1:30	29	
		15 min	02HC027	1	08/07/2013 17:30	08/07/2013 20:15	10	
		15 min	02HC005	1	08/07/2013 16:30	08/07/2013 17:30	3	
		30 min	02HC057	*missing*	*N/A*	*N/A*	*N/A*	Gauge data is missing.
		30 min	02HC009	1	08/07/2013 22:00	01/07/2013 1:00	5	
Water Level	Water Survey of Canada	15 min	02HC056	N/A	*N/A*	*N/A*	N/A	First sampling point for every day is missing.
Total	**Water Level**			**1**			**121**	Not including missing gauges
	Stream Flow			**20**			**450**	Not including missing gauges

Grade	Comment	Description	Applicable to
1	UNVERIFIED	Outside of rating curve & extrapolation	Discharge data only
7	PRELIMINARY	Data are subject to future change	Discharge data only
30	ESTIMATED GOOD	Extrapolated value within rating curve	Level and discharge data
31	GOOD	Data have no known issues	Level and discharge data

Note : Extrapolated values have been modelled using ®Aquarius Software Model Based Correction Tool up to three times the highest measured point of the current rating curve.

MEMORANDUM

Re: July 8th, 2013 Extreme Rainfall Event: Summary & Analysis and Climatological Reports Progress Update Memo from AMEC

Date: June 27, 2014

To: Ron Scheckenberger, Terry Krauss, Vahid Taleban
cc: Jamie Duncan, Michael Heralall
From: Rita Lucero

This memorandum is in response to the Memo from AMEC titled '*Progress Update and Data Gap Summary July 8th 2013 Extreme Rainfall Event For: Summary and Analysis Report & Climatological Report*' File No. TP1145045-26 dated June 24, 2014.
TRCA wishes to clarify some of the points made about the data assessment and gap analysis as well as address any outstanding items from the May 23rd, start-up meeting, as stated in the above mentioned memo.

A. Summary and Analysis Report

Task 1: Data Collection and Review

Subtask 1.1: Collection of Supplemental Rainfall and Streamflow/Water Level Data

- Additional data was uploaded by TRCA to the AMEC ftp site that was not included in the Data Tracking Schedule table. See below
    1. Rating Curve Info uploaded to ftp site on May 30, 2014 - containing rating curves and rating tables as well as actual field measurements of water level and discharge used to create the rating curves.
        - Please note that survey points and channel profiles are not available for any TRCA gauge location at this time.
    2. WSC raw stream data uploaded to ftp site on June 2, 2014 – preliminary data downloaded by TRCA from the WSC real time website in July of 2013

Subtask 1.2: Review of Available Data and Identification Gaps

- Minor data gaps - TRCA comments and clarifications regarding the identified data gaps in the TRCA stream data are as follows:
    1. Water level gap in HY005 at Black Creek at 401 is due to the station being inundated during the storm event and stopped recording at 17:45 on 7/8/2013. This station remained offline until it was repaired in late August 2013.
    2. Stream Flow data gaps at stations HY024, HY035, HY045, HY053, HY054, HY059, HY062, and HY081 were due to the water levels being outside of the rating curve at these stations. TRCA staff have extrapolated flow values where reasonably possible using ®*Aquarius Software Model Based*

Correction Tool up to three times the highest measured point of the current rating curve. The data gaps exist because values were even beyond this.
    - A special note about stream flow gauge HY081 – Spring Creek North is that it was also inundated during the storm and stopped recording data at 20:30 on 7/8/2013. However TRCA staff were able to use the ®*Aquarius Software Modelling Tool* to infill some of the data by correlating with a nearby downstream stream gauge (HY059 – Spring Creek South) and this data was provided to AMEC.
3. Stream Flow data quality flags at HY065 and HY081 were assigned as preliminary because the rating curves at both these stations are still preliminary (less than 10 points on the curve). Therefore values are still subject to future changes when the curves become finalized later on.

- Additional data/information requested at the May 23, 2014 meeting - Regarding some information cited in the May 23, 2014 AMEC meeting minutes that was identified as outstanding;
    1. Ref. Item 3 (vi) – TRCA staff was requested to highlight what it thought to be positive and also lacking in the historical storm report documentation.
        - After reviewing the historical storm reports for a second time, TRCA is happy with the list of tasks it had requested in the original Request for Proposals, however a short list of positive and negative analysis will be further provided to AMEC in the coming week or two; however it is not anticipated to include any major deviations from the initial direction provided.
    2. Ref. Item 3 (viii) – It was indicated City of Toronto has done a report on the same storm event, which TRCA has in *Draft,* which can similarly be provided.
        - There are several reports available publicly from the City of Toronto regarding the July 8th storm. TRCA will upload two of them to the AMEC ftp site and they are listed below:
            - Staff Report – Impact of July 8, 2013 storm on the City's Sewer and Stormwater Systems dated September 6, 2013.
            - Staff Report – Impacts from the July 8, 2013 Storm Event on the City of Toronto
        - Two other additional reports are available and will also be uploaded to the AMEC ftp site, however these reports are internal confidential documents that are for information purposes only. They may not be included in the report or reproduced in anyway.
            - Transportation Services' Response to July 8, 2013 Storm dated July 26, 2013
            - Toronto Office of Emergency Management – After Action Report on the Severe Storm July 8-13, 2013
    3. Ref. Item 4 (iii) – Michael Heralall indicated that he will provide additional information on storm impacts.
        - Michael Heralall will send AMEC a list of contacts that might be able to provide additional data in the coming week or two.

Task 2: Provide General Storm Overview Analysis...

Subtask 2.2: Summary Discussion

- Note about issue with Environment Canada report
    - Environment Canada sent TRCA a final version of the '*July 8, 2013 Toronto and Area Extreme Rainfall Event: Rainfall Amounts and Return Periods*' report prepared by Joan Klaassen of MSC, via email on June 20, 2014. It was

communicated by EC that a copy of the report was already sent to Terry Krauss of AMEC. Additionally, a letter has been drafted by TRCA to be provided to Environment Canada which clearly states the intended use of any internal reporting used in the completion of the two July 8th storm reports. A copy of this will be made available to AMEC upon finalization.

B. Climatological Report

Currently the TRCA has no comments on this section.

Joint Progress Meeting

The joint progress meeting that was initially blocked off for the week of July 7-11th, can be moved; however not all TRCA staff are able to attend a meeting during the week of July 14th. Below are meeting dates and times that TRCA staff are available to convene at the TRCA Head Office:

- Monday, July 21st: 9:30am -12noon
- Monday, July 21st: 1:30-4:00pm
- Tuesday, July 22nd: 1:30-4:00pm
- Wednesday, July 23rd: 9:30am-12noon
- Wednesday, July 23rd : 1:30-4:00pm

Please indicate the date and time which agrees with the AMEC team.

APPENDIX C

Data Tracking Chart

July 8th 2013 Storm Event Summary Analysis and Climatologic Report, TRCA
DATA TRACKING SCHEDULE

DATA CATEGORY				STATUS			COMMENTS/RELEVANCE
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	City of Mississauga Rainfall Data	spreadsheet	.xlsx	Date Requested: 23/05/2014	Received	23-May-14	Rainfall data with 5 min interval for 14 gauges starting from July 1st until July 15th of 2013 - Station metadata included as well.
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	Major Roads	Digital Vector Data	.shp	Date Requested: 23/05/2014	Received	26-May-14	
	Municipal Boundaries	Digital Vector Data	.shp	Date Requested: 23/05/2014	Received	26-May-14	
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July 8th 2013 Storm Event Summary Analysis and Climatologic Report, TRCA
DATA TRACKING SCHEDULE

DATA CATEGORY				STATUS			COMMENTS/RELEVANCE
Item	**Description**	**Type**	**Format**	**Details of Data Request**	**Status**	**Date Received**	
	TRCA watercourses	Digital Vector Data	.shp	Date Requested: 23/05/2014	Received	26-May-14	
	TRCA watersheds	Digital Vector Data	.shp	Date Requested: 23/05/2014	Received	26-May-14	
	TRCA Subwatersheds	Digital Vector Data	.shp	Date Requested: 23/05/2014	Received	26-May-14	Jamie Duncan stated that the provided layer for subwatershed is not the intended one and alternative layer will be provided
	TRCA High Water Mark Data - Survey Results for 4 TRCA Watersheds	Digital Data	.dwg	Date Requested: 23/05/2014	Received	23-May-14	CAD drawings for survey results for Don River, Etobicoke, Mimico and Humber River High Water Marks during July 8th storm event
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	Dillon_Harrow_Storm_July-19-20-1989	Report	.pdf	Date Requested: 23/05/2014	Received	23-May-14	Prepared by M.M. Dillon Limited for MNR
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	The storm of October 15, 1954	Report	.pdf	Date Requested: 23/05/2014	Received	23-May-14	Prepared by National Oceanic and Atmospheric Administration
	Hurrican Hazel in Ontario - Transport Canada Report 1955	Report	.pdf	Date Requested: 23/05/2014	Received	23-May-14	Prepared by Meteorological Division - Department of Transport - Canada
	The Summer 2004 Storm Study - Peterborough	Report	.pdf	Date Requested: 23/05/2014	Received	23-May-14	Prepared by Environment Canada
	EC report to TRCA on July 8th event	Report		Date Requested: 10/06/2014			
4. Models	HEC-RAS Model for 4 TRCA Watersheds	Digital model		Date Requested: 23/05/2014	Received	23-May-14	HEC-RAS model for Etobicoke Creek, Mimico Creek, Humber River and Don River Watersheds

APPENDIX D-1

Rain Gauge Stations Information

ID	Station Name	Owner	Station ID	Easting	Northing	Data Interval
1	Toronto Pearson Int'L A	Environment Canada	6158731	612871	4835804	0.2 mm tips
2	Toronto North York	Environment Canada	615S001	623415	4847100	0.2 mm tips
3	Toronto Buttonville A	Environment Canada	615HMAK	631245	4858361	0.2 mm tips
4	Toronto City	Environment Canada	6158355	628995	4836095	15 min
5	Swansea	City of Toronto	RG-001	622795	4833434	5 min
6	Howard	City of Toronto	RG-002	625030	4834448	5 min
7	Central	City of Toronto	RG-003	627219	4835099	5 min
8	Brown	City of Toronto	RG-004	628807	4838097	5 min
9	Church	City of Toronto	RG-006	630647	4835738	5 min
10	Jane	City of Toronto	RG-019	619203	4846891	5 min
11	Greenwood	City of Toronto	RG-007	634511	4837191	5 min
12	Albion	City of Toronto	RG-012	614201	4843874	5 min
13	Martin Grove	City of Toronto	RG-013	615102	4839003	5 min
14	Richview	City of Toronto	RG-014	617521	4837763	5 min
15	Bering	City of Toronto	RG-015	618592	4832730	5 min
16	Kipling	City of Toronto	RG-016	619262	4829904	5 min
17	Castlefield	City of Toronto	RG-017	622009	4836723	5 min
18	Thorncliffe	City of Toronto	RG-018	633532	4840287	5 min
19	Finch Yard	City of Toronto	RG-020	623111	4847444	5 min
20	Emery Yard	City of Toronto	RG-021	616823	4845699	5 min
21	Fire Station 116	City of Toronto	RG-022	631572	4847525	5 min
22	Bermondsey Yard	City of Toronto	RG-023	635949	4842648	5 min
23	Wilson	City of Toronto	RG-024	619717	4841893	5 min
24	Ancaster	City of Toronto	RG-025	623595	4843283	5 min
25	Mitchell Field	City of Toronto	RG-027	628074	4848067	5 min
26	Cummer	City of Toronto	RG-028	631005	4850895	5 min
27	Pharmacy/401	City of Toronto	RG-030	635760	4847431	5 min
28	Liamoreaux	City of Toronto	RG-031	636302	4852390	5 min
29	Nashdene Yard	City of Toronto	RG-033	640133	4853171	5 min
30	Ellesmere Yard	City of Toronto	RG-034	639009	4847553	5 min
31	Morningsidede Yard	City of Toronto	RG-035	645184	4850434	5 min
32	Ashbridges Bay	City of Toronto	RG-036	635453	4835334	5 min
33	Edwards Gardens	City of Toronto	RG-037	632203	4843657	5 min
34	Fire Station 215	City of Toronto	RG-038	649004	4848804	5 min
35	Mount Pleasant	City of Toronto	RG-039	629685	4840972	5 min
36	Denton	City of Toronto	RG-040	638273	4839359	5 min
37	Poplar	City of Toronto	RG-041	645604	4847152	5 min
38	Seminole	City of Toronto	RG-042	640906	4845066	5 min
39	Fire Station 121	City of Toronto	RG-044	628258	4845171	5 min
40	Fairbank Middle Public School	City of Toronto	RG-045	624938	4839088	5 min
41	Albion Hills	TRCA	HY002	593103	4864192	5 min
42	Alex Duff Memorial Pool	TRCA	HY003	627227	4835871	5 min
43	Brickworks	TRCA	HY008	631681	4838137	5 min
44	Brock West Landfill	TRCA	HY009	653071	4858659	5 min
45	Bruces Mill CA	TRCA	HY011	633058	4867376	5 min
46	Caledon Pumping Station	TRCA	HY012	591249	4857883	5 min
47	Claireville Dam	TRCA	HY014	610307	4843575	5 min
48	Claremont Shop	TRCA	HY015	654503	4868035	5 min
49	Danforth and Coxwell	TRCA	HY016	635169	4837961	5 min
50	Dufferin Reservoir	TRCA	HY021	622273	4854332	5 min
51	Etobicoke at QEW	TRCA	HY025	616511	4828660	5 min
52	G Ross Dam	TRCA	HY027	623870	4847634	5 min

ID	Station Name	Owner	Station ID	Easting	Northing	Data Interval
53	Glen Haffy	TRCA	HY030	584115	4865417	5 min
54	Goodwood Pumping Station	TRCA	HY031	644316	4877007	5 min
55	Heart Lake CA	TRCA	HY033	597473	4843626	5 min
56	Kennedy Pump Station	TRCA	HY036	636226	4853118	5 min
57	King and Albion-Vaughan	TRCA	HY037	603010	4860226	5 min
58	East Humber at Mill Road	TRCA	HY038	611484	4862039	5 min
59	Laidlaw Bus Depot	TRCA	HY041	599780	4850069	5 min
60	Little Rouge at 16th	TRCA	HY043	643234	4863196	5 min
61	Milne Dam	TRCA	HY044	639672	4858742	5 min
62	Missisauga Works Yard	TRCA	HY046	608004	4838427	5 min
63	Morningside Works Yard	TRCA	HY050	645526	4848833	5 min
64	Petticoat CA	TRCA	HY051	651729	4851833	5 min
65	Restoration Services	TRCA	HY055	612320	4853464	5 min
66	Stouffville Dam	TRCA	HY060	640347	4870869	5 min
67	Sue Grange Farm	TRCA	HY061	589844	4847831	5 min
68	TRCA Head Office	TRCA	HY064	619623	4847523	5 min
69	York Pumping Station	TRCA	HY069	622466	4863747	5 min
70	York Region Works Yard	TRCA	HY070	629933	4860292	5 min
71	Bayly and Church	TRCA	HY004	657393	4855742	15 min
72	Kortright	TRCA	HY039	613133	4854526	15 min
73	Transport Canada	TRCA	HY063	648308	4869985	15 min
74	R_ET_HL01	York Region	R_ET_HL01	622655	4884071	5 min
75	R_ET_MA03	York Region	R_ET_MA03	638280	4855623	5 min
76	R_ET_NO01	York Region	R_ET_NO01	608675	4861714	5 min
77	R_ET_ST02	York Region	R_ET_ST02	639427	4869443	5 min
78	R_ET_VA01	York Region	R_ET_VA01	614108	4851071	5 min
79	R_ET_VA02	York Region	R_ET_VA02	610590	4855071	5 min
80	R_YR_AU02	York Region	R_YR_AU02	623137	4875318	5 min
81	R_YR_KE01	York Region	R_YR_KE01	622103	4897028	5 min
82	R_YR_MA03	York Region	R_YR_MA03	630800	4852348	5 min
83	R_YR_MO01	York Region	R_YR_MO01	635564	4890571	5 min
84	R_YR_NE01	York Region	R_YR_NE01	623886	4881138	5 min
85	R_YR_RH01	York Region	R_YR_RH01	625015	4858521	5 min
86	R_YR_SU01	York Region	R_YR_SU01	630544	4908103	5 min
87	R_YR_VA03	York Region	R_YR_VA03	614347	4846604	5 min
88	R_YR_VA04	York Region	R_YR_VA04	618339	4854540	5 min
89	R_YR_WB01	York Region	R_YR_WB01	626400	4907910	5 min
90	Third St.	City of Mississauga	STN 01	615626	4825293	5 min
91	Clarkson	City of Mississauga	STN 02	611719	4816672	5 min
92	Wolfedale	City of Mississauga	STN 03	608994	4825385	5 min
93	South Common	City of Mississauga	STN 04	606330	4821959	5 min
94	Winding Trail	City of Mississauga	STN 05	613021	4830551	5 min
95	Mississauga Valley	City of Mississauga	STN 06	611097	4828039	5 min
96	Britannia	City of Mississauga	STN 07	602643	4826389	5 min
97	Tomken	City of Mississauga	STN 08	606447	4835236	5 min
98	Truscott	City of Mississauga	STN 09	609067	4818528	5 min
99	Falbourne	City of Mississauga	STN 10	606436	4830233	5 min
100	Garry Morden FTC	City of Mississauga	STN 11	596433	4826975	5 min
101	CVC	City of Mississauga	STN 12	602027	4830851	5 min
102	Goreway	City of Mississauga	STN 13	610046	4841217	5 min
103	Port Credit	City of Mississauga	STN 14	614028	4822619	5 min
104	Stornoway P.S.	City of Markham	RG1	627785	4854201	5 min

ID	Station Name	Owner	Station ID	Easting	Northing	Data Interval
105	Thornhill C.C.	City of Markham	RG2	628658	4853133	5 min
106	German Mills P.S.	City of Markham	RG3	631367	4852616	5 min
107	Lincoln Alexander P.S.	City of Markham	RG4	631104	4859511	5 min
108	8100 Warden Ave	City of Markham	RG5	633972	4856219	5 min
109	Milliken Mills C.C.	City of Markham	RG6	636238	4855521	5 min
110	Fire Hall #94	City of Markham	RG7	635460	4859483	5 min
111	Roy H Crosby P.S.	City of Markham	RG8	638556	4858475	5 min
112	Markham Museum	City of Markham	RG9	639083	4861571	5 min
113	Rouge River C.C.	City of Markham	RG10	641367	4857922	5 min
114	Angus Glen C.C.	City of Markham	RG11	633591	4861556	5 min
115	RG03	Peel Region	RG03	609559	4820596	15 min
116	RG11	Peel Region	RG11	601836	4826523	15 min
117	RG16	Peel Region	RG16	608227	4833553	15 min
118	RG20	Peel Region	RG20	607043	4840544	15 min
119	RG22	Peel Region	RG22	604389	4840938	15 min
120	RG23	Peel Region	RG23	602417	4835199	15 min
121	RG24	Peel Region	RG24	598257	4831643	15 min
122	RG25	Peel Region	RG25	601436	4839471	15 min
123	RG26	Peel Region	RG26	598637	4837298	15 min
124	RG27	Peel Region	RG27	593999	4837764	15 min
125	RG28	Peel Region	RG28	594813	4842683	15 min
126	RG29	Peel Region	RG29	596894	4841761	15 min
127	RG31	Peel Region	RG31	600832	4842368	15 min
128	RG32	Peel Region	RG32	603824	4844549	15 min
129	RG33	Peel Region	RG33	602038	4846513	15 min
130	RG34	Peel Region	RG34	605997	4849302	15 min
131	RG36	Peel Region	RG36	592557	4850497	15 min
132	RG39	Peel Region	RG39	586120	4849679	15 min
133	RG42	Peel Region	RG42	578596	4859061	15 min
134	RG44	Peel Region	RG44	603185	4821715	15 min
135	Discovery	Town of RichmondHill	-	628004	4861595	5 min
136	Oak Ridges	Town of RichmondHill	-	624002	4867068	5 min
137	Operations	Town of RichmondHill	-	626700	4855867	5 min

APPENDIX D-2

Streamflow Gauge Stations Information

ID	Station Name	Owner	Station ID	Easting	Northing	Data Interval
1	Humber River At Weston	WSC	02HC003	619225	4839500	30 min
2	Don River At York Mills	WSC	02HC005	628585	4844263	15 min
3	East Humber River Near Pine Grove	WSC	02HC009	613893	4849532	30 min
4	Highland Creek Near West Hill	WSC	02HC013	645537	4848828	15 min
5	Etobicoke Creek At Brampton	WSC	02HC017	599979	4838366	15 min
6	Duffins Creek Above Pickering	WSC	02HC019	655881	4861629	5 min
7	Rouge River Near Markham	WSC	02HC022	641960	4857659	30 min
8	Cold Creek Near Bolton	WSC	02HC023	602812	4860483	15 min
9	Don River At Todmorden	WSC	02HC024	632057	4838288	15 min
10	Humber River At Elder Mills	WSC	02HC025	610381	4851832	30 min
11	Black Creek Near Weston	WSC	02HC027	620566	4836781	15 min
12	Little Rouge Creek Near Locust Hill	WSC	02HC028	643230	4863190	30 min
13	Etobicoke Creek Below Qew	WSC	02HC030	616517	4828655	15 min
14	West Humber River At Highway No. 7	WSC	02HC031	606344	4845883	15 min
15	East Humber River At King Creek	WSC	02HC032	611401	4862011	15 min
16	Mimico Creek At Islington	WSC	02HC033	619384	4833772	15 min
17	West Duffins Creek Above Green River	WSC	02HC038	646162	4864127	30 min
18	Humber River Near Palgrave	WSC	02HC047	594478	4864605	30 min
19	Duffins Creek At Ajax	WSC	02HC049	656246	4856927	30 min
20	Centreville Creek Near Albion	WSC	02HC051	593567	4864141	30 min
21	Little Rouge River Near Dicksons Hill	WSC	02HC053	637896	4865054	15 min
22	Don River East Branch Near Thornhill	WSC	02HC056	625590	4853801	15 min
23	Humber River Near Ballycroy	WSC	02HC057	589221	4869177	15 min
24	Claireville Dam	TRCA	HY014	610301	4843563	15 min
25	G Ross Dam	TRCA	HY027	623843	4847628	15 min
26	Milne Dam	TRCA	HY044	639672	4858742	15 min
27	Stouffville Dam	TRCA	HY060	640347	4870869	15 min
28	Black Creek at 401	TRCA	HY005	620281	4841719	15 min
29	Bolton McFall Dam	TRCA	HY006	601518	4859596	15 min
30	Brougham Creek	TRCA	HY010	654668	4863409	15 min
31	Carruthers at Achilles	TRCA	HY013	660490	4857744	15 min
32	Don at Glenshields	TRCA	HY017	622908	4850018	15 min
33	Don at Todmorden	TRCA	HY019	632064	4838284	15 min
34	East Don at York Mills	TRCA	HY022	633243	4846331	15 min
35	East Duffins at Claremont	TRCA	HY023	653994	4868084	15 min
36	Etobicoke at Dixie and Derry	TRCA	HY024	606743	4836865	15 min
37	Etobicoke Creek at Brampton	TRCA	HY026	599978	4838365	15 min
38	Ganetsekiagon Creek	TRCA	HY028	653822	4858843	15 min
39	Highland Cr - Malvern	TRCA	HY034	642295	4850971	15 min
40	Humber at Goreway	TRCA	HY035	604266	4846971	15 min
41	Krosno Creek	TRCA	HY040	654838	4854106	15 min
42	Mimico at Wildwood Park	TRCA	HY045	610348	4840698	15 min
43	Mitchell Creek at Claremont	TRCA	HY047	653691	4868213	15 min
44	Morningside at Finch	TRCA	HY048	643785	4853426	15 min
45	Petticoat CA	TRCA	HY051	652003	4851818	15 min
46	Pine Creek	TRCA	HY052	653715	4854297	15 min
47	Plunkett Creek	TRCA	HY053	612501	4848127	15 min
48	Purpleville Creek	TRCA	HY054	612643	4854651	15 min
49	Spring Creek	TRCA	HY059	606849	4838503	15 min
50	Taylor Creek South	TRCA	HY062	634702	4840085	15 min
51	Urfe Creek	TRCA	HY065	654730	4859181	15 min
52	West Duffins at Hwy7	TRCA	HY066	646080	4862510	15 min
53	West Humber at Hwy7	TRCA	HY067	606342	4845875	15 min
54	Wilket Creek	TRCA	HY068	632109	4843444	15 min
55	Don at Dundas	TRCA	HY079	632597	4835607	15 min
56	Taylor Creek North	TRCA	HY080	638983	4843456	15 min
57	Spring Creek North	TRCA	HY081	602922	4841805	15 min
58	Reesors Creek	TRCA	HY082	644399	4866311	15 min

APPENDIX E

METAR and Special Meteorological Reports at Toronto Pearson International Airport (CYYZ) on July 7 and 8, 2013

CYYZ, Toronto Pearson Int'L. Ont. (Canada).
WMO index: 71624. Latitude 43-40N. Longitude 079-38W.
Altitude 173 m.

METAR/SPECI from CYYZ, Toronto Pearson Int'L. Ont. (Canada).

SA	08/07/2013 12:00->	METAR CYYZ 081200Z 27004KT 10SM FEW160 SCT240 23/19 A3003 RMK AC2CI2 SLP166 DENSITY ALT 1400FT=
SA	08/07/2013 13:00->	METAR CYYZ 081300Z 29002KT 15SM SCT180 BKN250 24/20 A3003 RMK AC4CI2 SLP167 DENSITY ALT 1600FT=
SA	08/07/2013 14:00->	METAR CYYZ 081400Z 13004KT 130V220 12SM FEW080 BKN140 OVC250 26/20 A3003 RMK AC1AC6CI1 SLP167 DENSITY ALT 1800FT=
SA	08/07/2013 15:00->	METAR CYYZ 081500Z 21003KT 170V240 15SM FEW028 BKN090 OVC150 26/20 A3003 RMK CU1AC4AC3 SLP168 DENSITY ALT 1800FT=
SA	08/07/2013 16:00->	METAR CYYZ 081600Z 15007KT 11SM FEW030 BKN100 BKN160 OVC250 26/21 A3005 RMK CU1AC4AC2CI1 SLP173 DENSITY ALT 1800FT=
SA	08/07/2013 17:00->	METAR CYYZ 081700Z 15008KT 12SM FEW030TCU FEW100 OVC220 27/20 A3004 RMK TCU1AC1CI6 TCU SW-NW SLP169 DENSITY ALT 1900FT=
SA	08/07/2013 18:00->	METAR CYYZ 081800Z 14010KT 15SM FEW040 SCT100 BKN250 28/21 A3001 RMK CU2AC2CI3 SLP160 DENSITY ALT 2000FT=
SA	08/07/2013 19:00->	METAR CYYZ 081900Z 16008KT 12SM SCT040 BKN250 28/21 A2999 RMK CU4CI3 SLP154 DENSITY ALT 2100FT=
SA	08/07/2013 20:00->	METAR CYYZ 082000Z 16013KT 12SM SCT040TCU BKN100 BKN250 28/21 A2997 RMK TCU3AC2CI2 TCU S-N SLP148 DENSITY ALT 2100FT=
SP	08/07/2013 20:23->	*SPECI CYYZ 082023Z 15009KT 4SM -SHRA BKN038TCU BKN150 27/21 A2997 RMK TCU5AC2 VIS HIER NE-S SLP145 DENSITY ALT 2000FT=*
SP	08/07/2013 20:32->	*SPECI CYYZ 082032Z 22016KT 150V220 2 1/2SM R23/5500VP6000FT/D +SHRA OVC025TCU 25/20 A2998 RMK TCU8 PRESRR SLP150 DENSITY ALT 1800FT=*
SP	08/07/2013 20:37->	*SPECI CYYZ 082037Z 27010G20KT 170V270 3/4SM*

		R15L/2600FT/N R24R/6000FT/N R23/1800FT/N +SHRA OVC015TCU 23/20 A2999 RMK TCU8 WSHFT PRESRR SLP153 DENSITY ALT 1500FT=
SP	08/07/2013 20:40->	*SPECI CYYZ 082040Z 26008G20KT 200V270 1SM R15L/3000FT/N R24R/6000FT/D R23/2800FT/N +TSRA OVC024CB 23/19 A2999 RMK CB8 PRESRR SLP155 DENSITY ALT 1500FT=*
SP	08/07/2013 20:54->	*SPECI CYYZ 082054Z 05011G16KT 1SM R15L/3000FT/N +TSRA BKN008 OVC020CB 22/21 A2999 RMK CF5CB3 SLP153 DENSITY ALT 1400FT=*
SA	08/07/2013 21:00->	**METAR CYYZ 082100Z 06018KT 3/4SM R15L/2800VP6000FT/N +TSRA VV006 22/21 A2998 RMK RA8 /R16/ CB EMBD LTGIC SLP152 DENSITY ALT 1400FT=**
SP	08/07/2013 21:27->	*SPECI CYYZ 082127Z 01023KT 1/2SM R15L/3000V4500FT/U R05/3000V6000FT/U +TSRA VV005 22/21 A2999 RMK RA8 CB EMBD LTGIC +SHRA VRY HVY SLP155 DENSITY ALT 1400FT=*
SP	08/07/2013 21:37->	*SPECI CYYZ 082137Z 05020G26KT 1/4SM R15L/3000FT/N +TSRA VV003 21/20 A2999 RMK RA8 CB+LTNG OVRHD +SHRA VRY HVY SLP155 DENSITY ALT 1300FT=*
SP	08/07/2013 21:45->	*SPECI CYYZ 082145Z 06010G26KT 3/4SM R15L/3000V6000FT/U R06L/2600V4000FT/N +TSRA VV005 21/20 A3001 RMK RA8 CB EMBD LTNG OVRHD +SHRA VRY HVY PRESRR SLP161 DENSITY ALT 1300FT=*
SA	08/07/2013 22:00->	**METAR CYYZ 082200Z CCA 32021G32KT 3/4SM R06L/4000V5500FT/ R05/5000V6000FT/ +TSRA VV005 21/20 A3006 RMK RA8 /R90/OCNL LTGIC CB EMBD +SHRA VRY HVY WSHFT PRESRR SLP178 DENSITY ALT 1200FT=**
SP	08/07/2013 22:17->	*SPECI CYYZ 082217Z 01012G18KT 2SM +TSRA OVC010CB 21/20 A3004 RMK CB8 OCNL LTGIC WSHFT 2158 PRESRR SLP172 DENSITY ALT 1200FT=*
SP	08/07/2013 22:44->	*SPECI CYYZ 082244Z 07006KT 4SM +TSRA OVC015 21/20 A3004 RMK SC8 CB EMBD MVG E CIG BLN ESTD SLP172 DENSITY ALT 1200FT=*

SA	08/07/2013 23:00->	**METAR CYYZ 082300Z 08007KT 6SM -SHRA OVC020 21/20 A3004 RETSRA RMK SC8 CIG BLN ESTD /R94/ SLP172 DENSITY ALT 1200FT=**
SA	09/07/2013 00:00->	**METAR CYYZ 090000Z 36010KT 6SM TSRA OVC015 23/20 A3003 RMK SC8 /R106/ CB EMBD VIA CYOW SLP168 DENSITY ALT 1400FT=**
SP	09/07/2013 00:25->	***SPECI CYYZ 090025Z 03015KT 2SM +TSRA OVC015CB 22/ RMK CB8 WND ESTD VIA CYOW=***
SP	09/07/2013 00:43->	***SPECI CYYZ 090043Z 29015KT 4SM SHRA OVC015 22/ RETS RMK SC8 WND ESTD CB EMBD VIA CYOW=***
SA	09/07/2013 01:00->	**METAR CYYZ 090100Z 03010KT 7SM -SHRA BKN030 OVC040 22/ RETSRA RMK SC5SC3 WND ESTD VIA CYOW=**
SA	09/07/2013 02:00->	**METAR CYYZ 090200Z 03010KT 10SM -SHRA OVC050 22/ RMK SC8 /R17/ WND ESTD VIA CYOW=**
SA	09/07/2013 03:00->	**METAR CYYZ 090300Z 32004KT 12SM -RA FEW070 OVC130 20/19 A3002 RMK AC2AS6 SLP164 DENSITY ALT 1100FT=**
SA	09/07/2013 04:00->	**METAR CYYZ 090400Z 11004KT 15SM -RA FEW070 OVC110 20/19 A3003 RMK AC1AS7 SLP165 DENSITY ALT 1200FT=**
SP	09/07/2013 04:27->	***SPECI CYYZ 090427Z 16005KT 15SM FEW075 OVC120 20/19 A3003 RMK AC1AS7 SLP166 DENSITY ALT 1100FT=***
SA	09/07/2013 05:00->	**METAR CYYZ 090500Z 18005KT 9SM OVC140 20/19 A3003 RMK AS8 SLP165 DENSITY ALT 1100FT=**
SA	09/07/2013 06:00->	**METAR CYYZ 090600Z 00000KT 10SM OVC015 20/19 A3003 RMK ST8 SLP165 DENSITY ALT 1100FT=**
SA	09/07/2013 07:00->	**METAR CYYZ 090700Z 00000KT 9SM FEW010 OVC120 20/19 A3002 RMK ST2AS6 SLP163 DENSITY ALT 1100FT=**
SP	09/07/2013 07:19->	***SPECI CYYZ 090719Z 04002KT 9SM BKN006 OVC120 20/19 A3002 RMK SF5AS3 SLP162 DENSITY ALT 1100FT=***
SP	09/07/2013 07:49->	***SPECI CYYZ 090749Z CCA 07002KT 10SM FEW006 OVC011 20/19 A3002 RMK ST2SC6 SLP162 DENSITY ALT 1200FT=***
SA	09/07/2013 08:00->	**METAR CYYZ 090800Z 06002KT 10SM FEW007 OVC012 20/19 A3002 RMK ST1SC7 SLP163 DENSITY ALT**

		1100FT=
SA	09/07/2013 09:00->	**METAR CYYZ 090900Z 16003KT 9SM BKN010 BKN180 20/19 A3001 RMK ST5AC2 SLP160 DENSITY ALT 1200FT=**
SA	09/07/2013 10:00->	**METAR CYYZ 091000Z 12002KT 5SM BR BKN007 OVC011 21/19 A3002 RMK SF5SC3 SLP165 DENSITY ALT 1200FT=**
SA	09/07/2013 11:00->	**METAR CYYZ 091100Z 10004KT 5SM BR FEW007 OVC012 21/20 A3002 RMK SF2SC6 SLP165 DENSITY ALT 1300FT=**
SP	09/07/2013 11:39->	***SPECI CYYZ 091139Z 14003KT 5SM -SHRA BR BKN012 OVC025 22/20 A3002 RMK SC5SC3 SLP165 DENSITY ALT 1300FT=***
SA	09/07/2013 12:00->	**METAR CYYZ 091200Z 16005KT 5SM -SHRA BR FEW013 BKN024 BKN079 21/20 A3003 RMK CF2SC4AC1 SLP166 DENSITY ALT 1300FT=**
SA	09/07/2013 13:00->	**METAR CYYZ 091300Z 13005KT 3SM -RA BR FEW014 OVC031 21/20 A3003 RMK SF2SC6 SLP166 DENSITY ALT 1300FT=**
SP	09/07/2013 13:30->	***SPECI CYYZ 091330Z 12005KT 4SM BR SCT007 OVC032 22/20 A3002 RMK SF4SC4 SLP163 DENSITY ALT 1300FT=***
SA	09/07/2013 14:00->	**METAR CYYZ 091400Z 13006KT 6SM BR SCT009 OVC018 22/20 A3001 RMK SF4SC4 SLP162 DENSITY ALT 1400FT=**
SA	09/07/2013 15:00->	**METAR CYYZ 091500Z 15008KT 10SM OVC011 23/20 A3001 RMK SC8 SLP161 DENSITY ALT 1400FT=**
SP	09/07/2013 15:44->	***SPECI CYYZ 091544Z 14005KT 8SM BKN007 OVC012 22/21 A3000 RMK SC5SC3 SLP158 DENSITY ALT 1400FT=***
SA	09/07/2013 16:00->	**METAR CYYZ 091600Z 15006KT 8SM BKN007 OVC012 22/20 A3000 RMK SC5SC3 SLP158 DENSITY ALT 1400FT=**
SA	09/07/2013 17:00->	**METAR CYYZ 091700Z 12008KT 10SM SCT008 OVC012 23/21 A3000 RMK SC4SC4 SLP157 DENSITY ALT 1400FT=**
SA	09/07/2013 18:00->	**METAR CYYZ 091800Z 15006KT 10SM BKN007 OVC012 23/21 A2999 RMK SC5SC3 SLP155 DENSITY ALT 1500FT=**

APPENDIX F

Weather Forecasts Issued by Environment Canada for the July 8, 2013 Extreme Rainfall Event

FPCN11 CWTO 070500 AAG
UPDATED FORECASTS FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL REGION ISSUED BY ENVIRONMENT CANADA AT 12.59 AM EDT SUNDAY 7 JULY 2013 FOR TONIGHT SUNDAY AND SUNDAY NIGHT.
THE NEXT SCHEDULED FORECAST WILL BE ISSUED AT 5.00 AM.

CITY OF TORONTO.
TONIGHT..MAINLY CLOUDY. A FEW SHOWERS OVERNIGHT. LOW 21.
SUNDAY..A MIX OF SUN AND CLOUD. 30 PERCENT CHANCE OF SHOWERS IN THE AFTERNOON WITH RISK OF A THUNDERSTORM. WIND BECOMING SOUTHWEST 20 KM/H IN THE AFTERNOON. HIGH 28. UV INDEX 9 OR VERY HIGH.
SUNDAY NIGHT..PARTLY CLOUDY. 30 PERCENT CHANCE OF SHOWERS EARLY IN THE EVENING WITH RISK OF A THUNDERSTORM. WIND SOUTHWEST 20 KM/H BECOMING LIGHT IN THE EVENING. LOW 21.

FPCN11 CWTO 070846
FORECASTS FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL REGION ISSUED BY ENVIRONMENT CANADA AT 5.00 AM EDT SUNDAY 7 JULY 2013 FOR TODAY AND MONDAY.
THE NEXT SCHEDULED FORECAST WILL BE ISSUED AT 11.00 AM.

CITY OF TORONTO.
TODAY..MAINLY CLOUDY. 40 PERCENT CHANCE OF SHOWERS. RISK OF A THUNDERSTORM THIS AFTERNOON. HIGH 28. UV INDEX 7 OR HIGH.
TONIGHT..PARTLY CLOUDY. 40 PERCENT CHANCE OF SHOWERS EARLY THIS EVENING WITH RISK OF A THUNDERSTORM. LOW 22.
MONDAY..MAINLY CLOUDY. 60 PERCENT CHANCE OF SHOWERS IN THE AFTERNOON AND EVENING WITH RISK OF A THUNDERSTORM. HIGH 27.

FPCN11 CWTO 071445
FORECASTS FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL REGION ISSUED BY ENVIRONMENT CANADA AT 11.00 AM EDT SUNDAY 7 JULY 2013 FOR TODAY AND MONDAY.
THE NEXT SCHEDULED FORECAST WILL BE ISSUED AT 3.30 PM.

CITY OF TORONTO.
TODAY..MAINLY CLOUDY WITH 60 PERCENT CHANCE OF SHOWERS. RISK OF A THUNDERSTORM THIS AFTERNOON. WIND BECOMING SOUTHWEST 20 KM/H THIS AFTERNOON. HIGH 28. UV INDEX 6 OR HIGH.
TONIGHT..PARTLY CLOUDY. 60 PERCENT CHANCE OF SHOWERS EARLY THIS EVENING WITH RISK OF A THUNDERSTORM. WIND SOUTHWEST 20 KM/H BECOMING LIGHT THIS EVENING. LOW 22.
MONDAY..MAINLY CLOUDY. 60 PERCENT CHANCE OF SHOWERS IN THE AFTERNOON AND EVENING WITH RISK OF A THUNDERSTORM. HIGH 27.

FPCN11 CWTO 071916
FORECASTS FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL REGION ISSUED BY ENVIRONMENT CANADA AT 3.30 PM EDT SUNDAY 7 JULY 2013 FOR TONIGHT MONDAY AND MONDAY NIGHT.
THE NEXT SCHEDULED FORECAST WILL BE ISSUED AT 5.00 AM MONDAY.

CITY OF TORONTO.
TONIGHT..PARTLY CLOUDY. 60 PERCENT CHANCE OF SHOWERS EARLY THIS
EVENING WITH RISK OF A THUNDERSTORM. WIND SOUTHWEST 20 KM/H BECOMING
LIGHT THIS EVENING. LOW 21.
MONDAY..A MIX OF SUN AND CLOUD. 60 PERCENT CHANCE OF SHOWERS IN THE
AFTERNOON WITH RISK OF A THUNDERSTORM. HIGH 29. UV INDEX 9 OR VERY
HIGH.
MONDAY NIGHT..PARTLY CLOUDY. 60 PERCENT CHANCE OF SHOWERS IN THE
EVENING WITH RISK OF A THUNDERSTORM. LOW 20.

FPCN11 CWTO 072005 AAA
UPDATED FORECASTS FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL
REGION ISSUED BY ENVIRONMENT CANADA AT 4.04 PM EDT SUNDAY 7 JULY 2013
FOR TONIGHT MONDAY AND MONDAY NIGHT.
THE NEXT SCHEDULED FORECAST WILL BE ISSUED AT 5.00 AM MONDAY.

CITY OF TORONTO.
TONIGHT..SHOWERS ENDING THIS EVENING THEN PARTLY CLOUDY. RISK OF A
THUNDERSTORM EARLY THIS EVENING. WIND SOUTHWEST 20 KM/H BECOMING
LIGHT THIS EVENING. LOW 21.
MONDAY..A MIX OF SUN AND CLOUD. 60 PERCENT CHANCE OF SHOWERS IN THE
AFTERNOON WITH RISK OF A THUNDERSTORM. HIGH 29. UV INDEX 9 OR VERY
HIGH.
MONDAY NIGHT..PARTLY CLOUDY. 60 PERCENT CHANCE OF SHOWERS IN THE
EVENING WITH RISK OF A THUNDERSTORM. LOW 20.

FPCN11 CWTO 080845
FORECASTS FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL REGION ISSUED
BY ENVIRONMENT CANADA AT 5.00 AM EDT MONDAY 8 JULY 2013 FOR TODAY AND
TUESDAY.
THE NEXT SCHEDULED FORECAST WILL BE ISSUED AT 11.00 AM.

CITY OF TORONTO.
TODAY..MAINLY CLOUDY. A FEW SHOWERS BEGINNING THIS AFTERNOON. RISK OF
THUNDERSTORMS THIS AFTERNOON. HIGH 28. UV INDEX 7 OR HIGH.
TONIGHT..A FEW SHOWERS ENDING THIS EVENING THEN MAINLY CLOUDY WITH
40 PERCENT CHANCE OF SHOWERS. RISK OF THUNDERSTORMS EARLY THIS
EVENING. LOW 21.
TUESDAY..A MIX OF SUN AND CLOUD. 40 PERCENT CHANCE OF SHOWERS IN THE
MORNING AND AFTERNOON. RISK OF THUNDERSTORMS LATE IN THE MORNING AND
IN THE AFTERNOON. HIGH 29.

FPCN11 CWTO 081212 AAB
UPDATED FORECASTS FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL
REGION ISSUED BY ENVIRONMENT CANADA AT 8.11 AM EDT MONDAY 8 JULY 2013
FOR TODAY AND TUESDAY.
THE NEXT SCHEDULED FORECAST WILL BE ISSUED AT 11.00 AM.

CITY OF TORONTO.

TODAY..INCREASING CLOUDINESS. A FEW SHOWERS BEGINNING THIS AFTERNOON.
 RISK OF THUNDERSTORMS THIS AFTERNOON. HIGH 28. UV INDEX 5 OR
 MODERATE.
TONIGHT..A FEW SHOWERS ENDING THIS EVENING THEN MAINLY CLOUDY WITH
 40 PERCENT CHANCE OF SHOWERS. RISK OF THUNDERSTORMS EARLY THIS
 EVENING. LOW 21.
TUESDAY..A MIX OF SUN AND CLOUD. 40 PERCENT CHANCE OF SHOWERS IN THE
 MORNING AND AFTERNOON. RISK OF THUNDERSTORMS LATE IN THE MORNING AND
 IN THE AFTERNOON. HIGH 29.

FPCN11 CWTO 081445
FORECASTS FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL REGION ISSUED
BY ENVIRONMENT CANADA AT 11.00 AM EDT MONDAY 8 JULY 2013 FOR TODAY
AND TUESDAY.
THE NEXT SCHEDULED FORECAST WILL BE ISSUED AT 3.30 PM.

CITY OF TORONTO.
TODAY..A MIX OF SUN AND CLOUD. A FEW SHOWERS BEGINNING THIS
 AFTERNOON. RISK OF THUNDERSTORMS THIS AFTERNOON. HIGH 29. UV INDEX 9
 OR VERY HIGH.
TONIGHT..A FEW SHOWERS ENDING THIS EVENING THEN MAINLY CLOUDY WITH
 40 PERCENT CHANCE OF SHOWERS. RISK OF THUNDERSTORMS EARLY THIS
 EVENING. LOW 21.
TUESDAY..MAINLY CLOUDY. 40 PERCENT CHANCE OF SHOWERS IN THE MORNING
 AND AFTERNOON. RISK OF THUNDERSTORMS LATE IN THE MORNING AND IN THE
 AFTERNOON. HIGH 29.

FPCN11 CWTO 081916
FORECASTS FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL REGION ISSUED
BY ENVIRONMENT CANADA AT 3.30 PM EDT MONDAY 8 JULY 2013 FOR TONIGHT
TUESDAY AND TUESDAY NIGHT.
THE NEXT SCHEDULED FORECAST WILL BE ISSUED AT 5.00 AM TUESDAY.

CITY OF TORONTO
VAUGHAN - RICHMOND HILL - MARKHAM
PICKERING - OSHAWA - SOUTHERN DURHAM REGION.
TONIGHT..INCREASING CLOUDINESS. A FEW SHOWERS EARLY THIS EVENING THEN
 40 PERCENT CHANCE OF SHOWERS OVERNIGHT. RISK OF THUNDERSTORMS EARLY
 THIS EVENING. LOW 20.
TUESDAY..MAINLY CLOUDY WITH 60 PERCENT CHANCE OF SHOWERS. RISK OF
 THUNDERSTORMS IN THE AFTERNOON. HIGH 27. UV INDEX 6 OR HIGH.
TUESDAY NIGHT..CLOUDY WITH 40 PERCENT CHANCE OF SHOWERS IN THE
 EVENING THEN PARTLY CLOUDY. RISK OF THUNDERSTORMS IN THE EVENING.
 LOW 21.

FPCN11 CWTO 082115 AAA
UPDATED FORECASTS FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL
REGION ISSUED BY ENVIRONMENT CANADA AT 5.14 PM EDT MONDAY 8 JULY 2013
FOR TONIGHT TUESDAY AND TUESDAY NIGHT.
THE NEXT SCHEDULED FORECAST WILL BE ISSUED AT 5.00 AM TUESDAY.

CITY OF TORONTO
VAUGHAN - RICHMOND HILL - MARKHAM.
TONIGHT..SHOWERS AT TIMES HEAVY WITH THUNDERSTORMS ENDING THIS
 EVENING THEN MAINLY CLOUDY WITH 40 PERCENT CHANCE OF SHOWERS.
 LOW 20.
TUESDAY..MAINLY CLOUDY WITH 60 PERCENT CHANCE OF SHOWERS. RISK OF
 THUNDERSTORMS IN THE AFTERNOON. HIGH 27. UV INDEX 6 OR HIGH.
TUESDAY NIGHT..CLOUDY WITH 40 PERCENT CHANCE OF SHOWERS IN THE
 EVENING THEN PARTLY CLOUDY. RISK OF THUNDERSTORMS IN THE EVENING.
 LOW 21.

FPCN11 CWTO 090135 AAB
UPDATED FORECASTS FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL
REGION ISSUED BY ENVIRONMENT CANADA AT 9.34 PM EDT MONDAY 8 JULY 2013
FOR TONIGHT TUESDAY AND TUESDAY NIGHT.
THE NEXT SCHEDULED FORECAST WILL BE ISSUED AT 5.00 AM TUESDAY.

CITY OF TORONTO
VAUGHAN - RICHMOND HILL - MARKHAM.
TONIGHT..SHOWERS WITH THUNDERSTORMS ENDING NEAR MIDNIGHT THEN MAINLY
 CLOUDY WITH 40 PERCENT CHANCE OF SHOWERS. LOW 20.
TUESDAY..MAINLY CLOUDY WITH 60 PERCENT CHANCE OF SHOWERS. RISK OF
 THUNDERSTORMS IN THE AFTERNOON. HIGH 27. UV INDEX 6 OR HIGH.
TUESDAY NIGHT..CLOUDY WITH 40 PERCENT CHANCE OF SHOWERS IN THE
 EVENING THEN PARTLY CLOUDY. RISK OF THUNDERSTORMS IN THE EVENING.
 LOW 21.

FPCN11 CWTO 090846
FORECASTS FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL REGION ISSUED
BY ENVIRONMENT CANADA AT 5.00 AM EDT TUESDAY 9 JULY 2013 FOR TODAY
AND WEDNESDAY.
THE NEXT SCHEDULED FORECAST WILL BE ISSUED AT 11.00 AM.

CITY OF TORONTO.
TODAY..MAINLY CLOUDY WITH 60 PERCENT CHANCE OF SHOWERS. RISK OF A
 THUNDERSTORM THIS AFTERNOON. HIGH 25. UV INDEX 6 OR HIGH.
TONIGHT..PARTLY CLOUDY WITH 40 PERCENT CHANCE OF SHOWERS. RISK OF A
 THUNDERSTORM EARLY THIS EVENING. LOW 21.
WEDNESDAY..MAINLY CLOUDY. A FEW SHOWERS WITH THUNDERSTORMS BEGINNING
 IN THE MORNING AND ENDING LATE IN THE AFTERNOON THEN 30 PERCENT
 CHANCE OF SHOWERS LATE IN THE AFTERNOON AND EARLY IN THE EVENING.
 WIND BECOMING WEST 30 KM/H LATE IN THE MORNING. HIGH 28.

APPENDIX G

Special Weather Statements, Weather Alerts, Advisories, Watches, and Warnings Issued by Environment Canada on July 8, 2013

WOCN11 CWTO 081731
SPECIAL WEATHER STATEMENT ISSUED BY ENVIRONMENT CANADA AT **1:31 PM** EDT MONDAY 8 JULY 2013.

SPECIAL WEATHER STATEMENT FOR:
=NEW= CALEDON
=NEW= YORK - DURHAM
=NEW= MOUNT FOREST - ARTHUR - NORTHERN WELLINGTON COUNTY =NEW= DUFFERIN - INNISFIL =NEW= HANOVER - DUNDALK - SOUTHERN GREY COUNTY =NEW= OWEN SOUND - BLUE MOUNTAINS - NORTHERN GREY COUNTY =NEW= BARRIE - ORILLIA - MIDLAND =NEW= BELLEVILLE - QUINTE - NORTHUMBERLAND =NEW= KINGSTON - PRINCE EDWARD =NEW= PETERBOROUGH - KAWARTHA LAKES =NEW= STIRLING - TWEED - SOUTH FRONTENAC.

LOCAL HEAVY DOWNPOURS THIS AFTERNOON.

==DISCUSSION==
LOCAL HEAVY DOWNPOURS GIVING **30 TO 40 MILLIMETRES** OF RAIN IN LESS THAN ONE HOUR ARE LIKELY IN THE ABOVE REGIONS. THESE HEAVY SHOWERS MAY OR MAY NOT BE ASSOCIATED WITH THUNDERSTORMS AND MAY OCCUR SUDDENLY. REDUCED VISIBILITY IN HEAVY RAIN IS ALSO POSSIBLE.
TRAVELLERS SHOULD USE CAUTION IN AREAS OF HEAVY RAIN THIS EVENING.
END

The severe weather statement was extended to include the city of Toronto at 2:16 pm EDT.

WOCN11 CWTO 081816
SPECIAL WEATHER STATEMENT UPDATED BY ENVIRONMENT CANADA AT **2:16 PM** EDT MONDAY 8 JULY 2013.

SPECIAL WEATHER STATEMENT FOR:
=NEW= CITY OF TORONTO
=NEW= BURLINGTON - OAKVILLE
=NEW= HALTON HILLS - MILTON
=NEW= MISSISSAUGA - BRAMPTON
=NEW= HURON - PERTH
=NEW= KITCHENER - CAMBRIDGE - REGION OF WATERLOO =NEW= GUELPH - ERIN - SOUTHERN WELLINGTON COUNTY
CALEDON
YORK - DURHAM
MOUNT FOREST - ARTHUR - NORTHERN WELLINGTON COUNTY
…
KINGSTON - PRINCE EDWARD
PETERBOROUGH - KAWARTHA LAKES
STIRLING - TWEED - SOUTH FRONTENAC.

LOCAL HEAVY DOWNPOURS POSSIBLE THIS AFTERNOON.

==DISCUSSION==

LOCAL HEAVY DOWNPOURS GIVING **30 TO 40 MILLIMETRES** OF RAIN IN LESS THAN ONE HOUR …

WWCN51 CWTO 081840
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 2:40 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - ISSUED AT 2:34 PM EDT MONDAY 8 JULY 2013 FOR:
=NEW= INNISFIL - NEW TECUMSETH - ANGUS
=NEW= BARRIE - COLLINGWOOD - HILLSDALE.

AT 2:30 PM EDT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF SEVERE THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING LOCALIZED FLOODING.

COMMUNITIES IN THE PATH INCLUDE: ANGUS AND BARRIE

A WEATHER WATCHER REPORTED 50 MM OF RAIN IN 30 MINUTES IN THE ANGUS AREA.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 081855
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 2:55 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - ISSUED AT 2:34 PM EDT MONDAY 8 JULY 2013 FOR:
=NEW= INNISFIL - NEW TECUMSETH - ANGUS
=NEW= BARRIE - COLLINGWOOD - HILLSDALE.

AT 2:30 PM EDT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF SEVERE THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING

LOCALIZED FLOODING.

COMMUNITIES IN THE PATH INCLUDE: ANGUS AND BARRIE

A WEATHER WATCHER REPORTED 50 MM OF RAIN IN 30 MINUTES IN THE ANGUS AREA.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 081910
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 3:10 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - ISSUED AT 2:34 PM EDT MONDAY 8 JULY 2013 FOR:
=NEW= INNISFIL - NEW TECUMSETH - ANGUS
=NEW= BARRIE - COLLINGWOOD - HILLSDALE.

AT 2:30 PM EDT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF SEVERE THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING LOCALIZED FLOODING.

COMMUNITIES IN THE PATH INCLUDE: ANGUS AND BARRIE

A WEATHER WATCHER REPORTED 50 MM OF RAIN IN 30 MINUTES IN THE ANGUS AREA.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 081925
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 3:25 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO

AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - UPDATED AT 3:17 PM EDT MONDAY 8 JULY 2013 FOR:
INNISFIL - NEW TECUMSETH - ANGUS
BARRIE - COLLINGWOOD - HILLSDALE.

AT 3:15 PM EDT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF SEVERE THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING LOCALIZED FLOODING.

COMMUNITIES IN THE PATH INCLUDE: ANGUS, BARRIE AND COOKSTOWN.

AT 2:30 PM, A WEATHER WATCHER REPORTED 50 MM OF RAIN IN 30 MINUTES IN THE ANGUS AREA.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 081940
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 3:40 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - UPDATED AT 3:17 PM EDT MONDAY 8 JULY 2013 FOR:
INNISFIL - NEW TECUMSETH - ANGUS
BARRIE - COLLINGWOOD - HILLSDALE.

AT 3:15 PM EDT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF SEVERE THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING LOCALIZED FLOODING.

COMMUNITIES IN THE PATH INCLUDE: ANGUS, BARRIE AND COOKSTOWN.

AT 2:30 PM, A WEATHER WATCHER REPORTED 50 MM OF RAIN IN 30 MINUTES IN THE ANGUS AREA.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 081955
ALERT MESSAGE SUMMARY

ISSUED BY ENVIRONMENT CANADA
AT 3:55 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT
EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE
ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO
AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - UPDATED AT 3:17 PM EDT MONDAY 8 JULY
2013 FOR:
      INNISFIL - NEW TECUMSETH - ANGUS
      BARRIE - COLLINGWOOD - HILLSDALE.

AT 3:15 PM EDT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF
SEVERE THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING
LOCALIZED FLOODING.

COMMUNITIES IN THE PATH INCLUDE: ANGUS, BARRIE AND COOKSTOWN.

AT 2:30 PM, A WEATHER WATCHER REPORTED 50 MM OF RAIN IN 30 MINUTES
IN THE ANGUS AREA.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL
REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 082010
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 4:10 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT
EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE
ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO
AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - UPDATED AT 3:56 PM EDT MONDAY 8 JULY
2013 FOR:
      BARRIE - COLLINGWOOD - HILLSDALE.

AT 3:50 PM EDT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF
SEVERE THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING
LOCALIZED FLOODING. THIS CLUSTER WILL MOVE INTO THE COLLINGWOOD AREA
BY 4:00 PM ADDING TO AREAS THAT MAY HAVE ALREADY RECEIVED BETWEEN 50
AND 75 MM.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL
REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 082025
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 4:25 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - UPDATED AT 3:56 PM EDT MONDAY 8 JULY 2013 FOR:
BARRIE - COLLINGWOOD - HILLSDALE.

AT 3:50 PM EDT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF SEVERE THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING LOCALIZED FLOODING. THIS CLUSTER WILL MOVE INTO THE COLLINGWOOD AREA BY 4:00 PM ADDING TO AREAS THAT MAY HAVE ALREADY RECEIVED BETWEEN 50 AND 75 MM.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 082040
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 4:40 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - UPDATED AT 3:56 PM EDT MONDAY 8 JULY 2013 FOR:
BARRIE - COLLINGWOOD - HILLSDALE.

AT 3:50 PM EDT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF SEVERE THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING LOCALIZED FLOODING. THIS CLUSTER WILL MOVE INTO THE COLLINGWOOD AREA BY 4:00 PM ADDING TO AREAS THAT MAY HAVE ALREADY RECEIVED BETWEEN 50 AND 75 MM.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 082055
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 4:55 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT
EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE
ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO
AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - ISSUED AT 4:46 PM EDT MONDAY 8 JULY
2013 FOR:
=NEW= INNISFIL - NEW TECUMSETH - ANGUS
BARRIE - COLLINGWOOD - HILLSDALE.

AT 4:45 PM EDT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF
SEVERE THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING
LOCALIZED FLOODING.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL
REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 082110
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 5:10 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT
EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE
ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO
AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - ISSUED AT 4:46 PM EDT MONDAY 8 JULY
2013 FOR:
=NEW= INNISFIL - NEW TECUMSETH - ANGUS
BARRIE - COLLINGWOOD - HILLSDALE.

AT 4:45 PM EDT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF
SEVERE THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING
LOCALIZED FLOODING.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL
REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 082125
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 5:25 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT
EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE
ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO
AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - UPDATED AT 5:20 PM EDT MONDAY 8 JULY
2013 FOR:
      INNISFIL - NEW TECUMSETH - ANGUS
      BARRIE - COLLINGWOOD - HILLSDALE.

AT 5:20 PM EDT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF
SEVERE THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING
LOCALIZED FLOODING.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL
REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 082140
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 5:40 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT
EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE
ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO
AND THE NATIONAL CAPITAL REGION.

NO ACTIVE TORNADO WARNINGS.
NO ACTIVE SEVERE THUNDERSTORM WARNINGS.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON ALL REMAINING PUBLIC
WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 082155
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 5:55 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT
EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE
ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO
AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - ISSUED AT 5:51 PM EDT MONDAY 8 JULY
2013 FOR:
=NEW= VAUGHAN - RICHMOND HILL - MARKHAM
=NEW= CITY OF TORONTO
=NEW= MISSISSAUGA - BRAMPTON.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL
REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 082210
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 6:10 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT
EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE
ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO
AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - ISSUED AT 6:03 PM EDT MONDAY 8 JULY
2013 FOR:
=NEW= HANOVER - DUNDALK - SOUTHERN GREY COUNTY
=NEW= SHELBURNE - MANSFIELD - NORTHERN DUFFERIN COUNTY.

AT 6:00 PM EDT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF
THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING
LOCALIZED FLOODING.

AFFECTED COMMUNITIES IN THE PATH INCLUDE: MARKDALE, FLESHERTON,
DUNDALK, SHELBURNE.
SEVERE THUNDERSTORM WARNING - UPDATED AT 5:51 PM EDT MONDAY 8 JULY
2013 FOR:
      VAUGHAN - RICHMOND HILL - MARKHAM
      CITY OF TORONTO
      MISSISSAUGA - BRAMPTON.

AT 5:45DT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF
THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING
LOCALIZED FLASH FLOODING. THE THUNDERSTORMS ARE OVER THE MISSISSAUGA
AND BRAMPTON REGIONS AND MOVING SLOWLY EASTWARD TOWARD MARKHAM,
RICHMOND HILL AND TORONTO.

THESE THUNDERSTORMS WILL PASS OVER AREAS WHICH HAVE ALREADY RECEIVED
OVER 30 MM OF RAIN FROM PREVIOUS STORMS. TOTAL RAINFALL AMOUNTS
COULD LOCALLY REACH 50 TO 75 MM.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL

REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 082225
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 6:25 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - ISSUED AT 6:03 PM EDT MONDAY 8 JULY 2013 FOR:
=NEW= HANOVER - DUNDALK - SOUTHERN GREY COUNTY
=NEW= SHELBURNE - MANSFIELD - NORTHERN DUFFERIN COUNTY.

AT 6:00 PM EDT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING LOCALIZED FLOODING.

AFFECTED COMMUNITIES IN THE PATH INCLUDE: MARKDALE, FLESHERTON, DUNDALK, SHELBURNE.
SEVERE THUNDERSTORM WARNING - UPDATED AT 5:51 PM EDT MONDAY 8 JULY 2013 FOR:
VAUGHAN - RICHMOND HILL - MARKHAM
CITY OF TORONTO
MISSISSAUGA - BRAMPTON.

AT 5:45DT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING LOCALIZED FLASH FLOODING. THE THUNDERSTORMS ARE OVER THE MISSISSAUGA AND BRAMPTON REGIONS AND MOVING SLOWLY EASTWARD TOWARD MARKHAM, RICHMOND HILL AND TORONTO.

THESE THUNDERSTORMS WILL PASS OVER AREAS WHICH HAVE ALREADY RECEIVED OVER 30 MM OF RAIN FROM PREVIOUS STORMS. TOTAL RAINFALL AMOUNTS COULD LOCALLY REACH 50 TO 75 MM.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 082240
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 6:40 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO
AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - ISSUED AT 6:03 PM EDT MONDAY 8 JULY
2013 FOR:
=NEW= HANOVER - DUNDALK - SOUTHERN GREY COUNTY
=NEW= SHELBURNE - MANSFIELD - NORTHERN DUFFERIN COUNTY.

AT 6:00 PM EDT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF
THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING
LOCALIZED FLOODING.

AFFECTED COMMUNITIES IN THE PATH INCLUDE: MARKDALE, FLESHERTON,
DUNDALK, SHELBURNE.
SEVERE THUNDERSTORM WARNING - UPDATED AT 5:51 PM EDT MONDAY 8 JULY
2013 FOR:
      VAUGHAN - RICHMOND HILL - MARKHAM
      CITY OF TORONTO
      MISSISSAUGA - BRAMPTON.

AT 5:45DT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF
THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING
LOCALIZED FLASH FLOODING. THE THUNDERSTORMS ARE OVER THE MISSISSAUGA
AND BRAMPTON REGIONS AND MOVING SLOWLY EASTWARD TOWARD MARKHAM,
RICHMOND HILL AND TORONTO.

THESE THUNDERSTORMS WILL PASS OVER AREAS WHICH HAVE ALREADY RECEIVED
OVER 30 MM OF RAIN FROM PREVIOUS STORMS. TOTAL RAINFALL AMOUNTS
COULD LOCALLY REACH 50 TO 75 MM.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL
REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 082255
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 6:55 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT
EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE
ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO
AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - ISSUED AT 6:03 PM EDT MONDAY 8 JULY
2013 FOR:
=NEW= HANOVER - DUNDALK - SOUTHERN GREY COUNTY
=NEW= SHELBURNE - MANSFIELD - NORTHERN DUFFERIN COUNTY.

AT 6:00 PM EDT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF
THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING

LOCALIZED FLOODING.

AFFECTED COMMUNITIES IN THE PATH INCLUDE: MARKDALE, FLESHERTON,
DUNDALK, SHELBURNE.
SEVERE THUNDERSTORM WARNING - UPDATED AT 5:51 PM EDT MONDAY 8 JULY
2013 FOR:
      VAUGHAN - RICHMOND HILL - MARKHAM
      CITY OF TORONTO
      MISSISSAUGA - BRAMPTON.

AT 5:45DT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF
THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING
LOCALIZED FLASH FLOODING. THE THUNDERSTORMS ARE OVER THE MISSISSAUGA
AND BRAMPTON REGIONS AND MOVING SLOWLY EASTWARD TOWARD MARKHAM,
RICHMOND HILL AND TORONTO.

THESE THUNDERSTORMS WILL PASS OVER AREAS WHICH HAVE ALREADY RECEIVED
OVER 30 MM OF RAIN FROM PREVIOUS STORMS. TOTAL RAINFALL AMOUNTS
COULD LOCALLY REACH 50 TO 75 MM.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL
REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 082310
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 7:10 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT
EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE
ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO
AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - UPDATED AT 7:09 PM EDT MONDAY 8 JULY
2013 FOR:
      CITY OF TORONTO
      VAUGHAN - RICHMOND HILL - MARKHAM
      MISSISSAUGA - BRAMPTON.
SEVERE THUNDERSTORM WARNING - UPDATED AT 6:03 PM EDT MONDAY 8 JULY
2013 FOR:
      HANOVER - DUNDALK - SOUTHERN GREY COUNTY
      SHELBURNE - MANSFIELD - NORTHERN DUFFERIN COUNTY.

AT 6:00 PM EDT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF
THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING
LOCALIZED FLOODING.

AFFECTED COMMUNITIES IN THE PATH INCLUDE: MARKDALE, FLESHERTON,
DUNDALK, SHELBURNE.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL

REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 082325
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 7:25 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - UPDATED AT 7:09 PM EDT MONDAY 8 JULY 2013 FOR:
CITY OF TORONTO
VAUGHAN - RICHMOND HILL - MARKHAM
MISSISSAUGA - BRAMPTON.

METEOROLOGISTS CONTINUE TO MONITOR SLOW MOVING THUNDERSTORMS WITH TORRENTIAL DOWNPOURS THAT HAVE BEEN PRODUCING SIGNIFICANT FLASH FLOODING IN THE REGIONS.

TOTAL RAINFALL AMOUNTS OVER 90 MM HAVE BEEN REPORTED IN SOME LOCATIONS THUS FAR, AND WILL LIKELY EXCEED 100 MM BEFORE THE RAINFALL TAPERS OFF LATER THIS EVENING.
SEVERE THUNDERSTORM WARNING - UPDATED AT 6:03 PM EDT MONDAY 8 JULY 2013 FOR:
HANOVER - DUNDALK - SOUTHERN GREY COUNTY
SHELBURNE - MANSFIELD - NORTHERN DUFFERIN COUNTY.

AT 6:00 PM EDT, METEOROLOGISTS ARE TRACKING A SLOW MOVING CLUSTER OF THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING LOCALIZED FLOODING.

AFFECTED COMMUNITIES IN THE PATH INCLUDE: MARKDALE, FLESHERTON, DUNDALK, SHELBURNE.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 082340
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 7:40 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO
AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - UPDATED AT 7:09 PM EDT MONDAY 8 JULY
2013 FOR:
      CITY OF TORONTO
      VAUGHAN - RICHMOND HILL - MARKHAM
      MISSISSAUGA - BRAMPTON.

METEOROLOGISTS CONTINUE TO MONITOR SLOW MOVING THUNDERSTORMS WITH
TORRENTIAL DOWNPOURS THAT HAVE BEEN PRODUCING SIGNIFICANT FLASH
FLOODING IN THE REGIONS.

TOTAL RAINFALL AMOUNTS OVER 90 MM HAVE BEEN REPORTED IN SOME
LOCATIONS THUS FAR, AND WILL LIKELY EXCEED 100 MM BEFORE THE
RAINFALL TAPERS OFF LATER THIS EVENING.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL
REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 082355
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 7:55 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT
EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE
ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO
AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - UPDATED AT 7:09 PM EDT MONDAY 8 JULY
2013 FOR:
      CITY OF TORONTO
      VAUGHAN - RICHMOND HILL - MARKHAM
      MISSISSAUGA - BRAMPTON.

METEOROLOGISTS CONTINUE TO MONITOR SLOW MOVING THUNDERSTORMS WITH
TORRENTIAL DOWNPOURS THAT HAVE BEEN PRODUCING SIGNIFICANT FLASH
FLOODING IN THE REGIONS.

TOTAL RAINFALL AMOUNTS OVER 90 MM HAVE BEEN REPORTED IN SOME
LOCATIONS THUS FAR, AND WILL LIKELY EXCEED 100 MM BEFORE THE
RAINFALL TAPERS OFF LATER THIS EVENING.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL
REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 090010
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 8:10 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT
EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE
ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO
AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - ISSUED AT 8:03 PM EDT MONDAY 8 JULY
2013 FOR:
=NEW= CALEDON
=NEW= ORANGEVILLE - GRAND VALLEY - SOUTHERN DUFFERIN COUNTY
=NEW= HANOVER - DUNDALK - SOUTHERN GREY COUNTY
CITY OF TORONTO
MISSISSAUGA - BRAMPTON.

METEOROLOGISTS CONTINUE TO MONITOR SLOW MOVING THUNDERSTORMS WITH
TORRENTIAL DOWNPOURS THAT HAVE BEEN PRODUCING SIGNIFICANT FLASH
FLOODING IN THE REGIONS.

RAINFALL AMOUNTS OVER 90 MM HAVE BEEN REPORTED IN PARTS OF THE
GREATER TORONTO AREA THUS FAR, AND WILL LIKELY EXCEED 100 MM BEFORE
THE RAINFALL TAPERS OFF LATE THIS EVENING.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL
REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 090025
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 8:25 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT
EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE
ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO
AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - ISSUED AT 8:03 PM EDT MONDAY 8 JULY
2013 FOR:
=NEW= CALEDON
=NEW= ORANGEVILLE - GRAND VALLEY - SOUTHERN DUFFERIN COUNTY
=NEW= HANOVER - DUNDALK - SOUTHERN GREY COUNTY
CITY OF TORONTO
MISSISSAUGA - BRAMPTON.

METEOROLOGISTS CONTINUE TO MONITOR SLOW MOVING THUNDERSTORMS WITH
TORRENTIAL DOWNPOURS THAT HAVE BEEN PRODUCING SIGNIFICANT FLASH

FLOODING IN THE REGIONS.

RAINFALL AMOUNTS OVER 90 MM HAVE BEEN REPORTED IN PARTS OF THE
GREATER TORONTO AREA THUS FAR, AND WILL LIKELY EXCEED 100 MM BEFORE
THE RAINFALL TAPERS OFF LATE THIS EVENING.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL
REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 090040
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 8:40 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT
EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE
ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO
AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - ISSUED AT 8:03 PM EDT MONDAY 8 JULY
2013 FOR:
=NEW= CALEDON
=NEW= ORANGEVILLE - GRAND VALLEY - SOUTHERN DUFFERIN COUNTY
=NEW= HANOVER - DUNDALK - SOUTHERN GREY COUNTY
      CITY OF TORONTO
      MISSISSAUGA - BRAMPTON.

METEOROLOGISTS CONTINUE TO MONITOR SLOW MOVING THUNDERSTORMS WITH
TORRENTIAL DOWNPOURS THAT HAVE BEEN PRODUCING SIGNIFICANT FLASH
FLOODING IN THE REGIONS.

RAINFALL AMOUNTS OVER 90 MM HAVE BEEN REPORTED IN PARTS OF THE
GREATER TORONTO AREA THUS FAR, AND WILL LIKELY EXCEED 100 MM BEFORE
THE RAINFALL TAPERS OFF LATE THIS EVENING.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL
REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 090055
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 8:55 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT
EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE
ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO

AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - ISSUED AT 8:47 PM EDT MONDAY 8 JULY
2013 FOR:
=NEW= GUELPH - ERIN - SOUTHERN WELLINGTON COUNTY
=NEW= HALTON HILLS - MILTON
      CITY OF TORONTO
      CALEDON
      ORANGEVILLE - GRAND VALLEY - SOUTHERN DUFFERIN COUNTY
      MISSISSAUGA - BRAMPTON
      HANOVER - DUNDALK - SOUTHERN GREY COUNTY.

METEOROLOGISTS CONTINUE TO MONITOR SLOW MOVING THUNDERSTORMS WITH
TORRENTIAL DOWNPOURS THAT HAVE BEEN PRODUCING SIGNIFICANT FLASH
FLOODING IN THE REGIONS.

RAINFALL AMOUNTS OVER 90 MM HAVE BEEN REPORTED IN PARTS OF THE
GREATER TORONTO AREA THUS FAR, AND WILL LIKELY EXCEED 100 MM BEFORE
THE RAINFALL TAPERS OFF LATE THIS EVENING.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL
REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END
WWCN51 CWTO 090110
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 9:10 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT
EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE
ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO
AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - ISSUED AT 8:47 PM EDT MONDAY 8 JULY
2013 FOR:
=NEW= GUELPH - ERIN - SOUTHERN WELLINGTON COUNTY
=NEW= HALTON HILLS - MILTON
      CITY OF TORONTO
      CALEDON
      ORANGEVILLE - GRAND VALLEY - SOUTHERN DUFFERIN COUNTY
      MISSISSAUGA - BRAMPTON
      HANOVER - DUNDALK - SOUTHERN GREY COUNTY.

METEOROLOGISTS CONTINUE TO MONITOR SLOW MOVING THUNDERSTORMS WITH
TORRENTIAL DOWNPOURS THAT HAVE BEEN PRODUCING SIGNIFICANT FLASH
FLOODING IN THE REGIONS.

RAINFALL AMOUNTS OVER 90 MM HAVE BEEN REPORTED IN PARTS OF THE
GREATER TORONTO AREA THUS FAR, AND WILL LIKELY EXCEED 100 MM BEFORE
THE RAINFALL TAPERS OFF LATE THIS EVENING.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL
REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 090125
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 9:25 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT
EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE
ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO
AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - ISSUED AT 9:20 PM EDT MONDAY 8 JULY
2013 FOR:
=NEW= STIRLING - TWEED - MADOC
=NEW= KALADAR - BANNOCKBURN - BON ECHO PARK
=NEW= HALIBURTON - MINDEN - SOUTHERN HALIBURTON COUNTY
=NEW= BANCROFT - HASTINGS HIGHLANDS - DENBIGH
=NEW= OXTONGUE LAKE - FORT IRWIN - NORTHERN HALIBURTON COUNTY
=NEW= APSLEY - WOODVIEW - NORTHERN PETERBOROUGH COUNTY
=NEW= TAMWORTH - SYDENHAM - SOUTH FRONTENAC.

METEOROLOGISTS ARE TRACKING A SLOW MOVING AREA OF THUNDERSTORMS WITH
VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING LOCALIZED FLOODING.
SEVERE THUNDERSTORM WARNING - UPDATED AT 8:47 PM EDT MONDAY 8 JULY
2013 FOR:
CITY OF TORONTO
GUELPH - ERIN - SOUTHERN WELLINGTON COUNTY
CALEDON
HALTON HILLS - MILTON
ORANGEVILLE - GRAND VALLEY - SOUTHERN DUFFERIN COUNTY
MISSISSAUGA - BRAMPTON
HANOVER - DUNDALK - SOUTHERN GREY COUNTY.

METEOROLOGISTS CONTINUE TO MONITOR SLOW MOVING THUNDERSTORMS WITH
TORRENTIAL DOWNPOURS THAT HAVE BEEN PRODUCING SIGNIFICANT FLASH
FLOODING IN THE REGIONS.

RAINFALL AMOUNTS OVER 90 MM HAVE BEEN REPORTED IN PARTS OF THE
GREATER TORONTO AREA THUS FAR, AND WILL LIKELY EXCEED 100 MM BEFORE
THE RAINFALL TAPERS OFF LATE THIS EVENING.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL
REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 090140
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 9:40 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT
EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE
ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO
AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - UPDATED AT 9:34 PM EDT MONDAY 8 JULY
2013 FOR:
      GUELPH - ERIN - SOUTHERN WELLINGTON COUNTY
      CALEDON
      HALTON HILLS - MILTON
      ORANGEVILLE - GRAND VALLEY - SOUTHERN DUFFERIN COUNTY.

METEOROLOGISTS CONTINUE TO MONITOR SLOW MOVING THUNDERSTORMS WITH
TORRENTIAL DOWNPOURS THAT HAVE BEEN PRODUCING SIGNIFICANT FLASH
FLOODING IN THE REGIONS.

RAINFALL AMOUNTS OF WELL OVER 50 MM ARE LIKELY IN PORTIONS OF THE
WARNED REGIONS.
SEVERE THUNDERSTORM WARNING - UPDATED AT 9:20 PM EDT MONDAY 8 JULY
2013 FOR:
      STIRLING - TWEED - MADOC
      KALADAR - BANNOCKBURN - BON ECHO PARK
      HALIBURTON - MINDEN - SOUTHERN HALIBURTON COUNTY
      BANCROFT - HASTINGS HIGHLANDS - DENBIGH
      OXTONGUE LAKE - FORT IRWIN - NORTHERN HALIBURTON COUNTY
      APSLEY - WOODVIEW - NORTHERN PETERBOROUGH COUNTY
      TAMWORTH - SYDENHAM - SOUTH FRONTENAC.

METEOROLOGISTS ARE TRACKING A SLOW MOVING AREA OF THUNDERSTORMS WITH
VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING LOCALIZED FLOODING.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL
REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 090155
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 9:55 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT
EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE
ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO
AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - UPDATED AT 9:34 PM EDT MONDAY 8 JULY
2013 FOR:
      GUELPH - ERIN - SOUTHERN WELLINGTON COUNTY
      CALEDON

HALTON HILLS - MILTON
ORANGEVILLE - GRAND VALLEY - SOUTHERN DUFFERIN COUNTY.

METEOROLOGISTS CONTINUE TO MONITOR SLOW MOVING THUNDERSTORMS WITH TORRENTIAL DOWNPOURS THAT HAVE BEEN PRODUCING SIGNIFICANT FLASH FLOODING IN THE REGIONS.

RAINFALL AMOUNTS OF WELL OVER 50 MM ARE LIKELY IN PORTIONS OF THE WARNED REGIONS.
SEVERE THUNDERSTORM WARNING - UPDATED AT 9:20 PM EDT MONDAY 8 JULY 2013 FOR:
STIRLING - TWEED - MADOC
KALADAR - BANNOCKBURN - BON ECHO PARK
HALIBURTON - MINDEN - SOUTHERN HALIBURTON COUNTY
BANCROFT - HASTINGS HIGHLANDS - DENBIGH
OXTONGUE LAKE - FORT IRWIN - NORTHERN HALIBURTON COUNTY
APSLEY - WOODVIEW - NORTHERN PETERBOROUGH COUNTY
TAMWORTH - SYDENHAM - SOUTH FRONTENAC.

METEOROLOGISTS ARE TRACKING A SLOW MOVING AREA OF THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING LOCALIZED FLOODING.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 090210
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 10:10 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - UPDATED AT 9:34 PM EDT MONDAY 8 JULY 2013 FOR:
GUELPH - ERIN - SOUTHERN WELLINGTON COUNTY
CALEDON
HALTON HILLS - MILTON
ORANGEVILLE - GRAND VALLEY - SOUTHERN DUFFERIN COUNTY.

METEOROLOGISTS CONTINUE TO MONITOR SLOW MOVING THUNDERSTORMS WITH TORRENTIAL DOWNPOURS THAT HAVE BEEN PRODUCING SIGNIFICANT FLASH FLOODING IN THE REGIONS.

RAINFALL AMOUNTS OF WELL OVER 50 MM ARE LIKELY IN PORTIONS OF THE WARNED REGIONS.
SEVERE THUNDERSTORM WARNING - UPDATED AT 9:20 PM EDT MONDAY 8 JULY 2013 FOR:
STIRLING - TWEED - MADOC

KALADAR - BANNOCKBURN - BON ECHO PARK
HALIBURTON - MINDEN - SOUTHERN HALIBURTON COUNTY
BANCROFT - HASTINGS HIGHLANDS - DENBIGH
OXTONGUE LAKE - FORT IRWIN - NORTHERN HALIBURTON COUNTY
APSLEY - WOODVIEW - NORTHERN PETERBOROUGH COUNTY
TAMWORTH - SYDENHAM - SOUTH FRONTENAC.

METEOROLOGISTS ARE TRACKING A SLOW MOVING AREA OF THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING LOCALIZED FLOODING.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 090225
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 10:25 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - UPDATED AT 10:20 PM EDT MONDAY 8 JULY 2013 FOR:
STIRLING - TWEED - MADOC
KALADAR - BANNOCKBURN - BON ECHO PARK
HALIBURTON - MINDEN - SOUTHERN HALIBURTON COUNTY
OXTONGUE LAKE - FORT IRWIN - NORTHERN HALIBURTON COUNTY.

METEOROLOGISTS ARE TRACKING SLOW MOVING AREAS OF THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING LOCALIZED FLOODING. THESE THUNDERSTORMS AND HEAVY SHOWERS ARE EXPECTED TO WEAKEN LATER THIS EVENING.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 090240
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 10:40 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO

AND THE NATIONAL CAPITAL REGION.

SEVERE THUNDERSTORM WARNING - UPDATED AT 10:20 PM EDT MONDAY 8 JULY 2013 FOR:
STIRLING - TWEED - MADOC
KALADAR - BANNOCKBURN - BON ECHO PARK
HALIBURTON - MINDEN - SOUTHERN HALIBURTON COUNTY
OXTONGUE LAKE - FORT IRWIN - NORTHERN HALIBURTON COUNTY.

METEOROLOGISTS ARE TRACKING SLOW MOVING AREAS OF THUNDERSTORMS WITH VERY HEAVY DOWNPOURS CAPABLE OF PRODUCING LOCALIZED FLOODING. THESE THUNDERSTORMS AND HEAVY SHOWERS ARE EXPECTED TO WEAKEN LATER THIS EVENING.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON THESE WARNINGS AND ALL REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

WWCN51 CWTO 090255
ALERT MESSAGE SUMMARY
ISSUED BY ENVIRONMENT CANADA
AT 10:55 PM EDT MONDAY 8 JULY 2013.

NEXT SUMMARY WILL BE ISSUED FOLLOWING A CHANGE IN INFORMATION AT EITHER 10, 25, 40 OR 55 MINUTES PAST THE HOUR. TORNADO WARNINGS ARE ALWAYS LISTED FIRST.

ACTIVE ALERTS DISTRIBUTED BY ENVIRONMENT CANADA FOR SOUTHERN ONTARIO AND THE NATIONAL CAPITAL REGION.

NO ACTIVE TORNADO WARNINGS.
NO ACTIVE SEVERE THUNDERSTORM WARNINGS.

REFER TO WEATHER.GC.CA FOR FURTHER DETAILS ON ALL REMAINING PUBLIC WATCHES AND WARNINGS ISSUED BY ENVIRONMENT CANADA.

END

APPENDIX H

TRCA Public Messages During July 8th, 2013 Storm Event

TORONTO AND REGION CONSERVATION

FLOOD MANAGEMENT

WATER SAFETY
WATERSHED CONDITIONS STATEMENT

DATE: SUNDAY JULY 7, 2013

TIME: 10:30 AM

ISSUED TO: SCHOOL BOARDS, MUNICIPALITIES, LOCAL CONSERVATION AUTHORITIES, LOCAL POLICE, EMERGENCY SERVICES AND MEDIA

Toronto and Region Conservation Authority (TRCA) advises that Environment Canada has forecasted significant rainfall, including possible thunderstorms for today and tonight in Southern Ontario including the Greater Toronto Area. Some of these isolated and slow moving thunderstorms could produce heavy downpours with rainfall amounts of 30mm or more.

While widespread flooding is not currently anticipated, our rivers and streams will result in higher than normal water levels and flows, creating dangerous conditions.

Please alert any children under your care of these dangers and supervise their activities. Also, low lying areas may experience localized flooding. Drivers should exercise extreme caution and avoid driving through low lying areas and roadways, particularly at underpasses.

This Water Safety - Watershed Conditions Statement will be in effect through Tuesday July 9, 2013. For more information please contact the on-call Flood Duty Officer at 416.661.6514.

Flood Duty Officer
Fabio Tonto
416-661-6514
416-661-6600 ext.5697

Chief Flood Duty Officer
Laurian Farrell

Note: A Water Safety Watershed Conditions Statement may be issued when there are high flows, unsafe banks, melting ice or other factors could be dangerous for recreational users such as anglers, canoeists, hikers, children, pets, etc. Flooding is not expected.

TORONTO AND REGION CONSERVATION
FLOOD MANAGEMENT

FLOOD WATCH

DATE: JULY 08, 2013

TIME: 5:30 PM

ISSUED TO: SCHOOL BOARDS, MUNICIPALITIES, LOCAL CONSERVATION AUTHORITIES, LOCAL POLICE, EMERGENCY SERVICES AND MEDIA

Toronto and Region Conservation advises that Environment Canada is forecasting slow moving heavy showers for this afternoon and into the evening. There may be local heavy downpours giving 30 to 40 millimeters of rain in less than one hour for areas within the Greater Toronto Area. These heavy downpours may or may not be associated with thunderstorms and may occur suddenly.

The forecasted rainfall will result in higher flows and water levels in all our rivers and streams, creating dangerous conditions. Water levels can rise quickly in rivers and streams, and the public is advised to keep away from rivers and streams. Although the location and intensity of heavy downpours remain uncertain, areas affected may experience localized flooding. Drivers should exercise extreme caution and avoid driving through low lying areas and roadways, particularly at underpasses.

Please alert any children under your care of these dangers and supervise their activities.

This Flood Watch will be in effect through July 9, 2013. For more information please contact the on-call Flood Duty Officer.

Flood Duty Officer
Dilnesaw Chekol
416-661-6514
416-661-6600 ext.5697

Chief Flood Duty Officer
Michael Heralall

Note: A Flood Watch is a notice that flooding is possible in specific watercourses or municipalities (due to stream conditions and expected weather). Municipalities, emergency services and individual landowners in flood-prone areas should prepare.

TORONTO AND REGION CONSERVATION

FLOOD MANAGEMENT

FLOOD WARNING

DATE: JULY 08, 2013

TIME: 7:20 PM

ISSUED TO: SCHOOL BOARDS, MUNICIPALITIES, LOCAL CONSERVATION AUTHORITIES, LOCAL POLICE, EMERGENCY SERVICES AND MEDIA

Toronto and Region Conservation advises that our area has received up to 50 mm of rain within the last 3 hours, and up to 30 mm of additional rainfall is forecasted in the near term. This will result in flooding conditions within the low lying areas of TRCA watersheds.

The water levels and flow in TRCA's other watersheds are higher than normal resulting in dangerous conditions. Please exercise caution around all bodies of water. Please alert any children under your care of these dangers and supervise their activities.

Also, drivers should exercise extreme caution and avoid driving through low lying areas and roadways, particularly at underpasses if they are flooded.

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The TRCA will continue to closely monitor this weather system and will issue an update or cancellation to this Flood Warning by 12 midnight on Tuesday, July 9, 2013. For more information please contact the on-call Flood Duty Officer.

Flood Duty Officer
Dilnesaw Chekol
416-661-6514
416-661-6600 ext.5697

Chief Flood Duty Officer
Michael Heralall

Note: A Flood Warning is a notice that flooding which could be damaging to human lives or property is imminent or occurring in specific watercourses or municipalities.

TORONTO AND REGION CONSERVATION

FLOOD MANAGEMENT

CANCELLATION OF FLOOD WARNING

DATE: JULY 09, 2013

TIME: 7:30 AM

ISSUED TO: SCHOOL BOARDS, MUNICIPALITIES, LOCAL CONSERVATION AUTHORITIES, LOCAL POLICE, EMERGENCY SERVICES AND MEDIA

Toronto and Region Conservation advises that water levels in the TRCA's watersheds have receded to lower levels; therefore the Flood Warning issued on Monday July 8, 2013 is cancelled.

Current weather forecasts indicate chance of showers with a risk of thunderstorms for today. TRCA will continue to monitor watershed conditions and advise accordingly.

For more information please contact the on-call Flood Duty Officer.
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Flood Duty Officer
Dilnesaw Chekol
416-661-6514
416-661-6600 ext.5697

Chief Flood Duty Officer
Michael Heralall

Note: A Flood Warning is a notice that flooding which could be damaging to human lives or property is imminent or occurring in specific watercourses or municipalities.

TORONTO AND REGION CONSERVATION
FLOOD MANAGEMENT

FLOOD OUTLOOK
WATERSHED CONDITIONS STATEMENT

DATE: JULY 9, 2013

TIME: 7:30 AM

ISSUED TO: SCHOOL BOARDS, MUNICIPALITIES, LOCAL CONSERVATION AUTHORITIES, LOCAL POLICE, EMERGENCY SERVICES AND MEDIA

Toronto and Region Conservation advises that periods of rain over the Greater Toronto Area are expected throughout today and into tomorrow, and there is the potential for thunderstorms to occur later today, tonight and tomorrow. At this time forecasted rainfall amounts are in the range of 10 to 15 mm, with locally higher amounts possible in areas affected by thunderstorms that may bring an additional rainfall.

With rivers and streams already at higher than normal levels due to recent record rainfall, forecasted rainfall amounts will result in water levels in rivers and streams remaining elevated over the next two days. Although the location and intensity of heavy downpours remain uncertain, areas affected may experience localized flooding. Drivers should exercise extreme caution and avoid driving through water on low lying areas and roadways, particularly at underpasses.

Please alert any children under your care of these dangers and supervise their activities.

This Flood Outlook - Watershed Conditions Statement will be in effect through Thursday July 11th, 2013. For more information please contact the on-call Flood Duty Officers at 416.661.6514

Flood Duty Officers
Dilnesaw Chekol
416-661-6514
416-661-6600 ext.5697

Chief Flood Duty Officer
Michael Heralall

Note: A Flood Outlook Watershed Conditions Statement is an early notice of the potential for flooding based on weather forecasts calling for heavy rain, snow melt, high wind or other conditions that could lead to high runoff, cause ice jams, lakeshore flooding or erosion.

APPENDIX I

King City Radar Images

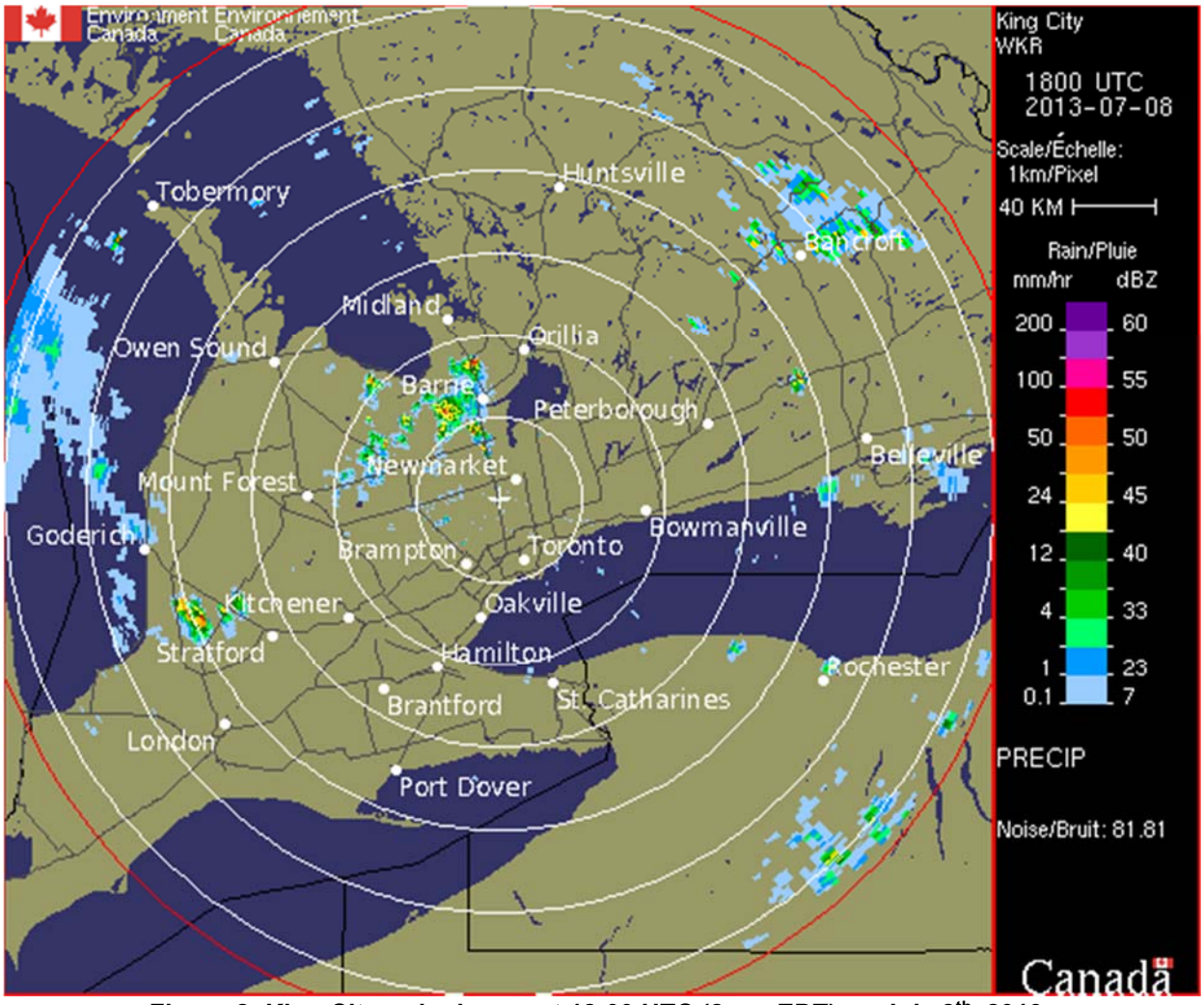


Figure 2: King City radar image at 18:00 UTC (2 pm EDT) on July 8th, 2013.

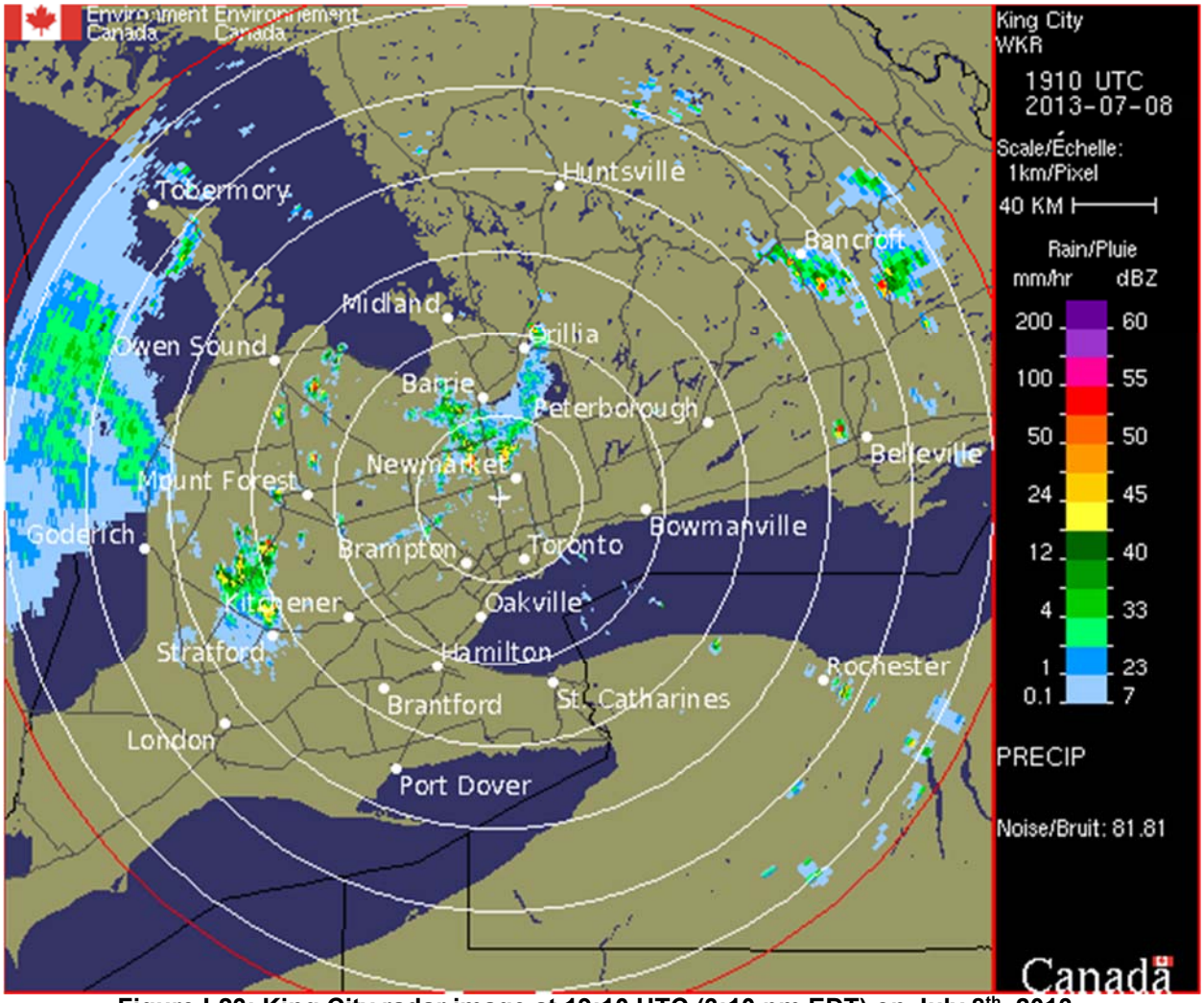


Figure I-23: King City radar image at 19:10 UTC (3:10 pm EDT) on July 8th, 2013.

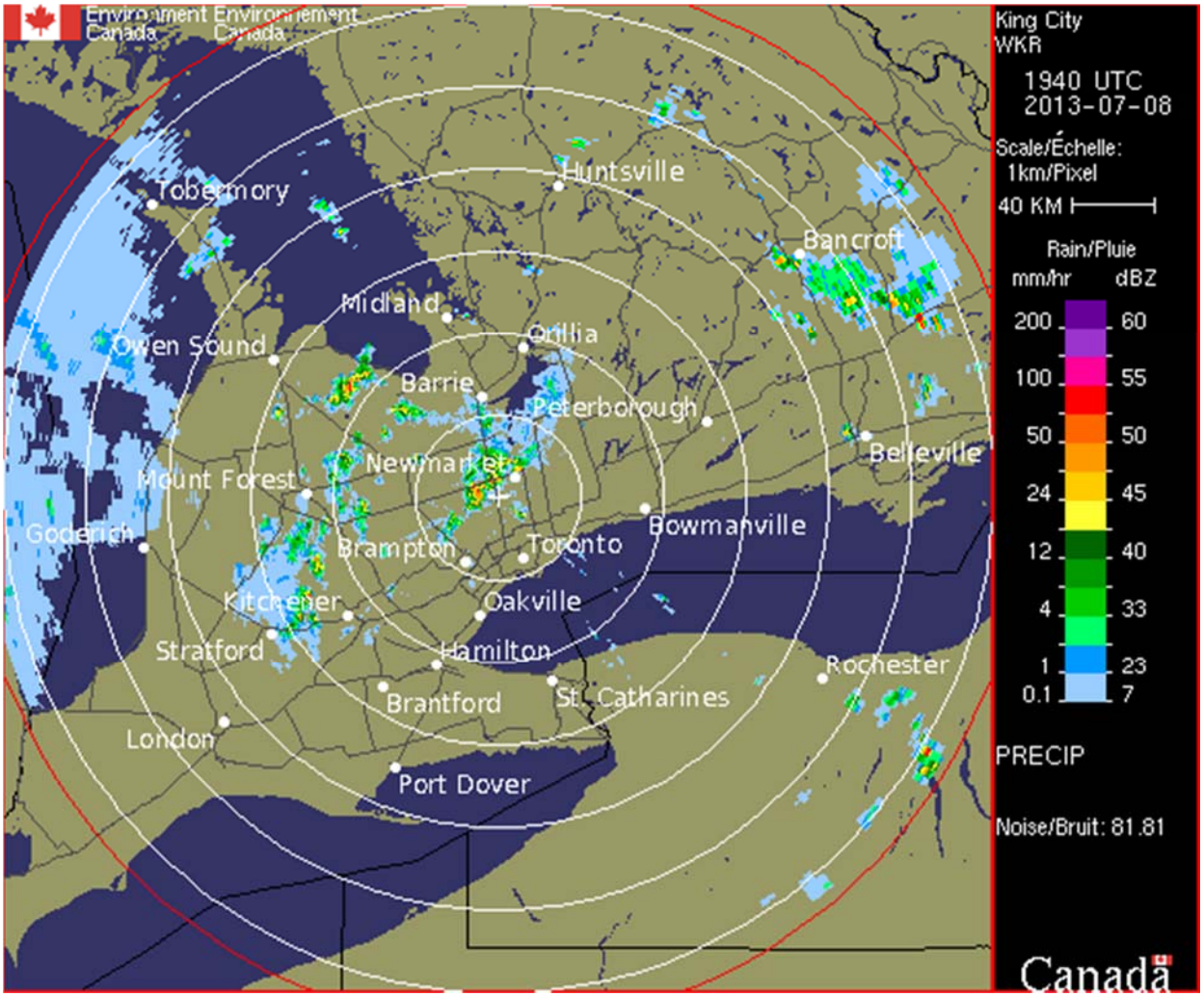


Figure I-3: King City radar image at 19:40 UTC (3:40 pm EDT) on July 8th, 2013.

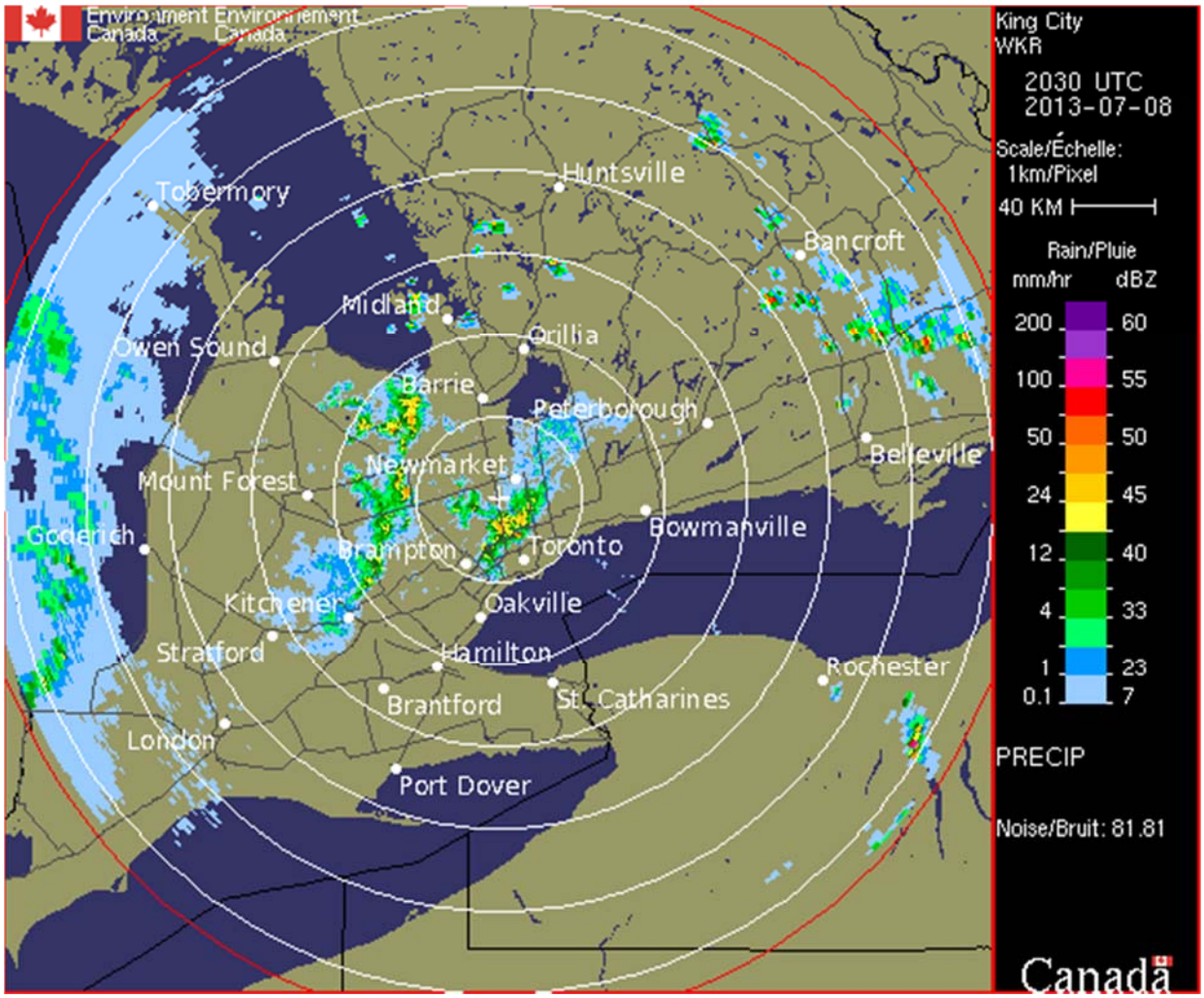


Figure I-4: King City radar image at 20:30 UTC (4:30 pm EDT) on July 8th, 2013.

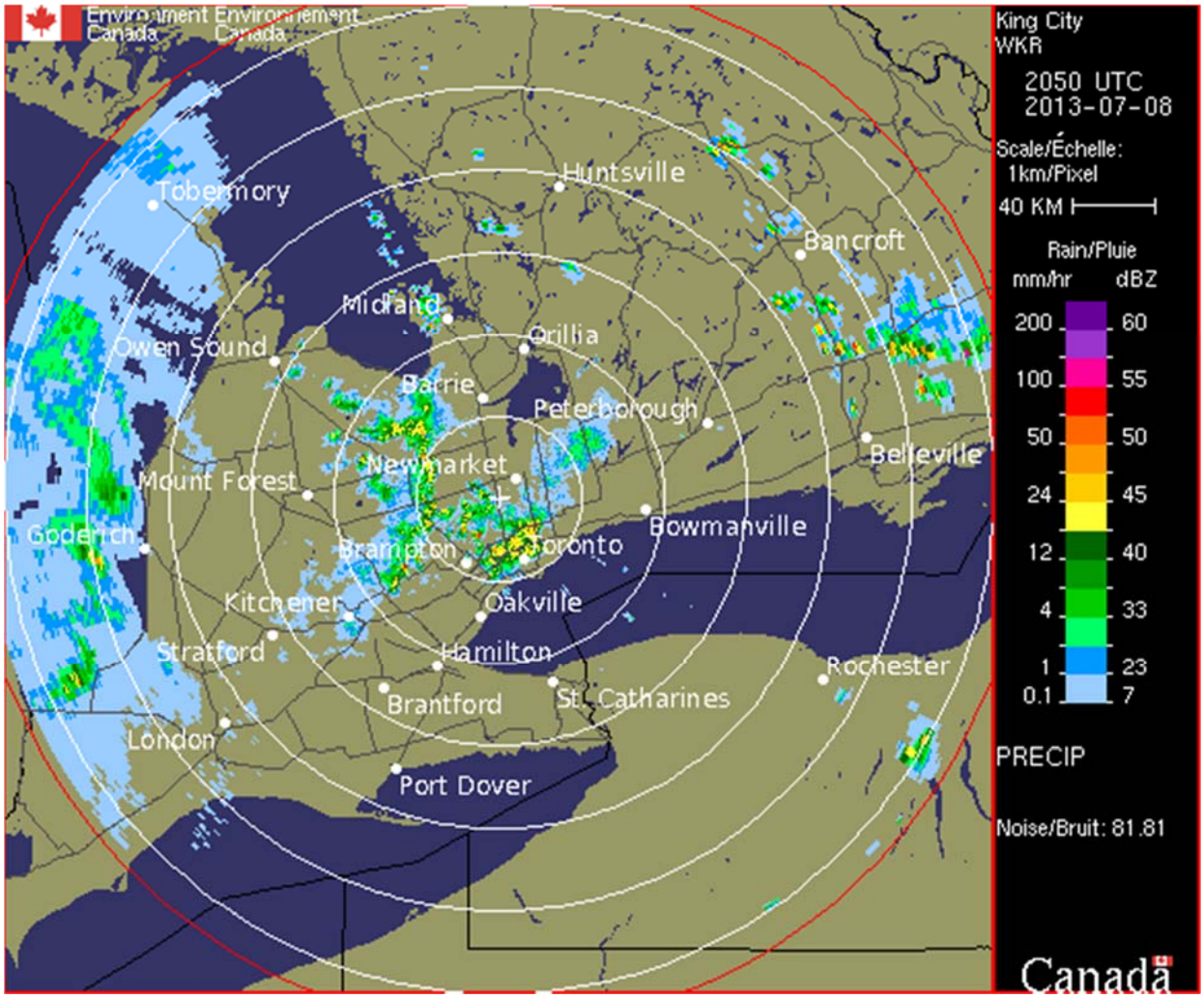


Figure I-5: King City radar image at 20:50 UTC (4:50 pm EDT) on July 8th, 2013.

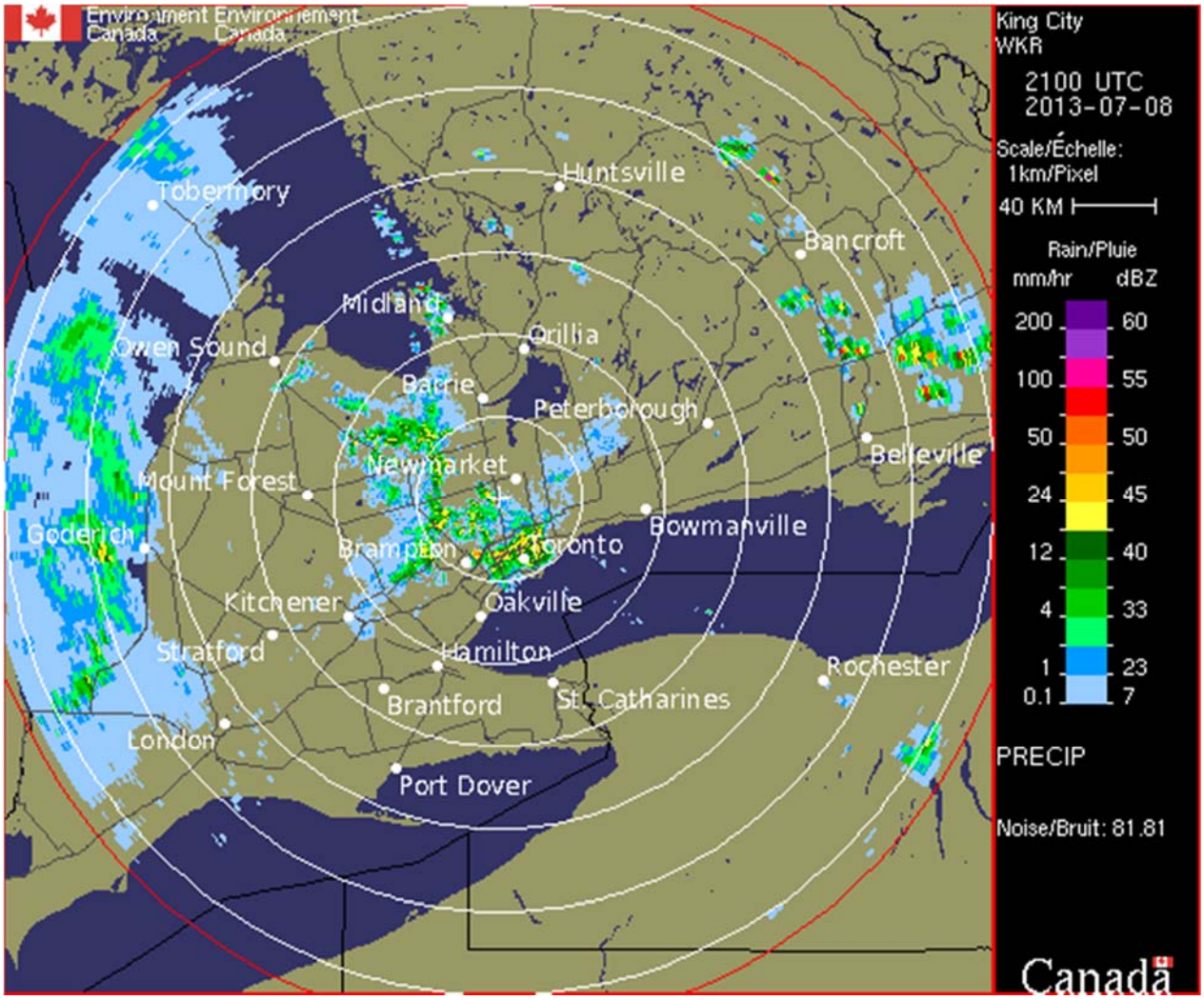


Figure I-6: King City radar image at 21:00 UTC (5 pm EDT) on July 8th, 2013.

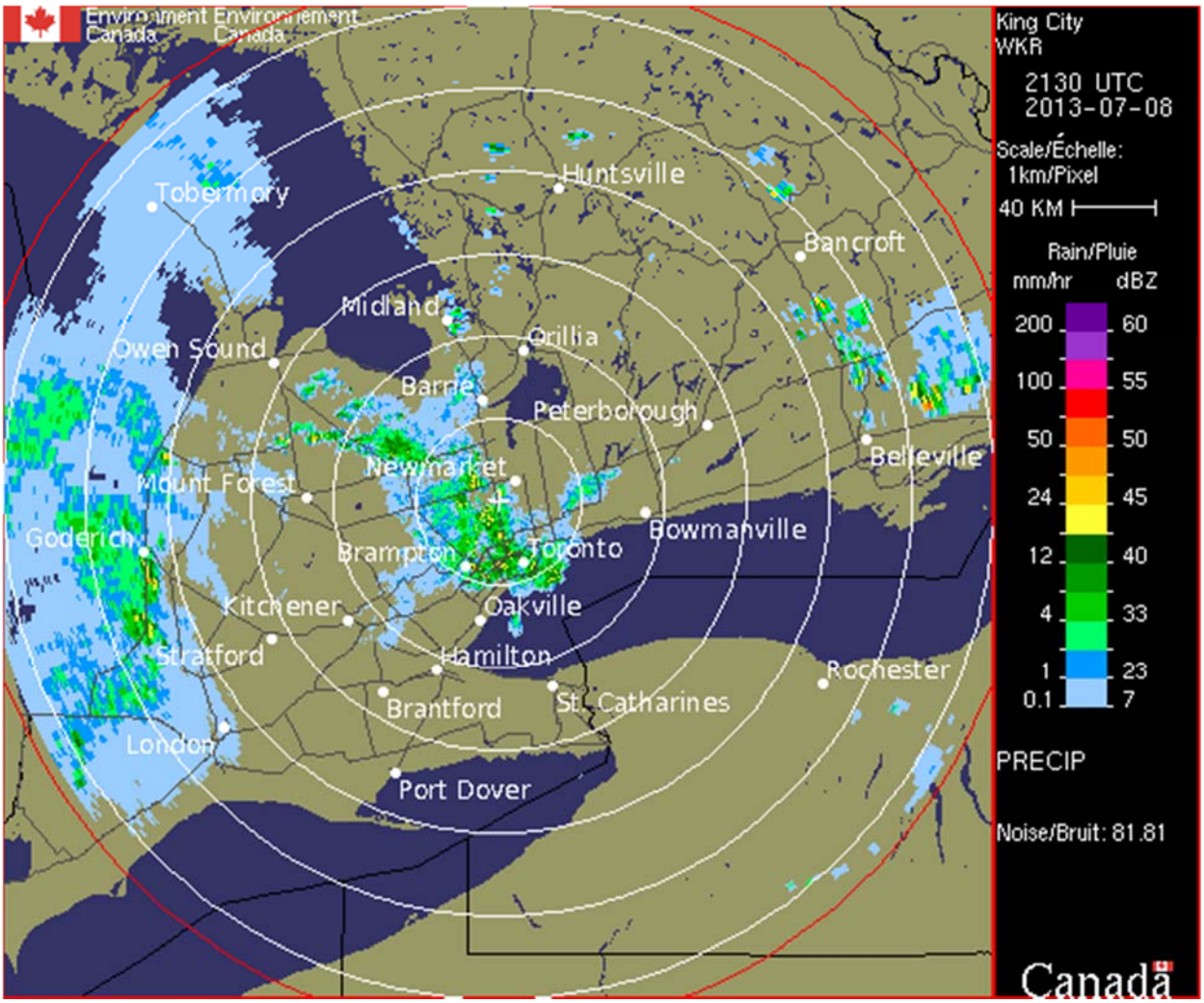


Figure I-7: King City radar image at 21:30 UTC (5:30 pm EDT) on July 8th, 2013.

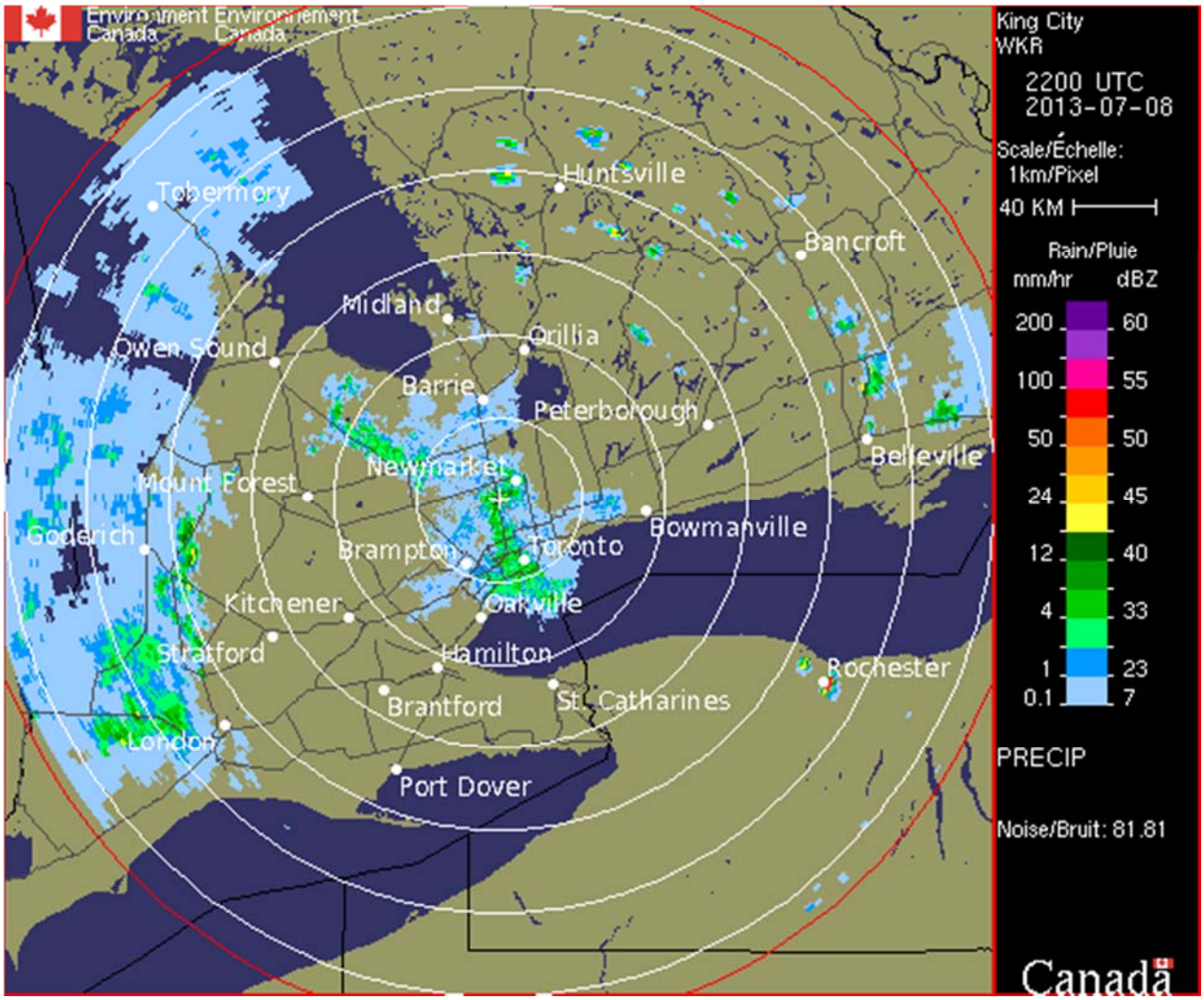


Figure I-8: King City radar image at 22:00 UTC (6 pm EDT) on July 8th, 2013.

APPENDIX J

Visible Satellite Images

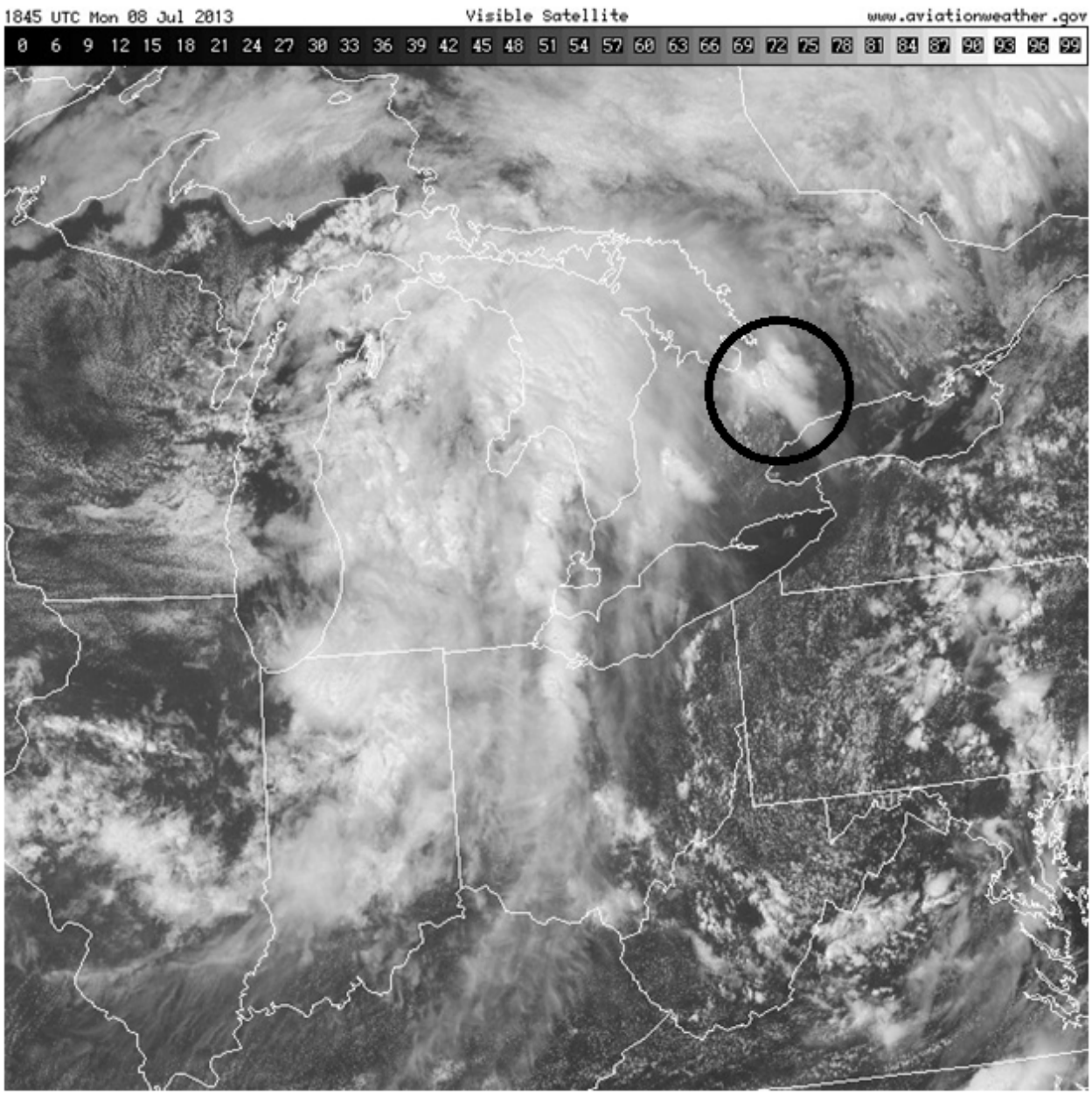


Figure J-14: Visible satellite image at 18:45 UTC (2:45 pm EDT) on July 8th, 2013.

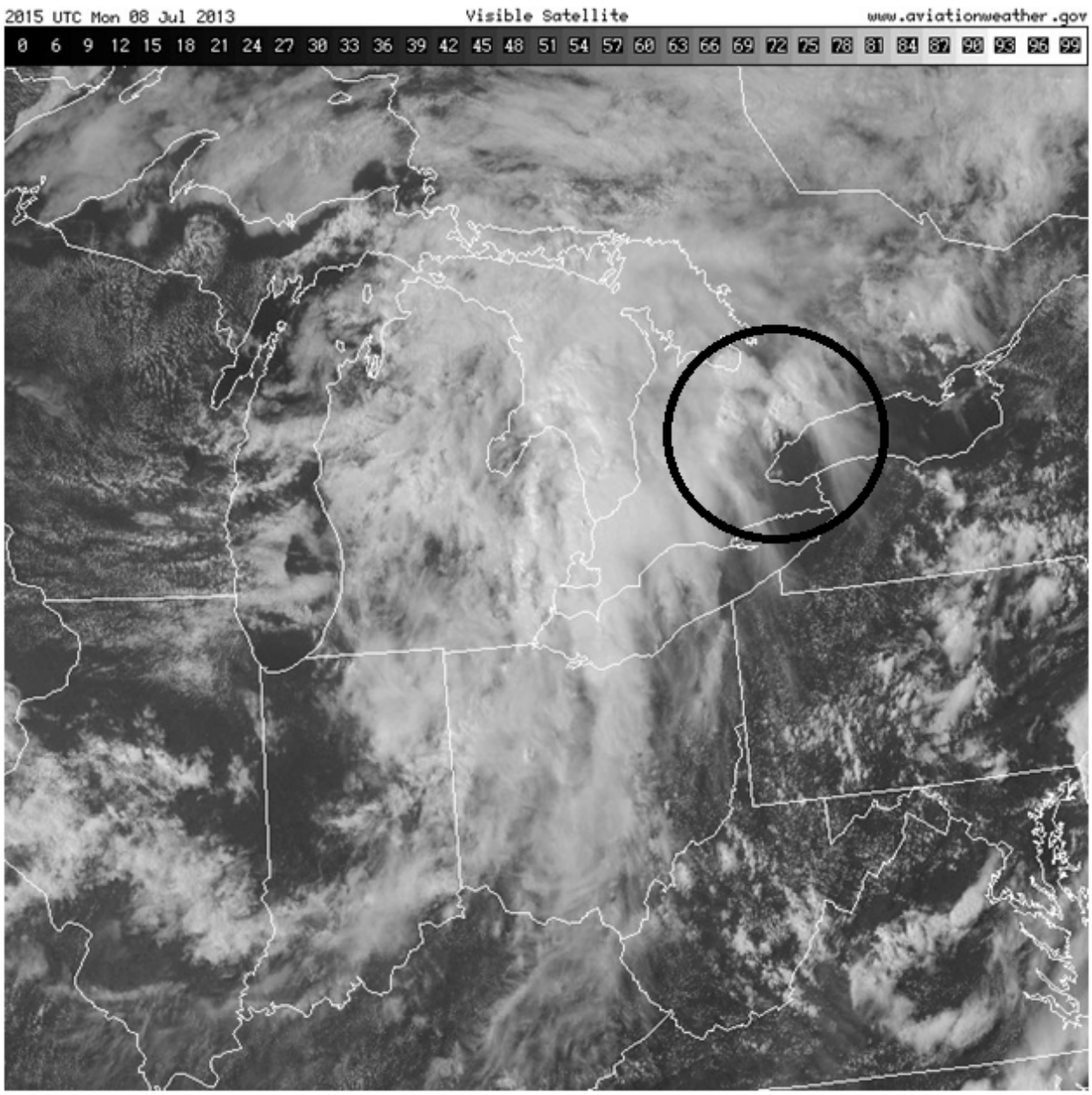


Figure J-2: Visible satellite image at 20:15 UTC (4:15 pm EDT) on July 8th, 2013.

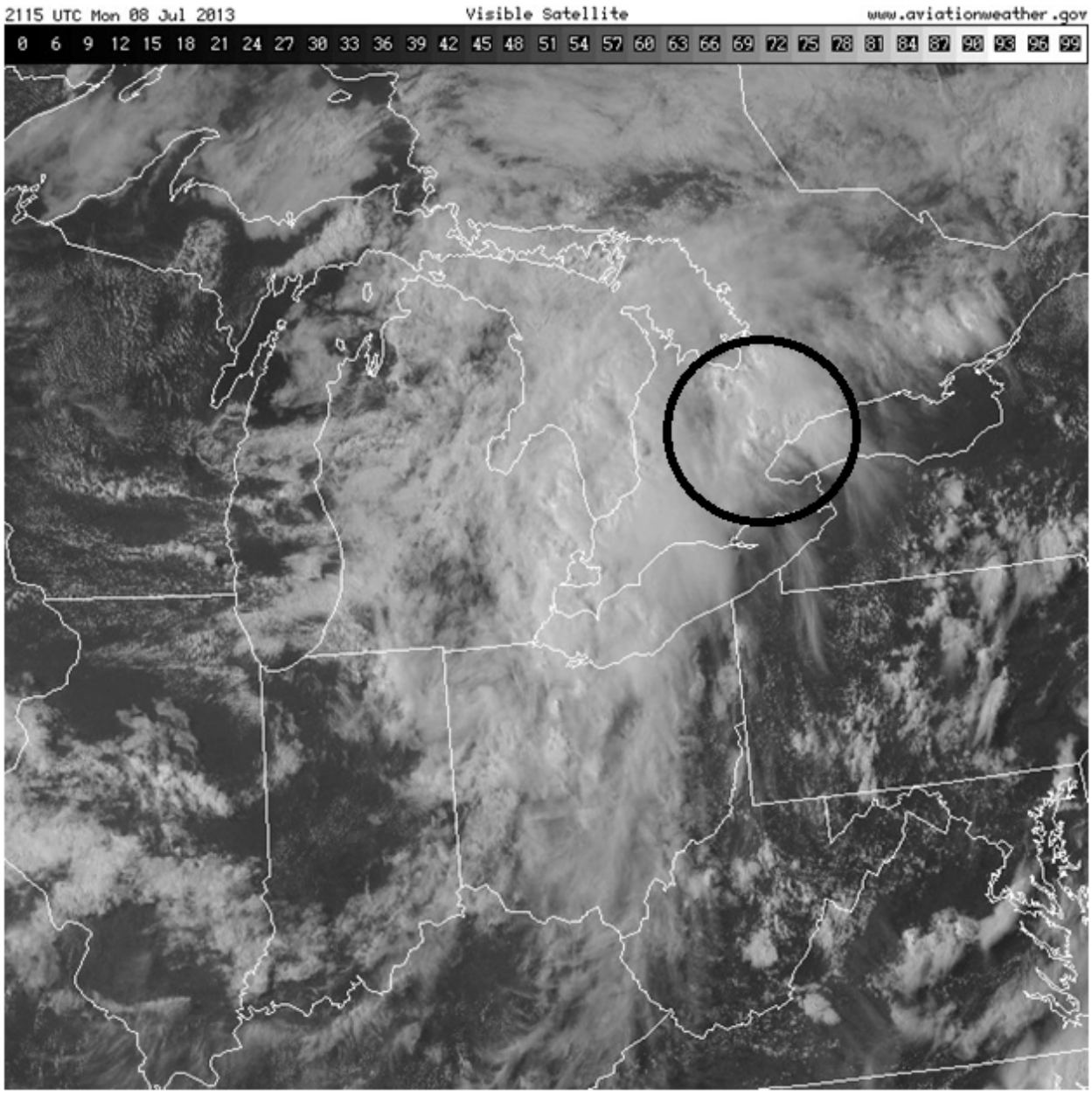


Figure J-3: Visible satellite image at 21:15 UTC (5:15 pm EDT) on July 8th, 2013.

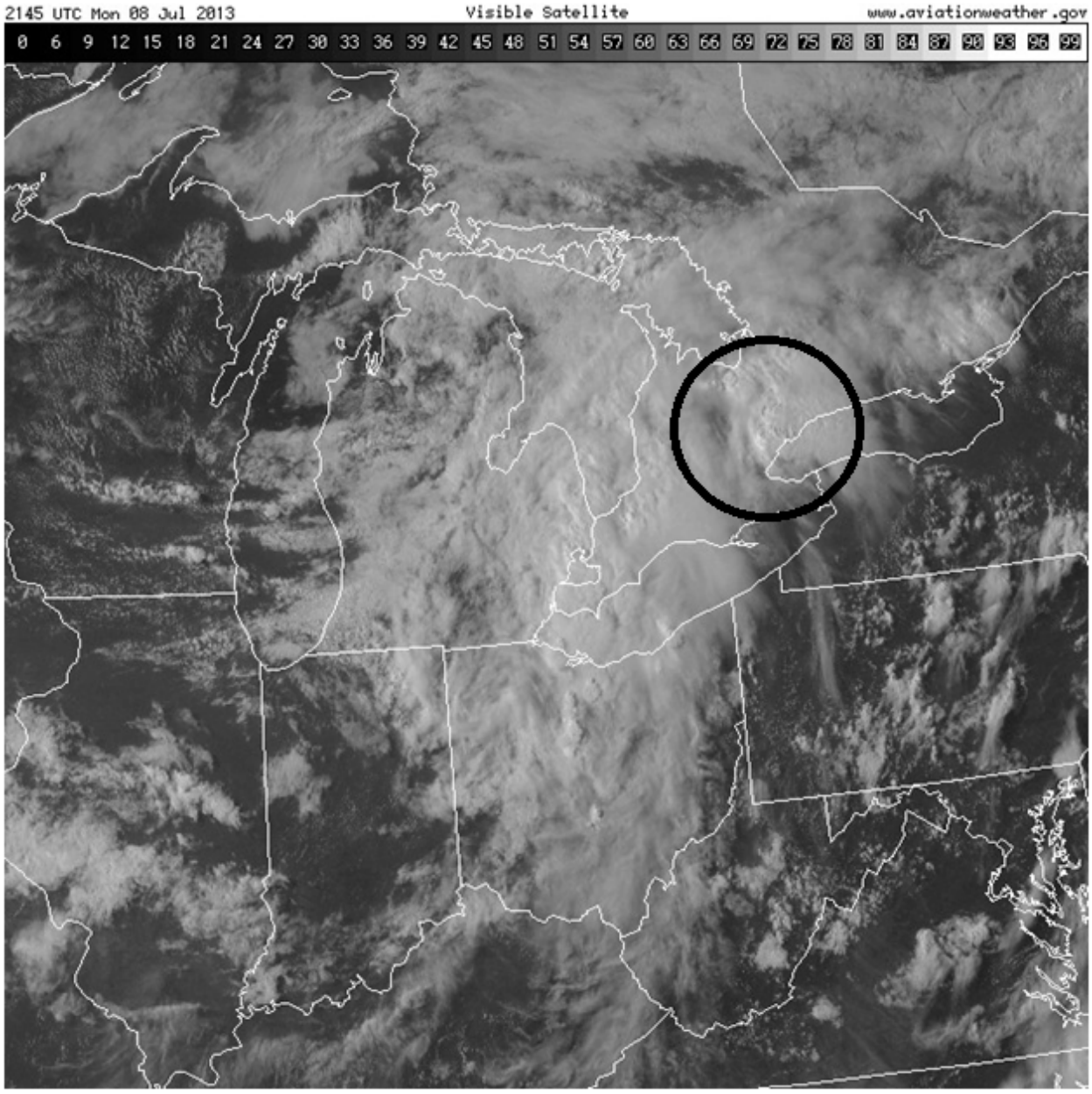


Figure J-4: Visible satellite image at 2145 UTC (5:45 pm EDT) on July 8th, 2013.

APPENDIX K

Summary of Impacts and Characteristics of July 8th, 2013 Storm Event

Summary of Impacts and Characteristics of July 8th, 2013 Storm Event													
Org / Agency	**Contact**	**Phone**	**Email**	**1. How many homes were flooded?**	**2. How many homes without hydro/ gas/ services?**	**3. How many businesses were closed?**	**4. Were malls closed? Which?**	**5. How many vehicles were damaged?**	**6. How many roads were impassible or closed?**	**7. Cost of road repair?**	**8. Number and type of infrastructure failures (storm sewers, bridges, culverts)?**	**9. Cost of infrastructure repair?**	**10. Following Programs**
Bell	Rosita Giles	416-296-6599	Rosita.Giles@bell.ca										
CBC	COREY BLACK	416-205-8710	Corey.black@cbc.ca										
City News	Natasha Ramsahai	416-764-7541	natasha.ramsahai@citynews.rogers.com										
City of Brampton	Maggie Liu		Maggie.Liu@brampton.ca										
City of Mississauga	Anthony Di Giandomenico Bob Levesque (road closures) Thomas Nightingale (creek damage)		Anthony.DiGiandomenico@mississauga.ca					No City vehicles were damaged (email 14-07-28)	Two City roads (South Service Road and Burnhamthorpe Road East) had lane restrictions. McLaughlin Road was closed for a short period of time just north of Courtneypark Drive East. There were a couple of roads in the Malton area that had short closures until water receded as well (email 14-07-28 Mississauga Holmes).	we really didn't have any road repairs (email 14-07-28).	Watercourse erosion (Cooksville, Serson, Cawthra, Applewood, Mimico, Little Etobicoke and Etobicoke Creeks), trail damage and flooding at City facilities. Evacuation of an apartment building and caused structural damage to a house (p.4 13-08-26 Corp Report).	$46,400 M New Cooksville SWM Facility (p.15 13-08-26 Corp Report).	$7.620 M Cooksville Crk Crossing (p.15 13-08-26 Corp Report). $350,000 Flood Evaluation Study - South-east Mississauga (p.15 13-08-26 Corp Report).
City of Toronto	Used available Staff reports			4759 (AAR) & (13-09-06 Staff Rpt) $850 M in insurance claims (13-09-10 Staff Report Storm Event)	10000 (AAR)				14 (AAR)		Union Station reported GO concourse flooded (AAR)	$55.5 M Capital Requirements (13-09-10 Stf Rpt). $9.9 M in insurable damages to City owned property (13-09-10 Stf Rpt).	$915 M (Basement Flooding Protection Program) over 10 yrs. $4 M per year over 15 yrs. The capital cost estimated to well over $1 Billion (13-09-06 Staff Rpt)
Enbridge Gas	Elizabeth Blaire	855-884-5112 416-753-6626	enbridgegasmedia@enbridge.com										
Enersource	Joanne Campea	905-273-9050	jcampea@enersource.com		155,000 of our 200,000 power interruption occurred around 6 pm, restored by 3:15 am on July 9 (email 14-07-23 enersource campea).						Enersource infrastructure sustained minimal damage (email 14-07-23 enersource campea).	costs associated with this storm were minimal for Enersource (email 14-07-23 enersource campea).	
Global TV	Anthony Farnell	416-446-5460	Anthony.Farnell@globalnews.ca										

Summary of Impacts and Characteristics of July 8th, 2013 Storm Event													
Org / Agency	**Contact**	**Phone**	**Email**	**1. How many homes were flooded?**	**2. How many homes without hydro/ gas/ services?**	**3. How many businesses were closed?**	**4. Were malls closed? Which?**	**5. How many vehicles were damaged?**	**6. How many roads were impassible or closed?**	**7. Cost of road repair?**	**8. Number and type of infrastructure failures (storm sewers, bridges, culverts)?**	**9. Cost of infrastructure repair?**	**10. Following Programs**
GO / Metrolinx	Russ Dowdich	416-354-7744	Russ.Dawydiuk@gotransit.com								Track washout damage at 4 locations on GO Transit owned corridors: Newmarket Subdivision – MP 5.90 Rogers Road; Weston Subdivision – MP 10.45 Islington Ave; Bala Subdivision –MP 10.20 Don Mills Road; Oakville subdivision – MP 10.18 Dixie Road . Track bed eroded down to 1.2 meters (6 ft.) of shoulder from end of track ties during the flood. Retaining wall design and installation was required to safeguard against further erosion. Repair 1 locomotive and refurbish 10 coaches flooded. Loss of use of equipment costs have not been calculated. (email 14-07-23 Go Dawydiuk).	$152,000.00 $2,900,000.00 $5,300,000.00 (email 14-07-23 Go Dawydiuk).	
Hydro One Networks Inc.	Chen Wei Performance Management Department	416-345-6079	Email: Chen.Wei@HydroOne.com		500,000 homes and businesses (13-12-23 Global News)						2 Transformer Stations (Richview and Manby), 1 operations building (13-07-08 Toronto FloodSummaryReport)		
Insurance Bureau of Canada (IBC).												Insured property damage caused by this event was more than $850 million	
MTO	Astrid Poei communications coordinator	416-235-5340`	astrid.poei@ontario.ca						along 409 (GTA)	409 & Martingroveunderpass flooded QEW @ Cawthra	none		

Summary of Impacts and Characteristics of July 8th, 2013 Storm Event													
Org / Agency	**Contact**	**Phone**	**Email**	**1. How many homes were flooded?**	**2. How many homes without hydro/ gas/ services?**	**3. How many businesses were closed?**	**4. Were malls closed? Which?**	**5. How many vehicles were damaged?**	**6. How many roads were impassible or closed?**	**7. Cost of road repair?**	**8. Number and type of infrastructure failures (storm sewers, bridges, culverts)?**	**9. Cost of infrastructure repair?**	**10. Following Programs**
Region of Peel	Mark Shiller Exec Director (WWW) Mahtab Tavana	(905) 791-7800 x 4373 X 7826	Mahtab.tavana@peelregion.ca	2500 (14-05-08-rc-agenda p.105)					Dixie at Canadian National Railway (CN) underpass, north of Lakeshore, Cawthra at CN underpass, north of Lakeshore (p.2 13-08-24 Report_-_PW-C1_Update).	The total costs for both underpass repairs are currently estimated at approximately $120,000 (p.3 13-08-24 Report_-_PW-C1_Update).	GE Booth Wastewater treatment facility flooded (p.3 13-08-24 Report_-_PW-C1_Update). phosphorous in effluent at GE Booth SWMF for the month of July was 1.02mg/L marginally higher than the limit of 1.0 mg/L. (p.4 13-08-24 Report_-_PW-C1_Update).	200 tonnes of floodrelated waste =$550,000 (p.3 13-08-24 Report_-_PW-C1_Update). GE Booth Wastewater Treatment $500,000+(p.3 13-08-24 Report_-_PW-C1_Update).	$4.725 M Downspout Disconnection Rebate. $3.5M+ Sanitary Backwater Valve Rebate (14-05-08-rc-agenda p.105). $5 M per year over the next 10 years.(pg.4 13-10-22 Report_-_PW-D1).
Toronto Hydro	Tanya Bruckmueller	416 542 2621 416 903 0440	tbruckmueller@torontohydro.com		300,000 (14-07-14 email) 20-70,000 customers over the following two days (email 14-07-14)		Sherway Mall (14-07-16 email)				1 pole (14-07-16 email)	$1.410 M includes operating costs (13-09-10 Staff Report Storm Event).	
Toronto Police	Mark Phair Critical Infrastructure	416-808-4943										$114,610 includes operating costs (13-09-10 Staff Report Storm Event).	
Toronto Transit Commission	Media	416-981-1900	Danny.Nicholson@ttc.ca								Union Station reported GO concourse flooded (AAR)	$1.318 M includes operating costs (p11. 13-09-10 Staff Report Storm Event).	
TRCA	Michael Heralall	416.661.6600 x 5703	mheralall@trca.on.ca										

APPENDIX L

Interpolation Techniques

Inverse Distance Weighting Interpolation[3]

Inverse Distance Weighting (IDW) is a type of deterministic method for multivariate interpolation with a known scattered set of points. The assigned values to unknown points are calculated with a weighted average of the values available at the known points. The weight is a function of inverse distance.
IDW relies mainly on the inverse of the distance raised to a mathematical power. The Power parameter lets you control the significance of known points on the interpolated values based on their distance from the output point. It is a positive, real number, and its default value is 2.

By defining a higher power value, more emphasis can be put on the nearest points. Thus, nearby data will have the most influence, and the surface will have more detail (be less smooth). As the power increases, the interpolated values begin to approach the value of the nearest sample point. Specifying a lower value for power will give more influence to surrounding points that are farther away, resulting in a smoother surface.

Spline Interpolation[4]

The Spline tool uses an interpolation method that estimates values using a mathematical function that minimizes overall surface curvature, resulting in a smooth surface that passes exactly through the input points.

Conceptually, the sample points are extruded to the height of their magnitude; spline bends a sheet of rubber that passes through the input points while minimizing the total curvature of the surface. It fits a mathematical function to a specified number of nearest input points while passing through the sample points. This method is best for generating gently varying surfaces such as elevation, water table heights, or pollution concentrations.

The basic form of the minimum curvature Spline interpolation imposes the following two conditions on the interpolant:

1- The surface must pass exactly through the data points.
2- The surface must have minimum curvature—the cumulative sum of the squares of the second derivative terms of the surface taken over each point on the surface must be a minimum.

The basic minimum curvature technique is also referred to as thin plate interpolation. It ensures a smooth (continuous and differentiable) surface, together with continuous first-derivative surfaces. Rapid changes in gradient or slope (the first derivative) can occur in the vicinity of the data points; hence, this model is not suitable for estimating second derivative (curvature).

[3] Source: ArcGIS resources:
http://resources.arcgis.com/en/help/main/10.2/index.html#/How_IDW_works/009z00000075000000/
[4] Source: ArcGIS resources:
http://resources.arcgis.com/en/help/main/10.2/index.html#/How_Spline_works/009z00000078000000/

Kriging Interpolation[5]

The IDW (inverse distance weighted) and Spline interpolation tools are referred to as deterministic interpolation methods because they are directly based on the surrounding measured values or on specified mathematical formulas that determine the smoothness of the resulting surface. A second family of interpolation methods consists of geostatistical methods, such as kriging, which are based on statistical models that include autocorrelation—that is, the statistical relationships among the measured points. Because of this, geostatistical techniques not only have the capability of producing a prediction surface but also provide some measure of the certainty or accuracy of the predictions.

Kriging assumes that the distance or direction between sample points reflects a spatial correlation that can be used to explain variation in the surface. The Kriging tool fits a mathematical function to a specified number of points, or all points within a specified radius, to determine the output value for each location. Kriging is a multistep process; it includes exploratory statistical analysis of the data, variogram modelling, creating the surface, and (optionally) exploring a variance surface. Kriging is most appropriate when you know there is a spatially correlated distance or directional bias in the data. It is often used in soil science and geology.

[5] Sources: ArcGIS Resources:
http://resources.arcgis.com/en/help/main/10.2/index.html#/How_Kriging_works/009z00000076000000/

APPENDIX M

Index of Agreement Techniques

Root Mean Square Error (RMSE)[6]

Root Mean Square Error is a dimensionless index of agreement which can be used to compare predicted values with observed in order to determine the goodness of prediction and can be calculated using the formula presented below:

$$\textbf{RMSE} = [n^{-1} \sum_{i=1}^{n} (P_i - O_i)^2]^{0.5}$$

Where:

- P is the predicted values
- O is the observed value
- n is the number of observations

The smaller the RMSE is, the difference between observed and simulated values is smaller as well. Sample calculations for RMSE for the IDW interpolation method with a power of 2 is presented below:

Gauge	Owner	Gauge Rainfall	IDW (P=2)	$(P_i-O_i)^2$
Oak Ridges	RichmondHill	29.60	32.44	8.06
Toronto North York	Environment Canada	67.20	67.77	0.32
Emery Yard	City of Toronto	55.75	84.20	809.25
Castlefield	City of Toronto	72.50	75.99	12.19
Central	City of Toronto	87.25	86.89	0.13
Edwards Gardens	City of Toronto	48.00	58.50	110.29
Fire Station 121	City of Toronto	61.25	61.24	0.00
R_YR_KE01	York Region	5.60	20.17	212.24
R_YR_NE01	York Region	31.60	39.88	68.63
R_ET_VA01	York Region	75.00	81.92	47.91
R_ET_ST02	York Region	6.80	6.70	0.01
Fire Hall #94	Markham	12.50	11.42	1.16
Thornhill C.C.	Markham	49.53	46.52	9.05
German Mills P.S.	Markham	39.00	40.22	1.50
Lincoln Alexander P.S.	Markham	20.00	19.55	0.20
STN 06 - Mississauga Valley	Mississauga	71.00	64.33	44.52
STN 08 - Tomken	Mississauga	56.40	72.27	251.76
STN 13 - Goreway	Mississauga	87.80	95.46	58.67
HY008	TRCA	69.40	74.97	31.03
HY012	TRCA	37.00	47.02	100.31
HY016	TRCA	50.20	53.84	13.26
HY033	TRCA	81.80	77.48	18.65
HY036	TRCA	9.80	11.26	2.13
HY039	TRCA	94.00	82.41	134.43
HY043	TRCA	6.80	8.55	3.05
HY044	TRCA	10.20	10.00	0.04
HY050	TRCA	8.60	8.64	0.00
HY051	TRCA	9.00	7.68	1.75
RG03	Peel Region	3.75	18.39	214.42
RG24	Peel Region	42.50	36.97	30.58
RG32	Peel Region	86.75	69.16	309.54
RG36	Peel Region	44.25	52.37	65.92
Sum				**2561.01**
RMSE	**8.95**			

Nash-Sutcliffe Coefficient[7]

[6] Willmott CJ, Matsuura K. 2005. Advantages of the mean absolute error (MAE) over the root mean square error (RMSE) in assessing average model performance. *Climate Research* **30**: 79–82.

Nash and Sutcliffe coefficient is another index of agreement used for comparison of predicted vs. observed hydrological parameters and it is calculated using the formula presented below:

$$\mathbf{E} = 1 - \frac{\sum_{i=1}^{n}(P_i - O_i)^2}{\sum_{i=1}^{n}(O_i - \bar{O})^2}$$

Where:

- P is the predicted values
- O is the observed value
- n is the number of observations
- $\bar{O}$ is the average observed value

This coefficient varies between a value of 0 indicative of no fit at all and a value of 1 indicative of 100 agreement between observed and predicted values. Sample calculations for Nash-Sutcliffe coefficient for the IDW interpolation method with a power of 2 is presented below:

Gauge	Owner	Rainfall Gauge	IDW (P=2)	$(P_i-O_i)^2$	$(O_i-\bar{O})^2$
Oak Ridges	RichmondHill	29.60	32.44	8.06	228.42
Toronto North York	Environment Canada	67.20	67.77	0.32	505.65
Emery Yard	City of Toronto	55.75	84.20	809.25	121.81
Castlefield	City of Toronto	72.50	75.99	12.19	772.09
Central	City of Toronto	87.25	86.89	0.13	1809.36
Edwards Gardens	City of Toronto	48.00	58.50	110.29	10.80
Fire Station 121	City of Toronto	61.25	61.24	0.00	273.46
R_YR_KE01	York Region	5.60	20.17	212.24	1529.86
R_YR_NE01	York Region	31.60	39.88	68.63	171.96
R_ET_VA01	York Region	75.00	81.92	47.91	917.28
R_ET_ST02	York Region	6.80	6.70	0.01	1437.43
Fire Hall #94	Markham	12.50	11.42	1.16	1037.71
Thornhill C.C.	Markham	49.53	46.52	9.05	23.20
German Mills P.S.	Markham	39.00	40.22	1.50	32.64
Lincoln Alexander P.S.	Markham	20.00	19.55	0.20	610.75
STN 06 - Mississauga Valley	Mississauga	71.00	64.33	44.52	690.98
STN 08 - Tomken	Mississauga	56.40	72.27	251.76	136.58
STN 13 - Goreway	Mississauga	87.80	95.46	58.67	1856.45
HY008	TRCA	69.40	74.97	31.03	609.43
HY012	TRCA	37.00	47.02	100.31	59.50
HY016	TRCA	50.20	53.84	13.26	30.10
HY033	TRCA	81.80	77.48	18.65	1375.41
HY036	TRCA	9.80	11.26	2.13	1218.95
HY039	TRCA	94.00	82.41	134.43	2429.17
HY043	TRCA	6.80	8.55	3.05	1437.43
HY044	TRCA	10.20	10.00	0.04	1191.18
HY050	TRCA	8.60	8.64	0.00	1304.18
HY051	TRCA	9.00	7.68	1.75	1275.45
RG03	Peel Region	3.75	18.39	214.42	1678.00
RG24	Peel Region	42.50	36.97	30.58	4.90
RG32	Peel Region	86.75	69.16	309.54	1767.07
RG36	Peel Region	44.25	52.37	65.92	0.21
Average		**44.71**			
Sum				**2561.01**	**26547.40**
NS		**0.904**			

[7] Nash JE, Sutcliffe JV. 1970. River flow forecasting through conceptual models part I – A discussion of principles. *Journal of Hydrology* **10**(3): 282–290.

APPENDIX N

King City Radar Data Processing Procedure

In order to calculate the scaled radar data, the process is as follows. For each radar file:

1. Load the radar file and preprocess the data so it is stored into a 2 or 3D matrix (depending on format or type of radar file). The radar data is typically extracted in a matrix with the dimensions relating to range, azimuth and elevation.
2. From the radar data matrix, extract the radar data at each rain gauge location. Given that each data element is identified by a particular range, azimuth it is straight forward to identify which data element represents each rain gauge. The lowest elevation scan is always used.
3. For each extracted data point convert the data to a rainfall accumulation based on a particular $Z - R$ relationship and period of observation (i.e. radar scan time). The conversion from a radar measurement to rainfall accumulation is a multi-stage process. The analysis used by AMEC uses the following criteria to convert a radar element to rainfall accumulation:
    a. Only do a conversion if the radar element is above 10 dBZ. This reduces the risk of adding minute amounts which do not greatly affect the outcome. If the radar element is less than 10 dBZ it is assumed the rainfall accumulation is zero.
    b. If the radar element is above 30 dBZ use a convective $Z - R$ relationship otherwise use a stratiform $Z - R$ relationship. The convective and stratiform relationships used in the analysis were:

$$Z = 300R^{1.4} \quad \text{(convective)}$$

$$Z = 200R^{1.6} \quad \text{(stratiform)}$$

    These are commonly used $Z - R$ relationships in the literature

    c. From the rain rate, scale by the radar scan time to get rain accumulation. In the case of data from King City this is a constant factor of 1/6 due to the constant scan rate.
4. Add the radar estimated rainfall accumulation to a running total for each rain gauge location.

Once all the radar files have been processed two types of MFB analysis were performed. The first is to sum across all the rain gauge and radar estimates to arrive at a two total estimates of rainfall. From these values calculate the MFB scale factor which is then applied to the radar data as a whole, effectively scaling all the data up or down. By applying an MFB scale factor in such a way, residuals or differences between the scaled radar data and rain gauge data can be calculated.

The second is to determine the “area of influence” for each rain gauge, calculate an MFB scale factor for each “area of influence” and then scale only the radar data within that area. This is done for all rain gauges and means that the radar data as a whole is affected by a patch work of scale factors. By applying individual MFB scale factors to each “area of influence” then the residuals or differences between scaled radar data and rain gauge data will always be zero.

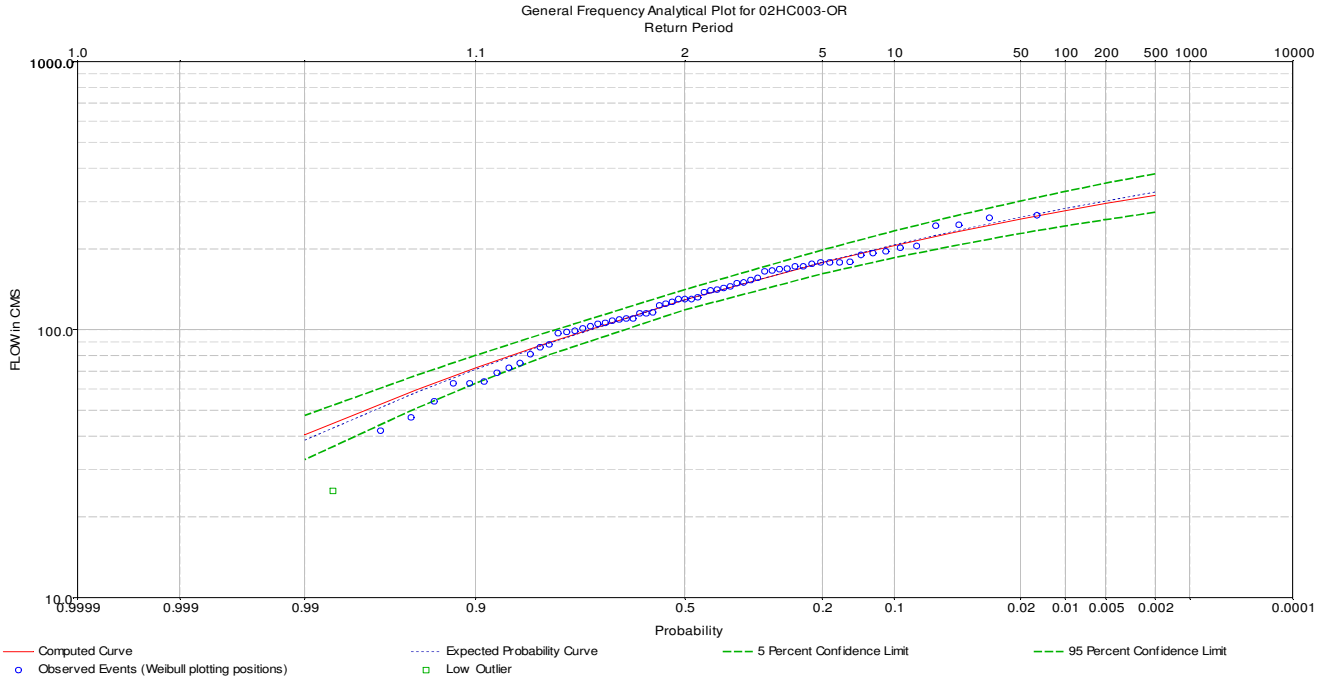
Once the radar data is scaled, it is written to an ESRI shapefile. The projection of the shapefile is 1km x 1km grid which cover the TRCA watersheds.

APPENDIX O

Single Station Frequency Analysis Results

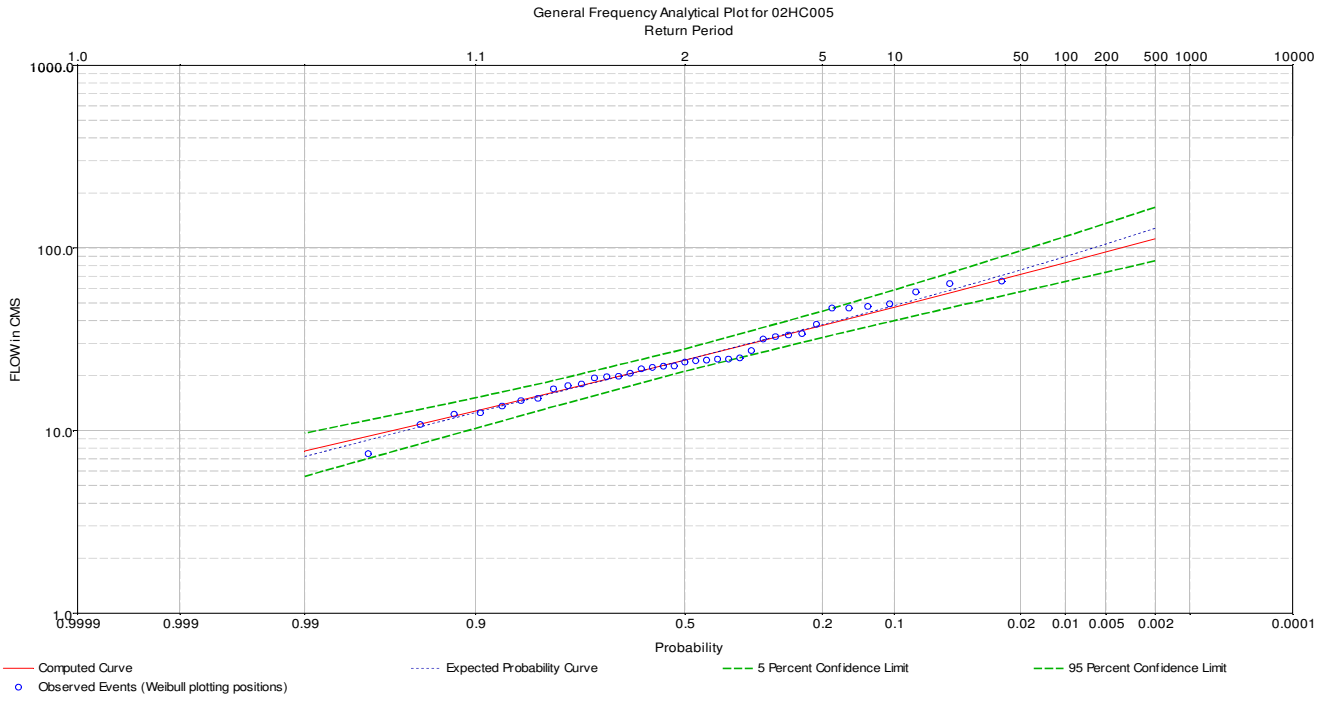
Station: 02HC003

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	40.57	38.6	47.86	32.71
95	1.05	59.54	58.3	67.45	50.84
90	1.11	71.93	71	80.12	63.02
80	1.25	89.2	88.7	97.89	80.08
50	2	129.19	129.2	141.05	118.52
20	5	177.67	178.4	198.33	161.71
10	10	205.81	207.3	233.56	185.46
5	20	230.14	232.7	264.91	205.48
2	50	258.36	262.5	302.15	228.23
1	100	277.48	283	327.84	243.4
0.5	200	295.07	302.1	351.78	257.22
0.2	500	316.37	325.8	381.11	273.78



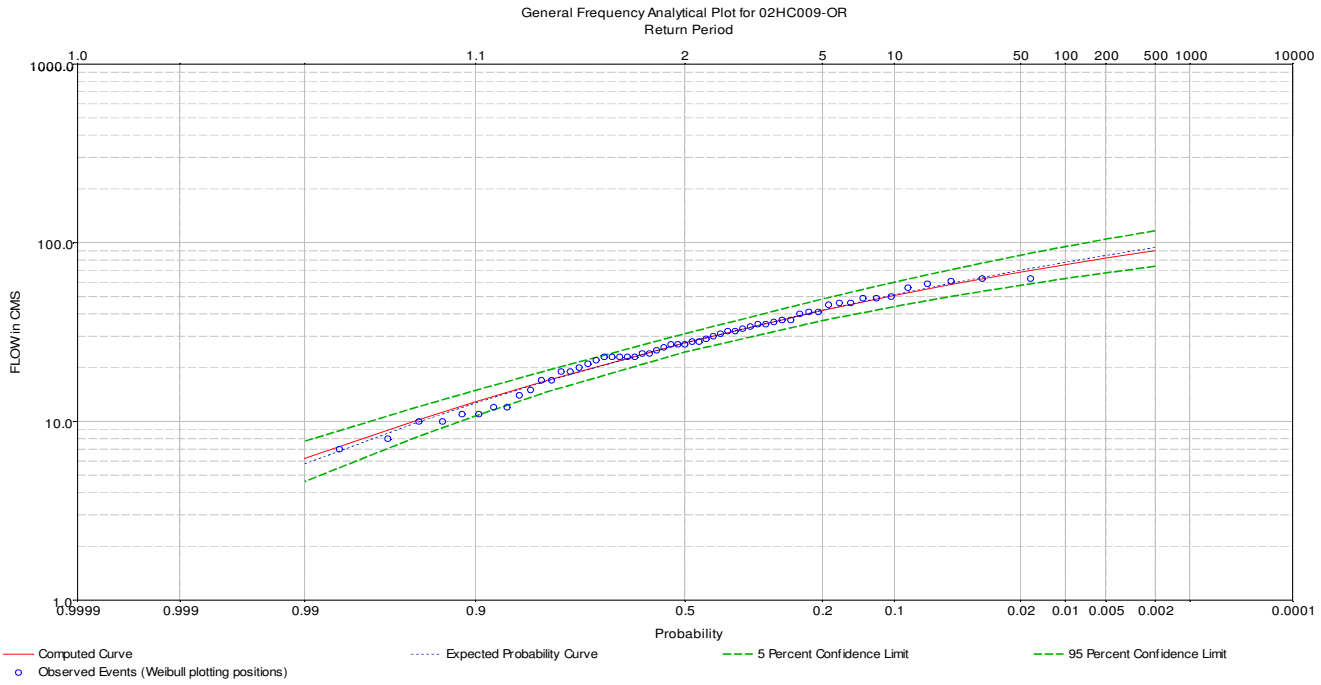
Station: 02HC005

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	7.71	7.2	9.68	5.62
95	1.05	10.71	10.4	12.9	8.34
90	1.11	12.79	12.5	15.11	10.29
80	1.25	15.9	15.7	18.45	13.25
50	2	24.31	24.3	27.97	21.11
20	5	37.54	38	45.02	32.37
10	10	47.32	48.4	58.91	40.01
5	20	57.41	59.5	74.1	47.54
2	50	71.53	75.8	96.51	57.64
1	100	82.93	89.6	115.45	65.53
0.5	200	95.06	105	136.28	73.71
0.2	500	112.29	128.2	167	85.03



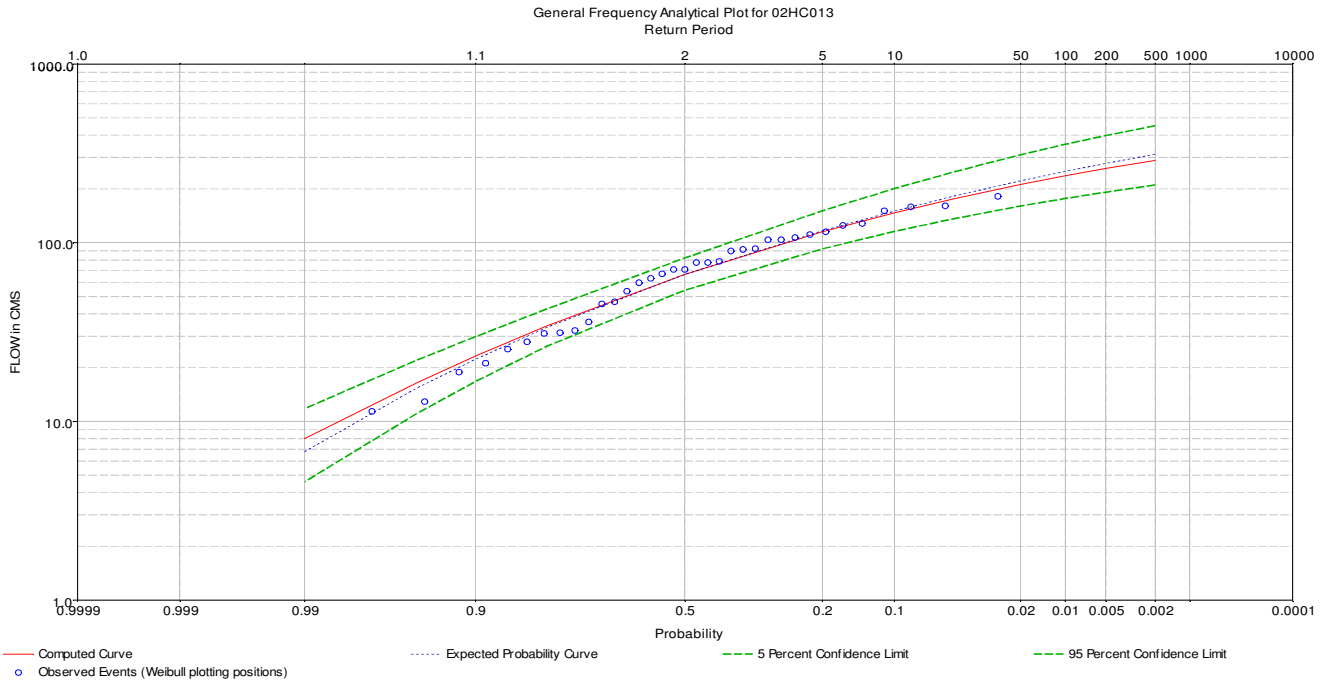
Station: 02HC009

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	6.19	5.8	7.74	4.61
95	1.05	10.11	9.8	11.98	8.14
90	1.11	12.89	12.7	14.93	10.75
80	1.25	17.01	16.9	19.31	14.66
50	2	27.48	27.5	30.99	24.43
20	5	41.7	42	48.5	36.68
10	10	50.62	51.2	60.26	43.92
5	20	58.71	59.7	71.31	50.29
2	50	68.51	70.2	85.12	57.82
1	100	75.41	77.7	95.07	63.01
0.5	200	81.93	84.9	104.64	67.86
0.2	500	90.05	94.1	116.75	73.81



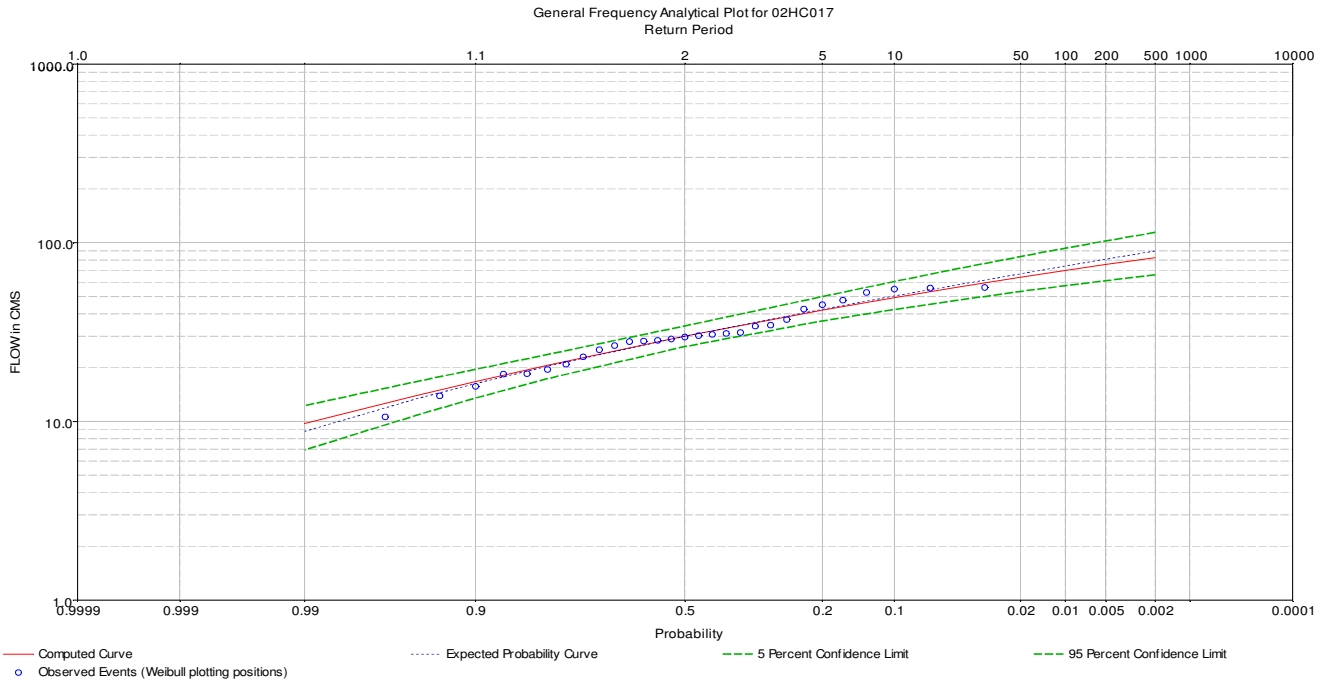
Station: 02HC013

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	8.03	6.8	11.81	4.6
95	1.05	16.42	15.3	21.93	11.02
90	1.11	23.26	22.3	29.84	16.73
80	1.25	34.4	33.7	42.69	26.42
50	2	66.51	66.5	82.15	54.2
20	5	115.06	116.5	150.84	92.45
10	10	147.02	150.3	200.72	115.75
5	20	176.39	182.3	249.1	136.3
2	50	212.07	222	310.61	160.44
1	100	237	250.7	355.15	176.86
0.5	200	260.33	278.1	397.88	191.96
0.2	500	288.91	312.7	451.54	210.14



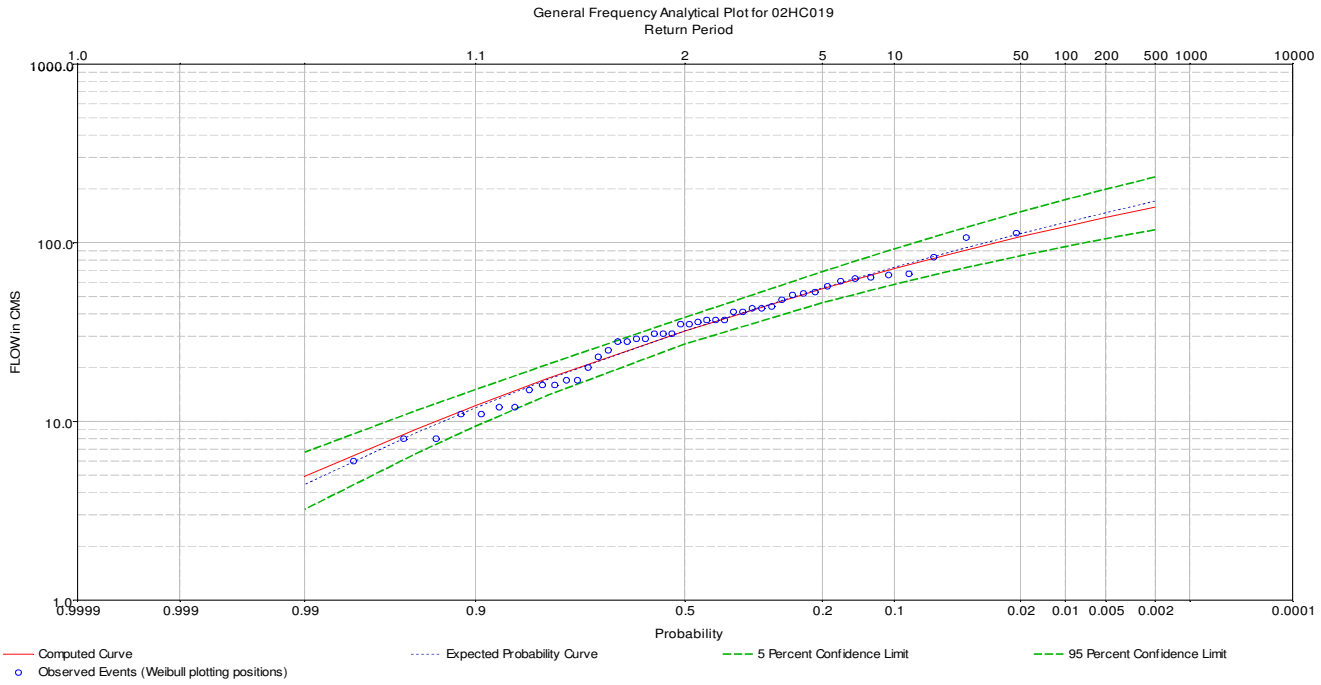
Station: 02HC017

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	9.74	8.8	12.27	6.92
95	1.05	13.95	13.4	16.68	10.83
90	1.11	16.72	16.3	19.56	13.51
80	1.25	20.63	20.4	23.67	17.35
50	2	29.95	30	34.26	26.26
20	5	41.96	42.4	50	36.53
10	10	49.35	50.3	60.67	42.34
5	20	56.04	57.7	70.8	47.39
2	50	64.18	67	83.67	53.33
1	100	69.96	74	93.12	57.44
0.5	200	75.48	80.8	102.37	61.29
0.2	500	82.46	89.9	114.34	66.08



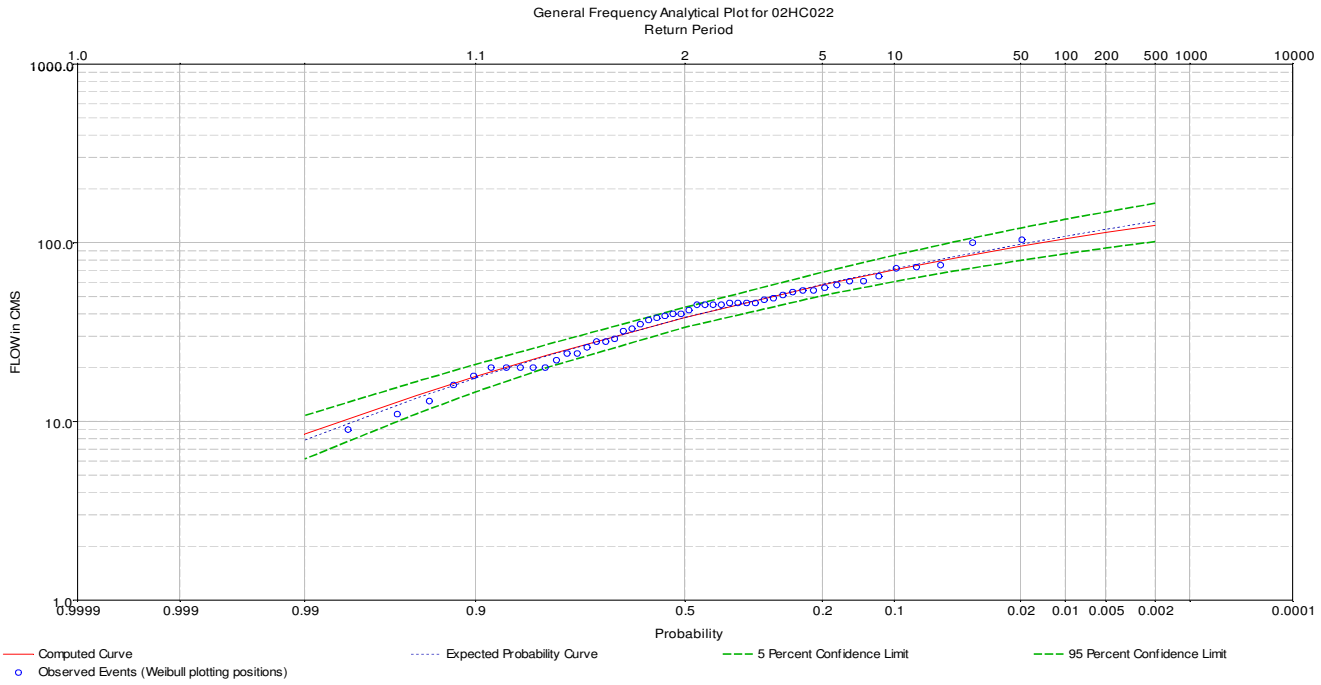
Station: 02HC019

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	4.93	4.4	6.73	3.22
95	1.05	9.05	8.6	11.49	6.61
90	1.11	12.26	11.9	15.1	9.41
80	1.25	17.39	17.2	20.84	14.02
50	2	32.12	32.1	38.17	27.12
20	5	55.34	55.9	68.91	46.1
10	10	71.6	72.9	92.39	58.49
5	20	87.41	89.9	116.38	70.06
2	50	107.89	112.4	148.84	84.56
1	100	123.16	129.7	173.9	95.08
0.5	200	138.25	147.2	199.34	105.29
0.2	500	157.96	171	233.4	118.36



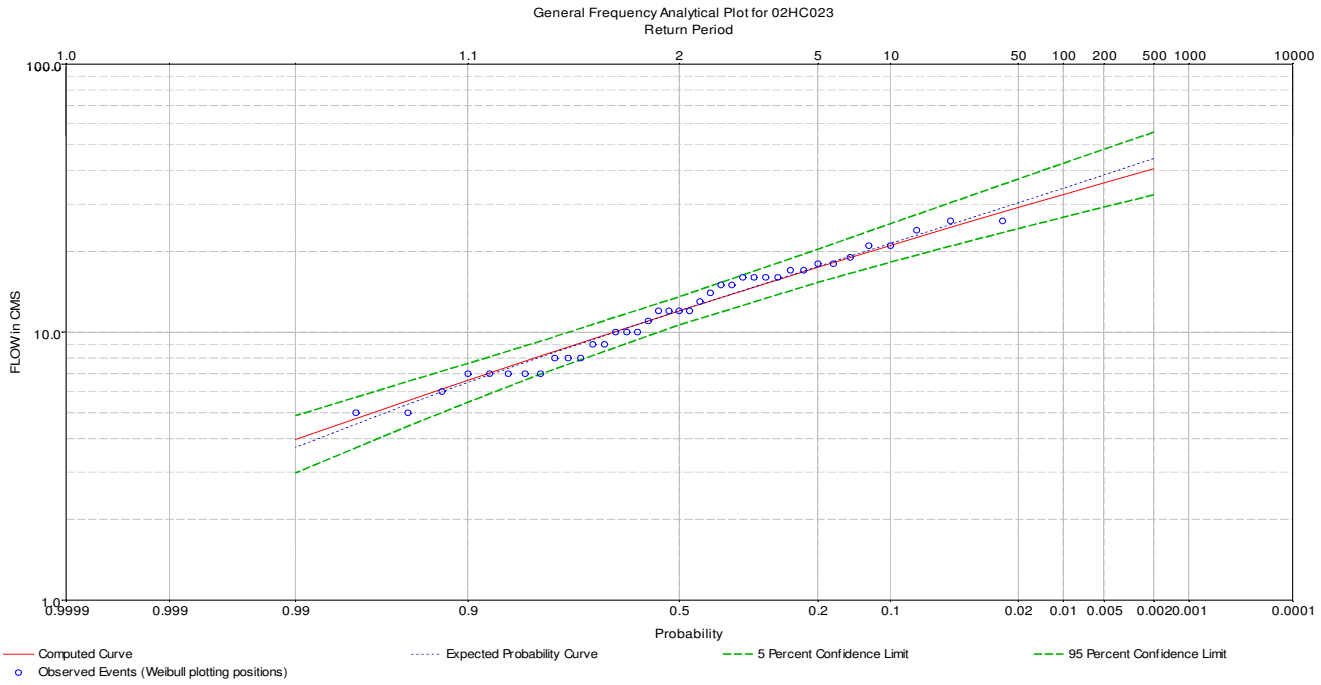
Station: 02HC022

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	8.51	7.9	10.8	6.17
95	1.05	13.95	13.5	16.72	11.03
90	1.11	17.83	17.5	20.85	14.63
80	1.25	23.57	23.3	27	20.08
50	2	38.21	38.2	43.49	33.66
20	5	58.08	58.5	68.4	50.63
10	10	70.54	71.4	85.21	60.62
5	20	81.82	83.4	101.03	69.37
2	50	95.48	98.1	120.82	79.68
1	100	105.07	108.7	135.08	86.78
0.5	200	114.12	118.9	148.79	93.38
0.2	500	125.39	131.9	166.16	101.48



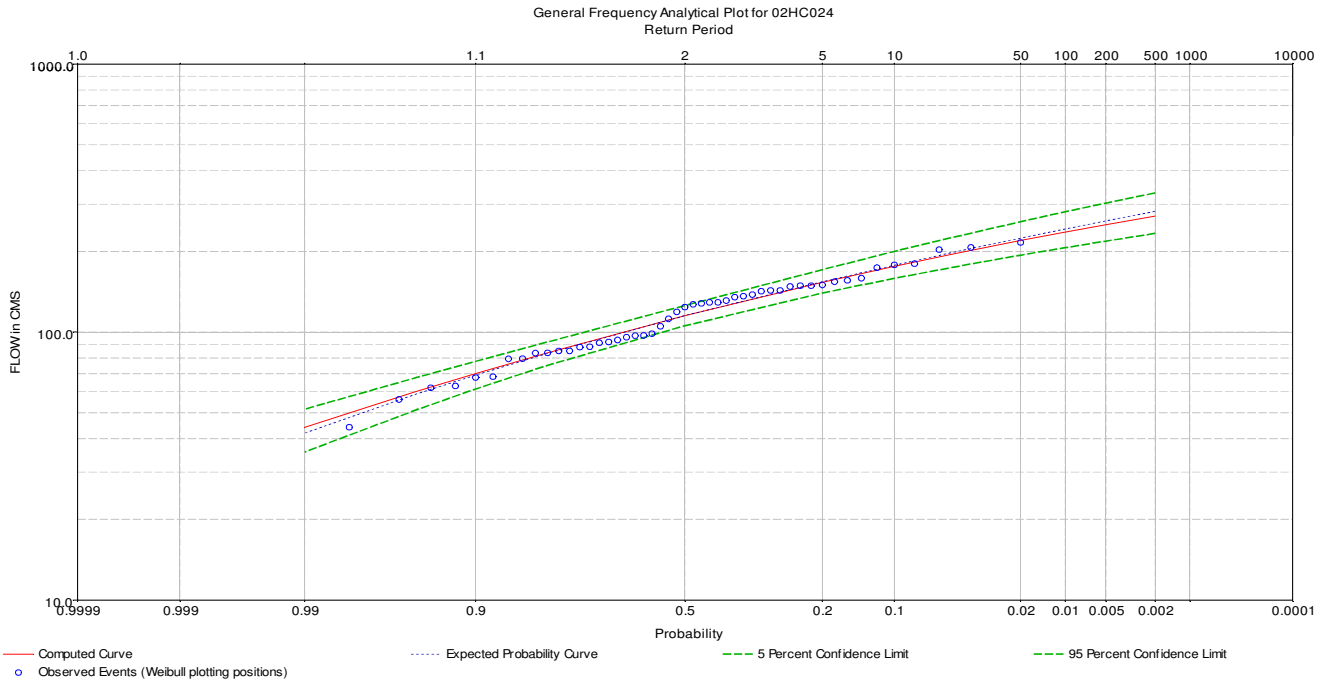
Station: 02HC023

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	3.97	3.7	4.88	2.98
95	1.05	5.55	5.4	6.54	4.46
90	1.11	6.61	6.5	7.65	5.48
80	1.25	8.14	8.1	9.25	6.97
50	2	11.99	12	13.54	10.63
20	5	17.42	17.6	20.38	15.32
10	10	21.06	21.4	25.37	18.23
5	20	24.56	25.2	30.41	20.93
2	50	29.12	30.3	37.25	24.32
1	100	32.56	34.4	42.6	26.8
0.5	200	36.01	38.6	48.11	29.26
0.2	500	40.64	44.4	55.68	32.48



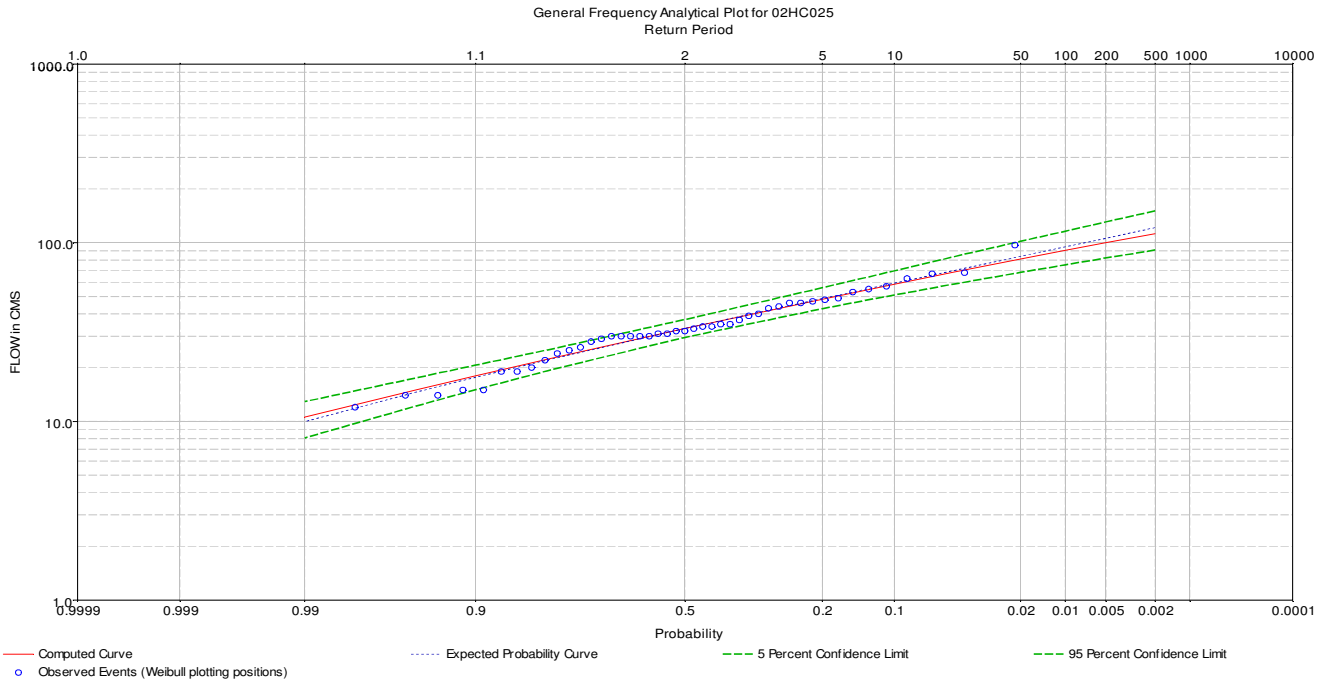
Station: 02HC024

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	44.08	41.9	51.53	35.71
95	1.05	59.97	58.7	67.65	51.26
90	1.11	70.02	69.1	77.78	61.32
80	1.25	83.77	83.2	91.8	75.15
50	2	115.12	115.1	125.56	105.69
20	5	153.25	154	171.11	139.74
10	10	175.82	177.4	199.91	158.68
5	20	195.72	198.5	226.18	174.89
2	50	219.41	224.1	258.32	193.73
1	100	235.9	242.3	281.17	206.6
0.5	200	251.42	259.8	303.01	218.57
0.2	500	270.74	282.2	330.61	233.29



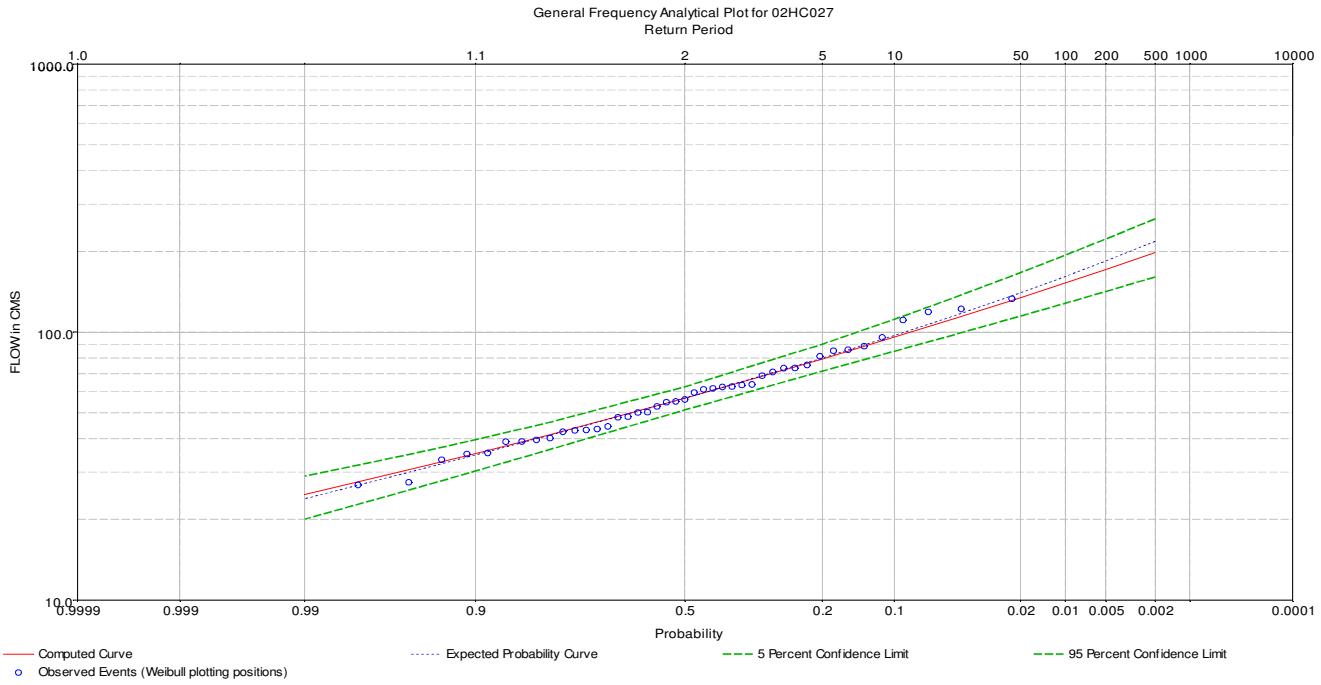
Station: 02HC025

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	10.58	10	12.9	8.08
95	1.05	14.99	14.6	17.55	12.2
90	1.11	17.97	17.7	20.64	15.05
80	1.25	22.26	22.1	25.15	19.23
50	2	33.1	33.1	37.14	29.52
20	5	48.35	48.7	56.02	42.77
10	10	58.53	59.4	69.68	51.02
5	20	68.3	69.9	83.36	58.63
2	50	80.94	83.8	101.78	68.19
1	100	90.45	94.7	116.06	75.19
0.5	200	99.97	105.9	130.71	82.09
0.2	500	112.65	121.4	150.67	91.1



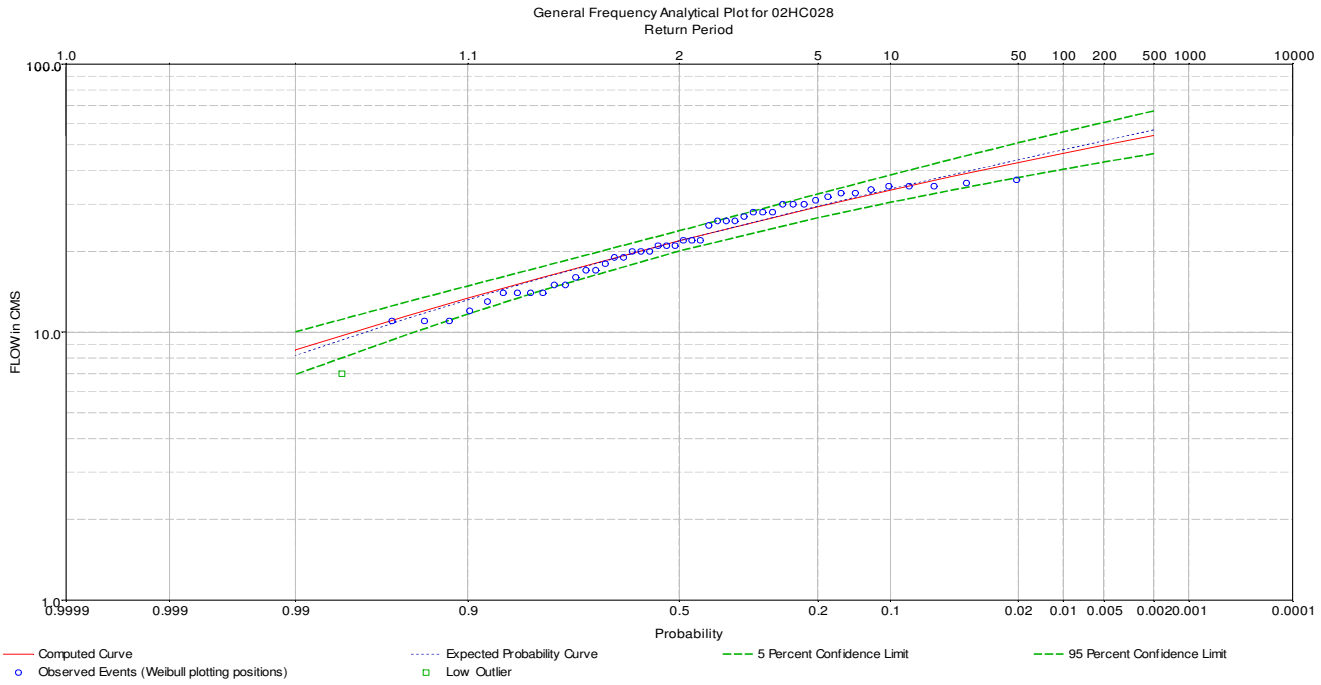
Station: 02HC027

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	24.82	23.9	29.03	20.06
95	1.05	31.08	30.5	35.42	26.17
90	1.11	35.23	34.8	39.66	30.29
80	1.25	41.22	41	45.83	36.27
50	2	56.59	56.6	62.48	51.2
20	5	79.39	80	90.13	71.45
10	10	95.6	97.1	111.53	84.77
5	20	111.98	114.8	134.19	97.68
2	50	134.47	140.2	166.68	114.8
1	100	152.39	161.2	193.5	128.05
0.5	200	171.23	184.2	222.51	141.7
0.2	500	197.76	218.2	264.55	160.5



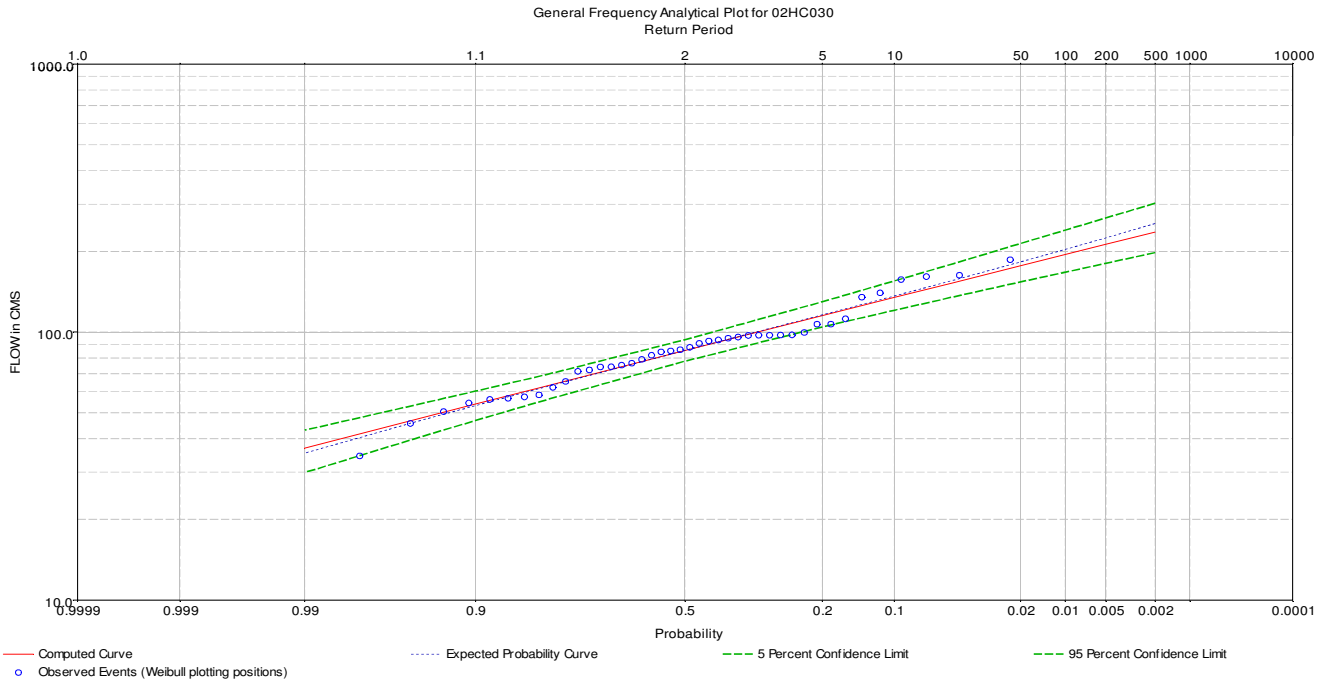
Station: 02HC028

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	8.58	8.2	10.02	6.95
95	1.05	11.51	11.3	12.99	9.82
90	1.11	13.37	13.2	14.87	11.69
80	1.25	15.93	15.8	17.49	14.26
50	2	21.87	21.9	23.89	20.05
20	5	29.31	29.5	32.79	26.69
10	10	33.84	34.2	38.59	30.48
5	20	37.92	38.5	44.02	33.79
2	50	42.9	43.9	50.82	37.72
1	100	46.43	47.9	55.77	40.46
0.5	200	49.83	51.7	60.6	43.06
0.2	500	54.13	56.8	66.84	46.31



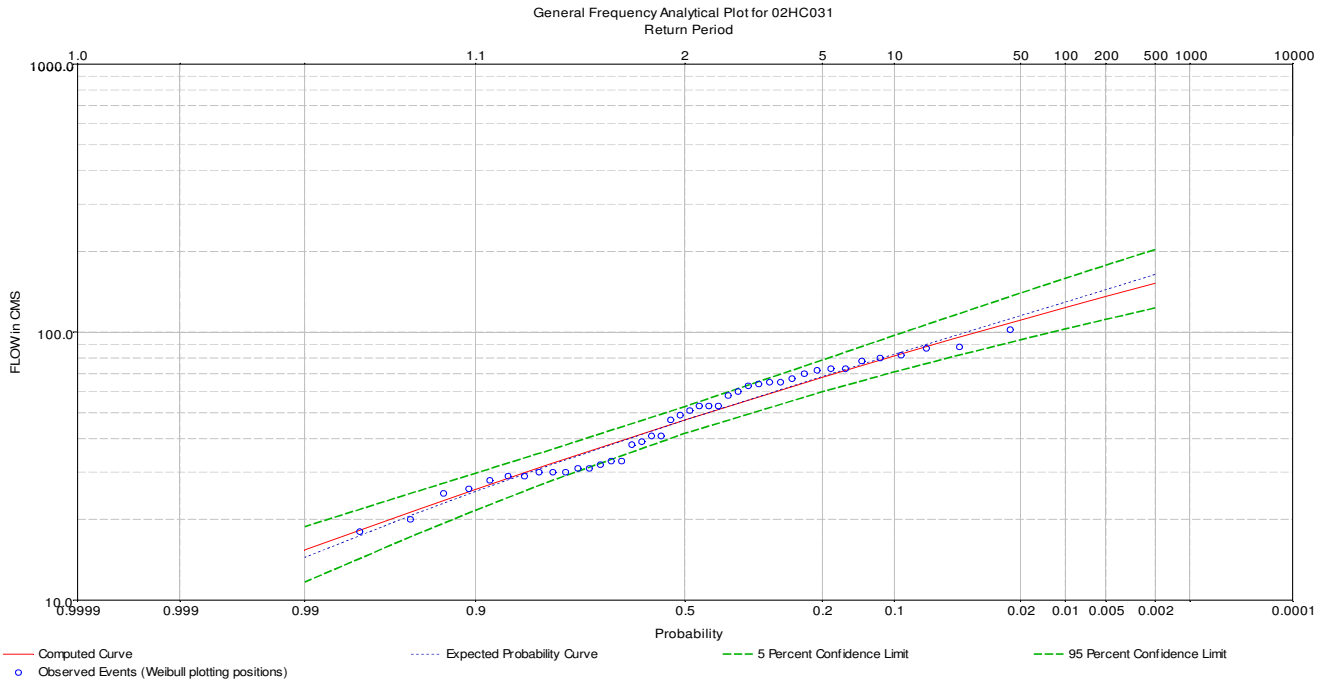
Station: 02HC030

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	36.95	35.3	43.08	29.93
95	1.05	47.28	46.3	53.53	40.12
90	1.11	53.91	53.2	60.2	46.78
80	1.25	63.15	62.7	69.64	56.1
50	2	85.36	85.4	93.61	77.85
20	5	115.2	116	129.69	104.46
10	10	134.66	136.4	155.13	120.58
5	20	153.12	156.3	180.32	135.33
2	50	176.88	182.7	213.92	153.73
1	100	194.7	203.3	239.86	167.2
0.5	200	212.54	224.6	266.42	180.46
0.2	500	236.32	254.2	302.62	197.83



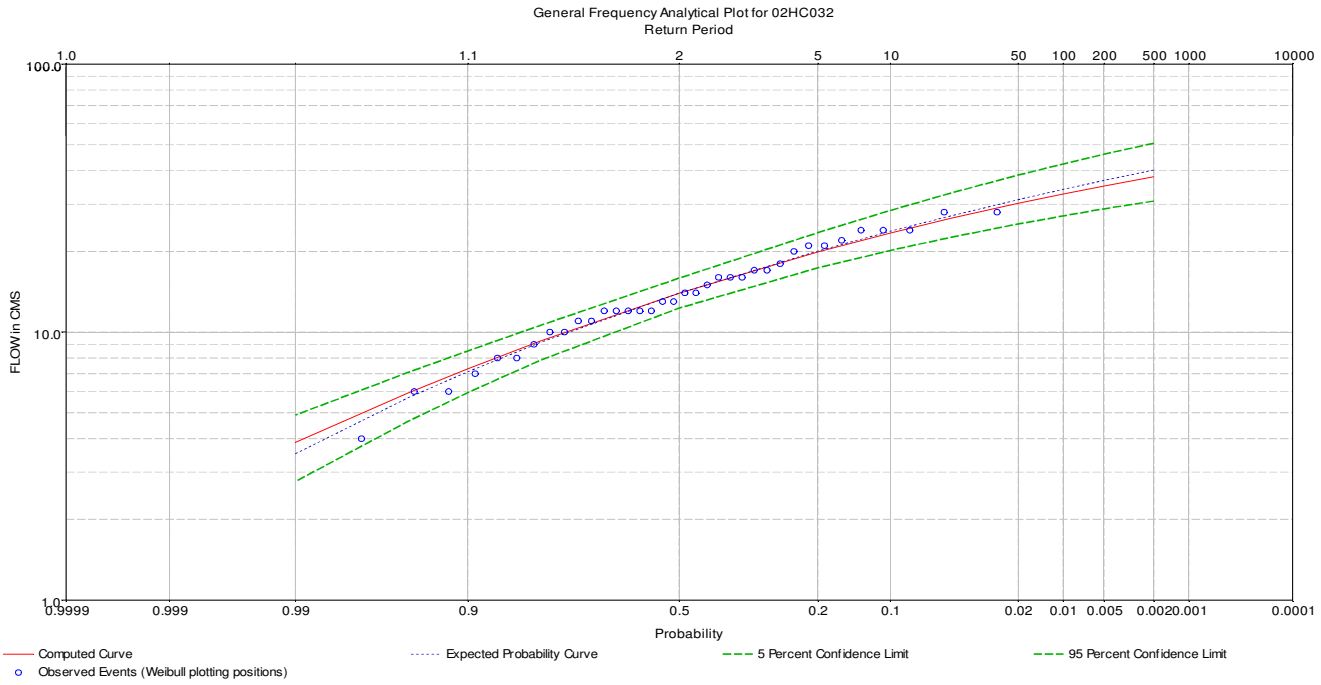
Station: 02HC031

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	15.39	14.4	18.79	11.69
95	1.05	21.68	21.1	25.39	17.59
90	1.11	25.89	25.4	29.76	21.65
80	1.25	31.93	31.6	36.09	27.55
50	2	46.98	47	52.76	41.87
20	5	67.76	68.3	78.63	59.93
10	10	81.43	82.6	97.1	70.97
5	20	94.41	96.6	115.42	81.06
2	50	111.03	115.1	139.82	93.59
1	100	123.41	129.3	158.57	102.68
0.5	200	135.71	143.9	177.64	111.56
0.2	500	151.94	164	203.42	123.07



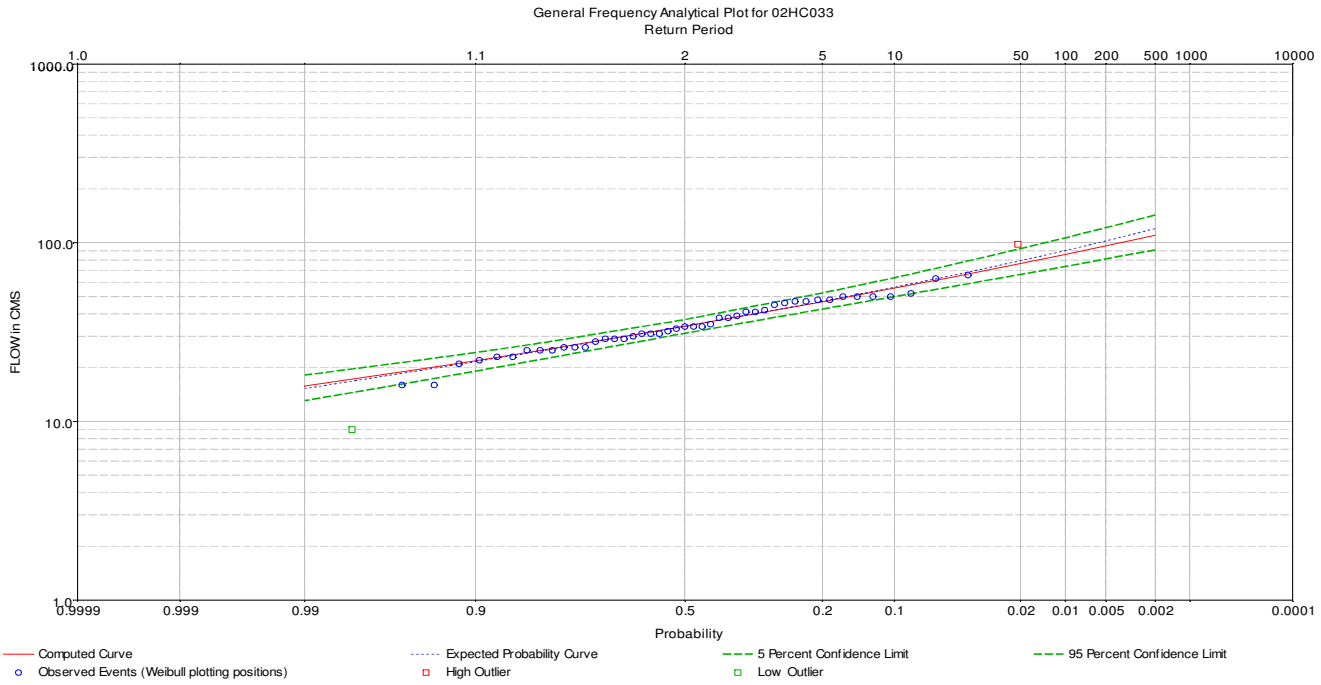
Station: 02HC032

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	3.87	3.5	4.9	2.77
95	1.05	5.92	5.7	7.07	4.64
90	1.11	7.29	7.1	8.51	5.95
80	1.25	9.26	9.2	10.59	7.85
50	2	13.96	14	15.9	12.29
20	5	19.89	20	23.52	17.36
10	10	23.43	23.8	28.45	20.18
5	20	26.54	27.1	32.98	22.56
2	50	30.2	31.2	38.5	25.3
1	100	32.72	34.1	42.39	27.13
0.5	200	35.05	36.8	46.08	28.81
0.2	500	37.91	40.2	50.66	30.83



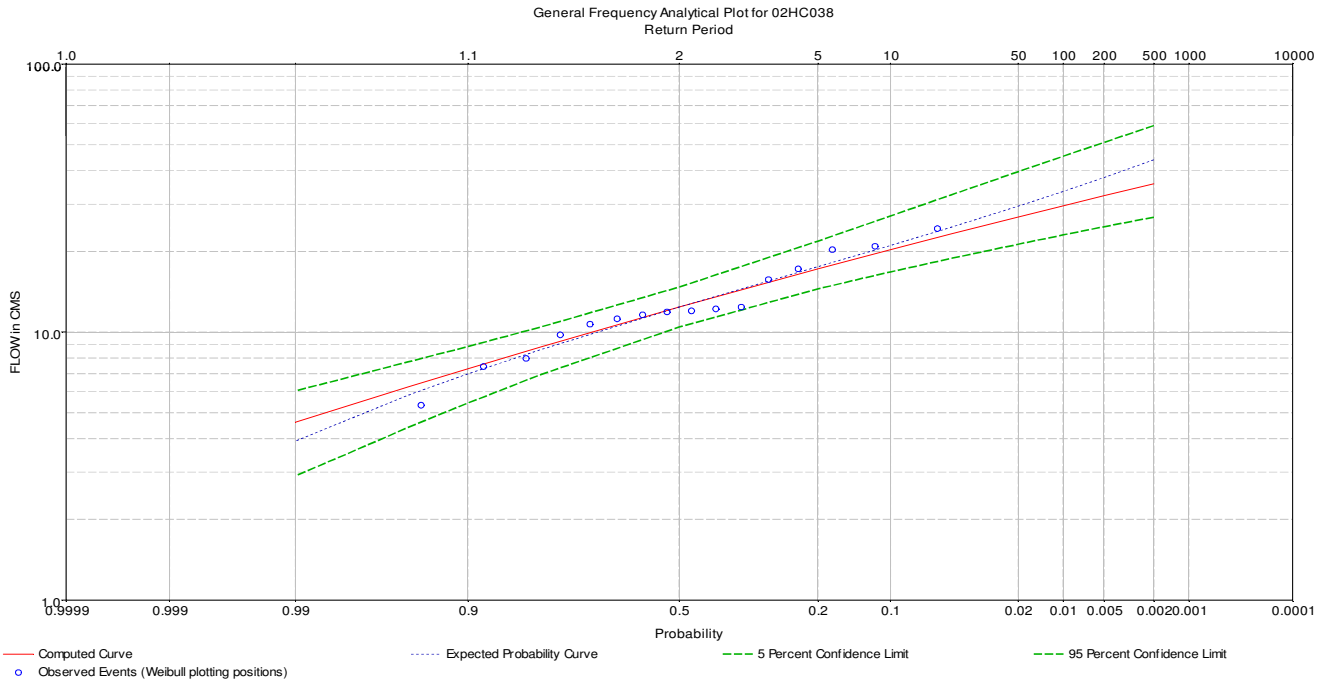
Station: 02HC033

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	15.79	15.3	18.17	13.08
95	1.05	19.45	19.1	21.88	16.71
90	1.11	21.86	21.6	24.31	19.12
80	1.25	25.3	25.2	27.83	22.58
50	2	34.01	34	37.16	31.1
20	5	46.69	47	52.27	42.48
10	10	55.58	56.3	63.73	49.89
5	20	64.48	65.9	75.72	57.03
2	50	76.58	79.4	92.67	66.42
1	100	86.15	90.4	106.5	73.65
0.5	200	96.14	102.4	121.32	81.06
0.2	500	110.11	119.8	142.6	91.22



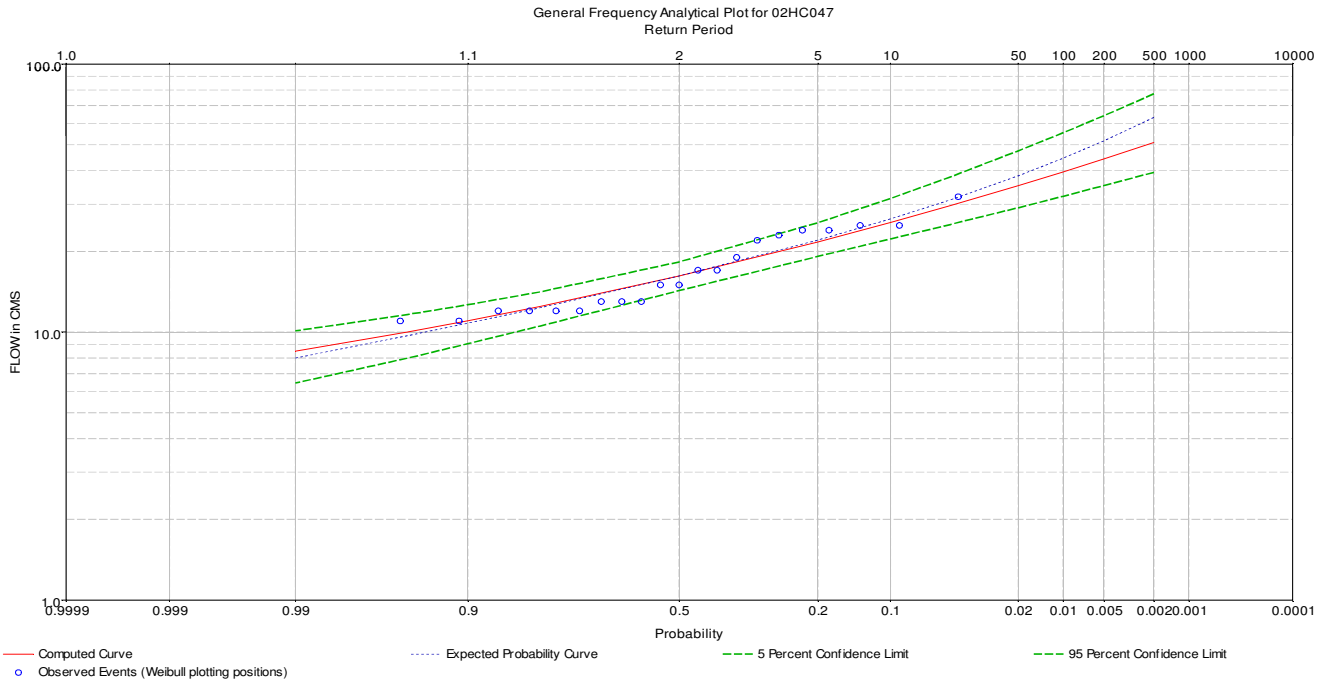
Station: 02HC038

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	4.61	3.9	6.04	2.91
95	1.05	6.24	5.8	7.73	4.4
90	1.11	7.3	7	8.84	5.44
80	1.25	8.79	8.6	10.43	6.93
50	2	12.39	12.4	14.73	10.44
20	5	17.2	17.5	21.84	14.48
10	10	20.29	21	27.1	16.79
5	20	23.19	24.6	32.42	18.82
2	50	26.86	29.5	39.63	21.27
1	100	29.57	33.4	45.24	23.01
0.5	200	32.24	37.7	51.01	24.69
0.2	500	35.75	43.9	58.9	26.83



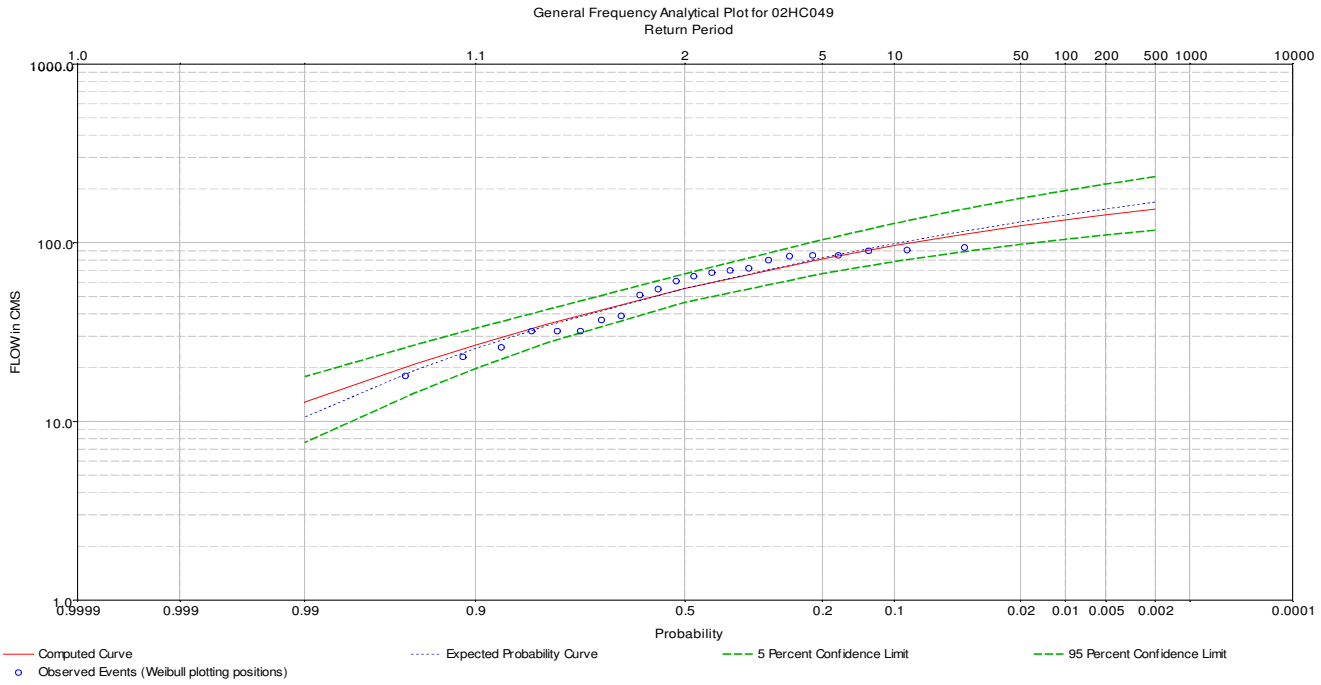
Station: 02HC047

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	8.48	8	10.1	6.45
95	1.05	10	9.7	11.63	8
90	1.11	11.01	10.8	12.64	9.04
80	1.25	12.47	12.3	14.14	10.55
50	2	16.18	16.2	18.28	14.28
20	5	21.7	22	25.57	19.15
10	10	25.64	26.4	31.48	22.25
5	20	29.63	31.1	37.91	25.21
2	50	35.16	38.3	47.37	29.1
1	100	39.58	44.5	55.38	32.1
0.5	200	44.27	51.7	64.22	35.19
0.2	500	50.91	63.2	77.34	39.44



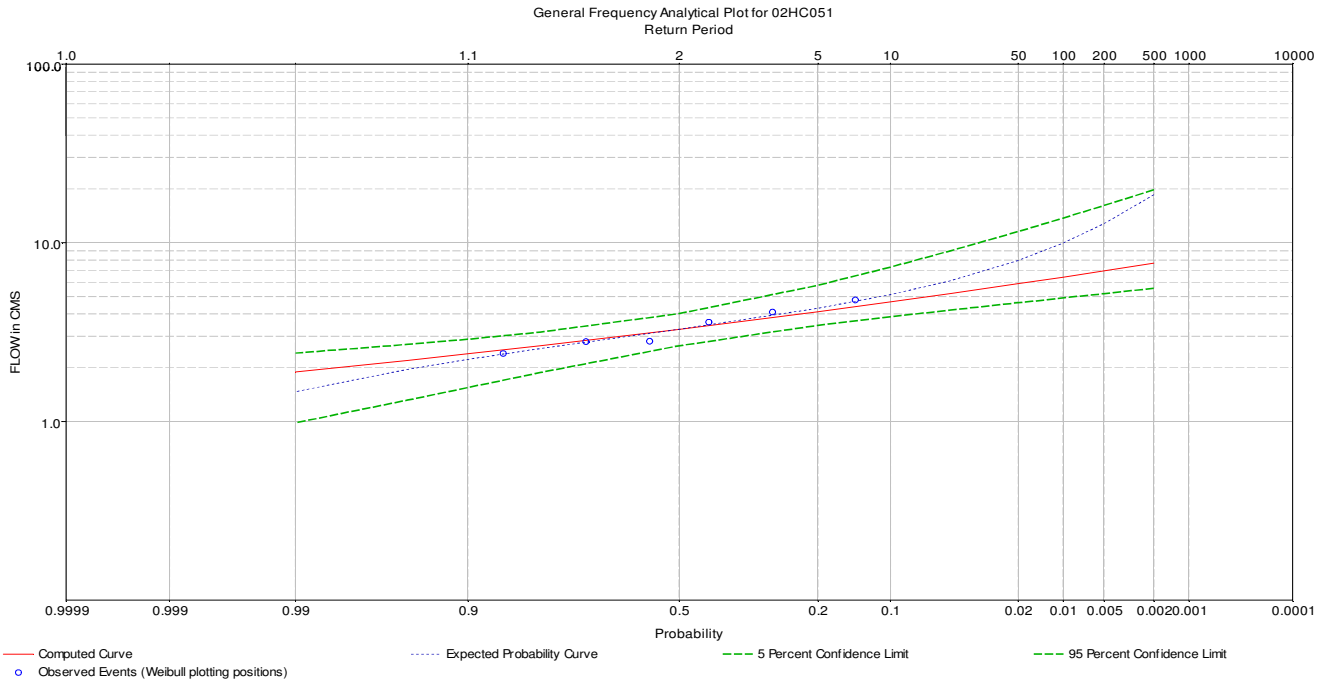
Station: 02HC049

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	12.85	10.6	17.82	7.63
95	1.05	21.08	19.5	26.95	14.54
90	1.11	26.82	25.6	33.17	19.76
80	1.25	35.16	34.4	42.34	27.62
50	2	55.5	55.5	66.97	46.34
20	5	81.17	82.3	104.01	67.24
10	10	96.23	98.6	128.3	78.43
5	20	109.22	113.4	150.49	87.67
2	50	124.16	130.9	177.22	97.91
1	100	134.16	143.2	195.76	104.59
0.5	200	143.23	154.6	213.03	110.55
0.2	500	154.04	168.6	234.08	117.53



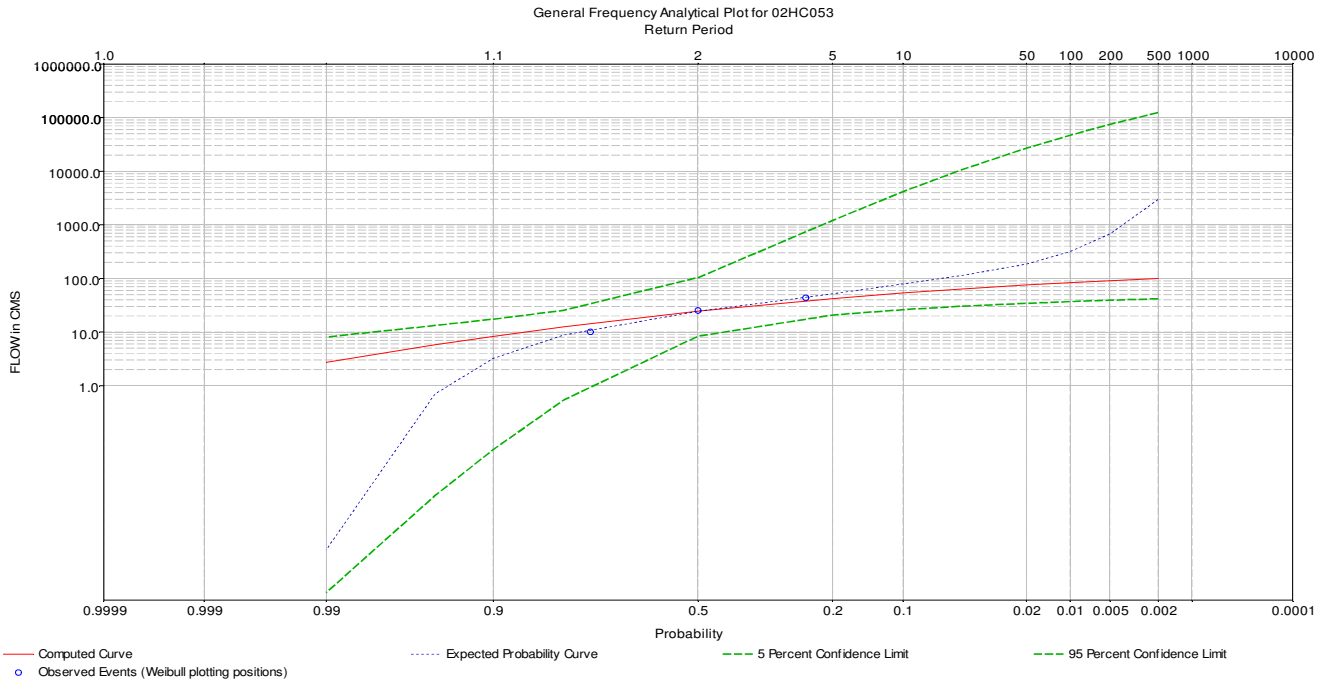
Station: 02HC051

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	1.89	1.5	2.41	0.98
95	1.05	2.2	2	2.7	1.32
90	1.11	2.39	2.2	2.89	1.55
80	1.25	2.65	2.6	3.17	1.88
50	2	3.28	3.3	4.01	2.65
20	5	4.12	4.3	5.77	3.45
10	10	4.67	5.1	7.3	3.85
5	20	5.2	6.1	9.01	4.2
2	50	5.89	7.9	11.55	4.61
1	100	6.42	10	13.73	4.9
0.5	200	6.96	12.8	16.15	5.19
0.2	500	7.68	18.6	19.77	5.57



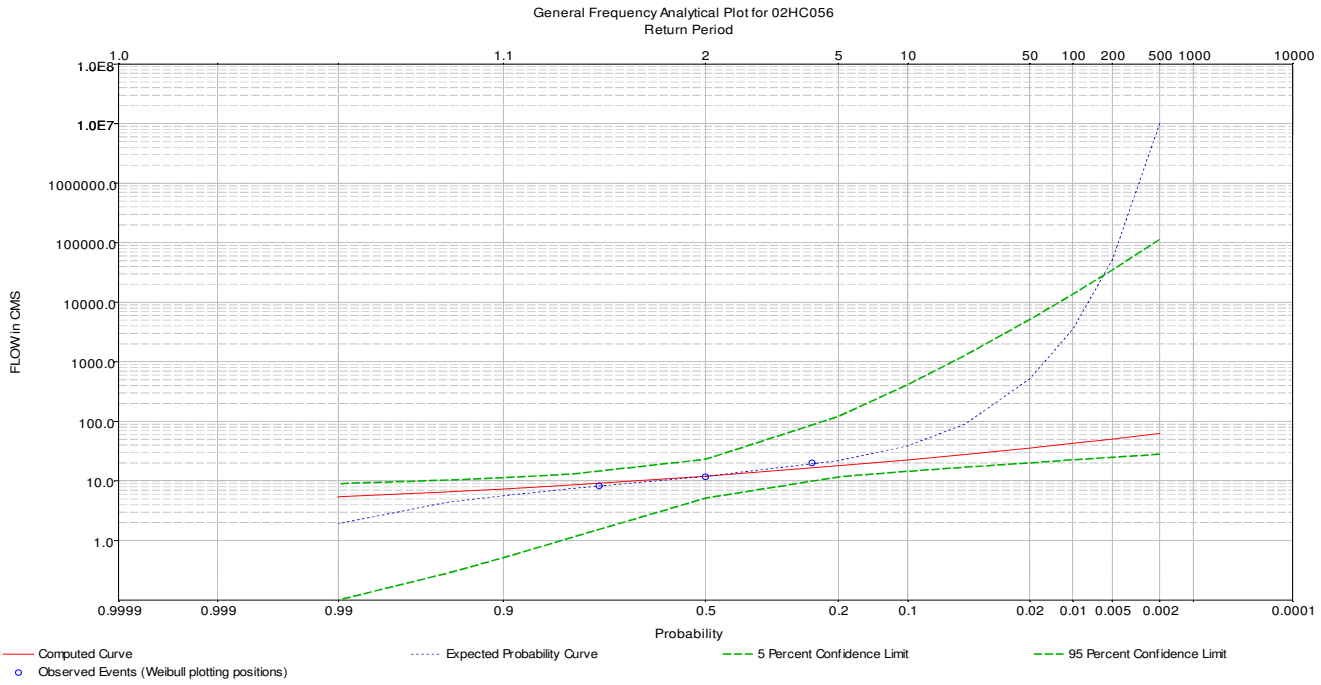
Station: 02HC053

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	2.72	0	8.1	0
95	1.05	5.79	0.7	13.21	0.01
90	1.11	8.33	3.2	17.34	0.06
80	1.25	12.48	8.8	25.42	0.54
50	2	24.45	24.4	103.56	8.39
20	5	42.14	51.8	1208.83	20.81
10	10	53.45	79.1	4178.9	26.15
5	20	63.58	113.4	10584.95	30.18
2	50	75.52	185.2	26935.03	34.38
1	100	83.63	317.2	47009.07	36.98
0.5	200	91.03	673.7	74833	39.24
0.2	500	99.84	2976	124406.33	41.78



Station: 02HC056

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	5.44	1.9	8.99	0.1
95	1.05	6.56	4.3	10.31	0.28
90	1.11	7.35	5.6	11.31	0.51
80	1.25	8.56	7.5	13.08	1.14
50	2	11.99	12	23.16	5.16
20	5	17.89	22	121.09	11.68
10	10	22.64	38.8	415.65	14.58
5	20	27.89	90.3	1289.72	17.05
2	50	35.82	517.9	5125.45	20.15
1	100	42.73	3517.2	13635.69	22.52
0.5	200	50.54	51308.8	34757.41	24.95
0.2	500	62.49	10142418	113678.61	28.31



Station: 02HC057

Percent Chance Exceedance	Return Period (Years)	Curve based on Data			
		Computed Curve Flow in CMS	Expected Prob. Flow in CMS	Confidence Limits FLOW in CMS	
				0.05	0.95
99	1.01	3.79	3.8	4.23	2.86
95	1.05	3.84	3.8	4.28	2.94
90	1.11	3.89	3.8	4.33	3.02
80	1.25	3.98	3.9	4.43	3.18
50	2	4.31	4.3	4.83	3.69
20	5	4.92	5.1	6.04	4.43
10	10	5.42	6	7.38	4.83
5	20	5.94	7.4	9.1	5.19
2	50	6.7	10.7	12.02	5.64
1	100	7.33	15.8	14.84	6
0.5	200	8.02	24.6	18.31	6.36
0.2	500	9.01	49.3	24.16	6.87