Analysis of Rainfall Events

July 16 and August 17, 2024

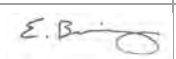
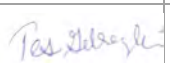
Toronto and Region Conservation Authority

27 March 2026

→ **The Power of Commitment**





Project name		Analysis of Rainfall Events on July 16 and August 17, 2024						
Document title		Analysis of Rainfall Events | July 16 and August 17, 2024						
Project number		12664155						
File name		12664155-REP-1-Analysis of Rainfall Events, July 16 and August 17, 2024_FINAL.docx						
Status Code	**Revision**	**Author**	**Reviewer**		**Approved for issue**			
			Name	**Signature**	**Name**	**Signature**	**Date**	
S4		Allyson Bingeman	Lisa Bowering		Tesfaye Gebrezghi		2/20/2026	
S4		Allyson Bingeman	Lisa Bowering		Tesfaye Gebrezghi		3/27/2026	

GHD Ltd
Contact: Allyson Bingeman, Senior Water Resources Engineer | GHD
455 Phillip Street, Unit 100A
Waterloo, Ontario N2L 3X2, Canada
T +1 519 884 0510 | **F** +1 519 884 0525 | **E** info-northamerica@ghd.com | **ghd.com**

© GHD 2026
This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

Executive summary

This report is subject to, and must be read in conjunction with, the limitations set out in section 1.3 and the assumptions and qualifications contained throughout the Report.

The Toronto and Region Conservation Authority (TRCA) has a mandate to protect people and property from flooding and other natural hazards. On July 16, 2024, and August 17, 2024, two short-duration, high intensity convective rainfall events occurred. This project developed a Storm Analysis Report (Report) to characterize the events.

Storm overview for July 16, 2024

The five-day antecedent rainfall totals (July 11 to July 15, 2024) ranged from 36 to 96 mm. The majority of the TRCA jurisdiction was classified as dry or average conditions (AMCI or AMCII). However, the watershed may have still been wet from the remnants of Hurricane Beryl, which occurred on July 10, 2024.

Environment Canada issued multiple Severe Thunderstorm Watches in the morning on July 16, 2024 (with Rainfall Warnings for 75 mm to 125 mm). There was very little warning or lead-time for the storm, as the earlier forecasts were for lower amounts of rainfall. The later forecasts had larger amounts but some of the rainfall had already happened.

TRCA issued a Flood Watch at 9:30 AM, and then upgraded to a Flood Warning at 11:30 AM on the morning of July 16, 2024. After the storm's conclusion, TRCA downgraded its flood messaging to a Watershed Conditions Statement for Water Safety at 11:00 PM in the evening of July 16, 2024. The Insurance Bureau of Canada estimated that the total damages to personal property were $990 million. There was no loss of life.

Storm overview for August 17, 2024

The 5-day antecedent rainfall totals (August 12 to August 16, 2024) ranged up to 8 mm. The TRCA jurisdiction was classified as dry conditions (AMCI). TRCA had an active Watershed Conditions Statement for Water Safety in effect on August 17, that was issued the day prior on August 16, 2024, due to forecasted thunderstorms occurring on August 16 and 17, with total rainfall amounts of 15 to 30 mm and the possibility of up to 60mm in localized areas.

Environment Canada issued multiple Rainfall Warnings throughout the afternoon of August 17, 2024 (for 40 mm to 50 mm in an hour). These Rainfall Warnings were later updated for total amounts of 100 mm and then 200 mm. Severe Thunderstorm Watches were issued by Environment Canada in the middle and late parts of the afternoon.

TRCA upgraded its previous Watershed Conditions Statement for Water Safety to a Flood Watch at 2:00 PM on August 17, 2024. TRCA continued its Flood Watch throughout the next day on August 18, until cancelling it at 11:30 AM on August 19, 2024 with the return to normal river conditions. The Insurance Bureau of Canada estimated that the total damages to personal property were $110 million. There was no loss of life.

Rainfall analysis

Both events travelled from west to east across the TRCA jurisdiction, starting in Mississauga and extending through the City of Toronto. The August storm event was located further north than the July storm event. Rainfall exceeding the 100-year event was received at some rain gauges during both events.

Initially, the July storm was located in the southern portions of the Etobicoke and Mimico watersheds. It then extended into the Humber and Don watersheds, but the Etobicoke and Mimico watersheds had the most intense rainfall. The northern portions of Humber, Don, Rouge, and Duffins watersheds received less rainfall. The event lasted 3 to 6 hours in length with multiple short "bursts" of rainfall. For the July event, the highest recorded 24-hr rainfall total within the TRCA jurisdiction was 101.5 mm, at station HY099 (TRCA gauge) in the Etobicoke watershed.

The August storm was initially located in the middle portions of the Etobicoke and Mimico watersheds. It then extended into the Humber and Don watersheds, but the Etobicoke and Mimico watersheds had the most intense rainfall. The northern portions of Humber, Don, Rouge, and Duffins watersheds and the Lake Ontario Waterfront received less rainfall. The event lasted 6 to 12 hours with multiple short "bursts" of rainfall. For the August event, the highest recorded 24-hr rainfall total was 135.7 mm, at station HY099 (TRCA gauge) in the City of Mississauga.

TRCA currently uses a mix of design storms which vary from watershed to watershed (AES, SCS Type II, and Chicago at various durations). The design storm analysis indicated that the AES and SCS Type II were suitable design storms, and the Chicago storm was conservative.

The Gauge-Adjusted Radar Rainfall (GARR) data set obtained from Region of Peel, indicated that the rainfall for both events occurred in thinner bands than a simple spatial interpolation of the observed rain gauge data would suggest.

Streamflow and water levels

For the July event, the peak water levels exceeded the 100-year water levels at 12 locations. In addition, there were 11 high water marks that exceeded the 100-year water level in the Don and Etobicoke watersheds. According to the flood frequency curves, the Don River experienced an exceedance of the 100-year return period. The flows in Etobicoke and Mimico were in exceedance of the 200-year. The Humber flow was only in exceedance of the 50-year return period.

For the August event, the peak water levels exceeded the 100-year water levels at 10 locations. There was one high water mark that exceeded the 100-year water level. According to the flood frequency curves, the Etobicoke and Mimico flows were in exceedance of the 500-year. The remaining watersheds ranged up to a 10-year return period.

Historical storm events

The July 16 and August 17, 2024 storm events were convective in nature, which is similar to five earlier historical events. Both storm events exceeded the maximum hourly rainfall and total accumulation for short durations of both the Hurricane Hazel and Harrow storms. The July 16, 2024 event had a larger 1-hr accumulation than the Hurricane Hazel and Harrow storms. The August 17, 2024 event had larger accumulations up to 3-hr than the Hurricane Hazel and Harrow storms. However, the Hurricane Hazel and Harrow storms are both larger (had higher accumulations overall) than the 2024 events.

Recommendations

The emergency response and preparedness actions for the August event were very rapid compared to the July event, due to heightened awareness. TRCA should continue to focus on educating the public and municipalities to improve communication and knowledge surrounding flood risk while remaining sensitive to people in flood vulnerable areas.

TRCA is interested in supporting the use of the National Public Alerting System, Alert Ready, specifically for flash flooding scenarios, with municipal partners and Environment and Climate Change Canada (ECCC). TRCA cannot directly issue or request emergency broadcasts from this system, but can work together with municipal and ECCC staff to define appropriate rainfall criteria for flash flood alerts.

TRCA should also consider changing to targeted messaging by watershed boundary, city, or area. Distribution lists would need to be tailored and a significant challenge is the implementation of customized river flow forecasts for each watershed and municipality, which is currently not available.

Due to the rapidly developing nature of the two 2024 convective storm events, TRCA should pursue more options including real-time hydrologic and hydraulic modelling through leveraging TRCA’s existing sets of flood modelling with integration of these models into the Flood Early Warning System.

TRCA should extend their rating curves as there were multiple locations where the flow rate needed to be extrapolated. The rating curves should be prioritized according to how much extrapolation was required.

The differences between the GARR data and the rain gauge interpolations indicate that the variation in rainfall is not fully captured by rain gauge interpolations. The GARR dataset and the rain gauge network should be further developed. The dataset should also be examined further to determine how the radar rainfall data can be used in the future. TRCA should consider coordinating with other agencies to standardize the rain gauge network and developing data sharing platforms to allow for faster data access.

Contents

1. Introduction **1**
1.1 Funding acknowledgement 1
1.2 Purpose of this report 1
1.3 Scope and limitations 1
1.4 Assumptions 2

2. Data collection **2**
2.1 Rainfall 2
2.1.1 Data summary 2
2.1.2 Data gaps 5
2.2 Radar images and rainfall data 5
2.3 Streamflow/water level 6
2.3.1 Data summary 6
2.3.2 Data gaps 8
2.3.3 Rating curve extrapolations 10
2.4 Mapping 11
2.5 Storm and damage reports 14
2.6 Additional documents 14

3. Storm overview **15**
3.1 Summary of storms 15
3.2 TRCA flood messages 16
3.3 Storm timeline 18
3.4 Antecedent conditions 30
3.5 Reported storm impacts 40
3.5.1 City of Toronto 40
3.5.2 City of Mississauga 41
3.5.3 Regional Municipality of Peel 42
3.5.4 Regional Municipality of York 42
3.5.5 Insurance damage reports 43
3.6 TRCA post-storm activities 43

4. Rainfall analysis **43**
4.1 Spatial mapping of total rainfall 43
4.2 Spatial mapping of rainfall intensity 48
4.3 Spatial mapping of storm duration 49
4.4 Spatial mapping of rainfall accumulations 53
4.5 Comparison to IDF curves 55
4.6 Design storm analysis 58
4.6.1 Candidate design storm distributions 58
4.6.2 Rain gauge selection 61
4.6.3 Comparative analysis 63

4.6.4 Summary 67
4.7 Comparison to GARR data 68
4.8 Discussion on rain gauge network 69
5. Streamflow and water levels 69
5.1 Water levels 69
5.2 Spatial mapping of high water marks 75
5.3 Spatial mapping of peak runoff rates 81
5.4 Comparison of peak streamflow to flood frequency curves 84
6. Historical storm events 90
6.1 Qualitative Comparison 90
6.2 Quantitative Comparison 93
6.2.1 Rainfall amounts 93
6.2.2 Spatial mapping of total rainfall 97
6.2.3 Spatial mapping of 1-hr rainfall intensity 100
6.2.4 Spatial mapping of storm duration 102
6.2.5 Spatial mapping of return periods 104
7. Conclusions and Recommendations 108
7.1 Conclusions 108
7.1.1 July 16, 2024 Storm 108
7.1.2 August 17, 2024 Storm 110
7.2 Recommendations 112
8. References 113

Table index

Table 1 Rainfall data collection summary 3
Table 2 Summary of rain gauges removed 5
Table 3 Streamflow/water level data collection summary 6
Table 4 Gauges with missing streamflow and water level data for entirety of July 16, 2024 and/or August 17, 2024 8
Table 5 Identified streamflow and water level temporal data gaps on July 16, 2024 9
Table 6 Identified streamflow and water level temporal data gaps on August 17, 2024 9
Table 7 Summary of Rating Curve Extrapolation 11
Table 8 Peak Flow Estimation Using Extended Rating Curves (TRCA, April 2025) 11
Table 9 Description of Flood Message Criteria (from TRCA) 17
Table 10 Chronological list of events during extreme rainfall event on July 16, 2024 18
Table 11 Chronological list of events during extreme rainfall event on August 17, 2024 23
Table 12 Average Precipitation Based on Environment and Climate Change Canada (ECCC) Gauges (mm) 30
Table 13 Summary of media statements issued by City of Mississauga 41
Table 14 Average Total Storm Depth in TRCA Watersheds 44
Table 15 Average Total Storm Depth in TRCA Watersheds 46
Table 16 Stations with maximum rainfall intensity for each duration 48

Table 17	Times for accumulation maps for July 16, 2024	53
Table 18	Times for accumulation maps for August 17, 2024	54
Table 19	Selected ECCC Climate Stations for IDF Comparison	55
Table 20	Maximum Return Period in Each TRCA Watershed - July 16, 2024	56
Table 21	Maximum Return Period in Each TRCA Watershed - August 17, 2024	56
Table 22	Comparative design storm distribution duration for observed event duration	61
Table 23	July 16, 2024 storm characteristics compared to synthetic design storm characteristics	64
Table 24	August 17, 2024 storm characteristics compared to synthetic design storm characteristics	66
Table 25	Design Storm Analysis Results Summary for July 16, and August 17, 2024 Storms	68
Table 26	Comparison of Maximum Observed Water Surface Elevations at Streamflow Gauges on July 16, 2024 and August 17, 2024	71
Table 27	Comparison of High Water Marks to 100-year Storm for July 16, 2024 Event	75
Table 28	Comparison of High Water Marks to 100-year Storm for August 17, 2024 Event	77
Table 29	Streamflow Gauges Used in Single Station Frequency Analysis	84
Table 30	Single Station Frequency Analysis Flood Estimates (m^3/s)	86
Table 31	Summary of Frequency Analysis Results – July 16, 2024	89
Table 32	Summary of Frequency Analysis Results – August 17, 2024	89
Table 33	Comparison of Major Historical Storm Events in Ontario	91
Table 34	Rainfall data collected for historical storms	93
Table 35	Comparison of Major Historical Storm Events in Ontario – Rainfall Amounts	96

Figure index

Figure 1	Rain Gauge Locations	4
Figure 2	Stream Gauge Locations	7
Figure 3	Total accumulation and maximum return frequency of the July 16, 2024 storm in York Region (York Region, 2024)	13
Figure 4	Antecedent Moisture Conditions July 16, 2024	32
Figure 5	Antecedent Precipitation 1 day prior July 16, 2024	33
Figure 6	Antecedent Precipitation 2 days prior July 16, 2024	34
Figure 7	Antecedent Precipitation 5 days prior July 16, 2024	35
Figure 8	Antecedent Moisture Conditions August 17, 2024	36
Figure 9	Antecedent Precipitation 1 day prior August 17, 2024	37
Figure 10	Antecedent Precipitation 2 days prior August 17, 2024	38
Figure 11	Antecedent Precipitation 5 days prior August 17, 2024	39
Figure 12	Total Precipitation – July 16, 2024	45
Figure 13	Total precipitation – August 17, 2024	47
Figure 14	Total storm duration – July 16 2024	51
Figure 15	Total storm duration – August 17 2024	52
Figure 16	Percent of rainfall in each half hour for the July 16, 2024 event	53
Figure 17	Percent of rainfall in each half hour for the August 17, 2024 event	54
Figure 18	Candidate Design Storms for Comparison	58

Figure 19	1-hour Candidate Design Storms	59
Figure 20	3-hour Candidate Design Storms	60
Figure 21	6-hour Candidate Design Storms	60
Figure 22	12-hour Candidate Design Storms	61
Figure 23	Historic rainfall data selection process	62
Figure 24	Location of selected rain gauges for design storm analysis	63
Figure 25	Comparison of 3-hour July 16, 2024 and synthetic rainfall distributions	65
Figure 26	Comparison of 6-hour July 16, 2024 and synthetic rainfall distributions	65
Figure 27	Comparison of 6-hour August 17, 2024 and synthetic rainfall distributions	67
Figure 28	Comparison of 12-hour August 17, 2024 and synthetic rainfall distributions	67
Figure 29	High Water Marks – July 16, 2024 storm	79
Figure 30	High Water Marks – August 17, 2024 storm	80
Figure 31	Peak Runoff – July 16, 2024	82
Figure 32	Peak Runoff – August 17, 2024	83
Figure 33	WSC stations colour coded by return period for July 16, 2024 event	87
Figure 34	WSC stations colour coded by return period for August 17, 2024 event	88
Figure 35	Maximum total rainfall for each historical storm event	94
Figure 36	Hyetograph of rain gauges with maximum rainfall for each historical storm event	95
Figure 37	Spatial mapping of the total rainfall for the historical storms	98
Figure 38	Spatial mapping of the storm extents for the historical storms	99
Figure 39	Spatial mapping of the 1-hr maximum rainfall for the historical storms	101
Figure 40	Spatial mapping of the duration for the historical storms	103
Figure 41	Spatial mapping of the extent of the 25-year and greater return period for the historical storms	105
Figure 42	Spatial mapping of the extent of the 50-year and greater return period for the historical storms	106
Figure 43	Spatial mapping of the extent of the 100-year and greater return period for the historical storms	107

Appendices

Appendix A	Rainfall intensities
Appendix B	Hourly accumulation figures
Appendix C	Spatial distribution of return periods for various storm durations
Appendix D	GARR Comparison Maps

1. Introduction

The Toronto and Region Conservation Authority (TRCA) has a mandate to protect people and property from flooding and other natural hazards. As part of this mandate, TRCA manages watershed-based data collection, flood and hazard mapping, event analysis, and knowledge sharing. This project adds to the knowledgebase of extreme rainfall events, watershed response, and flood management within the TRCA managed watersheds.

On July 16, 2024, and August 17, 2024, two short-duration, high intensity convective rainfall events occurred. These two events caused significant flooding and damage over portions of the Greater Toronto Area (GTA). The objective of this project is to produce a Storm Analysis Report (Report) which characterises these two events within the TRCA jurisdiction, providing a detailed analysis of the rainfall, antecedent conditions, peak flow rates and runoff distribution, water levels, impacts to local infrastructure, and public forecasts and alerts. In addition, the Report compares the July 16, and August 17, 2024 rainfall events to seven historically significant rainfall events in Southern Ontario. The purpose of the comparative analysis is to understand how these two events compare to historical events: in rainfall amount, area affected, and total damages. This analysis will improve understanding of historic patterns, surface runoff generated by major events, and resulting flooding within the TRCA jurisdiction. The focus of the hydraulic analysis will be on riverine flooding.

1.1 Funding acknowledgement

This Project is funded in part by the Government of Canada.

This Project was made possible in part by the Province of Ontario.

1.2 Purpose of this report

The purpose of this report is to provide a summary of the storm analyses for the two storms. This report contains the following sections:

- Section 2: Data Collection – Overview of the data collection process and any data gaps identified
- Section 3: Storm Overview – Overview of the storm timeline, antecedent conditions, and impacts
- Section 4: Rainfall Analysis – Mapping of the rainfall, comparison to IDF curves, and comparison to design storm distributions
- Section 5: Streamflow and Water Levels – Mapping of the peak flows, water levels, and comparison to flood frequency curves
- Section 6: Historical Storm Events – Comparison to historical storm events
- Section 7: Summary – Conclusions and recommendations

1.3 Scope and limitations

This report: has been prepared by GHD for TRCA and may only be used and relied on by TRCA for the purpose agreed between GHD and Toronto and Region Conservation Authority.

This report may be published publicly, but GHD otherwise disclaims responsibility to any person other than Toronto and Region Conservation Authority arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

GHD has prepared this report on the basis of information provided by Toronto and Region Conservation Authority and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section 1.4 of this report). GHD disclaims liability arising from any of the assumptions being incorrect.

Accessibility of documents

If this report is required to be accessible in any other format, this can be provided by GHD upon request and at an additional cost if necessary.

1.4 Assumptions

The following assumptions were used in this report.

- Storm overview was based on publicly available data and other data from TRCA and partner agencies for each storm.
- Rainfall data were collected from numerous agencies. GHD's QA/QC process included checks for data completeness and consistency with nearby rain gauges. The data quality may vary from agency to agency due to differing equipment and procedures.
- Design storm analysis considered durations from 1-hr to 12-hr, and considered the following typical design storms: AES, Chicago, Huff, and SCS Type II.
- Radar data assessment was based on the Gauge-Adjusted Radar Rainfall (GARR) dataset (Vieux, 2025).
- Flood frequency analysis was based on single-station analysis of the Water Survey of Canada stations in the TRCA jurisdiction only.
- The historical storm analysis considered the following storms: Hurricane Hazel (1954), Highland Creek (1976), Harrow Storm (1989), Finch Avenue (2005), Cooksville Creek (2009), July 8, 2013 Storm (2013), and Burlington Storm (2014). Rainfall data were collected for each historical storm from multiple agencies, but amount of data and data quality vary from storm to storm.

2. Data collection

2.1 Rainfall

2.1.1 Data summary

Rainfall data for the July 16, and August 17, 2024 storm events were compiled from a combination of publicly available data from TRCA, Environment and Climate Change Canada (ECCC) and City of Toronto, and data requests to participating municipalities within TRCA jurisdiction, including the Regional Municipality of York ("York Region"), City of Markham, Town of Richmond Hill, Regional Municipality of Peel ("Peel Region"), and City of Mississauga. A summary of the collected rainfall data is provided in **Table 1**. Note that overlaps in the gauges may exist between upper tier municipalities and the corresponding lower tier municipalities in their jurisdictions.

Table 1 Rainfall data collection summary

Agency/ Municipality	Data source	Data description
TRCA	TRCA Open Data portal	– 5-minute increment precipitation totals at 40 gauges for the July 16, 2024 storm event and at 39 gauges for the August 17, 2024 storm event
ECCC	ECCC Historical Data website	– Hourly precipitation totals for Toronto City station (Climate ID: 6158355), Toronto City Centre station (Climate ID: 6158359) – Daily precipitation totals for Toronto Intl A (Climate ID:6158731)
	Table 13 (data request to ECCC Climate Centre)	– Minutely precipitation totals at Toronto City 6158355 XTO for July-Aug 2024
City of Toronto	Toronto Open Data	– 5-minute increment precipitation totals at 21 gauges for the July 16, and August 17, 2024 storm events – Data collected in EST
York Region (YR)	FlowWorks platform (access obtained through data request)	– 5-minute increment precipitation totals at 45 gauges for the July 16, and August 17, 2024 storm events
City of Markham	Data request	– 5-minute increment precipitation totals at 13 gauges for the July 16, and August 17, 2024 storm events
Town of Richmond Hill	Data request	– 5-minute increment precipitation totals at 2 gauges for the July 16, and August 17, 2024 storm events
Peel Region	FlowWorks platform (access obtained through data request)	– 5-minute increment precipitation totals at 43 gauges for the July 16, and August 17, 2024 storm events – Data collected in EST
	Gauge-adjusted radar rainfall (GARR) obtained through Vieux platform	– GARR data for all TRCA watersheds for both rain events – 5-minute increment precipitation totals for 1-km pixels – Data collected in EST
City of Mississauga	Data request	– 5-minute increment precipitation totals at 13 gauges for the July 16, and August 17, 2024 storm events

The locations of the rain gauges provided by TRCA, as well as the 5-min GARR data are shown on **Figure 1.** A table providing the names of the stations that match with the numbers in the figure is included in **Appendix A.**

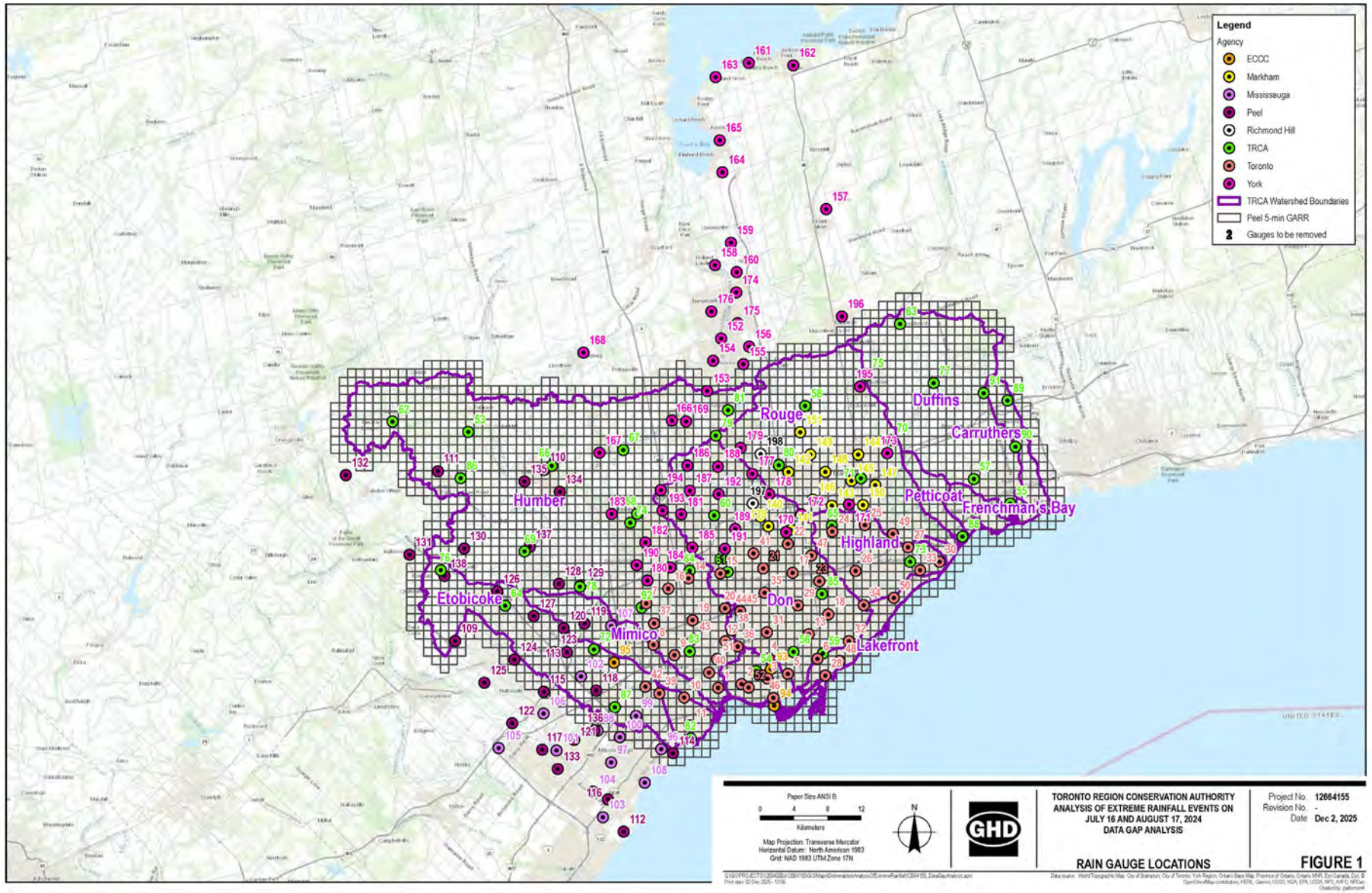


Figure 1 Rain Gauge Locations

2.1.2 Data gaps

The total number of rain gauges received by all the Agencies/Municipalities was 198, however 43 of these gauges fell outside of the TRCA jurisdiction. For the rainfall analysis, the ECCC gauges were removed due to their timestep being hourly and minutely, which was inconsistent with the 5-min timestep of the rest of the rain gauges. An additional six gauges with missing or inconsistent data were removed from the analysis, as summarized in **Table 2**.

For both the July 16, 2024 and August 17, 2024 storms, RG_030 and RG_063 from City of Toronto and R-YR-KI-01 from York Region did not have data recorded, so these 3 gauges were removed. For July 16, 2024, RG_027 from City of Toronto had missing data, recording zero precipitation for the entire storm date, so this gauge was removed. For August 17, 2024, HY027 from TRCA and R-MUN-MA-18 from City of Markham recorded zero precipitation for the entire storm date, so both gauges were removed. A manual spatial comparison was performed between nearby stations to confirm the precipitation totals were similar, and no outliers were found or removed as a result of this review.

Overall, there were 148 valid gauges for July 16, 2024 and 147 valid gauges for August 17, 2024 within the TRCA jurisdiction. Overall, the gauges removed did not leave any spatial gaps of concern and the rain gauges retained for analysis provided good coverage. These gauges were used for spatial interpolation of antecedent precipitation, rainfall intensities and storm duration as well as in the IDF comparison. Rain gauges that fell outside of the TRCA jurisdiction were still considered during the hydrologic modelling for Etobicoke Creek watershed, which is located along the edge of the TRCA and Credit Valley Conservation (CVC) jurisdictions, if they were within a 5 km buffer to the model subcatchments.

Table 2 Summary of rain gauges removed

Storm Event	Rain Gauges Removed	# Rain Gauges Retained for Analysis (within TRCA jurisdiction)
Both	- Toronto City (ECCC) - Toronto City Centre (ECCC) - Toronto International Airport (ECCC) - RG_030 (City of Toronto) - RG_063 (City of Toronto) - R-YR-KI-01 (York Region)	149
July 16, 2014	- RG_027 (City of Toronto)	148
August 17, 2014	- HY027 (TRCA) - R-MUN-MA-18 (City of Markham)	147

2.2 Radar images and rainfall data

Radar images and radar rainfall data were obtained from ECCC, the U.S. National Oceanic and Atmospheric Administration (NOAA) and Peel Region. Descriptions of the data are provided below.

ECCC Canadian Historical Weather Radar

ECCC provides radar images at 32 sites across Canada at 6-minute intervals, including King City (near Toronto) which covers an area that includes southern Ontario between London and Belleville, and upstate New York (NY). Radar images were downloaded at 30-minute intervals for July 16, 2024 between 6:30 am and 1:30 pm and for August 17, 2024 between 12:00 pm and 6:00 pm from King City radar to show the progression of the storm across the Greater Toronto Area. The images corresponding to the time at which the peak rain intensities of the two storms had occurred in TRCA catchments were also saved (16 July 2024 at 10:18 am and 17 August 2024 at 1:24 pm).

US NOAA Next Generation Weather Radar

The National Centers for Environmental Information (NCEI) in the US NOAA operates the Next Generation Weather Radar (NEXRAD) system, which comprises a network of 160 high-resolution weather radars operated jointly by the National Weather Service (NWS), the Federal Aviation Administration (FAA) and the U.S. Air Force. Level III weather radar which includes instantaneous and total precipitation data was obtained from the nearest site in Buffalo, NY (NEXRAD:KBUF).

Peel Region Gauge-Adjusted Radar Rainfall

Peel Region employs an advanced rainfall data gathering network that pairs rain gauge data from partner municipalities and conservation authorities with radar rainfall data from Buffalo (KBUF) Level II NEXRAD data to produce gauge-adjusted radar rainfall (GARR) data. The data are discretized into 1 km-by-1 km cells, with options to view weighted average results on a block or watershed basis. Data for the July and August 2024 events were obtained for the entire TRCA jurisdiction from Vieux (2025).

2.3 Streamflow/water level

2.3.1 Data summary

Streamflow and water level data were obtained from TRCA, Water Survey Canada (WSC) and Town of Richmond Hill gauges located within the project area.

Table 3 Streamflow/water level data collection summary

Agency/ Municipality	Data source	Data description
TRCA	TRCA Open Data portal	– 5-minute increment water levels at 51 gauges for the July 16, 2024 and August 17, 2024 storm events. – 5-minute increment discharge at 35 gauges for the July 16, storm event and at 34 gauges for the August 17, storm event. – Data collected in UTC-5 (EST).
WSC	ECCC WSC Real-Time Data website	– 5-minute increment discharge and water level data at 25 gauges for the July 16, 2024 and August 17, 2024 storm events – Data collected in UTC (GMC).
	ECCC Climate Data Extraction Tool	– Historical annual instantaneous peak discharge at 26 gauges from beginning of gauge record to the earlier of 2024 or end of gauge record.
Town of Richmond Hill	Data request	– Hourly average water levels at 7 gauges for July and August 2024 – Hourly average discharge at 7 gauges for July and August 2024 (with 6 of the gauges calculated based on level data).

The locations of the stream gauges used in this analysis are shown on **Figure 2**. **Figure 2** shows the locations of hydrometric gauges across the TRCA jurisdiction, including WSC, Richmond Hill, and TRCA-operated discharge and level stations.

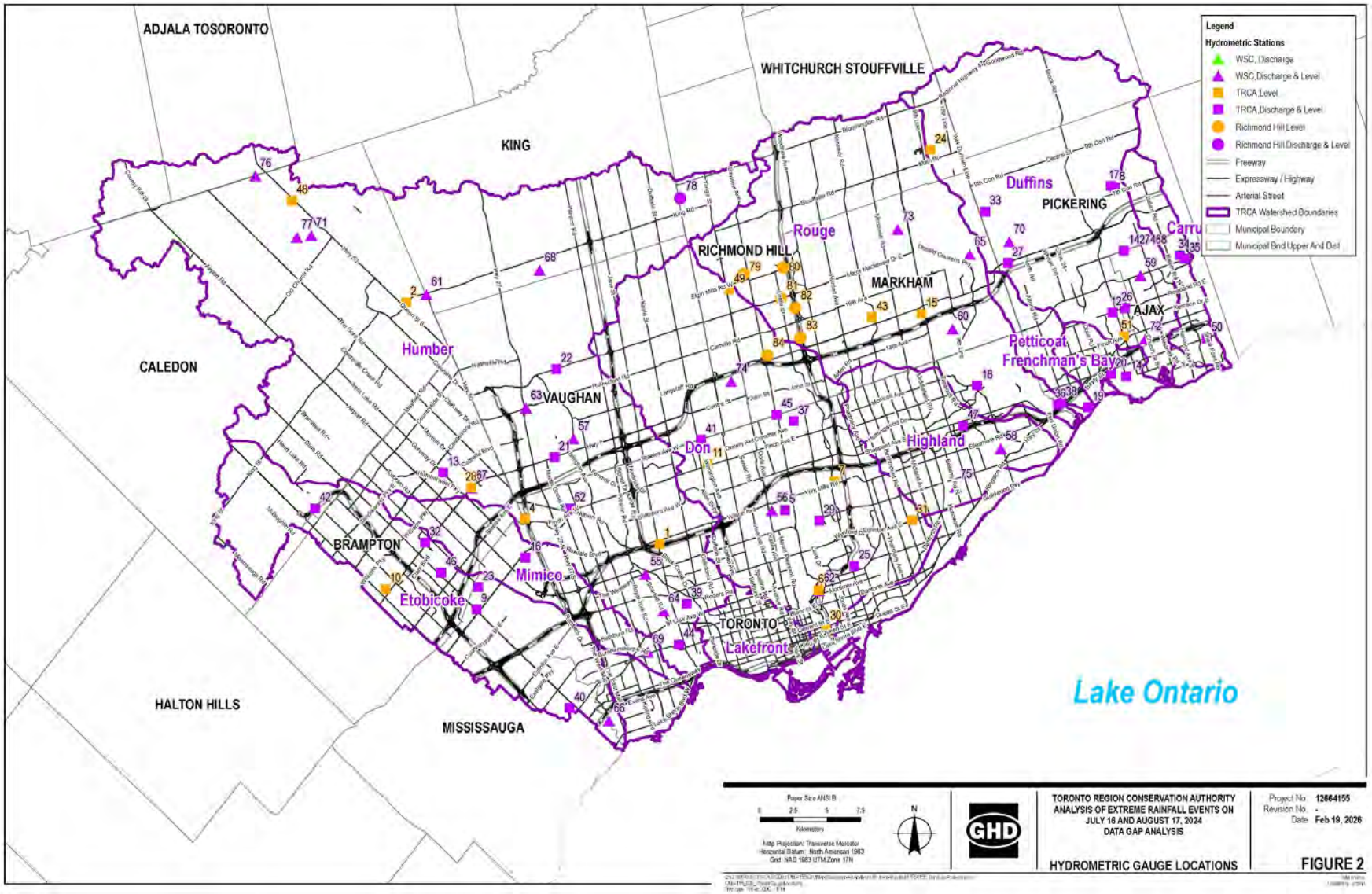


Figure 2 Stream Gauge Locations

2.3.2 Data gaps

The streamflow and water level data received was reviewed for any gaps in data during the July 16, 2024 and August 17, 2024 storms. From the 52 TRCA stream gauges received, streamflow was provided for 35 gauges for July 16, 2024 and 34 gauges for August 17, 2024, while the remainder of the stream gauges collected water level data only. For the stations that do calculate discharge, peak flow data may be missing due to a QAQC procedure followed by TRCA staff where discharge is not calculated beyond 3 times the highest measured discharge value in the rating curve. Additionally, discharge values greater than bankfull amounts are qualified as estimated values. GHD used TRCA's rating curves to extrapolate the peak flows in Section 2.3.3.

There were 16 TRCA water level only gauges. Of these, there was 1 gauge (HY120) with missing level data for August. For the TRCA gauges with both streamflow and level, there were 2 gauges with missing data: HY119 level and flow data were missing July, and HY131 flow data were missing for August. There were no streamflow data for HY118 in August but there was water level data. The peak flows were calculated by extrapolating TRCA's rating curves in Section 2.3.3.

For the WSC gauges, there was one gauge with missing streamflow data for July and one gauge was missing water level data: 02HC024 (August only).

From the Richmond Hill stream gauges, Stream I (level only) had missing level (and therefore streamflow) data on August 17, 2024, but otherwise all other data were available.

The gauges with missing data for the entire day of either storm event are summarized in **Table 4**.

Table 4 Gauges with missing streamflow and water level data for entirety of July 16, 2024 and/or August 17, 2024

Storm Event	Missing Streamflow Data	Missing Water Level Data
July 16, 2014	- HY119 (TRCA)	- HY119 (TRCA)
August 17, 2014	- HY131 (TRCA) - HY118 (TRCA) - Stream I (Richmond Hill)	- HY120 (TRCA) - 02HC024 (WSC) - Stream I (Richmond Hill)

For streamflow and water level gauges with available data during the two events, there were temporal gaps of data during the storm dates identified for several gauges, summarized in **Table 5** and **Table 6**. The streamflow data gaps are likely because discharge calculations cannot be performed during high flow periods when water level measurements fall outside of the stage-discharge relationship rating curve.

Table 5 Identified streamflow and water level temporal data gaps on July 16, 2024

	Station Name	Agency	Time step	Number of gaps	Gap Start (EST)	Gap End (EST)	Total timesteps missing
Stream flow	HY018*	TRCA	5 min	1	16/07/2024 10:30:00 AM	16/07/2024 12:10:00 PM	20
	HY024*	TRCA	5 min	1	16/07/2024 10:10:00 AM	16/07/2024 5:55:00 PM	93
	HY028	TRCA	5 min	1	16/07/2024 1:05:00 PM	16/07/2024 4:05:00 PM	36
	HY035	TRCA	5 min	1	16/07/2024 10:55:00 AM	16/07/2024 1:05:00 PM	26
	HY040	TRCA	5 min	1	16/07/2024 10:40:00 AM	16/07/2024 1:05:00 PM	29
	HY045	TRCA	5 min	1	16/07/2024 10:10:00 AM	16/07/2024 2:45:00 PM	55
	HY048	TRCA	5 min	3	16/07/2024 2:15:00 PM	16/07/2024 3:25:00 PM	14
					16/07/2024 3:30:00 PM	16/07/2024 4:05:00 PM	7
					16/07/2024 4:10:00 PM	16/07/2024 4:35:00 PM	5
	HY051	TRCA	5 min	2	16/07/2024 10:45:00 AM	16/07/2024 1:45:00 PM	36
					16/07/2024 2:25:00 PM	16/07/2024 8:55:00 PM	78
	HY052	TRCA	5 min	1	16/07/2024 11:05:00 AM	16/07/2024 1:45:00 PM	32
	HY053	TRCA	5 min	1	16/07/2024 10:00:00 AM	16/07/2024 2:25:00 PM	53
	HY059*	TRCA	5 min	1	16/07/2024 10:50:00 AM	16/07/2024 3:00:00 PM	50
	HY062*	TRCA	5 min	1	16/07/2024 10:45:00 AM	16/07/2024 12:45:00 PM	24
	HY068*	TRCA	5 min	1	16/07/2024 9:20:00 AM	16/07/2024 12:50:00 PM	42
	HY081*	TRCA	5 min	1	16/07/2024 10:15:00 AM	16/07/2024 11:45:00 AM	18
	HY092*	TRCA	5 min	1	16/07/2024 10:15:00 AM	16/07/2024 12:35:00 PM	18
	HY098*	TRCA	5 min	1	16/07/2024 9:30:00 AM	16/07/2024 1:45:00 PM	51
	HY104	TRCA	5 min	1	16/07/2024 11:55:00 AM	16/07/2024 12:45:00 PM	9
	HY112*	TRCA	5 min	1	16/07/2024 10:40:00 AM	16/07/2024 16:05:00 PM	65
	HY118*	TRCA	5 min	1	16/07/2024 9:35:00 AM	18/07/2024 2:55:00 PM	454
	HY131	TRCA	5 min	1	16/07/2024 9:05:00 AM	17/07/2024 10:25:00 AM	304
	02HC030	WSC	5 min	1	16/07/2024 10:55:00 AM	17/07/2024 4:20:00 PM	65
Water Level	HY129	TRCA	5 min	1	16/07/2024 2:10:00 AM	16/07/2024 2:15:00 PM	1
	02HC024	WSC	5 min	1	16/07/2024 11:35 :00 AM	16/07/2024 3:40 PM	49

* Peak flow data extrapolated as discussed in section 2.3.3.

Table 6 Identified streamflow and water level temporal data gaps on August 17, 2024

	Station Name	Agency	Time step	Number of gaps	Gap Start (EST)	Gap End (EST)	Total timesteps missing
Stream flow	HY018*	TRCA	5 min	1	17/08/2024 1:10:00 PM	17/08/2024 2:25:00 PM	15
	HY040	TRCA	5 min	1	17/08/2024 6:05:00 PM	17/08/2024 6:35:00 PM	6
	HY045	TRCA	5 min	1	17/08/2024 3:45:00 PM	17/08/2024 4:25:00 PM	8
	HY053	TRCA	5 min	2	17/08/2024 8:05:00 AM	17/08/2024 8:15:00 AM	2

	Station Name	Agency	Time step	Number of gaps	Gap Start (EST)	Gap End (EST)	Total timesteps missing
					17/08/2024 3:25:00 PM	17/08/2024 4:25:00 PM	12
	HY059*	TRCA	5 min	2	17/08/2024 3:35:00 PM	17/08/2024 6:20:00 PM	33
					18/08/2024 3:05:00 PM	18/07/2024 4:55:00 PM	22
	HY068*	TRCA	5 min	2	17/08/2024 1:15:00 PM	17/08/2024 3:20:00 PM	12
					17/08/2024 4:45:00 PM	17/08/2024 6:00:00 PM	15
	HY092*	TRCA	5 min	3	17/08/2024 2:05:00 PM	17/08/2024 2:10:00 PM	1
					17/08/2024 4:10:00 PM	17/08/2024 4:20:00 PM	2
					17/08/2024 4:40:00 PM	17/08/2024 7:20:00 PM	32
	HY098*	TRCA	5 min	2	17/8/2024 1:20:00 PM	17/08/2024 5:00:00 PM	44
					17/08/2024 4:55:00 PM	187/08/2024 5:25:00 PM	14
	HY112*	TRCA	5 min	1	17/08/2024 1:20:00 PM	17/08/2024 7:55:00 PM	79
	HY119	TRCA	5 min	2	17/08/2024 1:00:00 PM	17/08/2024 2:30:00 PM	18
					17/08/2024 5:20:00 PM	17/08/2024 6:15:00 PM	11
	02HC030	WSC	5 min	2	17/8/2024 2:05:00 PM	17/8/2024 3:05:00 PM	12
					17/8/2024 3:25:00 PM	17/8/2024 4:00:00 PM	7
	02HC032	WSC	5 min	2	17/08/2024 6:45:00 PM	17/08/2024 7:00:00 PM	3
					17/08/2024 9:45:00 PM	17/08/2024 9:50:00 PM	1
	02HC033	WSC	5 min	1	17/08/2024 3:05:00 PM	17/08/2024 5:05:00 PM	24
Water Level	02HC027	WSC	5 min	1	17/08/2024 1:05:00 PM	17/08/2024 4:30:00 PM	42
	02HC032	WSC	5 min	1	17/08/2024 6:45:00 PM	17/08/2024 7:00:00 PM	4

* Peak flow data extrapolated as discussed in Section 2.3.3.

The July 16, 2024 storm event occurred during the morning and early-afternoon while the August 17, 2024 storm event occurred in the afternoon. The temporal gaps given in the tables above indicated that all the gaps occurred during the peak of the respective storm events. The data gap review has identified a potential concern for the spatial availability of streamflow and water level data, thus GHD estimated the peak flows at the TRCA stream gauges where water levels were beyond the rating curve (Section 2.3.3).

2.3.3 Rating curve extrapolations

The missing peak data were extrapolated from TRCA's rating curves for each station (extrapolations were only performed for TRCA streamflow stations). The peak flow estimates are shown in **Table 7**. However, it should be noted that the rating curve extrapolations are subject to uncertainty. It is recommended that the rating curves be extended, with priority given to the ones with the largest extrapolations.

Table 7 Summary of Rating Curve Extrapolation

Streamflow Station	Maximum Water Level (m)	Rating Curve Equation	Maximum Water Level for Rating Curve (m)	Extrapolated Peak Flow Rate (m3/s)
July 16, 2024 Event				
HY018 – Don at Knightswood	120.219	X = 20.786 * (Y - 117.711)^2.062	119.346	138.391
HY024 – Etobicoke at Dixie and Derry	172.368	X = 29.111 * (Y - 170.400)^1.654	171.093	89.202
HY059 – Spring Creek South	174.782	X = 10.516 * (Y - 172.000)^1.965	173.356	78.531
HY062 – Taylor Creek South	91.605	X = 14.012 * (Y - 89.380)^1.597	91.270	50.256
HY068 – Wilket Creek	119.973	X = 15.928 * (Y - 117.518)^2.462	118.546	145.414
HY081 – Spring Creek North	210.704	X = 9.235 * (Y - 209.360)^2.422	210.293	18.883
HY092 – German Mills at Cummer	140.618	X = 11.363 * (Y - 138.395)^2.240	140.120	68.015
HY098 – Little Etobicoke at Dixie Dundas	125.580	X = 6.077 * (Y - 122.210)^1.420	124.961	34.110
HY112 – East Don at Steeles	145.490	X = 11.081 * (Y - 143.980)^2.630	145.020	32.743
HY118 – West Spring Creek at Dixie	193.871	X = 7.508 * (Y - 192.350)^2.646	192.960	22.770
HY131 – Albion Creek at Highfield Park	156.759	X = 3.523 * (Y - 153.710)^1.595	155.105	20.856
August 17, 2024 Event				
HY018 – Don at Knightswood	119.728	X = 20.786 * (Y - 117.711)^2.062	119.346	88.280
HY059 – Spring Creek South	173.654	X = 10.516 * (Y - 172.000)^1.965	173.356	28.282
HY068 – Wilket Creek	119.658	X = 15.928 * (Y - 117.518)^2.462	118.546	103.721
HY092 – German Mills at Cummer	140.349	X = 11.363 * (Y - 138.395)^2.240	140.120	50.932
HY098 – Little Etobicoke at Dixie Dundas	125.615	X = 6.077 * (Y - 122.210)^1.420	124.961	34.624
HY112 – East Don at Steeles	146.013	X = 11.081 * (Y - 143.980)^2.630	145.020	71.638
HY118 – West Spring Creek at Dixie	193.419	X = 7.508 * (Y - 192.350)^2.646	192.960	8.959
HY131 – Albion Creek at Highfield Park	155.155	X = 3.523 * (Y - 153.710)^1.595	155.105	6.338

In a TRCA report dated April 2025 (TRCA, 2025), TRCA has developed an extended rating curve for the HY081 station. The peak flow rate calculated using the extended rating curve is provided in **Table 8**.

Table 8 Peak Flow Estimation Using Extended Rating Curves (TRCA, April 2025)

Streamflow Station	Maximum Water Level (m)	Rating Curve Equation	Extrapolated Peak Flow Rate (m3/s)
July 16, 2025 Event			
HY081 – Spring Creek North	210.704	X = 5.81344586*Y^3 - 3681.84291042*Y^2 + 777305.96405101*Y - 54703303.53985620	26.867

2.4 Mapping

Several GIS shapefile layers were provided by TRCA for use in spatial mapping:

- 100-year flood line
- Regulatory floodplain

- TRCA watersheds

Furthermore, a map of the total accumulation and maximum return frequency recorded at York Region's rain gauges for the July 16, 2024 storm was provided by York Region. The map showed that the rainfall was concentrated in the southern half of the Region, particularly in the areas bordering Toronto. The map indicated the exceedance of the 100-year storm event at three rain gauges (two in Vaughan and one in Markham), exceedance of the 50-year storm event at one gauge in Vaughan, exceedance of the 25-year storm event at three gauges (two in Vaughan and one in Markham), and rainfall accumulation below the 25-year storm event at the remaining gauges. The map is shown on **Figure 3**.

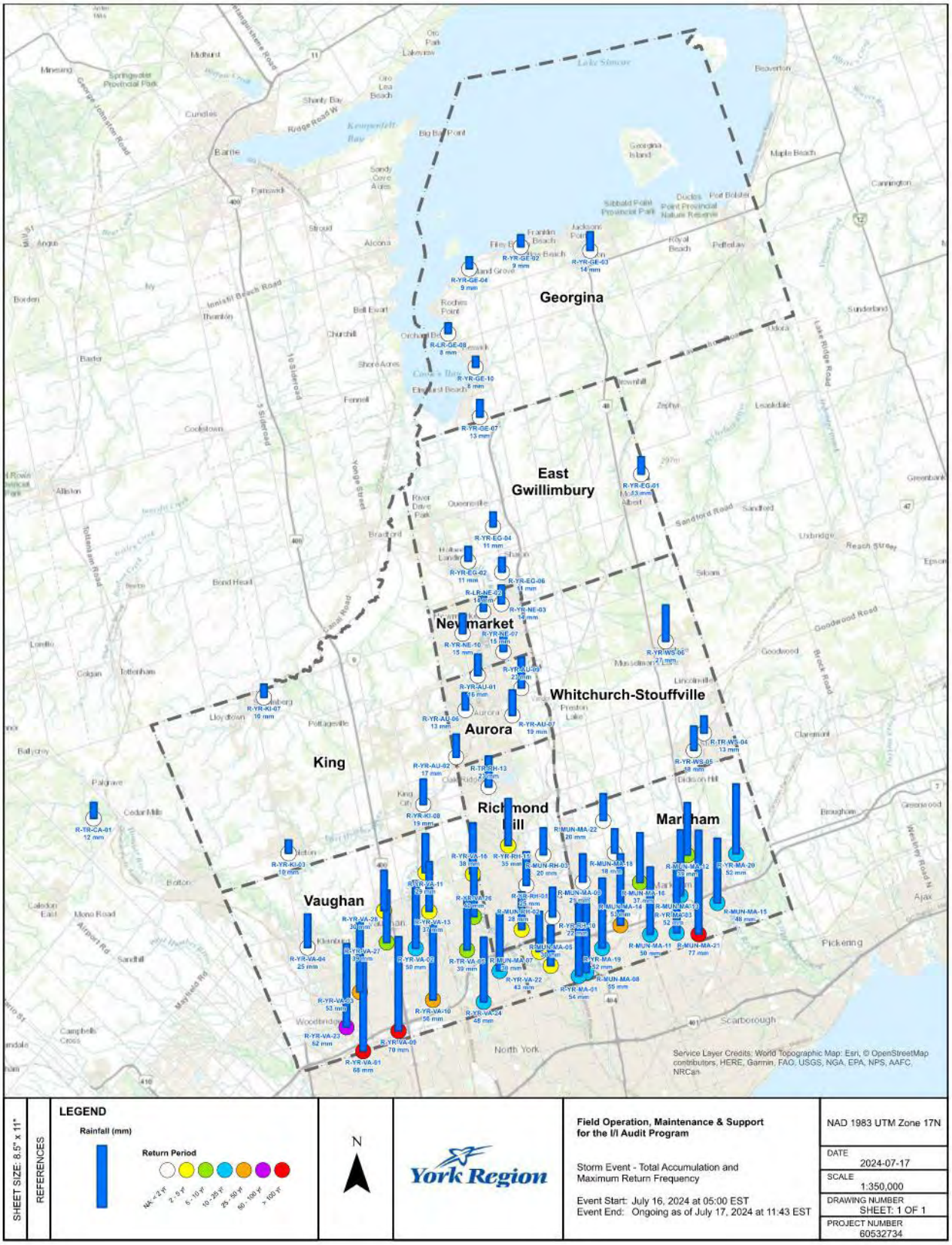


Figure 3 Total accumulation and maximum return frequency of the July 16, 2024 storm in York Region (York Region, 2024)

2.5 Storm and damage reports

Storm and damage reports were collected through data requests to local municipalities or online sources if the report was publicly available. The documents reviewed include:

- Council agenda and reports to Council from City of Toronto, City of Mississauga and Peel Region
- Emergency management documentation from York Region
- Toronto Hydro Major Event Response Report for July 16, 2024
- Damage and impact estimates from City of Toronto
- Public information releases from City of Toronto and City of Mississauga
- TRCA Board of Directors report
- Media releases from insurance boards
- Damage surveys: list of impacted properties during each storm event within the City of Toronto based on the record of 311 calls from the customer service representative (CSR) database
- Other publicly available information from news websites

2.6 Additional documents

The additional documents received by TRCA that have been reviewed in this study include:

- DPC spreadsheets: TRCA's daily planning cycle/flood risk assessment information for each day within the week of each storm event
- Flood messages: Public Watershed Conditions Statement, Flood Watch and Flood Warning messages issued by TRCA during each storm event and surrounding days
- Historical storm reports: reports from the six historic events requested for comparison by TRCA (1976 Highland Creek Storm, 1989 Harrow Storm, 2005 Finch Avenue Storm, 2009 Cooksville Storm, July 2013 Storm, and 2014 Burlington Storm)
- Historical rain gauge data:
  - 1954 Hurricane Hazel: daily rainfall data from 25 ECCC gauges
  - 1976 Highland Creek: daily rainfall data from 23 ECCC gauges
  - 1989 Harrow: daily rainfall data from 5 ECCC gauges (in addition to total rainfall from 47 gauges in the storm report)
  - 2005 Finch: 5-minute rainfall data from Mississauga (16 stations), Toronto (33 stations), TRCA (21 stations), Markham (2 stations), and Clarifica Inc. (3 stations)
  - 2009 Cooksville: 5-minute rainfall data from Mississauga (6 stations), Markham (4 stations), and Toronto (28 stations)
  - 2013 July 8: 5-minute rainfall data from Mississauga (14 stations), Toronto (35 stations), Peel (9 stations), Markham (10 stations), and 1-minute rainfall data from ECCC (3 stations)
  - 2014 Burlington: 5-minute rainfall data from Region of Halton (14 stations) and Conservation Halton (2 stations); 15-minute rainfall data from Conservation Halton (1 station) and daily rainfall data from Conservation Halton (30 stations)
- Minutely ECCC rainfall data for July-August 2013 and 2014
- TRCA storm event documentation, including staff logs and Flood Incident Management System (IMS) communications and information

3. Storm overview

3.1 Summary of storms

July 16, 2024

Each day, a Daily Planning Cycle (DPC) document is generated by TRCA for their daily assessment of flood risk. The DPC is not the official forecast; it provides the maximum forecasted precipitation for TRCA's jurisdiction from numerous official weather forecast sources. TRCA bases decisions on the information in the DPC, which can be updated multiple times in a day when necessary.

The day prior to the storm event, the DPC for July 15 indicated that heavy rainfall was possible according to various weather forecast models for July 15 (up to a maximum of 56.5 mm), with conditions favorable for thunderstorm development. Thunderstorms were expected to track eastward across the TRCA jurisdiction. The ground was already saturated from remnants of Hurricane Beryl (which occurred on July 10) and other recent storms (TRCA rain gauges recorded 5-day rainfall totals of 36 to 96 mm). By 7:25 PM on July 15, TRCA had received up to 38 mm of rainfall in the lower portions of the watersheds and water levels in the Lower Don River were running very high. Additional rainfall was also forecasted for the following morning. In response to these conditions, the TRCA released a Watershed Conditions Statement for Water Safety in the morning of Monday, July 15, to inform the public of increased river flows. This advisory remained in place through Tuesday, July 16.

On July 16, 2024, the updated forecast issued by Environment Canada at 5:00 am EDT for the City of Toronto and surrounding regions predicted mainly cloudy conditions with showers beginning early in the morning and ending in the afternoon, followed by a 40% chance of showers later in the day and a risk of thunderstorms. Local rainfall amounts were expected to range from 15 to 25 mm. At 8:22 am EDT, a Severe Thunderstorm Watch was issued for Toronto, Mississauga, Brampton, Caledon, and Durham, warning of potential rainfall up to 50 mm. Shortly after, at 8:24 am EDT, TRCA staff phoned the Ontario Storm Prediction Centre (OSPC) and found out that the meteorologists noted fast-moving thunderstorms and the potential for another system to bring 50 – 60 mm of rain. The DPC maximum precipitation forecast in the morning of July 16 was 75.41 mm. This prompted the decision by TRCA flood staff to upgrade from a Water Safety Statement to a Flood Watch flood message.

Forecasts were updated throughout the morning of July 16 with Environment Canada predicting rainfall totals of 50 to 70 mm by 9:52 am EDT, and then up to 125 mm with rainfall rates of 40 mm/hour by 11:05 am EDT. Meteorological Terminal Aviation Routine Weather Reports (METAR) from Toronto Pearson Airport (YYZ) confirmed moderate to heavy thunderstorms, with rainfall accumulations reaching 96 mm by 12:00 pm EDT.

In response to the weather forecasts, TRCA updated flood messages and initiated emergency response actions. Between 9:30 am EDT and 11:30 am EDT, TRCA issued multiple flood messages, culminating in a Flood Warning. By 12:35 pm EDT, TRCA documented widespread flooding, as confirmed by TRCA stream gauge data, live camera views and local news outlets, including road closures on Hwy 401, the Don Valley Parkway (DVP) within the City of Toronto, as well as Queen Frederica Drive in Mississauga. Water levels in the Don River and Little Etobicoke Creek rose rapidly, prompting municipal emergency response actions to mitigate impacts to public safety. By 2:00 pm, TRCA confirmed Don River levels had peaked at 81.408 m, having risen approximately 3.7 m since 9:00 am.

By 5:00 pm, total rainfall at Toronto International Airport (YYZ) had reached 128 mm, and water levels in the TRCA watersheds were beginning to recede. DVP Southbound at Dundas was closed in both directions due to flooding. The TRCA had participated in multiple coordination meetings held by the City of Toronto Emergency Management Office, throughout the day, and by 7:30 pm, water levels on the Don River began to recede. At 11:10 pm, TRCA downgraded the Flood Warning flood message to a Watershed Conditions Statement – Water Safety.

August 17, 2024

During the evening of Friday, August 16, some areas within the TRCA received approximately 15 mm of rainfall. In anticipation of the rainfall, the TRCA issued a Watershed Conditions Statement for Water Safety earlier that afternoon on Friday, August 16 at 3:00 PM, which was to remain in effect through Sunday, August 18.

On Saturday, August 17, 2024, Environment Canada issued an updated forecast at 4:58 am EDT for the City of Toronto and surrounding regions predicting significant rainfall over the weekend, with local amounts of 30 to 60 mm and rainfall rates up to 40 mm per hour. At 5:00 am EDT, a public forecast was issued for Toronto, Mississauga, Brampton, Vaughan, Richmond Hill, Markham, Pickering, Oshawa, and Southern Durham Region, predicting cloudy conditions with a 40% chance of showers in the morning, showers beginning near noon, and a risk of thunderstorms. A Special Weather Statement was issued at 5:02 am EDT for Caledon, forecasting local rainfall amounts of 40 to 80 mm and rates up to 40 mm per hour.

Forecast updates throughout the morning included a revision at 8:52 am EDT to 20 – 30 mm of expected rainfall, and another at 11:00 am predicting 10 – 20 mm during the day and 5 – 10 mm at night for Toronto and surrounding areas. Special weather statements were issued at 11:05 am and 11:11 am for Caledon and other regions, forecasting significant rainfall through Sunday. A tornado watch was issued at 11:31 am for Caledon.

At 1:00 pm, heavy thunderstorms were recorded at Toronto Pearson Airport (YYZ), with 14 mm of rain recorded in the previous hour. A Rainfall Warning followed at 1:44 pm for City of Toronto, Mississauga, Brampton, Caledon, and Vaughan/Richmond Hill/Markham forecasting up to 100 mm of rain.

TRCA staff observed rapidly rising water levels at the Little Etobicoke Creek stream gauge near Dixie and Dundas Roads, in Mississauga. This prompted the Flood Duty Officer to upgrade the flood message to a Flood Watch at 2:00 PM, noting 81 mm of rain had already fallen in the southwest portion of the jurisdiction within one hour at the Rathwood rain gauge located at Eglinton Ave and Tomken Rd in the City of Mississauga.

The TRCA Flood Watch message included the mention of slow-moving, intense showers capable of producing up to 50 mm of rainfall per hour across the region. Additionally, guidance provided by the OSPC, warned that the system could generate as much as 100 mm of total rainfall. TRCA was in communication with municipal partners and emergency services throughout the afternoon and evening, continuing to monitor water levels and providing updates to watershed conditions. Water levels began to recede overnight and were below warning levels by the morning of August 18.

3.2 TRCA flood messages

During flood events, TRCA plays a key role in keeping local agencies and the public informed by providing notice, information, and advice. These are shared through official flood messages sent to organizations such as school boards, municipalities, emergency services, police, media, as well as the general public and nearby conservation authorities. The flood messages are a component of the Flood Forecasting and Warning Program, which is one of the mandated programs and services delegated to Conservation Authorities in Ontario as part of the Conservation Authorities Act. The messages vary in urgency, as outlined in **Table 9**, and typically include weather forecasts, possible impacts, and recommended actions for the public.

Table 9 Description of Flood Message Criteria (from TRCA)

Condition/Statement	Description
Normal 	A **Normal** condition is defined as a general notice that no flooding conditions exist
Watershed Conditions Statement	A **Watershed Conditions Statement** is defined as a general notice that potential conditions exist that pose a risk to personal safety or which have the potential to lead to flooding. There are two types of Watershed Conditions Statements as noted below:
Water Safety Statement 	A **Water Safety Statement** is issued when 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.
Flood Outlook Statement 	A **Flood Outlook Statement** is 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.
Flood Watch 	**Flood Watch** is defined as a notice that flooding is possible in specific watercourses or municipalities. Municipalities, emergency services and individual landowners in flood-prone areas should prepare. A Flood Watch may be updated depending upon weather and runoff conditions and will be followed by a notice of cancellation once the potential for flooding has passed.
Flood Warning 	**Flood Warning** is defined as a notice that flooding is imminent or already occurring in specific watercourses or municipalities. Municipalities and individuals should take action to deal with flood conditions. This may include road closures and evacuations. Flood Warnings may be updated depending on weather and runoff conditions and will be followed by a notice of cancellation once the potential for flooding has passed.
Lake Ontario Shoreline Conditions Statement / Lake Ontario Shoreline Water Safety / Lake Ontario Shoreline Flood Watch / Lake Ontario Shoreline Flood Warning 	**Lake Ontario Shoreline Flood Messages** are similar in category to their watershed counterparts but are applicable to the Lake Ontario shoreline within TRCA's jurisdiction. They are issued when critical high-water levels and waves are forecasted, imminent or occurring, which could result in shoreline flooding and/or erosion. These types of messages are issued to municipalities emergency services regardless of whether or not they reside or operate along the Lake Ontario shoreline. The International Lake Ontario St. Lawrence River Board (ILOSRB) is responsible for the regulation of outflows from Lake Ontario, and also for providing forecasts.

3.3 Storm timeline

This section outlines a timeline of events related to the extreme rainfall that occurred on July 16 and August 17, 2024. It includes TRCA storm event documentation and flood messages issued by TRCA, as well as communications from Environment Canada, such as public forecasts, public weather alerts, (e.g. Special Weather Statements, Severe Thunderstorm Watches/Warnings, Rainfall Warnings), as well as select observations from the Toronto Pearson Airport weather station. **Table 10** and **Table 11** present a summary of the key developments for July 16 and August 17, respectively.

July 16, 2024

Table 10 Chronological list of events during extreme rainfall event on July 16, 2024

Time (EDT)	Type	Description
Monday, July 15th, 2024		
July 15	Daily Planning Cycle (DPC)	– Approximately **9 mm** to **27 mm** of total rainfall received within the last 24 hours. – Forecasted precipitation assessment showed a maximum of up to **56 mm** of rain for July 15 and **62 mm** for July 16. – For July 15, it was noted that thunderstorms forecasted throughout the TRCA jurisdiction with up to **40 mm** total rainfall possible in localized areas. – Ground surface was saturated due to rainfall from remnants of Hurricane Beryl over the previous week, and additional rainfall due to thunderstorms over the last three days. – TRCA released a Watershed Conditions Statement for Water Safety just before noon to inform the public of increased river flows. – TRCA storm event documentation at 7:25pm mentioned elevated water levels on the Don River and the risk of rain the following morning.
Tuesday, July 16, 2024		
July 16, Morning	Daily Planning Cycle (DPC)	– Forecasted precipitation assessment showed a range between **17 mm** to **75 mm** of rain for July 16. – Conditions were favourable for thunderstorm development July 16 based on thunderstorm parameters being exceeded. – A Water Safety flood message was in effect and staff were considering upgrading to Flood Outlook.
5:00 AM	Public Forecast issued by Environment Canada	**CITY OF TORONTO / VAUGHAN - RICHMOND HILL – MARKHAM / PICKERING - OSHAWA - SOUTHERN DURHAM REGION** TODAY.MAINLY CLOUDY. SHOWERS BEGINNING EARLY THIS MORNING AND ENDING THIS AFTERNOON THEN 40 PERCENT CHANCE OF SHOWERS LATER THIS AFTERNOON. RISK OF A THUNDERSTORM. LOCAL AMOUNT **15 TO 25 MM.** **MISSISSAUGA – BRAMPTON / CALEDON** TODAY.MAINLY CLOUDY. SHOWERS BEGINNING EARLY THIS MORNING AND ENDING THIS AFTERNOON THEN 30 PERCENT CHANCE OF SHOWERS LATER THIS AFTERNOON. RISK OF A THUNDERSTORM. LOCAL AMOUNT **15 TO 25 MM**.
8:22 AM	Severe Thunderstorm Watch issued by Environment Canada	SEVERE THUNDERSTORM WATCH FOR: - CITY OF TORONTO - MISSISSAUGA – BRAMPTON - CALEDON - DURHAM. HAZARDS: LOCAL RAINFALL AMOUNTS UP TO **50 MM** POSSIBLE.
8:24 AM	TRCA Storm Event Documentation	– TRCA flood staff contacted the Ontario Storm Prediction Centre (OSPC) at Environment Canada, which reported a fast-moving thunderstorm line (70–80 km/h) with ~20 mm rainfall. A second system was expected around 10–11 am, potentially bringing 50–60 mm of rain locally.

Time (EDT)	Type	Description
8:39 AM	Updated Forecast issued by Environment Canada	**MISSISSAUGA - BRAMPTON** TODAY.SHOWERS ENDING EARLY THIS AFTERNOON THEN A MIX OF SUN AND CLOUD WITH 30 PERCENT CHANCE OF SHOWERS. RISK OF A THUNDERSTORM. LOCAL AMOUNT **20 TO 30 MM.**
8:43 AM	Updated Forecast issued by Environment Canada	**MISSISSAUGA – BRAMPTON** TODAY.SHOWERS ENDING EARLY THIS AFTERNOON THEN A MIX OF SUN AND CLOUD WITH 30 PERCENT CHANCE OF SHOWERS. RISK OF A THUNDERSTORM. LOCAL AMOUNT **20 TO 30 MM.** **CALEDON.** TODAY.SHOWERS ENDING EARLY THIS AFTERNOON THEN A MIX OF SUN AND CLOUD WITH 30 PERCENT CHANCE OF SHOWERS. RISK OF A THUNDERSTORM. **LOCAL AMOUNT 15 TO 25 MM.**
8:50 AM	Updated Forecast issued by Environment Canada	**CITY OF TORONTO.** TODAY.SHOWERS ENDING EARLY THIS AFTERNOON THEN A MIX OF SUN AND CLOUD WITH 40 PERCENT CHANCE OF SHOWERS. RISK OF A THUNDERSTORM. LOCAL AMOUNT **20 TO 30 MM.**
9:00 AM	Meteorological Terminal Aviation Routine Weather Reports (METAR) issued by Environment Canada	– Moderate thunderstorms recorded at YYZ. METAR CYYZ 161300Z 24003KT 160V310 10SM **TSRA** SCT020CB BKN030 OVC110 22/22 A2971 RMK CB3SC3AC2 CB S OCNL LTGIC PRESRR SLP060 DENSITY ALT 1800FT
9:01 AM	TRCA Storm Event Documentation	– TRCA flood staff completed the DPC (or daily flood risk assessment, as part of the FFW program operations) and after reviewing forecasted and current weather and watershed conditions, TRCA flood staff decided an upgrade to the existing Water Safety flood message was required.
9:30 AM	Flood message notification issued by TRCA	– TRCA upgraded its previous *Watershed Conditions Statement – Water Safety* that was issued on July 15th, 2024 to a **Flood Watch**. – TRCA advised that Environment Canada forecasted a line of thunderstorms tracking eastward over southern Ontario from Tuesday morning into Tuesday evening with the potential to bring heavy rainfall amounts **50-60 mm** in short periods of time.
9:30 AM	TRCA Storm Event Documentation	– TRCA called Mississauga Emergency Management Office to notify of rising water levels on Little Etobicoke Creek and the upgrade of flood message to Flood Watch. TRCA informed that water levels were not at critical levels yet (**123.776** m, just above the Low alarm) but more rain would cause the creek to rise very quickly.
9:35 AM	Rainfall Warning issued by Environment Canada	RAINFALL WARNING FOR: - CITY OF TORONTO - HALTON – PEEL - VAUGHAN - RICHMOND HILL - MARKHAM. RAIN, AT TIMES HEAVY, CONTINUES. HAZARDS: RAINFALL AMOUNTS UP TO **75 MM.** RAINFALL RATES OF **40 MM** AN HOUR.
9:40 AM	TRCA Storm Event Documentation	– The Toronto Emergency Management (TEM) on-call coordinator was informed of TRCA's Flood Watch upgrade due to heavy rainfall risks affecting Black Creek and Don River water levels. Don River was at 77.758 m (not critical level yet); Black Creek also remained below critical (123.776 m at Alliance Ave.).
9:44 AM	TRCA Internal Email Communication (#2) to Flood Incident Management System (IMS) staff	– TRCA staff sent an internal communication by email to Flood IMS staff noting the Flood Watch issuance and summarized current conditions, including the uncertainty for thunderstorm total rainfall amounts.

Time (EDT)	Type	Description
9:52 AM	Updated Forecast issued by Environment Canada	**CITY OF TORONTO / VAUGHAN - RICHMOND HILL – MARKHAM** TODAY.SHOWERS ENDING EARLY THIS AFTERNOON THEN A MIX OF SUN AND CLOUD WITH 40 PERCENT CHANCE OF SHOWERS. RISK OF A THUNDERSTORM. TONIGHT.PARTLY CLOUDY. 40 PERCENT CHANCE OF SHOWERS THIS EVENING. LOCAL AMOUNT **50 TO 70 MM.** **CALEDON / MISSISSAUGA - BRAMPTON** TODAY.SHOWERS ENDING EARLY THIS AFTERNOON THEN A MIX OF SUN AND CLOUD WITH 30 PERCENT CHANCE OF SHOWERS. RISK OF A THUNDERSTORM. TONIGHT.PARTLY CLOUDY. 40 PERCENT CHANCE OF SHOWERS THIS EVENING. LOCAL AMOUNT **50 TO 70 MM.**
9:56 AM	Severe Thunderstorm Watch issued by Environment Canada	SEVERE THUNDERSTORM WATCH FOR: - CITY OF TORONTO - MISSISSAUGA – BRAMPTON - VAUGHAN - RICHMOND HILL - MARKHAM - PICKERING - OSHAWA - SOUTHERN DURHAM REGION. HAZARDS: LOCAL RAINFALL AMOUNTS UP TO **50 MM** POSSIBLE.
10:00 AM	METAR issued by Environment Canada	– Heavy thunderstorms reported and **33 mm** of rain accumulated at YYZ since 9.00 AM. METAR CYYZ 161400Z 16007KT 030V180 3SM R24R/5000VP6000FT/U **+TSRA** SCT014CB OVC025 20/20 A2966 RMK CB3SC5 CB S /**R33**/ PRESRR SLP046 DENSITY ALT 1700FT=
10:10 AM	TRCA Storm Event Documentation	– TRCA's Flood Duty Officer completed courtesy calls to Toronto Transportation Services, Metrolinx GO and Evergreen Brick Works for proactive notification of Flood Watch message and to recommend monitoring conditions closely for flooding. – Metrolinx requested a call back once critical levels at Don River stream gauge were reached.
10:24 AM	TRCA Storm Event Documentation	– TRCA's FDO called Mississauga Emergency Management Duty Officer again to notify water level at Little Etobicoke Creek stream gauge was almost reaching top of bank elevation (**125 m**): **124.808 m** at 10:20 am.
10:43 AM	Rainfall Warning issued by Environment Canada	RAINFALL WARNING FOR: - CITY OF TORONTO - HALTON – PEEL - VAUGHAN - RICHMOND HILL - MARKHAM. HEAVY RAIN IS EXPECTED. HAZARDS: RAINFALL AMOUNTS UP TO **100 MM.** RAINFALL RATES OF **40 MM** AN HOUR.
10:46 AM	Rainfall Warning issued by Environment Canada	RAINFALL WARNING FOR: - PICKERING - OSHAWA - SOUTHERN DURHAM REGION. RAIN, AT TIMES HEAVY, IS EXPECTED. HAZARDS: RAINFALL AMOUNTS UP TO **50 MM.** RAINFALL RATES OF **30 MM** AN HOUR.
10:48 AM	Severe Thunderstorm Watch issued by Environment Canada	SEVERE THUNDERSTORM WATCH FOR: - PICKERING - OSHAWA - SOUTHERN DURHAM REGION. HAZARDS: LOCAL RAINFALL AMOUNTS UP TO **50 MM** POSSIBLE.
11:00 AM	Updated Forecast issued by Environment Canada	**CITY OF TORONTO / VAUGHAN - RICHMOND HILL - MARKHAM.** TODAY.SHOWERS AT TIMES HEAVY ENDING EARLY THIS AFTERNOON THEN MAINLY CLOUDY WITH 40 PERCENT CHANCE OF SHOWERS. RISK OF A THUNDERSTORM. LOCAL AMOUNT **80 TO 110 MM.** **MISSISSAUGA - BRAMPTON.** TODAY.SHOWERS AT TIMES HEAVY ENDING EARLY THIS AFTERNOON THEN MAINLY CLOUDY WITH 30 PERCENT CHANCE OF SHOWERS. RISK OF A THUNDERSTORM. LOCAL AMOUNT **80 TO 110 MM.** **PICKERING - OSHAWA - SOUTHERN DURHAM REGION.** TODAY.SHOWERS AT TIMES HEAVY ENDING EARLY THIS AFTERNOON THEN MAINLY CLOUDY WITH 40 PERCENT CHANCE OF SHOWERS. RISK OF A THUNDERSTORM. LOCAL AMOUNT **50 MM.**

Time (EDT)	Type	Description
11:00 AM	METAR issued by Environment Canada	– Heavy thunderstorms reported and **64 mm** of rain accumulated at YYZ since 9.00AM. METAR CYYZ 161500Z 02008KT 300V030 1SM R24L/3500VP6000FT/D R24R/3500VP6000FT/D R23/2200V2600FT/N **+TSRA** OVC008CB 20/20 A2969 RMK RA4CB4 CB OHD OCNL LTGIC /**R64**/ SLP053 DENSITY ALT 1600FT=
11:05 AM	Rainfall Warning issued by Environment Canada	RAINFALL WARNING FOR: - CITY OF TORONTO - MISSISSAUGA – BRAMPTON - VAUGHAN - RICHMOND HILL - MARKHAM. HAZARDS: RAINFALL AMOUNTS UP TO **125 MM.** RAINFALL RATES OF **40 MM** AN HOUR.
11:05 to 11:25 AM	TRCA EOC Activation Briefing Meeting #1	– Flood EOC and IMS staff activated and virtual briefing provided to staff on current conditions. – Flood Warning message was drafted to be released as soon as possible. – TRCA River Watch staff were dispatched to areas experiencing flooding, such as the Dixie-Dundas area in Mississauga.
11:30 AM	Flood message notification issued by TRCA	- TRCA upgraded its previous **Flood Watch** notification to a **Flood Warning.** - Flooding was imminent or already occurring in watercourses within the TRCA jurisdiction.
11:35 AM	TRCA Storm Event Documentation	TRCA made the second phone call to Toronto Transportation Services (TTS), advising of very high water levels on the Don River and recommended to monitor conditions for road closures, specifically at Bayview at Pottery Road and the Don Valley Parkway at Dundas St. TRCA was advised that TTS may deploy their automated gate system.
11:40 AM	TRCA Storm Event Documentation	TRCA made the second phone call to Metrolinx GO Transit Control Center to notify the Don River stream gauge water level had surpassed critical levels that may impact railway tracks, specifically northeast of Bayview Ave and Bloor St.
11:50 AM	TRCA Storm Event Documentation	TRCA made the second phone call to Evergreen Brick Works. Facility Director confirmed they were aware of the situation and were in the process of evacuating. Don at Todmorden water level was at **80.202 m** and still rising.
12:00 PM	METAR issued by Environment Canada	– Moderate rain showers reported and **96 mm** of rain accumulated at YYZ since 9.00AM. METAR CYYZ 161600Z 04008KT 340V060 3SM R24L/4500VP6000FT/U R24R/4500VP6000FT/U **SHRA** BR OVC020 20/20 A2969 RMK SC8 /**R96**/ PRESFR SLP055 DENSITY ALT 1600FT=
12:00 to 12:30 PM	TRCA Storm Event Documentation	– TRCA staff provided an update on the situation for the Toronto Emergency Management (TEM) group. – TRCA noted the current Flood Warning message and associated weather details, watershed responses and communications to Toronto divisions and agencies.
12:35 PM	TRCA Internal Email Communication (#3) to Flood IMS staff	– Environment Canada forecasted heavy rainfall of up to **125 mm**. – TRCA watersheds had already received **10-66** mm. – Flooding had been reported in some areas of TRCA's jurisdiction, including: • Hwy 401 Westbound transfer at Jane Collector, all lanes closed. • DVP southbound at Dundas had been closed. • Queen Frederica in Mississauga was flooded (this is the area which was affected during **July 8, 2013 storm**). – The TRCA watersheds were fully saturated. Additional rainfall would runoff, increasing flooding. – Water levels in the lower portion of TRCA watercourses were running very high and the water levels in the remaining watercourses were rising as well. – TRCA activated its Flood EOC, and staff were assigned to priority monitoring, communication and documentation tasks.
12:40 PM	TRCA Storm Event Documentation	– TRCA received callback from Metrolinx Infrastructure and Control Centre. The Richmond Hill GO train tracks were shut down and remained closed until water receded and the tracks pass inspection. – TRCA advised Don River would likely start to recede by end of workday.

Time (EDT)	Type	Description
12:46 PM	TRCA Storm Event Documentation	– Toronto Transportation advised TRCA staff that they were deploying the automated gate system to close roads next to the Don River.
12:57 PM	Rainfall Warning issued by Environment Canada	RAINFALL WARNING FOR: - CITY OF TORONTO - VAUGHAN - RICHMOND HILL - MARKHAM. - HAZARDS: RAINFALL AMOUNTS UP TO **125 MM**. RAINFALL RATES OF **40 MM** AN HOUR.
1:00 to 1:30 PM	TRCA EOC Briefing Meeting #2	– TRCA was notified by Toronto Parks that Sunnybrook Park and ET Seton Park were closed due to flooding. – TRCA dam conditions update was provided for G. Ross Lord and Claireville Dams. Both dam reservoirs were still below operational threshold requirements.
1:30 to 2:00 PM	TRCA staff attending City of Toronto Business Continuity Meetings (BCM's) coordinated by TEM	– TRCA staff attended Toronto BCM #1 as an Incident Management Team (IMT) had been activated for this event by the City of Toronto. – TRCA staff indicated that the EC Rainfall Warning had ended for Toronto. TRCA had recorded almost **100 mm** of rainfall in the lower watershed areas, such as the Lower Don River. The peak water level for Don at Todmorden stream gauge was **81.405 m** at 1:40pm local time. – TRCA staff noted other updates provided by the other attending City divisions representatives, including reports of multiple power outages across the City of Toronto.
2:00 PM – 3:43 PM	TRCA Storm Event Documentation	– TRCA updated Evergreen Brick Works on Don River levels (**81.291 m** at 1:55 PM). Levels were expected to remain high for a few hours before receding. No further rain was expected. – TRCA informed Mississauga OEM Duty Officer of improving conditions at Queen Frederica Drive. There were still approximately 9–10 road closures and some park and trail closures. Minor power outages were reported, but not widespread. – TRCA received a weather update from OSPC which indicated a low chance of isolated thunderstorms north of Toronto, with up to **10–15 mm** of rain. – TRCA was notified of flooding at Todmorden Mills Heritage Site, 67 Pottery Road, Toronto. – TRCA provided an update: Little Etobicoke Creek was receding and no significant rainfall expected.
3:00 to 3:30 PM	TRCA staff attending City of Toronto BCM #2 coordinated by TEM	– Black Creek was receding. – Don River was at its peak level and was expected to remain high for 1–2 hours before receding.
3:30 to 4:00 PM	TRCA EOC Briefing Meeting #3	– TRCA discussed drawdown at G. Ross dam, which was scheduled for as soon as conditions in the Lower Don had improved.
4:30 to 4:50 PM	TRCA staff attending City of Toronto BCM #3 coordinated by TEM	– TRCA received calls for flooded basements and redirected callers to Toronto 311. – Road closures were still ongoing, but some had reopened. – TRCA continued monitoring and would update the Flood Warning when conditions improve.
4:40 PM	TRCA Storm Event Documentation	– TRCA talked with OSPC about another thunderstorm that was forming in the west part of TRCA around 7-8 PM but which might pass south of TRCA. It might bring **30 mm** of rain but chances were not very high.
5:00 to 5:30 PM	TRCA EOC Briefing Meeting #4	– TRCA delayed dam operations for G. Ross dam drawdown until July 17 once Don River levels had receded.
6:00 to 6:30 PM	TRCA staff attending City of Toronto BCM #4 coordinated by TEM	– Don River remained in flood stage but was receding. – Claireville Dam (West Humber) was being operated according to operational requirements to maximize storage for downstream areas. – G. Ross Dam (West Don) had its gates closed and was holding water in storage mode. – City staff were deployed for road closures and clean up.
7:00 to 7:30 PM	TRCA EOC Briefing Meeting #5	– River watch was on standby between 7-8 PM to watch for the possible thunderstorm. – Water levels were receding and there was no widespread rainfall forecasted for July 17.
7:30 to 8:00 PM	TRCA staff attending City of Toronto BCM #5 coordinated by TEM	– Water levels on the Don were now below flood stage and receding. – Isolated thunderstorm cells were still popping up to the west but were small and isolated.

Time (EDT)	Type	Description
9:00 to 9:30 PM	TRCA staff attending City of Toronto BCM #6 coordinated by TEM	– TRCA notified the TEM team that there were no new updates as of 9 pm and any new information would be sent through the update to the current active Flood Warning message.
11:00 PM	Flood message notification issued by TRCA	– TRCA cancelled the Flood Warning and downgraded to a Watershed Conditions Statement - Water Safety
11:00 to 11:30 PM	TRCA staff attending City of Toronto BCM #7 coordinated by TEM	– TRCA staff attended Toronto BCM #7 and notified of the downgrade to flood message.
11:10 PM	TRCA Internal Email Communication (#4) to Flood IMS staff	– Environment and Climate Change Canada lifted the rainfall warning and significant rainfall was not expected July 17. – TRCA rain gauges recorded **8 – 105 mm** of rainfall on July 16. – Flash flooding occurred in lower TRCA watersheds and other areas within the TRCA jurisdiction. – DVP was still closed, and it was reported that the City plans to re-open the DVP on July 17 at 6 am. – Claireville Dam had been operating in storage mode since the afternoon of July 16. – G Ross Lord Dam drawdown is deferred to July 17.
11:58 PM	TRCA Storm Event Documentation	– Dam drawdown operation was performed for G Ross Dam. The Low Level Gates North and South were opened 6 inches each.
Wednesday, July 17th, 2024		
July 17, Morning	Daily Planning Cycle (DPC)	– Forecasted a maximum of **5 mm** of rain for July 17. – Conditions were favourable for thunderstorm development based on thunderstorm parameters being exceeded, but flood risk is low due to low rainfall amounts.
July 17 6:00 to 6:30 AM	TRCA staff attending City of Toronto BCM #8 coordinated by TEM	– TRCA staff attended Toronto BCM #8
July 17 12:00 to 12:20 PM	TRCA staff attending City of Toronto BCM #10 coordinated by TEM	– Watercourses were stabilizing, including the lower Don River. – Dam operations were ongoing at Claireville and G. Ross Dams per standard procedures. – Other City divisions reported ongoing inspections and service requests due to the event.
July 17 3:00 to 3:30 PM	TRCA staff attending City of Toronto BCM #11 coordinated by TEM	– TRCA received calls from Toronto residents reporting basement flooding or blocked culverts/catch basins due to 311 access issues. – Rosedale Valley and Bayview reopened at 4 pm on July 17. – There was severe damage to parks infrastructure.
Legend: **Yellow – EC Severe Thunderstorm Warning / TRCA Watershed Conditions Statement** **Orange –TRCA Flood Watch \ EC Tornado Watch** **Red – TRCA Flood Warning \ EC Rainfall Warning**		

August 17, 2024

Table 11 Chronological list of events during extreme rainfall event on August 17, 2024

Time (EDT)	Type	Description
Friday, August 16, 2024		
August 16, Morning	Daily Planning Cycle (DPC) and Flood message notification issued by TRCA	– Forecasted precipitation assessment showed a maximum of up to **33 mm** of rain for August 16 and **50 mm** for August 17. – Conditions were favourable for thunderstorm development based on thunderstorm parameters being exceeded.

Time (EDT)	Type	Description
		– Forecasted **10 mm** to **15 mm** of rainfall possible up to midnight with risk of isolated thunderstorms bringing up to **30 mm** of total rainfall in isolated areas from noon to midnight. – Additional showers were forecasted from midnight to 6 AM, bringing another **5 mm** to **10 mm** of total rainfall. – TRCA released a Watershed Conditions Statement for Water Safety to inform the public of increased river flows.
Saturday, August 17th 2024		
August 17, Morning	Daily Planning Cycle (DPC)	– Forecasted precipitation assessment showed a range of 11 mm to **85 mm** of rain for August 17 and 10 to **53 mm** for August 18. – Conditions were favourable for thunderstorm development based on thunderstorm parameters being exceeded. – Forecasted **20 mm** to **40 mm** of total rainfall with **50 mm** to **80 mm** in localized areas possible due to re-occurring thunderstorms. – Forecasted a medium to high risk of flooding.
4:58 AM	Special Weather Statement issued by Environment Canada	SPECIAL WEATHER STATEMENT FOR: - CITY OF TORONTO - MISSISSAUGA – BRAMPTON - HALTON HILLS – MILTON - PICKERING - OSHAWA - SOUTHERN DURHAM REGION - VAUGHAN - RICHMOND HILL – MARKHAM SIGNIFICANT RAINFALL IS EXPECTED THIS WEEKEND. HAZARDS: LOCAL RAINFALL AMOUNTS OF **30 TO 60 MM**. RAINFALL RATES OF UP TO **40 MM** IN AN HOUR.
5:00 AM	Public Forecast issued by Environment Canada	**CITY OF TORONTO / MISSISSAUGA – BRAMPTON / VAUGHAN - RICHMOND HILL – MARKHAM / PICKERING - OSHAWA - SOUTHERN DURHAM REGION.** TODAY.CLOUDY WITH 40 PERCENT CHANCE OF SHOWERS THIS MORNING. SHOWERS BEGINNING NEAR NOON. RISK OF A THUNDERSTORM. LOCAL AMOUNT **10 TO 20 MM**. TONIGHT.SHOWERS WITH RISK OF A THUNDERSTORM. LOCAL AMOUNT **5 TO 10 MM**. **CALEDON.** TODAY.CLOUDY WITH 40 PERCENT CHANCE OF SHOWERS THIS MORNING. SHOWERS BEGINNING NEAR NOON. RISK OF A THUNDERSTORM. LOCAL AMOUNT **20 TO 30 MM**. TONIGHT.SHOWERS WITH RISK OF A THUNDERSTORM. LOCAL AMOUNT **10 TO 20 MM.**
5:02 AM	Special Weather Statement issued by Environment Canada	SPECIAL WEATHER STATEMENT FOR: - CALEDON SIGNIFICANT RAINFALL IS EXPECTED THIS WEEKEND. HAZARDS: LOCAL RAINFALL AMOUNTS OF **40 TO 80 MM.** RAINFALL RATES OF UP TO **40 MM** IN AN HOUR.
8:20 AM	TRCA Storm Event Documentation	– TRCA called Ontario Storm Prediction Centre (OSPC) to gather specific weather details, including the risk of thunderstorms, rainfall totals, etc. This was completed as part of the TRCA DPC, or daily flood risk assessment and details are summarized in the first row of this table under DPC.
8:52 AM	Updated Forecast issued by Environment Canada	**CITY OF TORONTO / MISSISSAUGA – BRAMPTON / VAUGHAN - RICHMOND HILL – MARKHAM** TODAY.SHOWERS WITH RISK OF A THUNDERSTORM. LOCAL AMOUNT **20 TO 30 MM.**

Time (EDT)	Type	Description
		TONIGHT.SHOWERS WITH RISK OF A THUNDERSTORM. LOCAL AMOUNT **5 TO 10 MM**.
8:55 AM	TRCA Storm Event Documentation	– TRCA Flood Duty Officer completed and sent out DPC by email, noting forecasted precipitation values of **11 mm** to **85 mm**. Guidance provided to TRCA by OSPC phone call (at 8:20 AM) indicated **20-40 mm** of total rainfall with **50-80 mm** possible in localized areas due to re-occurring thunderstorms, but uncertainty where those locations would be. – Flood Duty Officer drafted a Flood Watch flood message in case it was needed later.
11:00 AM	Updated Forecast issued by Environment Canada	**CITY OF TORONTO / MISSISSAUGA – BRAMPTON / VAUGHAN - RICHMOND HILL – MARKHAM / PICKERING - OSHAWA - SOUTHERN DURHAM REGION.** TODAY.MAINLY CLOUDY. 40 PERCENT CHANCE OF SHOWERS EARLY THIS AFTERNOON. SHOWERS BEGINNING THIS AFTERNOON. RISK OF A THUNDERSTORM. LOCAL AMOUNT **10 TO 20 MM.** TONIGHT.SHOWERS WITH RISK OF A THUNDERSTORM. LOCAL AMOUNT **5 TO 10 MM.** **CALEDON.** TODAY.SHOWERS WITH RISK OF A THUNDERSTORM. LOCAL AMOUNT **20 TO 30 MM.** TONIGHT.SHOWERS WITH RISK OF A THUNDERSTORM. LOCAL AMOUNT **10 TO 20 MM.**
11:05 AM	Special Weather Statement issued by Environment Canada	SPECIAL WEATHER STATEMENT FOR: - CALEDON SIGNIFICANT RAINFALL IS EXPECTED THROUGH SUNDAY. HAZARDS: LOCAL RAINFALL AMOUNTS OF **40 TO 80 MM.** RAINFALL RATES OF UP TO **40 MM** IN AN HOUR.
11:11 AM	Special Weather Statement issued by Environment Canada	SPECIAL WEATHER STATEMENT FOR: - CITY OF TORONTO - MISSISSAUGA – BRAMPTON - PICKERING - OSHAWA - SOUTHERN DURHAM REGION - VAUGHAN - RICHMOND HILL - MARKHAM. SIGNIFICANT RAINFALL IS EXPECTED THROUGH SUNDAY. HAZARDS: LOCAL RAINFALL AMOUNTS OF **30 TO 60 MM.** RAINFALL RATES OF UP TO **40 MM** IN AN HOUR.
11:30 AM and 1:00 PM	TRCA Storm Event Documentation	– TRCA communicated with TEM and discussed the Humber River (Black Creek) near Jane and Wilson which was increasing in water level, but did not reach critical levels.
11:31 AM	Tornado Watch issued by Environment Canada	TORNADO WATCH FOR: CALEDON
12:23 PM	Updated Forecast issued by Environment Canada	**CITY OF TORONTO / VAUGHAN - RICHMOND HILL - MARKHAM** TODAY.MAINLY CLOUDY. 40 PERCENT CHANCE OF SHOWERS EARLY THIS AFTERNOON. SHOWERS BEGINNING THIS AFTERNOON. RISK OF A THUNDERSTORM. LOCAL AMOUNT **20 TO 30 MM.** TONIGHT.SHOWERS WITH RISK OF A THUNDERSTORM. LOCAL AMOUNT **5 TO 10 MM.** **MISSISSAUGA - BRAMPTON.** TODAY.SHOWERS WITH RISK OF A THUNDERSTORM. LOCAL AMOUNT **30 TO 40 MM.** TONIGHT.SHOWERS. RISK OF A THUNDERSTORM THIS EVENING. LOCAL AMOUNT **5 TO 10 MM.** **CALEDON.** TODAY.SHOWERS WITH RISK OF A THUNDERSTORM. LOCAL AMOUNT **20 TO 30 MM.**

Time (EDT)	Type	Description
		TONIGHT.SHOWERS WITH RISK OF A THUNDERSTORM. LOCAL AMOUNT **10 TO 20 MM.**
1:00 PM	Meteorological Terminal Aviation Routine Weather Reports (METAR) issued by Environment Canada	– Heavy thunderstorms recorded at YYZ. **14 mm** of rain recorded in past hour. METAR CYYZ 171700Z 23005G28KT 210V340 1SM R33L/1200V2800FT/N R24L/2600V2800FT/N R23/3000VP6000FT/N **+TSRA** OVC008CB 19/19 A2977 RMK RA5CB3 CONS LTGIC ALQDS /**R14**/ PRESRR SLP082 DENSITY ALT 1400FT=
1:44 PM	Rainfall Warning issued by Environment Canada	RAINFALL WARNING FOR: - CITY OF TORONTO - MISSISSAUGA – BRAMPTON - CALEDON - VAUGHAN - RICHMOND HILL – MARKHAM HEAVY RAIN CONTINUES. HAZARDS: LOCAL RAINFALL AMOUNTS OF **50 TO 100 MM.** RAINFALL RATES OF UP TO **40 MM** IN AN HOUR.
1:45 PM & 2:45 PM	TRCA Storm Event Documentation	– TRCA contacted City of Mississauga to discuss: • Little Etobicoke Creek at Dixie Dundas stream gauge was rising rapidly. Over **100 mm** of rainfall had already been recorded at the nearby rain gauge (HY099 - Rathwood). • Mississauga was preparing for road closures, and referencing Little Etobicoke Dixie Dundas Site Specific Flood Risk Package, Scenario 1 up to Scenario 2.
2:00 PM	Flood message notification issued by TRCA	– TRCA upgraded its previous Watershed Conditions Statement Water Safety and replaced it with a **Flood Watch**. TRCA advised that Environment Canada issued severe thunderstorm warnings with the potential to bring up to **50 mm** per hour for most of the TRCA jurisdiction. – The OSPC indicated that the system could bring up to **100 mm** of total rainfall. – The southwest portion of the TRCA jurisdiction had already received **81 mm** within one hour.
2:00 PM	METAR issued by Environment Canada	– There were heavy thunderstorms and **78 mm** of accumulated precipitation since 12PM at YYZ. METAR CYYZ 171800Z 15009G15KT 120V180 3/4SM R33L/P6000FT/N R15L/P6000FT/N R24L/2600VP6000FT/U R23/P6000FT/N **+TSRA** OVC008CB 21/21 A2975 RMK RA5CB3 OCNL LTGIC OVHD **R/78/** SLP073 DENSITY ALT 1600FT=
2:13 PM	Special Weather Statement issued by Environment Canada	SPECIAL WEATHER STATEMENT FOR: - PICKERING - OSHAWA - SOUTHERN DURHAM REGION. SIGNIFICANT RAINFALL IS EXPECTED THROUGH SUNDAY. HAZARDS: LOCAL RAINFALL AMOUNTS OF **30 TO 60 MM.** RAINFALL RATES OF UP TO **40 MM** IN AN HOUR.
2:26 PM	Updated Forecast issued by Environment Canada	**CITY OF TORONTO / MISSISSAUGA – BRAMPTON / VAUGHAN - RICHMOND HILL – MARKHAM** TODAY.SHOWERS WITH RISK OF A THUNDERSTORM. LOCAL AMOUNT **40 TO 50 MM.** TONIGHT.SHOWERS WITH RISK OF A THUNDERSTORM. LOCAL AMOUNT **5 TO 10 MM.** **CALEDON.** TODAY.SHOWERS WITH RISK OF A THUNDERSTORM. LOCAL AMOUNT **40 TO 50 MM.** TONIGHT.SHOWERS WITH RISK OF A THUNDERSTORM. LOCAL AMOUNT **10 TO 20 MM.**
2:29 PM	TRCA Internal Email Communication (#1) to Flood Incident	– There were torrential downpours with hourly rainfall rates up to **50 mm** per hour. – Based on updated forecasts, TRCA upgraded the Water Safety message to a Flood Watch.

Time (EDT)	Type	Description
	Management System (IMS) staff	– Little Etobicoke at Rathwood rain gauge station had received **81 mm** in one hour. – Water levels in majority of the TRCA watersheds were normal, but the water levels in the watersheds that received significant rainfall were rising. – Localized flooding was possible in areas affected by thunderstorms, though exact locations remained uncertain. – The Flood Watch advised municipalities, emergency services, and landowners in flood-prone areas to prepare. – TRCA's Flood EOC was not required at this time.
2:44 PM	Rainfall Warning issued by Environment Canada	RAINFALL WARNING FOR: - PICKERING - OSHAWA - SOUTHERN DURHAM REGION HEAVY RAIN CONTINUES. HAZARDS: LOCAL RAINFALL AMOUNTS OF **50 TO 100 MM.** RAINFALL RATES OF UP TO **40 MM** IN AN HOUR.
2:59 PM	Updated Forecast issued by Environment Canada	**CITY OF TORONTO / MISSISSAUGA – BRAMPTON** TODAY.SHOWERS WITH RISK OF A THUNDERSTORM. LOCAL AMOUNT **50 TO 70 MM.** TONIGHT.SHOWERS WITH RISK OF A THUNDERSTORM. LOCAL AMOUNT **5 TO 10 MM.** **VAUGHAN - RICHMOND HILL - MARKHAM.** TODAY.SHOWERS WITH RISK OF A THUNDERSTORM. LOCAL AMOUNT **40 TO 50 MM.** TONIGHT.SHOWERS WITH RISK OF A THUNDERSTORM. LOCAL AMOUNT **5 TO 10 MM.**
3:00 PM	METAR issued by Environment Canada	– Light rain showers and an additional **36 mm** of rain were recorded at YYZ. METAR CYYZ 171900Z 09008KT 10SM R24L/4000VP6000FT/U **-SHRA** FEW007 BKN020TCU BKN060 21/21 A2973 RMK SF2TCU3SC2 /**R36**/ SLP068 DENSITY ALT 1700FT=
3:08 PM	Rainfall Warning issued by Environment Canada	RAINFALL WARNING FOR: - CITY OF TORONTO - MISSISSAUGA - BRAMPTON. EXTREMELY HEAVY RAIN CONTINUES. HAZARDS: LOCAL RAINFALL AMOUNTS OF **100 TO 200 MM.** RAINFALL RATES OF UP TO **50 MM** IN AN HOUR.
3:13 PM	TRCA Storm Event Documentation	– TRCA contacted TEM about river conditions and potential for flooding.
3:20 PM	Severe Thunderstorm Watch issued by Environment Canada	SEVERE THUNDERSTORM WATCH FOR: - CITY OF TORONTO - MISSISSAUGA – BRAMPTON - VAUGHAN - RICHMOND HILL – MARKHAM - PICKERING - OSHAWA - SOUTHERN DURHAM REGION CONDITIONS ARE FAVOURABLE FOR THE DEVELOPMENT OF SEVERE THUNDERSTORMS THAT MAY BE CAPABLE OF PRODUCING STRONG WIND GUSTS, LARGE HAIL AND HEAVY RAIN. HAZARDS: 90 KM/H WIND GUSTS. NICKEL SIZE HAIL.

Time (EDT)	Type	Description
		HEAVY DOWNPOURS. THERE IS A RISK OF TORNADOES.
3:30 PM	Updated Forecast issued by Environment Canada	**CITY OF TORONTO.** TONIGHT.SHOWERS ENDING NEAR MIDNIGHT THEN CLOUDY WITH 60 PERCENT CHANCE OF SHOWERS. RISK OF A THUNDERSTORM THIS EVENING AND OVERNIGHT. LOCAL AMOUNT **40 TO 50 MM**. **MISSISSAUGA - BRAMPTON.** TONIGHT.SHOWERS ENDING NEAR MIDNIGHT THEN CLOUDY WITH 60 PERCENT CHANCE OF SHOWERS. RISK OF A THUNDERSTORM THIS EVENING AND OVERNIGHT. LOCAL AMOUNT **30 TO 40 MM.** **CALEDON.** TONIGHT.SHOWERS ENDING NEAR MIDNIGHT THEN CLOUDY WITH 60 PERCENT CHANCE OF SHOWERS. RISK OF A THUNDERSTORM THIS EVENING AND OVERNIGHT. LOCAL AMOUNT **30 TO 40 MM.** **VAUGHAN - RICHMOND HILL - MARKHAM.** TONIGHT.SHOWERS ENDING NEAR MIDNIGHT THEN CLOUDY WITH 60 PERCENT CHANCE OF SHOWERS. RISK OF A THUNDERSTORM THIS EVENING AND OVERNIGHT. LOCAL AMOUNT **30 TO 40 MM.** **PICKERING - OSHAWA - SOUTHERN DURHAM REGION.** TONIGHT.SHOWERS ENDING NEAR MIDNIGHT THEN CLOUDY WITH 60 PERCENT CHANCE OF SHOWERS. RISK OF A THUNDERSTORM THIS EVENING AND OVERNIGHT. LOCAL AMOUNT **20 TO 30 MM.**
3:47 PM – 4:05 PM	TRCA Storm Event Documentation	– TRCA contacted Metrolinx GO Transit to advise them of increasing levels between Pottery Road and Bloor Street and recommended to assess possible closure of Richmond Hill Go Line. – TRCA contacted Evergreen Brick Works to warn them of imminent flooding due to a sharp rise in water levels and it was subsequently evacuated. – TRCA contacted Toronto Transportation Services (TTS) to flag potential flooding on Bayview Extension; TEM on-call was also notified.
4:00 PM	METAR issued by Environment Canada	– Moderate thunderstorms were recorded at YYZ. METAR CYYZ 172000Z 09008KT 060V130 4SM R23/4000VP6000FT/U **TSRA** BR SCT022CB BKN040 OVC060 22/22 A2971 RMK CB4SC3SC1 CB SW SLP060 DENSITY ALT 1800FT=
4:45 PM	TRCA Storm Event Documentation	– TRCA contacted TTS and TEM (2nd contact) to notify them of imminent flooding to the Bayview Ave extension.
5:00 PM	METAR issued by Environment Canada	– Additional accumulation of **14 mm** of rain since 3PM at YYZ. METAR CYYZ 172100Z CCA 04003KT 020V090 15SM R15R/4000V6000FT/U R15L/4000V6000FT/U SCT024 BKN051 BKN090 23/23 A2971 RMK CU3SC2AC2 /**R50**/ SLP061 DENSITY ALT 1900FT=
6:14 PM	TRCA Storm Event Documentation	– TRCA contacted City of Markham to report that flooding was imminent (due to sharp increase in Bruce Creek at Unionville).
6:26 – 6:38 PM	TRCA Storm Event Documentation	– TRCA called (3rd contact) Evergreen Brick Works, Metrolinx GO Transit and TTS, as well as TEM on-call to discuss potential for flooding of DVP at Dundas.
1:00 – 5:00 PM	METAR issued by Environment Canada	– Total precipitation was recorded from 12:00 PM to 5:00 PM at YYZ is **128 mm**.
5:19 PM	Rainfall Warning issued by Environment Canada	RAINFALL WARNING FOR: - CITY OF TORONTO - MISSISSAUGA – BRAMPTON - CALEDON RAIN, AT TIMES HEAVY, IS EXPECTED. THE GROUND, ALREADY NEAR SATURATION, HAS LITTLE ABILITY TO ABSORB FURTHER RAINFALL. HAZARDS:

Time (EDT)	Type	Description
		ADDITIONAL RAINFALL AMOUNTS OF **30 TO 60 MM.** RAINFALL RATES OF UP TO **50 MM** IN AN HOUR.
5:30 PM	TRCA Internal Email Communication (#2) to Flood IMS staff	– TRCA discussed with Environment Canada at OSPC, and they advised that approximately **20 mm** more of rainfall was possible widespread throughout the TRCA jurisdiction before 9 PM.
5:55 PM	Severe Thunderstorm Watch issued by Environment Canada	SEVERE THUNDERSTORM WATCH FOR: - CITY OF TORONTO - MISSISSAUGA – BRAMPTON - VAUGHAN - RICHMOND HILL – MARKHAM - PICKERING - OSHAWA - SOUTHERN DURHAM REGION CONDITIONS ARE FAVOURABLE FOR THE DEVELOPMENT OF SEVERE THUNDERSTORMS THAT MAY BE CAPABLE OF PRODUCING STRONG WIND GUSTS, LARGE HAIL AND HEAVY RAIN. HAZARDS: 90 KM/H WIND GUSTS. NICKEL SIZE HAIL. HEAVY DOWNPOURS. THERE IS A RISK OF TORNADOES.
8:16 PM	TRCA Internal Email Communication (#3) to IMS staff	– A Rainfall Warning remained in effect for Toronto, with **30–60 mm** of rain and rates up to **50 mm/hour** expected through night into Sunday, August 18. – The Etobicoke Creek watershed received **135 mm** of rain in the previous 6 hours, with reports of localized flooding. – Evergreen Brick Works was evacuated. – Bayview Avenue extension was closed due to flooding. – Humber River (Black Creek) near Wilson and Jane had water that were very close to overtopping the road but was likely due to storm sewer backup as water levels at TRCA stream gauges did not reach critical levels in this area. – There was flooding at Little Etobicoke Creek at Dixie and Dundas. – There was no activation of the TRCA Flood EOC at this time.
Sunday, August 18th, 2024		
August 18, Morning	Daily Planning Cycle (DPC)	– Forecasted precipitation assessment showed a range between **10 mm** and **62 mm** of rain for August 18. – Conditions were favourable for thunderstorm development based on thunderstorm parameters being exceeded. – Flood Watch was still in effect since August 17 afternoon. – From 3 PM to 9 PM, approximately **30 mm** to **40 mm** of total rainfall was possible widespread throughout the TRCA jurisdiction due to thunderstorms, with localized amounts of **50 mm** to **80 mm** possible due to multiple training thunderstorms. – All water levels were elevated, but below the critical elevations. Don at Todmorden was still very elevated but slowly receding. Don at Dundas was elevated. Bruce Creek at Unionville was receding.
August 18 9:00 AM	TRCA Storm Event Documentation	– TRCA de-briefed with TEM on-call and provided information on current situation.
August 18 9:30 AM – 10 AM	TRCA Storm Event Documentation	– TRCA de-briefed CFDO on current situation and actions to date.
August 18 1 PM – 9 PM	TRCA Storm Event Documentation	– TRCA contacted municipal partners, and agencies impacted as per FDO protocol. – TRCA contacted City of Mississauga CEMC to inform them that flooding is highly likely on Dixie-Dundas and provided continuous updates of flooding situation. – Communication with TEM on potential flooding within the City of Toronto – Later notified City of Mississauga again, about receding flood water at Dixie Dundas.

Time (EDT)	Type	Description
August 18 5:45 PM	TRCA Internal Email Communication (#4) to Flood IMS staff	– Little Etobicoke at Dixie gauge had exceeded critical water level elevations. – City of Mississauga CEMC was contacted to indicate that river was rising and flooding may occur.
August 18 6:30 PM	Flood message notification issued by TRCA	– TRCA updated and extended the current **Flood Watch** message in place. – TRCA received up to **171 mm** of total rainfall in southwest end of Mississauga over the previous 48 hours. – Environment Canada advised that an additional 20 mm of rainfall was predicted before 9 PM, with an additional 5 mm of rain overnight.
Monday, August 19th, 2024		
August 19 11:15 AM	TRCA Internal Email Communication (#5) to Flood IMS staff	– Environment Canada indicated trace amount of rainfall predicted for the day and dry for the next few days. – Watercourses had receded and were nearing normal levels. – Drawdown of G Ross reservoir had started.
August 19 11:30 AM	Flood message notification issued by TRCA	– TRCA cancelled its Flood Watch that was issued on Saturday, August 17 at 2:00 PM and returned to Normal Conditions. – Flooding was no longer expected, and river conditions were back to normal.
Legend: **Yellow – EC Severe Thunderstorm Warning \ TRCA Watershed Conditions Statement** **Orange– TRCA Flood Watch \ EC Tornado Watch** **Red– TRCA Flood Warning \ EC Rainfall Warning**		

3.4 Antecedent conditions

The spring and early summer of 2024 were wetter than normal, particularly in the Greater Toronto Area (GTA). Table 12 compares total monthly precipitation for April, May, June, and July 2024 at Toronto Pearson Airport with the 1991 – 2020 climate normals.

Table 12 Average Precipitation Based on Environment and Climate Change Canada (ECCC) Gauges (mm)

Guage	Year	April (mm)	May (mm)	June (mm)	July (mm)
Toronto Pearson Airport	2024	135.5	76.8	114.1	215.4
	1991 – 2020	76.7	77.6	80.7	74

The average monthly precipitation data results indicate that April, June, and July 2024 were wetter than normal, and May was near average. At Toronto Pearson Airport, April received 135.5 mm of precipitation compared to the 1991–2020 normal of 76.7 mm, while June saw 114.1 mm compared to a normal of 80.7 mm. Although May was slightly below normal, the overall trend suggests that the region entered July with elevated soil moisture and streamflow conditions.

The watershed wetness index used in the runoff estimation method is referred to as the Antecedent Moisture Condition (AMC) (United States Soil Conservation Service, 1985). This index is categorized into three levels:

– **AMC I**: Indicates the lowest potential for runoff. Soil conditions are dry enough to allow for effective plowing or cultivation.
– **AMC II:** Represents average soil moisture conditions.
– **AMC III**: Reflects the highest potential for runoff, where the watershed is nearly saturated due to prior rainfall.

The AMC level based on the Soil Conservation Services (SCS) method of rainfall abstractions can be estimated using 5-day antecedent rainfall totals, categorized by season (United States Soil Conservation Service, 1985). For the growing season, the classification is as follows:

- **AMC I:** Less than 35.56 mm of rainfall
- **AMC II:** Between 35.56 mm to 53.34 mm
- **AMC III:** Greater than 53.34 mm

To assess antecedent moisture conditions prior to the July 16, 2024 storm event, rainfall totals were analyzed over 1-day, 2-day, and 5-day periods. These short-term precipitation amounts are important in urban watersheds, where long-term rainfall has limited influence on streamflow response. As shown on **Figure 4** most watersheds in the western and central parts of the region such as Etobicoke, Mimico, Don, and Humber exhibited rainfall patterns consistent with AMC II, indicating average soil moisture. Furthermore, the results presented on **Figure 5, Figure 6,** and **Figure 7** indicate that southern and western watersheds such as Etobicoke and Mimico Creek, a portion of Humber and Don River watersheds received between <5 mm and 40 mm in the 24 hours prior, 15 to 44 mm in the 48 hours prior, and 40 to 45 mm over the 5-day period. In contrast, eastern watersheds such as Duffins, Petticoat, and Carruthers Creeks recorded lower totals: <10 mm in 24 hours, <21 mm in 48 hours, and generally <25 mm over 5 days, which are conditions more aligned with AMC I (dry). These spatial differences suggest that while most of the region experienced average antecedent wetness (AMC II), some eastern and northern watersheds appeared drier. Southern Ontario also experienced remnant rainfall from Hurricane Beryl July 9-10th 2024, so the 6-7 days antecedent precipitation may have resulted in a larger area of the TRCA watershed having wet conditions. The hydrologic modelling considered both AMC II and AMC III conditions in the sensitivity analysis, and used the observed antecedent conditions calculated according to the SCS method and model build documentation to initialize the base models.

As shown on **Figure 8**, on August 17, 2024, all watersheds in the region exhibited rainfall patterns consistent with AMC I, indicating dry conditions. Furthermore, the results presented on the **Figure 9, Figure 10,** and **Figure 11** show that for the August 17, 2024 storm event, rainfall totals in the 1- to 5-day period were low across the TRCA region. Etobicoke and Mimico Creeks, along with portions of the Don, and Humber watersheds, received <5 mm in the 24- and 48-hour periods, and <8 mm over 5 days. Eastern watersheds such as Duffins, Petticoat, and Carruthers Creeks generally received <1 mm in 24 hours, <2 mm in 48 hours, and <3 mm over 5 days, indicating dry antecedent conditions consistent with AMC I.

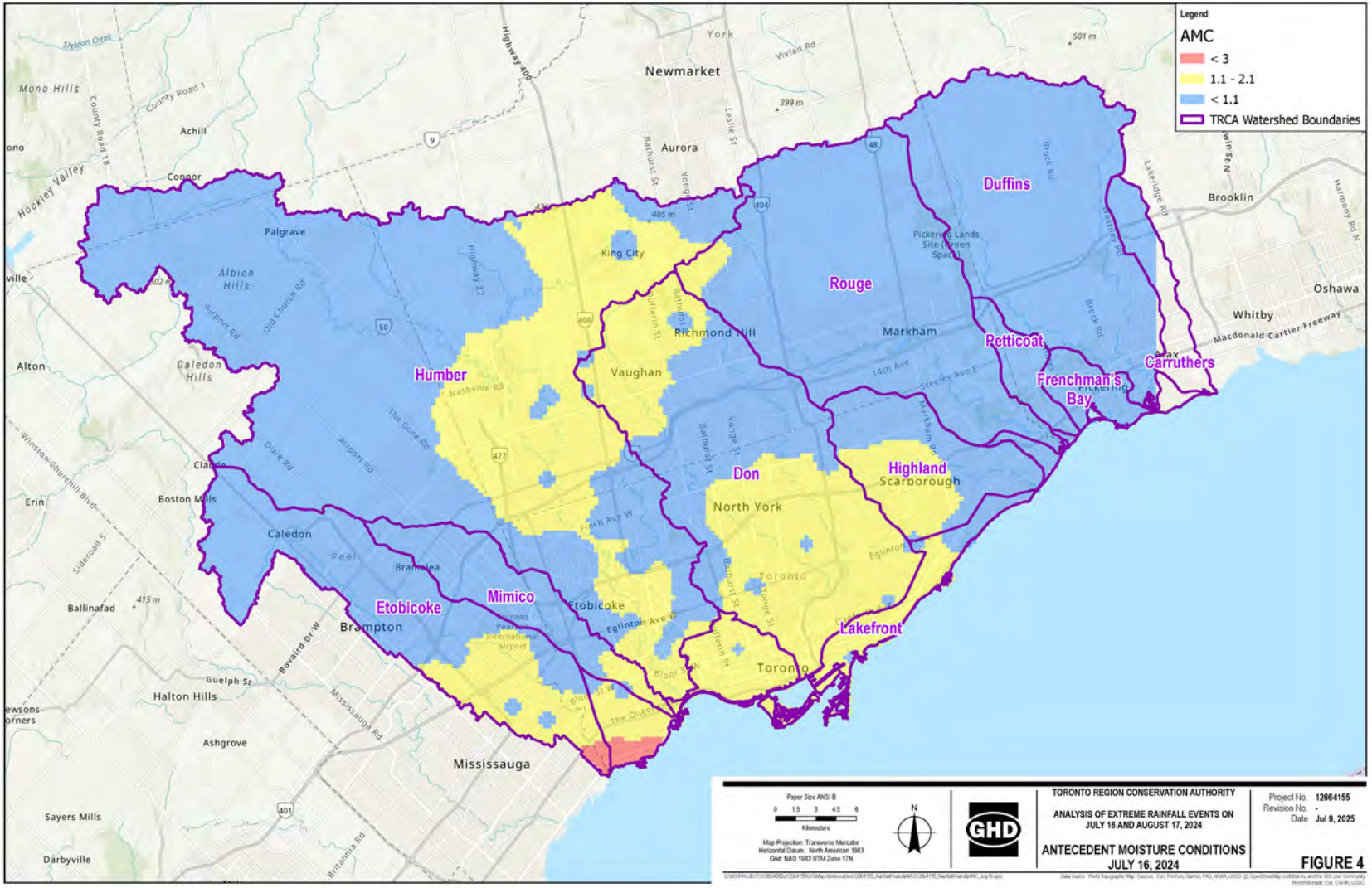


Figure 4 Antecedent Moisture Conditions July 16, 2024

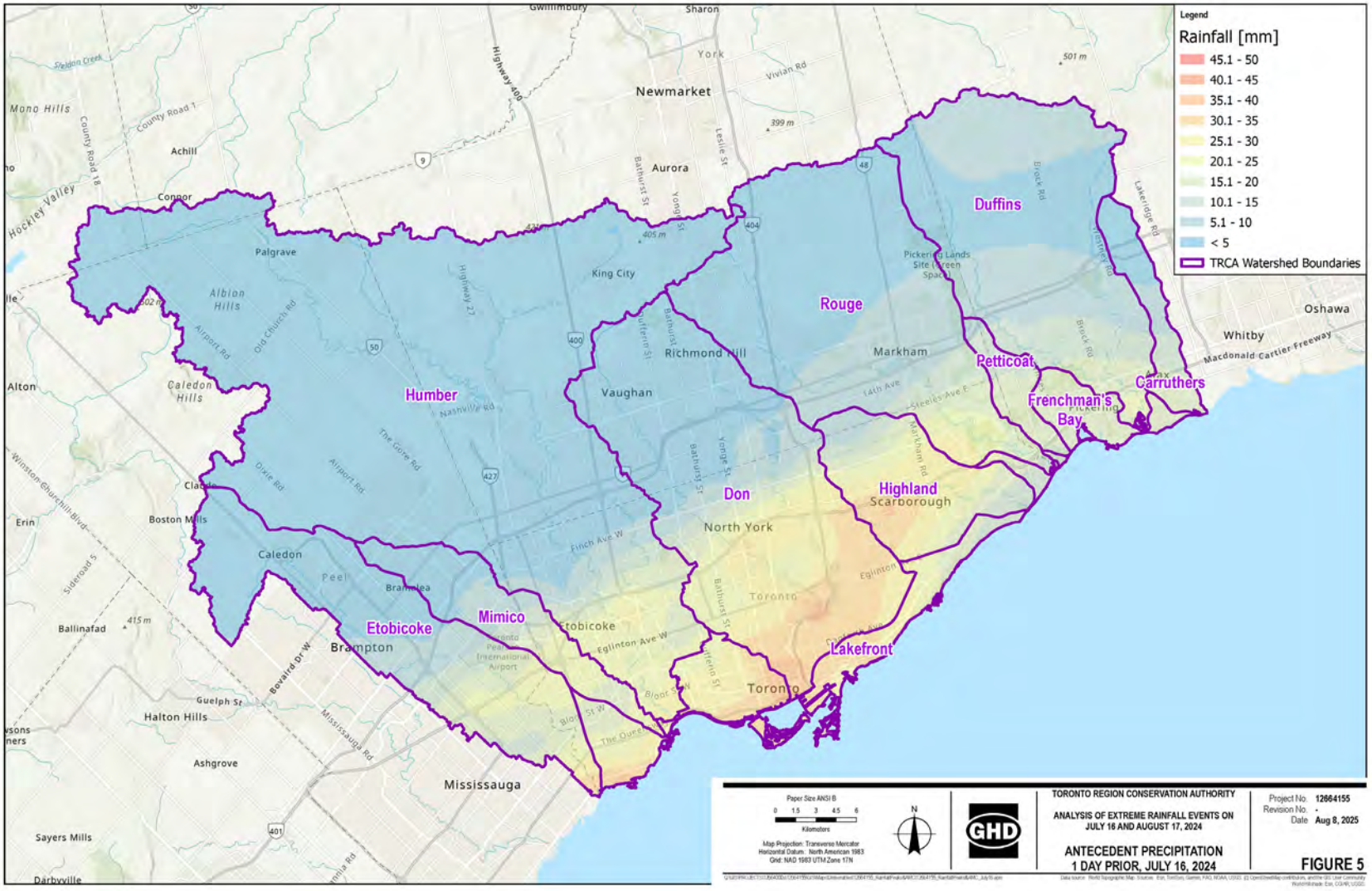


Figure 5 Antecedent Precipitation 1 day prior July 16, 2024

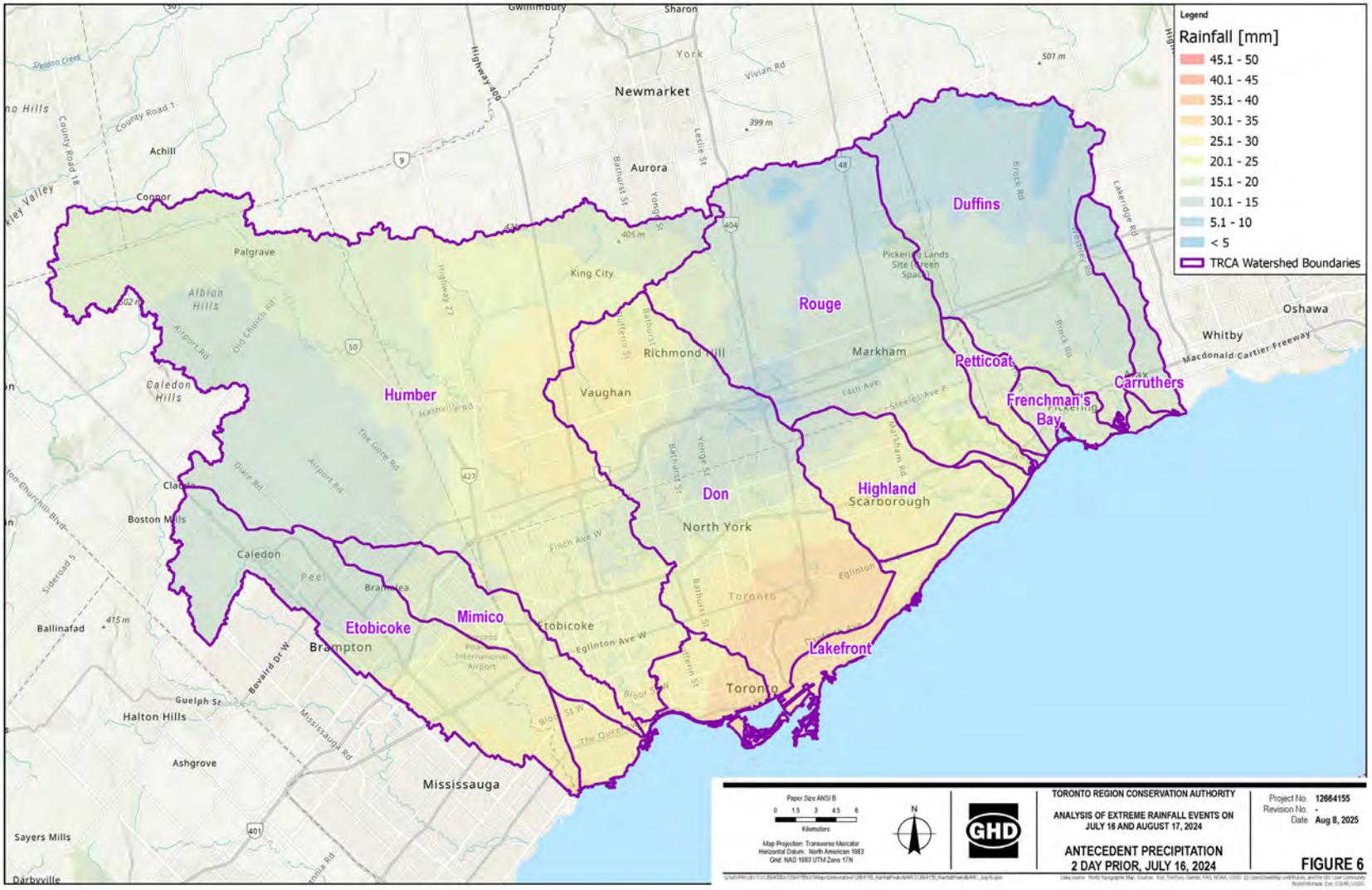


Figure 6 Antecedent Precipitation 2 days prior July 16, 2024

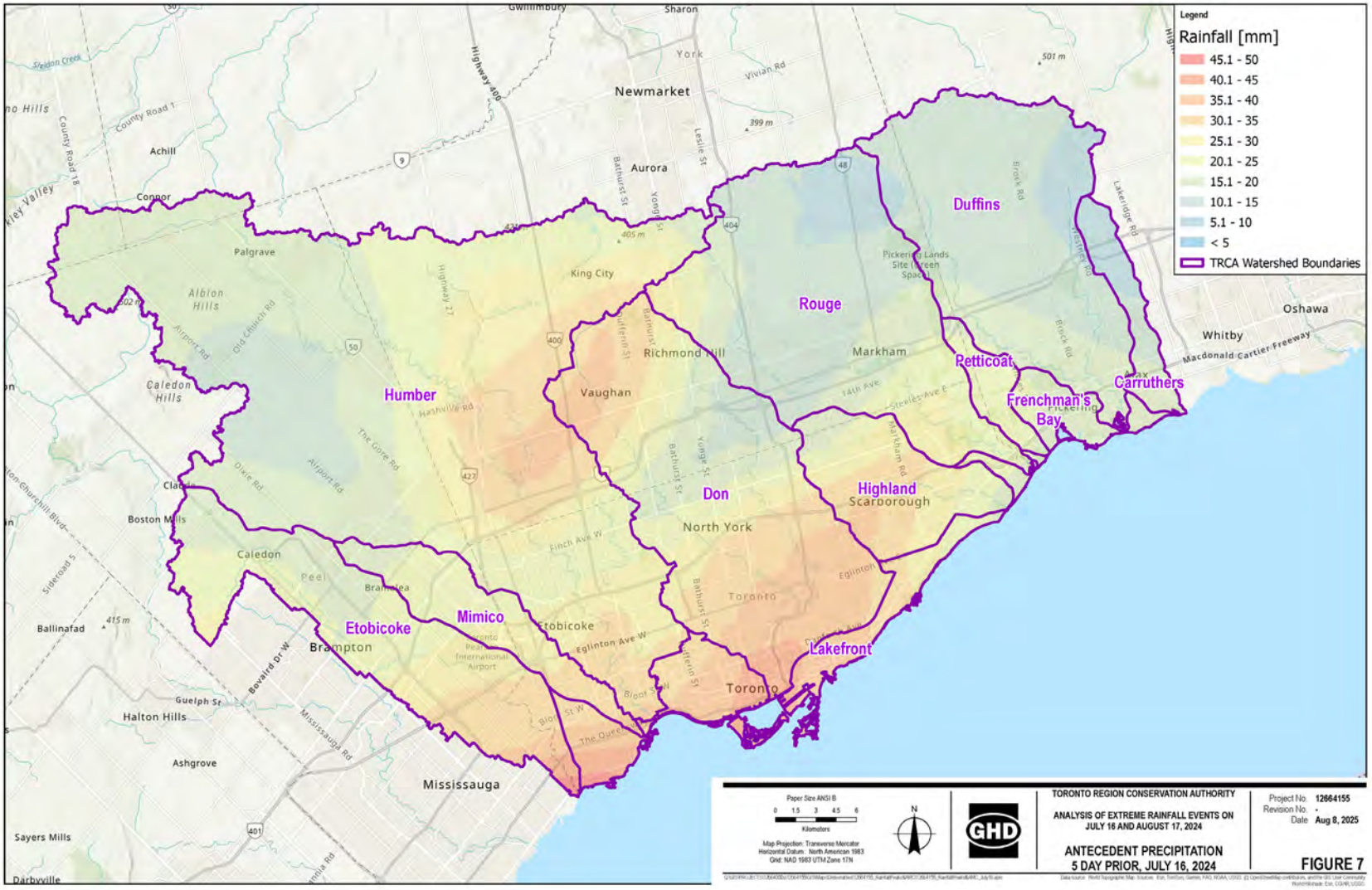


Figure 7 Antecedent Precipitation 5 days prior July 16, 2024

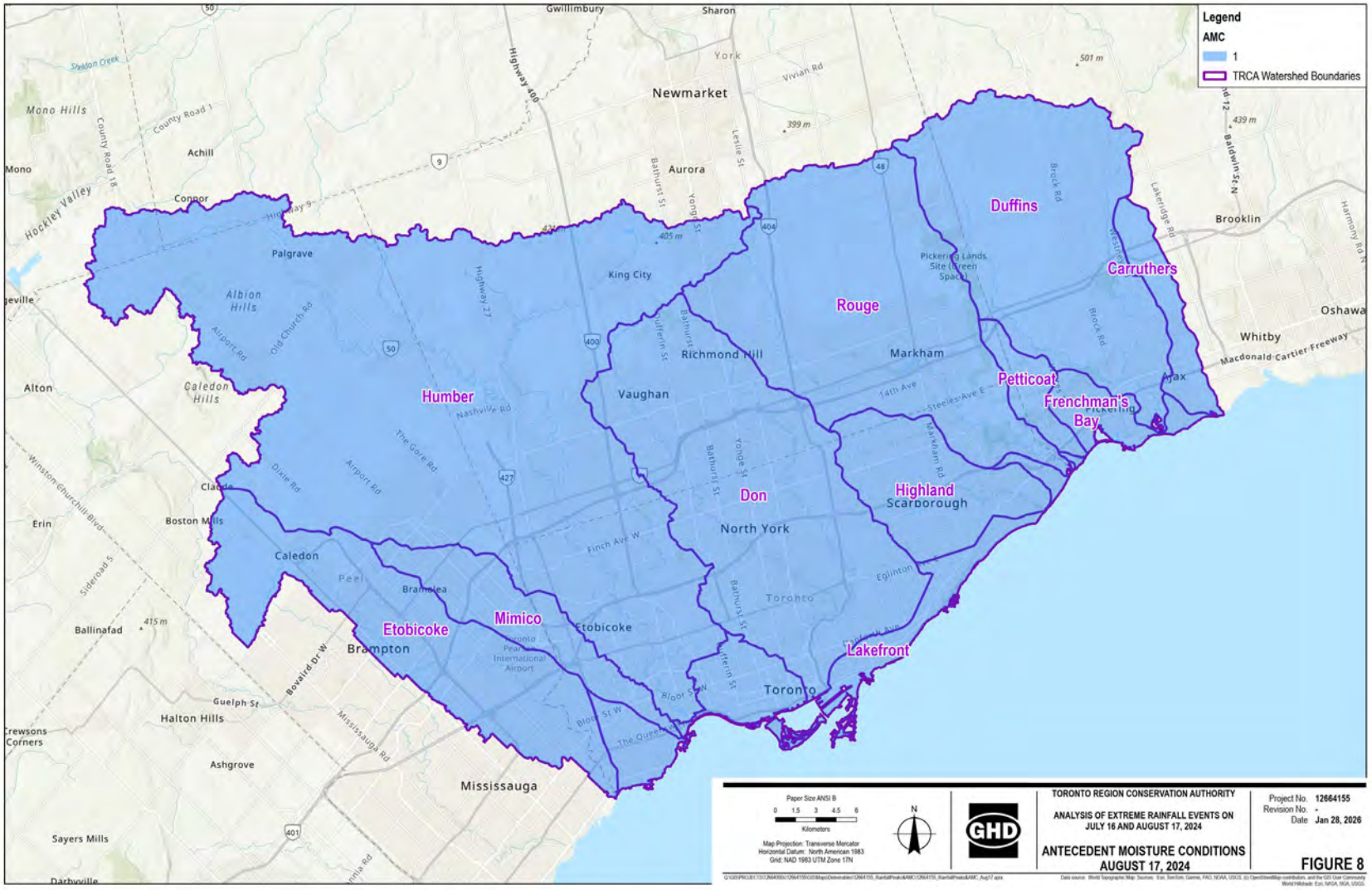


Figure 8 Antecedent Moisture Conditions August 17, 2024

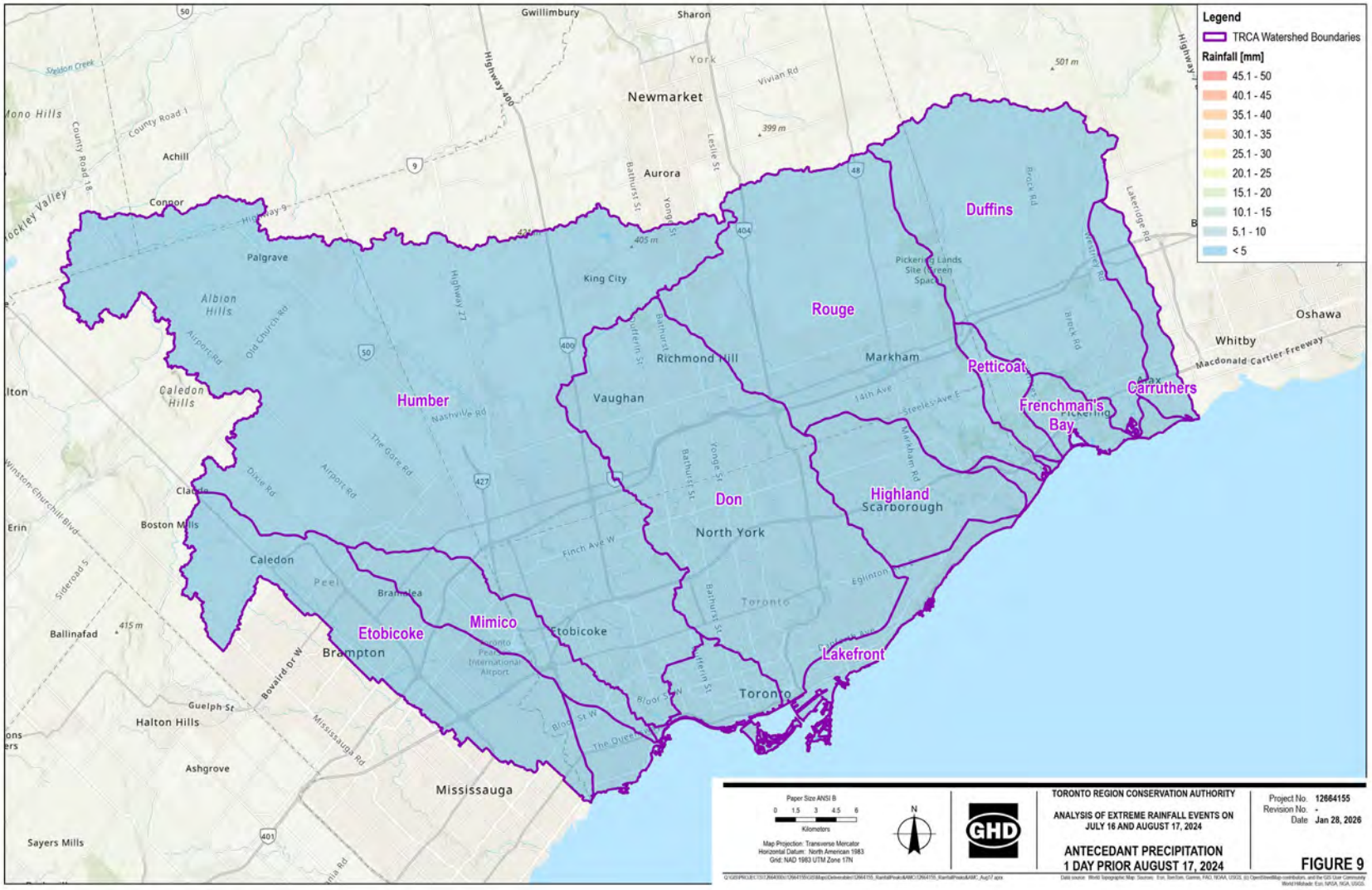


Figure 9 Antecedent Precipitation 1 day prior August 17, 2024

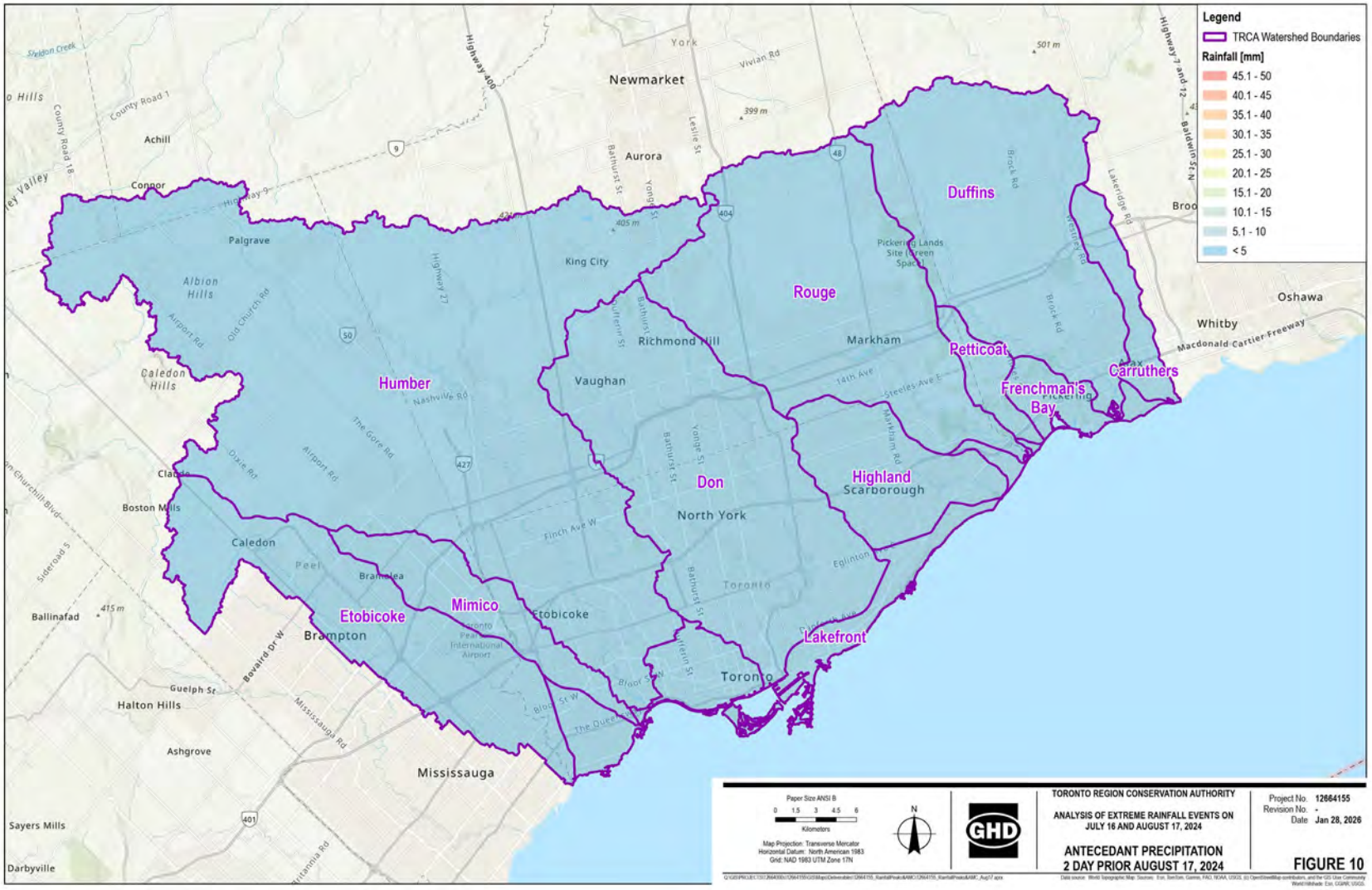


Figure 10 Antecedent Precipitation 2 days prior August 17, 2024

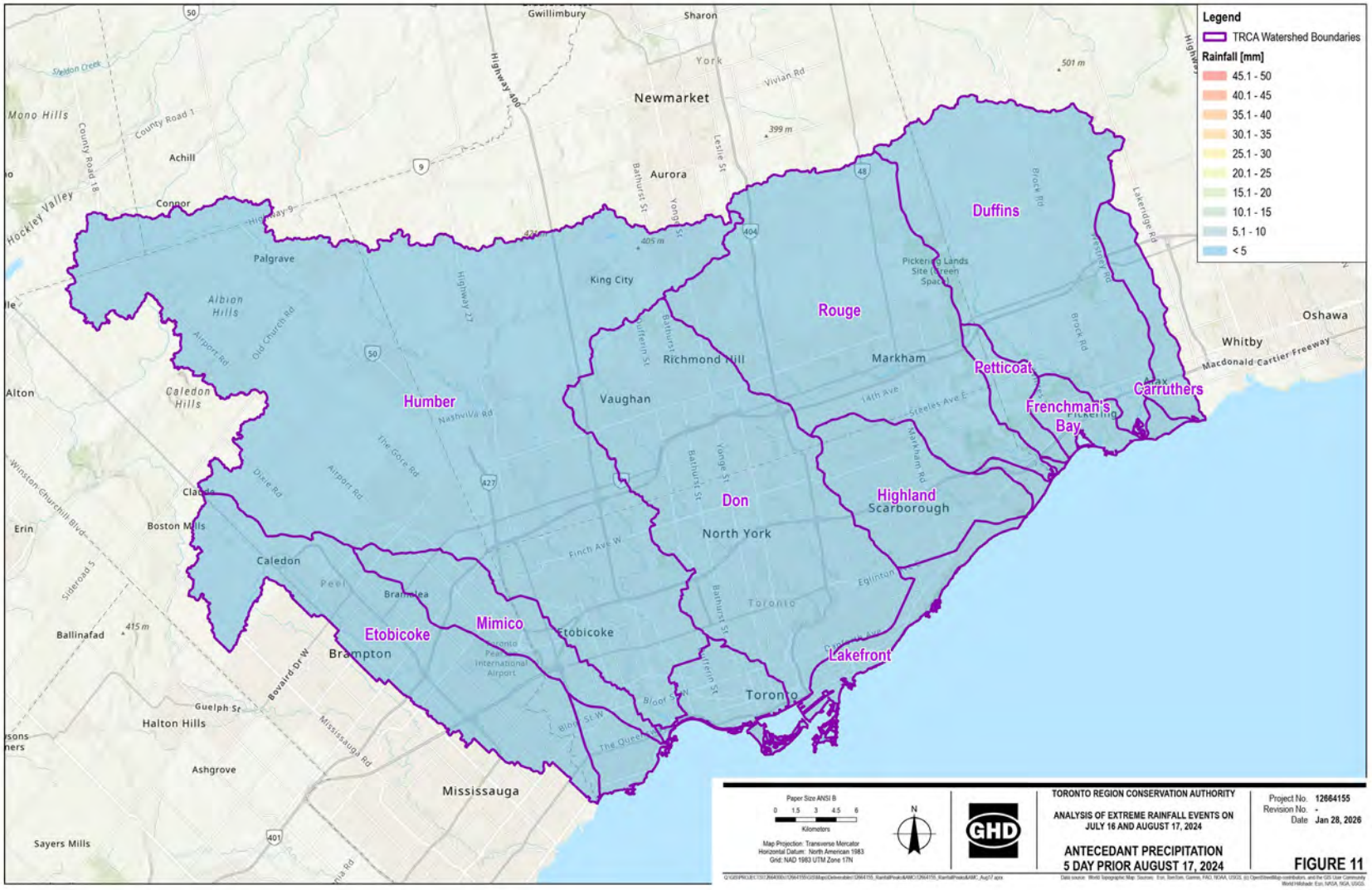


Figure 11 Antecedent Precipitation 5 days prior August 17, 2024

3.5 Reported storm impacts

3.5.1 City of Toronto

Council response and reports

In response to the July 16, 2024 storm event, a review of existing and potential new stormwater mitigation and adaptation programs for private property and corresponding public consultation was initiated through a directive from Toronto City Council on July 24 and 25, 2024 (agenda item MM20.24 – Reducing Runoff and Mitigating Flooding, text included below).

> *4. City Council request the Deputy City Manager, Infrastructure Services, the General Manager, Transportation Services, the General Manager, Toronto Water, and the Executive Director, Toronto Emergency Management to hold debrief sessions and exercises with Toronto and Region Conservation Authority to explore opportunities/measures to reduce flood risk and minimize flood impacts in known Flood Vulnerable Areas across the City of Toronto, including the Lower Don River/Don Valley Parkway and other areas that were severely impacted by the July 16, 2024 flood event by riverine flooding, with such assessment to include, but not be limited to:*
>
> *a. improved flood forecasting and monitoring systems (monitoring equipment, flood models, risk mapping);*
>
> *b. flood detection and emergency operations alert and management systems (flood sensors, signals, automatic gates);*
>
> *c. flood outreach (enhanced public awareness), flood remedial capital works (flood control structures); and*
>
> *d. stormwater management (green infrastructure).*

The City called upon specific divisions and TRCA for coordination to explore opportunities/measures to reduce flood risk and minimize flood impacts in known Flood Vulnerable Areas, including the Lower Don River and other areas severely impacted by the July 16 flood event. Recommendations included improvements to flood forecasting and monitoring systems, flood detection and emergency operations alert and management systems, flood outreach, flood remedial capital works and stormwater management.

Toronto Hydro

A Major Event Response Report by Toronto Hydro dated September 12, 2024 detailed the loss of power to over 200,000 Toronto Hydro customers on July 16, 2024 due to flooding in all four relay room basements of A.W. Manby Transmission Station in Etobicoke.

Damage and impact estimates

Communications between TRCA and City of Toronto revealed that the estimated total damage cost from the July 16, 2024 storm was over $4.8 million.

From correspondence between GHD and City of Toronto staff, the City received 1,711 customer calls between July 16 to 24, 2024 and 611 calls between August 17 to 23, 2024 related to blocked drains or basement flooding.

Public information releases

The City of Toronto published a news release on July 16, 2024 at 5:30 pm detailing updates on rainfall messages from ECCC and TRCA, the City's ongoing response to the storm event, City-wide closures to services and public amenities, impacts to transit infrastructure, over 10 road closures, and flooding in multiple areas.

3.5.2 City of Mississauga

Council response and reports

In response to the July 16, 2024 storm event, Mississauga City Council put forward a motion on July 31, 2024, directing City staff to provide recommendations on immediate, short-term mid-term and long-term actions for the City undertake to mitigate flood risk and impacts.

A Corporate Report titled “July and August 2024 Extreme Rainfall Events Update” dated September 6, 2024 was presented to Mississauga City Council on September 18, 2024. The report identified the following:

- Total rainfall amounts for both events were highly localized and ranged from 7.6 to 106 mm for the July 16, 2024 event and 6.2 to 172 mm for the August 17, 2024 storm event
- The 100-year design storm was exceeded for both events in areas that received the highest recorded rainfall.
- Neighbourhoods in Malton, Lisgar, Applewood, and Dixie-Dundas received the largest flood impact.
- The overall cost of downtime in services/programs and damage to municipal infrastructure was estimated to be over $3 million and $0.9 million, respectively.
- Recommendations included acceleration of stormwater and flood infrastructure capital projects, public information sessions, review and analysis of flooding and capacity mitigation options, improved flood data collection, and the implementation for governmental financial relief programs and basement flooding subsidy programs for residents.
- Hexbin heat maps of 311 flood calls showed 302 calls from the July 16, 2024 event and 77 calls from the August 17, 2024 event.

A second Corporate Report titled “Council Update – July and August 2024 Extreme Rainfall Events” dated September 23, 2024 was presented to Council on September 25, 2024. The report was prepared following directives from Council to propose a recommended financial assistance program for residents, a detailed flood mitigation action plan to implement flood mitigation initiatives and the required budget and staff resources to achieve these objectives. Recommendations from the report included:

- The implementation of a $3 million residential compassionate flood relief grant program to residential property owners who incurred damage caused by the two storm events.
- The implementation of a basement flooding prevention rebate program, projected to cost upwards of $64 million over a 10-year horizon.
- The acceleration of planned and new stormwater projects, including aggressive acceleration of the Dixie-Dundas Flood Mitigation Project by 6 years.
- Enhancements to routine maintenance of stormwater infrastructure.

Public information releases

The media statements that were released by the City of Mississauga on the days of the storm events are detailed in **Table 13.**

Table 13 Summary of media statements issued by City of Mississauga

Date/time	Title	Content
July 16, 2024	Heavy rain causes flooding around Mississauga	– Reports of localized flooding and City response – 10 reported road closures and 16 reported park and trail closures due to flooding – Reopening of city sports fields with the exceptions of 23 that remain closed – Safety and incident reporting guidance

Date/time	Title	Content
July 17, 2024	Update: Clean up continues after heavy rains	– Description of clean up efforts and restoration of business operations – Ongoing closures of 2 sports fields, 3 trails, and 1 road
August 17, 2024 4:30 pm	UPDATE: Severe thunderstorms and heavy rain cause local flooding and closures	– Reports of localized flooding and City response – 9 reported road closures due to flooding – Closures at all parks surrounding 6 creeks and watersheds due to flooding – Closure of all City sports fields – Safety and incident reporting guidance
August 18, 2024 6:45 pm	UPDATE (as of 6:45 p.m.): Closures and delays – August 18	– 1 reported road closure due to flooding – Precaution advised at all parks and trails – Closure of all City sports fields – 1 reported transit (MiWay) detour – Safety and incident reporting guidance

3.5.3 Regional Municipality of Peel

Council response and reports

A report titled “Peel Region Response to July 2024 Severe Weather Event” was presented to Peel Regional Council on September 9, 2024. The report identified the following items related to rainfall and flooding:

– The July 16, 2024 storm event was more intense and covered a broader area than the August 17, 2024 storm.
– The reported maximum 3-hour and total 24-hour rainfall for both events exceeded those of the historic July 8, 2013 storm and Hurricane Hazel.
– The number of flooding-related customer calls to Peel Region Water and Wastewater Operations for the July and August 2024 storms were 474 and 100, respectively, with the majority of calls originating from Mississauga and Brampton.
– Five areas were subject to severe flooding including: the Dixie Road and Blundell Road underpass, Winston Churchill Boulevard between Bovaird Drive to 10th Sideroad, the intersection between Britannia Road and Ninth Line, the Dixie Road and Orenda Road underpass, and the intersection between Dixie Road and Dundas Street.
– Following the last major storm event in 2013, significant investments have been made in improving Regional response and resilience for extreme weather events by expanding monitoring capabilities for sanitary sewer flow and rainfall, advancing sanitary system capital works projects, implementing an Inflow and Infiltration (I&I) Reduction and Mitigation Strategy, and continuing the Stormwater Management Program.
– Next steps identified include analysis of wastewater system performance under extreme conditions, collaboration with local municipalities and conservation authorities, and management of damage claims from property owners.

3.5.4 Regional Municipality of York

Emergency management

Communication between GHD and the Emergency Management team at York Region revealed that a Situation Report for the July 16, 2024 storm event was not triggered under their emergency management operations protocols due to the short lead time between the alerts and warnings delivered by ECCC and the peak of the storm. Although high precipitation totals were observed, the lack of significant rainfall in the week prior to the event led to high absorptive capacity within the Region and minimal reported damage. Vaughan and Markham experienced localised urban flooding along the southern border with Toronto, resulting in road closures and traffic rerouting.

Comparatively, a Situation Report was triggered for the August 17, 2024 event in response to severe thunderstorm warnings and a tornado watch issued for the Region, however York Region received minimal flood or damage impact from this storm.

3.5.5 Insurance damage reports

The Insurance Bureau of Canada reported that the insured damage estimates to personal property related to the July 16, and August 17, 2024 storm events and associated flooding were $990 million and $110 million, respectively. These events contributed to a nationwide total of $8.5 billion in insured severe weather losses in 2024, which was the costliest year on record (IBC, 2025).

An updated release from IBC on July 15, 2025 stated nearly $1 billion in insured damage to personal property, including homes, businesses, and vehicles from the July 16, 2024 event (**https://www.ibc.ca/news-insights/news/toronto-and-gta-flash-flood-anniversary-underscores-urgency-of-severe-weather-preparedness**). The nationwide total was increased to over $9 billion in insured severe weather losses.

3.6 TRCA post-storm activities

In response to the municipal and council reports and following TRCA post-storm procedures, TRCA completed the following activities in response to the two significant storm event causing flooding:

- Participated in storm debrief meetings with the City of Mississauga, City of Toronto and York Region
- Shared storm rainfall and stream data with municipal partners as well as the public
- Conducted post-storm data collection
- Attended multiple public meetings led by local municipal Councilors within the City of Mississauga
- Wrote and presented multiple reports to TRCA Board of Directors
- Collaborated with and supported municipal emergency management offices for conducting emergency exercise training with City of Mississauga and Toronto
- Implemented improvements to TRCA flood message notification system
- Procured professional consulting services to complete a storm analysis report

4. Rainfall analysis

Rainfall data were collected from 191 and 190 gauges during the extreme weather events on July 16, 2024 and August 17, 2024, respectively. These gauges are distributed across all TRCA watersheds and are operated by various municipalities and organizations. Of the total number of gauges with valid rainfall data, 43 are situated outside the TRCA boundary, with the remaining located primarily in the north and southwest of the TRCA watersheds.

Rainfall data collected at each gauge were used to estimate total precipitation, intensity across multiple durations, and overall storm duration for the July 16 and August 17, 2024 events. These estimates were then used to generate thematic maps illustrating the spatial distribution and extent of rainfall across the study area.

4.1 Spatial mapping of total rainfall

The spatial distribution of total precipitation during the July 16, 2024, and August 17, 2024, storm events is shown on **Figure 12** and **Figure 13**, respectively. These figures highlight the variability in total precipitation across the TRCA jurisdiction. It should be noted that the Lake Ontario Waterfront watershed discussed below is not an official watershed, but rather it is referencing the Lake Ontario shoreline drainage areas. Western portions of the Lake Ontario

waterfront received significant rainfall amounts during the July 16, 2024 storm and thus is important to be included in the analysis of the event.

July 16, 2024

Figure 12 presents the total precipitation observed on July 16, 2024, across TRCA watersheds. The most intense rainfall occurred in the southern portions of the watersheds, particularly in Mimico and Etobicoke, where precipitation exceeded 100 mm in localized areas. Surrounding watersheds such as Don and Highland also experienced high rainfall ranging from 70 to 90 mm. Moderate precipitation levels (40–60 mm) were recorded in Rouge, and Petticoat. In contrast, the northern and eastern parts of the region including Upper Humber River, Duffins, and Carruthers Creeks received significantly less rainfall, generally between 10 and 30 mm. This spatial pattern indicates that the July 16 storm was highly concentrated in the southern and western portions of the TRCA jurisdiction, with rainfall intensity tapering off toward the north and northeast.

Table 14 shows the spatially averaged total depth by watershed. This was estimated using a raster statistic calculation tool to determine the mean total rainfall based on all raster cells within each watershed boundary. The table shows that the highest rainfall was observed in the Mimico watershed with 77.8 mm, followed by the Lake Ontario Waterfront and Etobicoke watersheds with 69.4 mm and 64.1 mm respectively. Lower rainfall amounts were observed in Petticoat (44.4 mm), Rouge (32.9 mm), and Duffins (28.5 mm), with the Humber watershed receiving the least rainfall at 28.1 mm.

Table 14 Average Total Storm Depth in TRCA Watersheds

TRCA Watershed	Spatially Averaged Total Rainfall (mm)
Carruthers	50.4
Don	53.5
Duffins	28.5
Etobicoke	64.1
Highland	54.4
Humber	28.1
Mimico	77.8
Petticoat	44.4
Rouge	32.9
Lake Ontario Waterfront	69.4

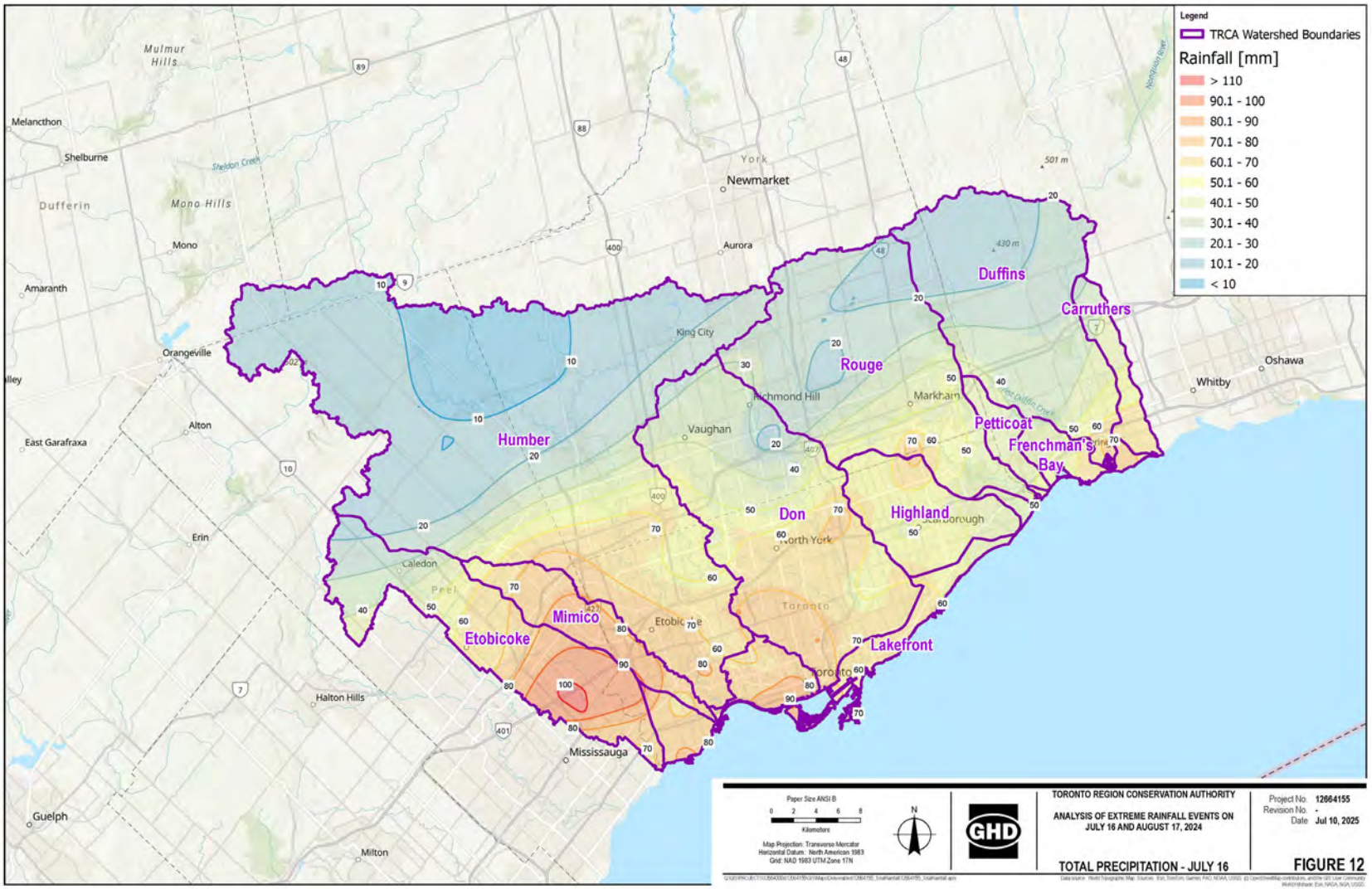


Figure 12 Total Precipitation – July 16, 2024

August 17, 2024

Figure 13 illustrates the total precipitation recorded on August 17, 2024, across the TRCA jurisdiction, delineated by watershed boundaries. The heaviest rainfall was concentrated in the central and southwestern portions of the region, particularly within the Don, Mimico, and Etobicoke watersheds, where precipitation levels exceeded 70 mm, ranging to over 100 mm in some localized areas. In contrast, the eastern and northern watersheds, including Carruthers, Duffins, and Petticoat experienced significantly lower rainfall amounts, generally ranging between 20 and 40 mm. The Lake Ontario Waterfront along the southern boundary also received relatively light rainfall, with totals below 20 mm in most areas. This spatial distribution highlights the localized nature of the storm, with more intense precipitation occurring inland and diminishing toward the periphery of the TRCA boundary.

The August 17, 2024 storm event depicts a more widespread distribution of rainfall across multiple watersheds, with generally higher precipitation totals compared to the July 16, 2024 storm event. The July 16 event was more localized in nature compared to the August 17 storm, with intense rainfall pockets embedded within a less broad area compared to August 17 event.

Table 15 shows the spatially averaged total rainfall depth by watershed (using a raster statistic calculation tool to determine the mean total rainfall based on all raster cells within each watershed boundary). The highest rainfall was observed in the Mimico watershed at 62.8 mm, followed by the Etobicoke and Don watersheds with 53.4 mm and 49.5 mm, respectively. Lower rainfall depths were observed in Petticoat (33.2 mm), Duffins (33.0 mm), and Carruthers (26.8 mm), with the Lake Ontario Waterfront receiving the least rainfall at 24.6 mm.

Table 15 Average Total Storm Depth in TRCA Watersheds

TRCA Watershed	Spatially Averaged Total Rainfall (mm)
Carruthers	26.8
Don	49.5
Duffins	33.0
Etobicoke	53.4
Highland	37.8
Humber	41.5
Mimico	62.8
Petticoat	33.2
Rouge	44.2
Lake Ontario Waterfront	24.6

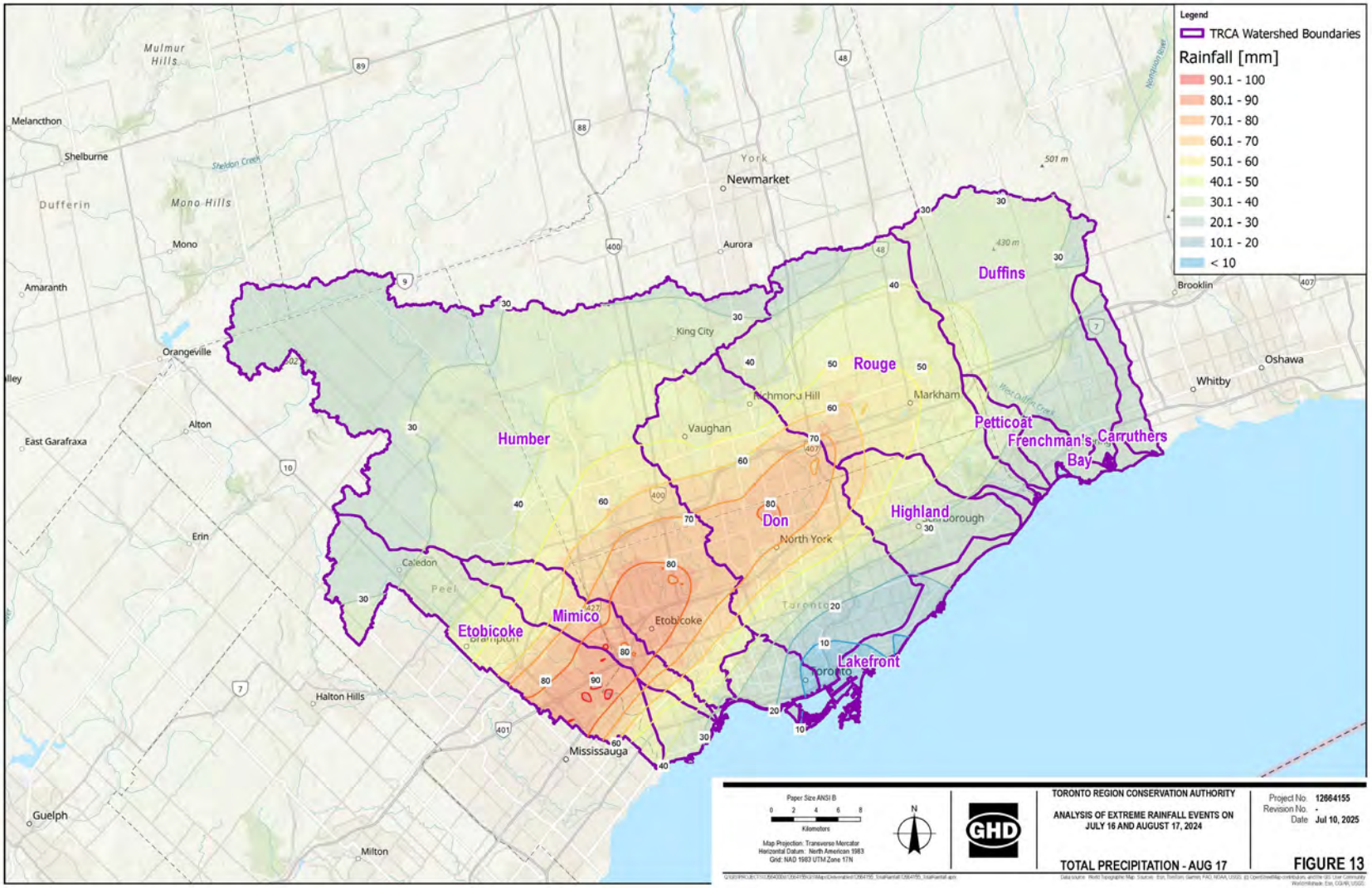


Figure 13 Total precipitation – August 17, 2024

4.2 Spatial mapping of rainfall intensity

Rainfall intensities for durations of 5, 10, 15 and 30 minutes, as well as 1, 2, 3, 6, 12, and 24 hours have been calculated at each gauge, and the results have been spatially interpolated in order to develop spatial mapping of peak rainfall for various durations within the study area. **Figures A-1** through **A-20** in **Appendix A** illustrate the spatial distribution of peak rainfall over various durations during the July 16, 2024 and August 17, 2024 storm event.

The stations with the maximum rainfall intensities for each duration are listed in **Table 16**. The rainfall data for these stations are included in **Appendix A**.

Table 16 Stations with maximum rainfall intensity for each duration

	July 16, 2024 Event		August 17, 2024 Event	
Duration	**Station Name and Agency**	**Rainfall Total (mm)**	**Station Name and Agency**	**Rainfall Total (mm)**
5-minute	HY099 - Rathwood, TRCA	16.0	RG_024, City of Toronto	14.7
10-minute	HY099 - Rathwood, TRCA	27.0	RG_024, City of Toronto	28.1
15-minute	RG23-Britannia Leachate Pumping, Region of Peel	29.6	St.HilaryRG, Region of Peel	38.0
30-minute	R-MUN-MA-21, Markham	36.5	St.HilaryRG, Region of Peel	62.4
1-hour	HY067 – West Humber at Hwy 7, TRCA	58.6	St.HilaryRG, Region of Peel	97.0
2-hour	RG16-Hanlan, Region of Peel	77.6	St.HilaryRG, Region of Peel	122.4
3-hour	RG07-Streetsville, City of Mississauga	102.6	St.HilaryRG, Region of Peel	129.0
6-hour	RG07-Streetsville, City of Mississauga	104.0	HY099 - Rathwood, TRCA	135.1
12-hour	RG07-Streetsville, City of Mississauga	104.2	HY099 - Rathwood, TRCA	135.7
24-hour	RG07-Streetsville, City of Mississauga HY099 (TRCA) is the highest inside the TRCA jurisdiction	104.2 101.5	HY099 - Rathwood, TRCA	135.7

July 16, 2024

A clear pattern emerges across all time intervals, with the highest rainfall intensities concentrated in the south-west portion of the region. At the five-minute duration, the area with the highest intensities is focused in Mississauga and Etobicoke, with rainfall totals of over 10 mm. The 10-minute and 15-minute durations were similar to the 5-minute duration in location (with rainfall totals increasing to 20-25 mm). In each of these durations there was less rainfall in Brampton, Toronto, North York, Scarborough, and Markham. However, at the 30-minute duration, the area with the highest intensity has shifted northwards to include Brampton and north Mississauga. A secondary high intensity area was developing in Toronto, North York, Scarborough, and into Markham. At the 1-hour duration, the spatial pattern is similar to the 30-minute duration. The highest intensity area is focused in Brampton, with a secondary high intensity area in Toronto, North York, Scarborough, and Markham. As the duration continues to increase, the pattern remains consistent. The 6-, 12-, and 24-hour durations are nearly identical, since the event lasted less than 6 hours in duration at most stations.

In all durations, the northern area (Caledon, Vaughan, Richmond Hill, and other northern areas) had low precipitation totals. The rainfall was focused in the southern portions of the TRCA watersheds. There may be climatic and/or physical reasons for the rainfall remaining in the southern portion of the TRCA area. For instance, it may be related to

factors such as: urban heat island effect for Toronto, topographic effects, and/or predominant wind patterns (AECOM, 2026, has investigated these factors for the 2024 storm events).

The rainfall event travelled from west to east across the TRCA area. The precipitation occurred in Mississauga, and Etobicoke first. Toronto, North York and Markham were impacted later. The predominant wind direction in the Toronto area is west to east, so the rainfall pattern indicates that the wind was travelling in the typical direction (although very quickly). In addition, the highest rainfall totals occurred in the western areas: the rainfall event was less severe as it travelled eastward. A separate report provides an analysis of the meteorological conditions (AECOM, 2026).

The rainfall occurred over a period of three to six hours. During the rainfall period, there were multiple short “bursts” of rainfall that were spaced very close together in time. At some stations, there were brief periods without rain within the event, while other stations had lower (but non-zero) rainfall between the “bursts” throughout the event.

August 17, 2024

Similar to the July 16, 2024 event, the figures consistently show that the south-western portion of the region experienced the most intense precipitation during the August 17, 2024 storm. For the 5-minute duration, the highest rainfall intensity occurred in Mississauga and Etobicoke, but there were also isolated pockets of high rainfall intensity in North York. At the 10- and 15-minute durations, the highest rainfall totals are still in Mississauga and Etobicoke, but there is significant rainfall in North York and Markham as well. In the 30-minute and 1-hour durations, the highest rainfall totals are in Mississauga and Etobicoke, but the high rainfall area in North York is less pronounced. In the 2-, 3-, and 6-hour durations, the highest rainfall totals are in Mississauga and Etobicoke, but the secondary area in North York became equally prominent by the 6-hour duration. This indicates that the rainfall occurred in multiple bursts, with time in-between. The 12- and 24-hour durations are nearly identical, since the duration was less than 12 hours at most stations.

In all durations, the northern area (Caledon, Vaughan, Richmond Hill, and other northern areas) had low precipitation totals. The rainfall was focused in the southern portions of the TRCA areas. This was similar to the July 16, 2024 storm event, and further indicates that there are possible climatological and/or physiographic effects that affect rainfall distribution (see AECOM, 2026, for a discussion of these effects).

Similar to the July 16, 2024 storm event, the August 17, 2024 rainfall event also travelled from west to east across the TRCA area. The precipitation occurred in Brampton, Mississauga, and Etobicoke first. Toronto, North York and Markham were impacted later. The highest rainfall totals occurred in Mississauga, Brampton, Etobicoke, and North York. Areas that were further east from North York were not impacted as severely.

The rainfall occurred over a period of up to 12 hours. During the rainfall period, there were multiple short “bursts” of rainfall that were spaced very close together in time. At most stations, there were periods without rain (up to three hours) within the event.

4.3 Spatial mapping of storm duration

The total storm duration for the July 16 and August 17, 2024 events was determined by analysing rainfall measurements from the start to the end of each event at individual gauges (the time between the first non-zero rainfall recorded on the storm date to the last non-zero rainfall). Breaks in rainfall were considered as part of the duration. **Figure 14** and **Figure 15** present the spatial distribution of storm duration across the TRCA jurisdiction for the July 16, 2024 and August 17, 2024 storm event, respectively. For consistency, all time references are reported in Eastern Standard Time and do not account for Daylight Savings Time (DST).

The results shown on **Figure 14** indicate that the July 16, 2024 storm event exhibited spatial variability in duration across the region. Most areas experienced storm durations ranging from 4 to 6 hours. The July 16, 2024 storm event was a very fast event. It had multiple strong “bursts” of rainfall that were very close together in time, and then it was over in a few hours. The northern areas that received less rainfall overall had durations of up to 14 hours (however, there were breaks between rainfall at these stations).

Figure 15 presents the storm duration for the August 17 event, which exhibited a broader range and longer durations than the July 16 storm event. Most of the eastern and southeastern parts of the region experienced storm durations of 5 to 10 hours. Certain areas within the Don River, Highland Creek, Rouge River, and Humber River watersheds experienced durations exceeding 12 hours. The Duffins Creek watershed recorded the greatest duration, exceeding 16 hours in the northern part of the watershed.

It should be noted that a long duration event may also indicate multiple thunderstorms passing over the same rain gauge with short or medium length breaks between them, a phenomenon known as training thunderstorms. Multiple rain gauges showed multiple peaks in the event hyetograph. This is key for the TRCA areas: both events were training thunderstorms, and were characterized by multiple high-intensity, short-duration thunderstorms.

The hydrological impacts of both events were severe. The areas with the highest rainfall totals (Mississauga, Brampton, Etobicoke, Toronto, North York, and Markham) are all urban and have a large amount of impervious area (and consequently high runoff). For the pervious area, the infiltration capacity (which is highest for a dry watershed) was likely exceeded during the intense rainfall bursts. The second and further rainfall bursts would have lower infiltration rates (because the watershed would be wetter). Drainage infrastructure would also likely be overwhelmed in the first burst of rainfall (stormwater sewers generally have capacity for 10-year events or less), with excess water flowing in the roads. The second and further bursts of rainfall would further exacerbate the issue, leading to high potential for flash flooding in the urban areas. The rapid nature of both events (particularly the July 16, 2024 event) would also add to the potential for flooding, since the system cannot recover between bursts.

Once the runoff reaches the rivers, it would result in rapid increases in depth. The response time for overland flow to enter a river from an urban area is generally very short (1 hour or less). Therefore, riverine flooding would quickly follow the urban flooding.

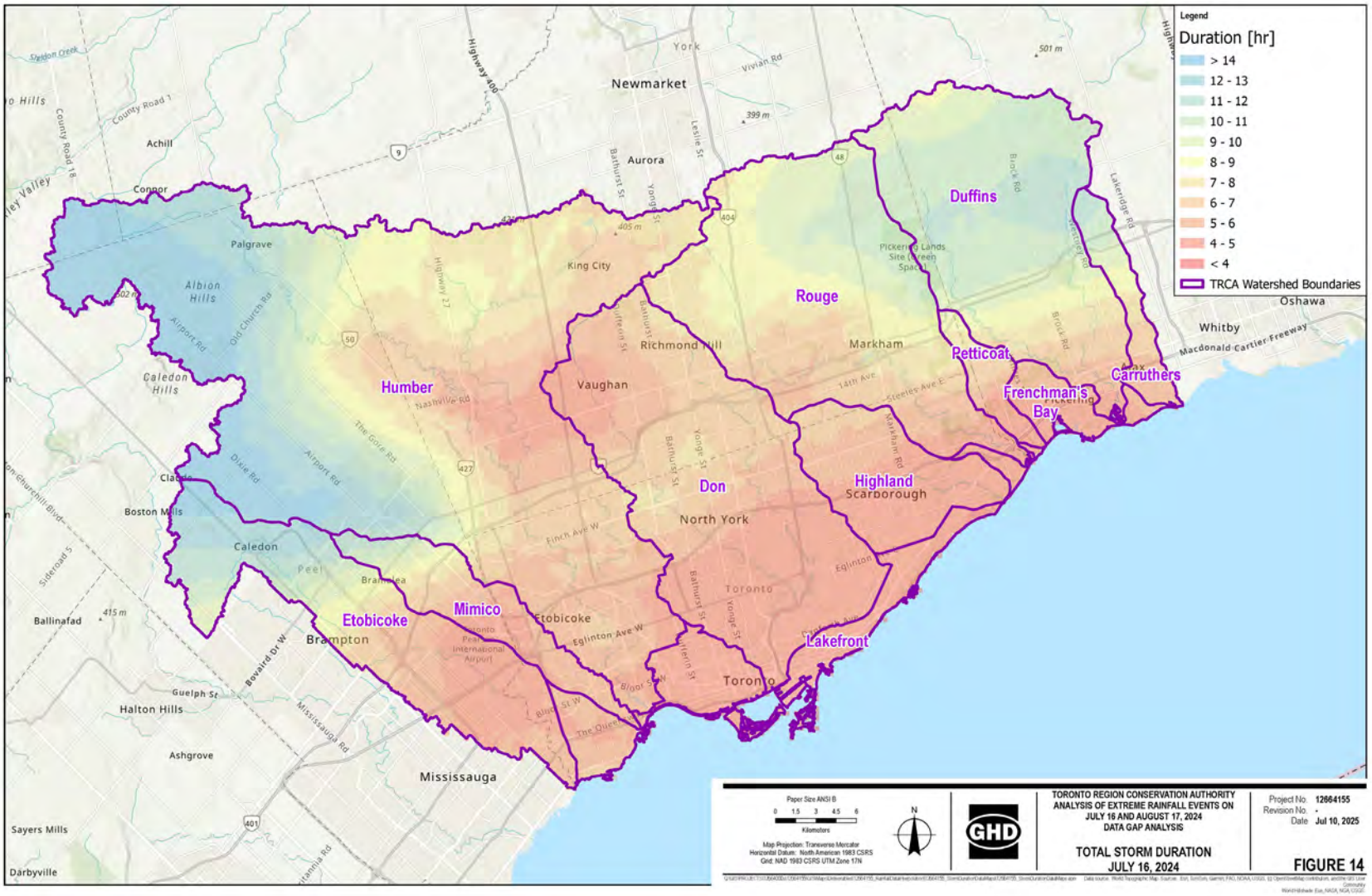


Figure 14 Total storm duration – July 16 2024

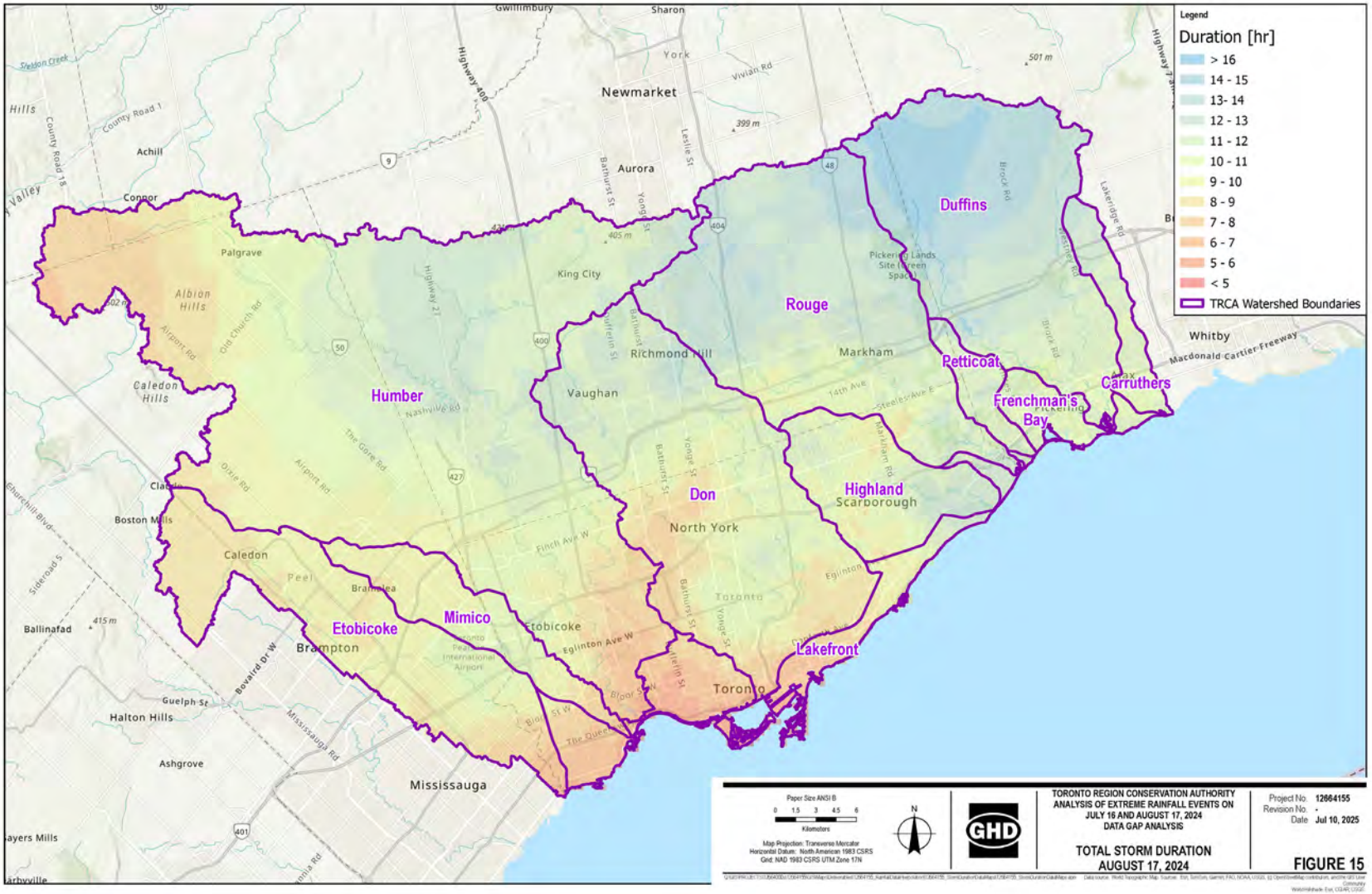


Figure 15 Total storm duration – August 17 2024

4.4 Spatial mapping of rainfall accumulations

Rainfall accumulation maps were generated for both the July 16 and August 17, 2024 events. The rainfall accumulation maps used the first timestep with rain at any gauge as time zero. For the July 16, 2024 event, the first timestep with rain was 7:40 AM. Therefore, the accumulation for the first hour included the timesteps from 7:40 to 8:35 AM at all gauges (even though not all gauges recorded rainfall during this time period). The accumulation for the second hour would include the timesteps from 7:40 to 9:35 AM, and so on. For the August 17, 2024 event, the first timestep with rain was 7:30 AM, so its accumulations started at that time. In general, the accumulations were hourly, but in order to get better information about the peaks of the storms the maps were generated more frequently.

For the July 26, 2024 storm event, a total of 10 rainfall accumulation maps were generated. The majority of the rainfall for the July 26, 2024 event occurred over a seven-hour period (with some small amounts after). A review of the rainfall across all gauges indicates that the majority of the rainfall occurred between hours 1 and 4 (see table colour-coded by rainfall depth in **Appendix B**). The percent of rainfall in each half hour was calculated for each gauge (these were half-hour totals, not accumulations for the entire event). The minimum, average, and maximum percentage of rainfall in each half hour for the July 16, 2024 event is provided on **Figure 16**. Based on the percentage of rainfall figure, it was decided to focus on the first four hours of the event, and particularly to focus on the part of the storm leading up to the peak at hour three of the storm (**Table 17**).

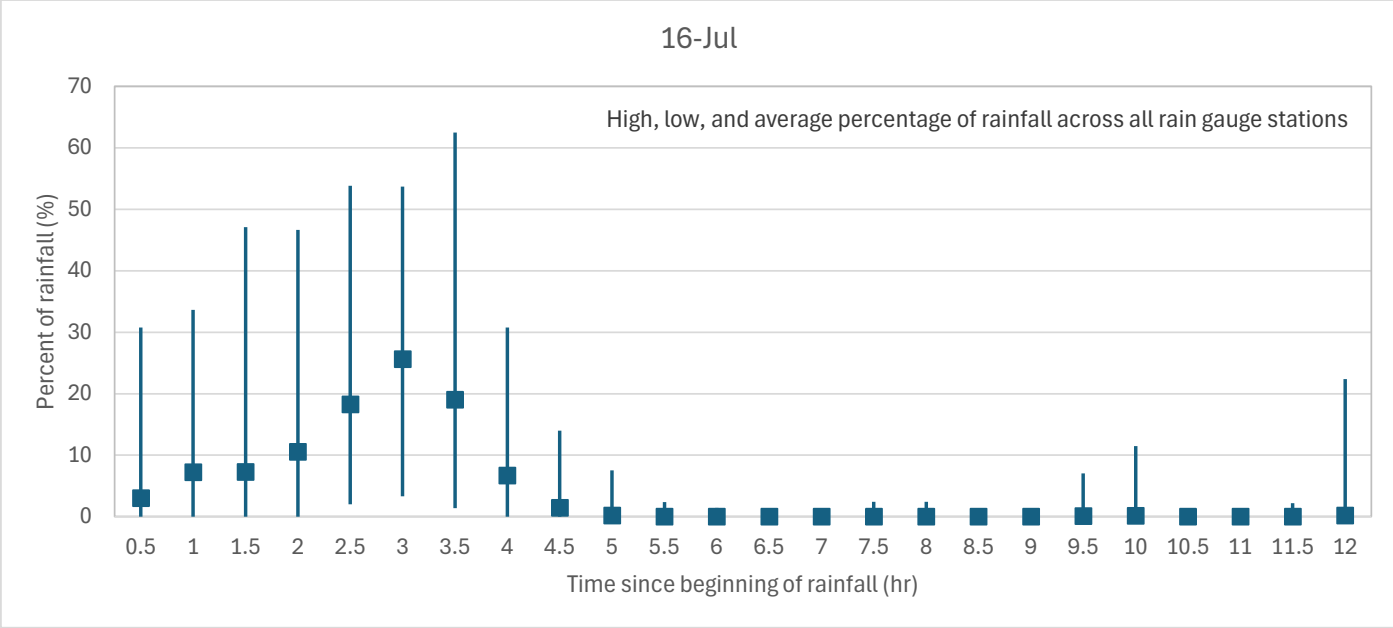


Figure 16 ***Percent of rainfall in each half hour for the July 16, 2024 event***

Table 17 ***Times for accumulation maps for July 16, 2024***

Map Number	1	2	3	4	5	6	7	8	9	10
Time since start of rainfall (hr)	1	1.5	2	2.25	2.5	2.75	3	3.5	4	7

The ten accumulation maps for July 16, 2024 are included in **Appendix B**. In the first hour of the storm, the rainfall is limited to the south portions of the Etobicoke and Mimico watersheds. In the second hour, the rainfall extends east into the Humber and Don watersheds, and ranges northwards almost to the headwaters of the rivers. The area with the highest rainfall is in the south parts of the Etobicoke and Mimico watersheds (near Lake Ontario). Over the third hour, the rainfall extent covers the entire TRCA area. The area with the most intense rainfall is in the southern portion of the Etobicoke and Mimico watersheds, but significant accumulations occur in the Humber and Don watersheds. In the fourth hour, the area with the most intense rainfall has expanded to cover the southern parts of Etobicoke, Mimico,

Humber, and Don watersheds. The change from the fourth hour to the seventh hour is minor. The highest rainfall covers the Etobicoke, Mimico, Humber, and Don watersheds, and the only area with minimal rainfall was the northern headwaters of the Humber watershed.

From the accumulation maps for the July 16, 2024 event, we summarize the following:

– The storm travelled from west to east across the TRCA area
– The storm entered TRCA's jurisdiction in Mississauga near the lakeshore
– The highest rainfall accumulation was 104.2 mm (but 101.5 mm was the largest rainfall accumulation inside the TRCA jurisdiction).
– The area with the highest rainfall included the southern portions of Etobicoke, Mimico, Humber, and Don watersheds
– The entire TRCA area was covered by the event, but the rainfall in the northern headwaters of the Humber, Rouge, and Duffins watersheds was relatively low.
– The majority of the rainfall ended after four hours

For the August 17, 2024 storm event, a total of 15 rainfall accumulation maps were generated. The majority of the rainfall for this event occurred over a twelve-hour period. The first four hours included some localized rainfall at a few rain gauges (see table colour-coded by rainfall depth in **Appendix B**). The majority of the rainfall occurred between hours 4 and 10. The percent of rainfall in each half hour was calculated for each gauge. The minimum, average, and maximum percentage of rainfall in each half hour for the August 17, 2024 event is provided on **Figure 17**. Based on the percentage of rainfall figure, it was decided to focus on the fourth to tenth hours of the event, and particularly to focus on the part of the storm leading up to the peak at hour six of the storm (**Table 18**).

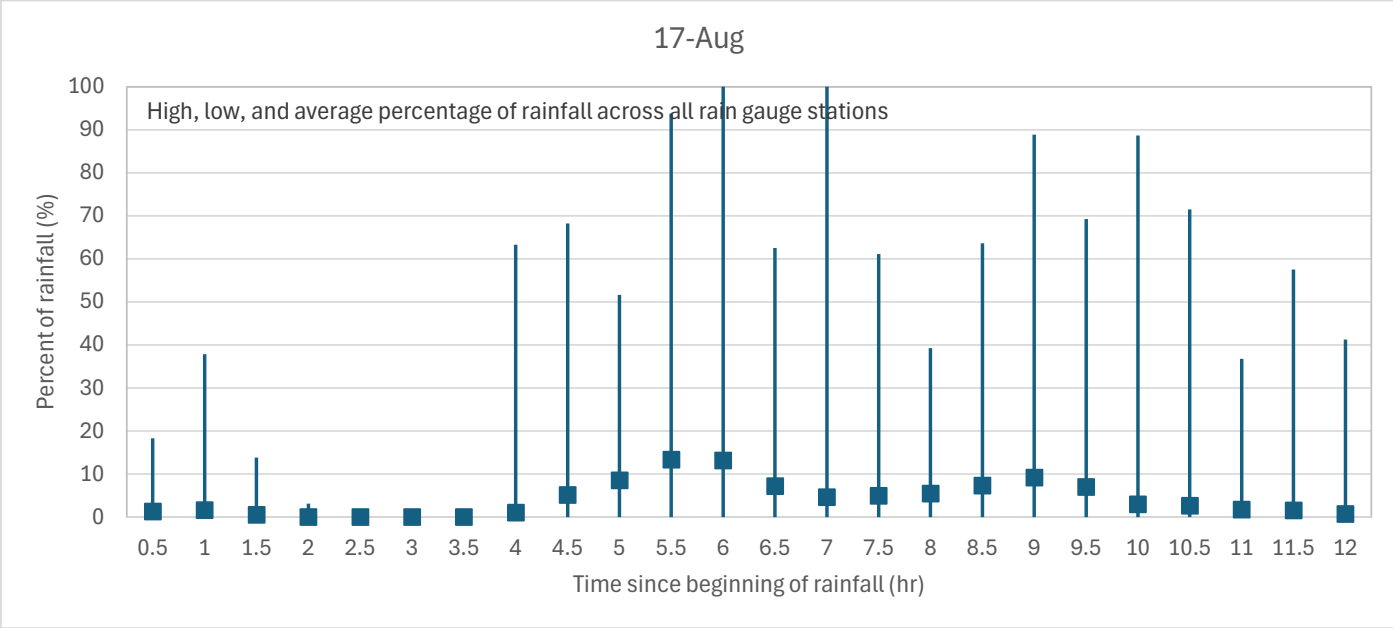


Figure 17 Percent of rainfall in each half hour for the August 17, 2024 event

Table 18 Times for accumulation maps for August 17, 2024

Map Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Time since start of rainfall (hr)	4.5	5	5.25	5.5	5.75	6	6.5	7	7.5	8	8.5	9	9.5	11	12

The 15 accumulation maps for August 17, 2024 event are included in **Appendix B**. In the first 4.5 hours of the storm, there is light rainfall in the north portions of Etobicoke, Mimico, and Don watersheds, and the central portion of the

Humber watershed. After five hours, the rainfall is increasing in intensity across the Etobicoke, Mimico, Humber, and Don watersheds. The heaviest rainfall is in the Etobicoke watershed. As the event continues for six hours, the storm continues to move from west to east across the TRCA area, covering all of the TRCA watersheds with the heaviest rainfall still occurring in the Etobicoke watershed. In contrast from the July event, the rainfall originates from further north, near Highway 401. The northern headwaters of the Humber watershed and the area near Lake Ontario have relatively low amounts of rainfall. At seven hours, the band of high rainfall has extended across all of the TRCA watersheds. There are still areas with low rainfall in the northern headwaters of the Humber watershed and near the lakeshore. At eight hours, the band of high rainfall has become wider through all of the TRCA watersheds, there is a growing area with very high rainfall in the central portions of the watersheds, and there is low rainfall in the northern headwaters of the Humber watershed and near the lakeshore. At nine hours, the band of very high rainfall continues to stretch across the TRCA watersheds. At eleven hours, the storm is tapered off in the Etobicoke and Mimico watershed but continues to expand in the Humber and more eastern watersheds. At twelve hours, the storm has finished, and there is very high rainfall extending from Etobicoke and Mimico watersheds (area near Highway 401) east through the Humber and Don watersheds and touching parts of the Rouge watershed. There is a medium to large amount of rainfall throughout the rest of the TRCA area except for the lakeshore within downtown Toronto.

From the accumulation maps for the August 17, 2024 event, we summarize the following:

– The storm travelled from west to east across the TRCA area
– The storm entered TRCA's jurisdiction in Mississauga near Highway 401
– The highest rainfall accumulation was 135.7 mm.
– The area with the highest rainfall included the central portions of Etobicoke, Mimico, Humber, and Don watersheds
– The entire TRCA area was covered by the event, with light rainfall in the Lake Ontario Waterfront area through downtown Toronto and also in the northern and eastern areas

4.5 Comparison to IDF curves

The July 16 and August 17, 2024 events were compared with existing ECCC Intensity-Duration-Frequency (IDF) curves within the study area to estimate the events' return period in each watershed. Note that the IDF curves were not updated with the two new events. AECOM (2026) updated IDF curves with these events, which may result in variations in these results compared to the AECOM report. There were 19 available IDF curves in the study area, but only the four stations summarized in **Table 19** were selected based on the criteria of having the longest and most recent records.

Table 19 Selected ECCC Climate Stations for IDF Comparison

Station Name	Climate ID	Latitude	Longitude	TRCA Watershed	Years of Data	#Years
Toronto North York	615S001	43 47'N	79 28'W	Don River	1964 – 2014	34
Toronto International Airport	6158731	43 41'N	79 38'W	Etobicoke Creek	1950 – 2017	64
Toronto City	6158355	43 40'N	79 24'W	Lake Ontario Waterfront	1940 – 2021	73
Buttonville Airport	615HMAK	43 52'N	79 22'W	Rouge	1986 – 2016	26

The remaining TRCA watersheds that do not contain one of the selected IDF curve stations were compared with the IDF curve of the closest selected station. The central watersheds (Don and Highland) used the North York IDF curve, western watersheds (Etobicoke Creek, Mimico, and Humber) used the Toronto Pearson International Airport IDF curve, and the eastern watersheds (Rouge, Duffins, Carruthers, and Petticoat) used the Buttonville Airport IDF curve.

The maximum return period associated with each TRCA watershed was estimated by comparing the maximum rainfall depths at each rain gauge for 5-min, 1-hr, 3-hr, 6-hr, 12-hr, and 24-hr durations with the corresponding IDF curve return period rainfall amounts. The rain gauges were then grouped by TRCA watershed, and the maximum return period of the rain gauges in each TRCA watershed is shown in **Table 20** and **Table 21.** The return periods are spatially mapped for durations from 5-min to 24-hr in **Appendix C**.

Table 20 Maximum Return Period in Each TRCA Watershed - July 16, 2024

July 16, 2024 – Maximum Return Period							
TRCA Watershed	**IDF Curve Used**	**5-min duration**	**1-hr duration**	**3-hr duration**	**6-hr duration**	**12-hr duration**	**24-hr duration**
Carruthers	IDF Buttonville A	<2	2-5	2-5	2-5	<2	<2
Don	IDF North York	2-5	5-10	25-50	10-25	10-25	5-10
Duffins	IDF Buttonville A	<2	10-25	>100 1	25-50	10-25	5-10
Etobicoke	IDF Toronto Intl A	25-50	50-100	>100	>100	50-100	25-50
Highland	IDF North York	<2	5-10	10-25	5-10	5-10	2-5
Humber	IDF Toronto Intl A	5-10	50-100	>100	25-50	25-50	10-25
Mimico	IDF Toronto Intl A	<2	50-100	>100	50-100	25-50	10-25
Petticoat	IDF Buttonville A	<2	2-5	10-25	5-10	2-5	2-5
Rouge	IDF Buttonville A	2-5	25-50	>100 [1]	25-50	10-25	10-25
Lake Ontario Waterfront	IDF Toronto City	2-5	25-50	>100	>100	>100	50-100

Note:

1 – For the Duffins and Rouge watersheds, there was one gauge located in the south part of the watershed with high rainfall accumulation (>70 mm). Remaining gauges were less than 100-year return period.

Table 21 Maximum Return Period in Each TRCA Watershed - August 17, 2024

August 17, 2024 – Maximum Return Period							
TRCA Watershed	**IDF Curve Used**	**5-min duration**	**1-hr duration**	**3-hr duration**	**6-hr duration**	**12-hr duration**	**24-hr duration**
Carruthers	IDF Buttonville A	<2	<2	<2	<2	<2	<2
Don	IDF North York	2-5	5-10	50-100	25-50	25-50	25-50
Duffins	IDF Buttonville A	10-25	2-5	5-10	2-5	2-5	2-5
Etobicoke	IDF Toronto Intl A	10-25	>100	>100	>100	>100	>100

TRCA Watershed	IDF Curve Used	5-min duration	1-hr duration	3-hr duration	6-hr duration	12-hr duration	24-hr duration
Highland	IDF North York	2-5	<2	<2	2-5	2-5	<2
Humber	IDF Toronto Intl A	10-25	25-50	>100	>100	>100	50-100
Mimico	IDF Toronto Intl A	2-5	<2	2-5	5-10	5-10	2-5
Petticoat	IDF Buttonville A	<2	<2	<2	<2	<2	<2
Rouge	IDF Buttonville A	2-5	5-10	10-25	50-100	25-50	10-25
Lake Ontario Waterfront	IDF Toronto City	<2	2-5	2-5	5-10	2-5	2-5

For the storm event on July 16, 2024, most of the TRCA watersheds experienced 25-year or greater return period rainfall amounts for several durations, indicating the storm covered multiple watersheds. The Etobicoke Creek watershed and Lake Ontario waterfront area displayed the most significant rainfall amounts, with exceedance of the 50-year return period for the 3, 6, and 12 hr durations, and 100-year exceedance for both the 3 hr and 6 hr durations. The next watersheds to experience high return period rainfall amounts were Mimico Creek, and then the Humber River. The results suggest that the storm hit the west and southern areas of the TRCA jurisdiction the hardest. It is important to note that of the nine watersheds , six of them had 100-year exceedances for the 3-hour duration. The Duffins watershed, located on the east side of TRCA, also received greater than 100-year return period rainfall for the 3-hour duration, which is unexpected due to its distance from where the storm hit the hardest across the western watersheds. However, the rain gauge HY004 in the Duffins watershed that has high rainfall is located on the southern point of the watershed and closer to Lake Ontario, where a higher peak rainfall amount of 70.8 mm was recorded. The remaining rainfall gauges in the Duffins watershed are distributed around the middle and top, where rainfall peaks were lower. The Rouge watershed, also located on the east side of TRCA, experienced greater than 100-year return period rainfall at one gauge similar to the Duffins watershed. The rain gauge R-MUN-MA-21 located at the southwest border of Rouge watershed recorded a 3-hour peak rainfall of 70 mm.

The August 17, 2024 storm event appeared narrower in spatial extent than the July event based on the results, as there were fewer watersheds that experienced 25-year or greater return period rainfall amounts. Etobicoke was hit the hardest, with maximum rainfall depths that exceeded the 100-year return period for all durations above 1-hr. Peak rainfall over the Humber watershed also resulted in high return period exceedances of 100-year for multiple durations. The Don and Rouge watersheds received rainfall in exceedance of the 50-year. There are only two rain gauges in the Mimico watershed, and both rain gauges were on the northern edge of the storm event (hence the low return period even though the watershed was highly impacted as shown on the figures in **Appendix C**). The results from this analysis indicate that the middle portion of the western watersheds was impacted the most.

The rainfall intensities from all IDF stations, as presented in **Table 20** and **Table 21** were used to develop spatial grids illustrating the distribution of rainfall intensities for various storm durations, including 5-minute, 10-minute, 15-min, 30-min, 1-hour, 3-hour, 6-hour, 12-hour, and 24-hours. 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.

The spatial distribution of the return periods calculated across the TRCA watersheds based on the IDF curve comparison are presented on **Figures 1 to 10** of **Appendix C** for the July 16, 2024 storm event, the most extreme rainfall was observed in the southern and western portion of the region. For instance, the southern Humber watershed saw >100-year return periods for both the 3-hour and 6-hour durations, while the southern Etobicoke and Mimico watersheds exceeded 100 years for the 1-hour and 3-hour durations.

For the August 17, 2024 storm event (**Appendix C Figures 11 to 20**), the most extreme rainfall was concentrated in the middle portion of the Etobicoke Creek watershed, where return periods exceeded 100 years across all durations

from 1-hour through 24-hour. Similarly, the southern Humber River watershed experienced rainfall with return periods greater than 100 years for the 3-hour, 6-hour, and 12-hour durations, and between 50 and 100 years for the 24-hour duration. In the lower Don River, rainfall exceeded the 50-year return period for the 3-hour duration. Based on the interpolation of the return periods, the central area of the Mimico watershed was also highly impacted.

4.6 Design storm analysis

Design storm distributions are an important part of stormwater management planning and design processes. They are used in hydrologic and hydraulic modelling to represent typical extreme rainfall patterns. GHD performed a comparison between common synthetic design storm distributions and the July 16, and August 17, 2024 rainfall events, to determine whether the synthetic storms recommended by TRCA modelling guidelines adequately represented the extreme rainfall patterns.

4.6.1 Candidate design storm distributions

GHD developed a list of candidate design storm distributions for short event durations (1-hr, 3-hr, and 6-hr) and long duration events (12-hr) based on the flood control criteria and modelling information given by the TRCA Stormwater Management Criteria (TRCA, 2012) for each TRCA watershed as well as design storms that are typically applied in Southern Ontario (S. ON). The AES and SCS 24-hour storms were not considered because the observed storm events were not 24 hours in duration. Additionally, the Chicago 4-hour 25mm storm was not included because it is defined by a total quantity of rainfall, and the pattern (short-duration Chicago) is represented by the 3-hour Chicago in the analysis.

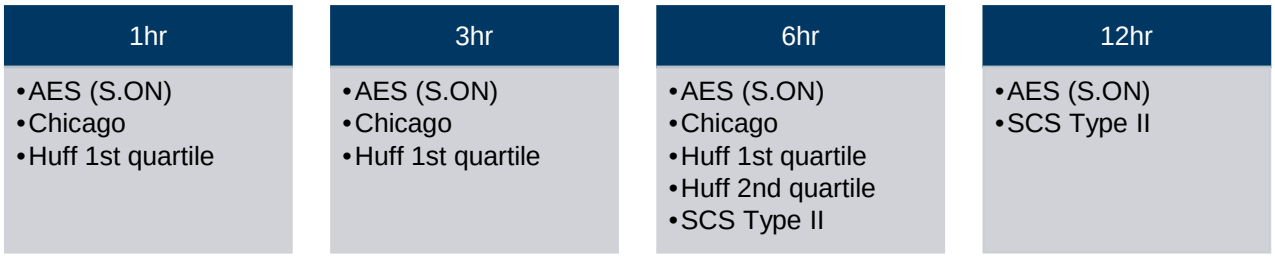


Figure 18 Candidate Design Storms for Comparison

The design storm distributions included the published Atmospheric Environment Service (AES) for Southern Ontario, Soil Conservation Service (SCS) Type II, Chicago, and Huff.

There are four Huff distributions with peaks in different quartiles. The quartile is typically selected according to the storm duration (Huff I for short durations, Huff II and Huff III for medium durations, and Huff IV for long durations). The Huff storms were originally developed for mid-Western USA using historical rainfall data and may represent multi-peak events better than one-peak methods (Huff, 1968).

The Chicago distribution was originally intended for design of storm sewers with a duration of 3-hours. It is characterized by high peak rainfall intensity, with lower intensity on either side of the peak. The "r" value controls the location of the peak rainfall and can be set according to the location of the peak in the historical data (Keifer and Chu, 1957).

The AES distributions were developed by AES (now ECCC) originally for 1-hour storms in Canada, using historical rainfall event data. There are 8 types of 1-hour AES storms defined by Canadian region, including Southern Ontario. The 1-hour event distributions can be extended to 2 and 3-hour durations. The 12-hour Southern Ontario AES distribution was also shortened to a 6-hour duration.

There are four (4) SCS (now National Resources Conservation Service, NRCS) distributions derived from historic rainfall data across the USA that represent different climate patterns. The SCS Type II is commonly applied in Southern Ontario. The storms were originally developed for use in small area drainage planning in both urban and

rural areas across North America for 24-hour durations but may also be used as short as 6-hours. The SCS Type II is characterized by high peak intensity rainfall (SCS, 1986).

The existing storm hyetographs were normalized (total storm depth of 1) and defined using a 5-minute time step for all durations.

The candidate design storm distributions are compared on **Figure 19** to **Figure 22**. The main differences between the design storm distributions are the locations of the peak rainfall and the relative size of the peaks. When the Chicago distribution is used, the r value must be determined (either from historical data or design guidelines). The "r" value was assumed to be 0.35 as an approximate value, with "r" = 0.5 and "r" = 0.44 added for the 3-hour events. For 6-hour events, the Chicago storm with "r" = 0.5 is very similar to the SCS Type II and so was not included in the analysis.

In a cumulative precipitation plot, the size of the peak is indicated by the steepness of the slope of the line. Chicago and SCS Type II distributions have significant peak rainfall (steep slope), while the Huff 1st and 2nd quartile storms have smaller peak rainfall (less steep slope). For the shorter durations of 1-hour and 3-hour, the AES distribution has a medium peak (slope is more gradual than Chicago and SCS Type II, but steeper than Huff), while the medium/longer durations of 6-hour and 12-hour, the AES distribution displays a smaller peak rainfall, similar to the Huff distributions.

The information above provides context of the typical applications of the candidate design storms and their distribution patterns that will be compared against the historical rainfall distributions.

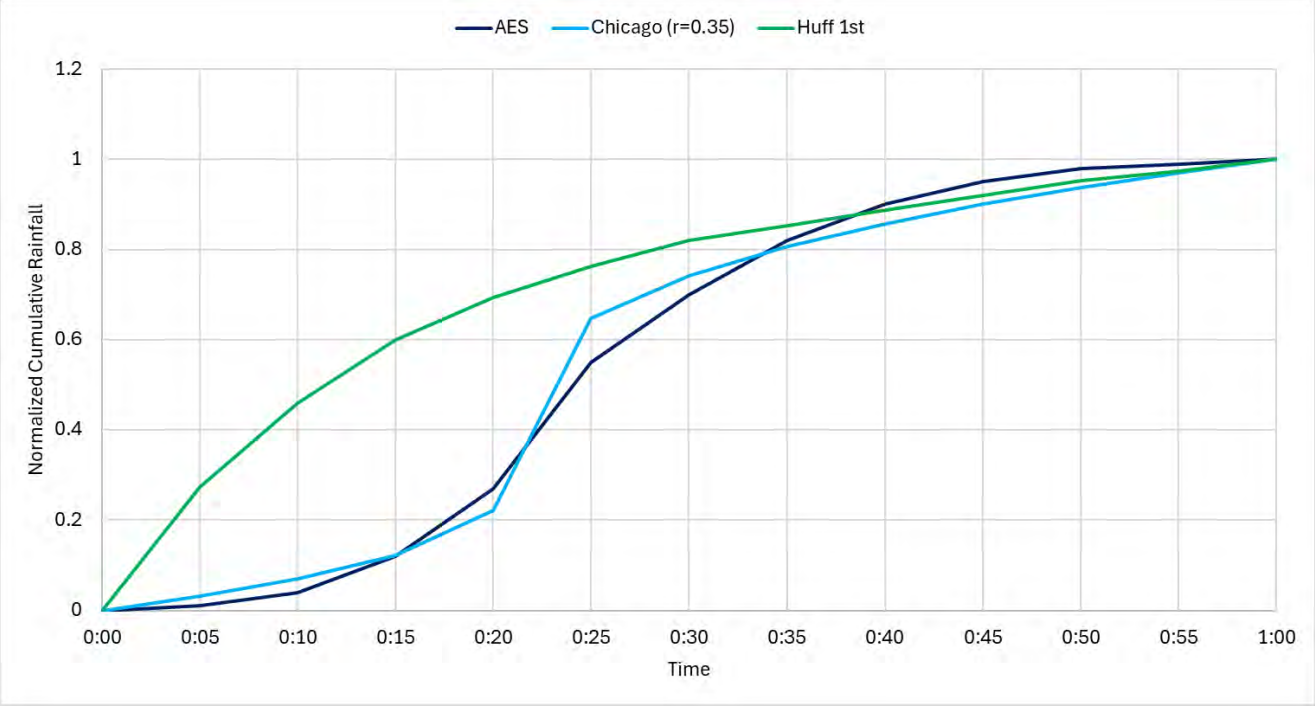


Figure 19 1-hour Candidate Design Storms

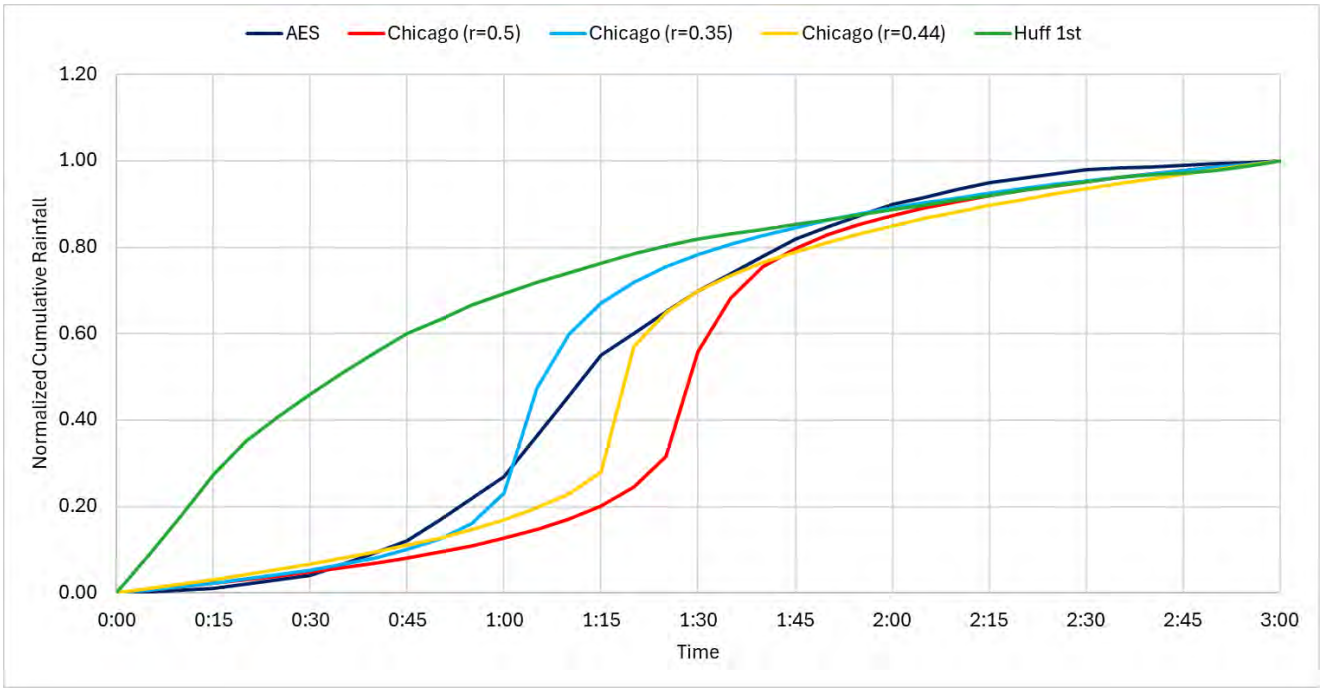


Figure 20 3-hour Candidate Design Storms

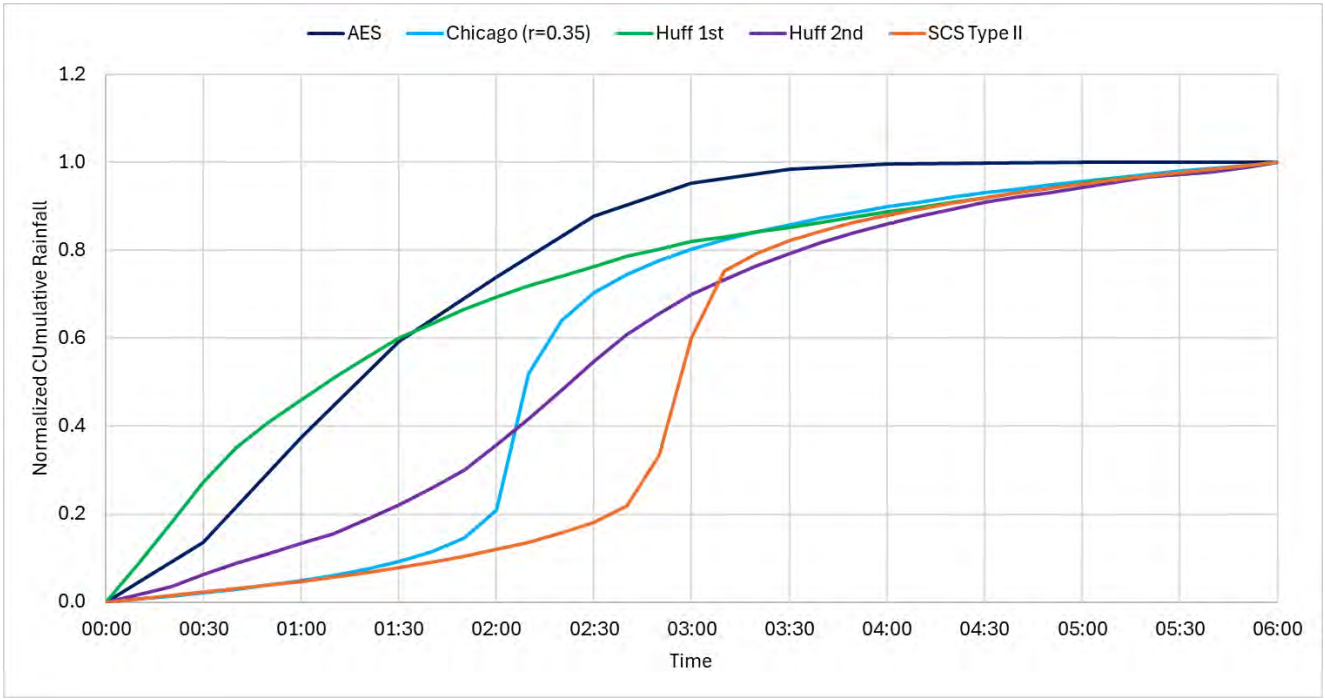


Figure 21 6-hour Candidate Design Storms

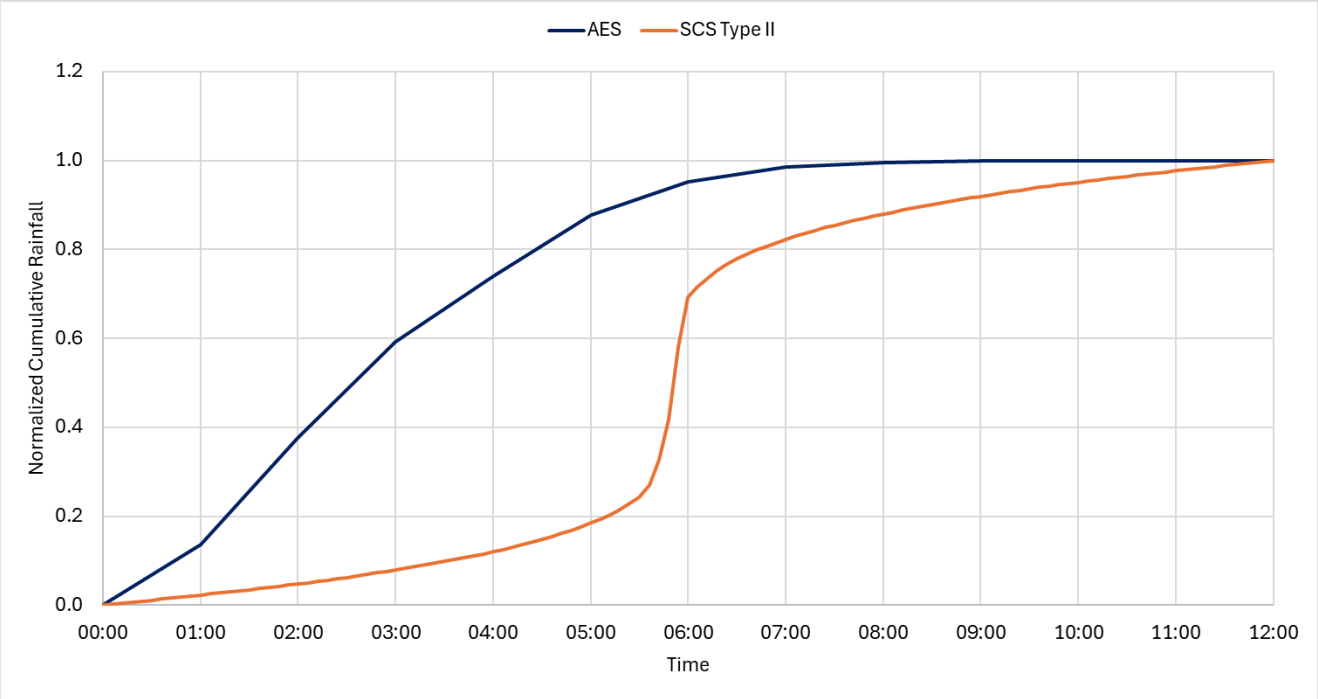


Figure 22 12-hour Candidate Design Storms

4.6.2 Rain gauge selection

A graphical analysis of the extreme rainfall events on July 16, and August 17, 2024 was completed for comparison to select synthetic design storms.

To generate the rainfall pattern and statistics of the July 16, and August 17, 2024 events, the rain gauge data as described in **Section 2** were analyzed. As in **Section 4.3**, the storm duration was defined at each rain gauge as the time between the first rainfall recorded on the storm date to the last rainfall recorded on the storm date. This is the same methodology used in **Section 4.3** for the spatial mapping of storm duration The observed durations were then matched to the closest design storm duration according to the ranges given in **Table 22.**

Table 22 Comparative design storm distribution duration for observed event duration

Observed Event Duration (hour)	Comparative Design Storm Distribution Duration (hour)
<0.5	N/A[2]
0.5 – 1.5	1
1.5 – 2.5	2
2.5 – 4	3
4 – 8	6
8 – 16	12
16 - 32	24

The rain gauges with the highest rainfall totals were selected out of every municipality and agency, by identifying the gauges that experienced a 25-year return period (or greater) extreme rainfall. This list of gauges was then further filtered by the highest total rainfall, with the top 15-20 gauges selected for each event. The process of selecting the historic rainfall data is shown on **Figure 23**.

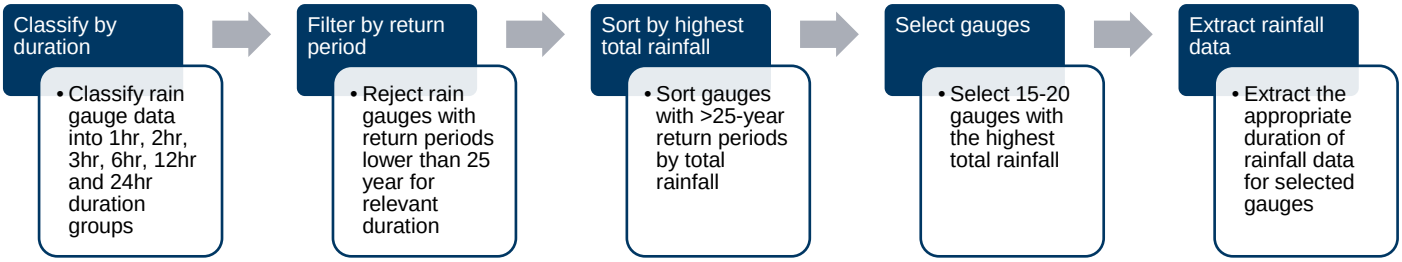


Figure 23 Historic rainfall data selection process

The analysis of all rain gauges showed that the July 16, 2024 event was generally shorter in duration, with 3-hour and 6-hour being the most typical, while the August 17th event was of medium duration, with 6-hour and 12-hour events being the most typical. As a result of this outcome, the 1-hour synthetic design storms were excluded from the comparison analysis.

On July 16, 2024, there were 13 rain gauges with return periods > 25 years for the gauges classified as 3-hour duration, and 12 gauges for those classified as 6-hour duration. The August 17, 2024 storm experienced lower return periods overall, with 8 gauges having return periods > 25 years for the 6-hour duration and 5 gauges for the 12-hour duration. The analysis aimed to use the gauges with both the largest rainfall totals and return periods > 25-year, therefore, a total of 20 gauges were selected for the July 16, 2024 event and 13 gauges were selected for August 17, 2024 event, with most gauges having return periods of greater than 100 years for the durations selected. The gauges selected to perform the design storm analysis are shown on **Figure 24**.

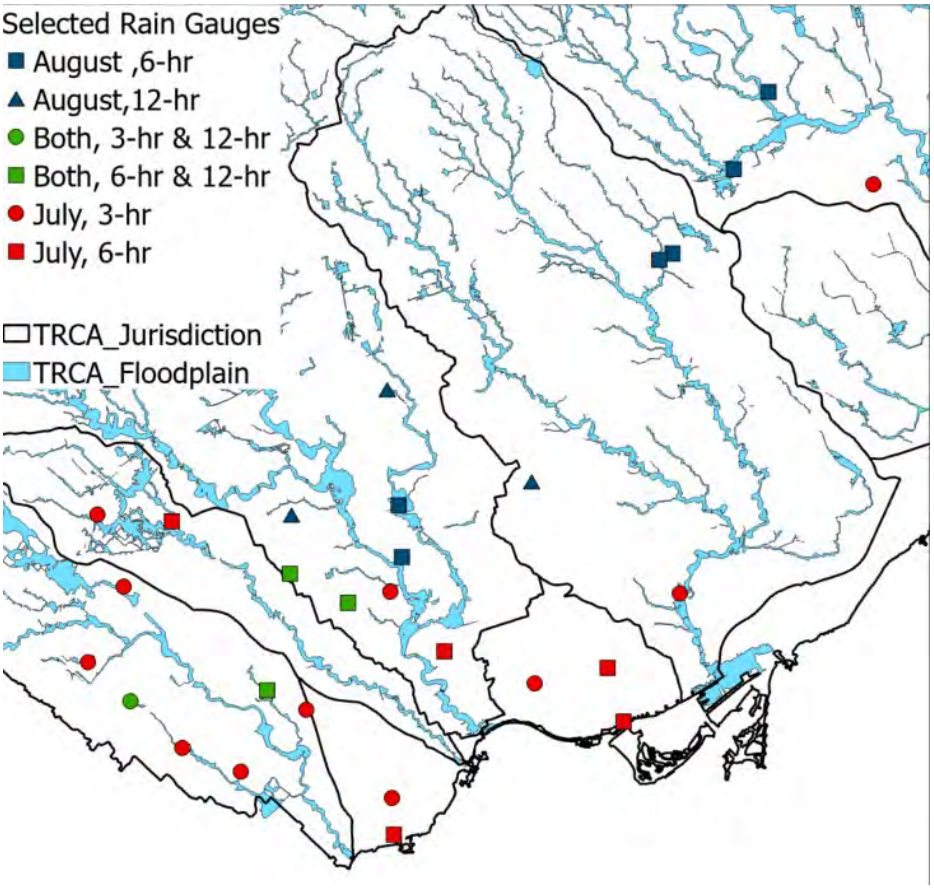


Figure 24 Location of selected rain gauges for design storm analysis

4.6.3 Comparative analysis

The July 16 and August 17, 2024 storm events were clipped to match the same duration as the synthetic storms, by extracting the continuous period with the maximum total rainfall. The event hyetographs were then converted to cumulative distribution functions (CDF), which is the cumulative rainfall over time. The CDFs were normalized (each timestep divided by event total so that the total rainfall is one) to facilitate graphical comparison with the existing synthetic design storms. The CDF plots for each event and synthetic design storm are provided on **Figure 25** to **Figure 28**. A steeper slope indicates a higher peak rainfall intensity. The location of the steepest slope section indicates the location of the peak rainfall.

The peak intensity of an event may also be described by the peak intensity ratio, which is the peak rainfall divided by the total event rainfall (ranging from >0 to 1). The location of the peak rainfall may also be described by the peak location ratio which is the timestep at which the peak rainfall occurred, divided by the total number of timesteps (ranging from >0 to1). Matching the synthetic design storm ratios to those observed during the events helps to demonstrate a fit between the observed and synthetic storms. The peak ratio is often more important when using a synthetic design storm for peak flow generation. The location ratio can be varied in the Chicago storm; however, the other design storms have a fixed peak location.

July 16, 2024

The peak rainfall intensity observed for the rain gauges selected for July 16, 2024 is well defined for both durations analyzed, as shown on **Figure 25** and **Figure 26**. The location of the peak rainfall varied between the 3-hr and 6-hr durations, but both durations had peak rainfall occurring in the first half of the storm. The peak intensities for the 3-hr and 6-hr July 16, 2024 storm are comparable to each other, with majority of the rainfall occurring in the first 2/3 for the 3-hr event and 1/2 for the 6-hr event, before tapering towards the end. The range of peak intensity ratio and peak

location ratio are provided in **Table 23** for the July 16, 2024 storm and synthetic design storms. The design storm with the closest matching parameter to the July 16, 2024 storm median peak ratio and best visual comparison to graphical distribution is highlighted in blue for each duration.

Table 23 July 16, 2024 storm characteristics compared to synthetic design storm characteristics

Duration	Historic Events		Synthetic Design Storm				
	Range (10th - 90th percentile)	Median	AES	Huff 1st	Huff 2nd	Chicago	SCS II
Peak Ratio							
3-hr	0.08 – 0.15	**0.10**	0.09	0.09	n/a	0.23	n/a
6-hr	0.08 – 0.14	**0.10**	0.04	0.05	0.03	0.23	0.19
Location Ratio							
3-hr	0.06 – 0.65	**0.28**	0.42	0.08	n/a	0-1	n/a
6-hr	0.04 – 0.48	**0.09**	0.11	0.07	0.38	0-1	0.50

1. n/a indicates that the synthetic storm is not compared for the given duration.
2. The Chicago peak location may be defined anywhere within the range 0 - 1.

*Blue highlighted squares indicated the design storm with closest matching median peak ratio to July 16, 2024 storm

Both July 16, 2024 durations (3-hr and 6-hr) had roughly the same narrow range of peak ratios, with the 10th to 90th percentile range being relatively low. The median 3-hour peak rainfall ratio is 0.10 which is a close match for the both the AES and Huff 1st quartile storm. However, the 3-hr rain gauge CDF distributions do not compare well with the Huff 1st distribution, which has a much more gradual slope than the historical rainfall pattern. The median location ratio indicated that the peak rainfall typically occurred within the first quarter of the event, with the 90th percentile occurring within the first 2/3 of the event. These characteristics best align with the AES storm, whose location ratio falls within the historic event 10th to 90th percentile range. However, some gauges showed multiple peaks that are shorter, higher intensity, so Chicago may be more conservative.

The 6-hr AES storm peak ratio corresponds more to the 10th percentile of the observed events than the median. For the July 16, 2024 6-hr event, AES shows a better overall match of the rainfall CDF distribution, with most rain falling in the first half of the event, but it underpredicts the peak rainfall. The high peak intensity of the July 16, 2024 6-hour storm (toward the 90th percentile) was better represented by the SCS Type II storm. The Huff events did not have high enough peak rainfall, and the Chicago was marginally too high. Although majority of the rain fell in the first half of the event, the peaks typically occurred before the mid-way point, as indicated by the median location ratio tending more towards the 10th percentile value.

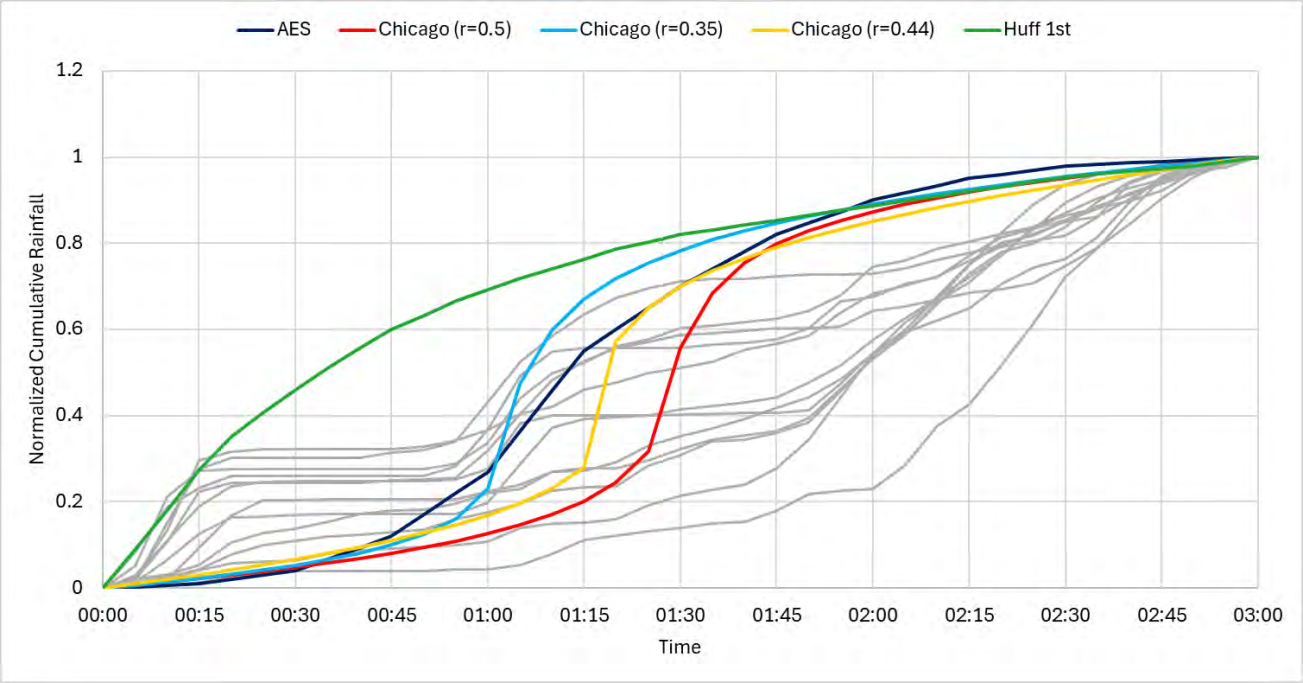


Figure 25 Comparison of 3-hour July 16, 2024 and synthetic rainfall distributions

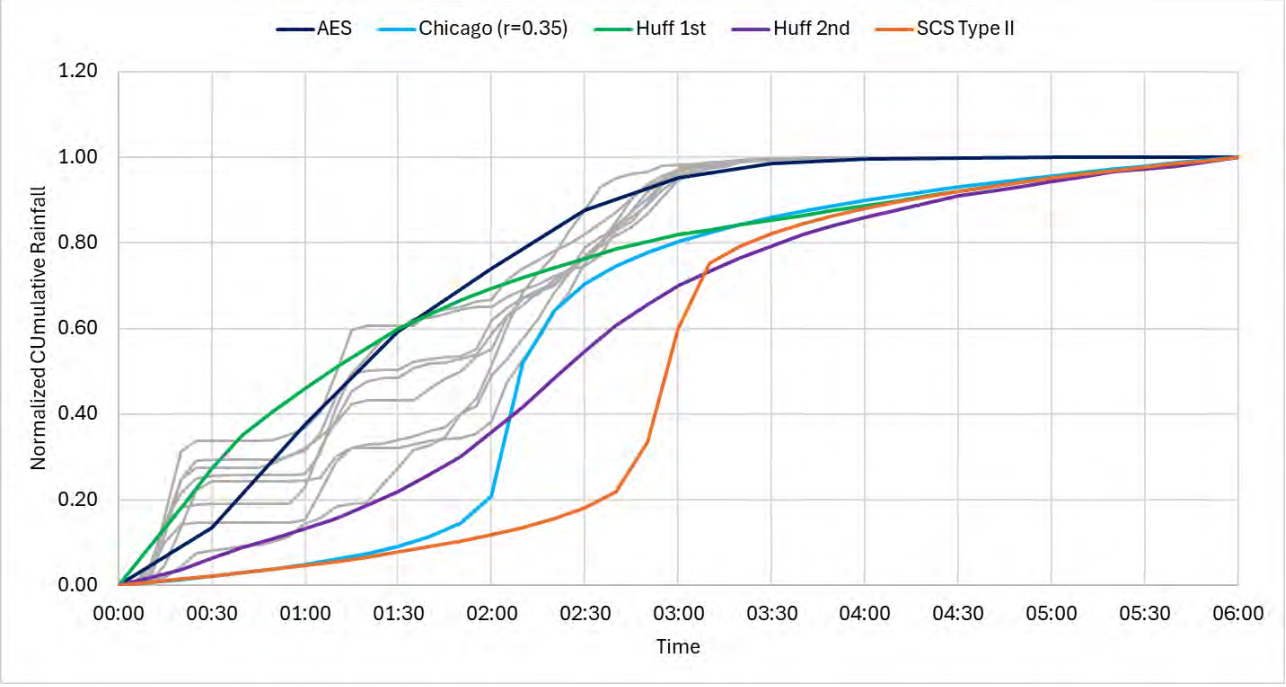


Figure 26 Comparison of 6-hour July 16, 2024 and synthetic rainfall distributions

August 17, 2024

The CDF distributions for the 6-hr and 12-hr August 17, 2024 storm durations differ in shape to each other, as shown on **Figure 27** and **Figure 28**. There are two peaks observed for the 6-hr event in August, one in the first quarter and one in the third quarter, and similar to the July 16, 2024 6-hr storm, the majority of the rain falls within the first half of the event. On the other hand, the 12-hr August 17, 2024 storm has one well-defined peak in the middle of the event, with low intensity for the first 4.5 hours and final 3 hours.

The range of peak intensity ratio and peak location ratio are provided in **Table 24** for the August 17, 2024 storm and synthetic design storms. The design storm with the closest matching parameter to the July 16, 2024 storm median peak ratio and best visual comparison to graphical distribution is highlighted in blue for each duration.

Table 24 August 17, 2024 storm characteristics compared to synthetic design storm characteristics

Duration	Historic Events		Synthetic Design Storm				
	Range (10^{th} - 90^{th} percentile)	Median	AES	Huff 1^{st}	Huff 2^{nd}	Chicago	SCS II
Peak Ratio							
6-hr	0.09 – 0.12	**0.10**	0.04	0.05	0.03	0.23	0.19
12-hr	0.08 – 0.13	**0.10**	0.02	n/a	n/a	n/a	0.13
Location Ratio							
6-hr	0.01 – 0.56	**0.02**	0.11	0.07	0.38	0-1	0.50
12-hr	0.51 – 0.72	**0.52**	0.09	n/a	n/a	n/a	0.49

1. n/a indicates that the synthetic storm is not compared for the given duration.
2. The Chicago peak location may be defined anywhere within the range 0 - 1.

*Blue highlighted squares indicated the design storm with closest matching median peak ratio to July 16 storm

The August 17, 2024 6-hr event also had a peak rainfall with a narrow range. Of the synthetic design storms considered, the closest match for peak rainfall is the SCS Type II storm, though it would better represent the higher intensity rainfall events (90^{th} percentile). Visually, the rainfall CDF distribution is best matched by the AES and Huff 1^{st} storms, but they both underpredict the peak rainfall. The Chicago storm overpredicts the peak rainfall, on the other hand. The peak typically occurred within the first 3/4 of the event, with a median occurrence at the very beginning of the event, based on the location ratio.

The 12-hr event for August 17, 2024 shows a clear match with the SCS Type II storm, with both the median peak rainfall and location ratios.

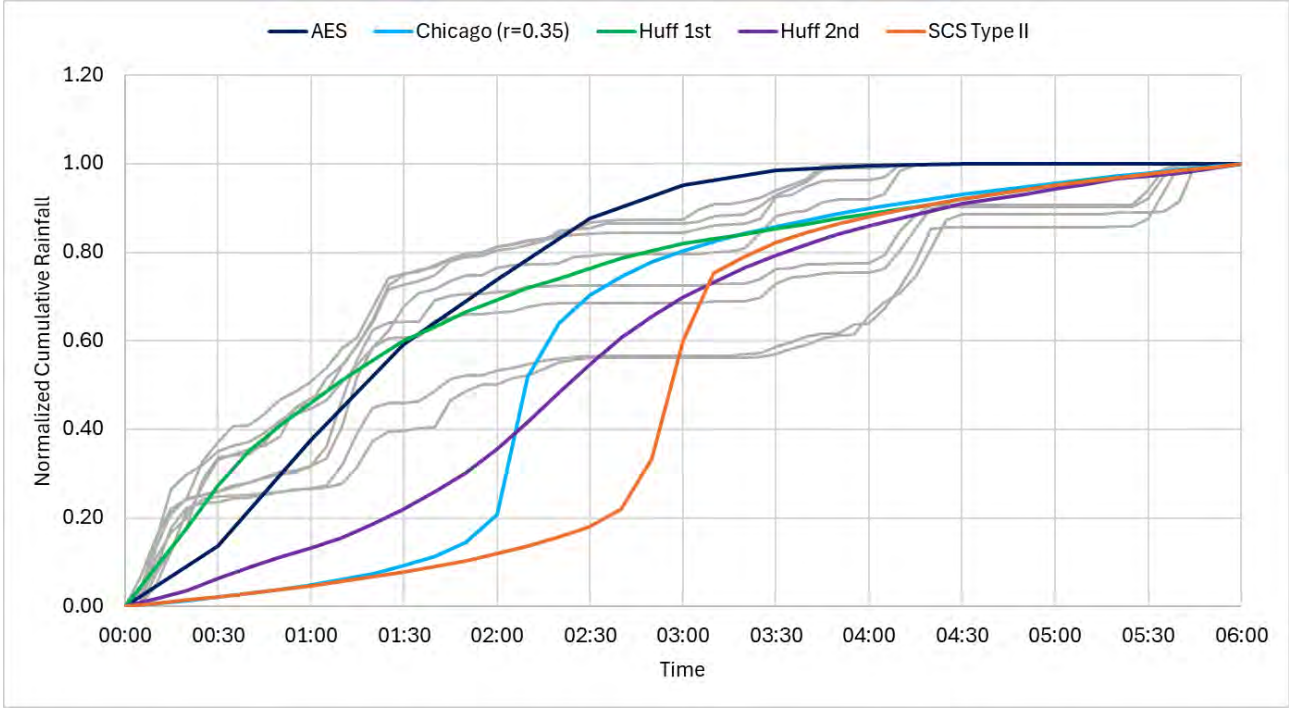


Figure 27 Comparison of 6-hour August 17, 2024 and synthetic rainfall distributions

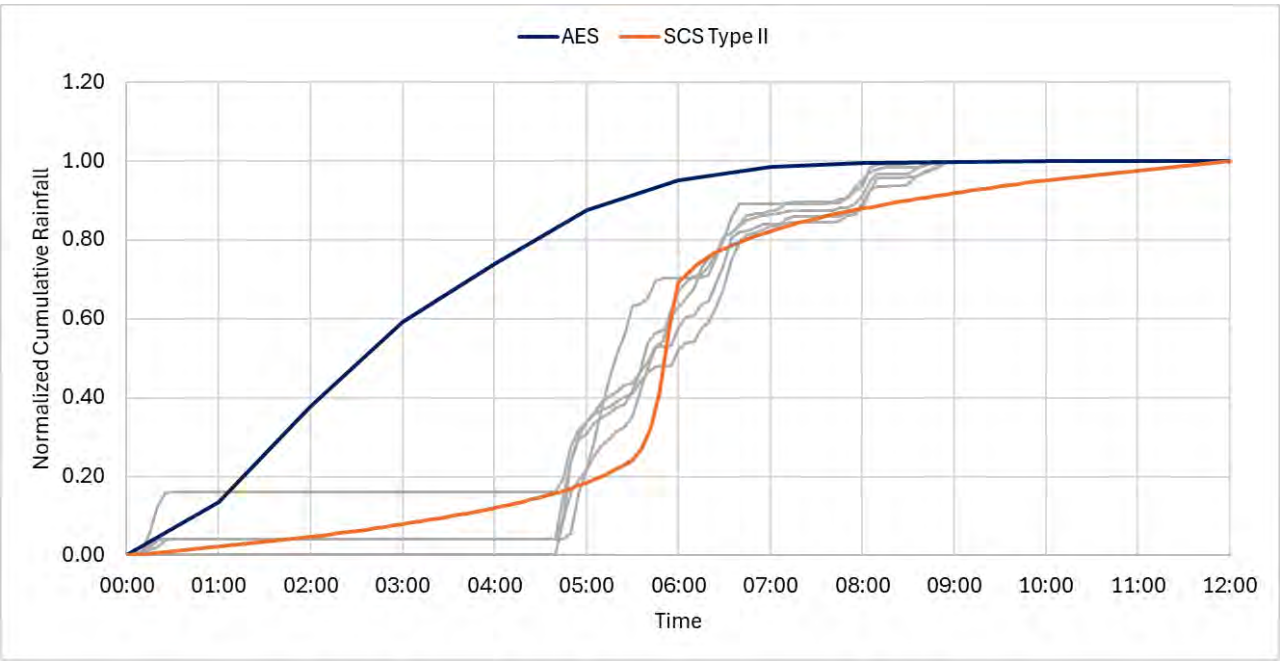


Figure 28 Comparison of 12-hour August 17, 2024 and synthetic rainfall distributions

4.6.4 Summary

The results suggest that despite the July event being slightly lower in rainfall intensity and shorter in duration than the August event, for the mutual 6-hour duration between the two historical events, the conclusion for the best fitting synthetic design storms was the same. Overall, the AES and SCS Type II distributions matched the best for both events. TRCA modelling guidelines recommend using AES and SCS Type II distributions as the flood control criteria for most watersheds, with durations varying between 1-hr, 6-hr, 12-hr, and 24-hr. Therefore, as shown by the results

of this analysis, these synthetic storms would adequately represent the extreme rainfall patterns of the July and August events. The design storm analysis results are summarized in **Table 25.**

Table 25 Design Storm Analysis Results Summary for July 16, and August 17, 2024 Storms

	July 16, 2024	August 17, 2024
Event Duration	Short	Medium
Median Duration	6 hours	9 hours
Durations Analyzed	3-hr (12 RGs) 6-hr (8 RGs)	6-hr (8 RGs) 12-hr (5 RGS)
Location of RGs (TRCA watershed)	Etobicoke, Mimico, Humber, Don, Rouge, Lake Ontario Waterfront	Etobicoke, Humber, Don, Rouge
Best synthetic storm match	3-hr: AES 6-hr: AES, SCS II (90th percentile)	6-hr: AES, SCS II 12-hr: SCS II

For a more conservative match, the Chicago storm may also be used for the 3-hour July 16, 2024 storm. However, the user should consider performing a sensitivity analysis with varying r values, based on the design objectives.

4.7 Comparison to GARR data

The GARR data (Vieux, 2025) were compared to the spatial mapping produced from the rain gauge data. The GARR data are developed from the Buffalo NEXRAD Level II radar (produced by the National Weather Service). The Buffalo radar has sufficient spatial range to obtain precipitation estimates over the TRCA jurisdiction. Level II radar data measures reflectivity in decibels of reflectance (dBZ), and at a spatial resolution of 0.5-degree by 0.25-km every 4 – 10 minutes with a data resolution of 0.5 dBZ amounting to 256 data levels of data. The radar station then converts reflectivity to rainfall using standard equations. However, the resulting data are known to be subject to bias.

The NEXRAD Buffalo data are then bias corrected using rain gauge data. The radar rainfall amount for each grid that contains a rain gauge is corrected to the rain gauge measurement. The correction factors for all of the rain gauges are then spatially mapped to develop a correction layer. The correction layer is then applied to all grids that do not contain a rain gauge. The GARR data are then produced at a 5-minute timestep on a 1-km grid over the entire TRCA jurisdiction.

Since the radar data are already spatial data, they represent an improved spatial mapping. For instance, if two rain gauges are 10 km apart, the rainfall between the two rain gauges is interpolated. If one rain gauge measured 0 mm of rainfall and the other measured 2 mm of rainfall in a particular timestep, the interpolation would assume that at the midpoint (at 5 km) between the rain gauges that approximately 1 mm of rainfall occurred. However, the radar measures the actual reflectivity, which could identify that a different amount (e.g. 0.5 m or even 3 mm) occurred at the midpoint of the two rain gauges.

The comparison was performed for the rainfall intensities from 5-min to 24-hr. The GARR data were plotted next to the spatially interpolated rain gauge data for each duration. The maps are included in **Appendix D**.

The maps for the July 16, 2024 storm event indicated that the high rainfall areas are thinner in the GARR data. This effect is most obvious for the shorter durations. For instance, at the 10-min timestep, the rain gauge interpolation shows that there is a band of orange through the south part of the Humber watershed. However, the GARR data shows a much thinner band. The locations and peak rainfall totals are similar – it is only the spatial extent that varies. At the longer durations (2-hr and longer), the two maps are very similar. The GARR data appear more “boxy”, which is because the data are based on a 1-km grid.

The maps for the August 17, 2024 storm event also indicated that the high rainfall areas were thinner in the GARR data. The effect is even more pronounced for this storm. Even at the 12-hr duration, the area of extreme rainfall is

narrower and straighter in the GARR data than the spatially interpolated rain gauge data suggested. These results highlight the highly localized nature of convective storm events, which are often intense but small in area. The locations and peak rainfall amounts are similar, as for the July 16, 2024 storm. The GARR data also highlight the impact on the Mimico watershed which does not have good rain gauge coverage, but the GARR data show extreme rainfall in the watershed.

The effect of these differences could have a significant impact on hydrological or hydraulic modelling. For instance, for these two storms, the GARR data resulted in lower rainfall overall (due to narrower bands of rainfall). If these data were used in a hydrologic model, lower flows would result (a hydrologic model that can accept gridded data would be required).

4.8 Discussion on rain gauge network

The rain gauge network in the TRCA jurisdiction is adequate through Mississauga, Brampton, and Toronto (when all agencies are included). However, the eastern watersheds (Petticoat, Frenchman's Bay, Duffins, and Carruthers) are relatively sparse in terms of rain gauge coverage, and so are the headwaters of the Etobicoke and Humber watersheds. It may be worthwhile for TRCA and their municipal partners to consider some additional rain gauges in these areas, even though they were not heavily impacted during these two events. There is a lack of rain gauges in the central Mimico watershed, which is because the Pearson airport takes up a large amount of the space in the watershed. There are several gauges nearby in the Etobicoke and Humber watersheds, which can be used as surrogates.

The GARR dataset is available in real-time for Peel. Recently, the GARR dataset has been provided for the entire TRCA jurisdiction for the two 2024 storms (Vieux, 2025). This represents an improvement over spatial interpolation from rain gauges. Expanding the GARR dataset to be available in real-time for the entire TRCA jurisdiction is recommended. In support of the expansion of the GARR dataset, continued expansion of the rain gauge network is also recommended.

The rain gauge network could also be improved by coordinating with the various agencies to ensure that data quality checks, maintenance checks, data storage, and other key operational issues are standardized across all agencies. In addition, data sharing agreements and/or an online portal should be developed, to allow for faster access to the data during events.

5. Streamflow and water levels

This section focuses on interpreting the data associated with runoff and related flooding responses of impacted TRCA watersheds during these extreme storm events. To support this analysis, streamflow and water level data were sourced from 75 monitoring stations operated by TRCA and Water Survey of Canada.

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 16, 2024 and August 17, 2024 and the 100-year storm flooding depths.

5.1 Water levels

Streamflow data from all monitored gauges were reviewed to compare the peak observed water surface elevations during the July 16, 2024 and August 17, 2024 storm events against the estimated depths associated with the 100-year flood events. The 100-year depths were obtained from TRCA's current hydraulic models for each watershed. Several TRCA gauges with observed WSE data were provided in CGVD28:pre78 vertical datum and the models had a vertical datum of CGVD28:78. Prior to modelling a conversion factor was calculated and applied to the observed data to account for this difference. Vertical datum elevation data were obtained from the COSINE Online Service tool. The

closest COSINE data points were matched with the respective TRCA gauges. The calculated factor, which is the difference between the CGVD28:pre78 and CGVD28:78 elevations, was applied to the observed WSE at each TRCA gauge as needed. The time to peak was analyzed and extracted for each storm event at all stations. For the July 16, 2024 storm, the starting time for calculation of time to peak for some gauges was assumed to be the flow on the morning of July 16, 2024 (which was not always base flow, due to antecedent rainfall from the previous days). Smaller watersheds had shorter times to peak than larger watersheds. Minor discrepancies in the calculated peak timing may be attributed to short-term fluctuations in rainfall intensity and the presence of multiple peaks observed throughout the storm duration. The results of this assessment have been presented in **Table 26.**

Table 26 Comparison of Maximum Observed Water Surface Elevations at Streamflow Gauges on July 16, 2024 and August 17, 2024

Watershed	Station	Station Name	100-Year Storm[1] (m)	July 16, 2024 Storm (m)	Difference (m)	Time of Peak	Time to Peak (h:mm)	August 17, 2024 Storm (m)	Difference (m)	Time of Peak	Time to Peak (h:mm)
Carruthers	HY089	West Carruthers at Squire	111.62	110.90	-0.72	16th 12:25	7:30	110.6	-1.02	18th 12:25	22:35
	HY090	Carruthers Creek at Taunton	107.79	107.00	-0.79	16th 15:35	4:55	106.2	-1.59	18th 10:50	21:40
	HY128	Carruthers at Bayly	80.67	80.60	-0.07	16th 13:10	3:10	79.8	-0.87	18th 09:20	19:40
Don	HY018	Knightswood	120.84	120.10	-0.74	16th 11:10	2:50	119.7	-1.14	17th 13:55	1:25
	HY019	Don at Todmorden	81.31	81.30	-0.01	16th 13:40	5:20	79.8	-1.51	17th 19:05	5:45
	HY022	East Don at York Mills	121.41	120.20	-1.21	16th 11:30	3:35	119.9	-1.51	17th 17:10	4:50
	HY062	Taylor Creek South	91.69	91.60	-0.09	16th 11:45	3:15	90.4	-1.29	17th 15:10	2:15
	HY068	Wilket Creek	118.98	120.00	1.02	16th 11:25	3:00	119.6	0.62	17th 14:40	2:10
	HY079	Don at Dundas	78.28	77.90	-0.38	16th 14:55	6:50	76.5	-1.78	17th 19:55	7:10
	HY080	Taylor Creek North	152.86	153.60	0.74	16th 11:25	2:50	152.8	-0.06	17th 13:35	0:55
	HY092	German Mills at Cummer	140.72	140.60	-0.12	16th 11:45	3:45	140.3	-0.42	17th 17:20	4:55
	HY100	West Don at Steeles	180.66	180.90	0.24	16th 11:35	3:00	180.7	0.04	17th 16:55	4:55
	HY112	East Don at Steeles	147.61	145.50	-2.11	16th 12:25	7:05	145.9	-1.71	17th 18:00	6:00
	HY123	German Mills at Industrial Rd	235.44	235.30	-0.14	16th 11:55	6:10	234.7	-0.74	17th 17:25	8:40
Duffins	HY010	Brougham Creek	122.28	120.70	-1.58	16th 13:15	2:40	120.6	-1.68	17th 15:35	2:30
	HY023	East Duffins at Claremont	155.27	153.00	-2.27	16th 14:45	3:45	152.9	-2.37	17th 22:25	9:15
	HY028	Ganetsekiagon Creek	109.31	109.00	-0.31	16th 13:50	2:55	108.4	-0.91	17th 17:10	4:10
	HY047	Mitchell Creek at Claremont	160.52	158.90	-1.62	16th 14:15	3:20	158.8	-1.72	18th 11:15	22:15
	HY065	Urfe Creek	90.09	89.60	-0.49	16th 18:05	10:10	89.3	-0.79	17th 21:50	14:40
	HY066	West Duffins at HWY 7	179.65	178.20	-1.45	16th 14:50	3:55	178.5	-1.15	18th 00:35	11:35

Watershed	Station	Station Name	100-Year Storm[1] (m)	July 16, 2024 Storm (m)	Difference (m)	Time of Peak	Time to Peak (h:mm)	August 17, 2024 Storm (m)	Difference (m)	Time of Peak	Time to Peak (h:mm)
	HY082	Reesor Creek	224.52	223.70	-0.82	16th 15:15	4:25	224.2	-0.32	17th 22:10	5:10
	HY129	Duffins Creek at Brock Road	83.70	82.90	-0.8	16th 14:00	4:1-0	82.8	-0.9	18th 03:15	14:05
Etobicoke	HY024	Etobicoke at Dixie and Derry	172.57	172.40	-0.17	16th 11:55	3:50	171.4	-1.17	17th 16:00	4:35
	HY026	Etobicoke at Brampton	212.50	211.70	-0.8	16th 11:15	3:10	211.2	-1.3	18th 14:30	1:25
	HY059	Spring Creek South	175.06	174.80	-0.26	16th 11:25	2:30	173.8	-1.26	18th 15:40	31:25
	HY081	Spring Creek North	211.10	210.70	-0.4	16th 10:50	1:50	210.2	-0.9	18th 14:25	30:20
	HY098	Little Etobicoke @ Dixie	125.85	125.60	-0.25	16th 11:55	3:50	125.5	-0.35	17th 14:20	2:15
	HY101	Etobicoke @ HWY 410	246.35	246.10	-0.25	16th 18:45	9:05	245.6	-0.75	18th 22:05	34:20
	HY118	West Spring Creek at Dixie	194.06	193.90	-0.16	16th 10:40	2:35	193.5	-0.56	17th 16:15	9:05
Frenchman's	HY040	Krosno Creek	77.97	77.50	-0.47	16th 11:50	2:50	76.6	-1.37	17th 18:15	5:10
	HY052	Pine Creek	79.29	78.40	-0.89	16th 12:05	3:10	77.5	-1.79	17th 18:35	5:30
Highland	HY119	Highland at Milner	153.50	Missing [2]	Missing [2]	-		150.8	-2.7	17th 13:35	
Humber	HY005	Black Creek at 401	125.89	123.20	-2.69	16th 10:20	2:05	123.4	-2.49	17th 13:35	1:58
	HY006	Bolton McFall Dam	214.20	213.00	-1.2	17th 04:30	18:40	213.2	-1	18th 21:35	4:00
	HY035	Humber at Goreway	183.41	183.10	-0.31	16th 11:50	2:15	182.6	-0.81	18th 14:25	1:30
	HY053	Plunkett Creek	155.35	154.10	-1.25	16th 10:35	2:10	153.8	-1.55	17th 15:55	8:10
	HY054	Purpleville Creek	176.84	177.40	0.56	16th 15:15	5:25	177.3	0.46	17th 18:50	10:55
	HY067	West Humber at HWY 7	170.47	168.60	-1.87	16th 13:05	3:55	167.9	-2.57	18th 16:25	31:40
	HY097	Black Creek at Alliance	104.28	102.90	-1.38	16th 11:30	3:15	102.4	-1.88	17th 14:10	2:55
	HY104	Humber River at Old Mill	78.99	79.80	0.81	16th 12:15	4:00	79.7	0.71	17th 14:30	4:10
	HY131	Albion Creek at Highfield Park	157.12	156.80	-0.32	16th 10:55	2:30	155.2	-1.92	17th 16:00	8:10
Mimico	HY045	Mimico at Wildwood Park	161.25	161.60	0.35	16th 11:30	3:15	161	-0.25	17th 16:00	8:40

Watershed	Station	Station Name	100-Year Storm[1] (m)	July 16, 2024 Storm (m)	Difference (m)	Time of Peak	Time to Peak (h:mm)	August 17, 2024 Storm (m)	Difference (m)	Time of Peak	Time to Peak (h:mm)
Petticoat	HY051	Petticoat Creek at Whites	79.24	80.20	0.96	16th 11:50	3:00	79.8	0.56	17th 18:10	5:05
Rouge	HY048	Morningside at Finch	148.84	146.70	-2.14	16th 15:10	6:30	146.3	-2.54	17th 23:20	10:30
	HY091	Rouge at Glen Rouge	76.26	77.60	1.34	16th 17:05	8:05	77.5	1.24	18th 05:55	16:05
	HY095	Little Rouge at Twyn Rivers	78.72	86.10	7.38	16th 14:35	5:35	86	7.28	18th 06:35	17:05
	HY103	Bruce Creek at Unionville	171.57	170.20	-1.37	16th 17:15	7:05	170.7	-0.87	17th 21:25	8:45
Etobicoke	02HC030	Etobicoke Creek below QEW	92.1	91.2	-0.9	16th 17:20	9:05	90.9	-1.2	17th 14:20	4:00

Values highlighted in red indicate that water level exceeded the 100-year storm elevations.

1 These values were obtained from the hydraulic models for these rivers.

2 Not available

No water level data were recorded at TRCA gauge HY119 (Highland Creek at Milner Avenue) during the July 16, 2024 storm event. The station was inoperable from June 19 to July 30 due to damage from a previous and unrelated storm. It has been excluded from the analysis for this event.

The results presented in **Table 26** indicate that observed water elevations at some of the water level gauges exceeded the flood levels associated with the 100-year storm event. The gauges that exceed the 100-year water level correspond to the areas with the highest rainfall accumulations. These gauges include:

- Don River
  - HY068 – Wilket Creek (both events)
  - HY080 – Taylor Creek North (July only)
  - HY100 – West Don at Steeles (both events)
- Humber River
  - HY054 – Purpleville Creek (both events)
  - HY104 – Humber River at Old Mill (both events)
- Mimico Creek
  - HY045 – Mimico at Wilwood Park (July only)
- Petticoat Creek
  - HY051 – Petticoat Creek at Whites (both events)
- Rouge River
  - HY091 – Rouge at Glen Rouge (both events)
  - HY095 – Little Rouge at Twyn Rivers (both events)

5.2 Spatial mapping of high water marks

High water marks observed during the July 16 and August 17, 2024 extreme storm events were recorded at numerous locations across the jurisdiction. There were 82 high water marks in the Don, Etobicoke, Frenchman's Bay, Highland, lower Humber, Mimico, and Rouge watersheds that were measured for the July 16, 2024 event. There were 33 high water marks in the Don, Etobicoke, lower Humber, Mimico, and Rouge watersheds that were measured for the August 17, 2024 event. Note that high water marks were collected across the TRCA jurisdiction for completeness. However, the focus of the storm event analysis is on the areas most impacted by the storm, and therefore comparison to the 100-year flood levels (which are available from TRCA's hydraulic models for each watershed) is not provided for all locations.

The high water marks for the watersheds were compared to the 100-year storm water levels (which were taken from the hydraulic models for Etobicoke Creek and Don River or from nearby TRCA gauges). The locations that were outside of the HEC-RAS / MIKE model extents or not located near a TRCA gauge were left in the table but the 100-year water level data were left blank. There were 16 high water marks that exceeded the 100-year water levels for the July event, and 9 high water marks that exceeded the 100-year water levels for the August event. For the July event, the high water marks that exceeded the 100-year water level were located in the Don River (West Branch and lower Don), Etobicoke Creek (West Branch and Little Etobicoke Creek), Humber River (Plunkett Creek), and Mimico Creek watersheds. For the August event, the high water marks that exceeded the 100-year water level were located in the Etobicoke Creek (Little Etobicoke Creek) watershed only.

The high water marks were generally located within the regulatory floodplain polygon (i.e. inside of the valley corridor). Of the 82 high water mark measurements for the July 16, 2024 event, 76 of them were located within the regulatory floodplain. The remaining 6 high water mark measurements were located in the Etobicoke Creek (Little Etobicoke Creek) and Humber River (Black Creek) watersheds. Of the 33 high water mark measurements for the August 17, 2024 event, 28 of them were located within the regulatory floodplain. The remaining 5 high water mark measurements were located in the Etobicoke Creek (Little Etobicoke Creek) watershed. The high water marks in all watersheds are shown graphically on **Figure 29** and **Figure 30**.

Table 27 Comparison of High Water Marks to 100-year Storm for July 16, 2024 Event

Watershed	Location Ref No.	Latitude	Longitude	100-Year Storm	July 16, 2024 Storm	Difference (m)
Don	9A	43.82117	-79.3493	-	175.94	-
Don	10A	43.78805	-79.4677	180.66	181.22	0.56
Don	11A	43.75747	-79.4316	-	143.71	-
Don	12A	43.74097	-79.4044	120.84	125.51	4.67
Don	12B	43.73990	-79.4031	120.84	124.82	3.98
Don	12C	43.73965	-79.3910	120.84	120.43	-0.41
Don	13A	43.68881	-79.3613	-	82.88	-
Don	13B	43.68555	-79.3614	81.17	81.85	0.68
Don	13C	43.68343	-79.3669	80.79	80.53	-0.26
Don	13D	43.67748	-79.3634	80.48	80.56	0.08
Don	14A	43.66306	-79.3564	78.42	78	-0.42
Don	14B	43.66060	-79.3557	78.22	77.6	-0.62
Don	14C	43.65950	-79.3553	78.18	77.55	-0.63
Don	15A	43.65400	-79.3497	77.27	75.94	-1.33
Don	29A	43.81131	-79.4859	-	190.95	-

Watershed	Location Ref No.	Latitude	Longitude	100-Year Storm	July 16, 2024 Storm	Difference (m)
Don	30A	43.79843	-79.4782	-	185.39	-
Don	30B	43.79735	-79.4754	-	184.46	-
Etobicoke	1A	43.72217	-79.7217	213.94	210.58	-3.36
Etobicoke	1B	43.72687	-79.7272	215.33	215.31	-0.02
Etobicoke	2A	43.61293	-79.5985	128.22	127.73	-0.49
Etobicoke	2B	43.61089	-79.5917	125.85	125.45	-0.4
Etobicoke	2C	43.61144	-79.5878	123.67	123.17	-0.5
Etobicoke	2D	43.60990	-79.5917	125.23	125	-0.23
Etobicoke	2E	43.60684	-79.5870	120.56	120.14	-0.42
Etobicoke	2F	43.60912	-79.5845	-	119.32	-
Etobicoke	2G1	43.62910	-79.6284	139.49	140.07	0.58
Etobicoke	2G2	43.62864	-79.6280	139.28	139.58	0.3
Etobicoke	2G3	43.62918	-79.6277	139.28	140.7	1.42
Etobicoke	4A	43.58667	-79.5434	77.1	76.25	-0.85
Etobicoke	21A	43.69836	-79.7736	216.23	217.49	1.26
Etobicoke	22A	43.69123	-79.7595	215.33	211.7	-3.63
Etobicoke	23A	43.67811	-79.7492	206.06	205.36	-0.7
Etobicoke	23B	43.68286	-79.7494	207.11	206.33	-0.78
Etobicoke	24A	43.67121	-79.7398	201.24	203.18	1.94
Etobicoke	24B	43.66839	-79.7333	200.91	200.25	-0.66
Etobicoke	24C	43.66803	-79.7305	199.64	199.56	-0.08
Etobicoke	26A	43.63987	-79.6733	-	183.99	-
Etobicoke	26B	43.64110	-79.6719	-	183.02	-
Etobicoke	27A	43.62467	-79.6220	135.33	135.62	0.29
Etobicoke	27B	43.62367	-79.6200	134.26	134.79	0.53
Etobicoke	27C	43.62325	-79.6175	133.79	134.17	0.38
Etobicoke	28A	43.63476	-79.5862	126.13	125.97	-0.16
Etobicoke	28B	43.63604	-79.5887	128.01	127.24	-0.77
Etobicoke	28C	43.63730	-79.5855	127.21	127.67	0.46
Etobicoke	35A	43.70670	-79.7106	-	196.42	-
Frenchman's Bay	20A	43.82377	-79.0744	77.97	77.61	-0.36
Frenchman's Bay	20B	43.82358	-79.0743	77.97	77.61	-0.36
Highland	16A	43.75453	-79.2280	-	137.17	-
Highland	16B	43.75412	-79.2302	-	138.61	-
Highland	16C	43.75335	-79.2307	-	138.84	-
Humber	5A	43.72117	-79.5077	125.89	123.57	-2.32

Watershed	Location Ref No.	Latitude	Longitude	100-Year Storm	July 16, 2024 Storm	Difference (m)
Humber	5B	43.71885	-79.5068	125.89	123.35	-2.54
Humber	6A	43.68063	-79.4820	104.28	103.04	-1.24
Humber	6B	43.67805	-79.4832	104.28	102.59	-1.69
Humber	6C	43.67646	-79.4842	104.28	102.76	-1.52
Humber	6D	43.67581	-79.4823	-	102.94	-
Humber	6E	43.67409	-79.4810	-	104.42	-
Humber	6F	43.67550	-79.4886	-	102.34	-
Humber	6G	43.67573	-79.4949	-	102.03	-
Humber	7A	43.65138	-79.4907	78.99	77.63	-1.36
Humber	7B	43.64210	-79.4905	-	76.88	-
Humber	8A	43.78137	-79.5918	-	139.03	-
Humber	31A	43.82523	-79.5557	-	211.81	-
Humber	31A (additional)	43.82382	-79.5555	-	211	-
Humber	32A	43.78073	-79.6063	-	159.3	-
Humber	32B	43.78103	-79.6023	-	157.92	-
Humber	32C	43.77921	-79.6031	155.35	155.44	0.09
Humber	33A	43.80139	-79.5636	-	190.2	-
Humber	33A (additional)	43.80132	-79.5638	-	190.29	-
Humber	33B	43.79962	-79.5685	-	184.93	-
Humber	34A	43.79070	-79.5723	-	172.28	-
Humber	34B	43.78993	-79.5741	-	170.08	-
Humber	34C	43.78889	-79.5749	-	166.95	-
Humber	34C (additional)	43.78861	-79.5749	-	167.88	-
Humber	36A	43.76969	-79.6874	-	186.53	-
Mimico	25A	43.71124	-79.6302	161.25	161.7	0.45
Mimico	25B	43.70588	-79.6445	-	165.75	-
Rouge	17A	43.86684	-79.3076	171.57	170.08	-1.49
Rouge	17B	43.86876	-79.3105	171.75	170.32	-1.43
Rouge	18A	43.81082	-79.1597	-	85.64	-
Rouge	19A	43.81363	-79.1567	-	85.82	-
Rouge	19B	43.81374	-79.1535	-	83.97	-

Table 28 Comparison of High Water Marks to 100-year Storm for August 17, 2024 Event

Watershed	Location Reference No.	Latitude	Longitude	100-Year Storm (m)	August 17, 2024 Storm (m)	Difference (m)
Don	11	43.71615	-79.3210	-	95.44	-
Don	12a	43.68316	-79.3662	80.79	80.31	-0.48

Watershed	Location Reference No.	Latitude	Longitude	100-Year Storm (m)	August 17, 2024 Storm (m)	Difference (m)
Don	12b	43.68276	-79.3659	80.78	79.01	-1.77
Etobicoke	1a	43.62897	-79.6301	140.63	140.64	0.01
Etobicoke	1b	43.62871	-79.6288	139.70	141.19	1.49
Etobicoke	1c	43.62862	-79.6283	139.28	140.21	0.93
Etobicoke	1d	43.62864	-79.6280	139.26	139.97	0.71
Etobicoke	1e	43.62912	-79.6284	139.70	140.83	1.13
Etobicoke	2	43.62376	-79.6202	134.26	134.86	0.6
Etobicoke	3	43.62100	-79.6122	132.67	133.21	0.54
Etobicoke	4	43.61696	-79.6070	130.28	130.58	0.3
Etobicoke	5a	43.61311	-79.5992	128.59	128.02	-0.57
Etobicoke	5b	43.61292	-79.5986	128.52	127.22	-1.3
Etobicoke	6a	43.60990	-79.5917	125.23	125.1	-0.13
Etobicoke	6b	43.60969	-79.5916	124.97 (2D) / 125.17 (1D) [1]	125.29	0.32 (2D) / 0.12 (1D)
Etobicoke	6c	43.60874	-79.5885	123.02	122.85	-0.17
Etobicoke	7	43.60694	-79.5869	120.57	120.24	-0.33
Etobicoke	8	43.60913	-79.5844	-	119.28	-
Etobicoke	9	43.60693	-79.5805	113.24	111.9	-1.34
Etobicoke	10	43.60976	-79.5676	101.74	100.62	-1.12
Etobicoke	24	43.64561	-79.6078	138.74	138.32	-0.42
Humber	14	43.71338	-79.5380	-	122.43	-
Humber	15	43.72122	-79.5079	125.89	123.69	-2.2
Humber	16	43.65131	-79.4908	78.99	77.1	-1.89
Humber	17	43.69258	-79.5294	-	135.97	-
Mimico	18	43.67235	-79.5693	-	139.43	-
Mimico	19 Bridge	43.65811	-79.5555	-	132.41	-
Mimico	19 Sign	43.65827	-79.5551	-	132.35	-
Mimico	20	43.65039	-79.5250	-	116.4	-
Mimico	21	43.64642	-79.5175	-	112.73	-
Mimico	22	43.62919	-79.4933	-	84.97	-
Mimico	23	43.62805	-79.4919	-	80.57	-
Rouge	13	43.86769	-79.3106	171.57	170.93	-0.64

Note:
1 Station 6b is located within the extent of both the 1D HEC-RAS model and the 2D MIKE (Dixie-Dundas) model.

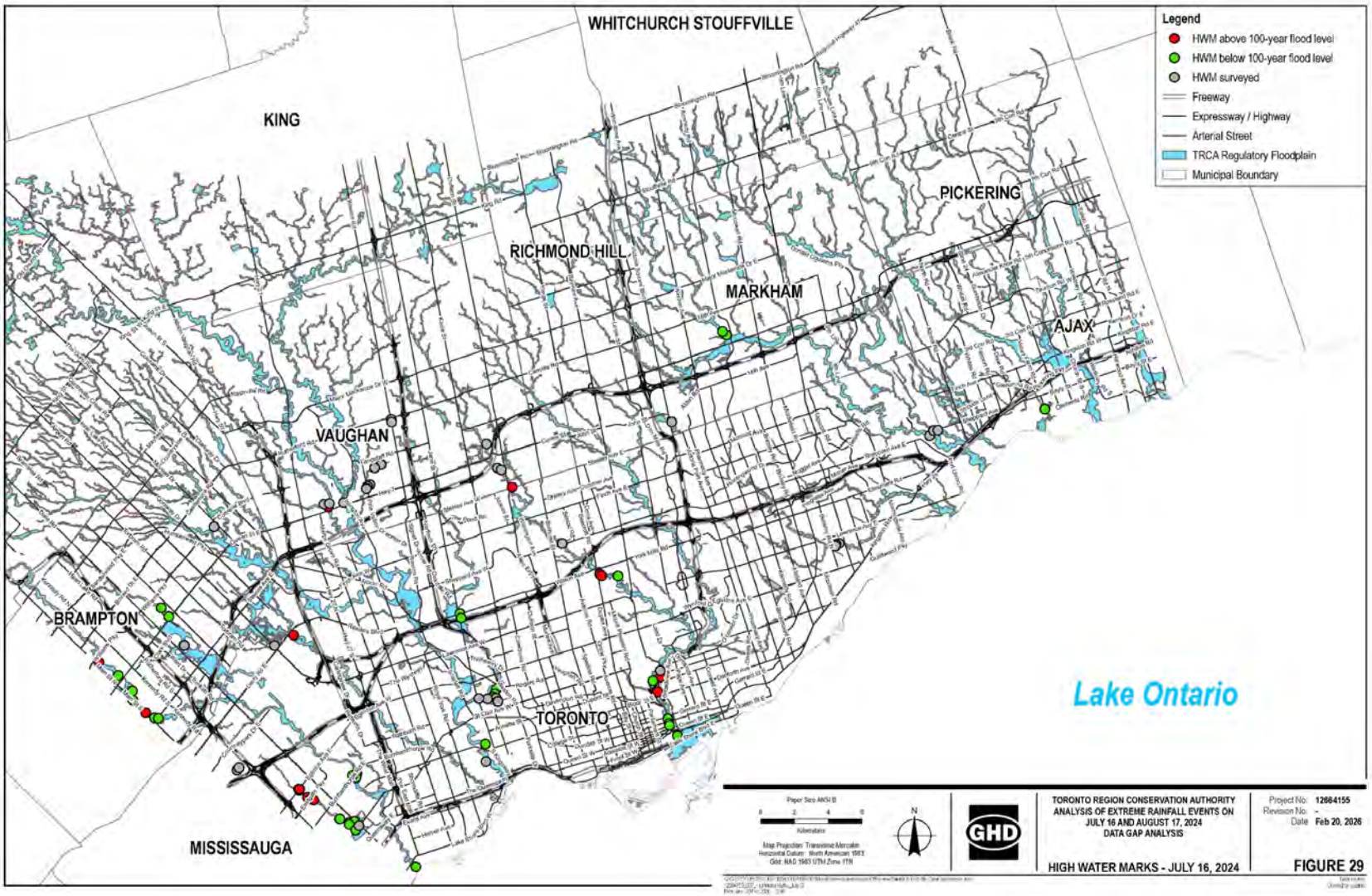


Figure 29 High Water Marks – July 16, 2024 storm

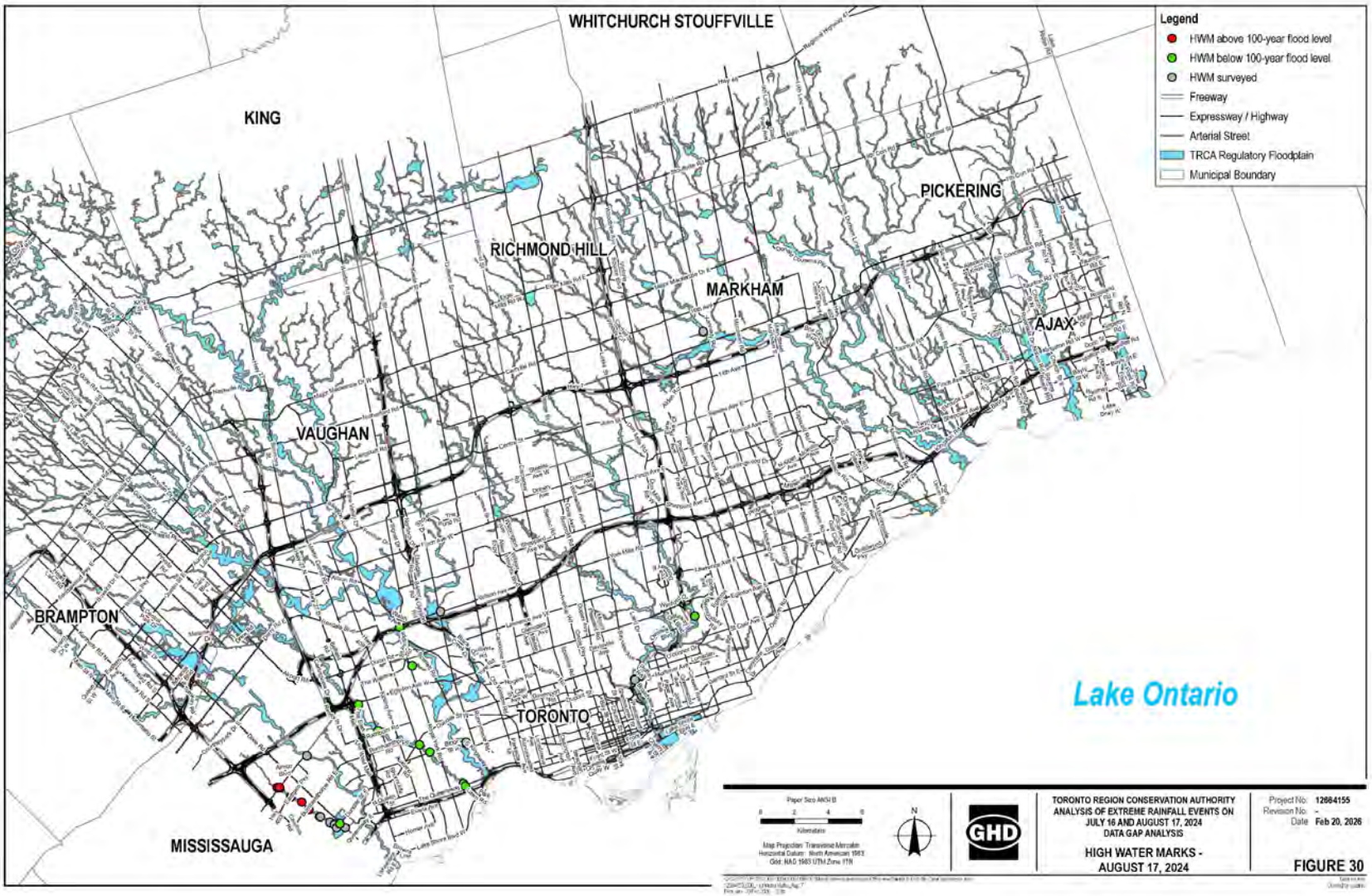


Figure 30 High Water Marks – August 17, 2024 storm

5.3 Spatial mapping of peak runoff rates

The TRCA and Water Survey of Canada both provide streamflow data at multiple sites in the TRCA jurisdiction. However, streamflow by itself is not a suitable indicator for flooding, since streamflow will naturally increase as drainage area increases. Therefore, a common technique to normalize streamflow is to divide it by the drainage area (flow per unit area), which is termed the runoff. Peak runoff normalizes peak flow data, which allows for a more direct comparison of hydrologic response across watersheds of varying scale.

$$Peak\ Runoff = \frac{Peak\ Q}{A}$$

While the peak runoff rate cannot be directly compared to flooding (e.g. by assigning a return period or indicating the flood extents), it is still a useful statistic since a higher peak runoff indicates a greater potential for flooding. **Figure** 31 and **Figure** 32 illustrate peak runoff rates from the July 16 and August 17 storm events. The highest runoff values during both events occurred in portions of the Etobicoke Creek, Don River, Humber River, and Rouge River, which are the areas with the highest rainfall accumulations.

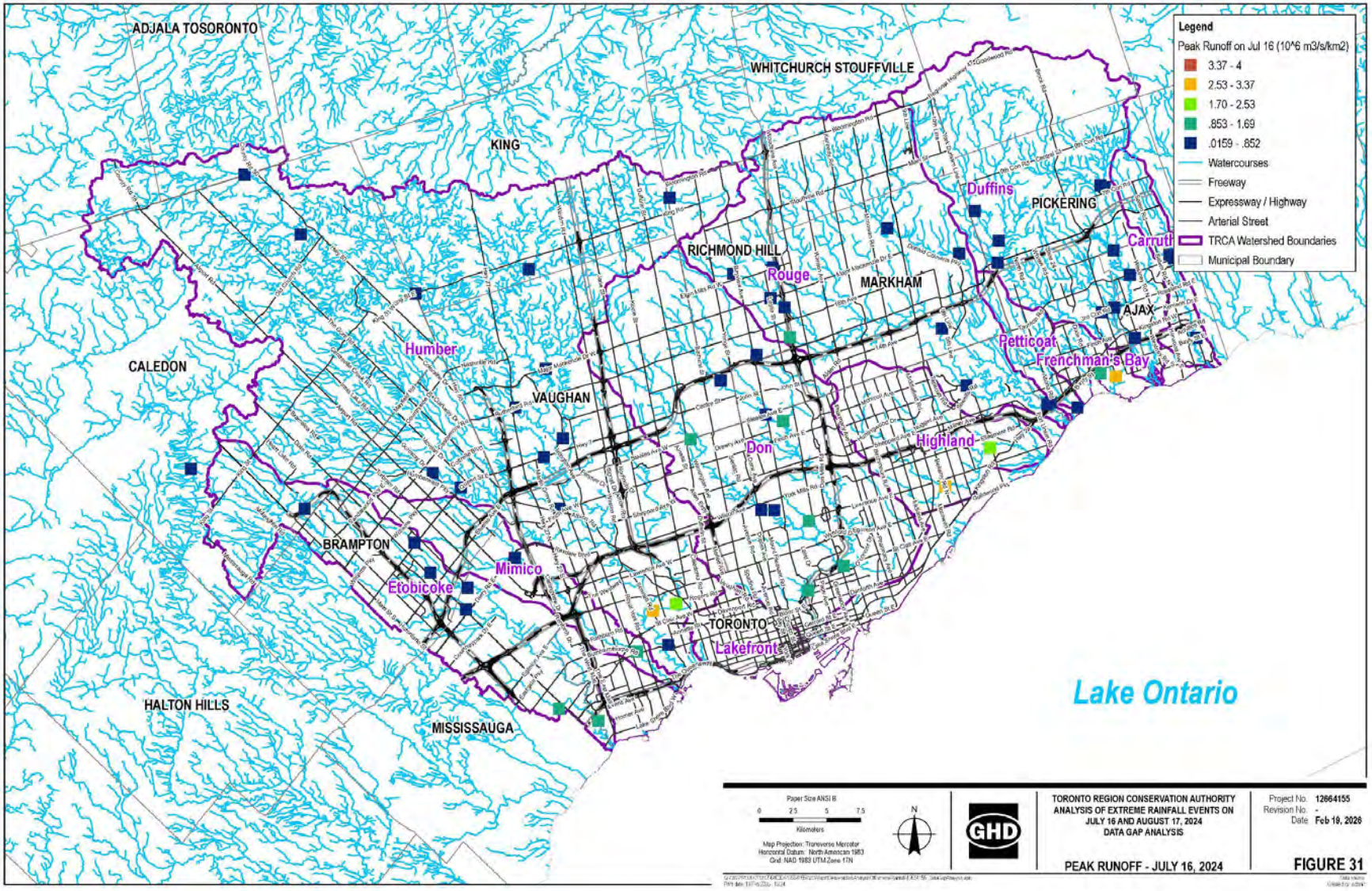


Figure 31 Peak Runoff – July 16, 2024

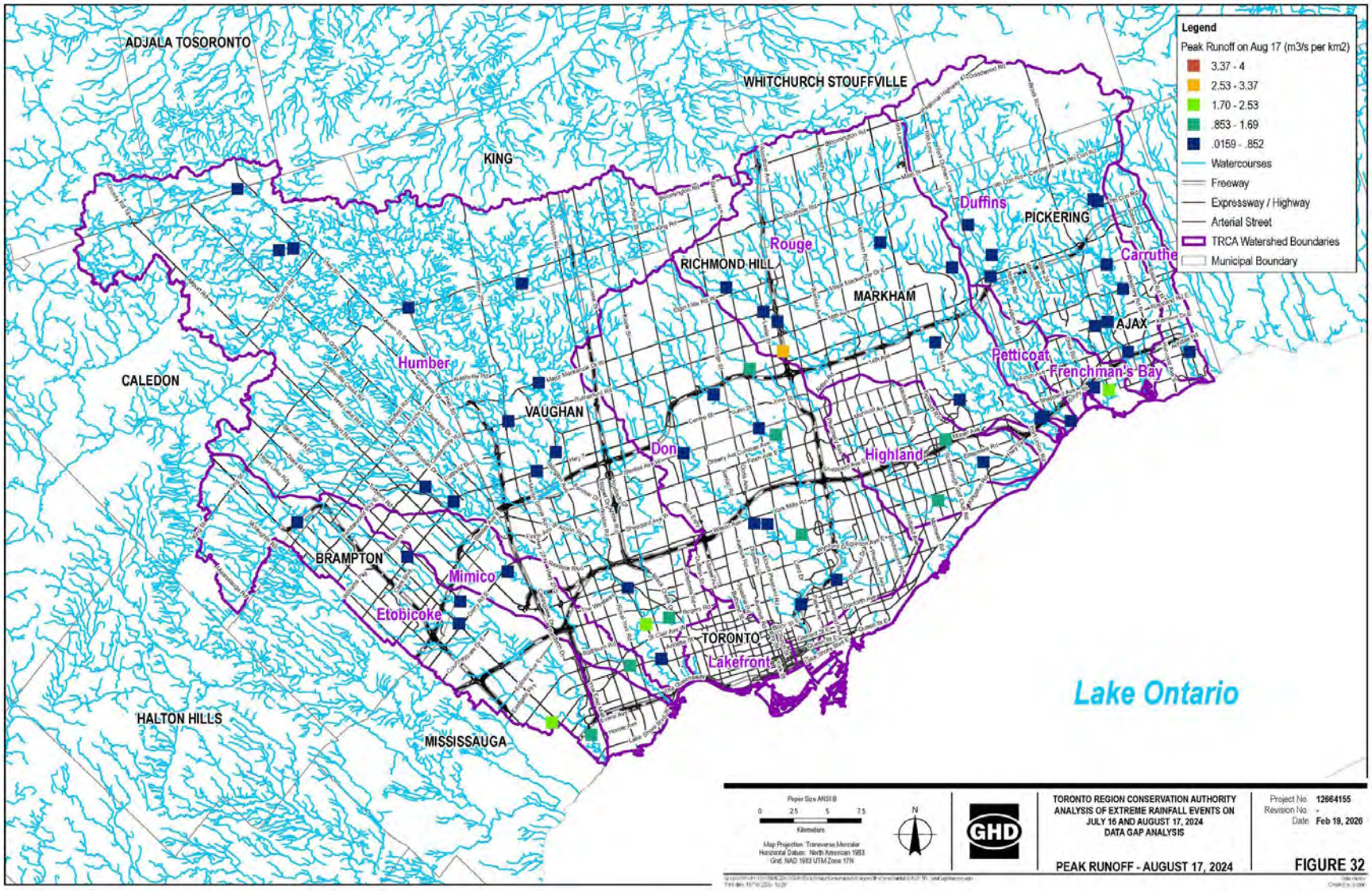


Figure 32 Peak Runoff – August 17, 2024

5.4 Comparison of peak streamflow to flood frequency curves

A single-station frequency analysis was conducted using long-term streamflow records from Water Survey Canada gauges, which included maximum instantaneous peak flows. These observed peaks were compared with estimated frequency flows to determine the return periods associated with the peak flows recorded during the July 16 and August 17, 2024 events. 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, downloaded on April 23, 2025. Before conducting the single-station frequency analysis, annual peak flow records at all gauges were reviewed to identify data gaps. Many gauges had missing peak flow values for several years and where strong correlations existed (greater than 0.8), these missing values were estimated using the relationship between annual instantaneous peak flows and corresponding maximum daily flows at each gauge. The results of the gap filling assessment have been presented in **Table 29.**

Table 29 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
02HC009	73	51	22	0	0.7548
02HC013	64	43	21	0	0.3810
02HC019	64	39	25	0	0.1812
02HC022	64	52	12	8	0.9197
02HC023	54	47	7	2	0.8274
02HC024	64	57	7	0	0.2817
02HC025	61	41	20	0	0.7899
02HC027	60	51	9	0	0.2528
02HC028	63	44	19	16	0.8541
02HC030	62	51	11	0	0.3505
02HC031	57	44	13	0	0.5972
02HC032	53	41	12	4	0.8409
02HC033	61	52	9	0	0.4075
02HC038	37	23	16	0	0.3832
02HC047	39	23	15	0	0.7979
02HC049	39	27	12	6	0.8113
02HC053	24	10	14	0	0.2812
02HC056	21	10	11	0	0.5706
02HC058	21	10	11	0	0.6769
02HC059	11	8	3	0	0.8412
02HC060	4	1	3	-	-

To estimate streamflow values for return periods of 2, 5, 10, 20, 50, 100, 200, and 500 years, a single-station frequency analysis was carried out using the HEC-SSP software developed by the U.S. Army Corps of Engineers (**Table 30**). The analysis applied the Log-Pearson Type III distribution, which is a widely accepted method for flood frequency estimation. For stations that are missing records of instantaneous peak flows, the data were estimated

using the regression approach above. These estimates were then included in the dataset to support the overall frequency analysis. The WSC stations are plotted spatially by return period range on **Figure 33** and **Figure 34**.

It should be noted that the number of years of data available for each station plays a critical role in the accuracy and reliability of return period estimates. A minimum of 30 years of data is suggested for single-station frequency curve development (ECCC, 1976). Stations with longer records such as 02HC003 (64 years) or 02HC024 (57 years) provide a stronger foundation for frequency analysis, leading to more stable and accurate return period estimates. Of particular note is 02HC058 in the Highland watershed. Its peak flow on July 16, 2024, was 132 m^3/s. According to the frequency curve (which was based on only 10 years of data), this flow rate would correspond to a 500-year event or greater. Due to the short length of the frequency curve, this return period is not considered reliable. The other station in the Highland watershed recorded a 10- to 20-year event, which is considered more reasonable.

Table 30 Single Station Frequency Analysis Flood Estimates (m^3/s)

Watershed	Station	Return Period (Years)								July 16, 2024		August 17, 2024	
		2	5	10	20	50	100	200	500	Flow Rate (m^3/s)	Return Period Range (years)	Flow Rate (m^3/s)	Return Period Range (years)
Don	02HC005	26.5	41.0	51.5	62.2	77.1	89.1	101.9	120.2	74.7	20 – 50	50.8	5 – 10
	02HC024	117.8	157.8	181.9	203.5	229.9	248.6	266.7	289.7	258	100 – 200	145	2 – 5
	02HC056	11.0	15.9	20.2	25.7	35.8	46.9	63.1	96.3	18.3	5 – 10	7.93	<2
Duffins	02HC019	30.6	59.1	84.8	115.8	167.1	215.7	274.9	373.5	5.98	<2	2.9	<2
	02HC038	11.9	16.7	20.1	23.6	28.4	32.4	36.7	43.0	3.04	<2	4.38	<2
	02HC049[1]	56.3	79.8	92.7	103.5	115.1	122.6	129.1	136.6	25.2	<2	13.3	<2
Etobicoke	02HC030	86.0	115.9	136.0	155.8	182.2	202.8	224.3	254.3	254	200 – 500	255	>500
Highland	02HC013	71.3	115.3	141.0	162.9	186.8	202.2	215.4	230.5	162	10 – 20	61.3	<2
	02HC058	53.1	63.8	71.1	78.4	88.9	97.8	107.9	123.6	132	>500	37.6	<2
Humber	02HC003[1]	121.0	190.0	245.1	306.0	398.4	479.1	571.2	713.0	127	2 – 5	113	<2
	02HC009	29.1	43.2	52.9	62.4	75.0	84.8	94.9	108.7	23.3	<2	13.1	<2
	02HC023[1]	10.2	15.6	19.3	22.8	27.3	30.8	34.2	38.7	0.967	<2	3.48	<2
	02HC025	29.7	41.7	49.3	56.4	65.3	71.9	78.4	87.1	7.34	<2	7.83	<2
	02HC027	59.2	84.2	102.4	121.3	148.0	170.0	193.9	228.9	167	50 – 100	110	10 – 20
	02HC031	44.8	66.3	81.9	98.1	121.0	139.8	160.2	190.1	66.8	5 – 10	21.5	<2
	02HC032[1]	11.0	16.7	20.5	24.3	29.1	32.8	36.4	41.4	2.43	<2	2.14	<2
	02HC047	15.1	20.7	24.8	29.0	35.3	40.7	46.7	55.9	2.68	<2	3.8	<2
	02HC059[1]	5.4	10.6	16.7	26.4	50.8	88.1	163.3	393.2	1.24	<2	1.17	<2
	02HC060	-	-	-	-	-	-	-	-	0.743		1.84	
Mimico	02HC033	34.8	48.1	57.6	67.3	81.1	92.4	104.7	122.5	106	200 – 500	123	>500
Rouge	02HC022[1]	37.2	57.3	70.6	83.4	99.7	111.9	123.9	139.9	33.6	<2	51.2	2 – 5
	02HC028[1]	21.2	29.4	34.7	39.6	45.9	50.5	55.1	61.2	8.08	<2	10.8	<2
	02HC053	19.3	30.7	40.7	53.0	75.1	98.8	131.8	197.1	10.9	<2	9.4	<2
Note	1. Regression based approach was used. 2. Red data indicates that the frequency curve was based on less than 30 years of data (and therefore suspect).												

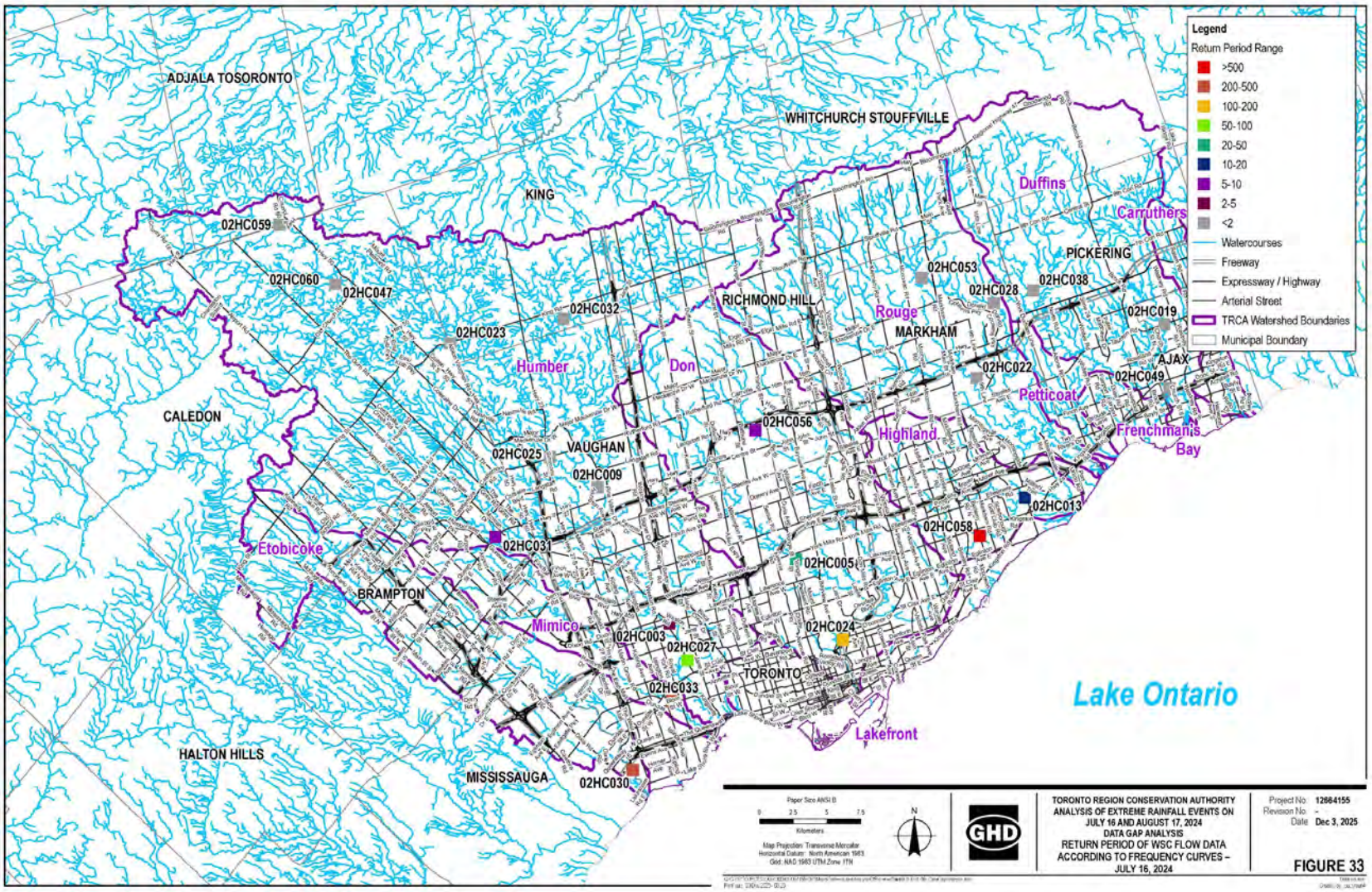


Figure 33 WSC stations colour coded by return period for July 16, 2024 event

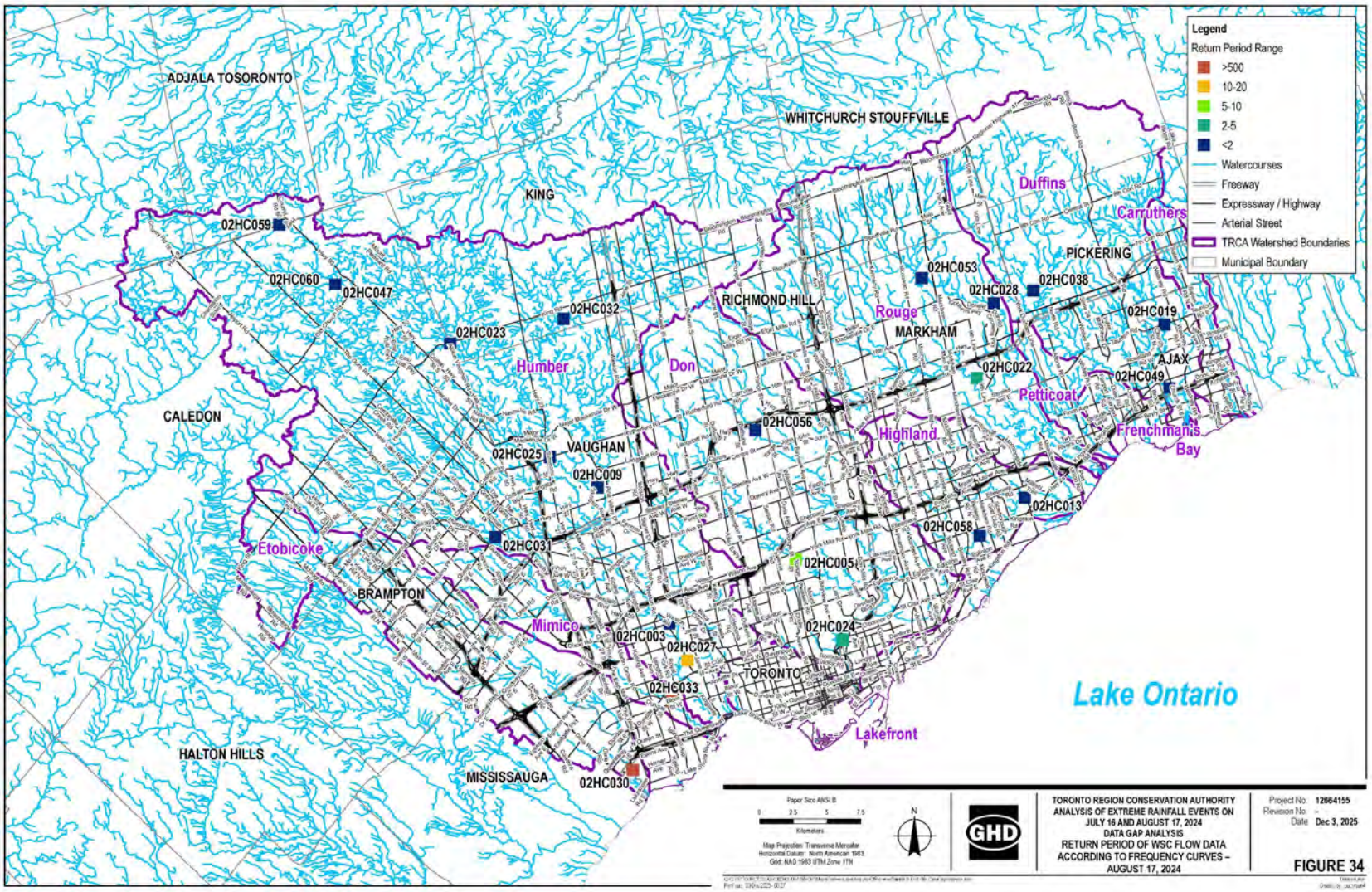


Figure 34 WSC stations colour coded by return period for August 17, 2024 event

A comparison of observed peak flows to return period estimates for the July 16, 2024 storm reveals a wide range of hydrologic responses across the monitored stations (**Table 30**). Several locations experienced flows with low (less than 2-year) return periods. These stations were primarily in the Duffins, north parts of Humber, and Rouge watersheds. In contrast, more extreme events were observed in the Don, Etobicoke, Mimico, and the southern portion of the Humber watersheds. Stations in Etobicoke, and Mimico experienced flows with return periods greater than 500-year. The distribution in return periods highlights the spatial variability of the storm's effects, with the highest intensity rainfall concentrated in the Don, Etobicoke, and Mimico watersheds.

The return periods for the August 17, 2024 event indicate that the majority of the TRCA jurisdiction had low flows (less than 2-year return period). The high return period flows were limited to the Etobicoke, Mimico, Humber, and Don watersheds. Only the Etobicoke and Mimico watersheds experienced flows with return periods greater than 500 years.

Table 31 and **Table 32** demonstrate a summary of the number of gauges in each watershed whose observed flow values have exceeded the frequency analysis return periods. For the July 16, 2024 event, the watersheds with the highest return periods (100-year or greater) were Don, Etobicoke, Highland, and Mimico. For the August 17, 2024 event, the return periods were lower overall, with only Etobicoke and Mimico having high return periods (>500-year). These patterns match the spatial maps of precipitation developed in Section 4.1.

Table 31 Summary of Frequency Analysis Results – July 16, 2024

		Return Period (years)								
Watershed	**Number of Gauges**	**<2**	**2**	**5**	**10**	**20**	**50**	**100**	**200**	**500**
Don	3			1		1		1		
Duffins	3	3								
Etobicoke	1								1	
Highland	2				1					1
Humber	10	7	1	1			1			
Mimico	1								1	
Rouge	3	3								
Red value indicates that this return period is considered suspect based on a frequency curve with only 10 years of data.										

Table 32 Summary of Frequency Analysis Results – August 17, 2024

		Frequency (years)								
Watershed	**Number of Gauges**	**<2**	**2**	**5**	**10**	**20**	**50**	**100**	**200**	**500**
Don	3	1	1	1						
Duffins	3	3								
Etobicoke	1									1
Highland	2	2								
Humber	10	9			1					
Mimico	1									1
Rouge	3	2	1							

6. Historical storm events

Southern Ontario has experienced several extreme rainfall events over the past century, with Hurricane Hazel in 1954 remaining one of the most significant in terms of both intensity and impact. Given the increasing frequency and severity of such events, it is valuable to compare the July 16, 2024 and August 17, 2024 storm with other major historic storm events that have affected the region. This section presents a qualitative and quantitative comparison of notable storm events, including Hurricane Hazel of 1954, the Highland Creek storm of 1976, Harrow Storm of 1989, the Finch Avenue storm of 2005, the Cooksville storm of 2009, the 2013 July storm, and the Burlington storm of 2014. These comparisons are based on available hydrological data, rainfall distribution, and documented flood damages. Understanding these events in context helps inform current flood risk assessments and infrastructure planning.

6.1 Qualitative Comparison

A literature review has been performed on major storm events in Ontario and the review of seven historic major storm events across the province. The results of the review have been presented in **Table 33.** The reviewed storms include Hurricane Hazel of 1954, the Highland Creek storm of 1976, Harrow Storm of 1989, the Finch Avenue storm of 2005, the Cooksville storm of 2009, the 2013 July storm, and the Burlington storm of 2014. The Hurricane Hazel storm covered large areas of Ontario.

Table 33 Comparison of Major Historical Storm Events in Ontario

Storm	Year	Storm Type	Location of Centre	Area (km^2)	Duration (hours)	Total Rainfall (mm)	Antecedent Precipitation (AMC condition)	Estimated Damages ($)	Loss of Life	Areas Impacted	Rainfall Rank	Damages Rank
Hurricane Hazel	1954	Hurricane Remnant + Cold Front	Brampton	30,000	48	285.0	Wetter than average (AMCIII)	>$1 billion (today)	81	Toronto and Southern Ontario – specifically Holland Marsh, Raymore Drive and Woodbridge on Humber, and Long Branch on Etobicoke Creek	2	1
Highland Creek Storm	1976	Air mass thunderstorm + Cold Front	Scarborough	~102	48	100.1	**August 27:** Average (AMCII) **August 28:** Wetter than average (AMCIII)	$1.3 million	0	Scarborough and portions of North York	8	8
Harrow Storm	1989	Convective	Essex County - Harrow	700	30	450.9	Near drought conditions (AMCI)	$40-50 million	0	Across Essex County	1	7
Finch Avenue Storm	2005	Convective	Toronto	3,000 [1]	4	153.4	Not provided in Storm Report	$125 million	0	West-East band across TRCA's jurisdiction	4	4
Cooksville Creek Storm	2009	Convective	Mississauga	~20	1.5	74.6	Wetter than average (AMCIII)	$60,000	0	Cooksville Creek (Mississauga)	9	9
July 8th, 2013 Storm	2013	Convective	Toronto	25,000	10	138.0	Wetter than average (AMCIII)	$932 million	0	Don River Corridor and Dixie-Dundas area most affected	5	3
Burlington Storm	2014	Convective	Burlington	~200	7	192.3	Wetter than average (AMCIII)	>$90 million	0	Tuck Creek, Shoreacres Creek, and Tuck Creek	3	6
July 16th Storm	2024	Convective	Toronto	1100 [2]	3-6	104.2	Average (AMCII)	$990 million	0	Greater Toronto Area (Toronto and Mississauga)	7	2
August 17th Storm	2024	Convective	Toronto	450 [2]	6-12	135.7	Near drought conditions (AMCI)	$110 million	0	Greater Toronto Area (Toronto and Mississauga)	6	5

Notes

1 Estimated from maps included in Finch Avenue Storm Report, includes area impacted in GTA only

2 Estimated based on spatial mapping of storm extent in Section 6.2.2, area rounded to nearest 50 km2

Table 33 provides a descriptive overview of significant historic storms that have impacted Southern Ontario, detailing their characteristics, hydrologic context, and resulting damages. When comparing these events, Hurricane Hazel (1954) remains the most catastrophic storm on record, with the broadest spatial coverage (~30,000 km²), the longest duration (48 hours), and over $1 billion in damages (equivalent to today's dollars). Occurring under saturated antecedent conditions (AMC III), Hazel delivered 285 mm of rainfall and had one of the highest 24-hour accumulations on record (230 mm). It resulted in 81 fatalities and fundamentally shaped watershed management in Southern Ontario.

The Highland Creek Storm of 1976 also delivered intense rainfall, concentrated over the Highland Creek watershed in Scarborough. Though less is documented about this storm compared to others, it remains significant due to its focused impact on an urbanized watershed. The damage from this event was relatively low (rank of eighth).

The Harrow Storm of 1989 was a highly localized but extreme convective event near the town of Harrow, in Southwest Ontario. Although the broader affected area was about 700 km², a concentrated 10 km² zone within the centre of the storm received up to 450 mm of rainfall over 30 hours. The event unfolded in two distinct phases, separated by a five-hour lull. The first phase brought 150 mm of rain over nine hours, followed by an additional 104 mm during the second five-hour phase. With almost no rainfall in the preceding three weeks, the first part of the storm likely fell on dry soils (AMCI), while the second occurred under saturated conditions. This storm illustrates the intensity and flood potential of small-area, short-duration rainfall events. Despite the fact that this storm recorded the highest rainfall totals, the total damage from this storm was relatively low (seventh rank) due to its small extent.

The Finch Avenue Storm (2005) was a convective event that brought high-intensity rainfall to urbanized areas in Toronto. This storm brought intense rainfall through a west-east corridor across the central TRCA watersheds, with the storm center located between Vaughan and Richmond Hill. The Highland Creek watershed experienced the most extreme rainfall, with over half the watershed receiving at least 130 mm in just 2 hours. Although total rainfall was less than that of Hurricane Hazel or the Harrow Storm, the event exceeded the July 2013 storm in terms of rainfall depth over both short and long durations. This storm resulted in $125 million in damages.

In 2009, the Cooksville Creek Storm delivered 67.6 mm of rainfall in just one hour, overwhelming storm and sanitary sewer systems across Mississauga. This storm, though very short (1.5 hour) and limited in area (~20 km²), generated intense rainfall and localized urban flooding, illustrating the impact of short-duration, high-intensity events even under modest total volumes. The resulting basement flooding underscored the vulnerability of urban areas, with a total damage of $60,000.

The July 8, 2013 storm was a widespread event that impacted four TRCA watersheds: Humber, Don, Etobicoke, and Mimico. It occurred under wetter than average conditions (AMCIII). In terms of maximum hourly rainfall and total accumulation over durations up to three hours, this storm surpassed both Hurricane Hazel and the Harrow Storm. However, when compared to the Finch Avenue Storm of 2005, the rainfall totals recorded were lower. The July 2013 storm caused $932 million in damages.

The Burlington Storm of 2014 was another high-intensity, localized event that caused widespread flooding of roads, homes, and businesses, and resulted in the overtopping of several watercourse crossings. Though smaller in scale than Regulatory events, its impact on local infrastructure was severe. This storm resulted in over $90 million in damages.

More recently, two significant storms occurred in 2024. The July 16 storm had a broad footprint across the western and southern TRCA watersheds, with Etobicoke Creek and the Lake Ontario shoreline experiencing the most pronounced effects. The event lasted between 3 and 6 hours, averaging 4.5 hours, and occurred under typical soil moisture conditions. In contrast, the August 17 storm was narrower in spatial extent but longer in duration, averaging 9 hours. It mainly impacted the mid-western TRCA watersheds, again with notable effects in the Etobicoke Creek area. Unlike the July event, it developed under dry antecedent conditions, highlighting the variability in storm dynamics and pre-existing ground saturation across events.

The July 16 and August 17, 2024 storms fall in the lower end of the range in terms of precipitation, but mid- to high-range in terms of scale and damage. The July 16 event occurred under AMC II and reached a total of 104.2 mm over 24 hours, ranking seventh in precipitation but second in damages among historical storms. The August 17 event, under AMC I, had a slightly higher intensity (97 mm/hour) and similar 24-hour totals (135.7 mm), ranked sixth in

precipitation but fifth in damages among historical storms. Despite average or dry initial conditions, both storms caused notable flooding impacts, particularly in the Etobicoke Creek watershed.

6.2 Quantitative Comparison

6.2.1 Rainfall amounts

GHD collected rainfall data for each historical storm. The data collected are summarized in **Table 34**. There were fewer rain gauges available for the earlier storms (Hurricane Hazel, Highland Creek, and Harrow), and they generally recorded at a daily timestep. Starting from the Finch storm, the number of rain gauges increases and the data are generally at a five minute timestep.

Table 34 Rainfall data collected for historical storms

Historical Storm	Agency	Number of Valid Stations	Notes
Hurricane Hazel	ECCC	25	Daily totals
Highland Creek	ECCC	23	Daily totals
Harrow	ECCC	5	Daily totals
Harrow	Storm Report	47	Daily totals
Finch	City of Toronto	16	5-min data
Finch	TRCA	21	5-min data
Finch	City of Markham	2	5-min data
Finch	Clarifica Inc	3	5-min data
Cooksville	Markham	4	5-min data
Cooksville	Mississauga	6	5-min data
Cooksville	Toronto	28	5-min data
July 2013	Markham	10	5-min data
July 2013	Mississauga	14	5-min data
July 2013	Peel	9	5-min data
July 2013	Toronto	35	5-min data
July 2013	ECCC	1	1-min data
Burlington	Region of Halton	13	5-min data
Burlington	Conservation Halton	33	Daily totals, 5min, 15min [1]

Notes

[1] Conservation Halton stations included two 5-min data gauges and one 15-min data gauge, the remaining stations were daily totals

The maximum total rainfall for each historical storm is shown on **Figure 35**, which shows the maximum total rainfall that was measured at any rain gauge in the area affected by the storm. The largest storm in terms of total rainfall was the Harrow Storm. The remaining storms range between 75 mm (Cooksville Storm) and 200 mm (Burlington Storm) of total rainfall. The July 16 and August 17 events are the third and fourth smallest events in terms of total rainfall.

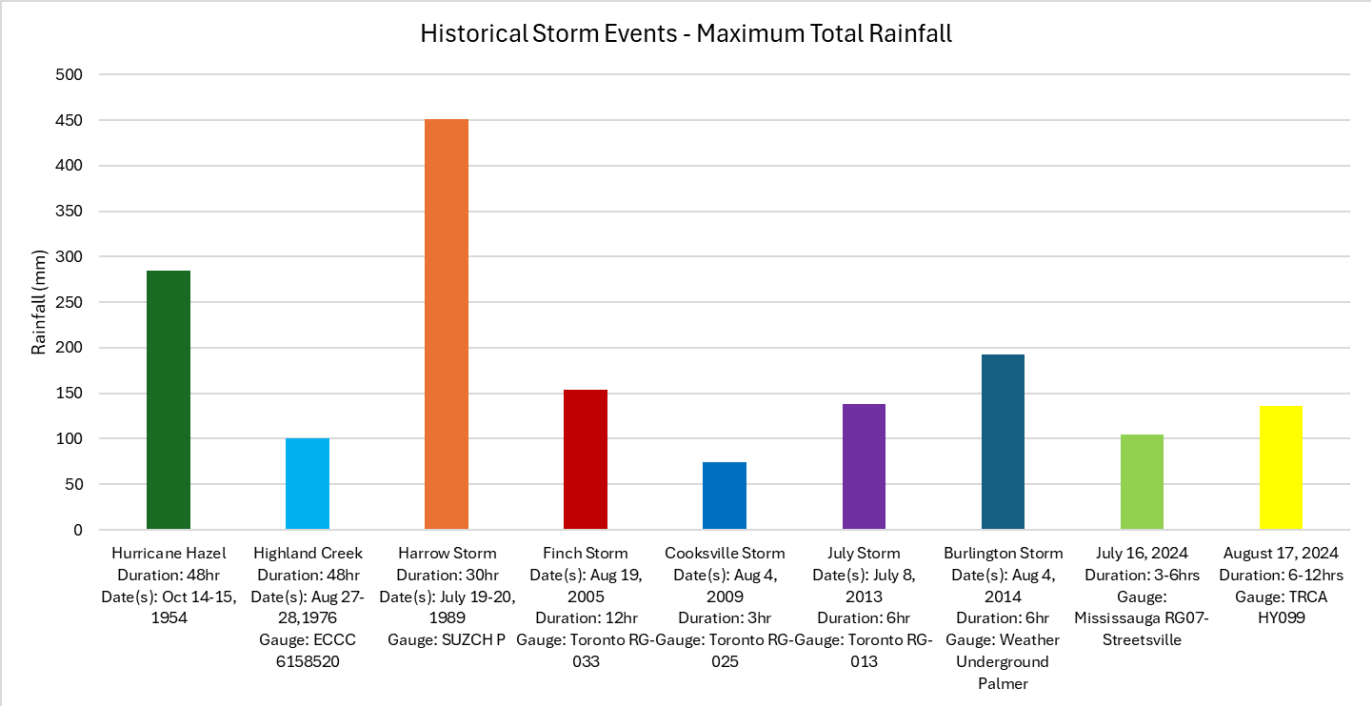


Figure 35 Maximum total rainfall for each historical storm event

The 5-min rainfall hyetographs for each historical storm are plotted on **Figure 36**. Only storms occurring from 2005 and onwards are included in this analysis, since the earlier storms did not have sufficient sub-daily data. The station with the highest total rainfall for each historical storm has been selected. The Cooksville storm and the Finch storm both had 5-min rainfall amounts over 20 mm. In contrast, the July and August events both had 5-min rainfall amounts that were approximately 15 mm. The duration of each historical storm generally ranged from 1.5 to six hours. The Finch storm appears to last 12 hours, however, the amount of rainfall in the first nine hours of the event is low and the majority of rainfall fell in the last three hours. The historical storms each had multiple “bursts” of rainfall, which is typical for thunderstorm-based events.

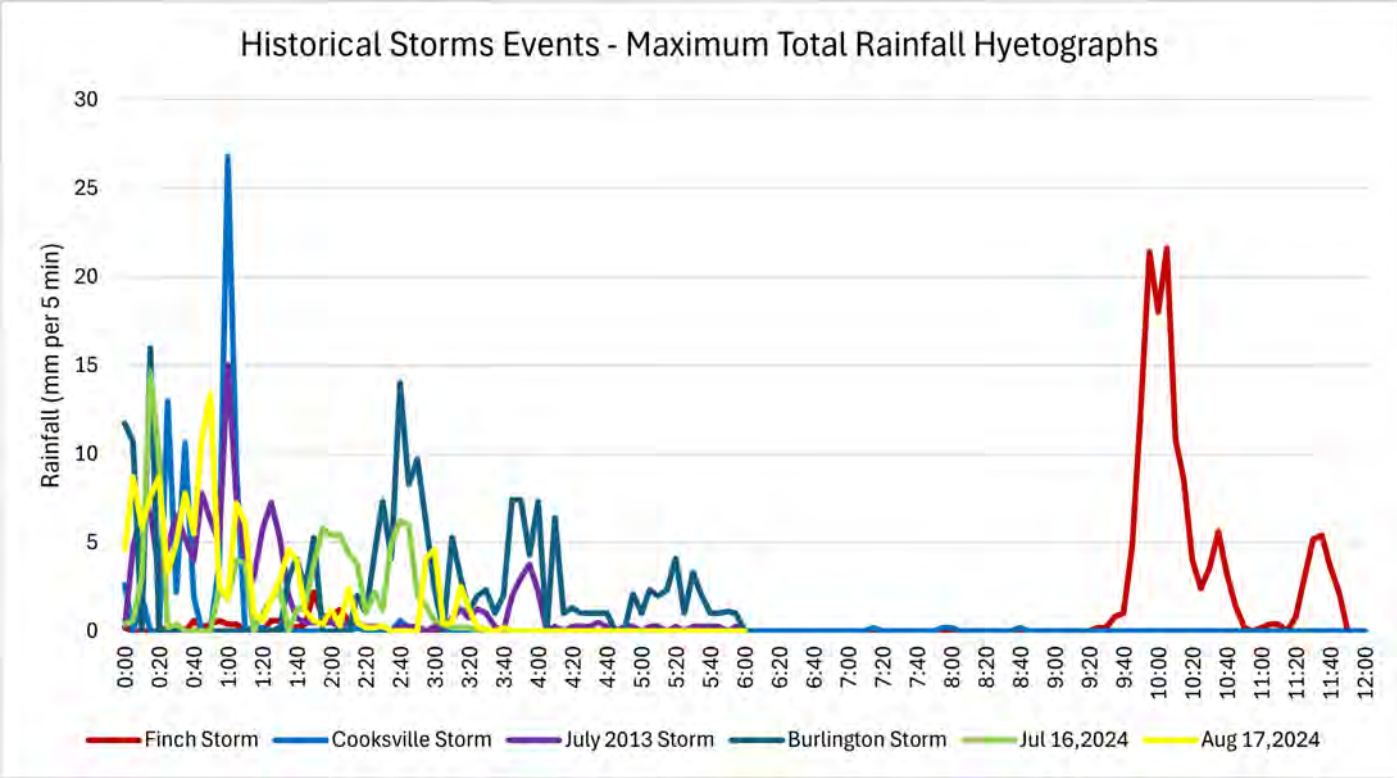


Figure 36 Hyetograph of rain gauges with maximum rainfall for each historical storm event

The station with the maximum rainfall for each storm was different for each storm, and some of the stations were far apart in location (i.e. in different cities or in different parts of the city). The rainfall pattern was also very different at the stations selected. In some cases, the station with the maximum rainfall in one storm received low rainfall for the other storms. These hyetographs highlight the highly localized nature of the rainfall during each historical storm. They also indicate that there are no rain gauges that are more likely to receive extreme rainfall than other rain gauges.

Table 35 provides a comparison of the 5-min to 48-hour maximum rainfall amounts for each historical storm. The table indicates that there are wide differences between historical storms for each duration. For instance, the hourly maximum rainfall ranged from 50 mm to over 100 mm. The daily maximum rainfall ranged from 100 mm to over 400 mm. The amount of rainfall that occurred during each historical storm varied widely and is likely caused by local meteorological conditions of each storm and not related to geographical location.

Table 35 Comparison of Major Historical Storm Events in Ontario – Rainfall Amounts

	Maximum Rainfall Depth Over Given Time Period (mm)												
Storm	**5 min**	**10 min**	**15 min**	**30 min**	**1 hour**	**2 hour**	**3 hour**	**6 hour**	**12 hour**	**24 hour**	**48 hour**	**Maximum Hourly Rainfall Rank**	**24-hour Rainfall Rank (greatest to least)**
Hurricane Hazel – 1954	N/A	N/A	N/A	N/A	53	91	104	153	212	230	285	7	2
Highland Creek Storm – 1976	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	100.1*	N/A	N/A
Harrow Storm – 1989	N/A	N/A	N/A	N/A	50	80	N/A	187	240	425	450.9*	8	1
Finch Avenue Storm – 2005	21.6	39.6	61	93	116.6	133.8	137.7	139.8	152.4	153.4*	N/A	1	4
Cooksville Creek Storm – 2009	11.8	23.4	N/A	N/A	67.6	N/A	73.6*	73.8*	74.6*	74.6*	N/A	4	8
July 8th Storm 2013	21.6	39.7	48.6	69.6	78.8	113.5	116.5	137.2	138	138*	N/A	3	5
Burlington Storm 2014	N/A	21.2	N/A	N/A	65.6*	N/A	N/A	192.3*	192.3*	192.3*	N/A	5	3
July 16th Storm 2024	16	27	29.6	36.5	58.6	77.6	102.6	104	104.2	104.2	N/A	6	7
August 17th Storm 2024	14.7	28.2	38	62.4	97	122.4	129	135.1	135.7	135.7	N/A	2	6
*Value filled in from gauge data													

6.2.2 Spatial mapping of total rainfall

The spatial maps of the historical storms are shown on **Figure 37**. Rainfall maps were produced by transforming discrete precipitation observations into a continuous spatial rainfall surface through kriging-based interpolation. The interpolated surface was used to create rainfall contours at specified intervals, enabling representation of spatial variability and precipitation gradients across the study area. The derived contour features were subsequently subjected to line smoothing to reduce geometric artifacts and enhance spatial continuity, resulting in a technically robust and cartographically refined depiction of rainfall distribution.

The six most recent storms have been spatially mapped. The earlier storms were not mapped since they had fewer stations and there was minimal sub-daily rainfall data. The spatial maps are plotted with the same legend so they can be compared directly. However, the area shown in each map is centred on each storm (the historical storms have different spatial extents).

The six historical storms show different behaviour in their areas with the largest total rainfall, both in size and location. The Finch storm had the largest area of peak rainfall, which covered most of northern Toronto. The Cooksville Creek storm was focused in a small area of southern Mississauga (the scale for the Cooksville Creek storm is smaller than the scale for the other storms because it is such a small area). The July 2013 event was located primarily in western Toronto. The Burlington storm was focused in Burlington. The July and August 2024 events had large extents that covered Mississauga, Brampton, and Toronto. In spatial extent, the July and August 2024 events were most like the July 2013 event. These three events had similar total rainfall amounts and covered relatively large areas of Mississauga, Brampton, and Toronto.

Figure 38 shows the area that received at least a 2-year return period of rainfall for each historical storm. The six historical storms are generally focused on the areas closer to Lake Ontario. The only exception is the Finch storm, which extends into the area north of Toronto. This may indicate a greater susceptibility to extreme rainfall closer to the Lake. This may be due to meteorological factors (such as higher humidity near the Lake or other similar effects), topographical factors (lower elevations near the Lake), and/or other factors such as urban heat island.

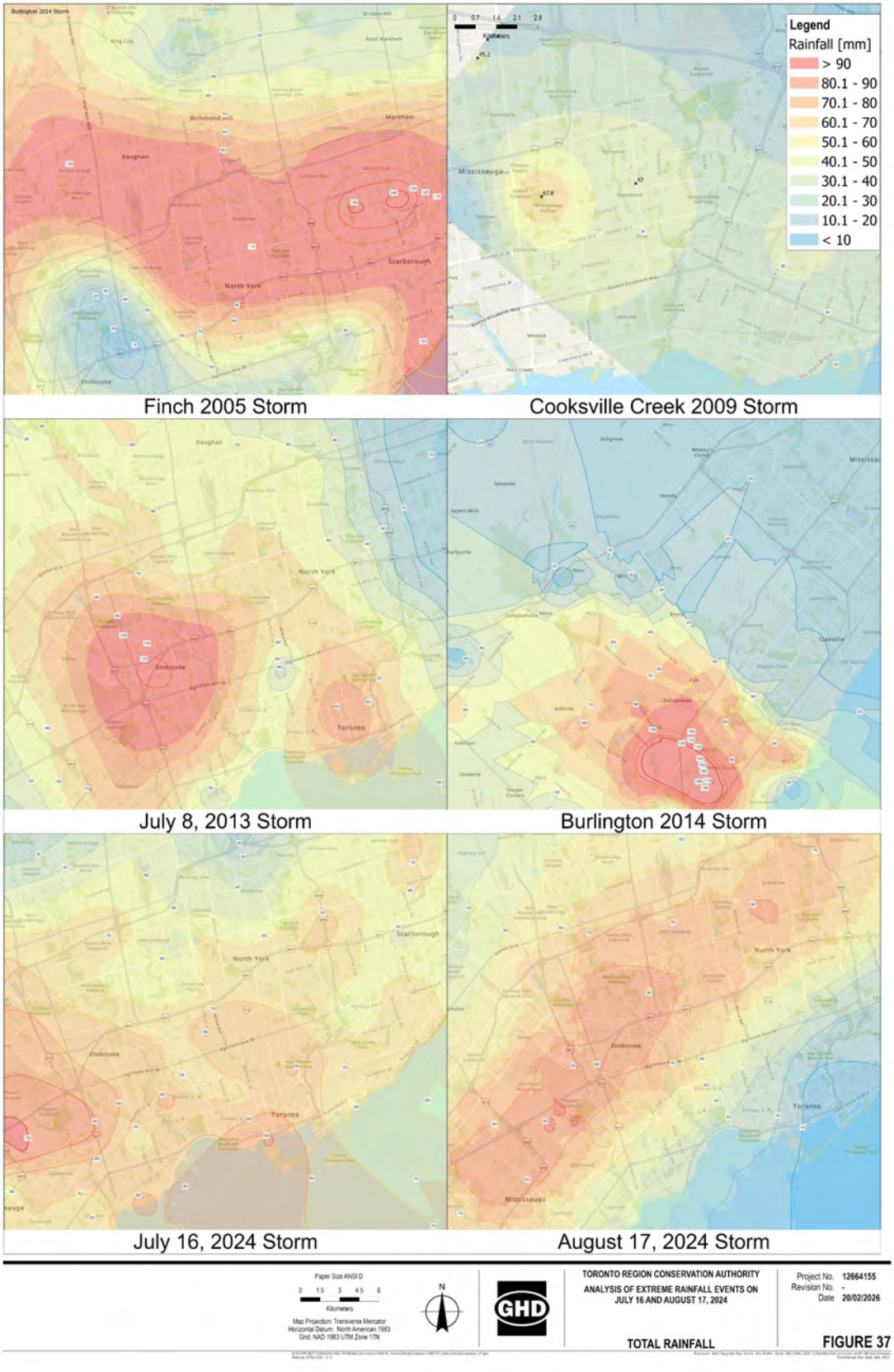


Figure 37 *Spatial mapping of the total rainfall for the historical storms*

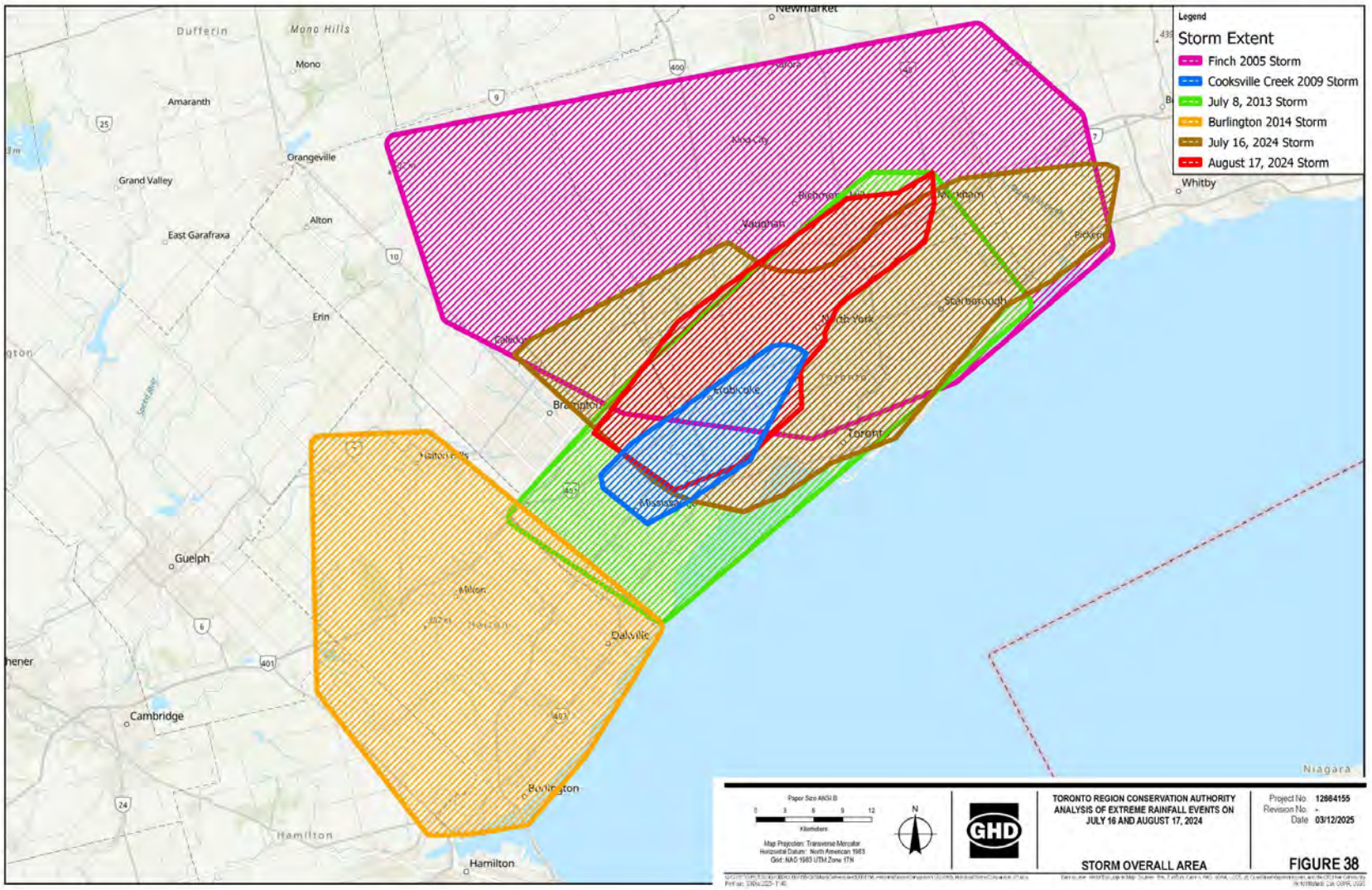


Figure 38 Spatial mapping of the storm extents for the historical storms

6.2.3 Spatial mapping of 1-hr rainfall intensity

The spatial mapping of the 1-hr maximum rainfall for the six historical storms is provided on **Figure 39**. The same six historical storms are mapped, with consistent legends but different spatial extents (and the scale for the Cooksville storm is smaller than the other storms).

The 1-hr maximum rainfall follows similar patterns to the total rainfall spatial patterns. The maximum 1-hr rainfall areas are located in the same areas as the maximum total rainfall. The July 2024 storm is an exception: it did not have any areas with large rainfall accumulations at the 1-hr duration (the largest 1-hr rainfall accumulation was only 58.6 mm). The July 2024 was spread throughout Mississauga, Brampton, and Toronto. The two storms with the largest 1-hr maximum rainfall were the Finch storm (116.6 mm) and the August 2024 storm (97 mm).

When the 1-hr maximum rainfall maps were compared to the total rainfall maps, it was found that the areas with the highest 1-hr maximum rainfall are generally smaller than the extent of the areas with the highest total rainfall. The storm durations generally ranged from 1.5 to 6 hours. The differences between the 1-hr maximum rainfall maps and the total rainfall maps are caused by the fact that the events have multiple “bursts” of rainfall. This leads to (relatively) low 1-hr rainfall accumulations, but high total rainfall accumulation. Note, however, that there are some storms where the majority of the rainfall falls within 1-hr (for example, the August 2024 event had a maximum 1-hr rainfall accumulation of 97 mm and a total rainfall accumulation of 135.7 mm).

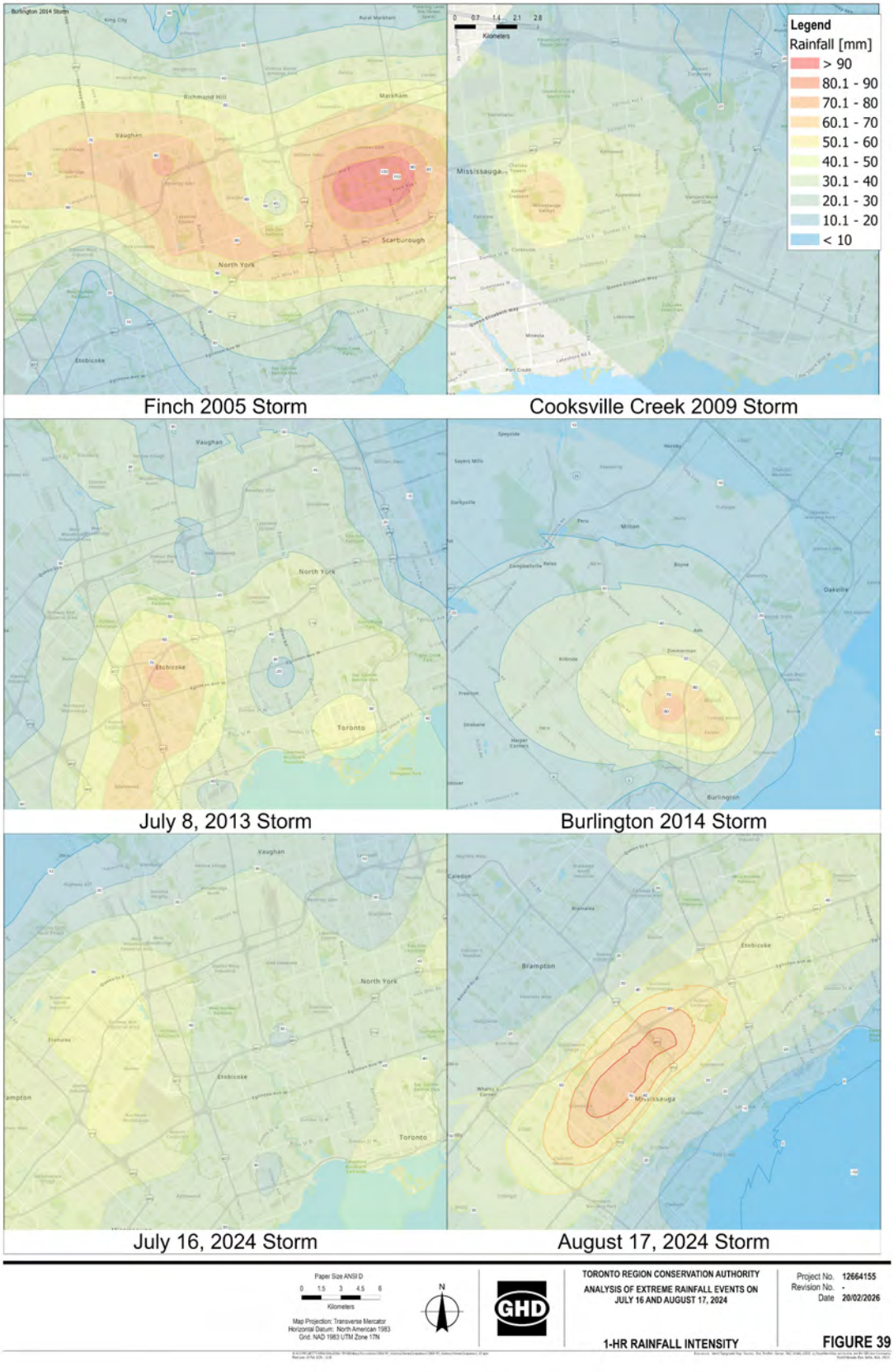


Figure 39 *Spatial mapping of the 1-hr maximum rainfall for the historical storms*

6.2.4 Spatial mapping of storm duration

The spatial mapping of the storm duration for the six historical storms is provided on **Figure 40**. The storm duration is defined as the length of time between the first timestep with rainfall and the last timestep with rainfall. The same six historical storms are mapped, with consistent legends but different spatial extents.

The Finch storm has a long duration (12 or more hours). However, it was noted earlier that the majority of the rainfall occurred over three hours. The Cooksville, July 2013, and Burlington storms ranged from 3 to 12 hours in duration. The July 2024 and August 2024 events have durations ranging from 3 to 12 hours in the areas with high rainfall, and durations over 12 hours in some of the areas with low rainfall. Note that in the areas with low rainfall during these two events, there was low rainfall throughout the day, which would lead to long durations but low total rainfall accumulations.

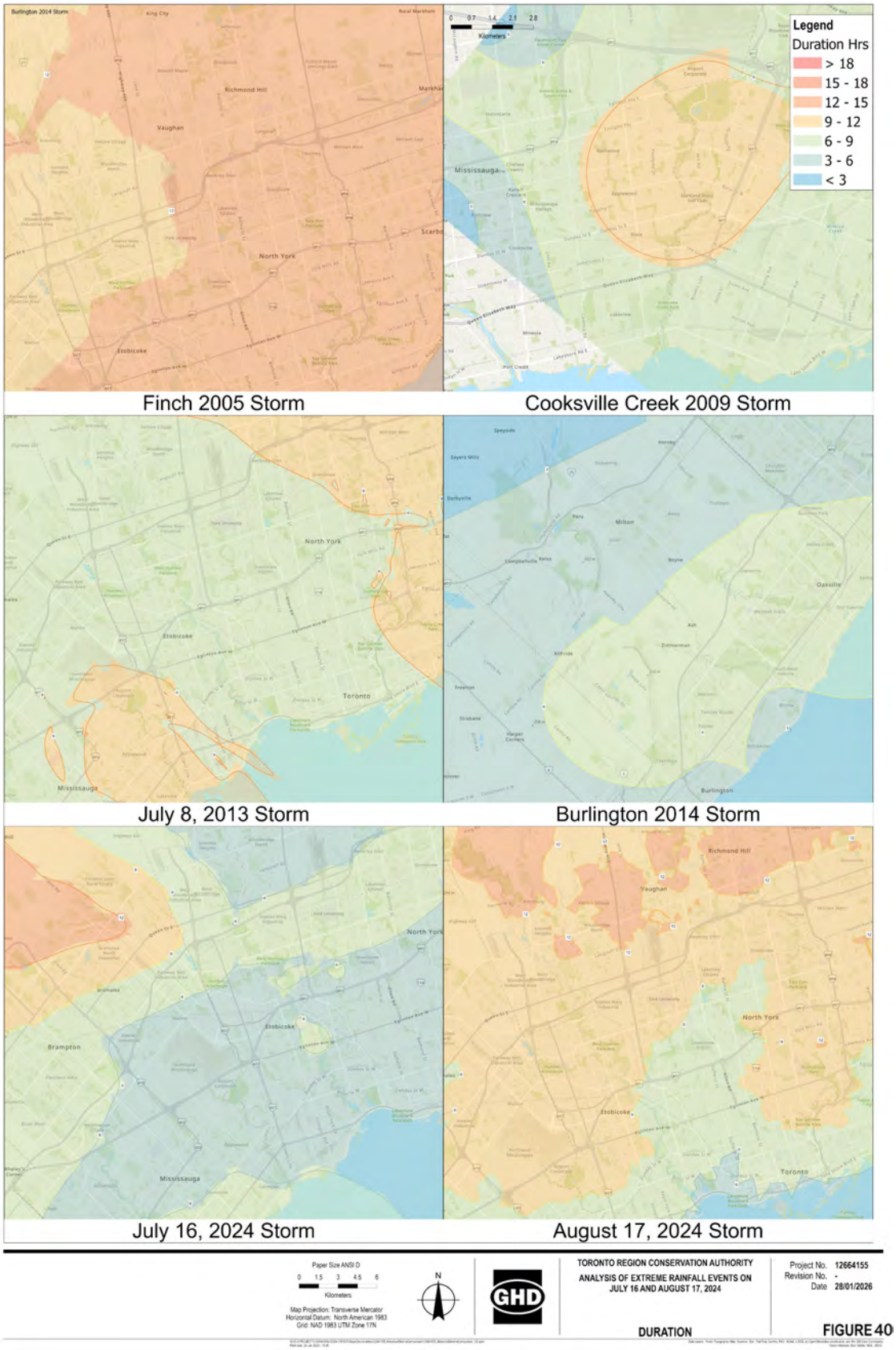


Figure 40 Spatial mapping of the duration for the historical storms

6.2.5 Spatial mapping of return periods

The spatial mapping of the return period for the six historical storms is provided on **Figure 41** to **Figure 43**. Each map shows the area that received rainfall that was at least 25-year, 50-year, or 100-year return period in each historical storm. The return period was assigned as the return period for 12-hour duration.

A single duration was chosen in order to be consistent with the different storms. Some storms were short and intense while others were longer and less intense. When the return periods were calculated with different durations, it led to inconsistencies (e.g. Cooksville storm had high return periods but lower rainfall than other events) and the storms could not be compared as easily. A duration of 12 hours was chosen as a mid-range duration.

The July 16, 2024 storm event had the largest spatial extent of 25-year or greater rainfall. The Cooksville storm event is not shown because it was less than a 25-year return period. In general, most storms are focused on the area near the Lake, with the exception of the Finch storm. The 50-year and 100-year spatial extents are smaller than the 25-year spatial extent and highlight the areas with the greatest rainfall.

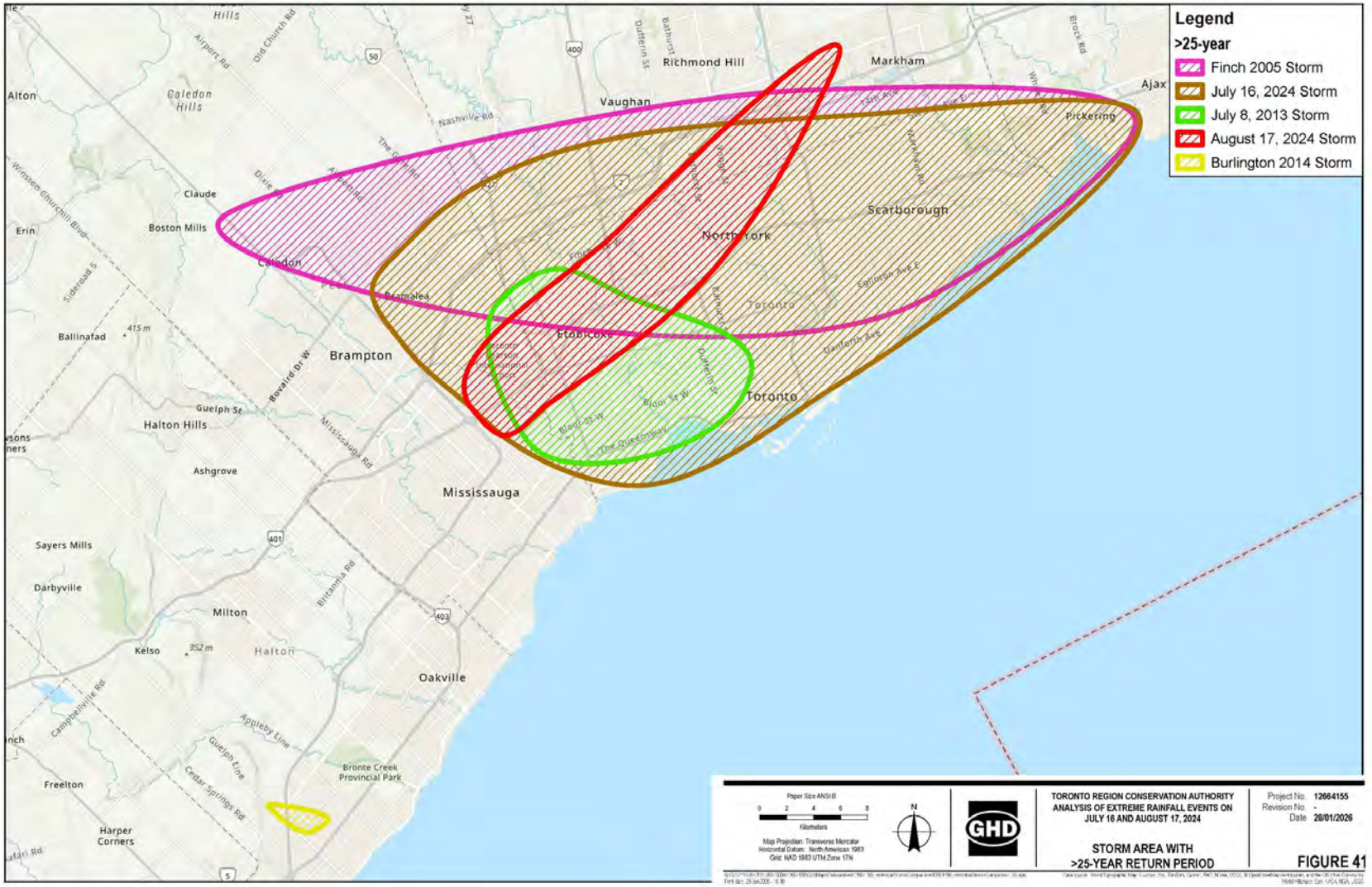


Figure 41 Spatial mapping of the extent of the 25-year and greater return period for the historical storms

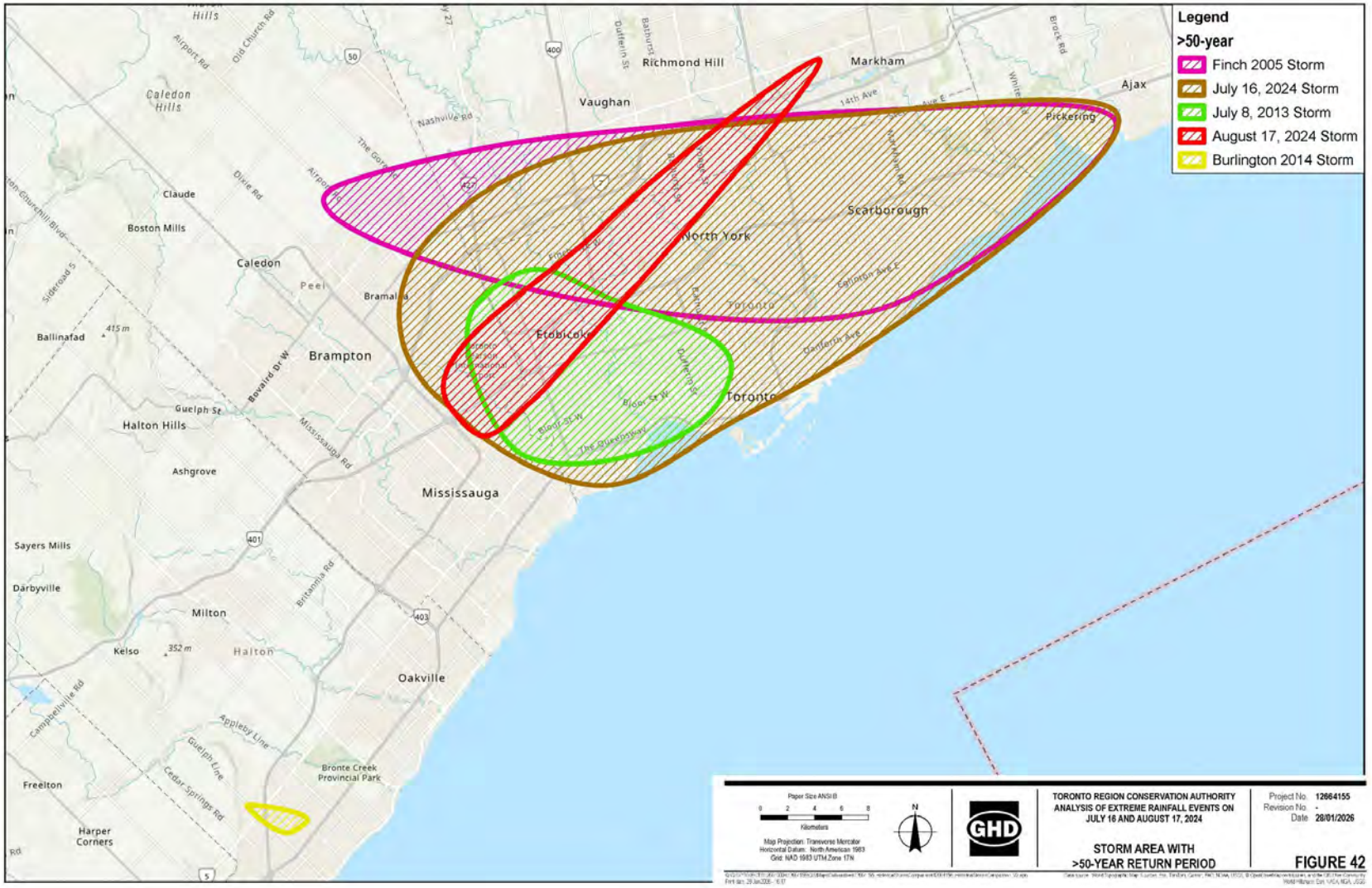


Figure 42 Spatial mapping of the extent of the 50-year and greater return period for the historical storms

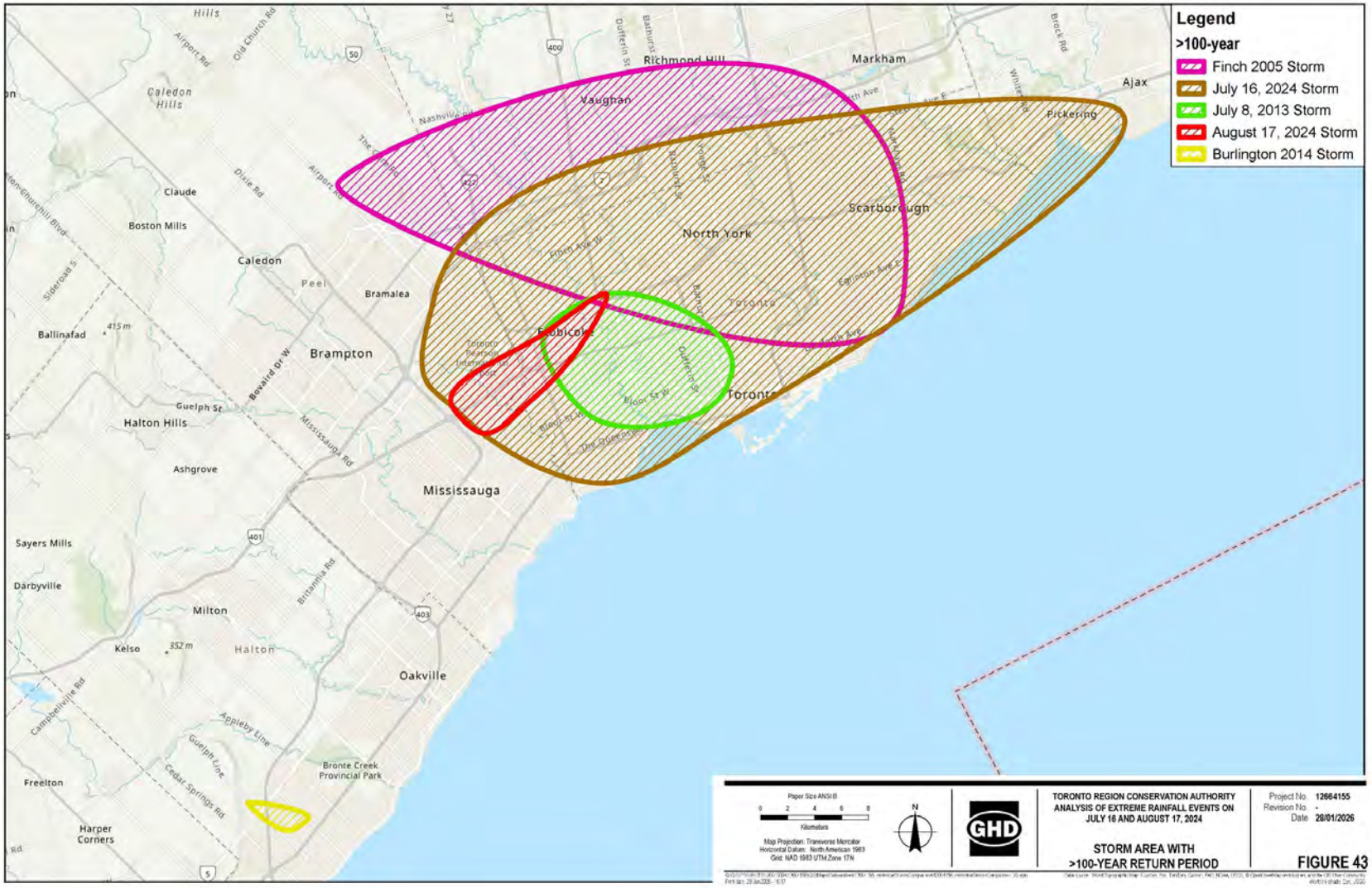


Figure 43 Spatial mapping of the extent of the 100-year and greater return period for the historical storms

7. Conclusions and Recommendations

7.1 Conclusions

The following conclusions are provided for the July 16, 2024 and August 17, 2024 storm events.

7.1.1 July 16, 2024 Storm

Storm overview

- The remnants of Hurricane Beryl, which occurred on July 10, 2024, saturated the watersheds. See the AECOM (2026) report for more detail on the atmospheric impact of this event just ahead of the July 16, 2024 event.
- The five-day antecedent rainfall totals (July 11 to July 15, 2024) ranged from 36 to 96 mm. The majority of the TRCA jurisdiction was classified as dry or average conditions (AMCI or AMCII). However, the watershed may have still been wet from Hurricane Beryl.
- Multiple Severe Thunderstorm Watches were issued by Environment Canada at 8:22 AM, 9:56 AM, 10:48 AM on July 16, 2024. The forecasted precipitation totals and areas impacted varied slightly but covered much of the TRCA jurisdiction. Environment Canada issued multiple Rainfall Warnings at 9:35 AM, 10:43 AM, 10:46 AM, 11:05 AM, and 12:57 AM. The rainfall warnings increased from forecasts of 75 mm up to 125 mm.
- There was very little warning or lead-time for the rainfall, as the earlier forecasts were for lower amounts. The later forecasts had larger amounts but some of the rainfall had already happened.
- TRCA issued a Watershed Conditions Statement for Water Safety on July 15, 2024. TRCA upgraded to a Flood Watch at 9:30 AM, and to a Flood Warning at 11:30 AM on the morning of July 16, 2024.
- TRCA activated its Flood Emergency Operations Centre at 11:05 AM on July 16, 2024, which liaised with City of Mississauga, City of Toronto, and City of Markham.

After the storm's conclusion, TRCA downgraded its flood messaging to a Watershed Conditions Statement for Water Safety at 11:00 PM in the evening of July 16, 2024.

The storm resulted in many flooding impacts across the GTA, including the following:

- Evacuation was ordered for Evergreen Brick Works facility in Toronto
- City of Toronto deployed their automated gates to close roads near the Don River, and also closed parks near the Don River
- City of Mississauga closed several roads and parks, in the Dixie Rd and Dundas St area including Queen Frederica Drive
- Richmond Hill GO train track lines were shut down near Bloor St and Don Valley Parkway area in Toronto
- Highway 401 Westbound transfer at Jane Collector was closed (all lanes)
- Don Valley Parkway (DVP) southbound at Dundas was closed
- G. Ross Lord and Claireville Dams were maximizing storage to minimize flooding in downstream areas throughout the storm event. Claireville Dam was operated to maintain storage capacity in the reservoir in the afternoon of July 16, 2024, and G. Ross Lord Dam was operated to slowly release water from its reservoir once water levels returned to normal on July 17, 2024.
- The City of Toronto received 1,711 customers complaints relative to blocked drains or basement flooding.
- The Insurance Bureau of Canada estimated that the total damages to personal property were $990 million.
- There was no loss of life.

Rainfall analysis

- The event travelled from west to east across the TRCA jurisdiction, starting in Mississauga and extending through the City of Toronto.
- The most intense precipitation occurred in the south-western portions of the TRCA watersheds, particularly in Mimico and Etobicoke. The highest recorded precipitation total within the TRCA jurisdiction was 101.5 mm, at station HY099 (TRCA gauge) in the Etobicoke watershed.
- The northern portions of Humber, Don, Rouge, and Duffins watersheds received very low rainfall (<20 mm).
- Spatially averaged across the watersheds, Mimico received the highest rainfall total (77.8 mm), followed by the Lake Ontario Waterfront area and the Etobicoke watershed at 69.4 mm and 64.1 mm respectively.
- The maximum recorded 1-hr rainfall total was 58.6 mm, at station HY067 (TRCA gauge) in the City of Mississauga.
- Initially, the storm was located in the southern portions of the Etobicoke and Mimico watersheds. It then extended into the Humber and Don watersheds, but the Etobicoke and Mimico watersheds had higher rainfall. The entire TRCA jurisdiction received some rainfall, but the southern portions of the TRCA jurisdiction had larger amounts of rainfall.
- The event lasted between three and six hours (depending on the rain gauge). There were multiple short “bursts” of rainfall that were spaced very close together in time.
- There were rain gauges that recorded rainfall in the Etobicoke watershed that exceeded the 100-year return period at all durations greater than 1-hr. The Don, Mimico and Humber watersheds had some durations with rainfall that exceeded the 100-year return period. The rainfall in the Rouge watershed and near the Lake Ontario Waterfront was between the 50- and 100-year return period.
- The best-matching synthetic design storms were the AES and SCS Type II (90^{th} percentile) design storms.
- The GARR data, obtained from the Region of Peel, indicated that the rainfall occurred in thinner bands than a simple spatial interpolation of the observed rain gauge data would suggest. This occurred for both events.
- There are some areas where the rain gauge coverage is sparse, which include the eastern watersheds (Petticoat, Frenchman’s Bay, Duffins, and Carruthers) and the headwaters of the Etobicoke and Humber watersheds.
- The recent development of the GARR dataset may be a suitable alternate method to address the sparseness of the rain gauge network. However, the GARR dataset also depends on the rain gauge network, and there is greater uncertainty in the results in sparse areas.
- The rain gauge network could also be improved by coordinating with the other agencies to ensure data quality checks, maintenance checks, data storage, and other key operational issues are standardized.

Streamflow and water levels

- The peak water levels exceeded the 100-year water levels at 12 locations. Four locations were in the Don River watershed, one location in Duffins, two locations in Humber, one in Mimico, one in Petticoat, and three in Rouge.
- There were 11 high water marks that exceeded the 100-year water level in the Don and Etobicoke watersheds. The 100-year water levels were taken from the hydraulic models for the two watersheds.
- Some of the peak flow data were missing because the peak water levels were outside of the range for TRCA’s stage-discharge relationships. The missing peak flow data for 10 stations were determined by extrapolating the stage-discharge relationships.
- According to the flood frequency curves, the Don River experienced an exceedance of the 100-year return period. The flows in Etobicoke and Mimico were in exceedance of the 200-year. The Humber River flow was only in exceedance of the 50-year return period.
- The AMCII (average antecedent moisture condition) was assumed for the hydrologic models, but the AMCIII condition was evaluated as part of the sensitivity analysis.

Historical storm events

– The July 16, 2024 storm was convective in nature, which is similar to five earlier historical events.
– The July 16, 2024 storm exceeded the maximum 1-hr rainfall and total accumulation for short durations of both the Hurricane Hazel and Harrow storms. However, the Hurricane Hazel and Harrow storms had higher accumulations overall.
– This storm event ranked seventh in terms of precipitation, but second in terms of damages.
– Each of the historical storms were centered on a different location, and the rain gauge with the highest rainfall total varied for each storm.
– The July 16, 2024 storm had lower 1-hr rainfall totals than four of the other five convective events.
– The area impacted by the July 16, 2024 was also impacted by the Finch storm (which was slightly further north), the Cooksville storm (which was slightly further south and west), the July 2013 storm, and the August 17, 2024 storm. Except for the Finch storm, the extreme rainfall is usually limited to the area near Lake Ontario.

7.1.2 August 17, 2024 Storm

Storm overview

– The five-day antecedent rainfall totals (August 12 to August 16, 2024) were less than 8 mm. The TRCA jurisdiction was classified as dry conditions (AMCI).
– TRCA had an active Watershed Conditions Statement for Water Safety in effect on August 17, that was issued the day prior on August 16, 2024, due to forecasted thunderstorms occurring on August 16 and 17, with total rainfall amounts of 15 to 30 mm and the possibility of up to 60mm in localized areas.
– A Tornado Watch was issued by Environment Canada for Caledon at 11:31 AM on August 17, 2024.
– Rainfall Warnings were issued by Environment Canada at 1:44 PM, 2:44 PM, 3:08 PM, and 5:19 PM on August 17, 2024, with gradually increasing rainfall totals, from 50 to 100 mm to a maximum of 100 to 200mm possible.
– TRCA upgraded its previous Watershed Conditions Statement for Water Safety to a Flood Watch at 2:00 PM on August 17, 2024. TRCA continued its Flood Watch throughout the next day on August 18, until cancelling it at 11:30 AM on August 19, 2024 with the return to normal river conditions.
– Severe Thunderstorm Watches were issued by Environment Canada at 3:20 PM and 5:55 PM on August 17, 2024.
– The following were impacted:
    - Evacuation was ordered for Evergreen Brick Works facility in Toronto
    - Richmond Hill GO train tracks were shut down
    - Bayview Avenue Extension was closed
    - Trails near Bruce Creek (Rouge River) at Unionville flooded in the City of Markham
– TRCA cancelled its Flood Watch and returned to Normal Conditions at 11:30 AM on August 19, 2024.
– The Insurance Bureau of Canada estimated that the total damages to personal property were $110 million.
– There was no loss of life.

Rainfall analysis

– The event travelled from west to east across the TRCA jurisdiction, starting in Mississauga and extending through the City of Toronto. This storm event was located further north than the July storm event.
– The most intense precipitation occurred in the south-western portions of the TRCA watersheds, particularly in Mimico and Etobicoke. The highest recorded precipitation total was 135.7 mm, at station HY099 (TRCA gauge) in the City of Mississauga.

- The northern portions of Humber, Don, Rouge, and Duffins watersheds received very low rainfall amounts (<20 mm).
- Spatially averaged across the watersheds, Mimico received the highest rainfall total (62.8 mm), followed by the Etobicoke and Don watersheds at 53.4 mm and 49.5 mm respectively.
- The maximum recorded 1-hr rainfall total was 97.0 mm, at station St_HilaryRG (Region of Peel gauge) in the City of Mississauga.
- Initially, the storm was located in the middle portions of the Etobicoke and Mimico watersheds. It then extended into the Humber and Don watersheds, but the Etobicoke and Mimico watersheds had higher rainfall. The storm event was less widespread than the July event – there were areas in the northern and eastern parts of the TRCA jurisdiction and also along the Lake Ontario Waterfront that received 10 mm or less of rainfall.
- The event lasted between six and twelve hours (depending on the rain gauge). There were multiple short “bursts” of rainfall that were spaced very close together in time.
- There were rain gauges that recorded rainfall in the Etobicoke watershed that exceeded the 100-year return period at all durations greater than 1-hr. The Humber watershed had some durations with rainfall that exceeded the 100-year return period. The rainfall in the Don and Rouge watersheds was between the 50- and 100-year return period. The rainfall in Mimico was high (based on accumulations at nearby gauges) but the two rain gauges were on the northern edge and therefore it had lower return periods.
- The best-matching synthetic design storms were the AES and SCS Type II design storms (6- and 12-hour durations).

Streamflow and water levels

- The peak water levels exceeded the 100-year water levels at 10 locations. Three locations were in the Don River watershed, one location in Duffins, two locations in Humber, one in Petticoat, and three in Rouge.
- There was one high water mark that exceeded the 100-year water level (taken from the HEC-RAS model for Etobicoke watershed).
- Some of the peak flow data were missing because the peak water levels were outside of the range for TRCA’s stage-discharge relationships. The missing peak flow data for seven locations were determined by extrapolating the stage-discharge relationships.
- According to the flood frequency curves, the Etobicoke and Mimico flows were in exceedance of the 500-year. The remaining watersheds ranged up to a 10-year return period.

Historical storm events

- The August 17, 2024 storm was convective in nature, which is similar to six earlier historical events.
- The August 17, 2024 storm exceeded the maximum hourly rainfall and total accumulation for short durations (up to 3-hr) of both the Hurricane Hazel and Harrow storms. However, the Hurricane Hazel and Harrow storms had higher accumulations overall.
- This storm event ranked sixth in terms of precipitation, but fifth in terms of damages.
- Each of the historical storms were centered on a different location, and the rain gauge with the highest rainfall total varied for each storm.
- The area impacted by the August 17, 2024 was also impacted by the Finch storm (which was slightly further north), the Cooksville storm (which was slightly further south and west), the July 2013 storm, and the July 16, 2024 storm. Except for the Finch storm, the extreme rainfall is usually limited to the area near Lake Ontario.

7.2 Recommendations

The following recommendations are provided from this project.

Storm overview

TRCA's storm response and flood messaging was effective for both storms, however future events could be enhanced with some or all of the following.

– TRCA noted that there were differences in lead time, preparedness and emergency response actions to their flood messages between the two events. For the July event, there was a delay in public response, largely due to the unforecasted and quick onset of the rainfall. In contrast, response and preparedness actions for the August event had very little delay in response due to having heightened awareness following the July event just one month earlier. TRCA should continue to focus on educating the public and municipalities, improving communication and knowledge surrounding flood risk while remaining sensitive to people living in flood vulnerable areas.

– TRCA is interested in supporting the use of the National Public Alerting System, Alert Ready, specifically for flash flooding scenarios. This system is used to perform intrusive broadcasts and push notifications through television, radio and wireless devices, to warn of potential life-threatening conditions and situations.

– TRCA cannot directly issue or request emergency broadcasts from this system, but can work together with municipal and ECCC staff to define appropriate rainfall criteria for flash flood alerts. Review of applicable agency legal requirements as well as operational considerations may need to be investigated to support the use of the system for flash flooding scenarios.

– TRCA should consider changing to targeted messaging by watershed boundary and/or area. Currently, the entire TRCA jurisdiction receives the warnings. Both of the 2024 events were localized to only a few watersheds and municipalities, rather than the entire jurisdiction. Distribution lists would need to be tailored and other operational supports may need to be added, with the largest challenge being the implementation of customized and accurate river flow forecasts for each watershed and municipality, which is currently not available.

– Due to the rapidly developing nature of the two 2024 convective storm events, TRCA should pursue more options including real-time hydrologic and hydraulic modelling through leveraging TRCA's existing sets of flood modelling with integration of these models into the Flood Early Warning System.

Rainfall analysis

– The rainfall for both events was concentrated mainly in the western watersheds (Etobicoke, Mimico, Humber, Don, and Highland), and primarily in the area closer to Lake Ontario.

– TRCA should extend their rating curves as there were multiple locations where the flow rate needed to be extrapolated. The rating curves should be prioritized according to how much extrapolation was required.

– TRCA's current design storms are suitable for continued use.

– The differences between the GARR data and the rain gauge interpolations indicate that the variation in rainfall is not fully captured by rain gauge interpolations. The GARR dataset should be further developed to address the sparseness of the rain gauge network. The dataset should also be examined further to determine how the radar rainfall data can be used in the future.

– Consider coordinating with other agencies to standardize the rain gauge network and developing data sharing platforms to allow for faster data access.

Historical storm events

– TRCA should continue to monitor for future extreme storms and continue to analyse their impacts and root causes.

8. References

AECOM. (2026). Extreme Rainfall Event Climate Pattern Analysis: July 16 and August 17, 2024. Report prepared for Toronto and Region Conservation Authority. Project Number: 60753521.

AMEC Environment & Infrastructure. (2014). July 8th 2013 Extreme Rainfall Event Summary & Analysis Report. Prepared for Toronto and Region Conservation Authority. https://trcaca.s3.ca-central-1.amazonaws.com/app/uploads/2020/07/07094436/14-12-17-Summary-Analysis-Repor1.pdf

Chow, V.T., Maidment, D.R., Mays, L.W. (1988). Applied Hydrology (1st ed.). McGraw-Hill Science/Engineering/Math.

Clarifica Ltd. (2006). Summary of Rainfall Analysis Completed for the August 19th, 2005 Storm Event. Report prepared for Toronto and Region Conservation Authority.

Cumming Cockburn Ltd. (2002). Hurricane Hazel and Extreme Rainfall in Southern Ontario. Institute for Catastrophic Loss Reduction (ICLR), Paper Series Number 9.

MMM Group Ltd. (2013). Etobicoke Creek Hydrology Update. Prepared for Toronto and Region Conservation Authority.

Environment and Climate Change Canada. (1976). Hydrologic and Hydraulic Procedures for Flood Plain Delineation. Government of Canada.

Environment and Climate Change Canada. (2023). Archived: Hurricane Hazel - Impacts. Government of Canada. **https://www.canada.ca/en/environment-climate-change/services/archive/hurricanes/hazel/impacts.html**.

Environmental Water Resources Group Ltd. (2010). Cooksville Creek – August 2009 Flooding. Report prepared for Credit Valley Conservation.

Environmental Water Resources Group Ltd. (2015). August 4th, 2014 Storm Event, Burlington. Report prepared for Conservation Halton.

Focus on Conservation. (2015). A Look Back at the August 4, 2014 Burlington Flood. Focus on Conservation. https://focusonconservation.wordpress.com/2015/08/04/a-look-back-at-the-august-4-2014-burlington-flood/

Holmes, R.R. (2018). River Rating Complexity. U.S. Geological Survey. Proceedings of the International Conference on Fluvial Hydraulics (River Flow 2016), St. Louis, Missouri. https://pubs.usgs.gov/ja/70193968/70193968.pdf

Insurance Bureau of Canada. (2025). 2024 shatters record for costliest year for severe weather-related losses in Canadian history at $8.5 billion. Insurance Bureau of Canada. https://www.ibc.ca/news-insights/news/2024-shatters-record-for-costliest-year-for-severe-weather-related-losses-in-canadian-history-at-8-5-billion

Institute for Catastrophic Loss Reduction. (2006). August 19 storm. ICLR. https://www.iclr.org/wp-content/uploads/PDFS/2006_Oct_August_Storm.pdf.

Kilborn Ltd. (1977). Report on the Storms of August 27th and 28th, 1976 and Subsequent Flooding on the Highland Creek. Report prepared for the Metropolitan Toronto and Region Conservation Authority.

M.M. Dillon Ltd. (1990). Harrow Storm and Flood Study. Report prepared for Ministry of Natural Resources.

MMM Group Ltd. (2015). Floodplain Mapping in Applewood and Dundas / Dixie Special Policy Area. Prepared for Toronto and Region Conservation Authority.

Moriasi, D.N., Arnold, J.G., Van Liew, M.W., Bingner, R.L., Harmel, R.D., Veith, T.L. (2007). Model Evaluation Guidelines for Systematic Quantification of Accuracy in Watershed Simulations. Transactions of the American Society of Agricultural and Biological Engineers, 50(3).

Ministry of Transportation Ontario. (1997). MTO Drainage Management Manual, Part 3. Available from **Ontario Ministry of Transportation Library**.

Toronto and Region Conservation Authority. (2025). Rating Curve Extension Within Etobicoke Creek Watershed.

USACE HEC. (n.d.). HEC-HMS Technical Reference Manual. U.S. Army Corps of Engineers Hydrologic Engineering Center.

United States Soil Conservation Service. (1985). *SCS National Engineering Handbook.*

Appendices

Appendix A

Rainfall intensities

Table A-1 Legend of Rain Gauge ID# Corresponding to Rain Gauge Names

Rain Gauge ID #	Rain Gauge Name	Rain Gauge ID #	Rain Gauge Name
1	RG_001	100	RG06-MississaugaValley
2	RG_002	101	RG07-Streetsville
3	RG_003	102	RG08-Tomken
4	RG_004	103	RG09-Truscott
5	RG_006	104	RG10-Erindale
6	RG_007	105	RG11-GarryMordenFTC
7	RG_012	106	RG12-CVC
8	RG_013	107	RG13-Goreway
9	RG_014	108	RG14-PortCredit
10	RG_015	109	AlloaReservoirRG
11	RG_016	110	BoltonSewagePumping
12	RG_017	111	CaledonEastReservoir
13	RG_018	112	ClarksonWWTPRG
14	RG_019	113	CopperRoadRG
15	RG_020	114	GEBoothRG
16	RG_021	115	PaulineVanierRG
17	RG_022	116	RG03-NorthSheridanLandfill
18	RG_023	117	RG11-Battleford
19	RG_024	118	RG16-Hanlan
20	RG_025	119	RG20-Peel-YorkOdourControl
21	RG_027	120	RG22-Bramalea

Rain Gauge ID #	Rain Gauge Name	Rain Gauge ID #	Rain Gauge Name
22	RG_028	121	RG23-BritanniaLeachatePumping
23	RG_030	122	RG24-MulletCreekSewage
24	RG_031	123	RG25-Reservoir-BeckettSproule
25	RG_033	124	RG26-McLaughlin
26	RG_034	125	RG27-Reservoir-WestBrampton
27	RG_035	126	RG29-Reservoir-NorthBrampton
28	RG_036	127	RG31-Reservoir-EastBrampton
29	RG_037	128	RG32-Reservoir-Airport
30	RG_038	129	RG34-McVeanSewagePumping
31	RG_039	130	RG36-ChinguacousyLeachatePumping
32	RG_040	131	RG39-InglewoodPumpingStn
33	RG_041	132	RG42-CaledonReservoir
34	RG_042	133	RG44-Reservoir-Streetsville
35	RG_044	134	RG45-BoltonRecycleCenter
36	RG_045	135	RG46-St.Nicholas
37	RG_046	136	St.HilaryRG
38	RG_047	137	TullamoreReservoirRG
39	RG_048	138	VictoriaYardRG
40	RG_049	139	R-MUN-MA-05
41	RG_051	140	R-MUN-MA-07
42	RG_052	141	R-MUN-MA-08
43	RG_054	142	R-MUN-MA-09
44	RG_055	143	R-MUN-MA-11
45	RG_056	144	R-MUN-MA-12
46	RG_057	145	R-MUN-MA-13
47	RG_058	146	R-MUN-MA-14

Rain Gauge ID #	Rain Gauge Name	Rain Gauge ID #	Rain Gauge Name
48	RG_059	147	R-MUN-MA-15
49	RG_060	148	R-MUN-MA-16
50	RG_061	149	R-MUN-MA-18
51	RG_062	150	R-MUN-MA-21
52	RG_063	151	R-MUN-MA-22
53	HY002 – Albion Hills	152	R-YR-AU-01
54	HY003 – Alex Duff Memorial Pool	153	R-YR-AU-02
55	HY004 – Bayly and Church	154	R-YR-AU-06
56	HY008 – Brickworks	155	R-YR-AU-07
57	HY009 – Brock West Landfill	156	R-YR-AU-09
58	HY011 – Bruce Mill CA	157	R-YR-EG-01
59	HY016 – Danforth and Coxwell	158	R-YR-EG-02
60	HY021 – Dufferin Reservoir	159	R-YR-EG-04
61	HY027 – G Ross Dam	160	R-YR-EG-06
62	HY030 – Glen Haffy	161	R-YR-GE-02
63	HY031 – Goodwood Pumping Station	162	R-YR-GE-03
64	HY033 – Heart Lake CA	163	R-YR-GE-04
65	HY036 – Kennedy Pump Station	164	R-YR-GE-07
66	HY037 – King and Albion-Vaughan	165	R-YR-GE-10
67	HY038 – East Humber at Mill Road	166	R-YR-KI-01
68	HY039 – Kortright	167	R-YR-KI-03
69	HY041 – Laidlaw Bus Depot	168	R-YR-KI-07
70	HY043 – Little Rouge at 16th	169	R-YR-KI-08
71	HY044 – Milne Dam	170	R-YR-MA-01
72	HY046 – Mississauga Works Yard	171	R-YR-MA-03
73	HY050 – Morningside Works Yard	172	R-YR-MA-19

Rain Gauge ID #	Rain Gauge Name	Rain Gauge ID #	Rain Gauge Name
74	HY055 – Restoration Services	173	R-YR-MA-20
75	HY060 – Stouffville Dam	174	R-YR-NE-03
76	HY061 – Sue Grange Farm	175	R-YR-NE-07
77	HY063 – Transport Canada	176	R-YR-NE-10
78	HY067 – West Humber at Hwy7	177	R-YR-RH-01
79	HY069 – York Pumping Station	178	R-YR-RH-10
80	HY070 – York Region Works Yard	179	R-YR-RH-15
81	HY083 – Oak Ridges	180	R-YR-VA-01
82	HY086 – RL Clark WTP	181	R-YR-VA-02
83	HY087 – Westmount Park	182	R-YR-VA-03
84	HY088 – Black Creek Pioneer Village	183	R-YR-VA-04
85	HY094 – Broadlands Community Centre	184	R-YR-VA-09
86	HY096 – Caledon East Soccer Complex	185	R-YR-VA-10
87	HY099 - Rathwood	186	R-YR-VA-11
88	HY102 – Petticoat Works Yard	187	R-YR-VA-13
89	HY121 – Balsam at 407	188	R-YR-VA-16
90	HY122 – Durham Works Yard	189	R-YR-VA-22
91	HY124 – Claremont Nature Centre	190	R-YR-VA-23
92	HY130 – Elmbank Community Centre	191	R-YR-VA-24
93	6158355 – Toronto City	192	R-YR-VA-26
94	6158359 – Toronto City Centre	193	R-YR-VA-27
95	6158731 – Toronto Intl A	194	R-YR-VA-28
96	RG01-Lakeview	195	R-YR-WS-05
97	RG03-Wolfedale	196	R-YR-WS-06
98	RG04-MississaugaCentral	197	Langstaff
99	RG05-WindingTrail	198	Operations

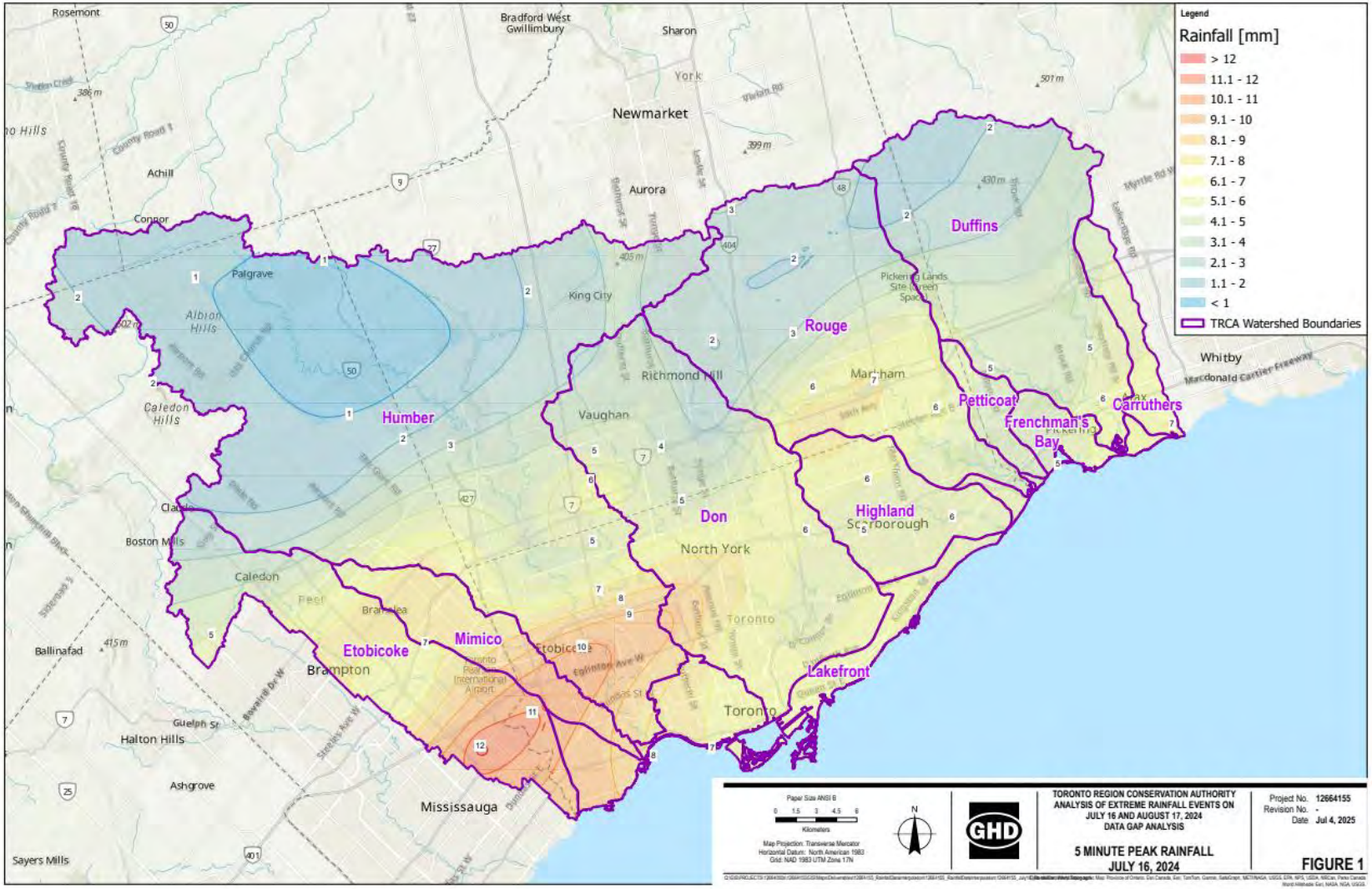


Figure 1 ***July 16, 2024 storm event – 5-min rainfall intensity***

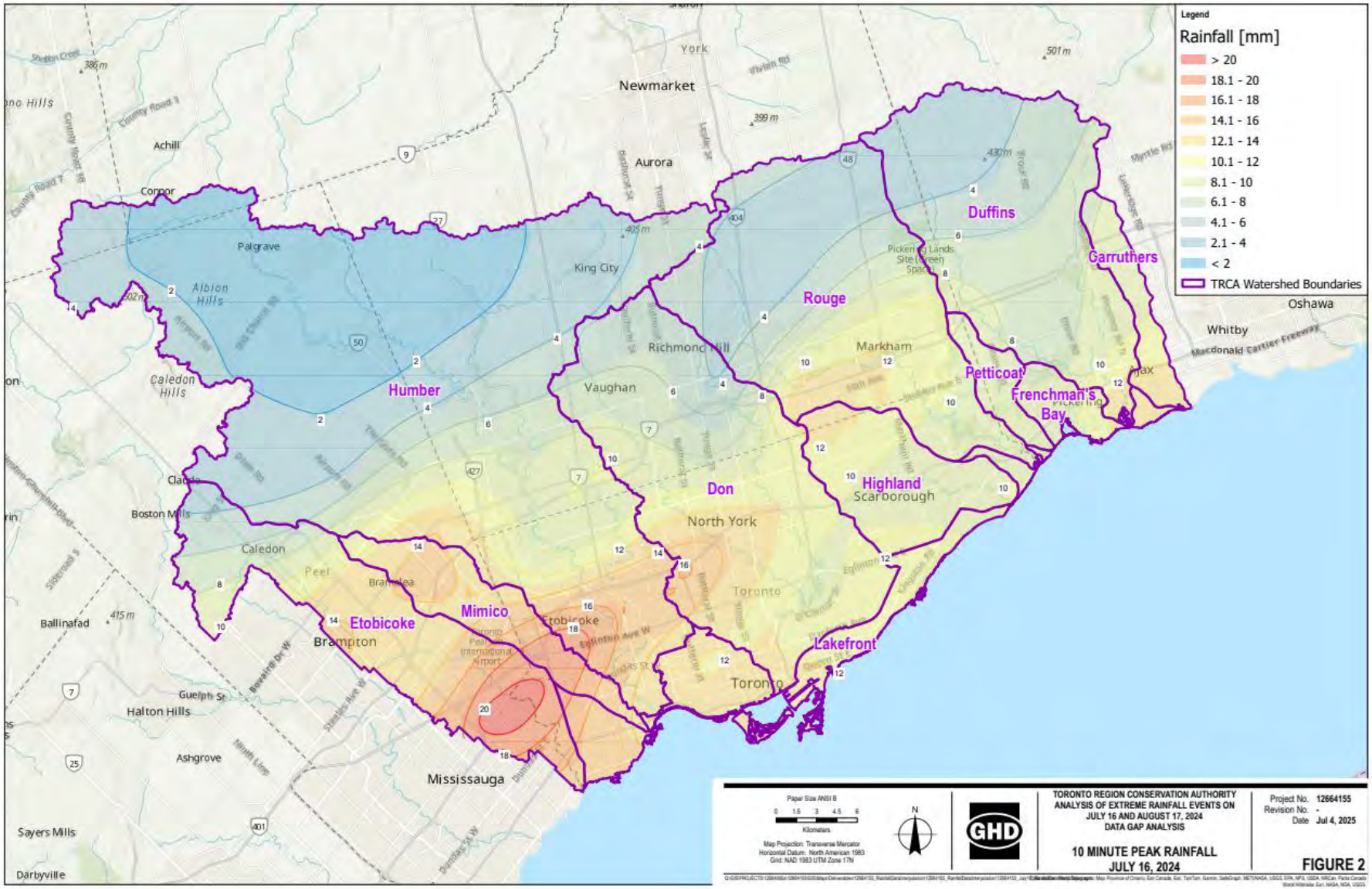


Figure 2 *July 16, 2024 storm event – 10-min rainfall intensity*

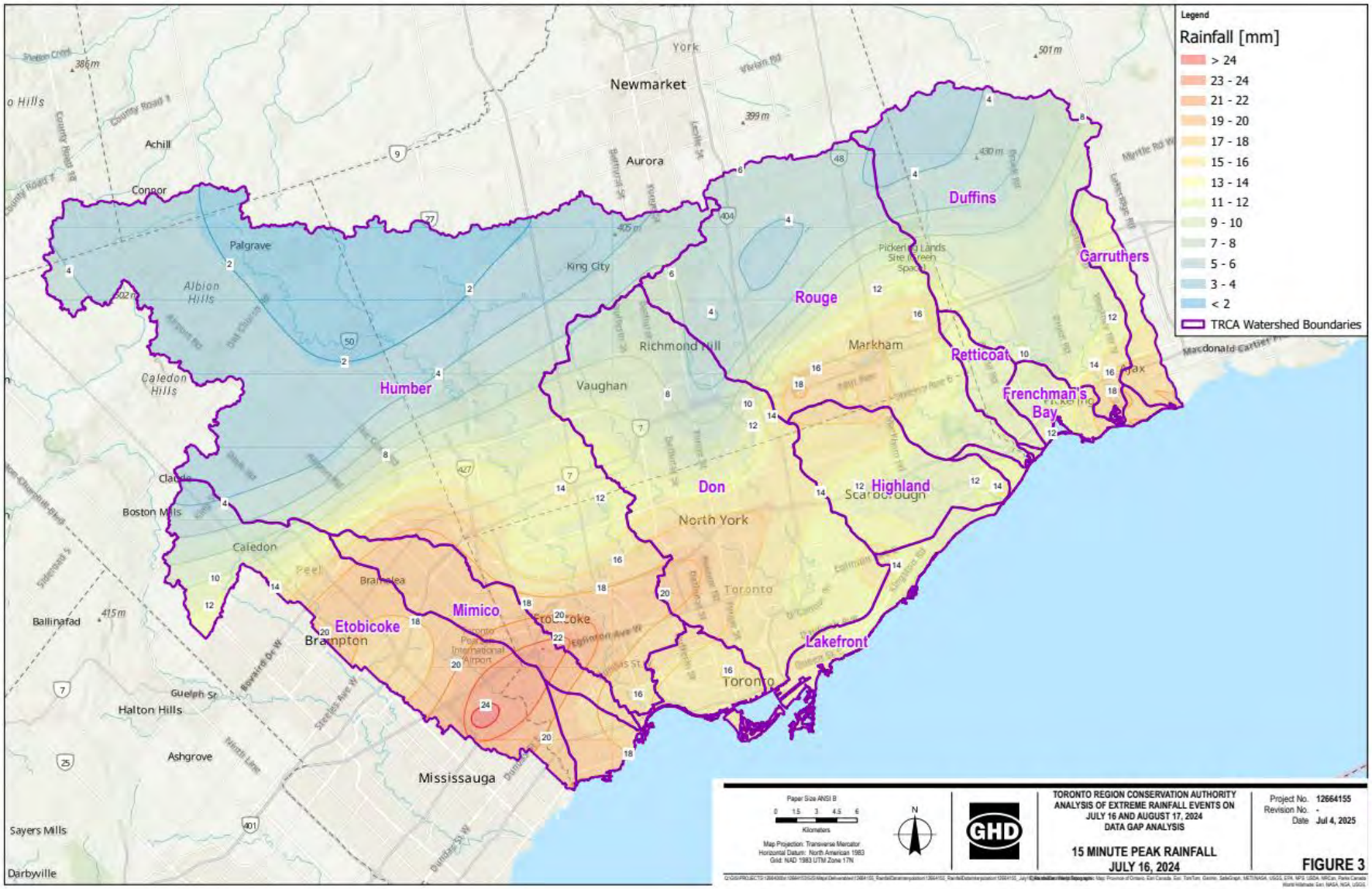


Figure 3 *July 16, 2024 storm event – 15-min rainfall intensity*

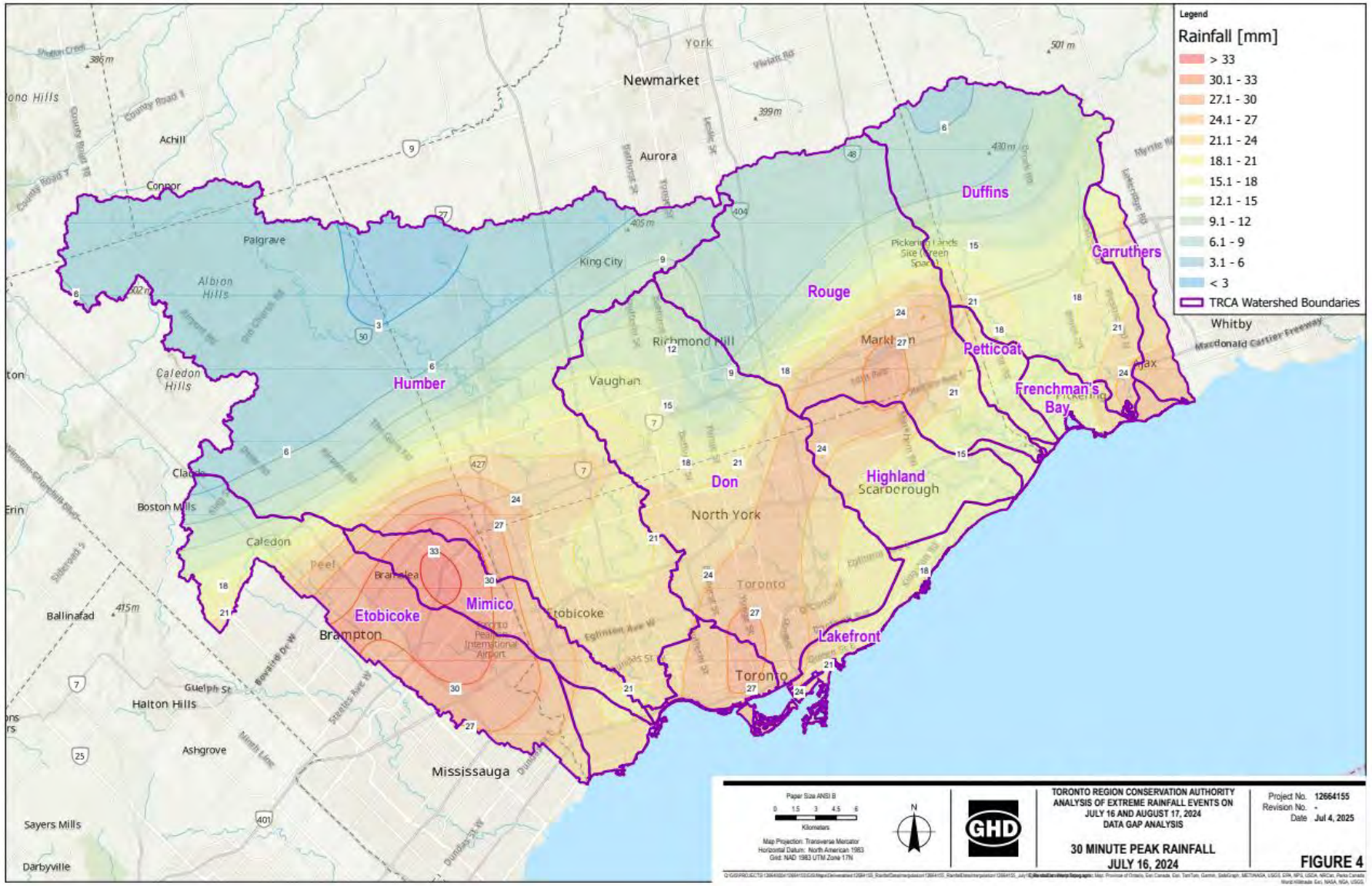


Figure 4 *July 16, 2024 storm event – 30-min rainfall intensity*

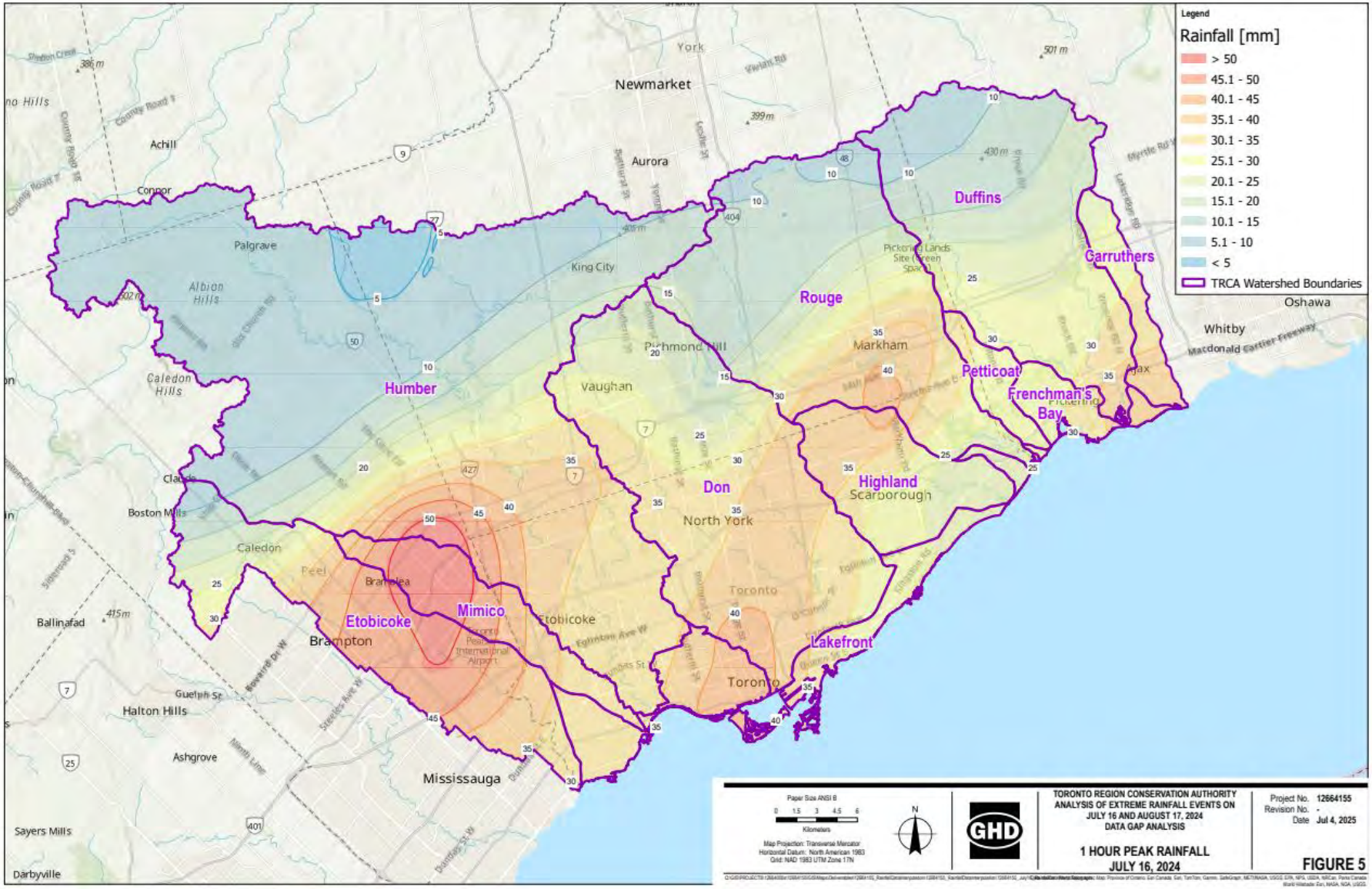


Figure 5 ***July 16, 2024 storm event – 1-hr rainfall intensity***

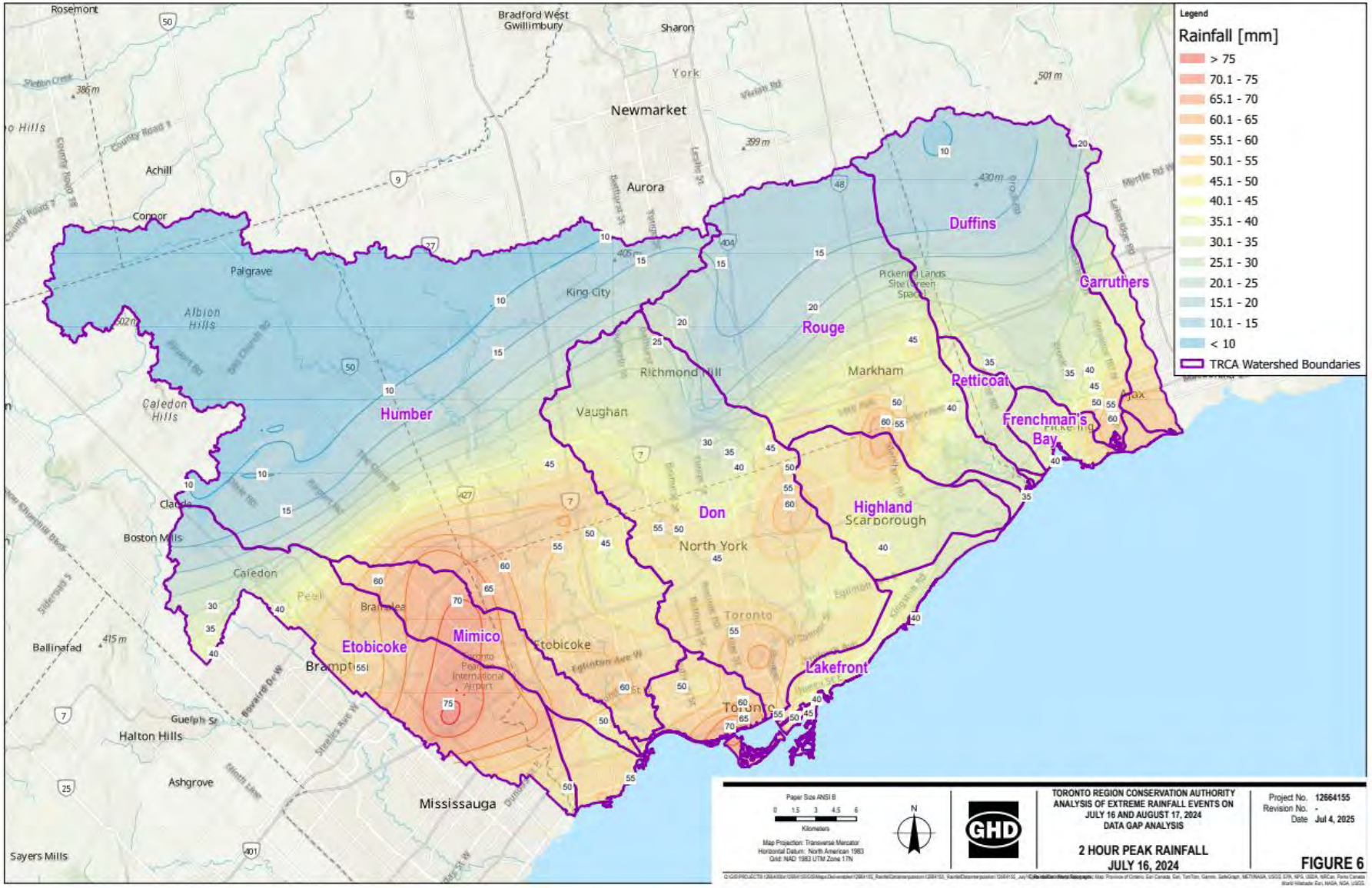


Figure 6 *July 16, 2024 storm event – 2-hr rainfall intensity*

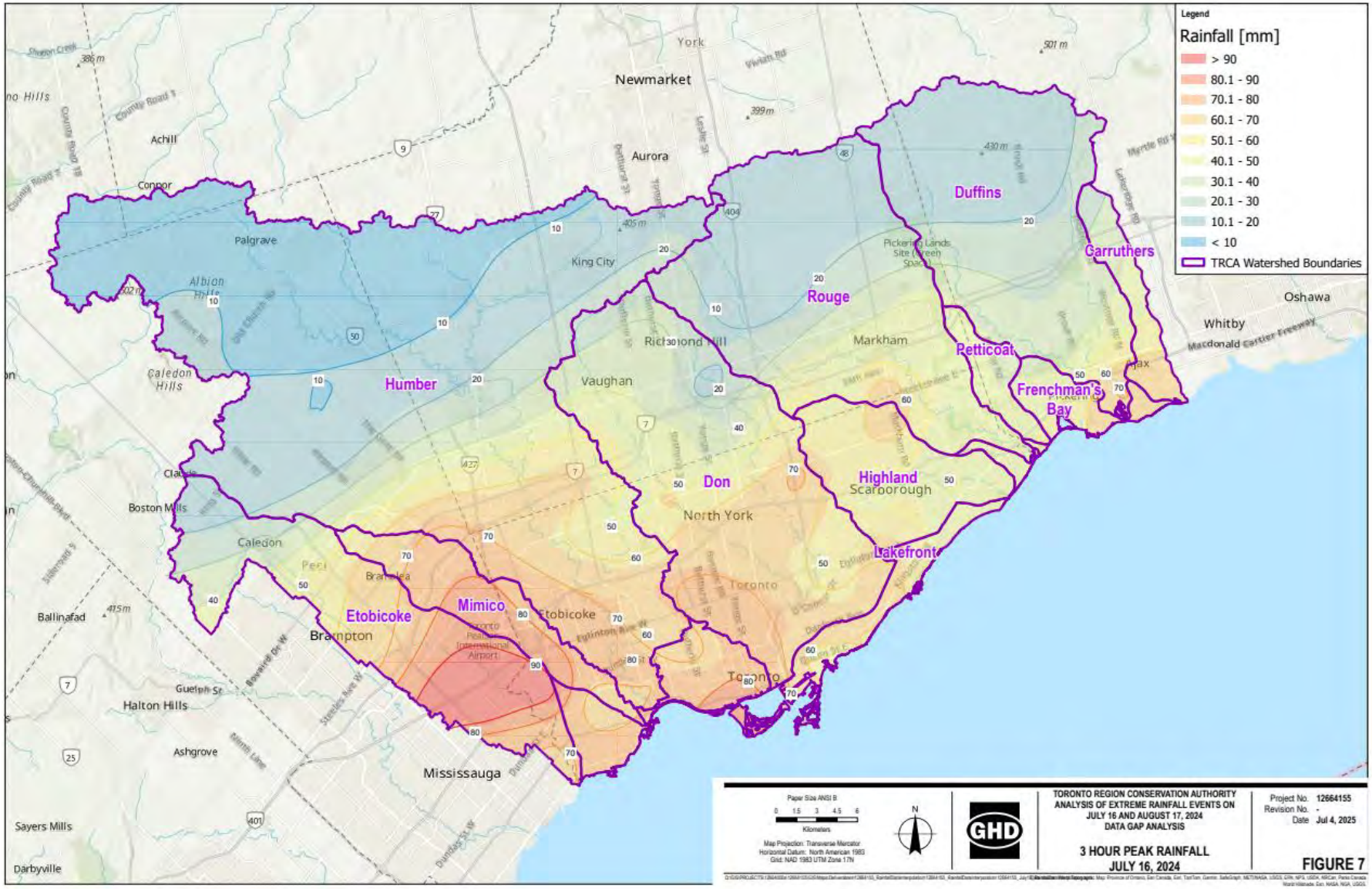


Figure 7 *July 16, 2024 storm event – 3-hr rainfall intensity*

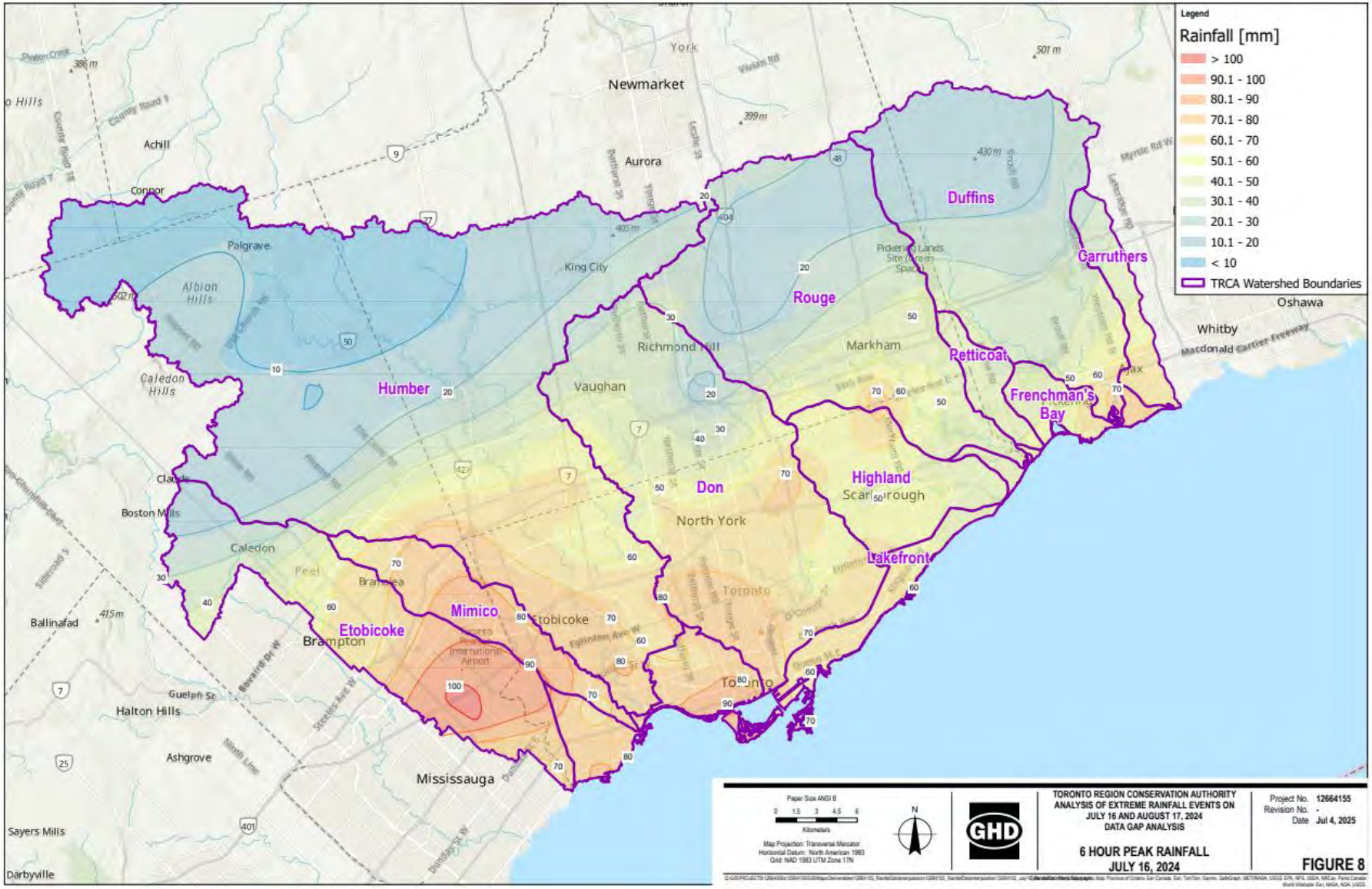


Figure 8 *July 16, 2024 storm event – 6-hr rainfall intensity*

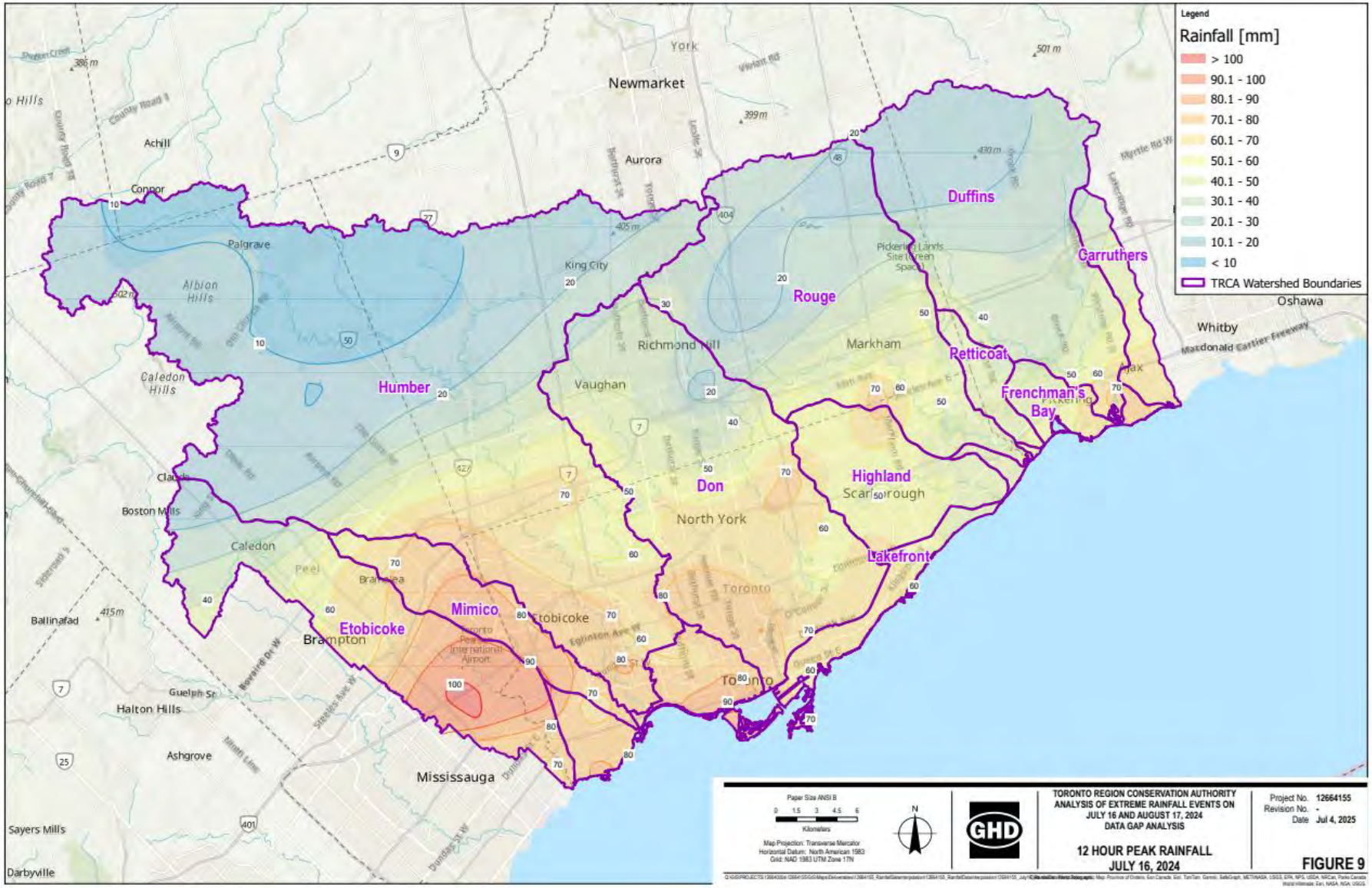


Figure 9 *July 16, 2024 storm event – 12-hr rainfall intensity*

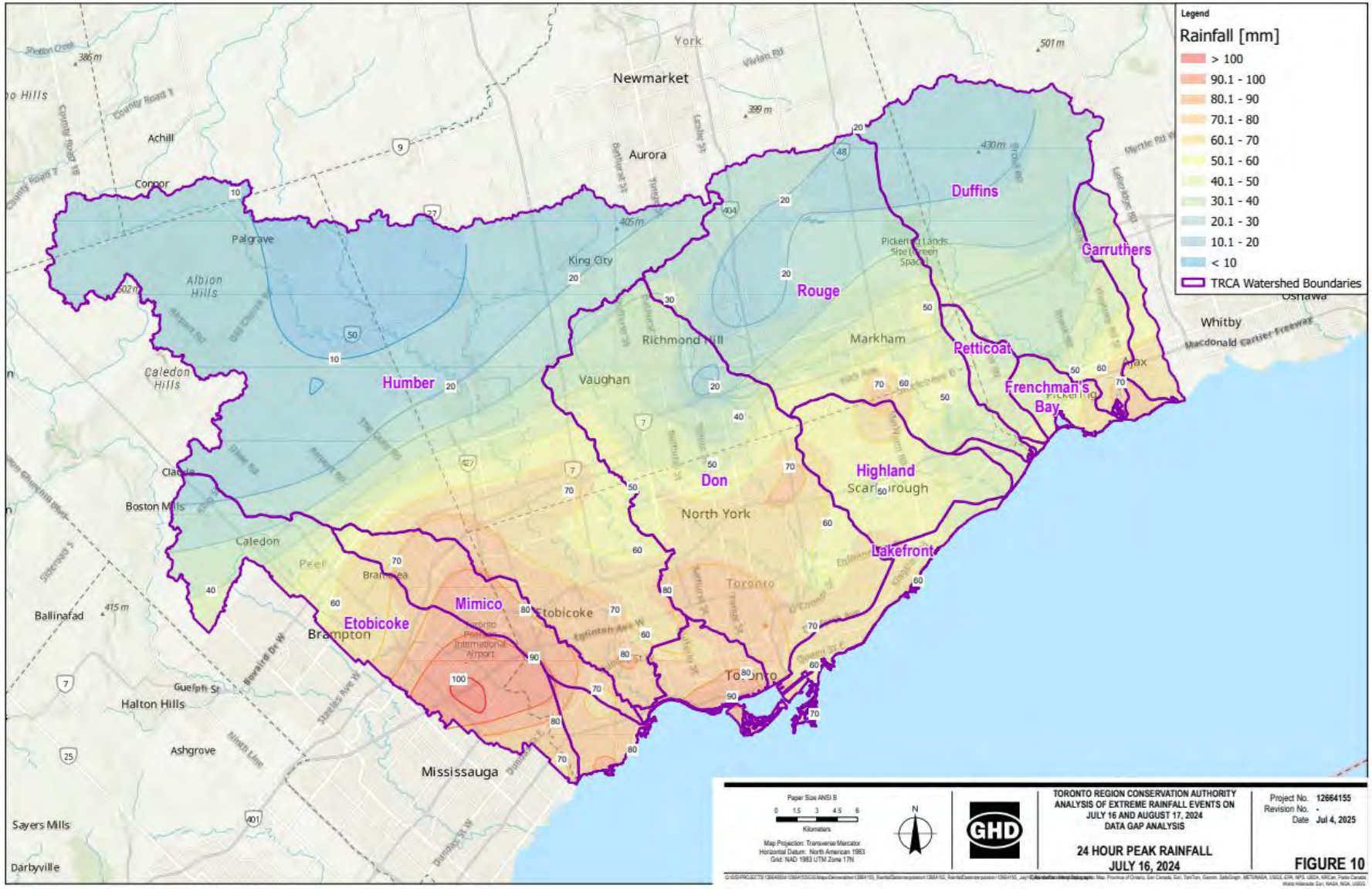


Figure 10 *July 16, 2024 storm event – 24-hr rainfall intensity*

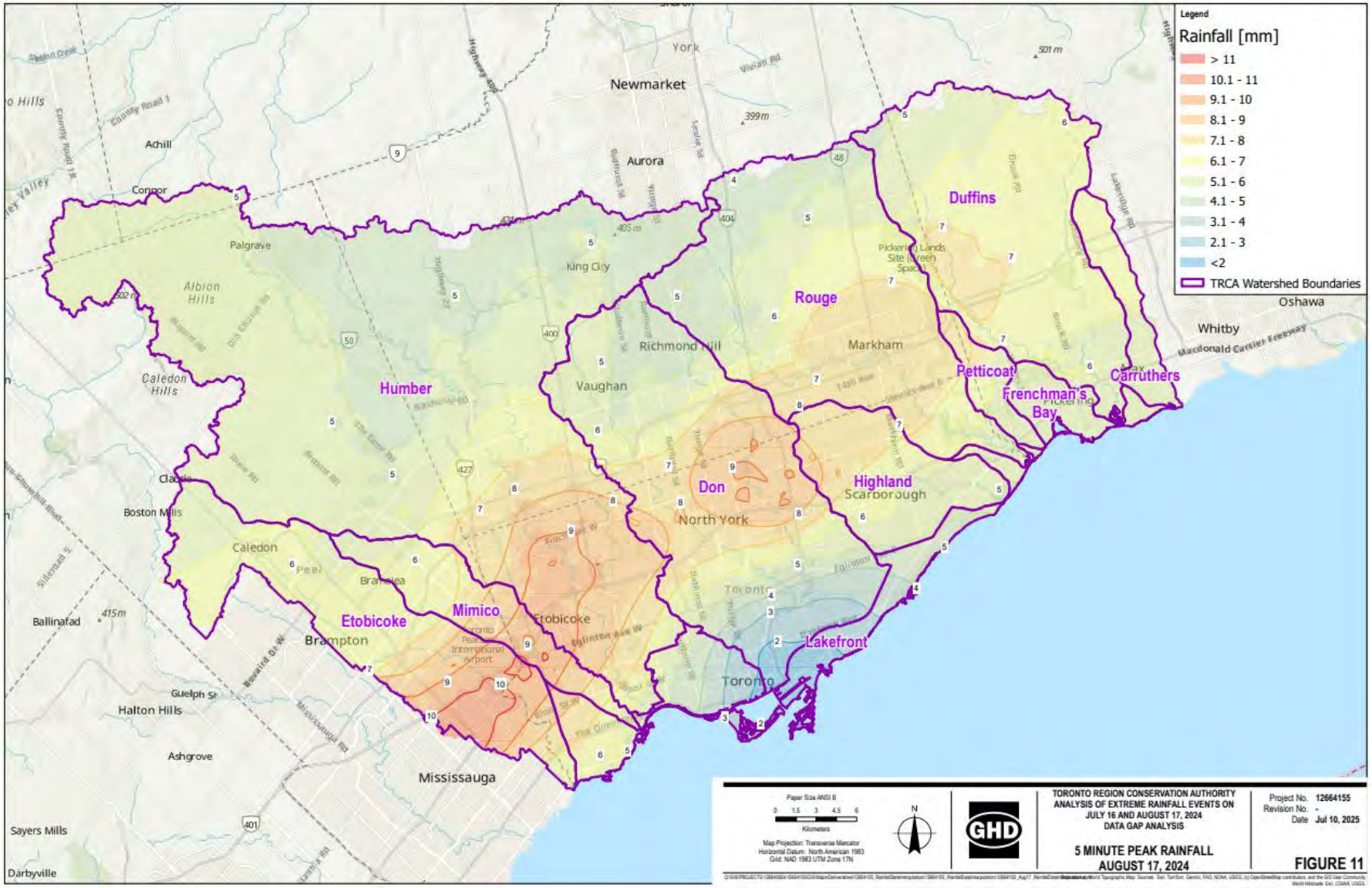


Figure 11 *August 17, 2024 storm event - 5-min rainfall intensity*

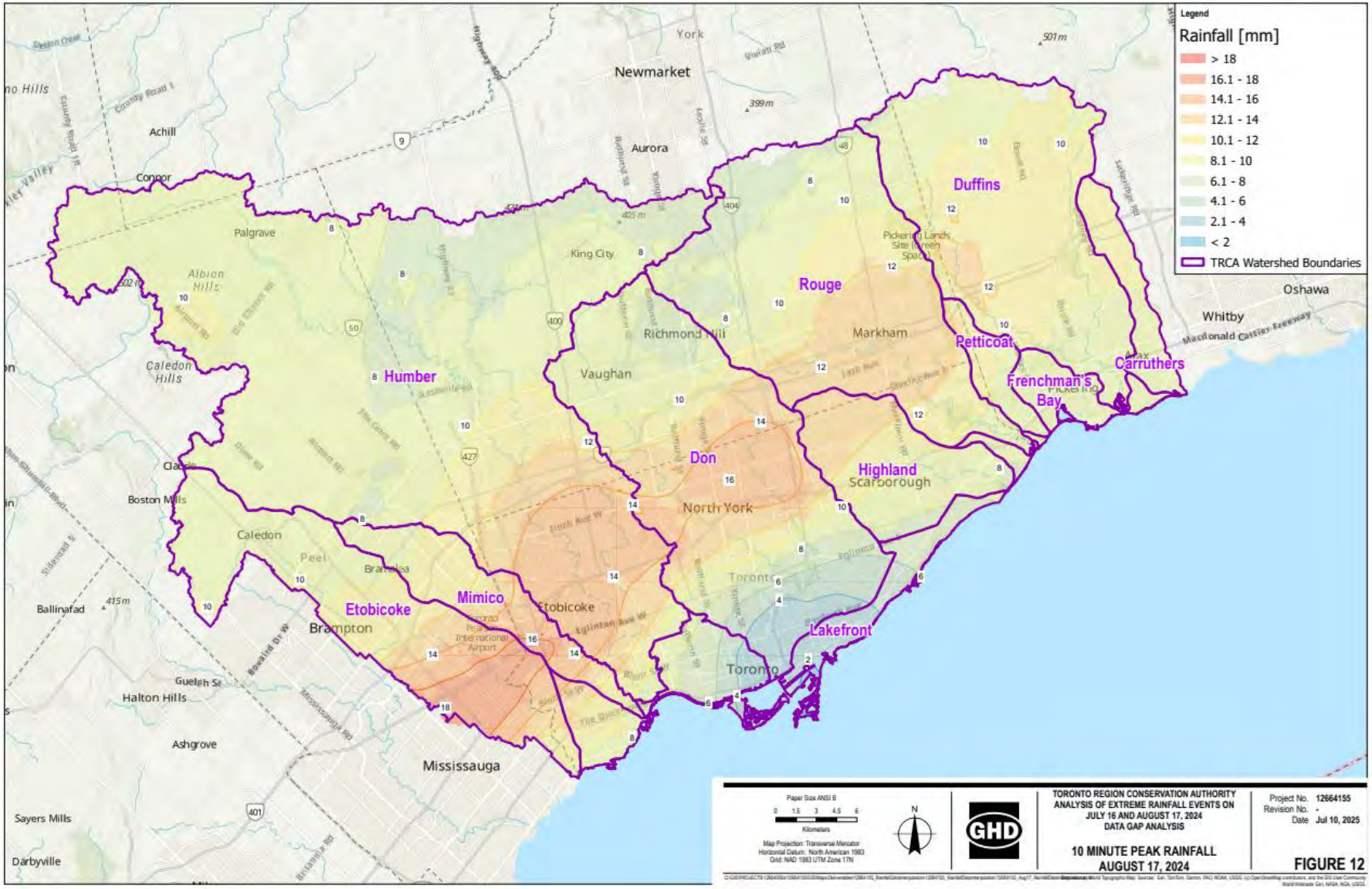


Figure 12 *August 17, 2024 storm event - 10-min rainfall intensity*

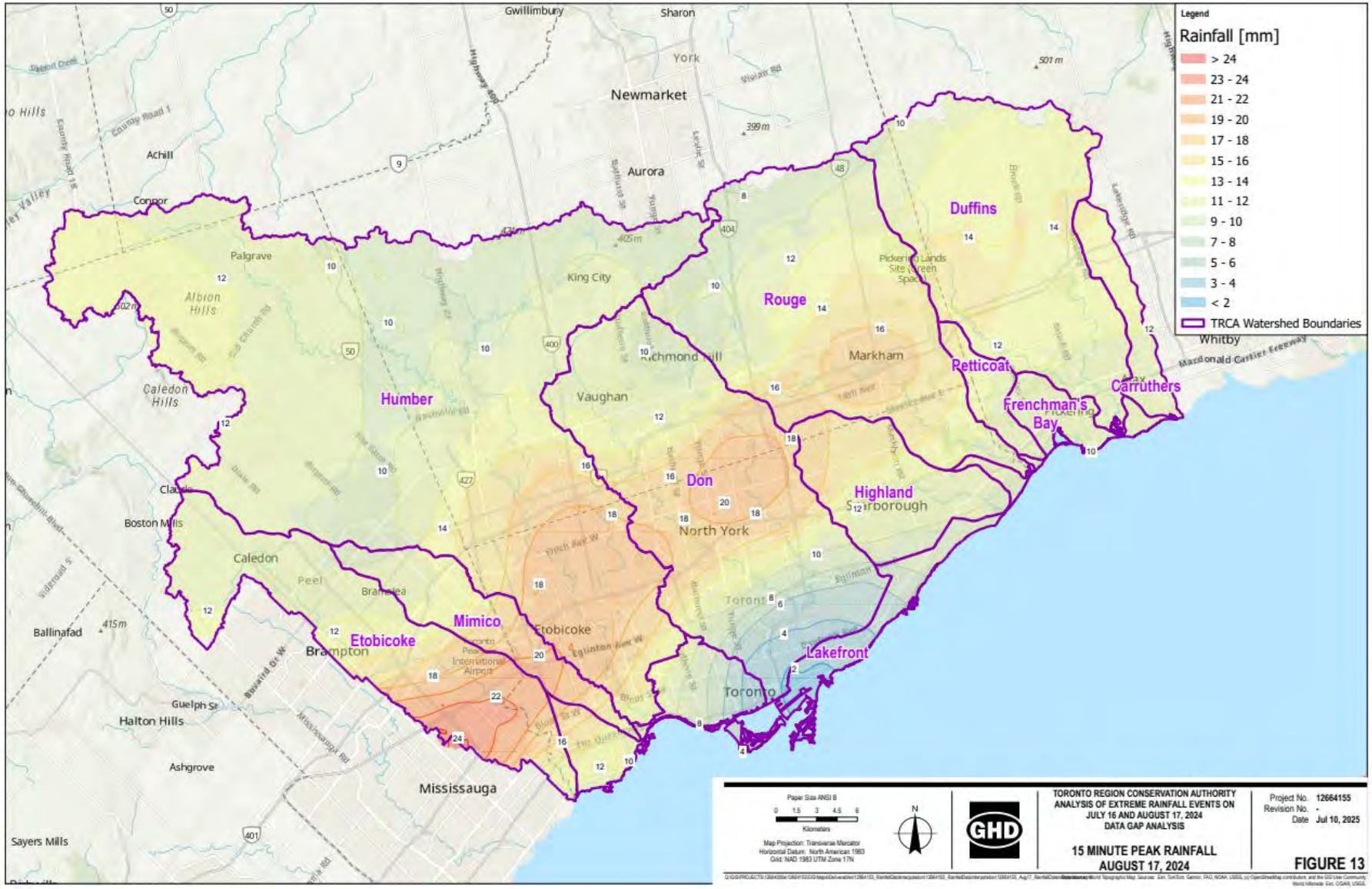


Figure 13 *August 17, 2024 storm event - 15-min rainfall intensity*

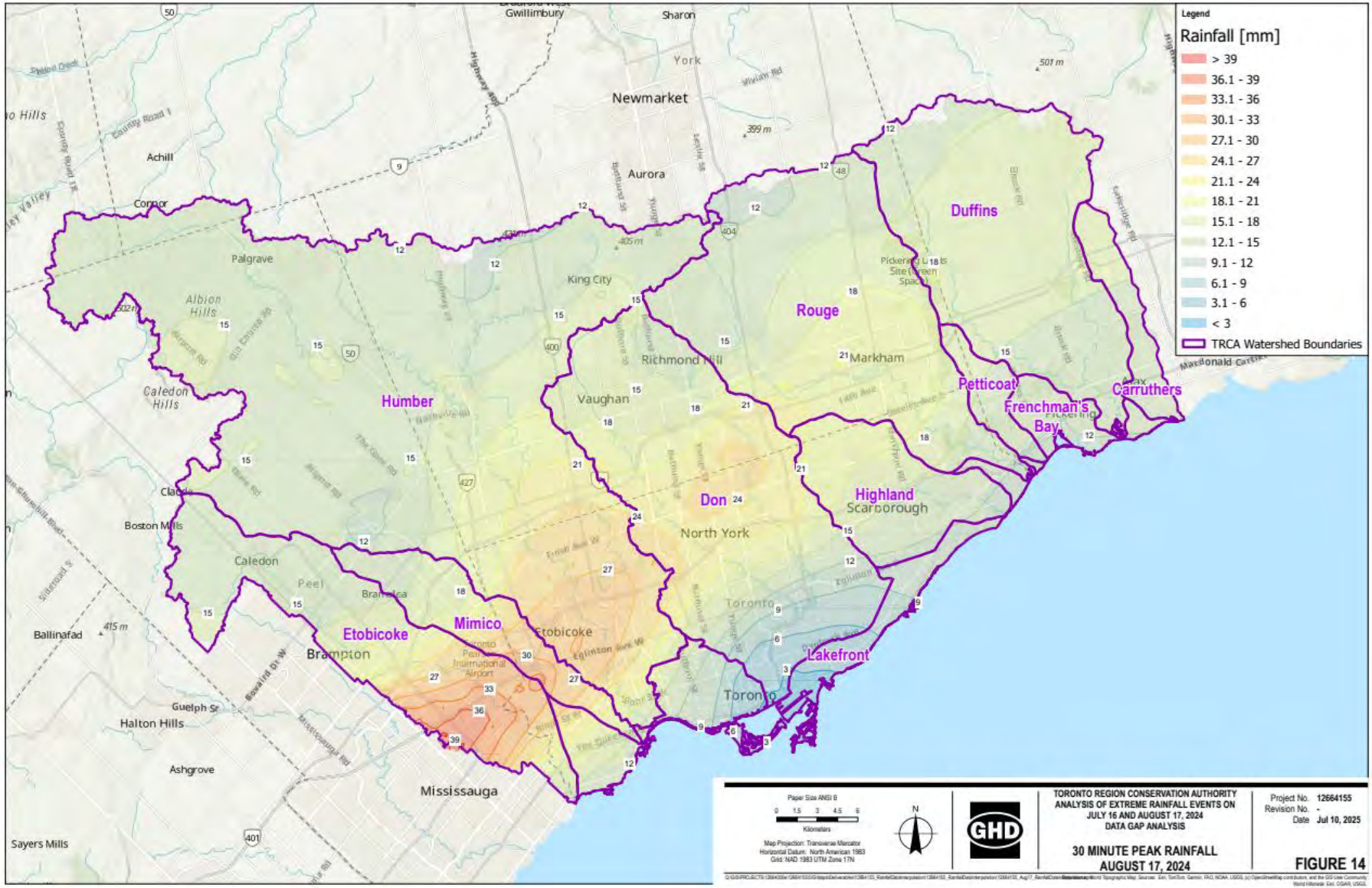


Figure 14 August 17, 2024 storm event - 30-min rainfall intensity

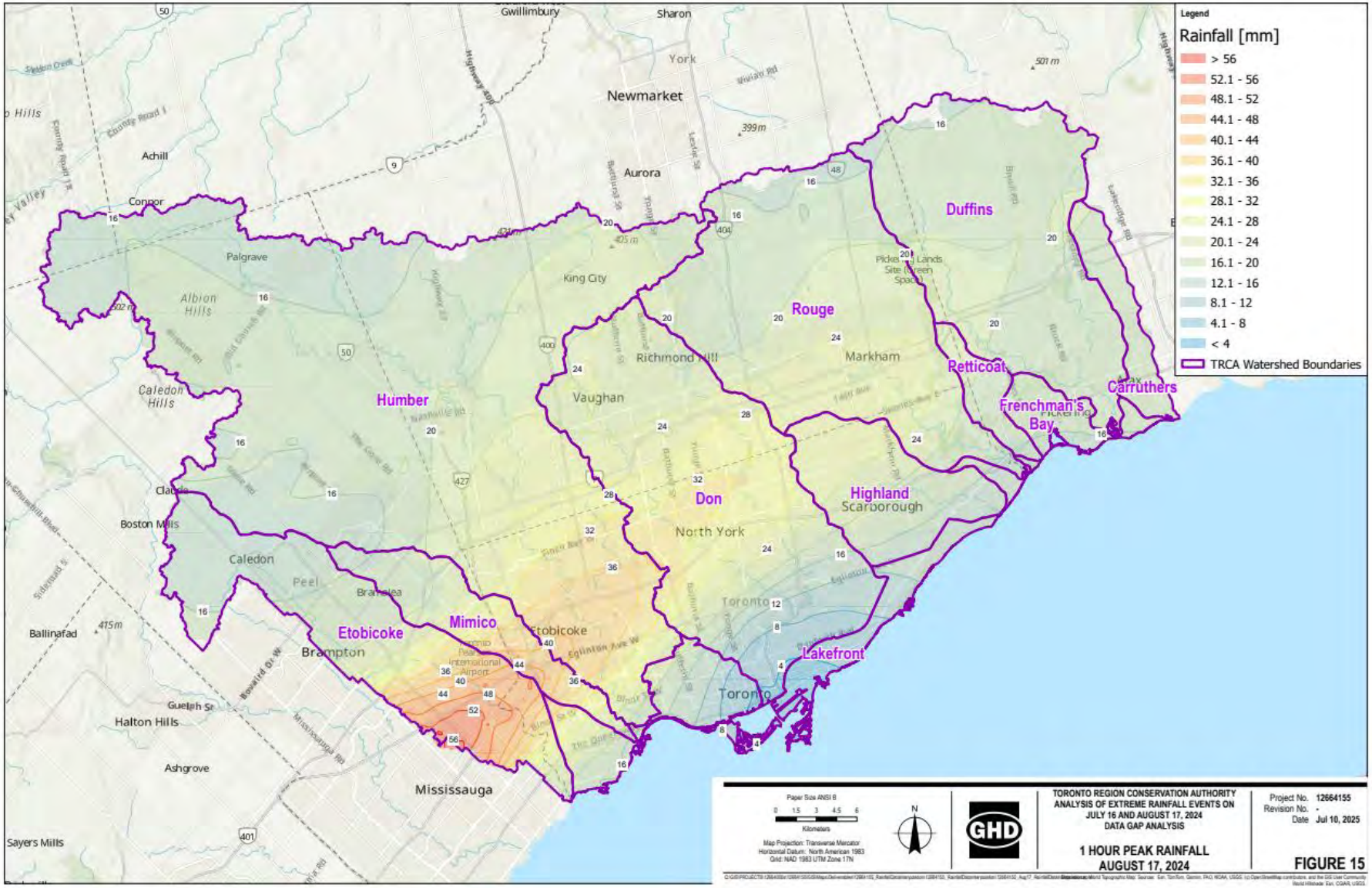


Figure 15 *August 17, 2024 storm event - 1-hr rainfall intensity*

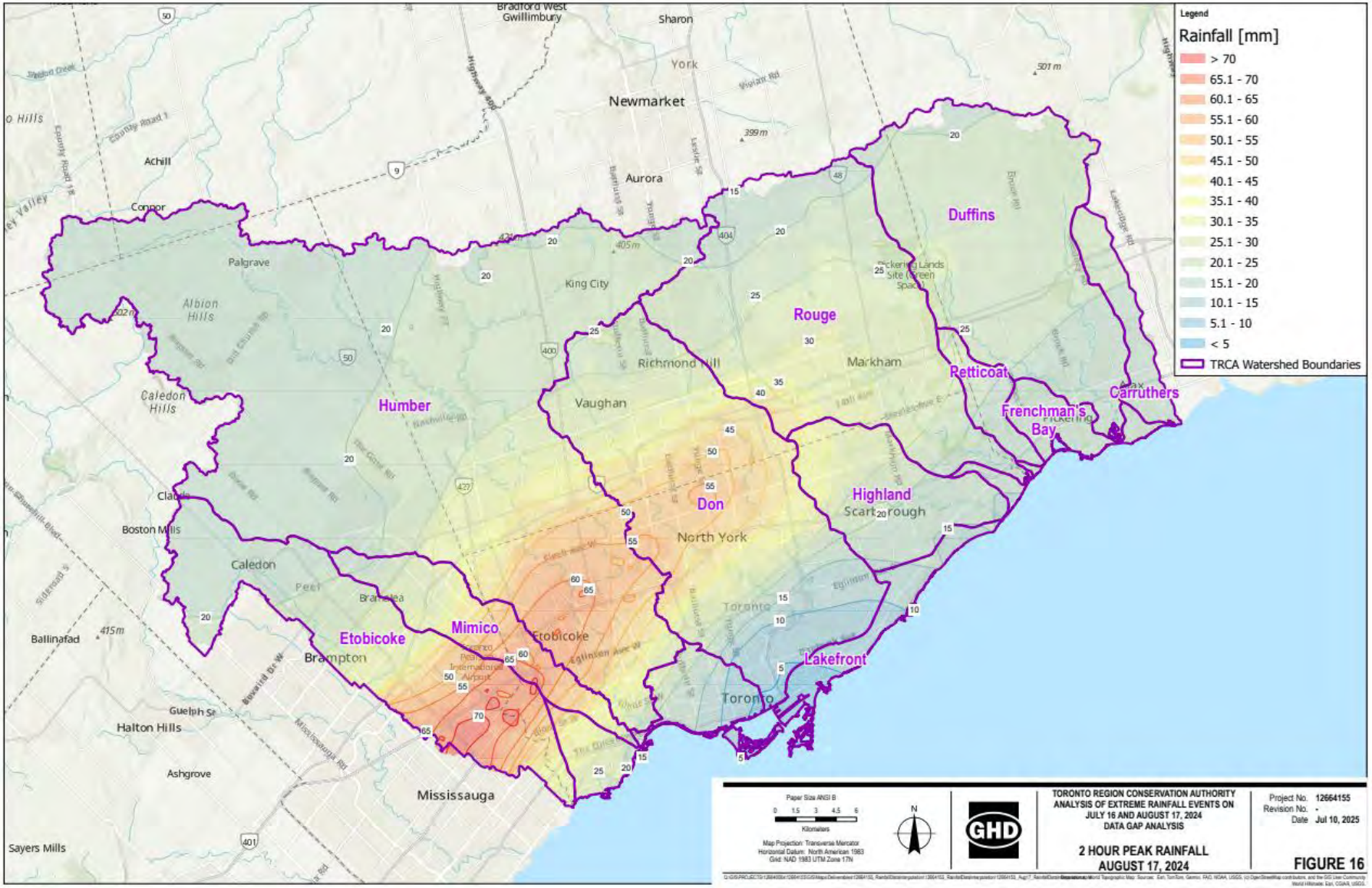


Figure 16 *August 17, 2024 storm event - 2-hr rainfall intensity*

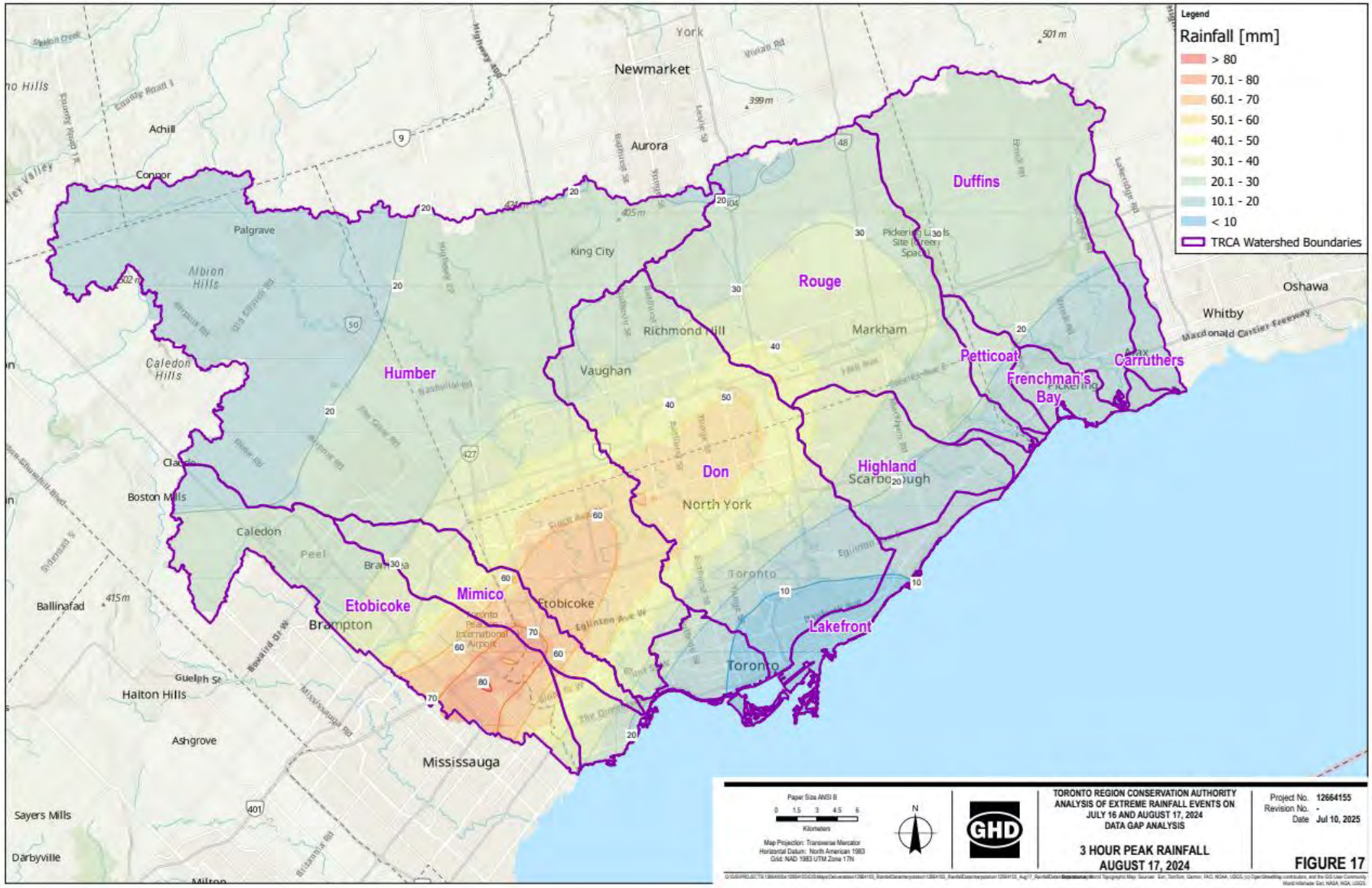


Figure 17 *August 17, 2024 storm event - 3-hr rainfall intensity*

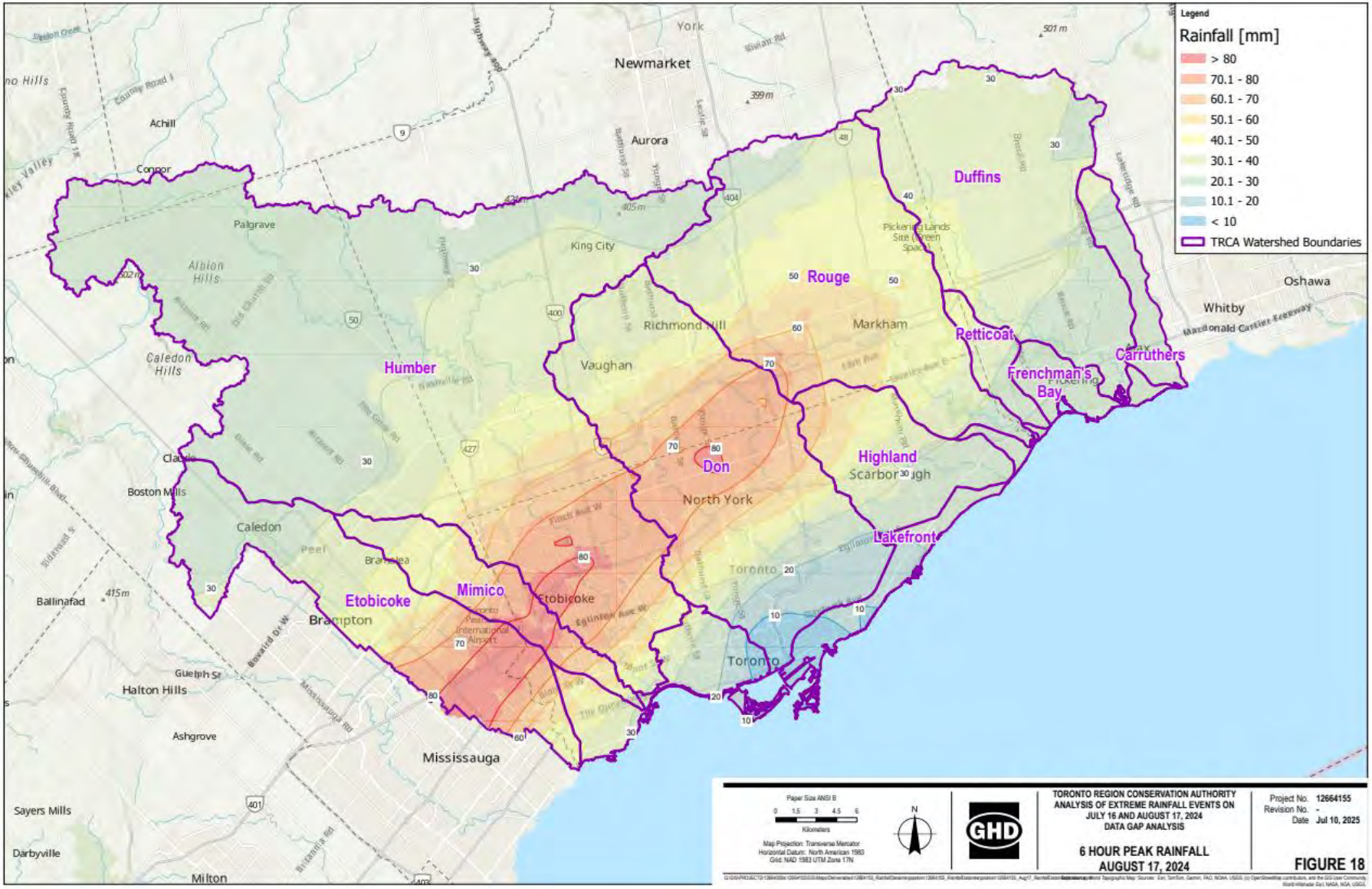


Figure 18 *August 17, 2024 storm event - 6-hr rainfall intensity*

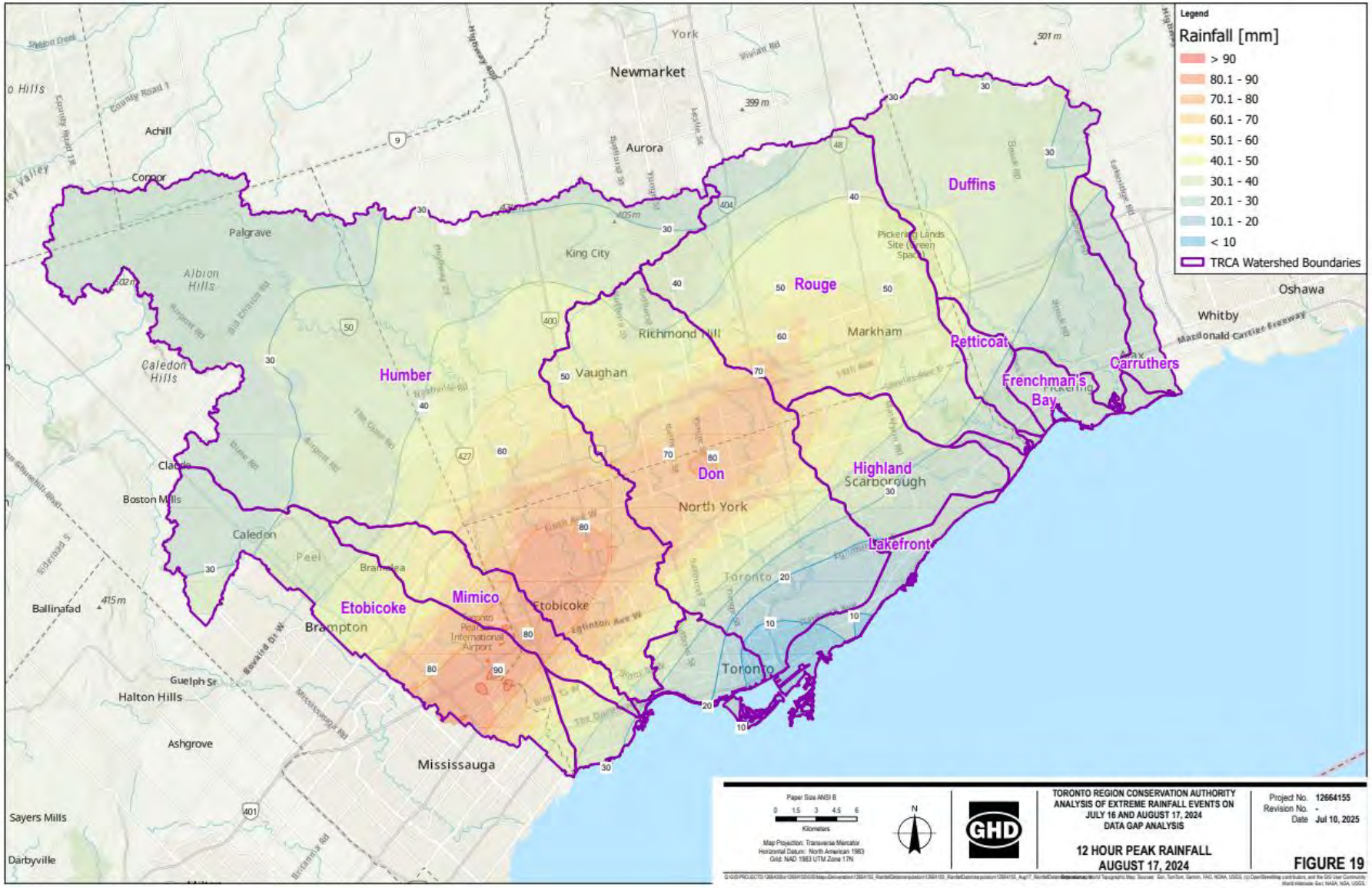


Figure 19 *August 17, 2024 storm event - 12-hr rainfall intensity*

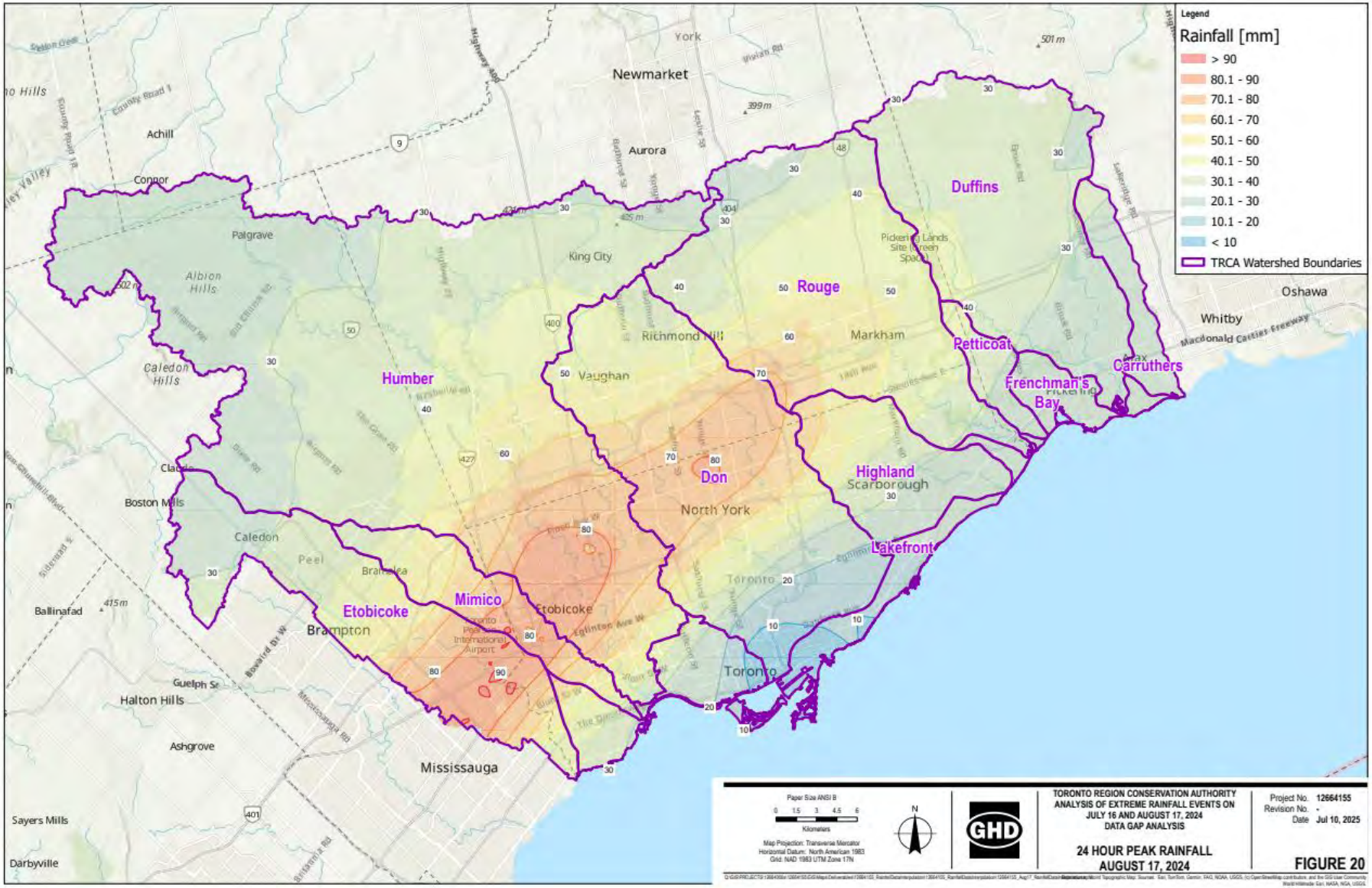


Figure 20 *August 17, 2024 storm event - 24-hr rainfall intensity*

Table 2 Rainfall data of select stations – July 16, 2024

Date/Time	HY099, TRCA	RG23-BritanniaLeachatePumping, Region of Peel	R-MUN-MA-21, City of Markham	HY067, TRCA	RG16-Hanlan, Region of Peel	RG07-Streetsville, City of Mississauga
16/07/2024 0:00	0	0	0	0	0	0
16/07/2024 0:05	0	0	0	0	0	0
16/07/2024 0:10	0	0	0	0	0	0
16/07/2024 0:15	0	0	0	0	0	0
16/07/2024 0:20	0	0	0	0	0	0
16/07/2024 0:25	0	0	0	0	0	0
16/07/2024 0:30	0	0	0	0	0	0
16/07/2024 0:35	0	0	0	0	0	0
16/07/2024 0:40	0	0	0	0	0	0
16/07/2024 0:45	0	0	0	0	0	0
16/07/2024 0:50	0	0	0	0	0	0
16/07/2024 0:55	0	0	0	0	0	0
16/07/2024 1:00	0	0	0	0	0	0
16/07/2024 1:05	0	0	0	0	0	0
16/07/2024 1:10	0	0	0	0	0	0
16/07/2024 1:15	0	0	0	0	0	0
16/07/2024 1:20	0	0	0	0	0	0
16/07/2024 1:25	0	0	0	0	0	0
16/07/2024 1:30	0	0	0	0	0	0
16/07/2024 1:35	0	0	0	0	0	0
16/07/2024 1:40	0	0	0	0	0	0
16/07/2024 1:45	0	0	0	0	0	0

Date/Time	HY099, TRCA	RG23-BritanniaLeachatePumping, Region of Peel	R-MUN-MA-21, City of Markham	HY067, TRCA	RG16-Hanlan, Region of Peel	RG07-Streetsville, City of Mississauga
16/07/2024 1:50	0	0	0	0	0	0
16/07/2024 1:55	0	0	0	0	0	0
16/07/2024 2:00	0	0	0	0	0	0
16/07/2024 2:05	0	0	0	0	0	0
16/07/2024 2:10	0	0	0	0	0	0
16/07/2024 2:15	0	0	0	0	0	0
16/07/2024 2:20	0	0	0	0	0	0
16/07/2024 2:25	0	0	0	0	0	0
16/07/2024 2:30	0	0	0	0	0	0
16/07/2024 2:35	0	0	0	0	0	0
16/07/2024 2:40	0	0	0	0	0	0
16/07/2024 2:45	0	0	0	0	0	0
16/07/2024 2:50	0	0	0	0	0	0
16/07/2024 2:55	0	0	0	0	0	0
16/07/2024 3:00	0	0	0	0	0	0
16/07/2024 3:05	0	0	0	0	0	0
16/07/2024 3:10	0	0	0	0	0	0
16/07/2024 3:15	0	0	0	0	0	0
16/07/2024 3:20	0	0	0	0	0	0
16/07/2024 3:25	0	0	0	0	0	0
16/07/2024 3:30	0	0	0	0	0	0
16/07/2024 3:35	0	0	0	0	0	0
16/07/2024 3:40	0	0	0	0	0	0
16/07/2024 3:45	0	0	0	0	0	0
16/07/2024 3:50	0	0	0	0	0	0
16/07/2024 3:55	0	0	0	0	0	0

Date/Time	HY099, TRCA	RG23-BritanniaLeachatePumping, Region of Peel	R-MUN-MA-21, City of Markham	HY067, TRCA	RG16-Hanlan, Region of Peel	RG07-Streetsville, City of Mississauga
16/07/2024 4:00	0	0	0	0	0	0
16/07/2024 4:05	0	0	0	0	0	0
16/07/2024 4:10	0	0	0	0	0	0
16/07/2024 4:15	0	0	0	0	0	0
16/07/2024 4:20	0	0	0	0	0	0
16/07/2024 4:25	0	0	0	0	0	0
16/07/2024 4:30	0	0	0	0	0	0
16/07/2024 4:35	0	0	0	0	0	0
16/07/2024 4:40	0	0	0	0	0	0
16/07/2024 4:45	0	0	0	0	0	0
16/07/2024 4:50	0	0	0	0	0	0
16/07/2024 4:55	0	0	0	0	0	0
16/07/2024 5:00	0	0	0	0	0	0
16/07/2024 5:05	0	0	0	0	0	0
16/07/2024 5:10	0	0	0	0	0	0
16/07/2024 5:15	0	0	0	0	0	0
16/07/2024 5:20	0	0	0	0	0	0
16/07/2024 5:25	0	0	0	0	0	0
16/07/2024 5:30	0	0	0	0	0	0
16/07/2024 5:35	0	0	0	0	0	0
16/07/2024 5:40	0	0	0	0	0	0
16/07/2024 5:45	0	0	0	0	0	0
16/07/2024 5:50	0	0	0.5	0	0	0
16/07/2024 5:55	0	0	5.75	0	0	0
16/07/2024 6:00	0	0	0	0	0	0
16/07/2024 6:05	0	0	0	0	0	0

Date/Time	HY099, TRCA	RG23-BritanniaLeachatePumping, Region of Peel	R-MUN-MA-21, City of Markham	HY067, TRCA	RG16-Hanlan, Region of Peel	RG07-Streetsville, City of Mississauga
16/07/2024 6:10	0	0	0	0	0	0
16/07/2024 6:15	0	0	0	0	0	0
16/07/2024 6:20	0	0	0	0	0	0
16/07/2024 6:25	0	0	0	0	0	0
16/07/2024 6:30	0	0	0	0	0	0
16/07/2024 6:35	0	0	0	0	0	0
16/07/2024 6:40	0	0	0	0	0	0
16/07/2024 6:45	0	0	0	0	0	0
16/07/2024 6:50	0	0	0	0	0	0
16/07/2024 6:55	0	0	0	0	0	0
16/07/2024 7:00	0	0	0	0	0	0
16/07/2024 7:05	0	0	0	0	0	0
16/07/2024 7:10	0	0	0	0	0	0
16/07/2024 7:15	0	0	0	0	0	0
16/07/2024 7:20	0	0	0	0	0	0
16/07/2024 7:25	0	0	0	0	0	0
16/07/2024 7:30	0	0	0	0	0	0
16/07/2024 7:35	0	0	0	0	0	0
16/07/2024 7:40	0	0	0	0	0	0
16/07/2024 7:45	0	1.4	0	0	0	0.4
16/07/2024 7:50	0	2.6	0	0	0.6	0.6
16/07/2024 7:55	0.5	13.2	0	0	1.4	3
16/07/2024 8:00	2.3	13.8	0	0.4	7.2	14.6
16/07/2024 8:05	11	0.4	0	0.4	7.4	9.8
16/07/2024 8:10	16	0	0	0.2	3.4	0.2
16/07/2024 8:15	2	0	0	0.8	0	0.4

Date/Time	HY099, TRCA	RG23-BritanniaLeachatePumping, Region of Peel	R-MUN-MA-21, City of Markham	HY067, TRCA	RG16-Hanlan, Region of Peel	RG07-Streetsville, City of Mississauga
16/07/2024 8:20	0.7	0	0	0.6	0.2	0
16/07/2024 8:25	0	0	0	0	0	0
16/07/2024 8:30	0	0	0.25	0	0	0
16/07/2024 8:35	0	0.4	0.25	0	0	0
16/07/2024 8:40	0	2.2	0.5	0.2	0	2.4
16/07/2024 8:45	0.4	2.4	0.75	0.2	1.8	1.8
16/07/2024 8:50	1.4	4.4	0.75	0.4	1.6	4
16/07/2024 8:55	2.5	0.8	0.25	0	3	3.8
16/07/2024 9:00	3.8	0.2	0	0	0.2	0
16/07/2024 9:05	1.6	3	0	2	2	1
16/07/2024 9:10	3.9	1.8	0	1.4	3.6	1.8
16/07/2024 9:15	1.5	0.8	0	0.2	2.2	2.4
16/07/2024 9:20	2.3	0.6	0.25	0.4	1.8	0
16/07/2024 9:25	1.2	3.8	0	6	2.2	1.2
16/07/2024 9:30	1.3	3.6	0.75	6.8	2.6	1.4
16/07/2024 9:35	2.9	4.2	1.75	3	2.4	3.8
16/07/2024 9:40	1.3	4.6	2.25	5	4	5.8
16/07/2024 9:45	1.8	3	0.75	1.4	5.8	5.4
16/07/2024 9:50	5.4	4.6	0.75	3.6	5	5.4
16/07/2024 9:55	4.4	5	0.5	7	2.8	4.4
16/07/2024 10:00	1.8	5.2	0.75	7.2	2.6	3.8
16/07/2024 10:05	2.2	2.4	0.25	4	5.6	1
16/07/2024 10:10	3.4	3.8	1.75	3.4	3.8	2.2
16/07/2024 10:15	3.3	1.8	2.75	7.2	2	1.2
16/07/2024 10:20	1.3	2.4	0.5	4	4.8	5
16/07/2024 10:25	1.2	2.8	0.25	1.6	8	6.2

Date/Time	HY099, TRCA	RG23-BritanniaLeachatePumping, Region of Peel	R-MUN-MA-21, City of Markham	HY067, TRCA	RG16-Hanlan, Region of Peel	RG07-Streetsville, City of Mississauga
16/07/2024 10:30	4.3	2.6	3.75	1	6	6
16/07/2024 10:35	7.7	1.8	6.5	0.4	2.4	2
16/07/2024 10:40	2.8	1	3.5	0.6	1.4	1.4
16/07/2024 10:45	1.4	0.6	6.25	0.6	0.6	0.6
16/07/2024 10:50	1.2	0.2	6.75	0.6	0.2	0.4
16/07/2024 10:55	0.7	0.2	7.5	0.2	0.6	0.2
16/07/2024 11:00	0.4	0.2	4.75	0.2	0.4	0.2
16/07/2024 11:05	0.3	0	5.75	0.4	0.6	0.2
16/07/2024 11:10	0.4	0	5.5	0.2	0.2	0
16/07/2024 11:15	0.3	0.2	2.25	0.2	0	0
16/07/2024 11:20	0.2	0	0.5	0	0.2	0
16/07/2024 11:25	0.1	0	0.75	0	0	0
16/07/2024 11:30	0.1	0	0.5	0	0	0
16/07/2024 11:35	0.1	0	0	0.4	0	0
16/07/2024 11:40	0.1	0	0.25	0	0.2	0
16/07/2024 11:45	0	0	0.25	0	0	0
16/07/2024 11:50	0	0	0	0	0	0
16/07/2024 11:55	0	0	0	0	0	0
16/07/2024 12:00	0	0	0	0	0	0
16/07/2024 12:05	0	0	0	0	0	0
16/07/2024 12:10	0	0	0.25	0	0	0
16/07/2024 12:15	0	0	0	0	0	0
16/07/2024 12:20	0	0	0	0	0	0
16/07/2024 12:25	0	0	0	0	0	0
16/07/2024 12:30	0	0	0	0	0	0
16/07/2024 12:35	0	0	0	0	0	0

Date/Time	HY099, TRCA	RG23-BritanniaLeachatePumping, Region of Peel	R-MUN-MA-21, City of Markham	HY067, TRCA	RG16-Hanlan, Region of Peel	RG07-Streetsville, City of Mississauga
16/07/2024 12:40	0	0	0	0	0	0
16/07/2024 12:45	0	0	0	0	0	0
16/07/2024 12:50	0	0	0	0	0	0
16/07/2024 12:55	0	0	0	0	0	0
16/07/2024 13:00	0	0	0	0	0	0
16/07/2024 13:05	0	0	0	0	0	0
16/07/2024 13:10	0	0	0	0	0	0
16/07/2024 13:15	0	0	0	0	0	0
16/07/2024 13:20	0	0	0	0	0	0
16/07/2024 13:25	0	0	0	0	0	0
16/07/2024 13:30	0	0	0	0	0	0
16/07/2024 13:35	0	0	0	0	0	0
16/07/2024 13:40	0	0	0	0	0	0
16/07/2024 13:45	0	0	0	0	0	0
16/07/2024 13:50	0	0	0	0	0	0
16/07/2024 13:55	0	0	0	0	0	0.2
16/07/2024 14:00	0	0	0	0	0	0
16/07/2024 14:05	0	0	0	0	0	0
16/07/2024 14:10	0	0	0	0	0	0
16/07/2024 14:15	0	0	0	0	0	0
16/07/2024 14:20	0	0	0	0	0	0
16/07/2024 14:25	0	0	0	0	0	0
16/07/2024 14:30	0	0	0	0	0	0
16/07/2024 14:35	0	0	0	0	0	0
16/07/2024 14:40	0	0	0	0	0	0
16/07/2024 14:45	0	0	0	0	0	0

Date/Time	HY099, TRCA	RG23-BritanniaLeachatePumping, Region of Peel	R-MUN-MA-21, City of Markham	HY067, TRCA	RG16-Hanlan, Region of Peel	RG07-Streetsville, City of Mississauga
16/07/2024 14:50	0	0	0	0	0	0
16/07/2024 14:55	0	0	0	0	0	0
16/07/2024 15:00	0	0	0	0	0	0
16/07/2024 15:05	0	0	0	0	0	0
16/07/2024 15:10	0	0	0	0	0	0
16/07/2024 15:15	0	0	0	0	0	0
16/07/2024 15:20	0	0	0	0	0	0
16/07/2024 15:25	0	0	0	0	0	0
16/07/2024 15:30	0	0	0	0	0	0
16/07/2024 15:35	0	0	0	0	0	0
16/07/2024 15:40	0	0	0	0	0	0
16/07/2024 15:45	0	0	0	0	0	0
16/07/2024 15:50	0	0	0	0	0	0
16/07/2024 15:55	0	0	0	0	0	0
16/07/2024 16:00	0	0	0	0	0	0
16/07/2024 16:05	0	0	0	0	0	0
16/07/2024 16:10	0	0	0	0	0	0
16/07/2024 16:15	0	0	0	0	0	0
16/07/2024 16:20	0	0	0	0	0	0
16/07/2024 16:25	0	0	0	0	0	0
16/07/2024 16:30	0	0	0	0	0	0
16/07/2024 16:35	0	0	0	0	0	0
16/07/2024 16:40	0	0	0	0	0	0
16/07/2024 16:45	0	0	0	0	0	0
16/07/2024 16:50	0	0	0	0	0	0
16/07/2024 16:55	0	0	0	0	0	0

Date/Time	HY099, TRCA	RG23-BritanniaLeachatePumping, Region of Peel	R-MUN-MA-21, City of Markham	HY067, TRCA	RG16-Hanlan, Region of Peel	RG07-Streetsville, City of Mississauga
16/07/2024 17:00	0	0	0	0	0	0
16/07/2024 17:05	0	0	0	0	0	0
16/07/2024 17:10	0	0	0	0	0	0
16/07/2024 17:15	0	0	0	0	0	0
16/07/2024 17:20	0	0	0	0	0	0
16/07/2024 17:25	0	0	0	0	0	0
16/07/2024 17:30	0	0	0	0	0	0
16/07/2024 17:35	0	0	0	0	0	0
16/07/2024 17:40	0	0	0	0	0	0
16/07/2024 17:45	0	0	0	0	0	0
16/07/2024 17:50	0	0	0	0	0	0
16/07/2024 17:55	0	0	0	0	0	0
16/07/2024 18:00	0	0	0	0	0	0
16/07/2024 18:05	0	0	0	0	0	0
16/07/2024 18:10	0	0	0	0	0	0
16/07/2024 18:15	0	0	0	0	0	0
16/07/2024 18:20	0	0	0	0	0	0
16/07/2024 18:25	0	0	0	0	0	0
16/07/2024 18:30	0	0	0	0	0	0
16/07/2024 18:35	0	0	0	0	0	0
16/07/2024 18:40	0	0	0	0	0	0
16/07/2024 18:45	0	0	0	0	0	0
16/07/2024 18:50	0	0	0	0	0	0
16/07/2024 18:55	0	0	0	0	0	0
16/07/2024 19:00	0	0	0	0	0	0
16/07/2024 19:05	0	0	0	0	0	0

Date/Time	HY099, TRCA	RG23-BritanniaLeachatePumping, Region of Peel	R-MUN-MA-21, City of Markham	HY067, TRCA	RG16-Hanlan, Region of Peel	RG07-Streetsville, City of Mississauga
16/07/2024 19:10	0	0	0	0	0	0
16/07/2024 19:15	0	0	0	0	0	0
16/07/2024 19:20	0	0	0	0	0	0
16/07/2024 19:25	0	0	0	0	0	0
16/07/2024 19:30	0	0	0	0	0	0
16/07/2024 19:35	0	0	0	0	0	0
16/07/2024 19:40	0	0	0	0	0	0
16/07/2024 19:45	0	0	0	0	0	0
16/07/2024 19:50	0	0	0	0	0	0
16/07/2024 19:55	0	0	0	0	0	0
16/07/2024 20:00	0	0	0	0	0	0
16/07/2024 20:05	0	0	0	0	0	0
16/07/2024 20:10	0	0	0	0	0	0
16/07/2024 20:15	0	0	0	0	0	0
16/07/2024 20:20	0	0	0	0	0	0
16/07/2024 20:25	0	0	0	0	0	0
16/07/2024 20:30	0	0	0	0	0	0
16/07/2024 20:35	0	0	0	0	0	0
16/07/2024 20:40	0	0	0	0	0	0
16/07/2024 20:45	0	0	0	0	0	0
16/07/2024 20:50	0	0	0	0	0	0
16/07/2024 20:55	0	0	0	0	0	0
16/07/2024 21:00	0	0	0	0	0	0
16/07/2024 21:05	0	0	0	0	0	0
16/07/2024 21:10	0	0	0	0	0	0
16/07/2024 21:15	0	0	0	0	0	0

Date/Time	HY099, TRCA	RG23-BritanniaLeachatePumping, Region of Peel	R-MUN-MA-21, City of Markham	HY067, TRCA	RG16-Hanlan, Region of Peel	RG07-Streetsville, City of Mississauga
16/07/2024 21:20	0	0	0	0	0	0
16/07/2024 21:25	0	0	0	0	0	0
16/07/2024 21:30	0	0	0	0	0	0
16/07/2024 21:35	0	0	0	0	0	0
16/07/2024 21:40	0	0	0	0	0	0
16/07/2024 21:45	0	0	0	0	0	0
16/07/2024 21:50	0	0	0	0.4	0	0
16/07/2024 21:55	0	0	0	0	0	0
16/07/2024 22:00	0	0	0	0	0	0
16/07/2024 22:05	0	0	0	0	0	0
16/07/2024 22:10	0	0	0	0	0	0
16/07/2024 22:15	0	0	0	0	0	0
16/07/2024 22:20	0	0	0	0.4	0	0
16/07/2024 22:25	0	0	0	0	0	0
16/07/2024 22:30	0	0	0	0	0	0
16/07/2024 22:35	0	0	0	0	0	0
16/07/2024 22:40	0	0	0	0	0	0
16/07/2024 22:45	0	0	0	0	0	0
16/07/2024 22:50	0	0	0	0	0	0
16/07/2024 22:55	0	0	0	0	0	0
16/07/2024 23:00	0	0	0	0	0	0
16/07/2024 23:05	0	0	0	0	0	0
16/07/2024 23:10	0	0	0	0	0	0
16/07/2024 23:15	0	0	0	0	0	0
16/07/2024 23:20	0	0	0	0	0	0
16/07/2024 23:25	0	0	0	0	0	0

Date/Time	HY099, TRCA	RG23-BritanniaLeachatePumping, Region of Peel	R-MUN-MA-21, City of Markham	HY067, TRCA	RG16-Hanlan, Region of Peel	RG07-Streetsville, City of Mississauga
16/07/2024 23:30	0	0	0	0	0	0
16/07/2024 23:35	0	0	0	0	0	0
16/07/2024 23:40	0	0	0	0	0	0
16/07/2024 23:45	0	0	0	0	0	0
16/07/2024 23:50	0	0	0	0	0	0
16/07/2024 23:55	0	0	0	0	0	0

Table 3 Rainfall data of select stations – August 17, 2024

Date/Time	RG_024, City of Toronto	St.HilaryRG, Region of Peel	HY099, TRCA
17/08/2024 0:00	0	0	0
17/08/2024 0:05	0	0	0
17/08/2024 0:10	0	0	0
17/08/2024 0:15	0	0	0
17/08/2024 0:20	0	0	0
17/08/2024 0:25	0	0	0
17/08/2024 0:30	0	0	0
17/08/2024 0:35	0	0	0
17/08/2024 0:40	0	0	0
17/08/2024 0:45	0	0	0
17/08/2024 0:50	0	0	0
17/08/2024 0:55	0	0	0
17/08/2024 1:00	0	0	0
17/08/2024 1:05	0	0	0
17/08/2024 1:10	0	0	0
17/08/2024 1:15	0	0	0

Date/Time	RG_024, City of Toronto	St.HilaryRG, Region of Peel	HY099, TRCA
17/08/2024 1:20	0	0	0
17/08/2024 1:25	0	0	0
17/08/2024 1:30	0	0	0
17/08/2024 1:35	0	0	0
17/08/2024 1:40	0	0	0
17/08/2024 1:45	0	0	0
17/08/2024 1:50	0	0	0
17/08/2024 1:55	0	0	0
17/08/2024 2:00	0	0	0
17/08/2024 2:05	0	0	0
17/08/2024 2:10	0	0	0
17/08/2024 2:15	0	0	0
17/08/2024 2:20	0	0	0
17/08/2024 2:25	0	0	0
17/08/2024 2:30	0	0	0
17/08/2024 2:35	0	0	0
17/08/2024 2:40	0	0	0
17/08/2024 2:45	0	0	0
17/08/2024 2:50	0	0	0
17/08/2024 2:55	0	0	0
17/08/2024 3:00	0	0	0
17/08/2024 3:05	0	0	0
17/08/2024 3:10	0	0	0
17/08/2024 3:15	0	0	0
17/08/2024 3:20	0	0	0
17/08/2024 3:25	0	0	0
17/08/2024 3:30	0	0	0
17/08/2024 3:35	0	0	0

Date/Time	RG_024, City of Toronto	St.HilaryRG, Region of Peel	HY099, TRCA
17/08/2024 3:40	0	0	0
17/08/2024 3:45	0	0	0
17/08/2024 3:50	0	0	0
17/08/2024 3:55	0	0	0
17/08/2024 4:00	0	0	0
17/08/2024 4:05	0	0	0
17/08/2024 4:10	0	0	0
17/08/2024 4:15	0	0	0
17/08/2024 4:20	0	0	0
17/08/2024 4:25	0	0	0
17/08/2024 4:30	0	0	0
17/08/2024 4:35	0	0	0
17/08/2024 4:40	0	0	0
17/08/2024 4:45	0	0	0
17/08/2024 4:50	0	0	0
17/08/2024 4:55	0	0	0
17/08/2024 5:00	0	0	0
17/08/2024 5:05	0	0	0
17/08/2024 5:10	0	0	0
17/08/2024 5:15	0	0	0
17/08/2024 5:20	0	0	0
17/08/2024 5:25	0	0	0
17/08/2024 5:30	0	0	0
17/08/2024 5:35	0	0	0
17/08/2024 5:40	0	0	0
17/08/2024 5:45	0	0	0
17/08/2024 5:50	0	0	0
17/08/2024 5:55	0	0	0

Date/Time	RG_024, City of Toronto	St.HilaryRG, Region of Peel	HY099, TRCA
17/08/2024 6:00	0	0	0
17/08/2024 6:05	0	0	0
17/08/2024 6:10	0	0	0
17/08/2024 6:15	0	0	0
17/08/2024 6:20	0	0	0
17/08/2024 6:25	0	1.8	0
17/08/2024 6:30	0	0.2	0
17/08/2024 6:35	0	0.2	0.4
17/08/2024 6:40	0	0	0.1
17/08/2024 6:45	0	0	0.1
17/08/2024 6:50	0	0	0
17/08/2024 6:55	0	0	0
17/08/2024 7:00	0	0	0
17/08/2024 7:05	0	0	0
17/08/2024 7:10	0	0	0
17/08/2024 7:15	0	0	0
17/08/2024 7:20	0	0	0
17/08/2024 7:25	0	0	0
17/08/2024 7:30	0	0	0
17/08/2024 7:35	0	0	0
17/08/2024 7:40	0	0	0
17/08/2024 7:45	0	0	0
17/08/2024 7:50	0	0	0
17/08/2024 7:55	0.136	0	0
17/08/2024 8:00	0	0	0
17/08/2024 8:05	0	0	0
17/08/2024 8:10	0	0	0
17/08/2024 8:15	0	0	0

Date/Time	RG_024, City of Toronto	St.HilaryRG, Region of Peel	HY099, TRCA
17/08/2024 8:20	0	0	0
17/08/2024 8:25	0	0	0
17/08/2024 8:30	0	0	0
17/08/2024 8:35	0	0	0
17/08/2024 8:40	0	0	0
17/08/2024 8:45	0	0	0
17/08/2024 8:50	0	0	0
17/08/2024 8:55	0	0	0
17/08/2024 9:00	0	0	0
17/08/2024 9:05	0	0	0
17/08/2024 9:10	0	0	0
17/08/2024 9:15	0	0	0
17/08/2024 9:20	0	0	0
17/08/2024 9:25	0	0	0
17/08/2024 9:30	0	0	0
17/08/2024 9:35	0	0	0
17/08/2024 9:40	0	0	0
17/08/2024 9:45	0	0	0
17/08/2024 9:50	0	0	0
17/08/2024 9:55	0	0	0
17/08/2024 10:00	0	0	0
17/08/2024 10:05	0	0	0
17/08/2024 10:10	0	0	0
17/08/2024 10:15	0	0	0
17/08/2024 10:20	0	0	0
17/08/2024 10:25	0	0	0
17/08/2024 10:30	0	0	0
17/08/2024 10:35	0	0	0

Date/Time	RG_024, City of Toronto	St.HilaryRG, Region of Peel	HY099, TRCA
17/08/2024 10:40	0	0	0
17/08/2024 10:45	0	0	0
17/08/2024 10:50	0	0	0
17/08/2024 10:55	0	0	0
17/08/2024 11:00	0	0	0
17/08/2024 11:05	0	0	0
17/08/2024 11:10	0	0	0
17/08/2024 11:15	0	0	0
17/08/2024 11:20	0	0	0
17/08/2024 11:25	0	0	0
17/08/2024 11:30	0	0	0
17/08/2024 11:35	0	0	0
17/08/2024 11:40	0	0.2	0
17/08/2024 11:45	0	8.6	0
17/08/2024 11:50	2.905	7.4	4.6
17/08/2024 11:55	14.654	9.2	8.7
17/08/2024 12:00	13.454	10.6	5.9
17/08/2024 12:05	3.85	5.2	7.6
17/08/2024 12:10	2.27	6	8.7
17/08/2024 12:15	3.691	8.8	3.3
17/08/2024 12:20	1.566	14.4	5
17/08/2024 12:25	0.894	11.8	7.8
17/08/2024 12:30	2.363	11.8	5.5
17/08/2024 12:35	3.208	3	10.9
17/08/2024 12:40	1.794	0.2	13.4
17/08/2024 12:45	1.42	3.6	2.5
17/08/2024 12:50	2.088	3.2	1.9
17/08/2024 12:55	5.042	0.6	7.2

Date/Time	RG_024, City of Toronto	St.HilaryRG, Region of Peel	HY099, TRCA
17/08/2024 13:00	4.225	0.4	6.1
17/08/2024 13:05	4.704	1	1
17/08/2024 13:10	4.48	2.4	0.6
17/08/2024 13:15	6.521	5	1.8
17/08/2024 13:20	3.466	5.6	2.9
17/08/2024 13:25	1.016	2	4.6
17/08/2024 13:30	2.014	0.2	4
17/08/2024 13:35	1.442	0.2	1.1
17/08/2024 13:40	0.179	1.2	0.6
17/08/2024 13:45	1.762	0.2	0.4
17/08/2024 13:50	0.906	2.4	1.2
17/08/2024 13:55	0.117	0.2	0.3
17/08/2024 14:00	0.133	0	2.4
17/08/2024 14:05	0.192	0	0.5
17/08/2024 14:10	1.734	0	0.2
17/08/2024 14:15	0.153	0	0.2
17/08/2024 14:20	0.517	0	0.3
17/08/2024 14:25	0.069	0	0
17/08/2024 14:30	0.008	0.4	0
17/08/2024 14:35	0.005	2.4	0
17/08/2024 14:40	0.002	1	0
17/08/2024 14:45	0.001	0	4.1
17/08/2024 14:50	0	0.2	4.6
17/08/2024 14:55	0.395	1.8	0.4
17/08/2024 15:00	0.237	1	0.5
17/08/2024 15:05	0.841	0	2.5
17/08/2024 15:10	3.985	0.2	1.3
17/08/2024 15:15	4.548	0	0.2

Date/Time	RG_024, City of Toronto	St.HilaryRG, Region of Peel	HY099, TRCA
17/08/2024 15:20	0.793	0	0.1
17/08/2024 15:25	0.57	0	0
17/08/2024 15:30	2.29	0	0.2
17/08/2024 15:35	0.719	0	0
17/08/2024 15:40	0.006	0	0
17/08/2024 15:45	0.005	0	0
17/08/2024 15:50	1.419	0	0
17/08/2024 15:55	5.895	0	0
17/08/2024 16:00	1.884	0	0
17/08/2024 16:05	0.022	0	0
17/08/2024 16:10	0.011	0	0
17/08/2024 16:15	0	0	0
17/08/2024 16:20	0.009000001	0	0
17/08/2024 16:25	0	0	0
17/08/2024 16:30	0	0	0
17/08/2024 16:35	0	0	0
17/08/2024 16:40	0	0	0
17/08/2024 16:45	0	0	0
17/08/2024 16:50	0	0	0
17/08/2024 16:55	0	0	0
17/08/2024 17:00	0	0	0
17/08/2024 17:05	0	0	0
17/08/2024 17:10	0	0	0
17/08/2024 17:15	0	0	0
17/08/2024 17:20	0	0	0
17/08/2024 17:25	0	0	0
17/08/2024 17:30	0	0	0
17/08/2024 17:35	0	0	0

Date/Time	RG_024, City of Toronto	St.HilaryRG, Region of Peel	HY099, TRCA
17/08/2024 17:40	0	0	0
17/08/2024 17:45	0	0	0
17/08/2024 17:50	0	0	0
17/08/2024 17:55	0	0	0
17/08/2024 18:00	0	0	0
17/08/2024 18:05	0	0	0
17/08/2024 18:10	0	0	0
17/08/2024 18:15	0	0	0
17/08/2024 18:20	0	0	0
17/08/2024 18:25	0	0	0
17/08/2024 18:30	0	0	0
17/08/2024 18:35	0	0	0
17/08/2024 18:40	0	0	0
17/08/2024 18:45	0	0	0
17/08/2024 18:50	0	0	0
17/08/2024 18:55	0	0	0
17/08/2024 19:00	0	0	0
17/08/2024 19:05	0	0	0
17/08/2024 19:10	0	0	0
17/08/2024 19:15	0	0	0
17/08/2024 19:20	0	0	0
17/08/2024 19:25	0	0	0
17/08/2024 19:30	0	0	0
17/08/2024 19:35	0	0	0
17/08/2024 19:40	0	0	0
17/08/2024 19:45	0	0	0
17/08/2024 19:50	0	0	0
17/08/2024 19:55	0	0	0

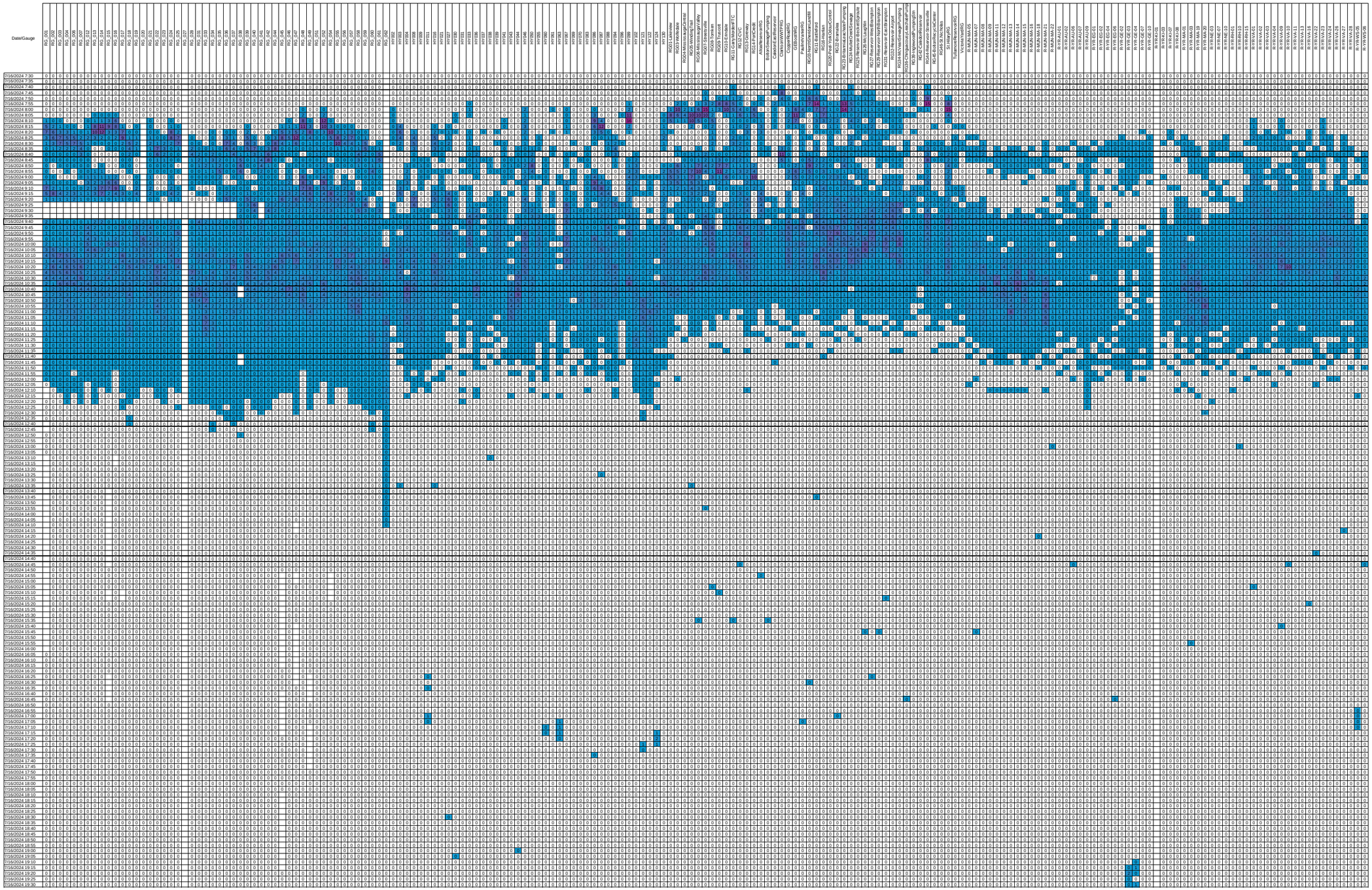
Date/Time	RG_024, City of Toronto	St.HilaryRG, Region of Peel	HY099, TRCA
17/08/2024 20:00	0	0	0
17/08/2024 20:05	0	0	0
17/08/2024 20:10	0	0	0
17/08/2024 20:15	0	0	0
17/08/2024 20:20	0	0	0
17/08/2024 20:25	0	0	0
17/08/2024 20:30	0	0	0
17/08/2024 20:35	0	0	0
17/08/2024 20:40	0	0	0
17/08/2024 20:45	0	0	0
17/08/2024 20:50	0	0	0
17/08/2024 20:55	0	0	0
17/08/2024 21:00	0	0	0
17/08/2024 21:05	0	0	0
17/08/2024 21:10	0	0	0
17/08/2024 21:15	0	0	0
17/08/2024 21:20	0	0	0
17/08/2024 21:25	0	0	0
17/08/2024 21:30	0	0	0
17/08/2024 21:35	0	0	0
17/08/2024 21:40	0	0	0
17/08/2024 21:45	0	0	0
17/08/2024 21:50	0	0	0
17/08/2024 21:55	0	0	0
17/08/2024 22:00	0	0	0
17/08/2024 22:05	0	0	0
17/08/2024 22:10	0	0	0
17/08/2024 22:15	0	0	0

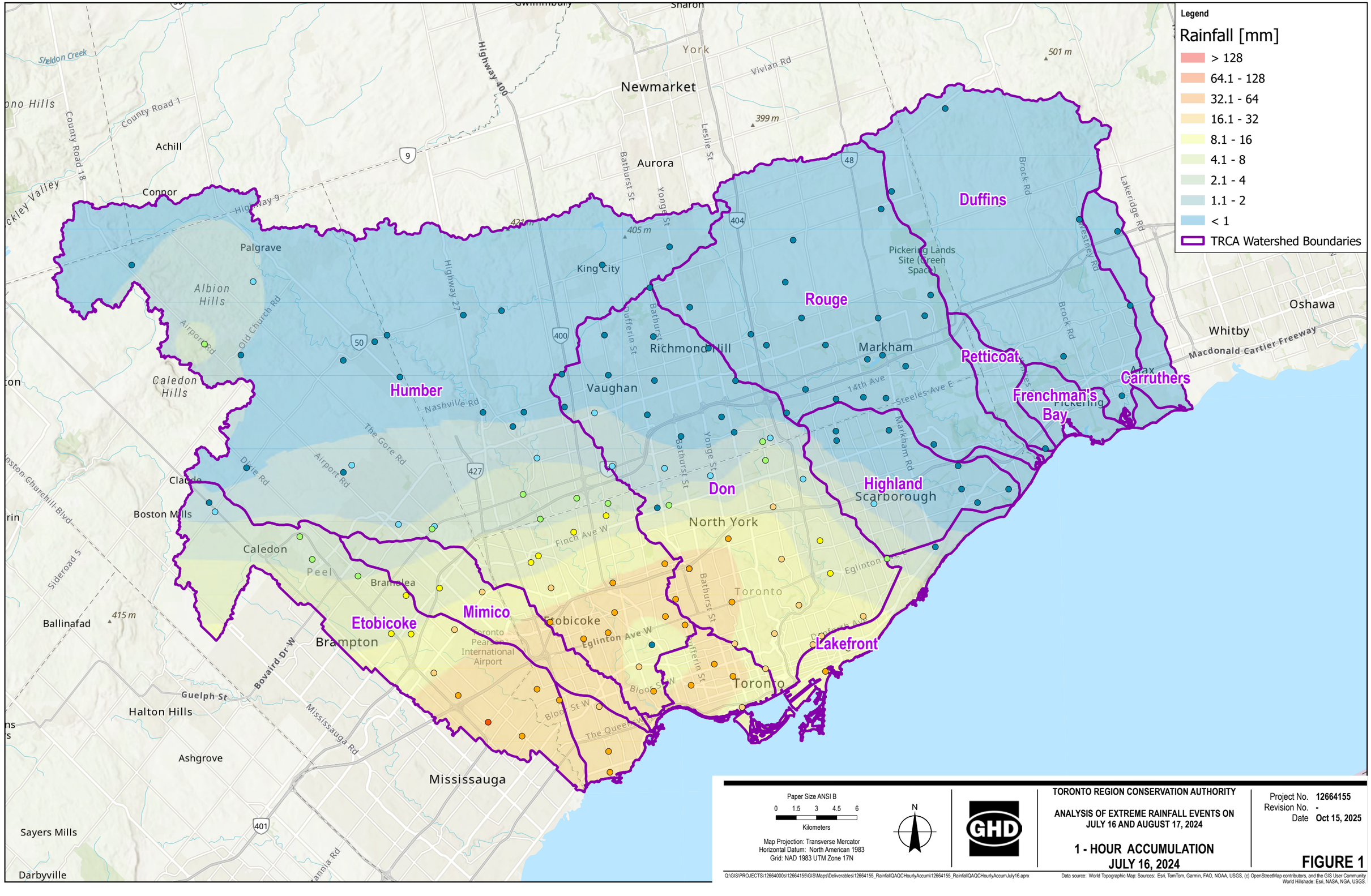
Date/Time	RG_024, City of Toronto	St.HilaryRG, Region of Peel	HY099, TRCA
17/08/2024 22:20	0	0	0
17/08/2024 22:25	0	0	0
17/08/2024 22:30	0	0	0
17/08/2024 22:35	0	0	0
17/08/2024 22:40	0	0	0
17/08/2024 22:45	0	0	0
17/08/2024 22:50	0	0	0
17/08/2024 22:55	0	0	0
17/08/2024 23:00	0	0	0
17/08/2024 23:05	0	0	0
17/08/2024 23:10	0	0	0
17/08/2024 23:15	0	0	0
17/08/2024 23:20	0	0	0
17/08/2024 23:25	0	0	0
17/08/2024 23:30	0	0	0
17/08/2024 23:35	0	0	0
17/08/2024 23:40	0	0	0
17/08/2024 23:45	0	0	0
17/08/2024 23:50	0	0	0
17/08/2024 23:55	0	0	0

Appendix B

Hourly accumulation figures

July 16, 2024 rainfall at all gauges




Legend
Rainfall [mm]
> 128
64.1 - 128
32.1 - 64
16.1 - 32
8.1 - 16
4.1 - 8
2.1 - 4
1.1 - 2
< 1
TRCA Watershed Boundaries
Duffins
Rouge
Petticoat
Frenchman's Bay
Carruthers
Highland
Don
Humber
Mimico
Etobicoke
Lakefront
Newmarket
Aurora
York
Richmond Hill
Markham
Vaughan
Pickering
Ajax
Whitby
Oshawa
North York
Scarborough
Toronto
Etobicoke
Brampton
Mississauga
Caledon
Boston Mills
Palgrave
King City
Achill
Connor
Albion Hills
Caledon Hills
Halton Hills
Ashgrove
Ballinafad
Sayers Mills
Darbyville
Claude
Peel
Brampton
Pickering Lands Site (Green Space)
Toronto Pearson International Airport
Highway 400
Highway 27
Highway 9
Bathurst St
Yonge St
Leslie St
Vivian Rd
Brock Rd
Lakeridge Rd
Westney Rd
Old Church Rd
Airport Rd
Nashville Rd
The Gore Rd
Dixie Rd
Bovaird Dr W
Guelph St
Mississauga Rd
Eglinton Ave W
Finch Ave W
Steeles Ave E
14th Ave
Markham Rd
Macdonald Cartier Freeway
Sideroad 5
Sheldon Creek
County Road 1
County Road 18
421 m
405 m
399 m
501 m
415 m
Paper Size ANSI B
0 1.5 3 4.5 6
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N
N
TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
1 - HOUR ACCUMULATION JULY 16, 2024
Project No. 12664155
Revision No. -
Date Oct 15, 2025
FIGURE 1
Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccuml\12664155_RainfallQAQCHourlyAccumJuly16.aprx
Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, NASA, NGA, USGS.

Legend

Rainfall [mm]

- > 128
- 64.1 - 128
- 32.1 - 64
- 16.1 - 32
- 8.1 - 16
- 4.1 - 8
- 2.1 - 4
- 1.1 - 2
- < 1
- TRCA Watershed Boundaries

Duffins
Rouge
Petticoat
Frenchman's Bay
Carruthers
Humber
Don
Highland
Mimico
Etobicoke
Lakefront

Paper Size ANSI B

0 1.5 3 4.5 6

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY

ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024

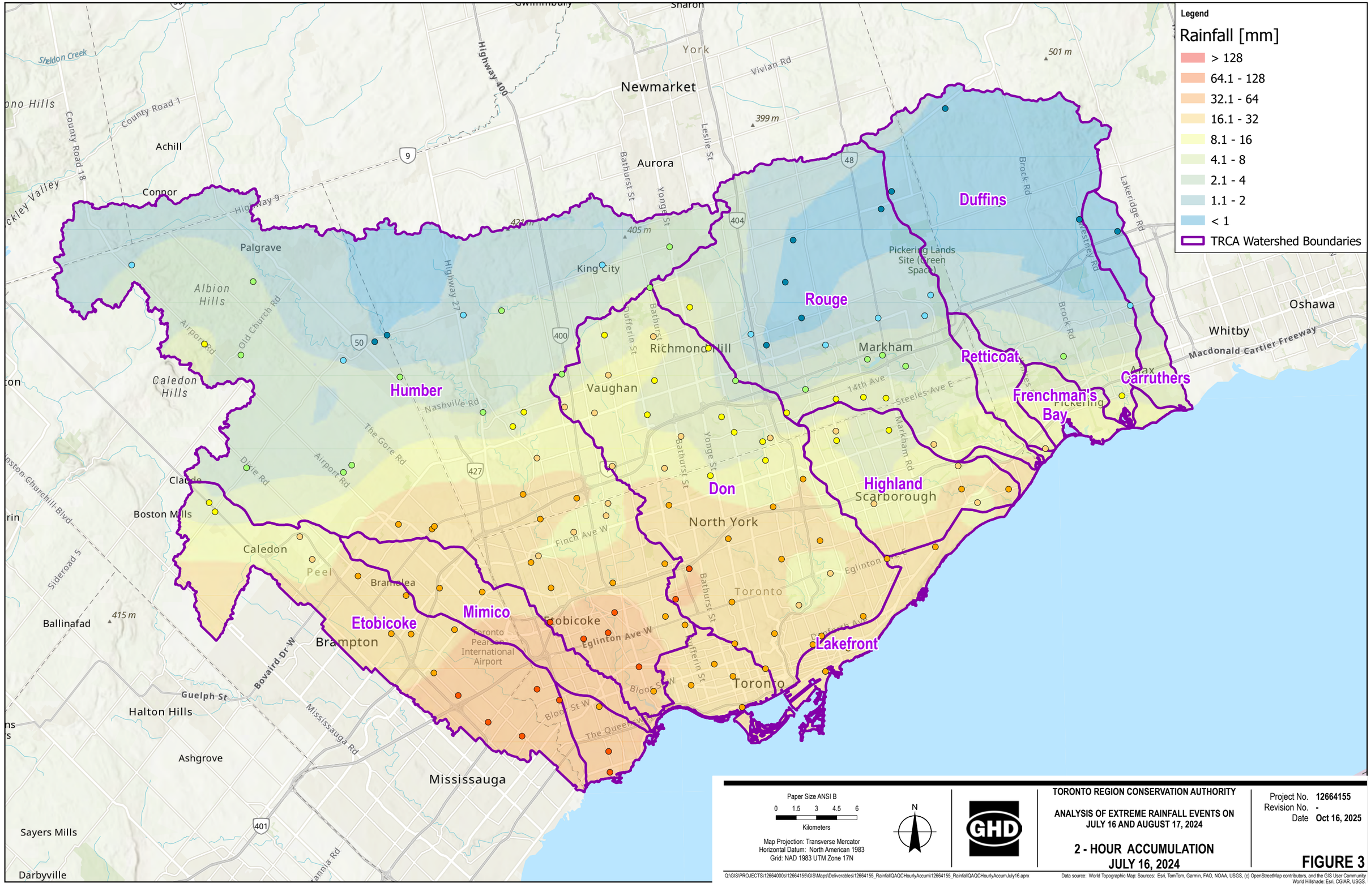
1.5 - HOUR ACCUMULATION JULY 16, 2024

Project No. 12664155
Revision No. -
Date Oct 16, 2025

FIGURE 2

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccuml\12664155_RainfallQAQCHourlyAccumJuly16.aprx

Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, NASA, NGA, USGS.


Legend
Rainfall [mm]
> 128
64.1 - 128
32.1 - 64
16.1 - 32
8.1 - 16
4.1 - 8
2.1 - 4
1.1 - 2
< 1
TRCA Watershed Boundaries
Duffins
Rouge
Petticoat
Frenchman's Bay
Carruthers
Highland
Don
Humber
Mimico
Etobicoke
Lakefront
Newmarket
Aurora
King City
Richmond Hill
Markham
Vaughan
Pickering Lands Site (Green Space)
Oshawa
Whitby
Ajax
Pickering
Scarborough
North York
Toronto
Etobicoke
Brampton
Mississauga
Caledon
Boston Mills
Palgrave
Connor
Achill
Halton Hills
Ashgrove
Sayers Mills
Darbyville
Ballinafad
Claude
Peel
Bramalea
Toronto Pearson International Airport
Albion Hills
Caledon Hills
Highway 400
Highway 9
Highway 27
Bathurst St
Yonge St
Leslie St
Vivian Rd
Brock Rd
Lakeridge Rd
Westney Rd
Old Church Rd
Airport Rd
Nashville Rd
The Gore Rd
Dixie Rd
Sideroad 5
Bovaird Dr W
Guelph St
Mississauga Rd
Eglinton Ave W
Finch Ave W
Steeles Ave E
14th Ave
Markham Rd
Macdonald Cartier Freeway
Bloor St W
The Queensway
Sheldon Creek
County Road 1
County Road 18
501 m
399 m
421 m
405 m
415 m
Paper Size ANSI B
0 1.5 3 4.5 6
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N
N
GHD
TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
2 - HOUR ACCUMULATION JULY 16, 2024
Project No. 12664155
Revision No. -
Date Oct 16, 2025
FIGURE 3
Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccum\12664155_RainfallQAQCHourlyAccumJuly16.aprx
Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Legend

Rainfall [mm]

- > 128
- 64.1 - 128
- 32.1 - 64
- 16.1 - 32
- 8.1 - 16
- 4.1 - 8
- 2.1 - 4
- 1.1 - 2
- < 1
- TRCA Watershed Boundaries

Duffins
Rouge
Petticoat
Frenchman's Bay
Carruthers
Highland
Don
Humber
Etobicoke
Mimico
Lakefront

Paper Size ANSI B

0 1.5 3 4.5 6

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY

ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024

2.25 - HOUR ACCUMULATION JULY 16, 2024

Project No. 12664155
Revision No. -
Date Oct 15, 2025

FIGURE 4

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccum\12664155_RainfallQAQCHourlyAccumJuly16.aprx

Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, NASA, NGA, USGS.

Legend

Rainfall [mm]

- > 128
- 64.1 - 128
- 32.1 - 64
- 16.1 - 32
- 8.1 - 16
- 4.1 - 8
- 2.1 - 4
- 1.1 - 2
- < 1
- TRCA Watershed Boundaries

Humber
Duffins
Rouge
Petticoat
Frenchman's Bay
Carruthers
Don
Highland
Mimico
Etobicoke
Lakefront

Paper Size ANSI B

0 1.5 3 4.5 6

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY

ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024

2.5 - HOUR ACCUMULATION JULY 16, 2024

Project No. 12664155
Revision No. -
Date Oct 15, 2025

FIGURE 5

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccuml\12664155_RainfallQAQCHourlyAccumJuly16.aprx

Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Legend

Rainfall [mm]

- > 128
- 64.1 - 128
- 32.1 - 64
- 16.1 - 32
- 8.1 - 16
- 4.1 - 8
- 2.1 - 4
- 1.1 - 2
- < 1
- TRCA Watershed Boundaries

Duffins
Rouge
Petticoat
Frenchman's Bay
Carruthers
Highland
Don
Humber
Mimico
Etobicoke
Lakefront

Paper Size ANSI B

0 1.5 3 4.5 6

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY

ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024

2.75 - HOUR ACCUMULATION JULY 16, 2024

Project No. 12664155
Revision No. -
Date Oct 15, 2025

FIGURE 6

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccuml12664155_RainfallQAQCHourlyAccumJuly16.aprx

Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, NASA, NGA, USGS.

Legend

Rainfall [mm]

- > 128
- 64.1 - 128
- 32.1 - 64
- 16.1 - 32
- 8.1 - 16
- 4.1 - 8
- 2.1 - 4
- 1.1 - 2
- < 1
- TRCA Watershed Boundaries

Duffins
Rouge
Petticoat
Frenchman's Bay
Carruthers
Humber
Don
Highland
Mimico
Etobicoke
Lakefront

Paper Size ANSI B
0 1.5 3 4.5 6
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY

ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024

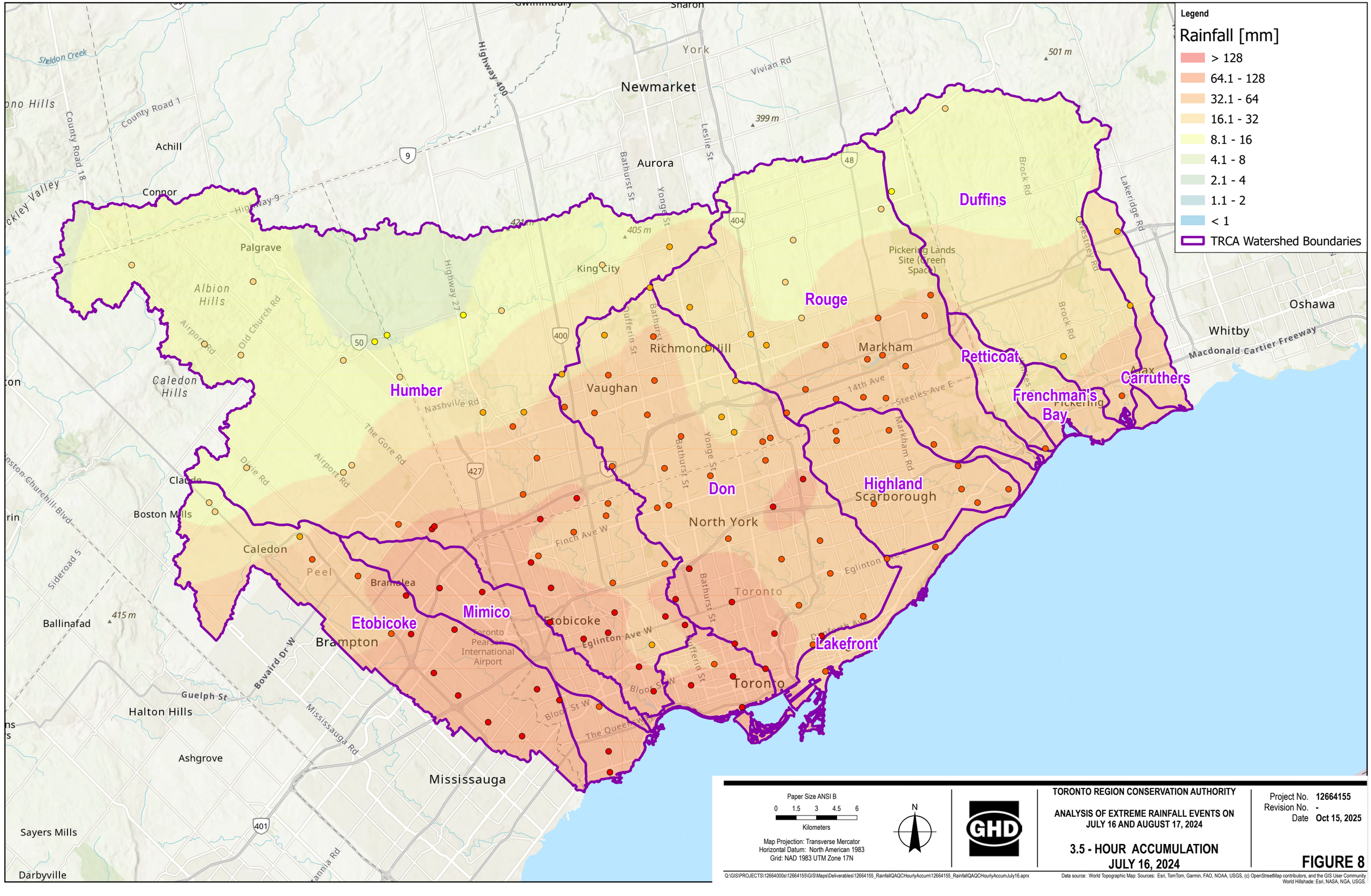
3 - HOUR ACCUMULATION JULY 16, 2024

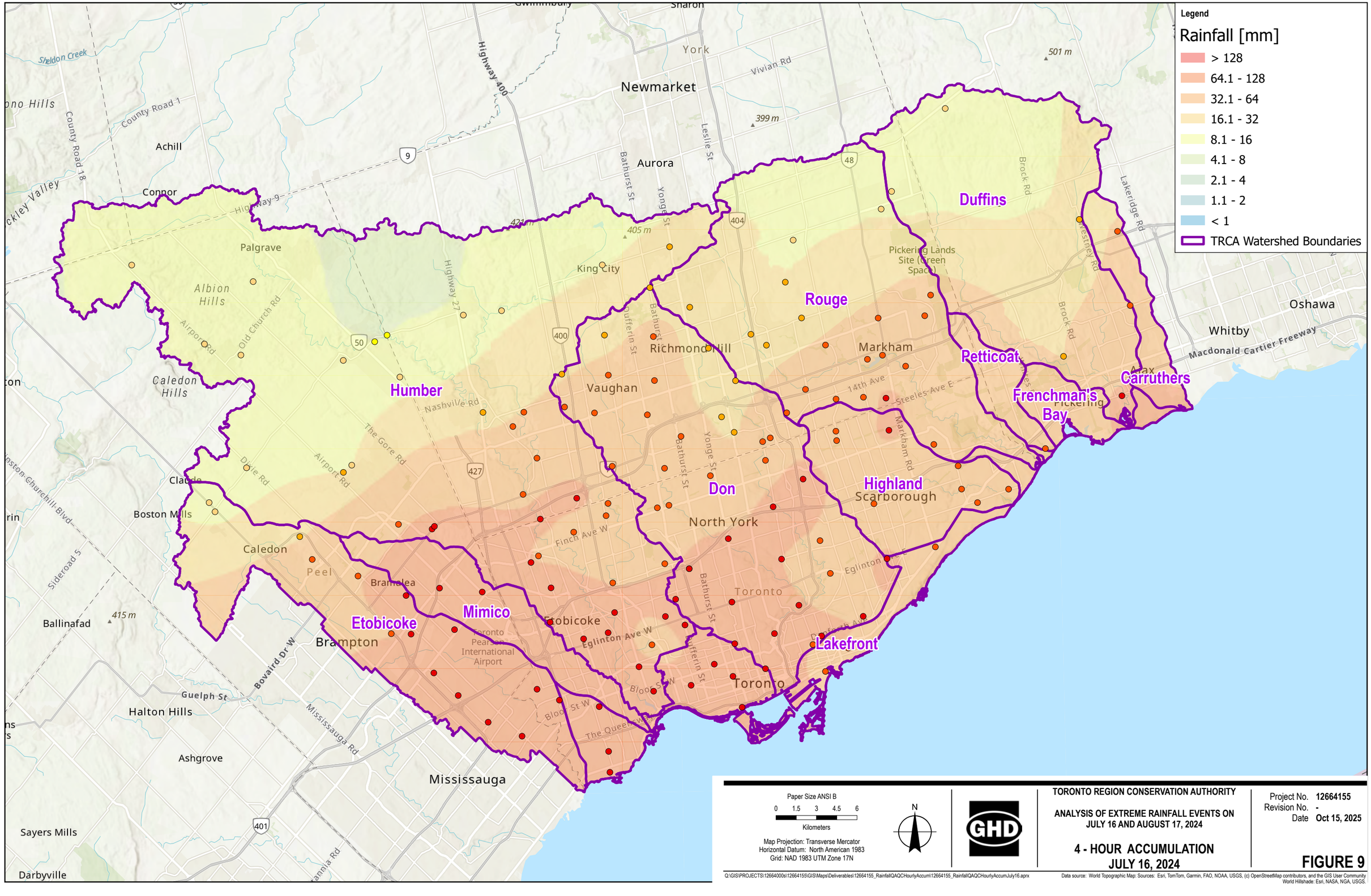
Project No. 12664155
Revision No. -
Date Oct 15, 2025

FIGURE 7

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccuml\12664155_RainfallQAQCHourlyAccumJuly16.aprx

Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, NASA, NGA, USGS.


Legend
Rainfall [mm]
> 128
64.1 - 128
32.1 - 64
16.1 - 32
8.1 - 16
4.1 - 8
2.1 - 4
1.1 - 2
< 1
TRCA Watershed Boundaries
Duffins
Rouge
Petticoat
Frenchman's Bay
Carruthers
Humber
Don
Highland
Mimico
Etobicoke
Lakefront
Newmarket
Aurora
York
Sharon
Achill
Connor
Palgrave
King City
Richmond Hill
Markham
Vaughan
Pickering Lands Site (Green Space)
Oshawa
Whitby
Ajax
Pickering
Scarborough
North York
Toronto
Etobicoke
Caledon
Peel
Brampton
Mississauga
Halton Hills
Ashgrove
Boston Mills
Claudo
Ballinafad
Sayers Mills
Darbyville
Albion Hills
Caledon Hills
Highway 400
Highway 9
Highway 27
Bathurst St
Yonge St
Leslie St
Vivian Rd
Brock Rd
Lakeridge Rd
Westney Rd
Old Church Rd
Airport Rd
Nashville Rd
The Gore Rd
Dixie Rd
Bovaird Dr W
Guelph St
Mississauga Rd
Eglinton Ave W
Finch Ave W
Steeles Ave E
14th Ave
Markham Rd
Bloor St W
Bloor St E
Macdonald Cartier Freeway
Toronto Pearson International Airport
501 m
399 m
421 m
405 m
415 m
Sheldon Creek
County Road 1
County Road 18
Sideroad 5
Paper Size ANSI B
0 1.5 3 4.5 6
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N
N
GHD
TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
3.5 - HOUR ACCUMULATION JULY 16, 2024
Project No. 12664155
Revision No. -
Date Oct 15, 2025
FIGURE 8
Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccum\12664155_RainfallQAQCHourlyAccumJuly16.aprx
Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, NASA, NGA, USGS.



Paper Size ANSI B

0 1.5 3 4.5 6

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY

ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024

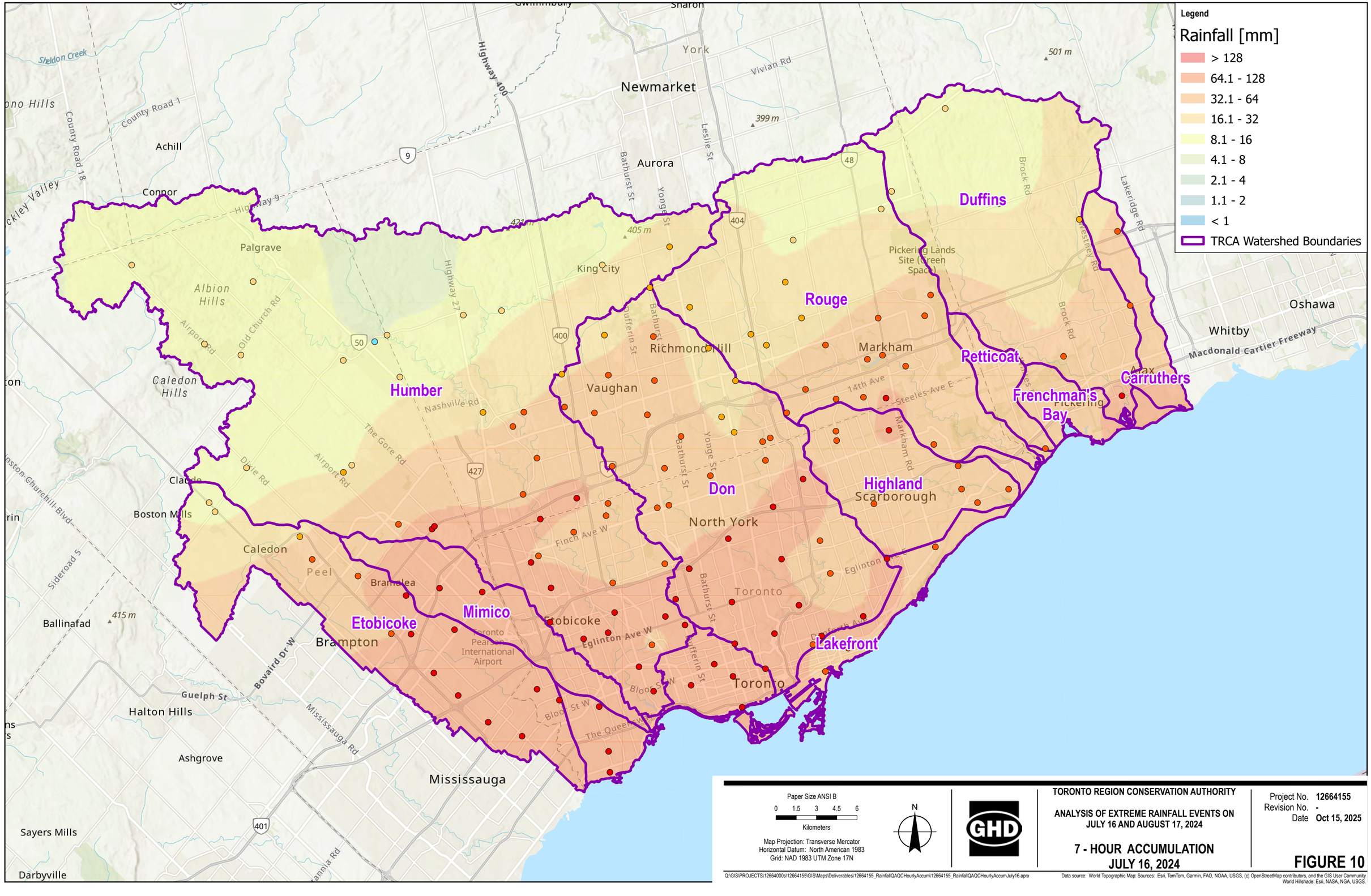
4 - HOUR ACCUMULATION JULY 16, 2024

Project No. **12664155**
Revision No. **-**
Date **Oct 15, 2025**

FIGURE 9

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccuml12664155_RainfallQAQCHourlyAccumJuly16.aprx

Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, NASA, NGA, USGS.


Legend
Rainfall [mm]
> 128
64.1 - 128
32.1 - 64
16.1 - 32
8.1 - 16
4.1 - 8
2.1 - 4
1.1 - 2
< 1
TRCA Watershed Boundaries
Duffins
Rouge
Petticoat
Frenchman's Bay
Carruthers
Humber
Don
Highland
Mimico
Etobicoke
Lakefront
Newmarket
Aurora
Richmond Hill
Markham
Vaughan
Scarborough
North York
Toronto
Brampton
Mississauga
Oshawa
Whitby
Ajax
Pickering
Palgrave
King City
Connor
Achill
Caledon
Boston Mills
Ballinafad
Halton Hills
Ashgrove
Sayers Mills
Darbyville
Claude
Peel
Bramalea
Sharon
York
Highway 400
Highway 9
Highway 27
Yonge St
Bathurst St
Leslie St
Vivian Rd
Brock Rd
Lakeridge Rd
Westney Rd
Markham Rd
Steeles Ave E
14th Ave
Eglinton Ave W
Finch Ave W
Bloor St W
Dufferin St
Nashville Rd
The Gore Rd
Airport Rd
Old Church Rd
Bovaird Dr W
Guelph St
Mississauga Rd
Dixie Rd
Sideroad 5
Macdonald Cartier Freeway
The Queensway
Pickering Lands Site (Green Space)
Toronto Pearson International Airport
Sheldon Creek
County Road 1
County Road 18
501 m
399 m
421 m
405 m
415 m
Paper Size ANSI B
0 1.5 3 4.5 6
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N
N
GHD
TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
7 - HOUR ACCUMULATION JULY 16, 2024
Project No. 12664155
Revision No. -
Date Oct 15, 2025
FIGURE 10
Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccuml\12664155_RainfallQAQCHourlyAccumJuly16.aprx
Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, NASA, NGA, USGS.

August 17, 2024 rainfall at all gauges

Date/Gauge
RG_001, RG_002, RG_003, RG_004, RG_006, RG_007, RG_012, RG_013, RG_014, RG_015, RG_016, RG_017, RG_018, RG_019, RG_020, RG_021, RG_022, RG_023, RG_024, RG_025, RG_027, RG_028, RG_031, RG_033, RG_034, RG_035, RG_036, RG_037, RG_038, RG_039, RG_040, RG_041, RG_042, RG_044, RG_045, RG_046, RG_047, RG_048, RG_049, RG_051, RG_052, RG_054, RG_055, RG_056, RG_057, RG_058, RG_059, RG_060, RG_061, RG_062, HY002, HY003, HY004, HY008, HY009, HY011, HY016, HY021, HY027, HY030, HY031, HY033, HY036, HY037, HY038, HY039, HY041, HY043, HY044, HY046, HY050, HY055, HY060, HY061, HY063, HY067, HY069, HY070, HY083, HY086, HY087, HY088, HY094, HY096, HY099, HY102, HY121, HY122, HY124, HY130, RG01-Lakeview, RG03-Wolfedale, RG04-MississaugaCentral, RG05-WindingTrail, RG06-MississaugaValley, RG07-Streetsville, RG08-Tomken, RG09-Truscott, RG10-Erindale, RG11-GaryMordenFTC, RG12-CVC, RG13-Goreway, RG14-PortCredit, AlloaReservoirRG, BoltonSewagePumping, CaledonEastReservoir, ClarksonWWTPRG, CopperRoadRG, GEBoothRG, PaulineVanierRG, RG03-NorthSheridanLandfill, RG11-Battleford, RG16-Hanlan, RG20-Peel-YorkOdourControl, RG22-Bramalea, RG23-BritanniaLeachatePumping, RG24-MulletCreekSewage, RG25-Reservoir-BeckettSproule, RG26-McLaughlin, RG27-Reservoir-WestBrampton, RG29-Reservoir-NorthBrampton, RG31-Reservoir-EastBrampton, RG32-Reservoir-Airport, RG34-McVeanSewagePumping, RG36-ChinguacousyLeachatePum, RG39-InglewoodPumpingStn, RG42-CaledonReservoir, RG44-Reservoir-Streetsville, RG45-BoltonRecycleCenter, RG46-St.Nicholas, St.HilaryRG, TullamoreReservoirRG, VictoriaYardRG, R-MUN-MA-05, R-MUN-MA-07, R-MUN-MA-08, R-MUN-MA-09, R-MUN-MA-11, R-MUN-MA-12, R-MUN-MA-13, R-MUN-MA-14, R-MUN-MA-15, R-MUN-MA-16, R-MUN-MA-18, R-MUN-MA-21, R-MUN-MA-22, R-YR-AU-01, R-YR-AU-02, R-YR-AU-06, R-YR-AU-07, R-YR-AU-09, R-YR-EG-01, R-YR-EG-02, R-YR-EG-04, R-YR-EG-06, R-YR-GE-02, R-YR-GE-03, R-YR-GE-04, R-YR-GE-07, R-YR-GE-10, R-YR-KI-01, R-YR-KI-03, R-YR-KI-07, R-YR-KI-08, R-YR-MA-01, R-YR-MA-03, R-YR-MA-19, R-YR-MA-20, R-YR-NE-03, R-YR-NE-07, R-YR-NE-10, R-YR-RH-01, R-YR-RH-10, R-YR-RH-15, R-YR-VA-01, R-YR-VA-02, R-YR-VA-03, R-YR-VA-04, R-YR-VA-09, R-YR-VA-10, R-YR-VA-11, R-YR-VA-13, R-YR-VA-16, R-YR-VA-22, R-YR-VA-23, R-YR-VA-24, R-YR-VA-26, R-YR-VA-27, R-YR-VA-28, R-YR-WS-05, R-YR-WS-06
8/17/2024 7:30 – 8/17/2024 19:30 (5-minute intervals)

Legend

Rainfall [mm]

- > 128
- 64.1 - 128
- 32.1 - 64
- 16.1 - 32
- 8.1 - 16
- 4.1 - 8
- 2.1 - 4
- 1.1 - 2
- < 1
- TRCA Watershed Boundaries

Duffins
Rouge
Petticoat
Carruthers
Frenchman's Bay
Highland
Don
Humber
Mimico
Etobicoke
Lakefront

Paper Size ANSI B
0 1.5 3 4.5 6
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY

ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024

4.5 - HOUR ACCUMULATION AUGUST 17, 2024

Project No. 12664155
Revision No. -
Date Oct 16, 2025

FIGURE 11

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccum\12664155_RainfallQAQCHourlyAccumAug17.aprx

Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Legend

Rainfall [mm]

- > 128
- 64.1 - 128
- 32.1 - 64
- 16.1 - 32
- 8.1 - 16
- 4.1 - 8
- 2.1 - 4
- 1.1 - 2
- < 1
- TRCA Watershed Boundaries

Duffins
Rouge
Petticoat
Frenchman's Bay
Carruthers
Highland
Don
Humber
Mimico
Etobicoke
Lakefront

Paper Size ANSI B
0 1.5 3 4.5 6
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY

ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024

5 - HOUR ACCUMULATION AUGUST 17, 2024

Project No. 12664155
Revision No. -
Date Oct 16, 2025

FIGURE 12

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccuml\12664155_RainfallQAQCHourlyAccumAug17.aprx

Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, NASA, NGA, USGS.

Legend

Rainfall [mm]

- > 128
- 64.1 - 128
- 32.1 - 64
- 16.1 - 32
- 8.1 - 16
- 4.1 - 8
- 2.1 - 4
- 1.1 - 2
- < 1
- TRCA Watershed Boundaries

Duffins
Rouge
Petticoat
Carruthers
Frenchman's Bay
Highland
Don
Humber
Mimico
Etobicoke
Lakefront

Paper Size ANSI B
0 1.5 3 4.5 6
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY

ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024

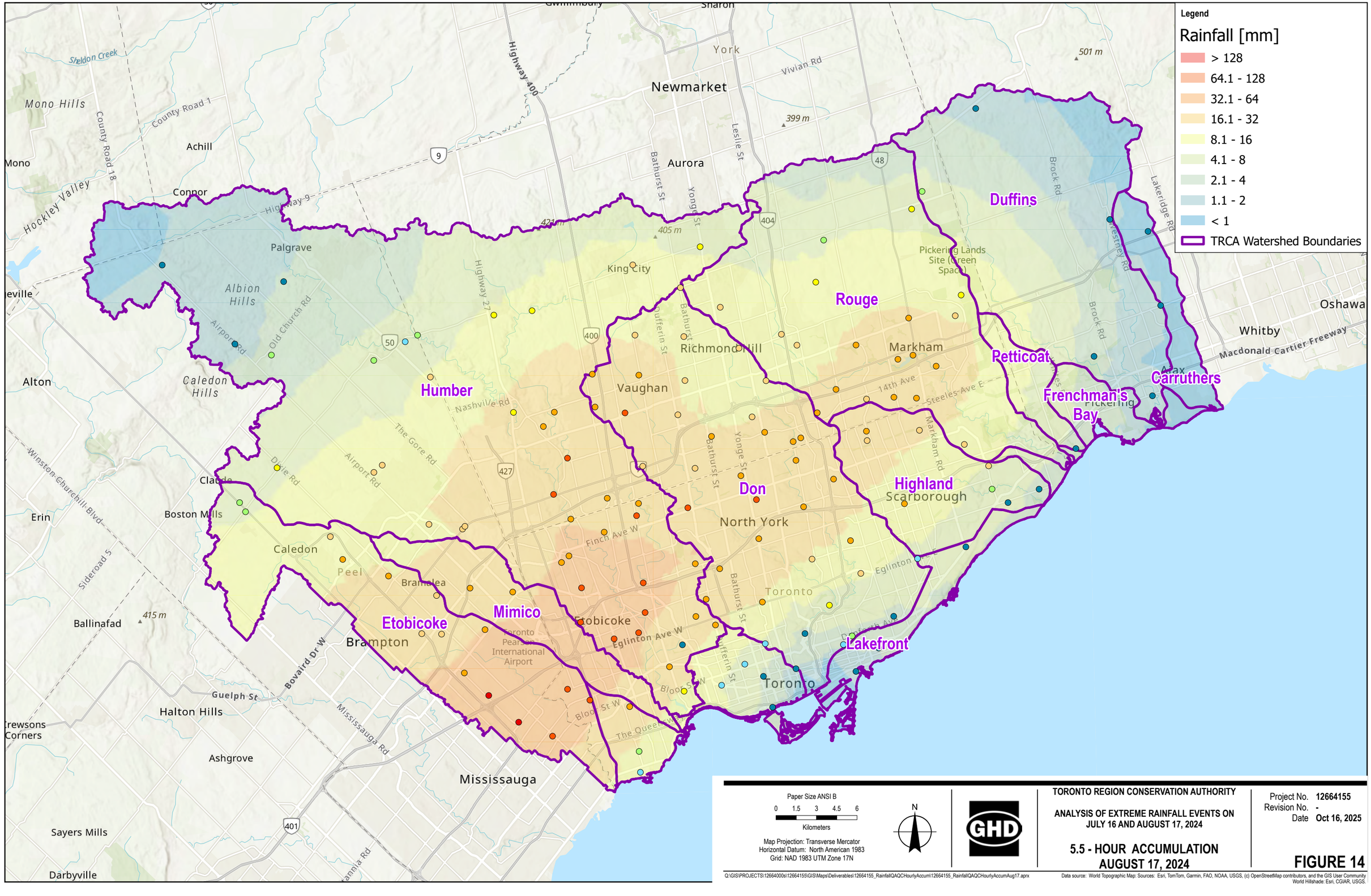
5.25 - HOUR ACCUMULATION AUGUST 17, 2024

Project No. 12664155
Revision No. -
Date Oct 16, 2025

FIGURE 13

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccuml\12664155_RainfallQAQCHourlyAccumAug17.aprx

Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, NASA, NGA, USGS.


Legend
Rainfall [mm]
> 128
64.1 - 128
32.1 - 64
16.1 - 32
8.1 - 16
4.1 - 8
2.1 - 4
1.1 - 2
< 1
TRCA Watershed Boundaries
Duffins
Rouge
Petticoat
Carruthers
Frenchman's Bay
Highland
Don
Humber
Mimico
Etobicoke
Lakefront
Newmarket
Aurora
York
Richmond Hill
Markham
Vaughan
Scarborough
North York
Toronto
Brampton
Mississauga
Oshawa
Whitby
Ajax
Pickering
Palgrave
King City
Connor
Achill
Alton
Caledon
Boston Mills
Erin
Ballinafad
Halton Hills
Ashgrove
Sayers Mills
Darbyville
Claude
Crewsons Corners
Albion Hills
Caledon Hills
Mono Hills
Hockley Valley
Mono
Sharon
Gwillimbury
Highway 400
Highway 9
Highway 27
Bathurst St
Yonge St
Leslie St
Vivian Rd
Brock Rd
Lakeridge Rd
Westney Rd
Pickering Lands Site (Green Space)
Macdonald Cartier Freeway
Steeles Ave E
14th Ave
Markham Rd
Eglinton Ave W
Finch Ave W
Bloor St W
The Queensway
Dufferin St
Old Church Rd
Airport Rd
Nashville Rd
The Gore Rd
Dixie Rd
Mississauga Rd
Bovaird Dr W
Guelph St
Sideroad 5
Winston Churchill Blvd
Toronto Pearson International Airport
Sheldon Creek
County Road 1
County Road 18
501 m
399 m
421 m
405 m
415 m
9
48
404
400
50
427
401
Paper Size ANSI B
0 1.5 3 4.5 6
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N
N
GHD
TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
5.5 - HOUR ACCUMULATION AUGUST 17, 2024
Project No. 12664155
Revision No. -
Date Oct 16, 2025
FIGURE 14
Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccum\12664155_RainfallQAQCHourlyAccumAug17.aprx
Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Legend

Rainfall [mm]

- > 128
- 64.1 - 128
- 32.1 - 64
- 16.1 - 32
- 8.1 - 16
- 4.1 - 8
- 2.1 - 4
- 1.1 - 2
- < 1
- TRCA Watershed Boundaries

Humber
Duffins
Rouge
Petticoat
Carruthers
Frenchman's Bay
Highland
Don
Mimico
Etobicoke
Lakefront

Paper Size ANSI B
0 1.5 3 4.5 6
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY

ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024

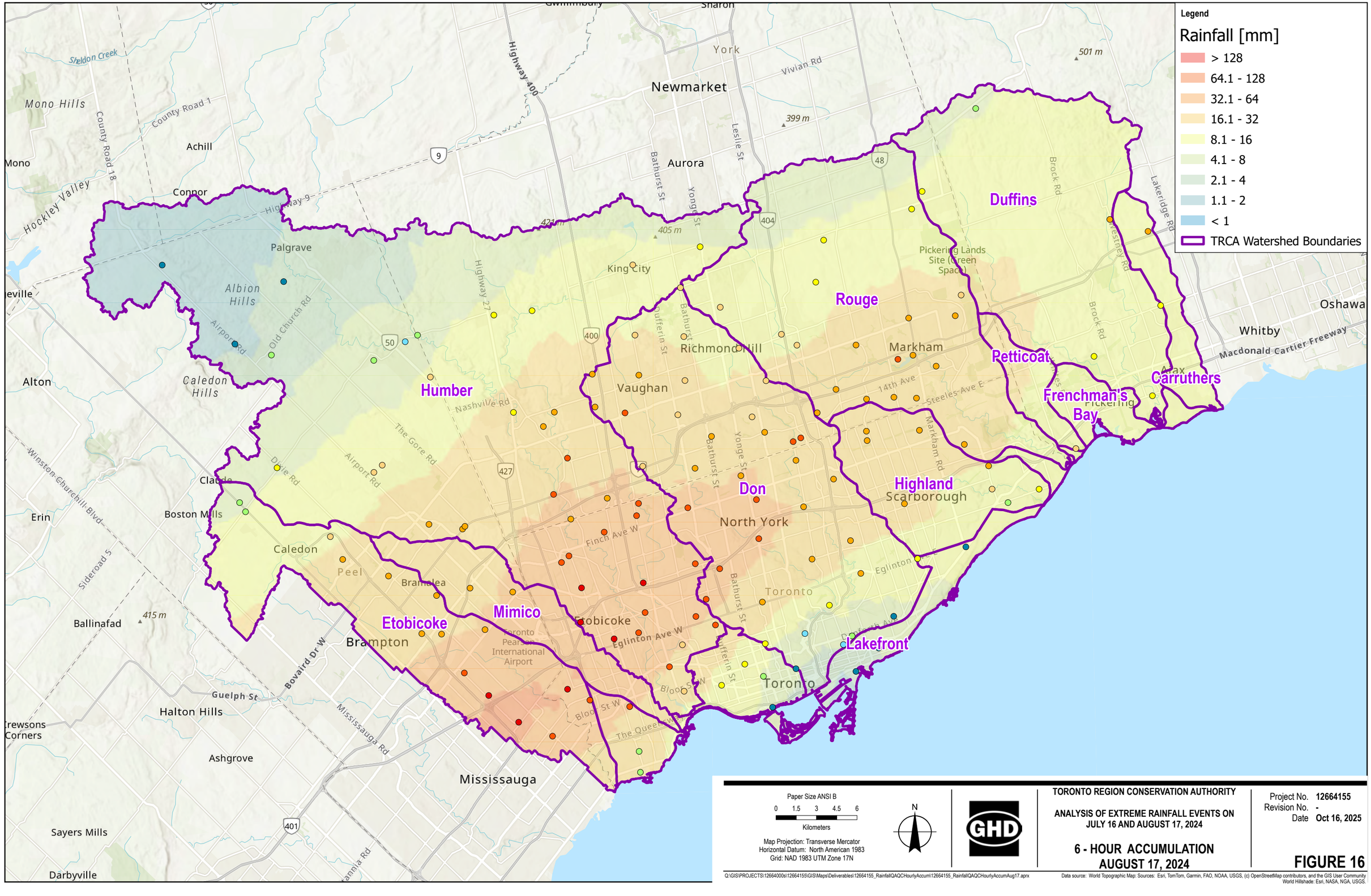
5.75 - HOUR ACCUMULATION AUGUST 17, 2024

Project No. 12664155
Revision No. -
Date Oct 16, 2025

FIGURE 15

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccuml\12664155_RainfallQAQCHourlyAccumAug17.aprx

Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, NASA, NGA, USGS.



Paper Size ANSI B

0 1.5 3 4.5 6

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY

ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024

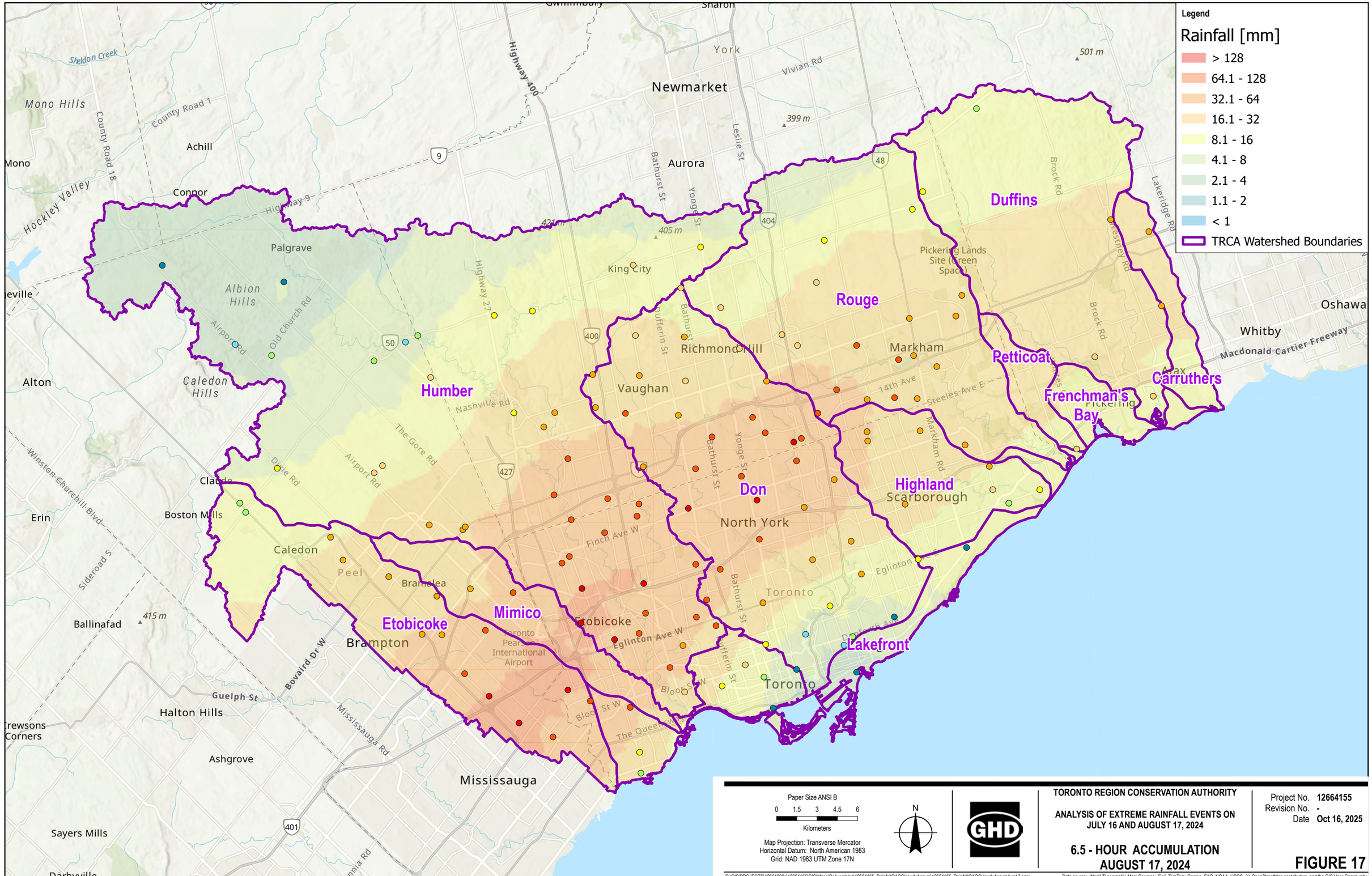
6 - HOUR ACCUMULATION
AUGUST 17, 2024

Project No. 12664155
Revision No. -
Date Oct 16, 2025

FIGURE 16

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccum\12664155_RainfallQAQCHourlyAccumAug17.aprx

Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, NASA, NGA, USGS.



Paper Size ANSI B

0 1.5 3 4.5 6

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY

ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024

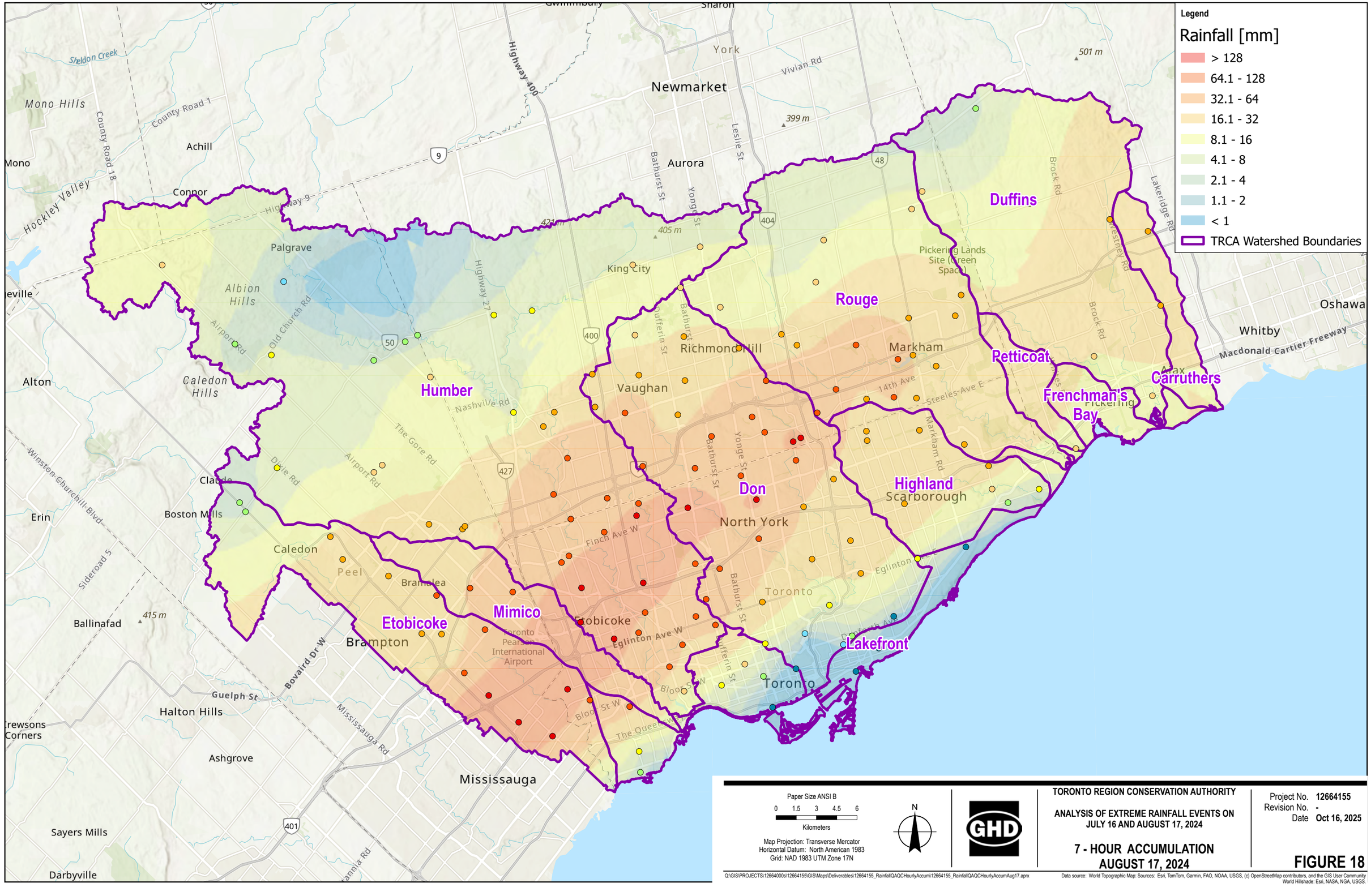
6.5 - HOUR ACCUMULATION AUGUST 17, 2024

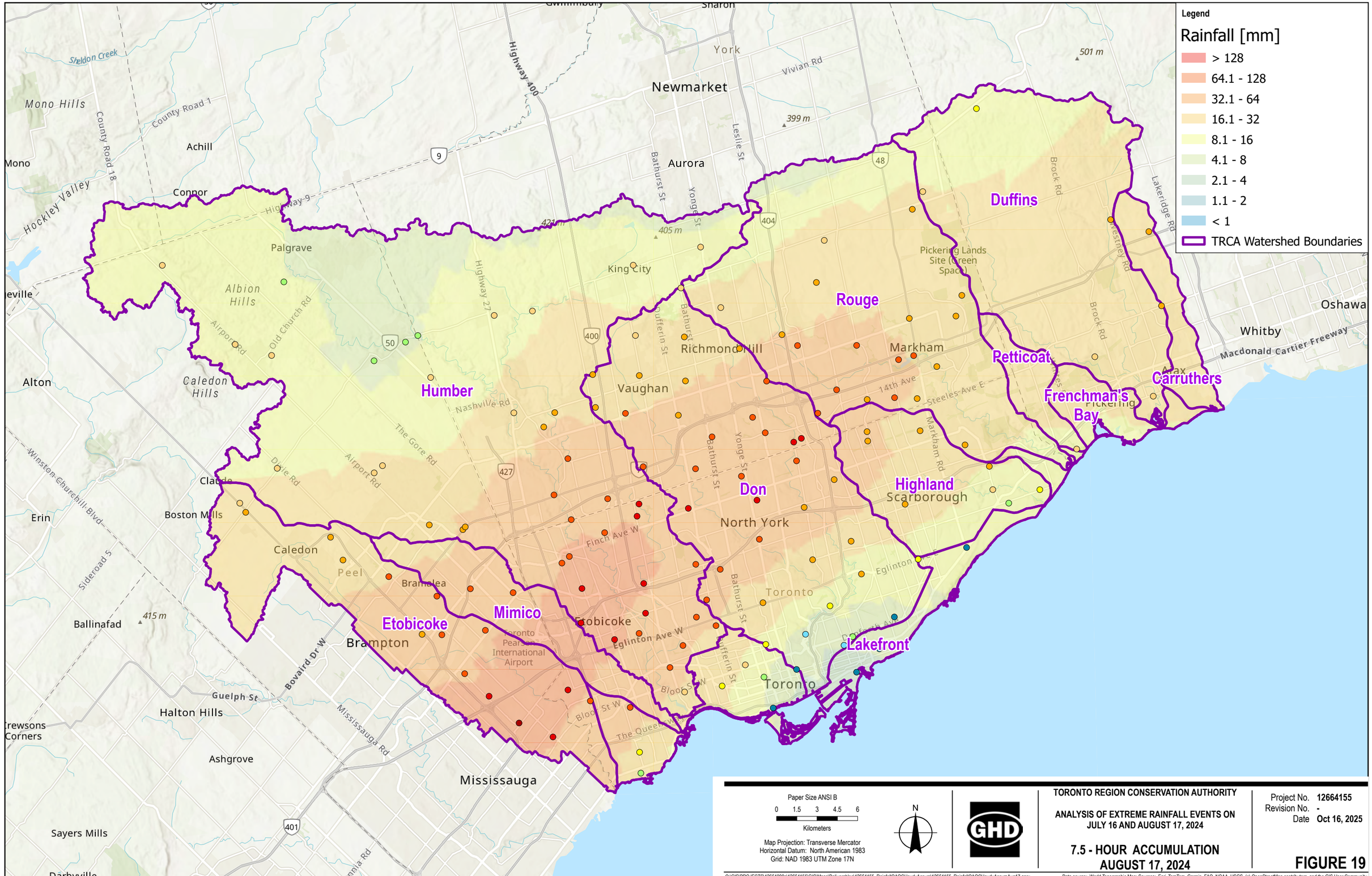
Project No. **12664155**
Revision No. **-**
Date **Oct 16, 2025**

FIGURE 17

O:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccum\12664155_RainfallQAQCHourlyAccumAug17.aprx

Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.


Legend
Rainfall [mm]
> 128
64.1 - 128
32.1 - 64
16.1 - 32
8.1 - 16
4.1 - 8
2.1 - 4
1.1 - 2
< 1
TRCA Watershed Boundaries
Duffins
Rouge
Petticoat
Frenchman's Bay
Carruthers
Highland
Don
Humber
Mimico
Etobicoke
Lakefront
Newmarket
Aurora
York
Richmond Hill
Markham
Vaughan
Scarborough
North York
Toronto
Mississauga
Brampton
Oshawa
Whitby
Ajax
Pickering
Alton
Caledon
Halton Hills
Ashgrove
Palgrave
King City
Connor
Achill
Boston Mills
Erin
Ballinafad
Claude
Sayers Mills
Darbyville
Crewsons Corners
Mono
Mono Hills
Hockley Valley
Albion Hills
Caledon Hills
Sheldon Creek
Highway 400
Highway 9
Highway 27
Bathurst St
Yonge St
Leslie St
Vivian Rd
Brock Rd
Lakeridge Rd
Westney Rd
Pickering Lands Site (Green Space)
Old Church Rd
Airport Rd
Dufferin St
Nashville Rd
The Gore Rd
Dixie Rd
Bovaird Dr W
Guelph St
Mississauga Rd
Sideroad 5
Winston Churchill Blvd
Finch Ave W
Eglinton Ave W
Bloor St W
The Queensway
14th Ave
Steeles Ave E
Markham Rd
Eglinton
Macdonald Cartier Freeway
Toronto Pearson International Airport
421 m
405 m
399 m
501 m
415 m
Paper Size ANSI B
0 1.5 3 4.5 6
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N
N
GHD
TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
7 - HOUR ACCUMULATION AUGUST 17, 2024
Project No. 12664155
Revision No. -
Date Oct 16, 2025
FIGURE 18
Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccuml\12664155_RainfallQAQCHourlyAccumAug17.aprx
Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, NASA, NGA, USGS.


Legend
Rainfall [mm]
> 128
64.1 - 128
32.1 - 64
16.1 - 32
8.1 - 16
4.1 - 8
2.1 - 4
1.1 - 2
< 1
TRCA Watershed Boundaries
Duffins
Rouge
Petticoat
Frenchman's Bay
Carruthers
Highland
Don
Humber
Mimico
Etobicoke
Lakefront
Newmarket
Aurora
York
Richmond Hill
Markham
Vaughan
Pickering
Ajax
Whitby
Oshawa
Scarborough
North York
Toronto
Etobicoke
Brampton
Mississauga
Caledon
Palgrave
King City
Connor
Achill
Alton
Erin
Boston Mills
Ballinafad
Halton Hills
Ashgrove
Sayers Mills
Darbyville
Claude
Trewsons Corners
Pickering Lands Site (Green Space)
Toronto Pearson International Airport
Highway 400
Highway 27
Highway 9
Bathurst St
Yonge St
Leslie St
Vivian Rd
Brock Rd
Lakeridge Rd
Westney Rd
Macdonald Cartier Freeway
Steeles Ave E
14th Ave
Markham Rd
Finch Ave W
Eglinton Ave W
Bloor St W
The Queensway
Dufferin St
Nashville Rd
The Gore Rd
Airport Rd
Old Church Rd
Dixie Rd
Bovaird Dr W
Guelph St
Mississauga Rd
Winston Churchill Blvd
Sideroad 5
County Road 1
County Road 18
Hockley Valley
Sheldon Creek
Mono Hills
Albion Hills
Caledon Hills
501 m
399 m
421 m
405 m
415 m
Paper Size ANSI B
0 1.5 3 4.5 6
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N
N
GHD
TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
7.5 - HOUR ACCUMULATION AUGUST 17, 2024
Project No. 12664155
Revision No. -
Date Oct 16, 2025
FIGURE 19
O:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccum\12664155_RainfallQAQCHourlyAccumAug17.aprx
Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Legend

Rainfall [mm]

- > 128
- 64.1 - 128
- 32.1 - 64
- 16.1 - 32
- 8.1 - 16
- 4.1 - 8
- 2.1 - 4
- 1.1 - 2
- < 1
- TRCA Watershed Boundaries

Duffins
Rouge
Petticoat
Frenchman's Bay
Carruthers
Highland
Don
Humber
Mimico
Etobicoke
Lakefront

Paper Size ANSI B
0 1.5 3 4.5 6
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY

ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024

8 - HOUR ACCUMULATION AUGUST 17, 2024

Project No. 12664155
Revision No. -
Date Oct 16, 2025

FIGURE 20

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccum\12664155_RainfallQAQCHourlyAccumAug17.aprx

Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Legend

Rainfall [mm]

- > 128
- 64.1 - 128
- 32.1 - 64
- 16.1 - 32
- 8.1 - 16
- 4.1 - 8
- 2.1 - 4
- 1.1 - 2
- < 1
- TRCA Watershed Boundaries

Humber
Mimico
Etobicoke
Don
Rouge
Duffins
Petticoat
Frenchman's Bay
Carruthers
Highland
Lakefront

Paper Size ANSI B
0 1.5 3 4.5 6
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY

ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024

8.5 - HOUR ACCUMULATION AUGUST 17, 2024

Project No. 12664155
Revision No. -
Date Oct 16, 2025

FIGURE 21

O:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccum\12664155_RainfallQAQCHourlyAccumAug17.aprx

Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, NASA, NGA, USGS.

Legend

Rainfall [mm]

- > 128
- 64.1 - 128
- 32.1 - 64
- 16.1 - 32
- 8.1 - 16
- 4.1 - 8
- 2.1 - 4
- 1.1 - 2
- < 1
- TRCA Watershed Boundaries

Duffins
Rouge
Petticoat
Frenchman's Bay
Carruthers
Highland
Don
Humber
Mimico
Etobicoke
Lakefront

Paper Size ANSI B
0 1.5 3 4.5 6
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY

ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024

9 - HOUR ACCUMULATION AUGUST 17, 2024

Project No. 12664155
Revision No. -
Date Oct 16, 2025

FIGURE 22

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccum\12664155_RainfallQAQCHourlyAccumAug17.aprx

Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, NASA, NGA, USGS.

Legend

Rainfall [mm]

- > 128
- 64.1 - 128
- 32.1 - 64
- 16.1 - 32
- 8.1 - 16
- 4.1 - 8
- 2.1 - 4
- 1.1 - 2
- < 1
- TRCA Watershed Boundaries

Duffins
Rouge
Petticoat
Frenchman's Bay
Carruthers
Highland
Don
Humber
Mimico
Etobicoke
Lakefront

Paper Size ANSI B
0 1.5 3 4.5 6
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY

ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024

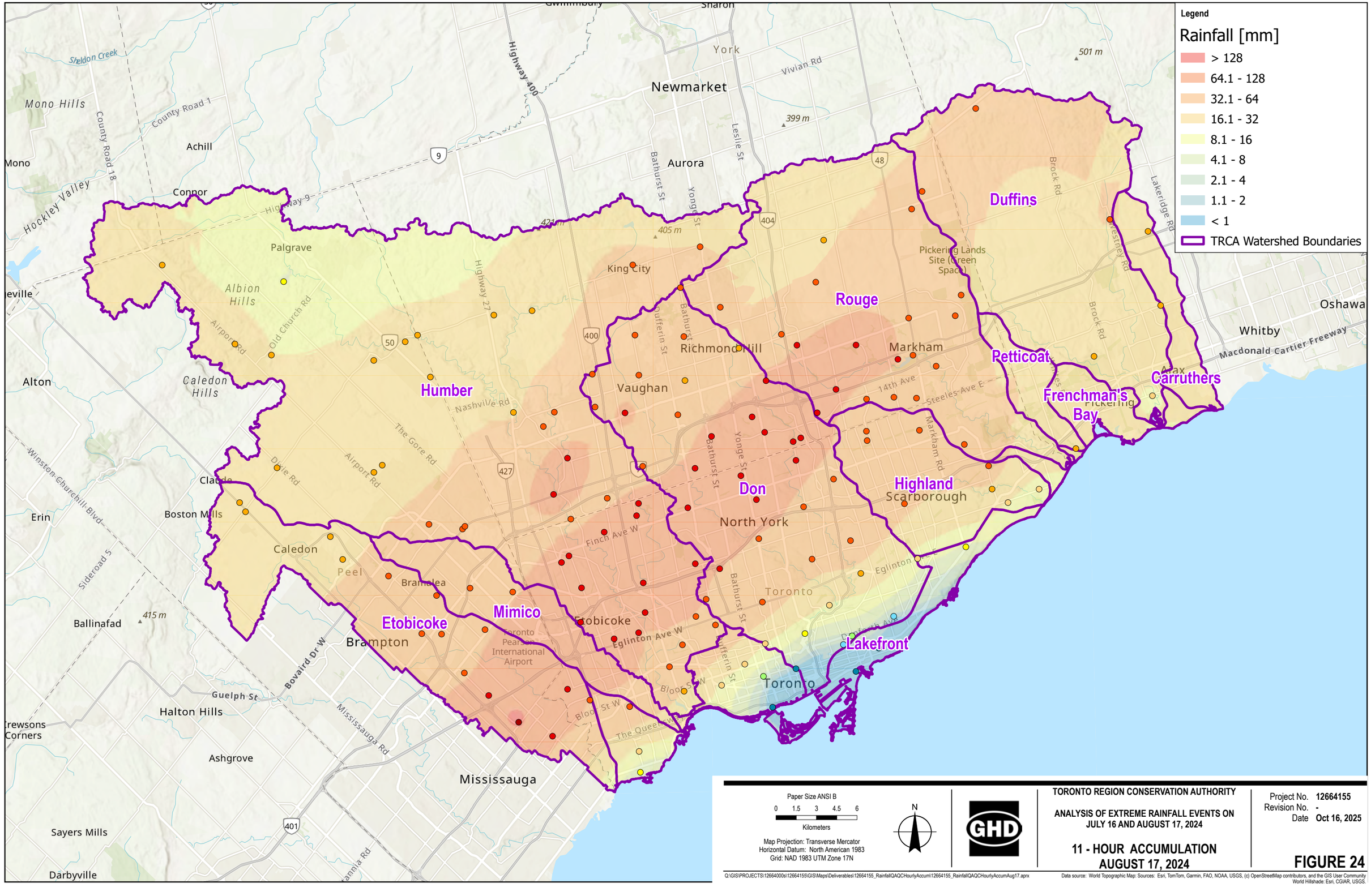
9.5 - HOUR ACCUMULATION AUGUST 17, 2024

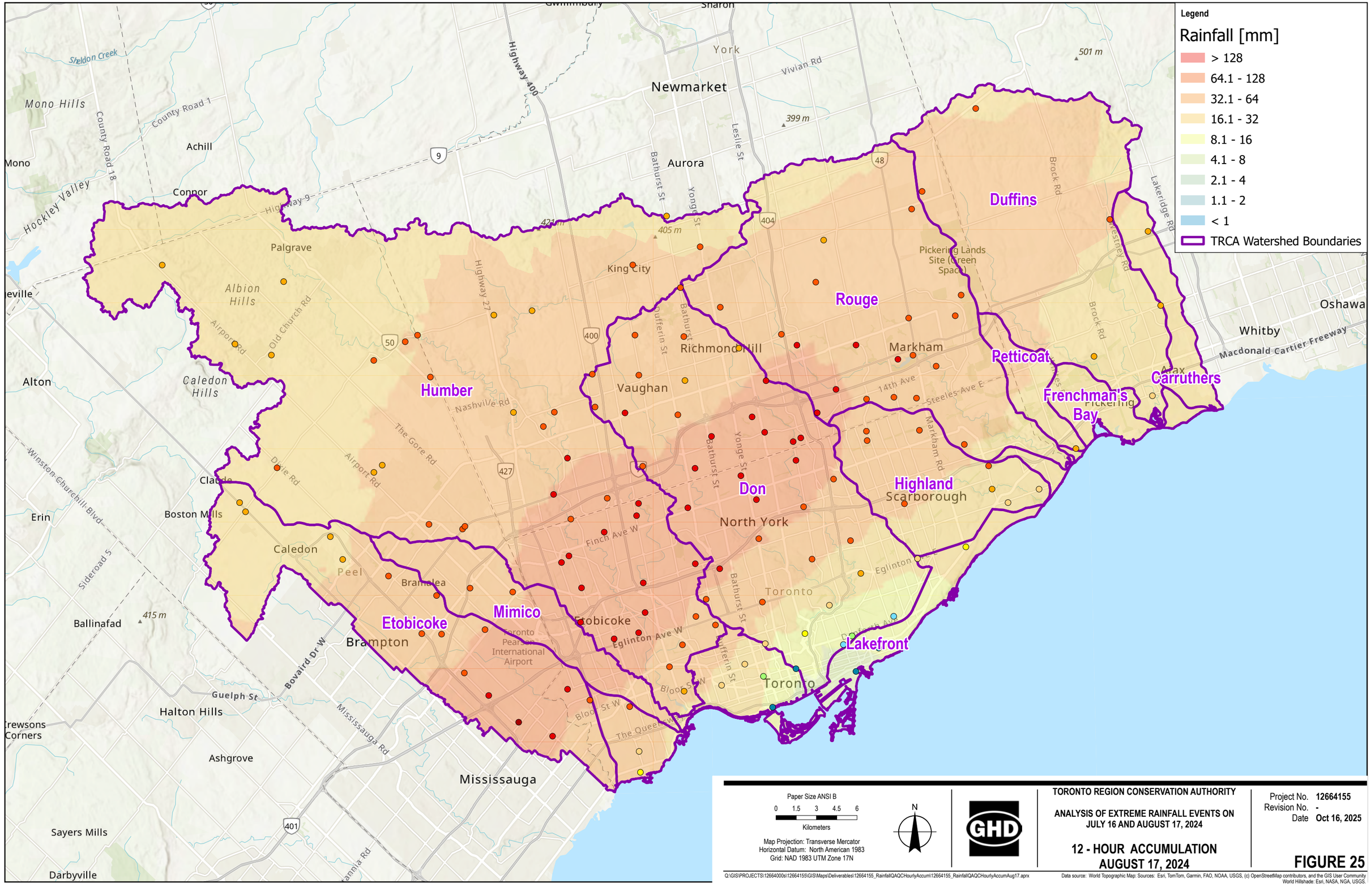
Project No. 12664155
Revision No. -
Date Oct 16, 2025

FIGURE 23

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccum\12664155_RainfallQAQCHourlyAccumAug17.aprx

Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, NASA, NGA, USGS.


Legend
Rainfall [mm]
> 128
64.1 - 128
32.1 - 64
16.1 - 32
8.1 - 16
4.1 - 8
2.1 - 4
1.1 - 2
< 1
TRCA Watershed Boundaries
Duffins
Rouge
Petticoat
Frenchman's Bay
Carruthers
Humber
Don
Highland
Mimico
Etobicoke
Lakefront
Newmarket
Aurora
York
Richmond Hill
Markham
Vaughan
King City
Palgrave
Connor
Achill
Mono
Hockley Valley
Mono Hills
Albion Hills
Caledon Hills
Alton
Erin
Boston Mills
Caledon
Brampton
Ballinafad
Halton Hills
Ashgrove
Mississauga
Sayers Mills
Darbyville
Crewsons Corners
Claude
Pickering
Ajax
Whitby
Oshawa
Scarborough
North York
Toronto
Etobicoke
Pickering Lands Site (Green Space)
Toronto Pearson International Airport
Highway 400
Highway 9
Highway 27
Bathurst St
Yonge St
Leslie St
Vivian Rd
Brock Rd
Lakeridge Rd
Westney Rd
Dufferin St
Eglinton Ave W
Finch Ave W
Steeles Ave E
14th Ave
Markham Rd
Nashville Rd
The Gore Rd
Airport Rd
Old Church Rd
Bovaird Dr W
Guelph St
Mississauga Rd
Dixie Rd
Sideroad 5
Winston Churchill Blvd
County Road 1
County Road 18
Sheldon Creek
Macdonald Cartier Freeway
421 m
405 m
399 m
501 m
415 m
Paper Size ANSI B
0 1.5 3 4.5 6
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N
N
GHD
TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
11 - HOUR ACCUMULATION AUGUST 17, 2024
Project No. 12664155
Revision No. -
Date Oct 16, 2025
FIGURE 24
Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccum\12664155_RainfallQAQCHourlyAccumAug17.aprx
Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.


Legend
Rainfall [mm]
> 128
64.1 - 128
32.1 - 64
16.1 - 32
8.1 - 16
4.1 - 8
2.1 - 4
1.1 - 2
< 1
TRCA Watershed Boundaries
Duffins
Rouge
Petticoat
Frenchman's Bay
Carruthers
Highland
Don
Humber
Mimico
Etobicoke
Lakefront
Newmarket
Aurora
York
Richmond Hill
Markham
Vaughan
Pickering
Ajax
Whitby
Oshawa
North York
Scarborough
Toronto
Brampton
Mississauga
Halton Hills
Caledon
Palgrave
King City
Connor
Achill
Alton
Erin
Boston Mills
Ballinafad
Ashgrove
Sayers Mills
Darbyville
Mono Hills
Hockley Valley
Albion Hills
Caledon Hills
Pickering Lands Site (Green Space)
Toronto Pearson International Airport
Highway 400
Highway 27
Highway 9
Eglinton Ave W
Steeles Ave E
14th Ave
Finch Ave W
Bloor St W
Bathurst St
Yonge St
Dufferin St
Leslie St
Brock Rd
Markham Rd
Westney Rd
Lakeridge Rd
Nashville Rd
The Gore Rd
Airport Rd
Old Church Rd
Dixie Rd
Mississauga Rd
Bovaird Dr W
Guelph St
Sideroad 5
Winston Churchill Blvd
County Road 18
County Road 1
Vivian Rd
Macdonald Cartier Freeway
The Queensway
Sheldon Creek
501 m
399 m
421 m
405 m
415 m
Paper Size ANSI B
0 1.5 3 4.5 6
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N
N
GHD
TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
12 - HOUR ACCUMULATION AUGUST 17, 2024
Project No. 12664155
Revision No. -
Date Oct 16, 2025
FIGURE 25
Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallQAQCHourlyAccum\12664155_RainfallQAQCHourlyAccumAug17.aprx
Data source: World Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, NASA, NGA, USGS.

Appendix C

Spatial distribution of return periods for various storm durations

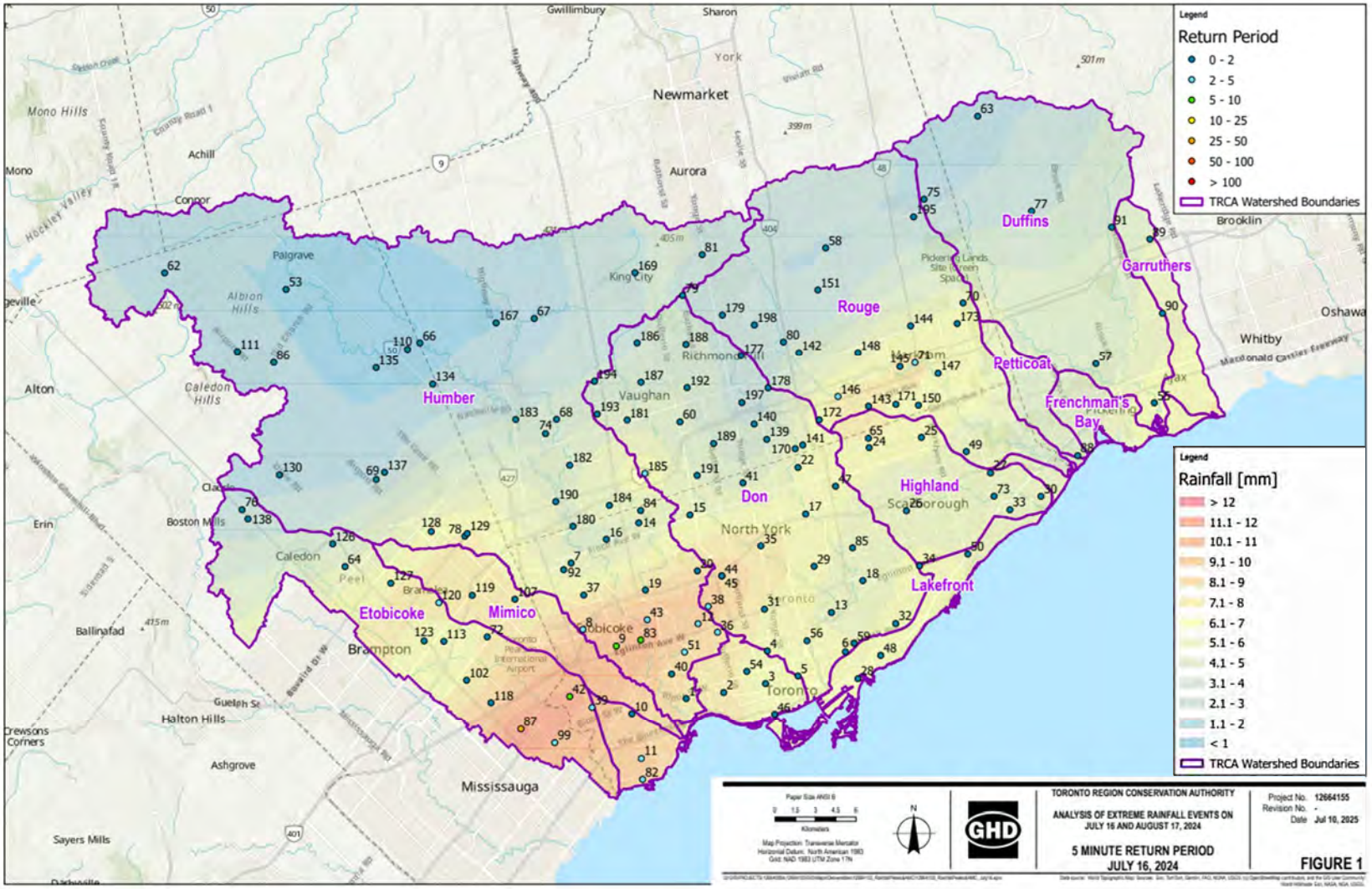


Figure C-1 July 16, 2024 storm event – 5-min duration return period

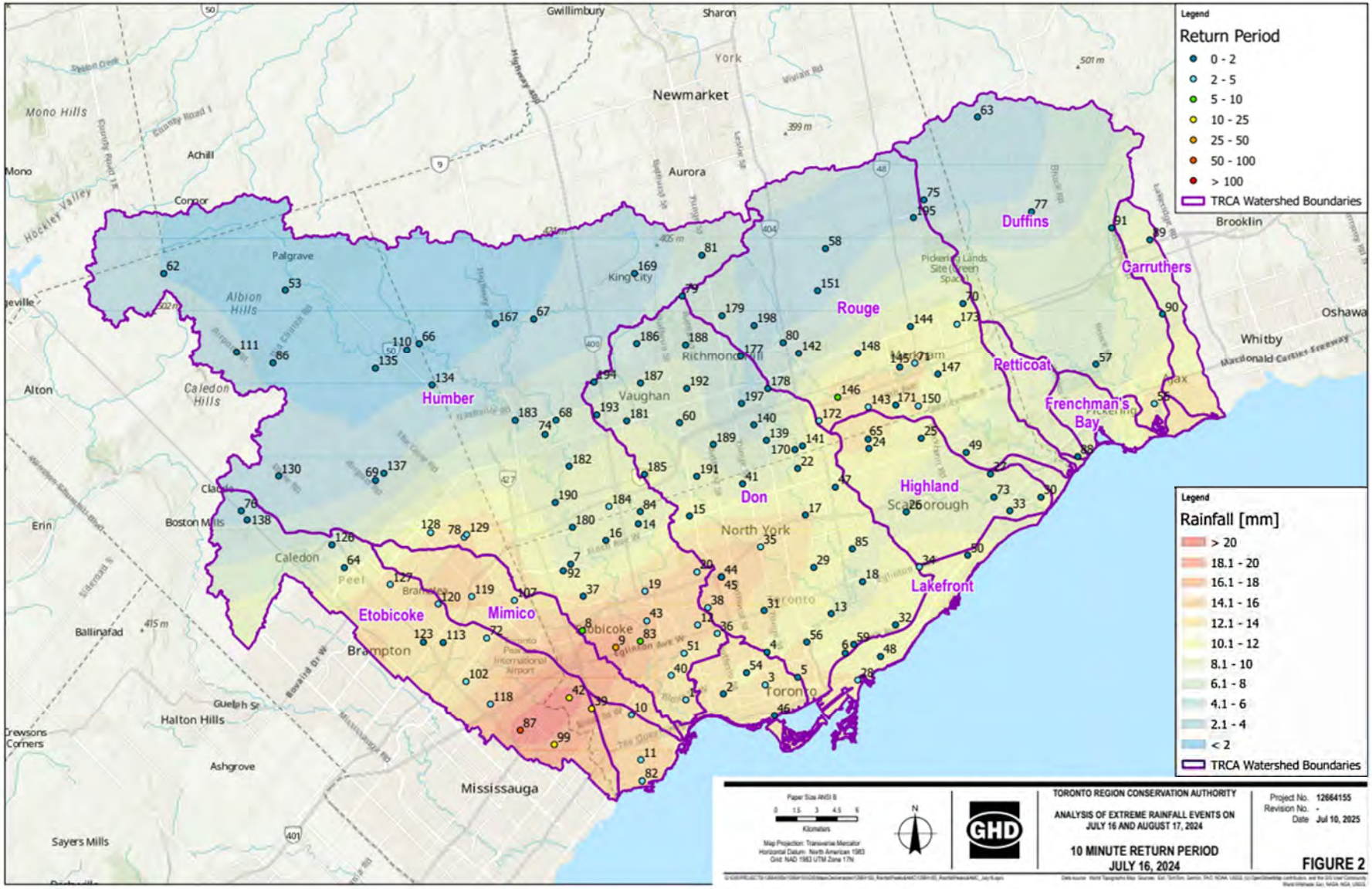


Figure C-2 July 16, 2024 storm event – 10-min duration return period

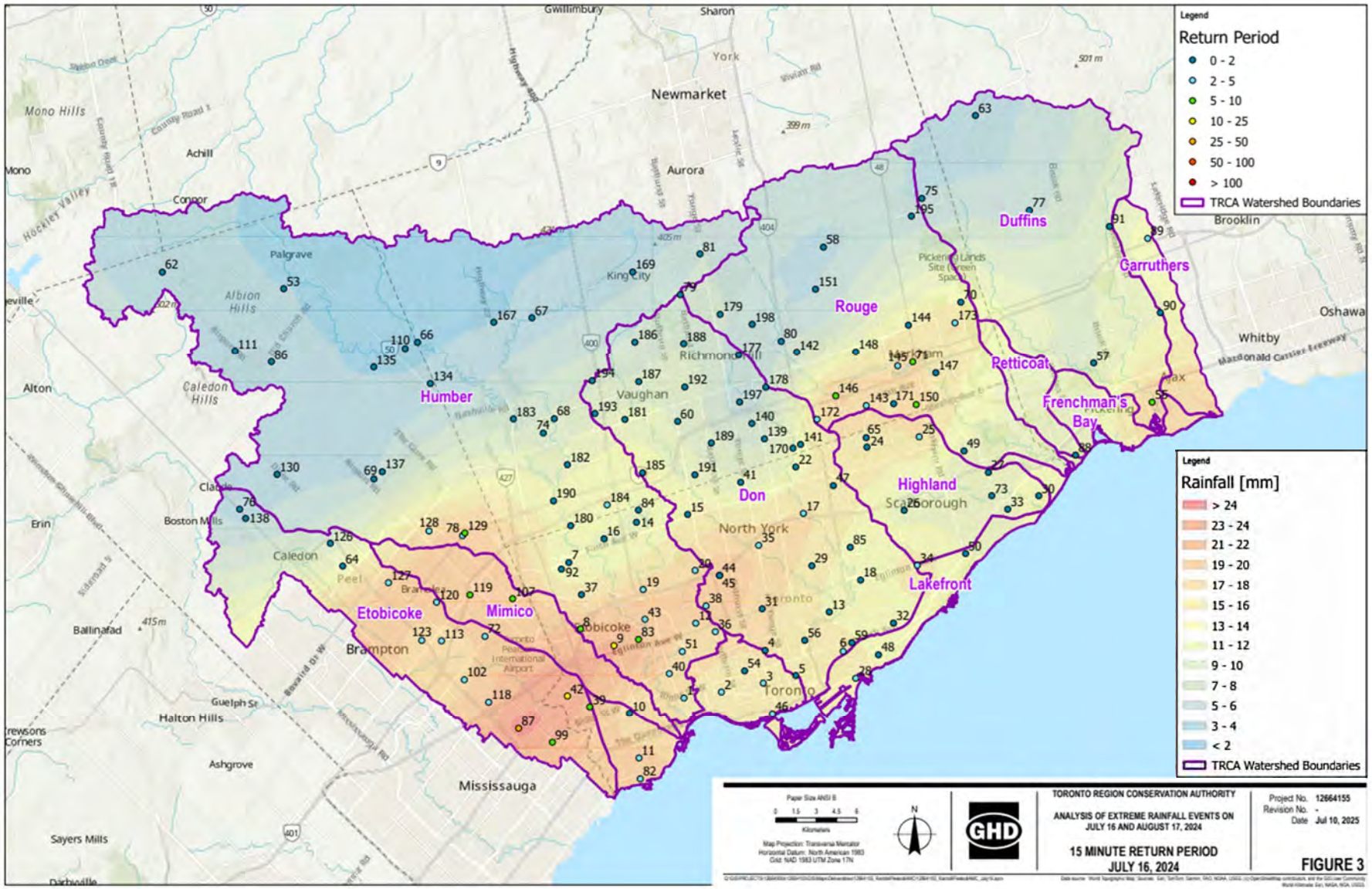


Figure C-3 July 16, 2024 storm event – 15-min duration return period

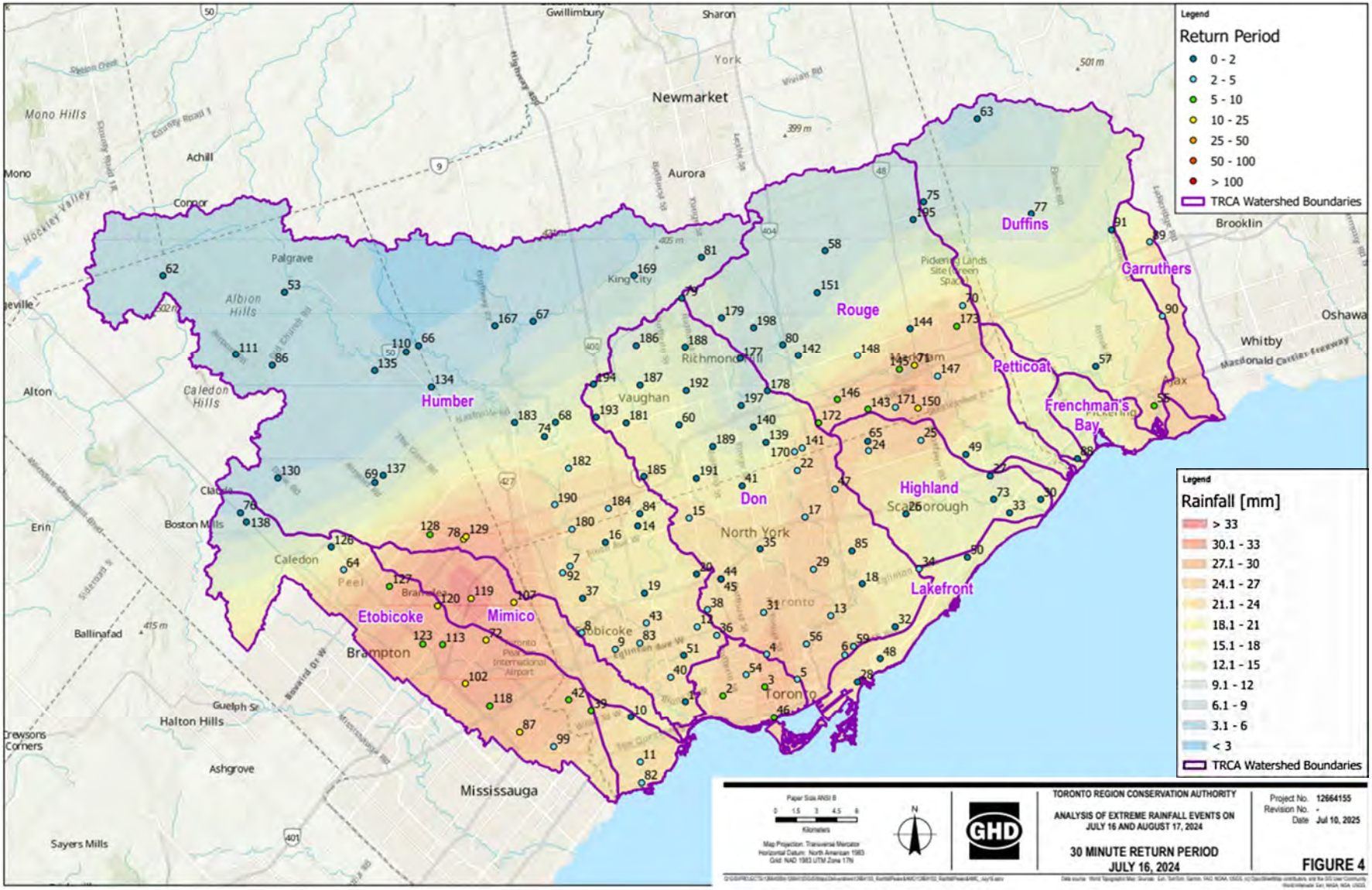


Figure C-4 July 16, 2024 storm event – 30-min duration return period

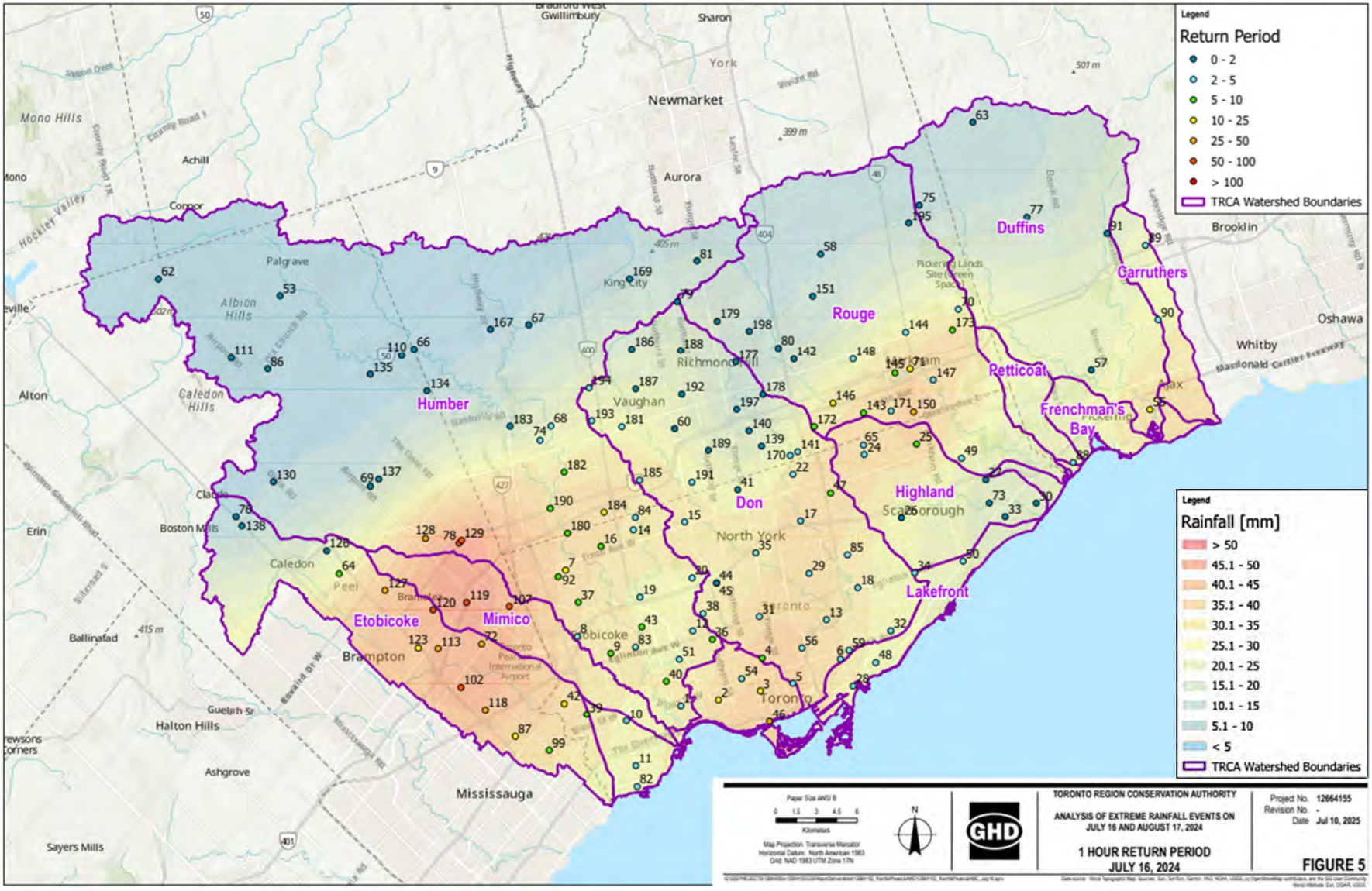


Figure C-5 July 16, 2024 storm event – 1-hr duration return period

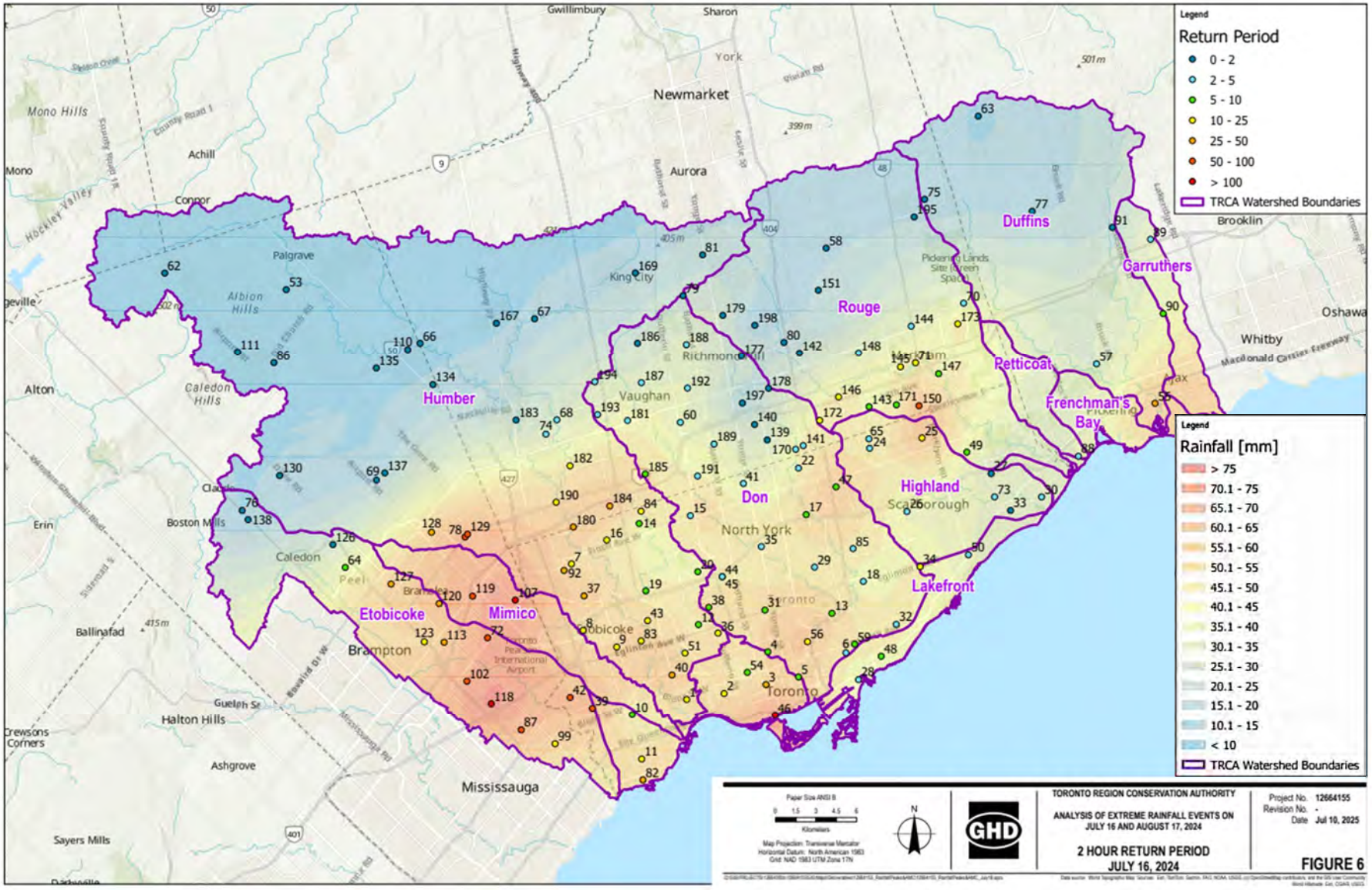


Figure C-6 July 16, 2024 storm event – 2-hr duration return period

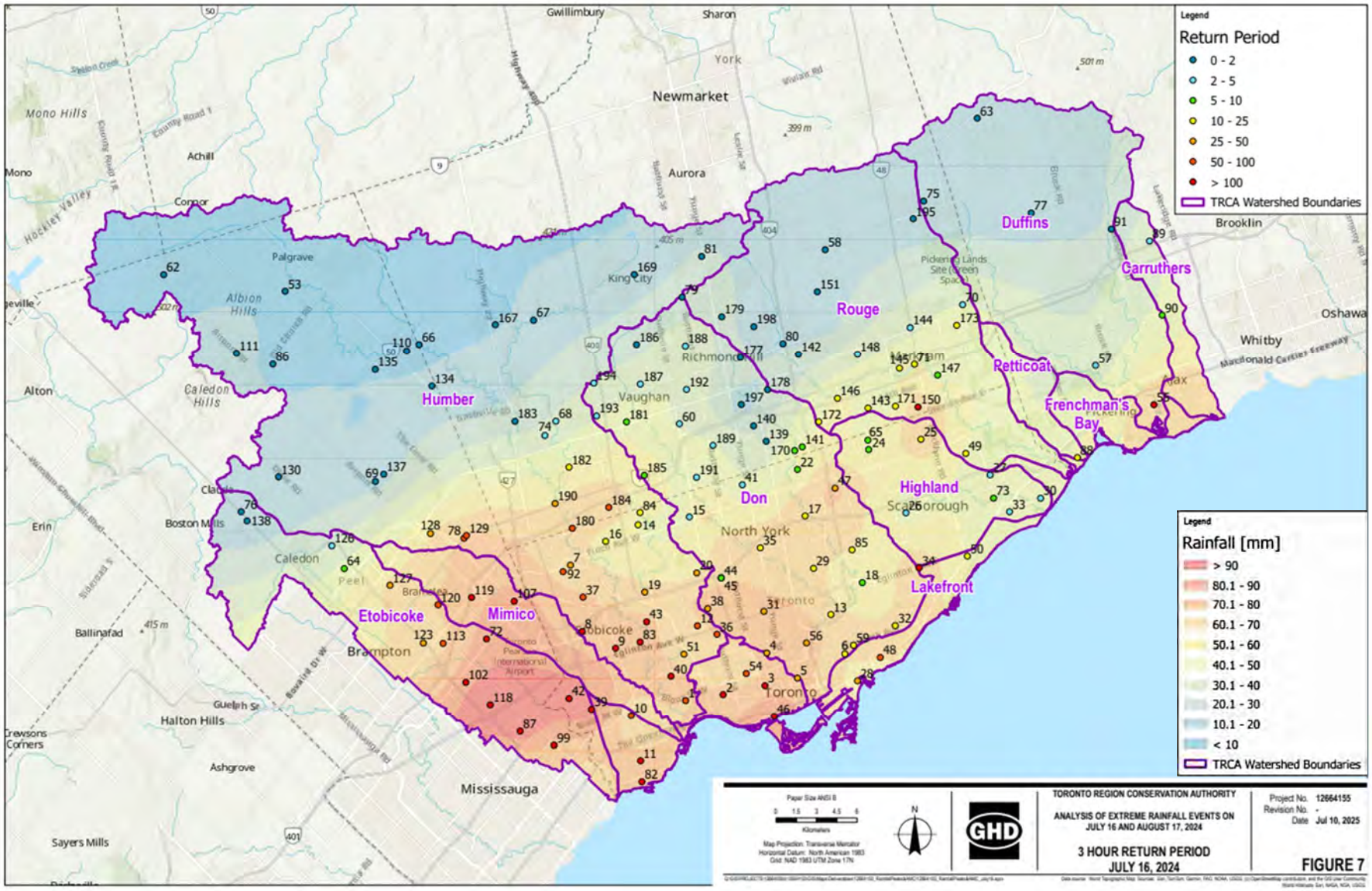


Figure C-7 July 16, 2024 storm event – 3-hr duration return period

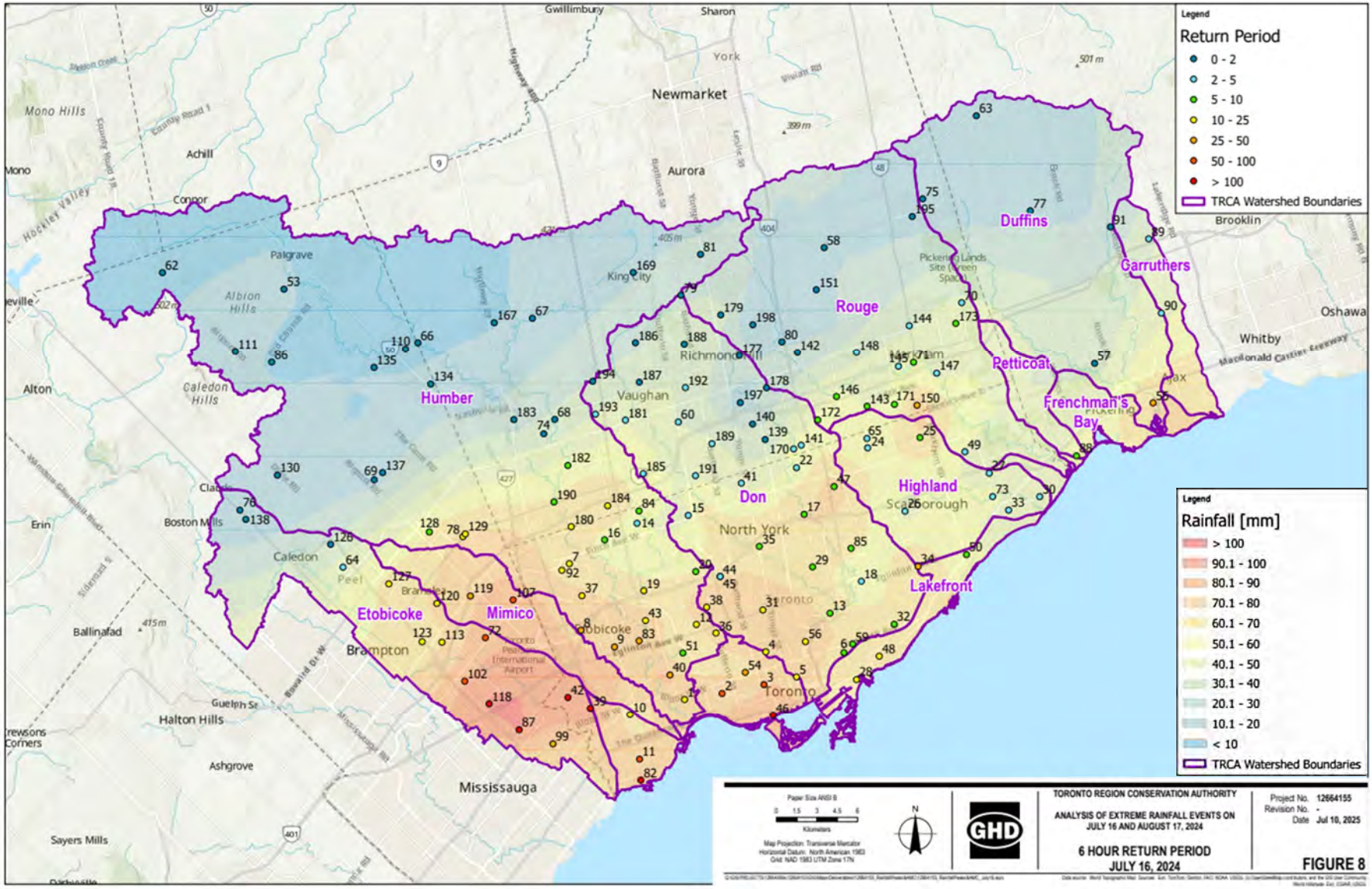


Figure C-8 July 16, 2024 storm event – 6-hr duration return period

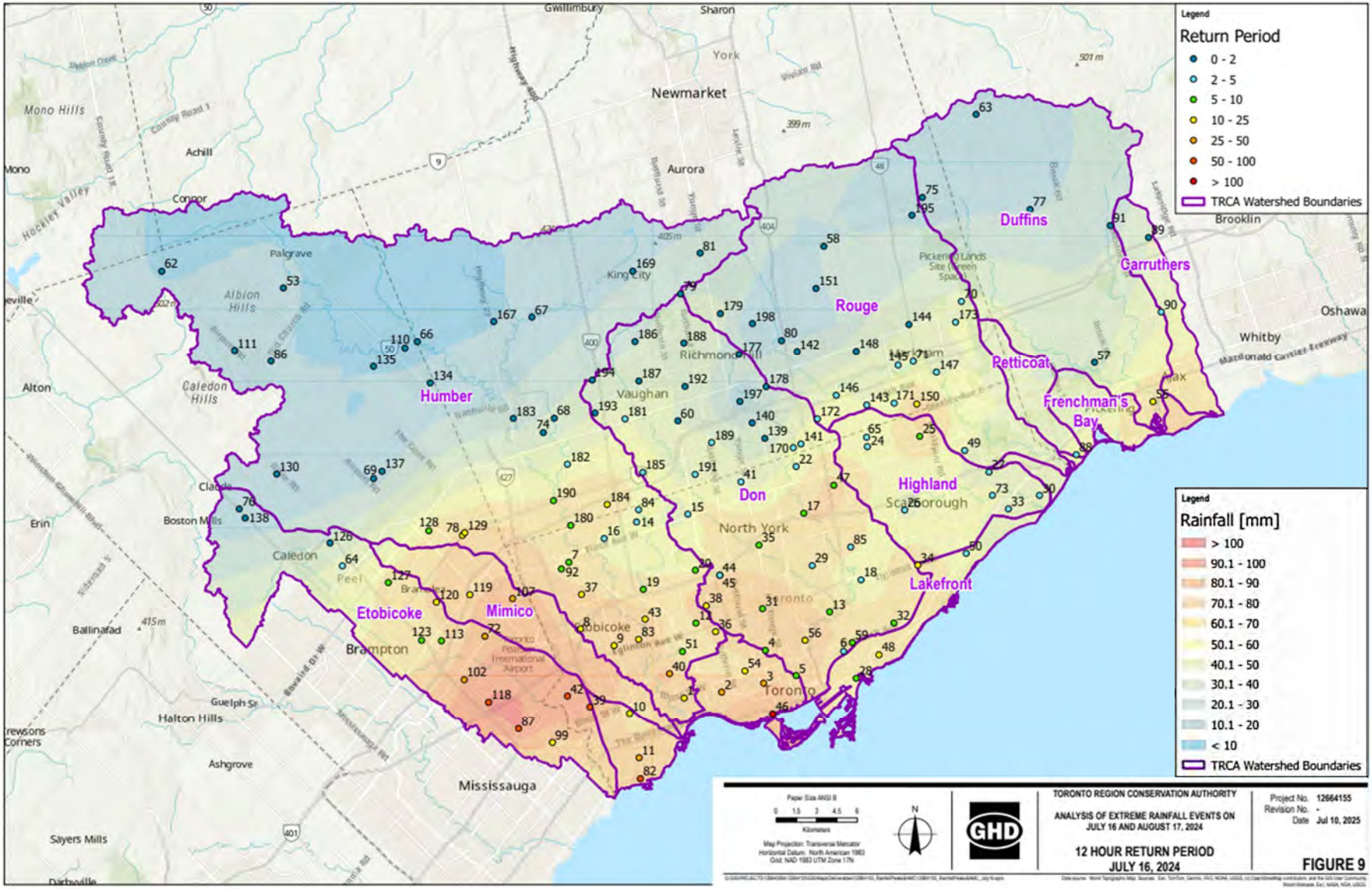


Figure C-9 July 16, 2024 storm event – 12-hr duration return period

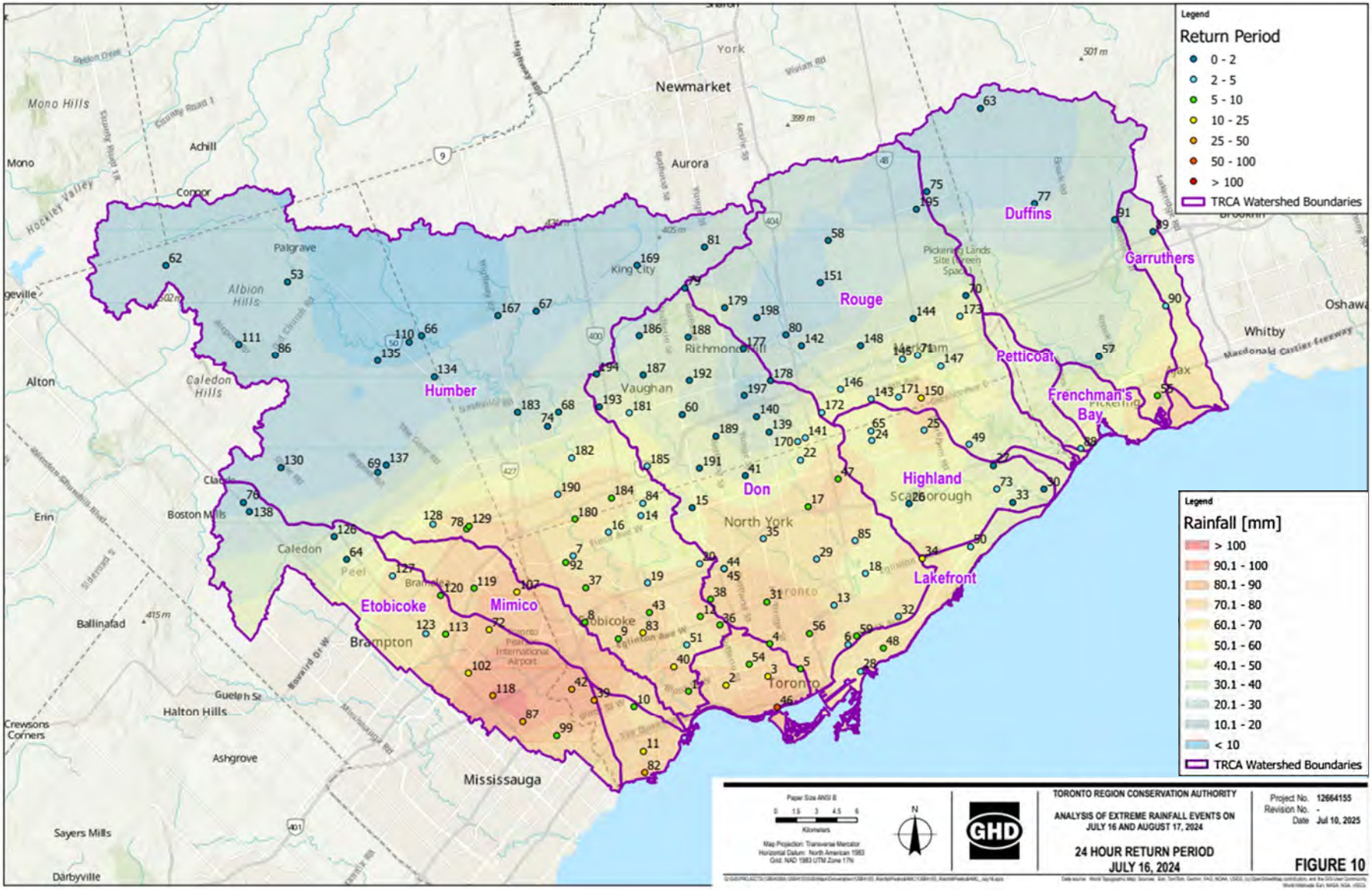


Figure C-10 July 16, 2024 storm event – 24-hr duration return period

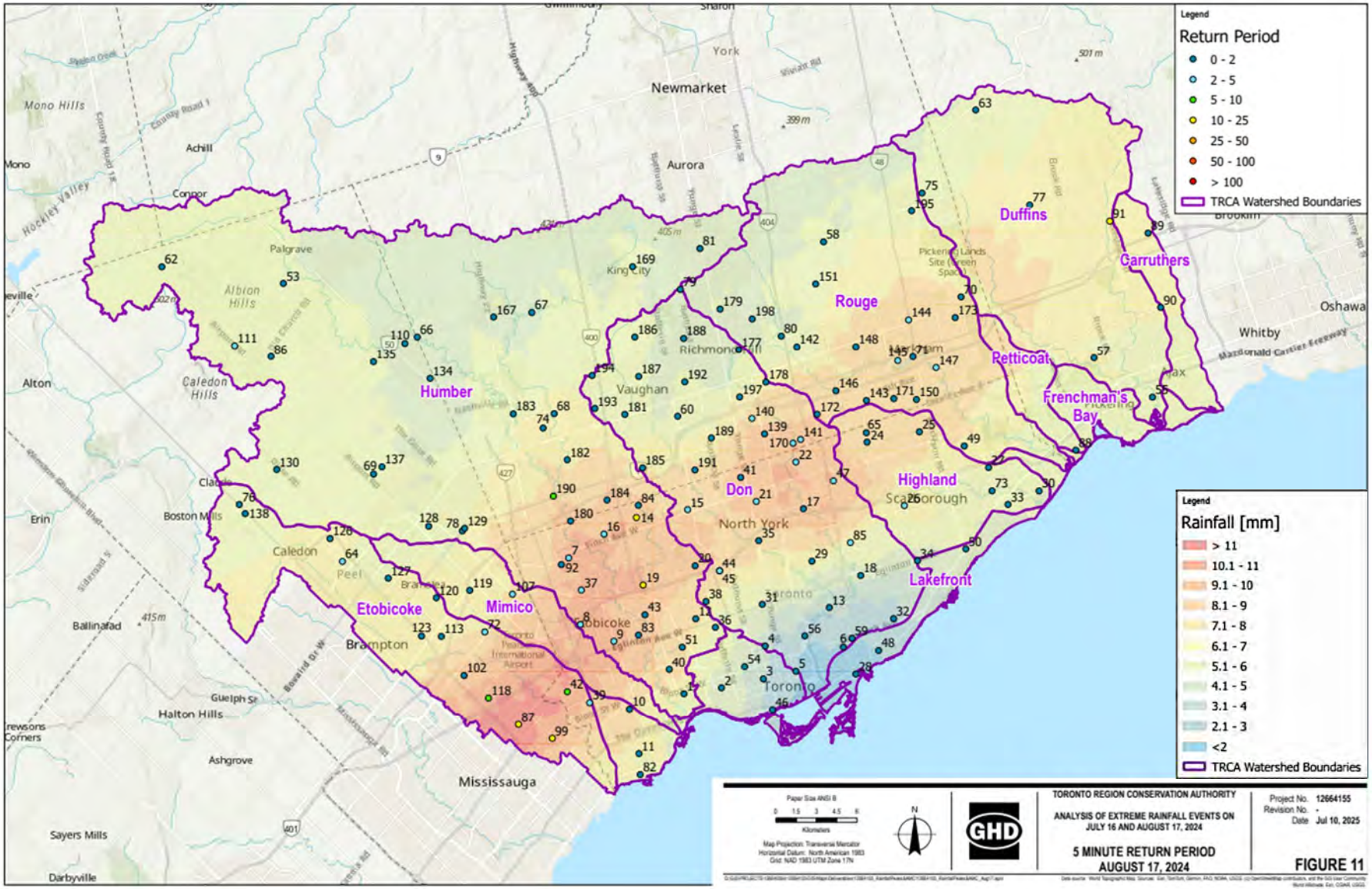


Figure C-11 August 17, 2024 storm event - 5-min duration return period

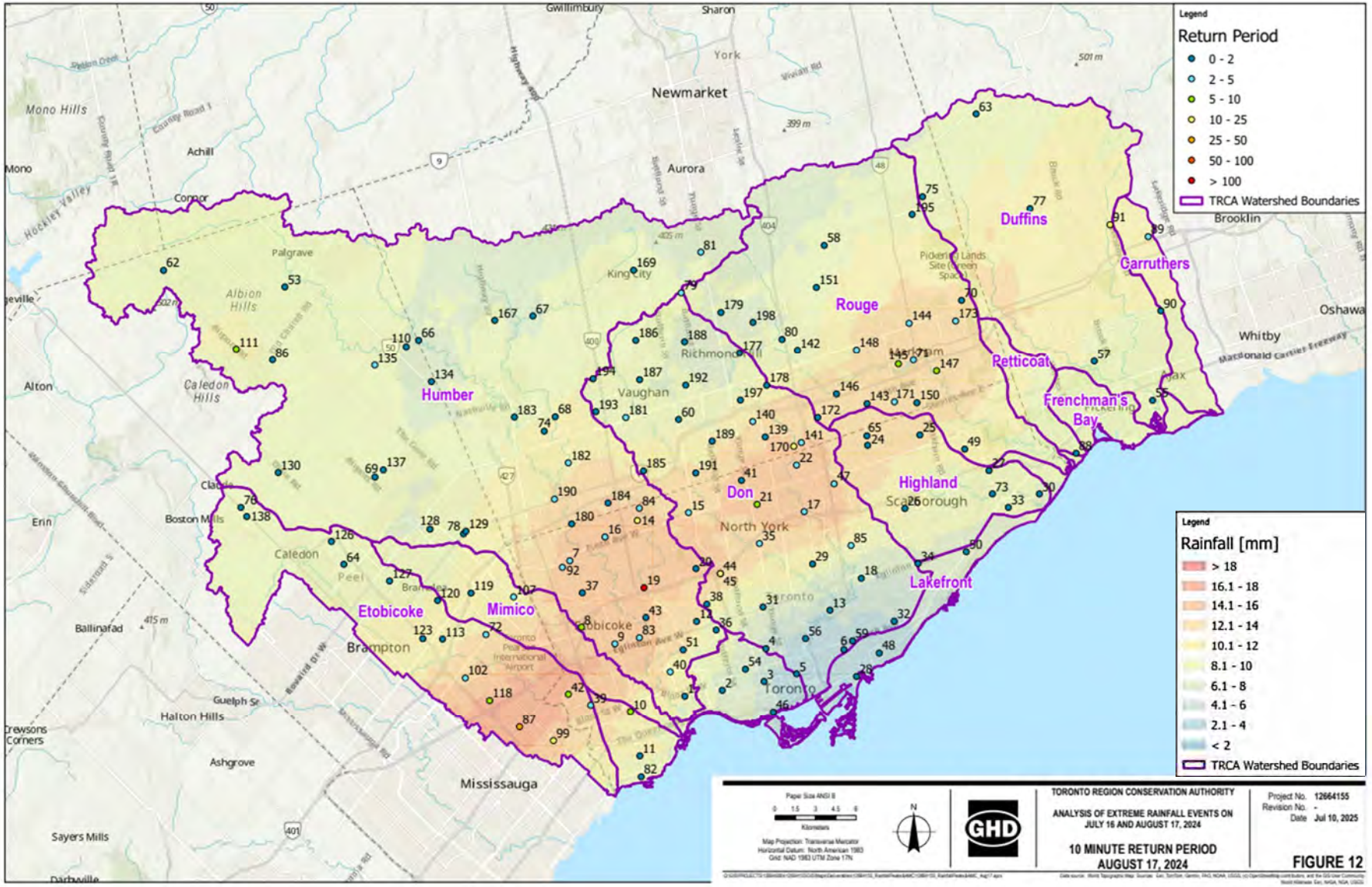


Figure C-12 August 17, 2024 storm event - 10-min duration return period

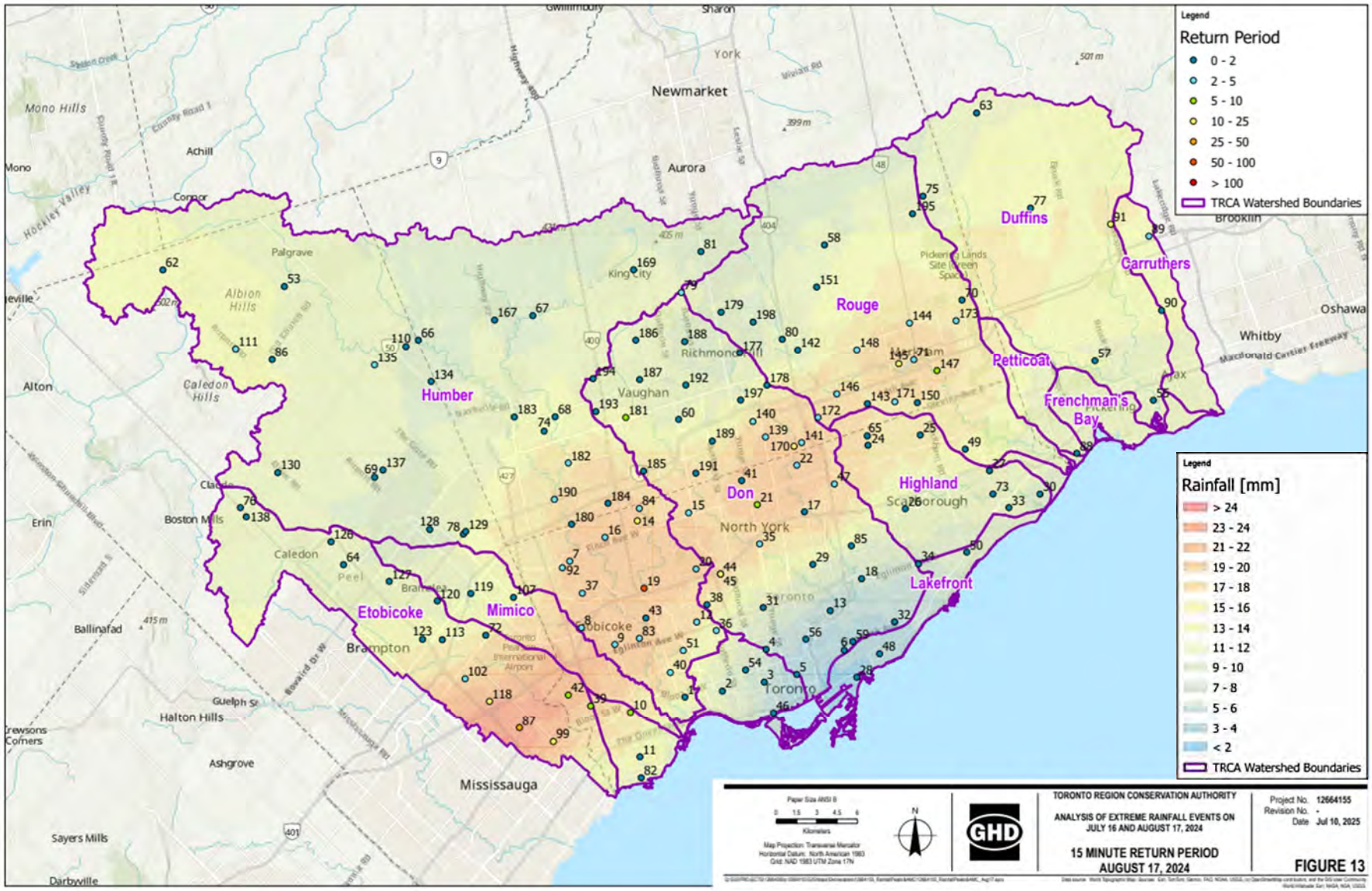


Figure C-13 August 17, 2024 storm event - 15-min duration return period

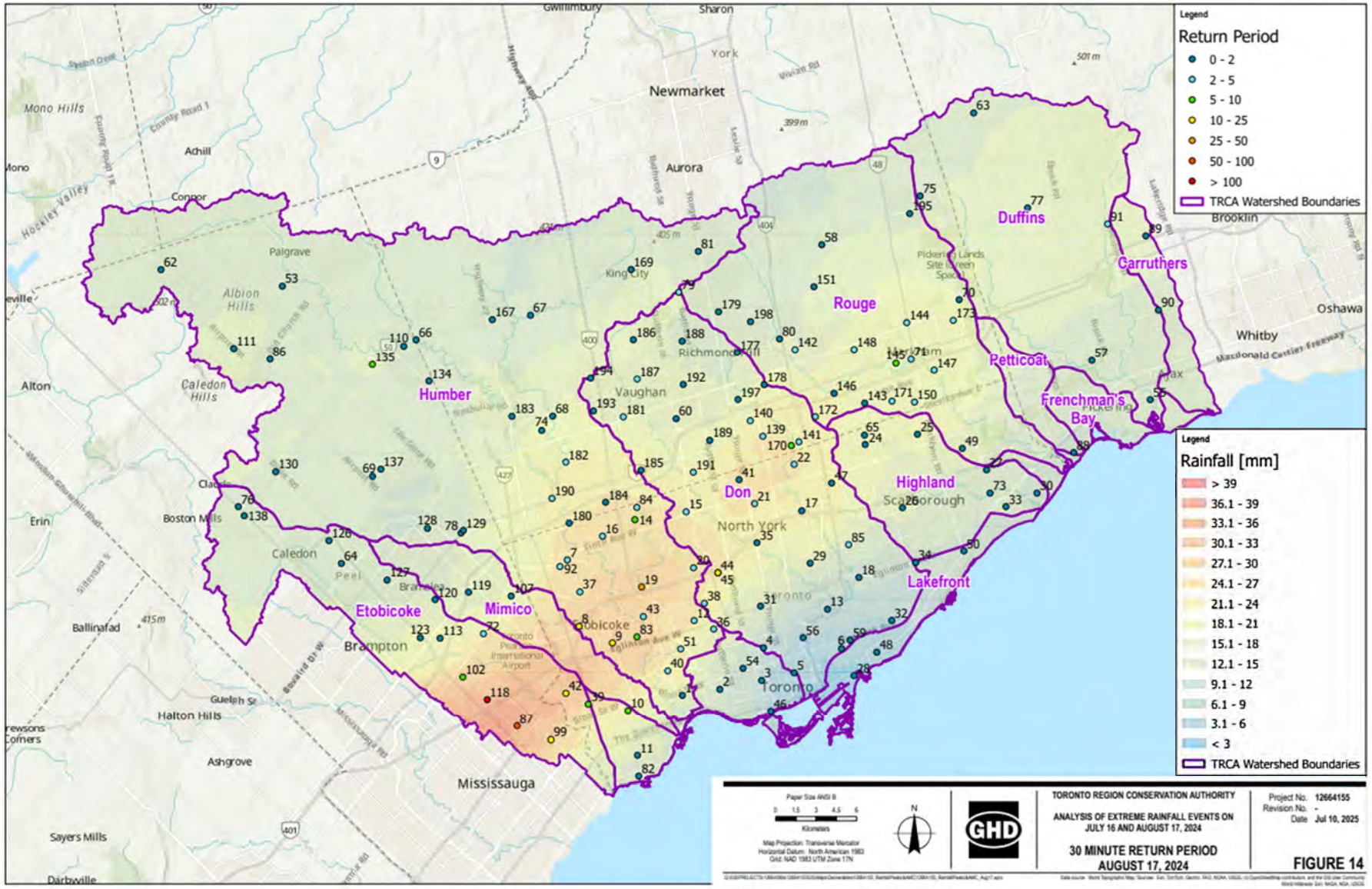


Figure C-14 August 17, 2024 storm event - 30-min duration return period

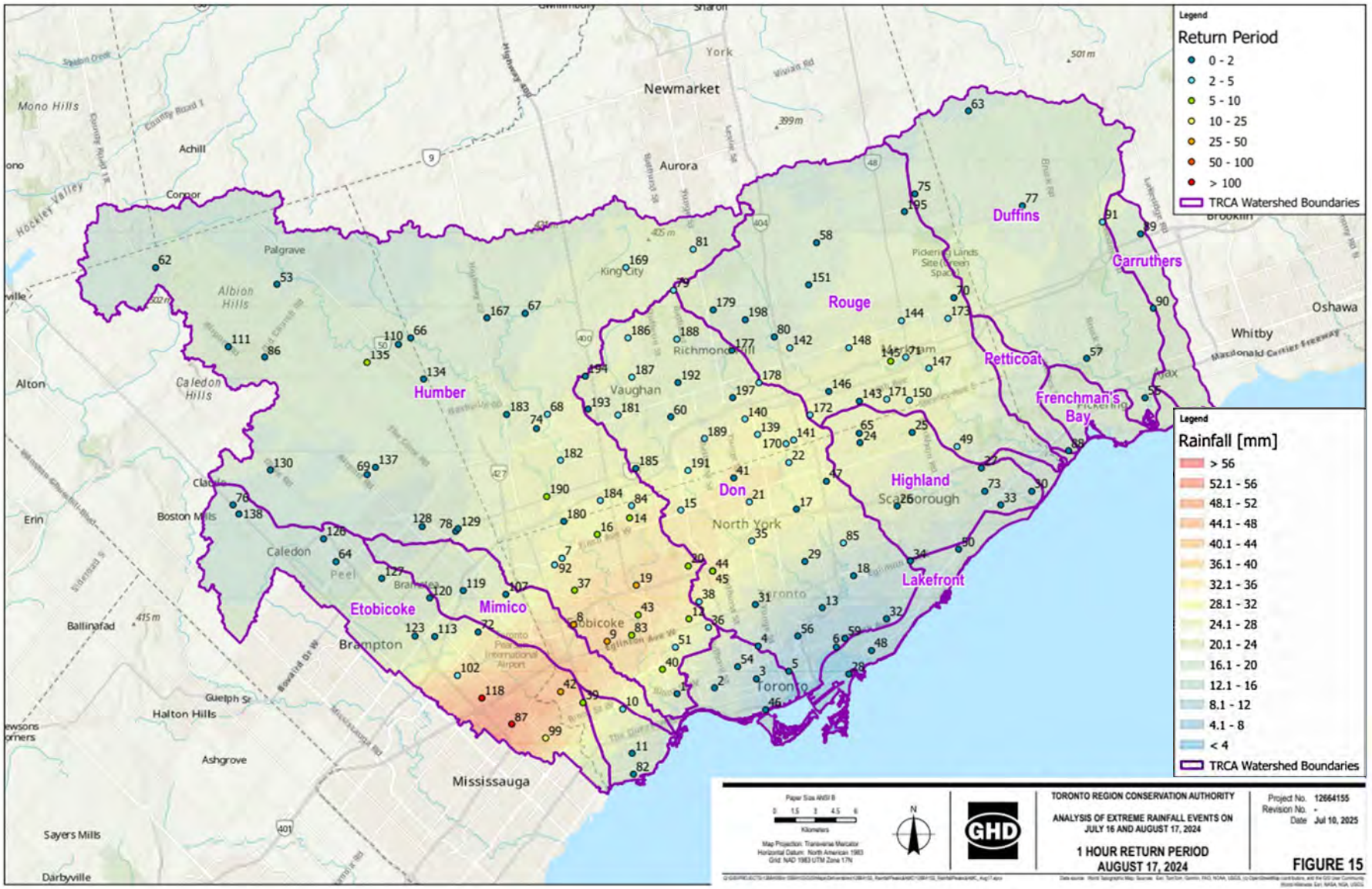


Figure C-15 August 17, 2024 storm event - 1-hr duration return period

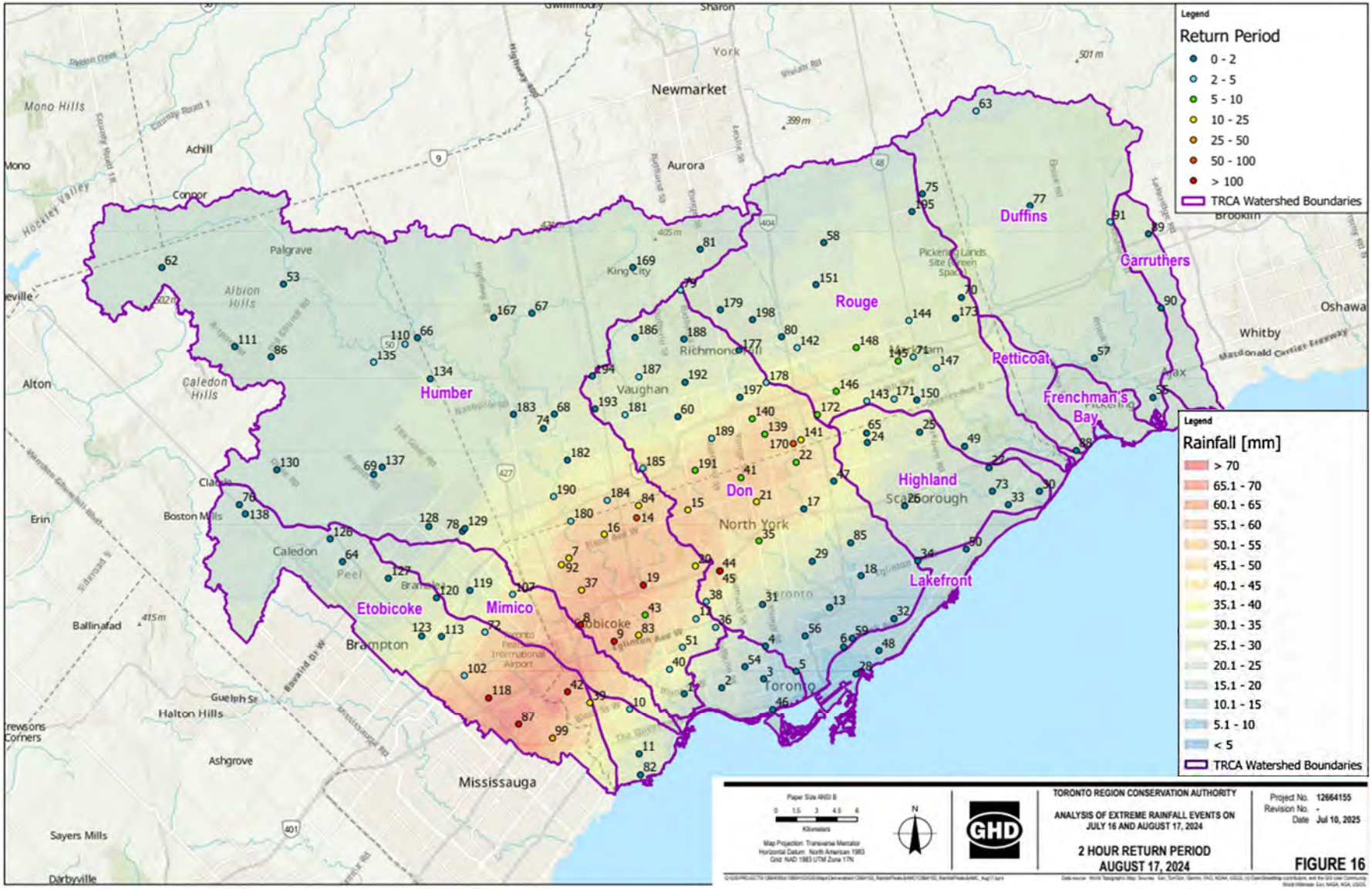


Figure C-16 August 17, 2024 storm event - 2-hr duration return period

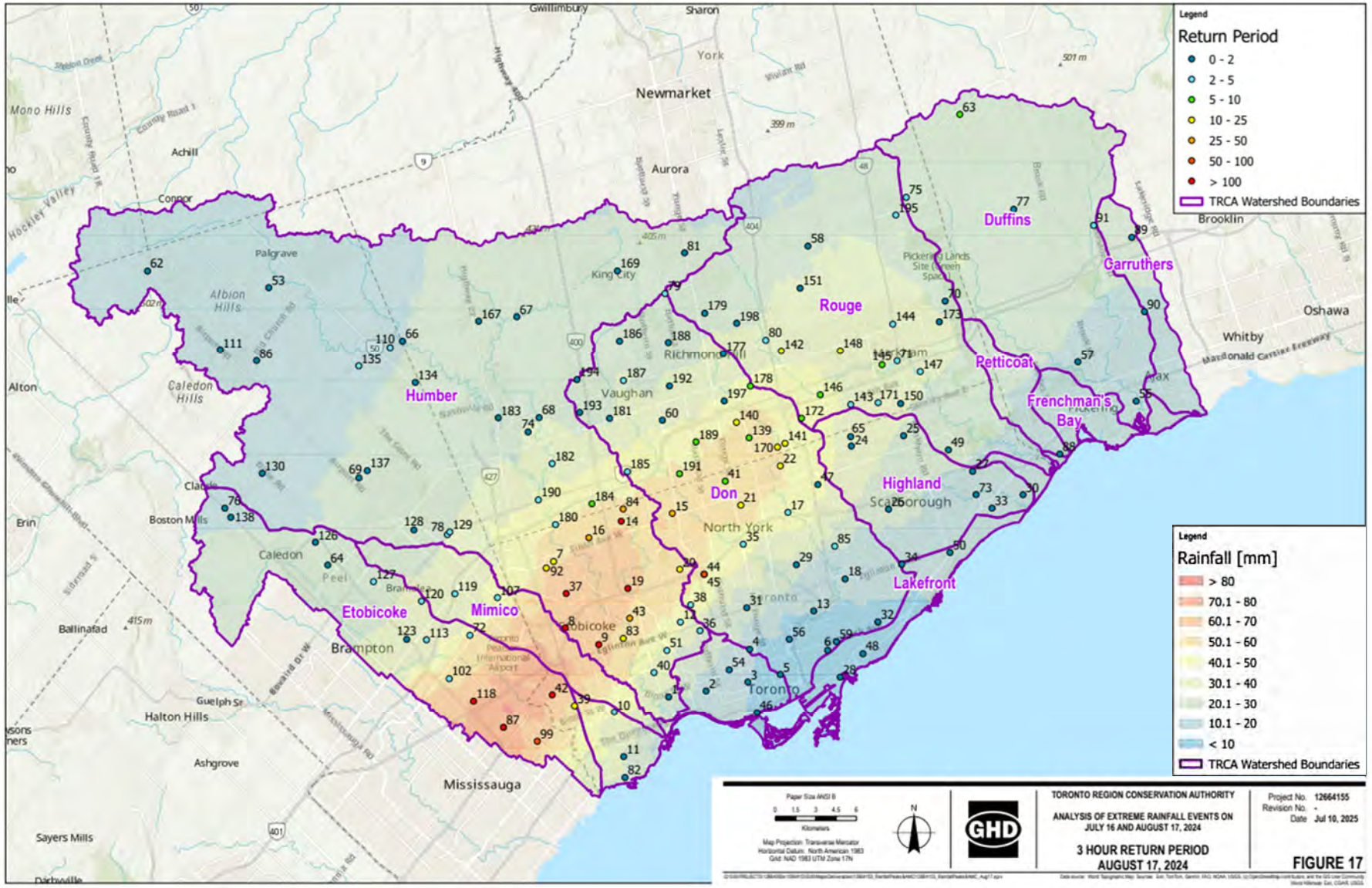


Figure C-17 August 17, 2024 storm event - 3-hr duration return period

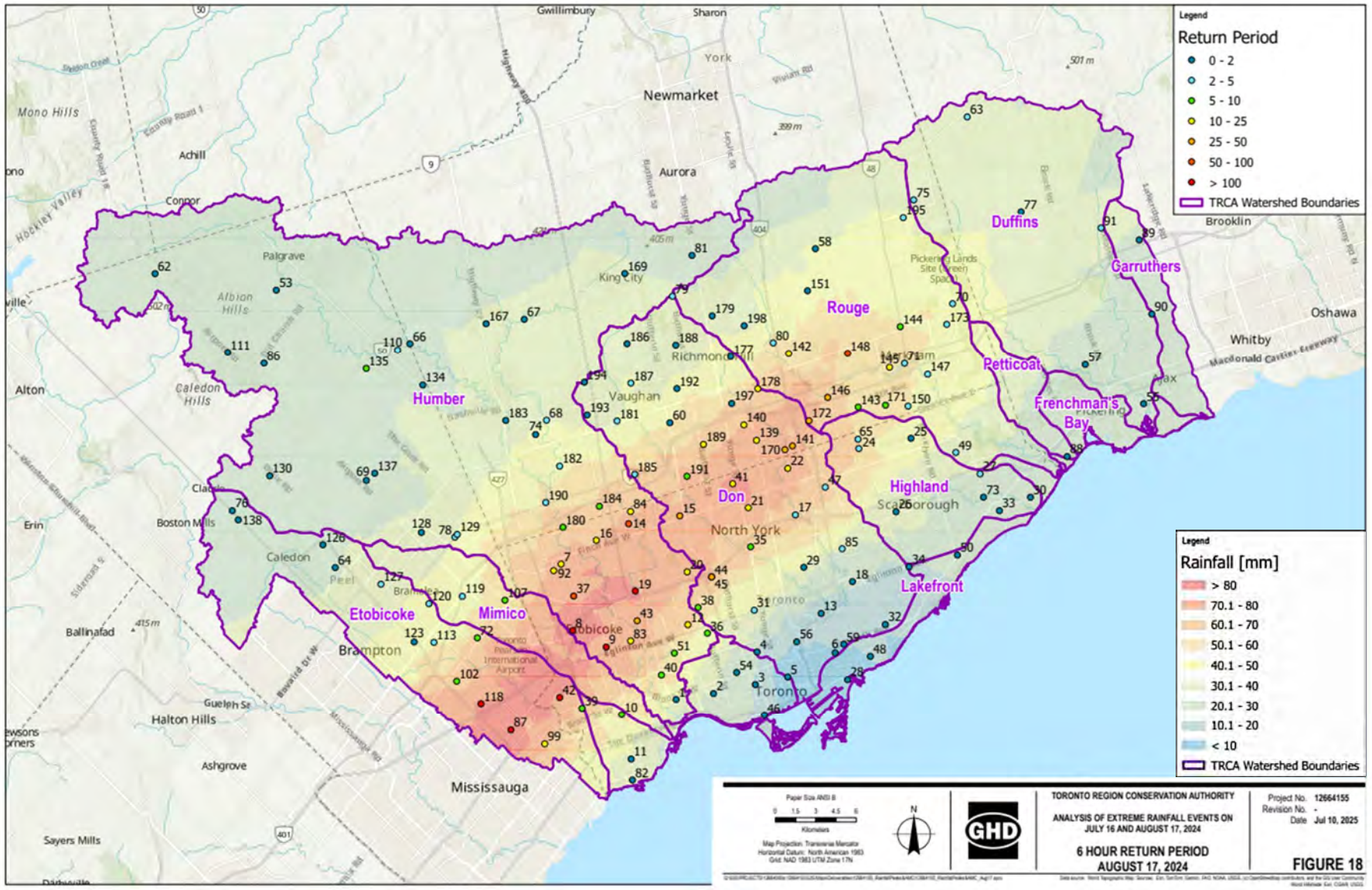


Figure C-18 August 17, 2024 storm event - 6-hr duration return period

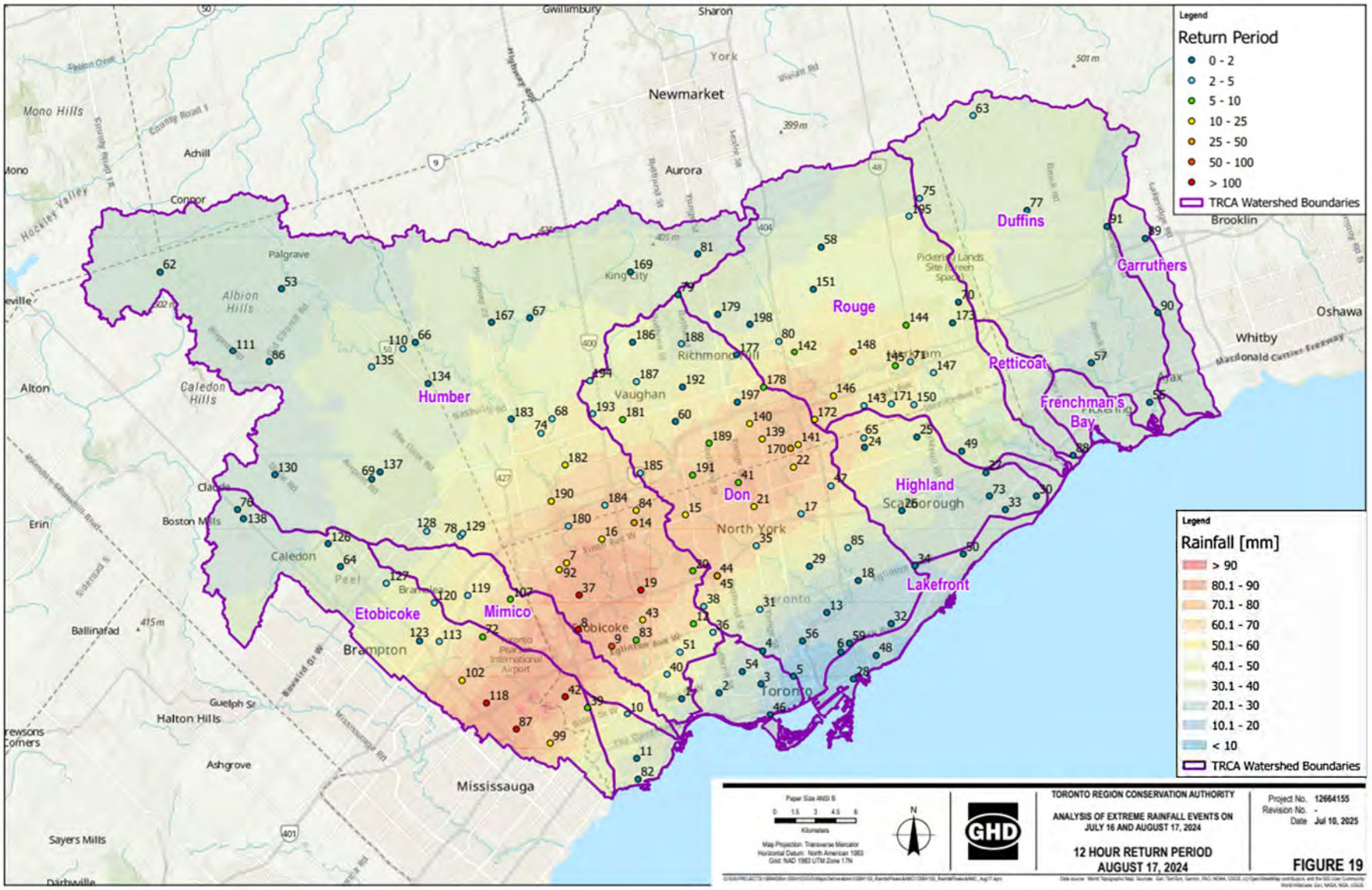


Figure C-19 August 17, 2024 storm event - 12-hr duration return period

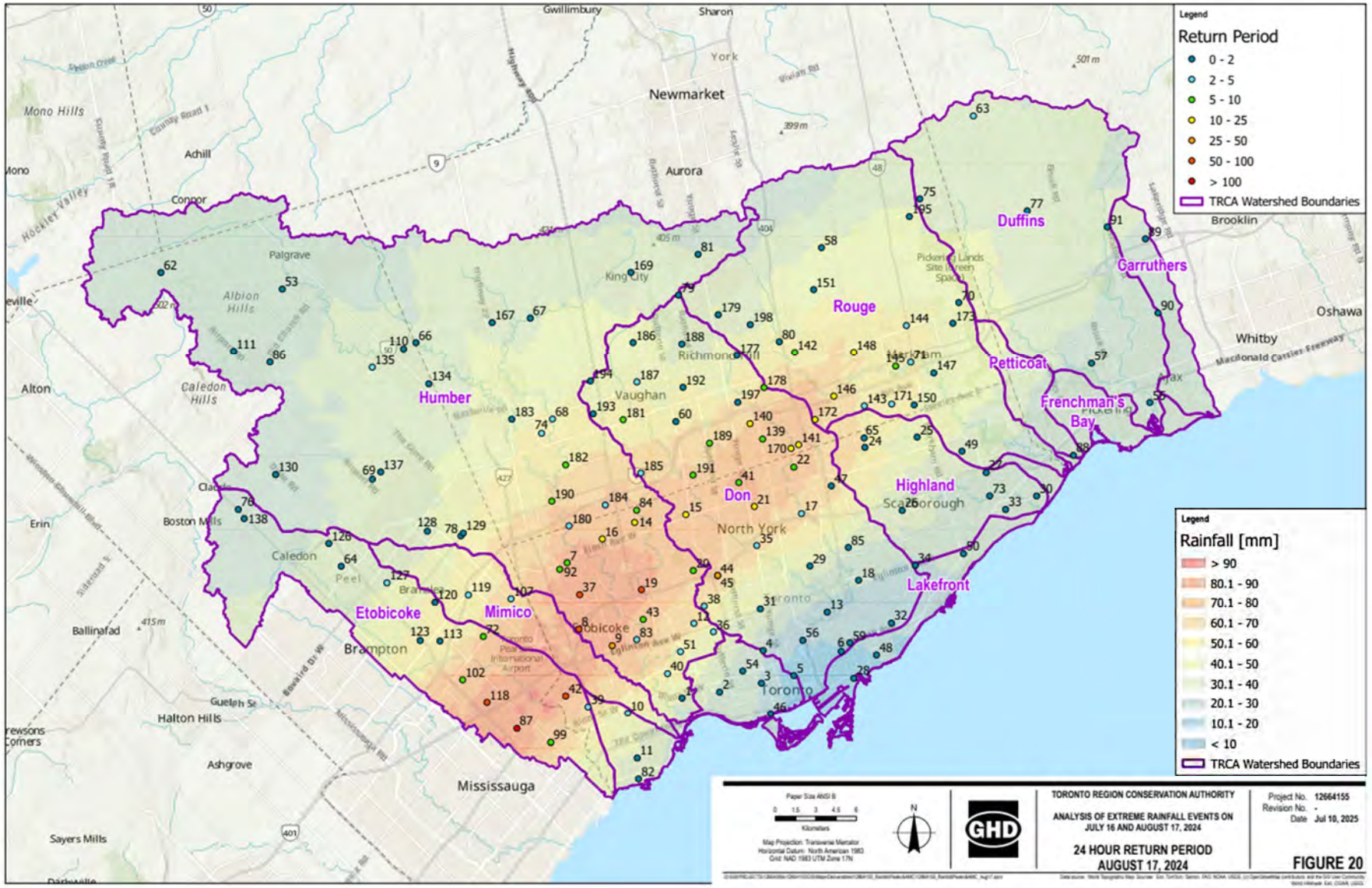


Figure C-20 August 17, 2024 storm event - 24-hr duration return period

Appendix D

GARR Comparison Maps

Interpolated from Rain Gauges

GARR Data

Legend

Rainfall [mm]

- > 12
- 11.1 - 12
- 10.1 - 11
- 9.1 - 10
- 8.1 - 9
- 7.1 - 8
- 6.1 - 7
- 5.1 - 6
- 4.1 - 5
- 3.1 - 4
- 2.1 - 3
- 1.1 - 2
- < 1
- TRCA Watershed Boundaries

Duffins
Carruthers
Rouge
Petticoat
Frenchman's Bay
Humber
Don
Highland
Mimico
Etobicoke
Lakefront

Forces Base Borden
Essa
Newmarket
York
Aurora
King City
Richmond Hill
Markham
Vaughan
North York
Toronto
Brampton
Caledon
Peel
Halton Hills
Mississauga
Milton
Halton
Oakville
Burlington
Alton
Erin
Hills
Sheldon Creek
Pefferlaw Brook
Nonquon River
501 m
430 m
439

Paper Size ANSI B

0 3.5 7 10.5 14

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
DATA GAP ANALYSIS

5 MINUTE RAINFALL JULY 16, 2024

Project No. **12664155**
Revision No. **-**
Date **Dec 2, 2025**

FIGURE 1

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallDataInterpolation\12664155_RainfallDataInterpolation\12664155_July16_RainfallDataInterpolation_MXD.mxd

Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Interpolated from Rain Gauges

GARR Data

Legend

Rainfall [mm]

- > 20
- 18.1 - 20
- 16.1 - 18
- 14.1 - 16
- 12.1 - 14
- 10.1 - 12
- 8.1 - 10
- 6.1 - 8
- 4.1 - 6
- 2.1 - 4
- < 2
- TRCA Watershed Boundaries

Duffins
Carruthers
Rouge
Petticoat
Frenchman's Bay
Humber
Don
Highland
Mimico
Etobicoke
Lakefront

Forces Base Borden
Essa
Newmarket
York
Aurora
King City
Richmond Hill
Markham
Vaughan
North York
Toronto
Brampton
Caledon
Peel
Halton Hills
Mississauga
Milton
Halton
Oakville
Burlington
Erin
Alton
Pefferlaw Brook
Nonquon River
Sheldon Creek
501 m
430 m

Paper Size ANSI B

0 3.5 7 10.5 14

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
DATA GAP ANALYSIS

10 MINUTE RAINFALL
JULY 16, 2024

Project No. **12664155**
Revision No. **-**
Date **Dec 2, 2025**

FIGURE 2

Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Interpolated from Rain Gauges

GARR Data

Legend

Rainfall [mm]

- > 24
- 22.1 - 24
- 20.1 - 22
- 18.1 - 20
- 16.1 - 18
- 14.1 - 16
- 12.1 - 14
- 10.1 - 12
- 8.1 - 10
- 6.1 - 8
- 4.1 - 6
- 2.1 - 4
- < 2
- TRCA Watershed Boundaries

Duffins
Carruthers
Rouge
Petticoat
Frenchman's Bay
Humber
Don
Highland
Mimico
Etobicoke
Lakefront

Forces Base Borden
Essa
Newmarket
Aurora
King City
Richmond Hill
Markham
Vaughan
North York
Toronto
Brampton
Caledon
Peel
Halton Hills
Mississauga
Milton
Halton
Oakville
Burlington
Alton
Erin
Sheldon Creek
Pefferlaw Brook
Nonquon River
501 m
430 m

Paper Size ANSI B

0 3.5 7 10.5 14

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
DATA GAP ANALYSIS

15 MINUTE RAINFALL
JULY 16, 2024

Project No. **12664155**
Revision No. **-**
Date **Dec 2, 2025**

FIGURE 3

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallDataInterpolation\12664155_RainfallDataInterpolation\12664155_July16_RainfallDataInterpolation_MXD.mxd
Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Interpolated from Rain Gauges

GARR Data

Legend

Rainfall [mm]

- > 33
- 30.1 - 33
- 27.1 - 30
- 24.1 - 27
- 21.1 - 24
- 18.1 - 21
- 15.1 - 18
- 12.1 - 15
- 9.1 - 12
- 6.1 - 9
- 3.1 - 6
- < 3
- TRCA Watershed Boundaries

Duffins
Carruthers
Rouge
Petticoat
Frenchman's Bay
Humber
Don
Highland
Mimico
Etobicoke
Lakefront

Forces Base Borden
Essa
Newmarket
York
Aurora
King City
Richmond Hill
Markham
Vaughan
North York
Toronto
Peel
Brampton
Etobicoke
Halton Hills
Mississauga
Milton
Halton
Oakville
Burlington
Caledon
Alton
Erin
Hills
Sheldon Creek
Pefferlaw Brook
Nonquon River
501 m
430 m

Paper Size ANSI B

0 3.5 7 10.5 14

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
DATA GAP ANALYSIS

30 MINUTE RAINFALL JULY 16, 2024

Project No. **12664155**
Revision No. **-**
Date **Dec 2, 2025**

FIGURE 4

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallDataInterpolation\12664155_RainfallDataInterpolation\12664155_July16_RainfallDataInterpolation_MXD.mxd

Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Interpolated from Rain Gauges

GARR Data

Legend

Rainfall [mm]

- > 50
- 45.1 - 50
- 40.1 - 45
- 35.1 - 40
- 30.1 - 35
- 25.1 - 30
- 20.1 - 25
- 15.1 - 20
- 10.1 - 15
- 5.1 - 10
- < 5
- TRCA Watershed Boundaries

Duffins
Carruthers
Rouge
Petticoat
Frenchman's Bay
Humber
Don
Highland
Mimico
Etobicoke
Lakefront

Forces Base Borden
Essa
Newmarket
York
Aurora
King City
Richmond Hill
Markham
Vaughan
North York
Toronto
Peel
Brampton
Caledon
Etobicoke
Halton Hills
Mississauga
Milton
Halton
Oakville
Burlington
Alton
Erin
Hills
Sheldon Creek
Pefferlaw Brook
Nonquon River
501 m
430 m

Paper Size ANSI B

0 3.5 7 10.5 14

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
DATA GAP ANALYSIS

1 HOUR RAINFALL
JULY 16, 2024

Project No. **12664155**
Revision No. **-**
Date **Dec 2, 2025**

FIGURE 5

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallDataInterpolation\12664155_RainfallDataInterpolation\12664155_July16_RainfallDataInterpolation_MXD.mxd © Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Interpolated from Rain Gauges

GARR Data

Legend

Rainfall [mm]

- > 75
- 70.1 - 75
- 65.1 - 70
- 60.1 - 65
- 55.1 - 60
- 50.1 - 55
- 45.1 - 50
- 40.1 - 45
- 35.1 - 40
- 30.1 - 35
- 25.1 - 30
- 20.1 - 25
- 15.1 - 20
- 10.1 - 15
- < 10
- TRCA Watershed Boundaries

Duffins
Carruthers
Rouge
Petticoat
Frenchman's Bay
Humber
Don
Highland
Mimico
Etobicoke
Lakefront

Paper Size ANSI B

0 3.5 7 10.5 14

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
DATA GAP ANALYSIS

2 HOUR RAINFALL JULY 16, 2024

Project No. **12664155**
Revision No. **-**
Date **Dec 2, 2025**

FIGURE 6

Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Interpolated from Rain Gauges

GARR Data

Legend

Rainfall [mm]

- > 100
- 90.1 - 100
- 80.1 - 90
- 70.1 - 80
- 60.1 - 70
- 50.1 - 60
- 40.1 - 50
- 30.1 - 40
- 20.1 - 30
- 10.1 - 20
- < 10
- TRCA Watershed Boundaries

Duffins
Carruthers
Rouge
Petticoat
Frenchman's Bay
Humber
Don
Highland
Mimico
Etobicoke
Lakefront

Forces Base Borden
Essa
Newmarket
York
Aurora
King City
Richmond Hill
Markham
Vaughan
North York
Toronto
Brampton
Caledon
Peel
Halton Hills
Mississauga
Milton
Halton
Oakville
Burlington
Erin
Alton
Sheldon Creek
Pefferlaw Brook
Nonquon River
501 m
430 m

Paper Size ANSI B

0 3.5 7 10.5 14

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
DATA GAP ANALYSIS

6 HOUR RAINFALL
JULY 16, 2024

Project No. **12664155**
Revision No. **-**
Date **Dec 2, 2025**

FIGURE 7

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallDataInterpolation\12664155_RainfallDataInterpolation\12664155_July16_RainfallDataInterpolation_MXD.mxd

Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Interpolated from Rain Gauges

GARR Data

Legend

Rainfall [mm]

- > 100
- 90.1 - 100
- 80.1 - 90
- 70.1 - 80
- 60.1 - 70
- 50.1 - 60
- 40.1 - 50
- 30.1 - 40
- 20.1 - 30
- 10.1 - 20
- < 10
- TRCA Watershed Boundaries

Duffins
Carruthers
Rouge
Petticoat
Frenchman's Bay
Humber
Don
Highland
Mimico
Etobicoke
Lakefront

Forces Base Borden
Essa
Newmarket
York
Aurora
King City
Richmond Hill
Markham
Vaughan
North York
Toronto
Brampton
Caledon
Peel
Halton Hills
Mississauga
Milton
Halton
Oakville
Burlington
Erin
Alton
Sheldon Creek
Pefferlaw Brook
Nonquon River
501 m
430 m

Paper Size ANSI B

0 3.5 7 10.5 14

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
DATA GAP ANALYSIS

12 HOUR RAINFALL
JULY 16, 2024

Project No. **12664155**
Revision No. **-**
Date **Dec 2, 2025**

FIGURE 8

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallDataInterpolation\12664155_RainfallDataInterpolation\12664155_July16_RainfallDataInterpolation_MXD.mxd

Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Interpolated from Rain Gauges

GARR Data

Legend

Rainfall [mm]

- > 100
- 90.1 - 100
- 80.1 - 90
- 70.1 - 80
- 60.1 - 70
- 50.1 - 60
- 40.1 - 50
- 30.1 - 40
- 20.1 - 30
- 10.1 - 20
- < 10
- TRCA Watershed Boundaries

Duffins
Carruthers
Rouge
Petticoat
Frenchman's Bay
Highland
Don
Humber
Mimico
Etobicoke
Lakefront

Forces Base Borden
Essa
Newmarket
York
Aurora
King City
Richmond Hill
Markham
Vaughan
North York
Toronto
Brampton
Caledon
Peel
Halton Hills
Mississauga
Milton
Halton
Oakville
Burlington
Erin
Alton
Sheldon Creek
Pefferlaw Brook
Nonquon River
501 m
430 m

Paper Size ANSI B

0 3.5 7 10.5 14

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
DATA GAP ANALYSIS

24 HOUR RAINFALL
JULY 16, 2024

Project No. **12664155**
Revision No. **-**
Date **Dec 3, 2025**

FIGURE 9

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallDataInterpolation\12664155_RainfallDataInterpolation\12664155_July16_RainfallDataInterpolation_MXD.mxd

Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Interpolated from Rain Gauges

GARR Data

Legend

Rainfall [mm]

- > 11
- 10.1 - 11
- 9.1 - 10
- 8.1 - 9
- 7.1 - 8
- 6.1 - 7
- 5.1 - 6
- 4.1 - 5
- 3.1 - 4
- 2.1 - 3
- < 2
- TRCA Watershed Boundaries

Duffins
Carruthers
Rouge
Petticoat
Frenchman's Bay
Humber
Don
Highland
Mimico
Etobicoke
Lakefront

Forces Base Borden
Essa
Pefferlaw Brook
Nonquon River
Sheldon Creek
Hills
York
Newmarket
501 m
Aurora
430 m
King City
Richmond Hill
Markham
Vaughan
North York
Toronto
Peel
Caledon
Brampton
Halton Hills
Mississauga
Milton
Halton
Oakville
Burlington
Alton
Erin

Paper Size ANSI B

0 3.5 7 10.5 14

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
DATA GAP ANALYSIS

5 MINUTE RAINFALL AUGUST 17, 2024

Project No. **12664155**
Revision No. **-**
Date **Dec 2, 2025**

FIGURE 9

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallDataInterpolation\12664155_RainfallDataInterpolation\12664155_Aug17_RainfallDataInterpolation_MXD.mxd

Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Interpolated from Rain Gauges

GARR Data

Legend

Rainfall [mm]	
> 18	8.1 - 10
16.1 - 18	6.1 - 8
14.1 - 16	4.1 - 6
12.1 - 14	2.1 - 4
10.1 - 12	< 2
	TRCA Watershed Boundaries

Duffins
Carruthers
Rouge
Petticoat
Frenchman's Bay
Humber
Don
Highland
Mimico
Etobicoke
Lakefront

Forces Base Borden
Essa
Pefferlaw Brook
Nonquon River
Sheldon Creek
Hills
York
Newmarket
501 m
Aurora
430 m
King City
Richmond Hill
Markham
Vaughan
North York
Toronto
Caledon
Peel
Brampton
Halton Hills
Mississauga
Milton
Halton
Oakville
Burlington
Alton
Erin

Paper Size ANSI B
0 3.5 7 10.5 14
Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
DATA GAP ANALYSIS

10 MINUTE RAINFALL AUGUST 17, 2024

Project No. **12664155**
Revision No. **-**
Date **Dec 2, 2025**

FIGURE 10

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallDataInterpolation\12664155_RainfallDataInterpolation\12664155_Aug17_RainfallDataInterpolation_MXD.mxd

Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Interpolated from Rain Gauges

GARR Data

Legend

Rainfall [mm]

- > 24
- 23 - 24
- 21 - 22
- 19 - 20
- 17 - 18
- 15 - 16
- 13 - 14
- 11 - 12
- 9 - 10
- 7 - 8
- 5 - 6
- 3 - 4
- < 2
- TRCA Watershed Boundaries

Duffins
Carruthers
Rouge
Petticoat
Frenchman's Bay
Humber
Don
Highland
Mimico
Etobicoke
Lakefront

Forces Base Borden
Essa
Newmarket
York
Aurora
King City
Richmond Hill
Markham
Vaughan
Caledon
Peel
Brampton
Etobicoke
North York
Toronto
Halton Hills
Mississauga
Milton
Halton
Oakville
Burlington
Alton
Erin
Pefferlaw Brook
Nonquon River
Sheldon Creek
501 m
430 m

Paper Size ANSI B

0 3.5 7 10.5 14

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
DATA GAP ANALYSIS

15 MINUTE RAINFALL AUGUST 17, 2024

Project No. **12664155**
Revision No. **-**
Date **Dec 2, 2025**

FIGURE 11

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallDataInterpolation\12664155_RainfallDataInterpolation\12664155_Aug17_RainfallDataInterpolation_MXD.mxd

Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Interpolated from Rain Gauges

GARR Data

Legend

Rainfall [mm]	
> 39	18.1 - 21
36.1 - 39	15.1 - 18
33.1 - 36	12.1 - 15
30.1 - 33	9.1 - 12
27.1 - 30	6.1 - 9
24.1 - 27	3.1 - 6
21.1 - 24	< 3
	TRCA Watershed Boundaries

Duffins
Carruthers
Rouge
Petticoat
Frenchman's Bay
Humber
Don
Highland
Mimico
Etobicoke
Lakefront

Forces Base Borden
Essa
Newmarket
York
Aurora
King City
Richmond Hill
Markham
Vaughan
North York
Toronto
Brampton
Caledon
Peel
Halton Hills
Mississauga
Milton
Halton
Oakville
Burlington
Alton
Erin
Pefferlaw Brook
Nonquon River
Sheldon Creek
501 m
430 m

Paper Size ANSI B
0 3.5 7 10.5 14
Kilometers
Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
DATA GAP ANALYSIS

30 MINUTE RAINFALL AUGUST 17, 2024

Project No. **12664155**
Revision No. **-**
Date **Dec 2, 2025**

FIGURE 12

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallDataInterpolation\12664155_RainfallDataInterpolation\12664155_Aug17_RainfallDataInterpolation_MXD.mxd

Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Interpolated from Rain Gauges

GARR Data

Legend

Rainfall [mm]

- > 56
- 52.1 - 56
- 48.1 - 52
- 44.1 - 48
- 40.1 - 44
- 36.1 - 40
- 32.1 - 36
- 28.1 - 32
- 24.1 - 28
- 20.1 - 24
- 16.1 - 20
- 12.1 - 16
- 8.1 - 12
- 4.1 - 8
- < 4
- TRCA Watershed Boundaries

Duffins
Carruthers
Rouge
Petticoat
Frenchman's Bay
Humber
Don
Highland
Mimico
Etobicoke
Lakefront

Forces Base Borden
Essa
Pefferlaw Brook
Nonquon River
Sheldon Creek
Hills
York
Newmarket
Aurora
501 m
430 m
King City
Richmond Hill
Markham
Vaughan
Alton
Erin
Caledon
Peel
Brampton
Toronto
North York
Etobicoke
Halton Hills
Mississauga
Milton
Halton
Oakville
Burlington

Paper Size ANSI B

0 3.5 7 10.5 14

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
DATA GAP ANALYSIS

1 HOUR RAINFALL
AUGUST 17, 2024

Project No. **12664155**
Revision No. **-**
Date **Dec 2, 2025**

FIGURE 13

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallDataInterpolation\12664155_RainfallDataInterpolation\12664155_Aug17_RainfallDataInterpolation_MXD.mxd

Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Interpolated from Rain Gauges

GARR Data

Legend

Rainfall [mm]

- > 70
- 65.1 - 70
- 60.1 - 65
- 55.1 - 60
- 50.1 - 55
- 45.1 - 50
- 40.1 - 45
- 35.1 - 40
- 30.1 - 35
- 25.1 - 30
- 20.1 - 25
- 15.1 - 20
- 10.1 - 15
- 5.1 - 10
- < 5
- TRCA Watershed Boundaries

Duffins
Carruthers
Rouge
Petticoat
Frenchman's Bay
Humber
Don
Highland
Mimico
Etobicoke
Lakefront

Paper Size ANSI B

0 3.5 7 10.5 14

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
DATA GAP ANALYSIS

2 HOUR RAINFALL AUGUST 17, 2024

Project No. **12664155**
Revision No. **-**
Date **Dec 2, 2025**

FIGURE 14

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallDataInterpolation\12664155_RainfallDataInterpolation\12664155_Aug17_RainfallDataInterpolation_MXD.mxd

Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Interpolated from Rain Gauges

GARR Data

Legend

Rainfall [mm]

- > 80
- 70.1 - 80
- 60.1 - 70
- 50.1 - 60
- 40.1 - 50
- 30.1 - 40
- 20.1 - 30
- 10.1 - 20
- < 10
- TRCA Watershed Boundaries

Duffins
Carruthers
Rouge
Petticoat
Frenchman's Bay
Humber
Don
Highland
Mimico
Etobicoke
Lakefront

Forces Base Borden
Essa
Pefferlaw Brook
Nonquon River
Sheldon Creek
Hills
York
Newmarket
Aurora
501 m
430 m
King City
Richmond Hill
Markham
Vaughan
North York
Toronto
Caledon
Peel
Brampton
Halton Hills
Mississauga
Milton
Halton
Oakville
Burlington
Erin
Alton

Paper Size ANSI B

0 3.5 7 10.5 14

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
DATA GAP ANALYSIS

6 HOUR RAINFALL AUGUST 17, 2024

Project No. **12664155**
Revision No. **-**
Date **Dec 2, 2025**

FIGURE 15

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallDataInterpolation\12664155_RainfallDataInterpolation\12664155_Aug17_RainfallDataInterpolation_MXD.mxd

Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Interpolated from Rain Gauges

GARR Data

Legend

Rainfall [mm]

- > 90
- 80.1 - 90
- 70.1 - 80
- 60.1 - 70
- 50.1 - 60
- 40.1 - 50
- 30.1 - 40
- 20.1 - 30
- 10.1 - 20
- < 10
- TRCA Watershed Boundaries

Duffins
Carruthers
Rouge
Petticoat
Frenchman's Bay
Humber
Don
Highland
Mimico
Etobicoke
Lakefront

Forces Base Borden
Essa
Pefferlaw Brook
Nonquon River
Sheldon Creek
Hills
York
Newmarket
Aurora
501 m
430 m
King City
Richmond Hill
Markham
Vaughan
North York
Toronto
Caledon
Peel
Brampton
Halton Hills
Mississauga
Milton
Halton
Oakville
Burlington
Alton
Erin

Paper Size ANSI B

0 3.5 7 10.5 14

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
DATA GAP ANALYSIS

12 HOUR RAINFALL AUGUST 17, 2024

Project No. **12664155**
Revision No. **-**
Date **Dec 2, 2025**

FIGURE 16

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallDataInterpolation\12664155_RainfallDataInterpolation\12664155_Aug17_RainfallDataInterpolation_MXD.mxd

Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

Interpolated from Rain Gauges

GARR Data

Legend

Rainfall [mm]

- > 90
- 80.1 - 90
- 70.1 - 80
- 60.1 - 70
- 50.1 - 60
- 40.1 - 50
- 30.1 - 40
- 20.1 - 30
- 10.1 - 20
- < 10
- TRCA Watershed Boundaries

Duffins
Carruthers
Rouge
Petticoat
Frenchman's Bay
Humber
Don
Highland
Mimico
Etobicoke
Lakefront

Forces Base Borden
Essa
Pefferlaw Brook
Nonquon River
Sheldon Creek
Hills
York
Newmarket
Aurora
501 m
430 m
King City
Richmond Hill
Markham
Vaughan
North York
Toronto
Caledon
Peel
Brampton
Halton Hills
Mississauga
Milton
Halton
Oakville
Burlington
Alton
Erin

Paper Size ANSI B

0 3.5 7 10.5 14

Kilometers

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 UTM Zone 17N

N

GHD

TORONTO REGION CONSERVATION AUTHORITY
ANALYSIS OF EXTREME RAINFALL EVENTS ON JULY 16 AND AUGUST 17, 2024
DATA GAP ANALYSIS

24 HOUR RAINFALL
AUGUST 17, 2024

Project No. **12664155**
Revision No. **-**
Date **Dec 3, 2025**

FIGURE 18

Q:\GIS\PROJECTS\12664000s\12664155\GIS\Maps\Deliverables\12664155_RainfallDataInterpolation\12664155_RainfallDataInterpolation\12664155_Aug17_RainfallDataInterpolation_MXD.mxd

Topographic Map: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, (c) OpenStreetMap contributors, and the GIS User Community
World Hillshade: Esri, CGIAR, USGS.

