Toronto's Current and Future Climate

APPENDICES

Prepared for the City of Toronto
By Toronto and Region Conservation Authority - 2024

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Appendix A: Detailed summary tables of Toronto's projected climate

The following presents detailed summary tables of Toronto's projected climate for 12 climate parameters (and 54 climate variables) under the medium emissions scenario (SSP2-4.5; Appendix A1) and very high emissions scenario (SSP5-8.5; Appendix A2). These were derived from modelled and historical daily climate projections available through PAVICS (Power Analytics and Visualization for Climate Science). For full summary tables, including the 10th and 90th percentile modelled historical values, please see the accompanying climate projection dataset.

Appendix A1: Toronto's projected climate under the medium emissions scenario (SSP2-4.5)

A1.1 Mean, maximum, and minimum temperature (SSP2-4.5)

Climate Parameter	Climate Variable	Unit	1980s (1971-2000)		2030s (2015-2040, SSP2-4.5)			2050s (2041-2070, SSP2-4.5)			2080s (2071-2100, SSP2-4.5)			Overall Trend
			Observed	Modelled (Median)	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	
Mean Temperature	Annual Mean Temperature	°C	**7.9**	**8.1**	9.1	**10.1**	11.2	10.1	**11.3**	12.5	10.9	**12.1**	13.8	↑
	Winter Mean Temperature	°C	**-4.3**	**-4.1**	-3.8	**-1.7**	0.3	-2.7	**-0.4**	1.7	-1.5	**0.9**	3.3	↑
	Spring Mean Temperature	°C	**6.5**	**6.5**	6.8	**8.4**	10.2	7.8	**9.5**	11.2	8.5	**10.4**	12.2	↑
	Summer Mean Temperature	°C	**19.7**	**19.9**	20.6	**21.7**	23.0	21.5	**22.9**	24.4	22.2	**23.8**	25.7	↑
	Fall Mean Temperature	°C	**9.5**	**9.9**	10.5	**11.8**	13.3	11.4	**12.8**	14.5	12.1	**13.7**	15.7	↑
Maximum Temperature	Annual Maximum Temperature	°C	**12.5**	**12.5**	13.4	**14.5**	15.7	14.4	**15.7**	17.0	15.2	**16.6**	18.4	↑
	Winter Maximum Temperature	°C	**-0.4**	**-0.5**	-0.4	**1.5**	3.3	0.6	**2.6**	4.6	1.6	**3.8**	6.0	↑
	Spring Maximum Temperature	°C	**11.3**	**11.2**	11.3	**13.2**	15.2	12.2	**14.3**	16.3	13.0	**15.1**	17.3	↑
	Summer Maximum Temperature	°C	**25.1**	**25.1**	25.7	**27.1**	28.7	26.6	**28.3**	30.2	27.4	**29.2**	31.6	↑
	Fall Maximum Temperature	°C	**13.8**	**14.1**	14.6	**16.1**	18.0	15.6	**17.2**	19.1	16.3	**18.0**	20.4	↑
Minimum Temperature	Annual Minimum Temperature	°C	**3.4**	**3.6**	4.7	**5.6**	6.7	5.7	**6.8**	8.0	6.6	**7.7**	9.3	↑
	Winter Minimum Temperature	°C	**-7.9**	**-7.7**	-7.3	**-5.0**	-2.7	-6.0	**-3.3**	-1.1	-4.7	**-2.0**	0.6	↑
	Spring Minimum Temperature	°C	**1.7**	**1.9**	2.2	**3.7**	5.2	3.3	**4.7**	6.1	4.0	**5.5**	7.2	↑
	Summer Minimum Temperature	°C	**14.4**	**14.6**	15.4	**16.3**	17.4	16.3	**17.4**	18.7	17.0	**18.3**	19.8	↑
	Fall Minimum Temperature	°C	**5.3**	**5.6**	6.2	**7.4**	8.9	7.1	**8.4**	10.1	7.8	**9.3**	11.2	↑

A1.2 Extreme heat and extreme cold (SSP2-4.5)

Climate Parameter	Climate Variable	Unit	1980s (1971-2000)		2030s (2015-2040, SSP2-4.5)			2050s (2041-2070, SSP2-4.5)			2080s (2071-2100, SSP2-4.5)			Overall Trend
			Observed	Modelled (Median)	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	
Extreme Heat	Days Above 35°C	days/year	**0.3**	**0.0**	1.1	**0.0**	1.1	6.5	**0.2**	3.3	13.2	**0.5**	5.6	↑
	Days Above 30°C	days/year	**9.9**	**9.9**	20.1	**11.5**	23.9	40.2	**18.9**	36.2	58.5	**26.6**	46.2	↑
	Days Above 25°C	days/year	**57.8**	**57.6**	72.1	**66.0**	83.1	101.0	**77.9**	97.1	116.2	**87.6**	107.6	↑
	Days Above 20°C (Tropical Nights)	days/year	**5.0**	**5.5**	11.9	**7.4**	15.0	26.5	**14.0**	26.0	40.3	**20.7**	35.5	↑
	Hottest Day Temperature	°C	**31.3**	**33.4**	35.5	**33.0**	35.4	38.2	**34.1**	36.6	39.4	**34.9**	37.4	↑
	Temperature-based Heat Warning Frequency	warnings/year	**0.5**	**0.2**	2.2	**0.2**	1.8	4.3	**1.5**	4.2	7.2	**2.3**	5.1	↑
	Maximum Consecutive Temperature-based Heat Warning Days	days/year	**1.2**	**0.6**	4.8	**0.5**	5.1	14.2	**3.9**	14.1	28.4	**7.4**	22.0	↑
	Humidex > 30	days/year	-	**41.1**	52.9	**49.4**	63.1	78.5	**62.0**	79.0	97.0	**71.5**	91.4	↑
	Humidex > 35	days/year	-	**8.7**	17.4	**11.0**	22.1	34.2	**19.6**	36.7	55.1	**29.1**	49.3	↑
	Humidex > 40	days/year	-	**0.2**	2.0	**0.2**	2.0	6.8	**1.1**	6.7	15.8	**2.9**	12.3	↑
Extreme Cold	Days Below -20°C	days/year	**3.7**	**2.6**	0.0	**0.2**	2.6	0.0	**0.0**	0.9	0.0	**0.0**	0.2	↓
	Days Below -10°C	days/year	**39.2**	**36.3**	7.5	**18.7**	32.9	2.2	**11.5**	24.6	0.2	**5.9**	16.8	↓
	Days Below 0°C (Frost Days)	days/year	**133.7**	**129.8**	87.5	**106.5**	124.9	68.5	**92.3**	113.1	47.9	**79.7**	102.8	↓

A1.3 Heating and cooling degree days (SSP2-4.5)

Climate Parameter	Climate Variable	Unit	1980s (1971-2000)		2030s (2015-2040, SSP2-4.5)			2050s (2041-2070, SSP2-4.5)			2080s (2071-2100, SSP2-4.5)			Overall Trend
			Observed	Modelled (Median)	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	
Heating and Cooling Degree Days	Heating Degree Days	HDD	**3933.9**	**3887.6**	3010.0	**3324.2**	3629.2	2618.5	**2939.9**	3323.7	2332.0	**2723.1**	3088.2	↓
	Cooling Degree Days	CDD	**256.7**	**269.9**	333.5	**441.2**	582.6	441.3	**615.9**	780.2	530.1	**729.2**	923.0	↑

A1.4 Total and extreme precipitation (SSP2-4.5)

Climate Parameter	Climate Variable	Unit	1980s (1971-2000)		2030s (2015-2040, SSP2-4.5)			2050s (2041-2070, SSP2-4.5)			2080s (2071-2100, SSP2-4.5)			Overall Trend
			Observed	Modelled (Median)	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	
Total Precipitation	Annual Total Precipitation	mm	**753.4**	**795.1**	700.6	**832.8**	989.5	733.9	**871.5**	1021.9	737.4	**885.4**	1041.3	↑
	Winter Total Precipitation	mm	**156.8**	**171.3**	139.6	**188.0**	256.0	140.5	**198.9**	268.0	146.9	**208.8**	275.3	↑
	Spring Total Precipitation	mm	**189.3**	**199.0**	149.2	**212.1**	282.9	158.9	**224.5**	298.5	158.0	**230.7**	309.4	↔
	Summer Total Precipitation	mm	**197.6**	**204.0**	140.4	**208.7**	293.9	138.3	**212.0**	301.9	140.0	**207.9**	299.1	↔
	Fall Total Precipitation	mm	**208.3**	**207.6**	148.8	**213.1**	294.8	152.1	**225.3**	306.9	150.9	**220.0**	313.6	↔
Extreme Precipitation	Maximum 1-day or Wettest Day Percipitation	mm	**37.3**	**37.4**	29.4	**40.4**	63.0	31.8	**42.4**	67.8	32.6	**44.1**	70.2	↑
	Maximum 3-day Precipitation	mm	**50.2**	**55.2**	42.9	**58.2**	86.7	46.6	**62.4**	92.2	47.3	**63.5**	95.4	↑
	Simple Daily Intensity Index (SDII)	mm/day	**4.9**	**5.1**	4.6	**5.3**	6.2	4.8	**5.5**	6.3	4.9	**5.6**	6.5	↑
	95th Percentile Precipitation	mm	**11.2**	**11.9**	10.4	**12.3**	14.8	10.7	**12.9**	15.5	10.8	**13.2**	15.7	↑
	99th Percentile Precipitation	mm	**21.9**	**22.8**	19.7	**24.1**	29.6	20.8	**25.2**	31.2	21.3	**25.7**	32.2	↑
	Maximum Consecutive Wet Days	days/year	**8.0**	**5.4**	4.4	**5.6**	7.6	4.4	**5.6**	7.6	4.4	**5.7**	7.6	↔

A1.5 Dry days (SSP2-4.5)

Climate Parameter	Climate Variable	Unit	1980s (1971-2000)		2030s (2015-2040, SSP2-4.5)			2050s (2041-2070, SSP2-4.5)			2080s (2071-2100, SSP2-4.5)			Overall Trend
			Observed	Modelled (Median)	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	
Dry Days	Annual Total Dry Days	days/year	**211.0**	**207.2**	193.2	**207.5**	220.3	192.5	**207.4**	220.1	192.9	**207.1**	221.6	↔
	Maximum Consecutive Dry Days	days/year	**13.4**	**11.9**	9.1	**12.0**	16.8	9.0	**12.1**	17.2	9.3	**12.2**	17.3	↔

A1.6 Frost-free season and agricultural variables (SSP2-4.5)

Climate Parameter	Climate Variable	Unit	1980s (1971-2000)		2030s (2015-2040, SSP2-4.5)			2050s (2041-2070, SSP2-4.5)			2080s (2071-2100, SSP2-4.5)			Overall Trend
			Observed	Modelled (Median)	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	
Frost-free Season	Frost-free Season Start Date (Last Spring Frost)	date	**April 5**	**April 5**	March 7	**March 24**	April 8	February 28	**March 19**	April 6	February 19	**March 15**	April 2	↑
	Frost-free Season End Date (First Fall Frost)	date	**November 19**	**November 18**	November 13	**November 26**	December 14	November 16	**December 1**	December 18	November 19	**December 5**	December 20	↑
	Frost-free Season Length	days/year	**233**	**230**	227	**260**	315	243	**290**	340	257	**314**	355	↑
Agricultural Variables	Corn Heat Units	CHU	**3602.7**	**3631.4**	3907.2	**4250.4**	4590.2	4222.0	**4597.3**	4963.5	4436.1	**4876.6**	5354.3	↑
	Growing Degree Days (Base 0°C)	GDD0	**3426.4**	**3465.0**	3716.1	**3995.4**	4293.9	3994.1	**4325.1**	4662.8	4206.0	**4586.1**	5070.0	↑
	Canola Growing Degree Days (Base 4°C)	GDD4	**2422.4**	**2453.5**	2658.3	**2899.8**	3173.4	2897.2	**3177.6**	3477.7	3068.1	**3408.3**	3803.0	↑
	Forage Crops Growing Degree Days (Base 5°C)	GDD5	**2200.5**	**2231.0**	2423.9	**2656.7**	2923.7	2650.1	**2922.1**	3215.1	2811.9	**3145.0**	3525.1	↑
	Corn and Bean Growing Degree Days (Base 10°C)	GDD10	**1248.3**	**1274.2**	1417.4	**1600.0**	1821.9	1583.6	**1812.4**	2075.9	1714.2	**1991.1**	2326.1	↑
	Growing Degree Days - Risk of Presence of Pests (Base 15°C)	GDD15	**548.0**	**568.6**	663.3	**798.0**	972.3	780.7	**961.4**	1175.8	886.6	**1091.5**	1368.8	↑

A1.7 Freeze-thaw and freezing rain potential (SSP2-4.5)

Climate Parameter	Climate Variable	Unit	1980s (1971-2000)		2030s (2015-2040, SSP2-4.5)			2050s (2041-2070, SSP2-4.5)			2080s (2071-2100, SSP2-4.5)			Overall Trend
			Observed	Modelled (Median)	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	
Freeze-thaw and Freezing Rain Potential	Freeze-thaw Cycles	cycles/ year	**65.5**	**61.9**	41.9	**54.5**	68.1	35.0	**49.5**	63.7	26.5	**44.9**	60.1	↓
	Freezing Rain Potential	days/year	**3.2**	**2.1**	0.4	**2.3**	5.3	0.6	**2.8**	6.5	0.7	**3.1**	7.5	↑

Appendix A2: Toronto's projected climate under the very high emissions scenario (SSP5-8.5)

A2.1 Mean, maximum, and minimum temperature (SSP5-8.5)

Climate Parameter	Climate Variable	Unit	1980s (1971-2000)		2030s (2015-2040, SSP5-8.5)			2050s (2041-2070, SSP5-8.5)			2080s (2071-2100, SSP5-8.5)			Overall Trend
			Observed	Modelled (Median)	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	
Mean Temperature	Annual Mean Temperature	°C	**7.9**	**8.1**	9.1	**10.2**	11.4	10.9	**12.1**	13.7	13.0	**14.6**	16.8	↑
	Winter Mean Temperature	°C	**-4.3**	**-4.1**	-3.8	**-1.4**	0.8	-1.6	**0.7**	3.3	0.8	**3.2**	5.8	↑
	Spring Mean Temperature	°C	**6.5**	**6.5**	6.5	**8.4**	10.1	8.5	**10.3**	12.0	10.7	**12.5**	14.7	↑
	Summer Mean Temperature	°C	**19.7**	**19.9**	20.6	**21.7**	23.3	22.2	**23.6**	25.6	24.1	**26.4**	29.0	↑
	Fall Mean Temperature	°C	**9.5**	**9.9**	10.5	**11.8**	13.3	12.0	**13.6**	15.6	14.1	**16.2**	19.1	↑
Maximum Temperature	Annual Maximum Temperature	°C	**12.5**	**12.5**	13.4	**14.6**	16.0	15.2	**16.5**	18.2	17.2	**18.9**	21.3	↑
	Winter Maximum Temperature	°C	**-0.4**	**-0.5**	-0.4	**1.8**	3.8	1.5	**3.5**	6.0	3.6	**5.9**	8.2	↑
	Spring Maximum Temperature	°C	**11.3**	**11.2**	11.0	**13.1**	15.3	13.0	**15.1**	17.1	15.1	**17.4**	19.8	↑
	Summer Maximum Temperature	°C	**25.1**	**25.1**	25.7	**27.1**	28.9	27.3	**29.0**	31.7	29.2	**31.8**	35.2	↑
	Fall Maximum Temperature	°C	**13.8**	**14.1**	14.6	**16.1**	17.8	16.2	**18.0**	20.3	18.3	**20.6**	23.8	↑
Minimum Temperature	Annual Minimum Temperature	°C	**3.4**	**3.6**	4.7	**5.8**	6.9	6.6	**7.7**	9.2	8.7	**10.2**	12.4	↑
	Winter Minimum Temperature	°C	**-7.9**	**-7.7**	-7.3	**-4.7**	-2.2	-4.8	**-2.2**	0.7	-2.2	**0.5**	3.6	↑
	Spring Minimum Temperature	°C	**1.7**	**1.9**	2.1	**3.7**	5.1	3.9	**5.5**	7.0	6.1	**7.7**	9.8	↑
	Summer Minimum Temperature	°C	**14.4**	**14.6**	15.4	**16.4**	17.7	17.0	**18.2**	19.7	18.9	**20.9**	22.9	↑
	Fall Minimum Temperature	°C	**5.3**	**5.6**	6.2	**7.5**	8.9	7.8	**9.2**	11.2	9.8	**11.7**	14.6	↑

A2.2 Extreme heat and extreme cold (SSP5-8.5)

Climate Parameter	Climate Variable	Unit	1980s (1971-2000)		2030s (2015-2040, SSP5-8.5)			2050s (2041-2070, SSP5-8.5)			2080s (2071-2100, SSP5-8.5)			Overall Trend
			Observed	Modelled (Median)	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	
Extreme Heat	Days Above 35°C	days/year	**0.3**	**0.0**	0.0	**1.2**	8.0	0.5	**5.5**	22.6	5.4	**22.6**	58.1	↑
	Days Above 30°C	days/year	**9.9**	**9.9**	11.8	**24.3**	43.8	25.4	**44.3**	74.7	48.5	**77.9**	112.3	↑
	Days Above 25°C	days/year	**57.8**	**57.6**	66.1	**83.6**	104.6	86.8	**106.1**	126.6	107.1	**130.6**	157.8	↑
	Days Above 20°C (Tropical Nights)	days/year	**5.0**	**5.5**	8.2	**15.9**	28.5	21.4	**34.7**	54.4	42.5	**69.7**	98.3	↑
	Hottest Day Temperature	°C	**31.3**	**33.4**	35.5	**33.1**	35.5	38.5	**34.6**	37.2	40.8	**36.8**	40.0	↑
	Temperature-based Heat Warning Frequency	warnings/year	**0.5**	**0.2**	0.3	**1.8**	4.6	2.5	**5.3**	8.2	4.6	**7.0**	9.8	↑
	Maximum Consecutive Temperature-based Heat Warning Days	days/year	**1.2**	**0.6**	0.7	**5.6**	16.2	7.9	**23.1**	44.0	25.7	**60.4**	88.5	↑
	Humidex > 30	days/year	-	**41.1**	49.2	**64.2**	81.4	72.4	**89.3**	107.8	94.1	**116.9**	140.4	↑
	Humidex > 35	days/year	-	**8.9**	11.4	**22.2**	36.7	30.6	**47.5**	68.9	55.2	**80.5**	108.5	↑
	Humidex > 40	days/year	-	**0.2**	0.1	**2.2**	7.1	3.1	**12.1**	26.2	17.5	**39.5**	72.0	↑
Extreme Cold	Days Below -20°C	days/year	**3.7**	**2.6**	0.0	**0.1**	2.3	0.0	**0.0**	0.4	0.0	**0.0**	0.0	↓
	Days Below -10°C	days/year	**39.2**	**36.3**	5.8	**17.7**	32.1	0.4	**6.5**	18.1	0.0	**0.7**	6.3	↓
	Days Below 0°C (Frost Days)	days/year	**133.7**	**129.8**	84.9	**104.8**	122.6	47.1	**80.5**	102.4	11.6	**47.5**	77.4	↓

A2.3 Heating and cooling degree days (SSP5-8.5)

Climate Parameter	Climate Variable	Unit	1980s (1971-2000)		2030s (2015-2040, SSP5-8.5)			2050s (2041-2070, SSP5-8.5)			2080s (2071-2100, SSP5-8.5)			Overall Trend
			Observed	Modelled (Median)	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	
Heating and Cooling Degree Days	Heating Degree Days	HDD	**3933.9**	**3887.6**	2972.5	**3295.6**	3640.9	2330.6	**2713.4**	3119.6	1652.5	**2142.4**	2561.8	↓
	Cooling Degree Days	CDD	**256.7**	**269.9**	334.0	**446.5**	615.8	521.3	**730.2**	955.7	764.9	**1154.9**	1488.5	↑

A2.4 Total and extreme precipitation (SSP5-8.5)

Climate Parameter	Climate Variable	Unit	1980s (1971-2000)		2030s (2015-2040, SSP5-8.5)			2050s (2041-2070, SSP5-8.5)			2080s (2071-2100, SSP5-8.5)			Overall Trend
			Observed	Modelled (Median)	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	
Total Precipitation	Annual Total Precipitation	mm	**753.4**	**795.1**	712.7	**840.4**	988.3	730.6	**874.9**	1041.9	775.1	**921.4**	1101.0	↑
	Winter Total Precipitation	mm	**156.8**	**171.3**	137.2	**191.2**	276.3	148.1	**203.5**	274.3	165.2	**224.5**	303.9	↔
	Spring Total Precipitation	mm	**189.3**	**199.0**	150.0	**211.0**	290.3	161.3	**229.1**	312.6	171.8	**243.8**	336.2	↑
	Summer Total Precipitation	mm	**197.6**	**204.0**	139.8	**211.1**	296.5	138.1	**208.1**	301.5	131.5	**205.5**	297.4	↔
	Fall Total Precipitation	mm	**208.3**	**207.6**	148.3	**212.4**	303.8	150.9	**223.6**	308.5	155.3	**229.8**	329.6	↑
Extreme Precipitation	Maximum 1-day Precipitation or Wettest Day Precipitation	mm	**37.3**	**37.4**	30.1	**41.4**	65.0	31.9	**43.9**	69.0	33.9	**47.5**	74.1	↑
	Maximum 3-day Precipitation	mm	**50.2**	**55.2**	44.4	**59.5**	87.9	47.0	**64.1**	94.8	50.6	**69.4**	104.1	↑
	Simple Daily Intensity Index (SDII)	mm/day	**4.9**	**5.1**	4.6	**5.3**	6.1	4.9	**5.6**	6.4	5.1	**5.9**	6.8	↑
	95th Percentile Precipitation	mm	**11.2**	**11.9**	10.4	**12.4**	14.8	10.8	**13.1**	15.7	11.5	**13.9**	16.8	↑
	99th Percentile Precipitation	mm	**21.9**	**22.8**	20.1	**24.4**	30.3	20.9	**25.7**	31.8	22.3	**27.4**	34.2	↑
	Maximum Consecutive Wet Days	days/year	**8.0**	**5.4**	4.3	**5.7**	7.5	4.3	**5.7**	7.7	4.4	**5.8**	7.8	↑

A2.5 Dry days (SSP5-8.5)

Climate Parameter	Climate Variable	Unit	1980s (1971-2000)		2030s (2015-2040, SSP5-8.5)			2050s (2041-2070, SSP5-8.5)			2080s (2071-2100, SSP5-8.5)			Overall Trend
			Observed	Modelled (Median)	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	
Dry Days	Annual Total Dry Days	days/year	**211.0**	**207.2**	194.4	**207.3**	220.8	193.5	**207.0**	221.1	193.6	**207.9**	222.3	↔
	Maximum Consecutive Dry Days	days/year	**13.4**	**11.8**	9.0	**12.1**	17.1	9.2	**12.0**	17.0	9.3	**12.3**	17.6	↔

A2.6 Frost-free season and agricultural variables (SSP5-8.5)

Climate Parameter	Climate Variable	Unit	1980s (1971-2000)		2030s (2015-2040, SSP5-8.5)			2050s (2041-2070, SSP5-8.5)			2080s (2071-2100, SSP5-8.5)			Overall Trend
			Observed	Modelled (Median)	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	
Frost-free Season	Frost-free Season Start Date (Last Spring Frost)	date	**April 5**	**April 5**	March 7	**March 25**	April 8	February 20	**March 15**	April 1	February 2	**February 27**	March 20	↑
	Frost-free Season End Date (First Fall Frost)	date	**November 19**	**November 18**	November 12	**November 25**	December 15	November 19	**December 6**	December 20	November 27	**December 13**	December 23	↑
	Frost-free Season Length	days/year	**233**	**230**	230	**264**	320	258	**310**	353	296	**347**	364	↑
Agricultural Variables	Corn Heat Units	CHU	**3602.7**	**3631.4**	3895.8	**4237.6**	4618.2	4455.0	**4844.1**	5315.6	5071.8	**5660.8**	6295.9	↑
	Growing Degree Days (Base 0°C)	GDD0	**3426.4**	**3465.0**	3717.5	**4005.1**	4346.6	4224.9	**4560.7**	5039.5	4824.7	**5372.1**	6110.6	↑
	Canola Growing Degree Days (Base 4°C)	GDD4	**2422.4**	**2453.5**	2655.8	**2904.7**	3216.0	3085.5	**3383.4**	3793.5	3578.4	**4086.8**	4737.3	↑
	Forage Crops Growing Degree Days (Base 5°C)	GDD5	**2200.5**	**2231.0**	2421.0	**2661.1**	2964.5	2829.0	**3119.1**	3517.2	3297.3	**3795.8**	4422.2	↑
	Corn and Bean Growing Degree Days (Base 10°C)	GDD10	**1248.3**	**1274.2**	1412.2	**1612.8**	1868.3	1716.4	**1958.3**	2316.4	2083.4	**2519.7**	3072.1	↑
	Growing Degree Days - Risk of Presence of Pests (Base 15°C)	GDD15	**548.0**	**568.6**	657.9	**813.3**	1015.0	881.5	**1070.6**	1376.9	1159.9	**1514.0**	1984.7	↑

A2.7 Freeze-thaw and freezing rain potential (SSP5-8.5)

Climate Parameter	Climate Variable	Unit	1980s (1971-2000)		2030s (2015-2040, SSP5-8.5)			2050s (2041-2070, SSP5-8.5)			2080s (2071-2100, SSP5-8.5)			Overall Trend
			Observed	Modelled (Median)	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	10th percentile	Median	90th percentile	
Freeze-thaw and Freezing Rain Potential	Freeze-thaw Cycles	cycles/ year	**65.5**	**61.9**	41.9	**54.6**	67.4	23.8	**44.4**	59.1	5.3	**29.3**	48.5	↓
	Freezing Rain Potential	days/year	**3.2**	**2.1**	0.4	**2.4**	6.1	0.8	**3.1**	8.8	0.1	**2.3**	7.9	↔

Appendix A3: Scan of additional climate variables

The following presents summary tables of some additional climate variables of relevance to Toronto that have been gathered from multiple sources (referenced at the end of each table). For full summary tables, please see the accompanying climate projection dataset.

A3.1 Lake Ontario over-land air temperature, over-lake precipitation, and lake levels (RCP4.5 and RCP8.5)

Climate Parameter	Climate Variable	Unit	1961-2000	2006-2035, RCP4.5	2036-2065, RCP4.5	2066-2095, RCP4.5	Overall Trend (RCP4.5)	2006-2035, RCP8.5	2036-2065, RCP8.5	2066-2095, RCP8.5	Overall Trend (RCP8.5)
Lake Ontario Over-land Air Temperature	Annual Mean Temperature	°C	7.3	8.6	9.8	10.3	↑	8.9	10.4	12.2	↑
	Winter Mean Temperature	°C	-5.5	-2.3	-0.9	-0.5	↑	-2.0	-0.6	1.3	↑
	Spring Mean Temperature	°C	6.2	6.0	7.0	7.6	↔	6.0	7.4	8.9	↔
	Summer Mean Temperature	°C	19.3	19.4	20.5	21.0	↑	19.6	21.4	23.3	↑
	Fall Mean Temperature	°C	9.2	11.5	12.6	13.2	↑	11.9	13.3	15.2	↑
Lake Ontario Over-lake Precipitation	Annual Total Precipitation	mm	846.6	938.8	970.9	970.5	↔	923.4	969.8	1033.1	↑
	Winter Total Precipitation	mm	194.9	211.6	224.3	225.9	↑	211.3	231.0	244.7	↑
	Spring Total Precipitation	mm	203.2	210.7	220.5	218.5	↔	213.0	227.6	257.2	↑
	Summer Total Precipitation	mm	213.5	240.5	247.8	245.4	↔	236.0	241.1	254.4	↑
	Fall Total Precipitation	mm	235.1	276.1	278.3	280.7	↑	263.1	270.0	276.7	↑
Lake Ontario Lake Levels	Annual Mean Lake Levels	m IGLD85	74.8	74.9	75.1	75.1	↑	74.8	75.0	75.1	↑
	5th Percentile of Annual Lake Levels	m IGLD85	74.4	74.1	74.3	74.3	↓	74.1	74.2	74.4	↔
	95th Percentile of Annual Lake Levels	m IGLD85	75.3	75.6	76.2	76.3	↑	75.6	76.2	76.3	↑

Lam, S., and Dokoska, K. 2022. Climate Change in the Great Lakes Basin: Summary of Trends and Impacts. https://binational.net/wp-content/uploads/2022/11/Climate-Change-in-the-Great-Lakes-Basin_English-1.pdf Based on projections developed by Environment and Climate Change Canada

A3.2 Lake Ontario ice cover (RCP8.5)

Climate Parameter	Climate Variable	Unit	1980-1999	-	2040-2059, RCP8.5	2080-2099, RCP8.5	Overall Trend (RCP4.5)
Lake Ontario Ice Cover	Ice Season Mean Ice Cover	%	6.1	-	2.0	0.5	↓
	Winter Mean Ice Cover	%	12.6	-	3.3	0.8	↓
	Spring Mean Ice Cover	%	3.5	-	0.8	0.3	↓

Lam, S., and Dokoska, K. 2022. Climate Change in the Great Lakes Basin: Summary of Trends and Impacts. https://binational.net/wp-content/uploads/2022/11/Climate-Change-in-the-Great-Lakes-Basin_English-1.pdf
Based on projections developed by the Nelson Institute Center for Climatic Research (CCR) at the University of Wisconsin-Madison

A3.3 Lake Ontario ice season length (RCP8.5)

Climate Parameter	Climate Variable	Unit	1981-1999	-	2041-2059, RCP8.5	2081-2099, RCP8.5	Overall Trend (RCP4.5)
Lake Ontario Ice Season Length	Annual Mean Ice Season Length	days	106	-	85	57	↓
	5th Percentile of Annual Mean Ice Season Length	days	87	-	79	38	↓
	95th Percentile of Annual Mean Ice Season Length	days	129	-	94	73	↓

Lam, S., and Dokoska, K. 2022. Climate Change in the Great Lakes Basin: Summary of Trends and Impacts. https://binational.net/wp-content/uploads/2022/11/Climate-Change-in-the-Great-Lakes-Basin_English-1.pdf
Based on projections developed by the Nelson Institute Center for Climatic Research (CCR) at the University of Wisconsin-Madison

A3.4 Infrastructure design values (Toronto City Hall station, Design Value Explorer 2.4.0, global warming levels; GWLs)

Climate Parameter	Climate Variable	Unit	NBCC (up to 2020)	PCIC (1986-2016)	Global Warming Levels				Overall Trend
					2.0°C	2.5°C	3.0°C	3.5°C	
Hourly Design Temperature	January 2.5% Dry Bulb	°C	-20.0	-19.0	-12.2	-10.6	-9.1	-7.7	↓
	January 1% Dry Bulb	°C	-20.0	-20.0	-12.6	-11.1	-9.4	-7.9	↓
	July 97.5% Dry Bulb	°C	31.0	30.0	32.9	33.6	34.0	34.6	↑
	July 97.5% Wet Bulb	°C	23.0	24.0	26.3	26.8	27.2	27.6	↑
Rainfall Loads	Annual Total Rainfall	mm	720.0	695.0	779.8	804.1	827.1	846.5	↑
	Annual Maximum 1-day Rain (50-yr return period)	mm	97.0	95.0	115.8	121.6	126.8	132.1	↑
	Annual Maximum 15-min Rainfall (10-yr return period)	mm	25.0	23.0	28.0	29.4	30.7	32.0	↑
Humidity	Annual Mean Relative Humidity	%	-	73.0	73.1	73.2	73.4	73.4	↑
Wind Loads	Annual Maximum Hourly Wind Pressures (10-yr return period)	kPa	0.4	0.4	0.4	0.4	0.4	0.4	↑
	Annual Maximum Hourly Wind Pressures (50-yr return period)	kPa	0.5	0.4	0.5	0.5	0.5	0.5	↑
	Annual Maximum Driving Rain Wind Pressures (5-yr return period)	Pa	160.0	150.0	159.6	163.1	167.7	167.4	↔
Snow Loads	Annual Maximum Snow Load (50-yr return period)	kPa	0.9	1.4	1.0	0.9	0.8	0.7	↓
	Annual Maximum Rain-on-snow Load (50-yr return period)	kPa	0.4	0.4	0.3	0.3	0.3	0.2	↓

A3.5 Climate-adjusted precipitation intensity rates for short-duration storms (Toronto City station, IDF_CC Tool 7.5, SSP2-4.5 and SSP5-8.5)

Climate Parameter	Climate Variable	Unit	PCIC Observed	2015-2044, SSP2-4.5	2041-2070, SSP2-4.5	2071-2100, SSP2-4.5	Overall Trend (SSP2-4.5)	2015-2044, SSP5-8.5	2041-2070, SSP5-8.5	2071-2100, SSP5-8.5	Overall Trend (SSP5-8.5)
5-minute Precipitation Intensity Rates	5-min Precipitation Intensity Rate (2-yr return period)	mm/h	102.8	106.3	114.3	116.3	↑	109.9	114.7	126.6	↑
	5-min Precipitation Intensity Rate (5-yr return period)	mm/h	140.1	145.5	154.6	158.3	↑	150.8	159.9	172.2	↑
	5-min Precipitation Intensity Rate (10-yr return period)	mm/h	169.3	177.5	185.2	193.7	↑	184.9	194.0	204.2	↑
	5-min Precipitation Intensity Rate (20-yr return period)	mm/h	201.2	214.4	226.1	238.3	↑	223.1	230.3	247.7	↑
	5-min Precipitation Intensity Rate (25-yr return period)	mm/h	212.3	226.0	240.5	252.5	↑	238.3	243.2	261.2	↑
	5-min Precipitation Intensity Rate (50-yr return period)	mm/h	249.2	270.0	291.8	296.6	↑	282.4	284.8	315.2	↑
	5-min Precipitation Intensity Rate (100-yr return period)	mm/h	290.7	314.3	347.5	353.5	↑	331.6	339.6	365.1	↑
10-minute Precipitation Intensity Rates	10-min Precipitation Intensity Rate (2-yr return period)	mm/h	73.6	76.1	81.8	83.2	↑	78.6	82.0	90.5	↑
	10-min Precipitation Intensity Rate (5-yr return period)	mm/h	96.6	100.4	106.7	109.4	↑	104.0	110.2	118.9	↑
	10-min Precipitation Intensity Rate (10-yr return period)	mm/h	113.8	119.5	124.9	130.5	↑	124.6	131.0	137.5	↑
	10-min Precipitation Intensity Rate (20-yr return period)	mm/h	132.0	141.1	149.2	157.0	↑	147.3	151.8	162.8	↑
	10-min Precipitation Intensity Rate (25-yr return period)	mm/h	138.1	147.6	157.3	165.2	↑	155.9	159.3	170.8	↑
	10-min Precipitation Intensity Rate (50-yr return period)	mm/h	158.2	171.4	185.6	189.8	↑	181.5	182.6	200.8	↑
	10-min Precipitation Intensity Rate (100-yr return period)	mm/h	180.0	194.8	213.8	221.3	↑	209.2	212.0	227.3	↑
15-minute Precipitation Intensity Rates	15-min Precipitation Intensity Rate (2-yr return period)	mm/h	58.1	60.1	64.6	65.7	↑	62.1	64.8	71.5	↑
	15-min Precipitation Intensity Rate (5-yr return period)	mm/h	78.6	81.7	86.7	88.9	↑	84.6	89.7	96.7	↑
	15-min Precipitation Intensity Rate (10-yr return period)	mm/h	94.7	99.2	103.6	108.3	↑	103.4	108.5	114.2	↑
	15-min Precipitation Intensity Rate (20-yr return period)	mm/h	112.2	119.6	126.1	132.9	↑	124.5	128.4	138.1	↑
	15-min Precipitation Intensity Rate (25-yr return period)	mm/h	118.2	125.9	133.9	140.7	↑	132.7	135.5	145.4	↑
	15-min Precipitation Intensity Rate (50-yr return period)	mm/h	138.4	150.0	162.1	164.8	↑	157.0	158.3	175.1	↑
	15-min Precipitation Intensity Rate (100-yr return period)	mm/h	161.1	174.1	192.6	196.0	↑	184.0	188.1	202.3	↑

Climate Parameter	Climate Variable	Unit	PCIC Observed	2015-2044, SSP2-4.5	2041-2070, SSP2-4.5	2071-2100, SSP2-4.5	Overall Trend (SSP2-4.5)	2015-2044, SSP5-8.5	2041-2070, SSP5-8.5	2071-2100, SSP5-8.5	Overall Trend (SSP5-8.5)
30-minute Precipitation Intensity Rates	30-min Precipitation Intensity Rate (2-yr return period)	mm/h	37.3	38.6	41.5	42.2	↑	39.8	41.5	45.9	↑
	30-min Precipitation Intensity Rate (5-yr return period)	mm/h	51.6	53.6	57.1	58.5	↑	55.5	59.1	63.5	↑
	30-min Precipitation Intensity Rate (10-yr return period)	mm/h	62.5	65.8	68.6	71.7	↑	68.6	71.8	75.5	↑
	30-min Precipitation Intensity Rate (20-yr return period)	mm/h	74.2	79.2	83.9	88.1	↑	82.6	85.2	91.5	↑
	30-min Precipitation Intensity Rate (25-yr return period)	mm/h	78.2	83.4	89.8	93.3	↑	88.3	89.9	96.8	↑
	30-min Precipitation Intensity Rate (50-yr return period)	mm/h	91.3	98.9	107.1	109.3	↑	104.2	104.9	115.6	↑
	30-min Precipitation Intensity Rate (100-yr return period)	mm/h	105.7	114.5	124.6	129.4	↑	121.7	123.9	133.6	↑
1-hour Precipitation Intensity Rates	1-hr Precipitation Intensity Rate (2-yr return period)	mm/h	23.4	24.2	26.1	26.5	↑	25.0	26.0	28.8	↑
	1-hr Precipitation Intensity Rate (5-yr return period)	mm/h	32.2	33.4	35.8	36.6	↑	34.6	37.0	39.6	↑
	1-hr Precipitation Intensity Rate (10-yr return period)	mm/h	38.4	40.7	42.5	44.4	↑	42.4	44.3	46.7	↑
	1-hr Precipitation Intensity Rate (20-yr return period)	mm/h	44.7	47.9	51.2	53.4	↑	50.3	51.8	55.7	↑
	1-hr Precipitation Intensity Rate (25-yr return period)	mm/h	46.8	50.1	53.9	56.2	↑	53.4	54.1	58.5	↑
	1-hr Precipitation Intensity Rate (50-yr return period)	mm/h	53.3	57.7	63.2	64.6	↑	61.9	61.9	67.8	↑
	1-hr Precipitation Intensity Rate (100-yr return period)	mm/h	60.1	65.1	71.3	74.5	↑	70.7	71.1	76.6	↑
2-hour Precipitation Intensity Rates	2-hr Precipitation Intensity Rate (2-yr return period)	mm/h	13.8	14.3	15.3	15.6	↑	14.7	15.3	17.0	↑
	2-hr Precipitation Intensity Rate (5-yr return period)	mm/h	18.9	19.6	21.0	21.4	↑	20.3	21.7	23.2	↑
	2-hr Precipitation Intensity Rate (10-yr return period)	mm/h	22.6	23.9	24.9	26.0	↑	24.9	26.0	27.4	↑
	2-hr Precipitation Intensity Rate (20-yr return period)	mm/h	26.5	28.3	30.2	31.6	↑	29.6	30.6	32.8	↑
	2-hr Precipitation Intensity Rate (25-yr return period)	mm/h	27.7	29.7	31.9	33.3	↑	31.5	32.0	34.6	↑
	2-hr Precipitation Intensity Rate (50-yr return period)	mm/h	31.9	34.5	37.7	38.4	↑	36.8	36.9	40.5	↑
	2-hr Precipitation Intensity Rate (100-yr return period)	mm/h	36.3	39.3	42.9	44.8	↑	42.4	42.8	46.0	↑

Climate Parameter	Climate Variable	Unit	PCIC Observed	2015-2044, SSP2-4.5	2041-2070, SSP2-4.5	2071-2100, SSP2-4.5	Overall Trend (SSP2-4.5)	2015-2044, SSP5-8.5	2041-2070, SSP5-8.5	2071-2100, SSP5-8.5	Overall Trend (SSP5-8.5)
6-hour Precipitation Intensity Rates	6-hr Precipitation Intensity Rate (2-yr return period)	mm/h	5.7	5.9	6.3	6.4	↑	6.1	6.3	7.0	↑
	6-hr Precipitation Intensity Rate (5-yr return period)	mm/h	7.6	7.9	8.4	8.6	↑	8.2	8.6	9.3	↑
	6-hr Precipitation Intensity Rate (10-yr return period)	mm/h	9.1	9.5	9.9	10.4	↑	9.9	10.4	10.9	↑
	6-hr Precipitation Intensity Rate (20-yr return period)	mm/h	10.6	11.4	12.0	12.6	↑	11.8	12.2	13.1	↑
	6-hr Precipitation Intensity Rate (25-yr return period)	mm/h	11.2	11.9	12.7	13.3	↑	12.6	12.9	13.8	↑
	6-hr Precipitation Intensity Rate (50-yr return period)	mm/h	13.0	14.1	15.2	15.5	↑	14.8	14.9	16.4	↑
	6-hr Precipitation Intensity Rate (100-yr return period)	mm/h	15.0	16.2	17.9	18.3	↑	17.2	17.6	18.9	↑
12-hour Precipitation Intensity Rates	12-hr Precipitation Intensity Rate (2-yr return period)	mm/h	3.4	3.5	3.8	3.8	↑	3.6	3.8	4.2	↑
	12-hr Precipitation Intensity Rate (5-yr return period)	mm/h	4.4	4.6	4.9	5.0	↑	4.8	5.0	5.4	↑
	12-hr Precipitation Intensity Rate (10-yr return period)	mm/h	5.2	5.5	5.7	6.0	↑	5.7	6.0	6.3	↑
	12-hr Precipitation Intensity Rate (20-yr return period)	mm/h	6.0	6.4	6.8	7.1	↑	6.7	6.9	7.4	↑
	12-hr Precipitation Intensity Rate (25-yr return period)	mm/h	6.3	6.7	7.2	7.5	↑	7.1	7.2	7.8	↑
	12-hr Precipitation Intensity Rate (50-yr return period)	mm/h	7.2	7.8	8.4	8.6	↑	8.2	8.3	9.1	↑
	12-hr Precipitation Intensity Rate (100-yr return period)	mm/h	8.1	8.8	9.6	10.0	↑	9.5	9.6	10.2	↑
24-hour Precipitation Intensity Rates	24-hr Precipitation Intensity Rate (2-yr return period)	mm/h	1.9	2.0	2.2	2.2	↑	2.1	2.2	2.4	↑
	24-hr Precipitation Intensity Rate (5-yr return period)	mm/h	2.5	2.6	2.8	2.9	↑	2.7	2.9	3.1	↑
	24-hr Precipitation Intensity Rate (10-yr return period)	mm/h	2.9	3.1	3.2	3.3	↑	3.2	3.4	3.5	↑
	24-hr Precipitation Intensity Rate (20-yr return period)	mm/h	3.3	3.5	3.8	3.9	↑	3.7	3.8	4.1	↑
	24-hr Precipitation Intensity Rate (25-yr return period)	mm/h	3.4	3.7	3.9	4.1	↑	3.9	4.0	4.3	↑
	24-hr Precipitation Intensity Rate (50-yr return period)	mm/h	3.8	4.2	4.6	4.7	↑	4.5	4.5	4.9	↑
	24-hr Precipitation Intensity Rate (100-yr return period)	mm/h	4.3	4.6	5.1	5.3	↑	5.0	5.1	5.4	↑

Western University - IDF_CC tool Version 7.5 (June 2024)

A3.6 Climate-adjusted precipitation intensity rates for short-duration storms (Toronto City station, ClimateData.ca, SSP2-4.5 and SSP5-8.5)

Climate Parameter	Climate Variable	Unit	Climate Data Observed	2011-2040, SSP2-4.5	2041-2070, SSP2-4.5	2071-2100, SSP2-4.5	Overall Trend (SSP2-4.5)	2011-2040, SSP5-8.5	2041-2070, SSP5-8.5	2071-2100, SSP5-8.5	Overall Trend (SSP5-8.5)
5-minute Precipitation Intensity Rates	5-min Precipitation Intensity Rate (2-yr return period)	mm/h	106.9	120.0	130.0	138.0	↑	121.0	139.0	162.0	↑
	5-min Precipitation Intensity Rate (5-yr return period)	mm/h	146.6	164.0	179.0	190.0	↑	166.0	190.0	222.0	↑
	5-min Precipitation Intensity Rate (10-yr return period)	mm/h	172.9	193.0	211.0	224.0	↑	196.0	224.0	262.0	↑
	5-min Precipitation Intensity Rate (20-yr return period)	mm/h	-	-	-	-	-	-	-	-	-
	5-min Precipitation Intensity Rate (25-yr return period)	mm/h	206.1	231.0	252.0	267.0	↑	233.0	267.0	313.0	↑
	5-min Precipitation Intensity Rate (50-yr return period)	mm/h	230.8	258.0	282.0	299.0	↑	261.0	299.0	350.0	↑
	5-min Precipitation Intensity Rate (100-yr return period)	mm/h	255.2	285.0	312.0	330.0	↑	289.0	331.0	387.0	↑
10-minute Precipitation Intensity Rates	10-min Precipitation Intensity Rate (2-yr return period)	mm/h	75.4	84.0	92.0	98.0	↑	85.0	98.0	114.0	↑
	10-min Precipitation Intensity Rate (5-yr return period)	mm/h	99.2	111.0	121.0	128.0	↑	112.0	129.0	150.0	↑
	10-min Precipitation Intensity Rate (10-yr return period)	mm/h	114.9	129.0	140.0	149.0	↑	130.0	149.0	174.0	↑
	10-min Precipitation Intensity Rate (20-yr return period)	mm/h	-	-	-	-	-	-	-	-	-
	10-min Precipitation Intensity Rate (25-yr return period)	mm/h	134.8	151.0	165.0	174.0	↑	153.0	175.0	204.0	↑
	10-min Precipitation Intensity Rate (50-yr return period)	mm/h	149.5	167.0	183.0	193.0	↑	169.0	194.0	227.0	↑
	10-min Precipitation Intensity Rate (100-yr return period)	mm/h	164.2	184.0	200.0	212.0	↑	186.0	213.0	249.0	↑
15-minute Precipitation Intensity Rates	15-min Precipitation Intensity Rate (2-yr return period)	mm/h	60.3	67.0	74.0	78.0	↑	68.0	78.0	91.0	↑
	15-min Precipitation Intensity Rate (5-yr return period)	mm/h	82.0	92.0	100.0	106.0	↑	93.0	106.0	124.0	↑
	15-min Precipitation Intensity Rate (10-yr return period)	mm/h	96.4	108.0	118.0	125.0	↑	109.0	125.0	146.0	↑
	15-min Precipitation Intensity Rate (20-yr return period)	mm/h	-	-	-	-	-	-	-	-	-
	15-min Precipitation Intensity Rate (25-yr return period)	mm/h	114.6	128.0	140.0	148.0	↑	130.0	149.0	174.0	↑
	15-min Precipitation Intensity Rate (50-yr return period)	mm/h	128.1	143.0	156.0	166.0	↑	145.0	166.0	194.0	↑
	15-min Precipitation Intensity Rate (100-yr return period)	mm/h	141.5	158.0	173.0	183.0	↑	160.0	184.0	215.0	↑

Climate Parameter	Climate Variable	Unit	Climate Data Observed	2011-2040, SSP2-4.5	2041-2070, SSP2-4.5	2071-2100, SSP2-4.5	Overall Trend (SSP2-4.5)	2011-2040, SSP5-8.5	2041-2070, SSP5-8.5	2071-2100, SSP5-8.5	Overall Trend (SSP5-8.5)
30-minute Precipitation Intensity Rates	30-min Precipitation Intensity Rate (2-yr return period)	mm/h	38.6	43.0	47.0	50.0	↑	44.0	50.0	59.0	↑
	30-min Precipitation Intensity Rate (5-yr return period)	mm/h	53.4	60.0	65.0	69.0	↑	60.0	69.0	81.0	↑
	30-min Precipitation Intensity Rate (10-yr return period)	mm/h	63.1	71.0	77.0	82.0	↑	71.0	82.0	96.0	↑
	30-min Precipitation Intensity Rate (20-yr return period)	mm/h	-	-	-	-	-	-	-	-	-
	30-min Precipitation Intensity Rate (25-yr return period)	mm/h	75.4	84.0	92.0	98.0	↑	85.0	98.0	114.0	↑
	30-min Precipitation Intensity Rate (50-yr return period)	mm/h	84.6	95.0	103.0	109.0	↑	96.0	110.0	128.0	↑
	30-min Precipitation Intensity Rate (100-yr return period)	mm/h	93.6	105.0	114.0	121.0	↑	106.0	121.0	142.0	↑
1-hour Precipitation Intensity Rates	1-hr Precipitation Intensity Rate (2-yr return period)	mm/h	23.8	27.0	29.0	31.0	↑	27.0	31.0	36.0	↑
	1-hr Precipitation Intensity Rate (5-yr return period)	mm/h	32.6	36.0	40.0	42.0	↑	37.0	42.0	49.0	↑
	1-hr Precipitation Intensity Rate (10-yr return period)	mm/h	38.4	43.0	47.0	50.0	↑	43.0	50.0	58.0	↑
	1-hr Precipitation Intensity Rate (20-yr return period)	mm/h	-	-	-	-	-	-	-	-	-
	1-hr Precipitation Intensity Rate (25-yr return period)	mm/h	45.7	51.0	56.0	59.0	↑	52.0	59.0	69.0	↑
	1-hr Precipitation Intensity Rate (50-yr return period)	mm/h	51.2	57.0	63.0	66.0	↑	58.0	66.0	78.0	↑
	1-hr Precipitation Intensity Rate (100-yr return period)	mm/h	56.6	63.0	69.0	73.0	↑	64.0	73.0	86.0	↑
2-hour Precipitation Intensity Rates	2-hr Precipitation Intensity Rate (2-yr return period)	mm/h	14.1	16.0	17.0	18.0	↑	16.0	18.0	21.0	↑
	2-hr Precipitation Intensity Rate (5-yr return period)	mm/h	19.5	22.0	24.0	25.0	↑	22.0	25.0	30.0	↑
	2-hr Precipitation Intensity Rate (10-yr return period)	mm/h	23.0	26.0	28.0	30.0	↑	26.0	30.0	35.0	↑
	2-hr Precipitation Intensity Rate (20-yr return period)	mm/h	-	-	-	-	-	-	-	-	-
	2-hr Precipitation Intensity Rate (25-yr return period)	mm/h	27.5	31.0	34.0	36.0	↑	31.0	36.0	42.0	↑
	2-hr Precipitation Intensity Rate (50-yr return period)	mm/h	30.9	35.0	38.0	40.0	↑	35.0	40.0	47.0	↑
	2-hr Precipitation Intensity Rate (100-yr return period)	mm/h	34.2	38.0	42.0	44.0	↑	39.0	44.0	52.0	↑

Climate Parameter	Climate Variable	Unit	Climate Data Observed	2011-2040, SSP2-4.5	2041-2070, SSP2-4.5	2071-2100, SSP2-4.5	Overall Trend (SSP2-4.5)	2011-2040, SSP5-8.5	2041-2070, SSP5-8.5	2071-2100, SSP5-8.5	Overall Trend (SSP5-8.5)
6-hour Precipitation Intensity Rates	6-hr Precipitation Intensity Rate (2-yr return period)	mm/h	5.8	6.5	7.1	7.5	↑	6.6	7.5	8.8	↑
	6-hr Precipitation Intensity Rate (5-yr return period)	mm/h	7.9	8.8	9.6	10.0	↑	8.9	10.0	12.0	↑
	6-hr Precipitation Intensity Rate (10-yr return period)	mm/h	9.2	10.0	11.0	12.0	↑	10.0	12.0	14.0	↑
	6-hr Precipitation Intensity Rate (20-yr return period)	mm/h	-	-	-	-	-	-	-	-	-
	6-hr Precipitation Intensity Rate (25-yr return period)	mm/h	10.9	12.0	13.0	14.0	↑	12.0	14.0	17.0	↑
	6-hr Precipitation Intensity Rate (50-yr return period)	mm/h	12.2	14.0	15.0	16.0	↑	14.0	16.0	19.0	↑
	6-hr Precipitation Intensity Rate (100-yr return period)	mm/h	13.4	15.0	16.0	17.0	↑	15.0	17.0	20.0	↑
12-hour Precipitation Intensity Rates	12-hr Precipitation Intensity Rate (2-yr return period)	mm/h	3.5	3.9	4.3	4.5	↑	4.0	4.5	5.3	↑
	12-hr Precipitation Intensity Rate (5-yr return period)	mm/h	4.5	5.0	5.5	5.8	↑	5.1	5.8	6.8	↑
	12-hr Precipitation Intensity Rate (10-yr return period)	mm/h	5.2	5.8	6.3	6.7	↑	5.9	6.7	7.9	↑
	12-hr Precipitation Intensity Rate (20-yr return period)	mm/h	-	-	-	-	-	-	-	-	-
	12-hr Precipitation Intensity Rate (25-yr return period)	mm/h	6.1	6.8	7.4	7.9	↑	6.9	7.9	9.3	↑
	12-hr Precipitation Intensity Rate (50-yr return period)	mm/h	6.8	7.6	8.3	8.8	↑	7.7	8.8	10.0	↑
	12-hr Precipitation Intensity Rate (100-yr return period)	mm/h	7.4	8.3	9.0	9.6	↑	8.4	9.6	11.0	↑
24-hour Precipitation Intensity Rates	24-hr Precipitation Intensity Rate (2-yr return period)	mm/h	2.0	2.2	2.4	2.6	↑	2.3	2.6	3.0	↑
	24-hr Precipitation Intensity Rate (5-yr return period)	mm/h	2.5	2.8	3.1	3.2	↑	2.8	3.2	3.8	↑
	24-hr Precipitation Intensity Rate (10-yr return period)	mm/h	2.9	3.2	3.5	3.8	↑	3.3	3.8	4.4	↑
	24-hr Precipitation Intensity Rate (20-yr return period)	mm/h	-	-	-	-	-	-	-	-	-
	24-hr Precipitation Intensity Rate (25-yr return period)	mm/h	3.4	3.8	4.2	4.4	↑	3.9	4.4	5.2	↑
	24-hr Precipitation Intensity Rate (50-yr return period)	mm/h	3.7	4.1	4.5	4.8	↑	4.2	4.8	5.6	↑
	24-hr Precipitation Intensity Rate (100-yr return period)	mm/h	4.1	4.6	5.0	5.3	↑	4.6	5.3	6.2	↑

ClimateData.ca - Short-duration Rainfall IDF Data Version 3.30 (October 31, 2022)

Appendix B: Methods and climate variable definitions

The characterization of Toronto's historical climate is intended to be illustrative of how Toronto's climate has already changed. The Toronto City climate station was selected because climate normal data for the most recent 1991-2020 period is currently available. It also provides a consistent, long-term record of daily weather in Toronto over 170+ years. Unfortunately, only a few other climate stations located in and around Toronto share similar data availability and quality, and consistent coverage across the entire city remains a key gap, particularly in the eastern part of the city (Figure B1).

Figure B1. Map of Environment and Climate Change Canada (ECCC) climate stations with daily temperature data between 1971-2000 in and around Toronto (with increasing 5-km buffers around the city). The circle highlights four climate stations that are located within 5 km of the city's boundaries, including the Toronto City and Toronto Island A stations in Toronto, Pearson International Airport station in Mississauga, and Woodbridge station in Vaughan. The star indicates the Toronto City climate station located near Bloor Street West and St. George Street that was used in this study to help characterize Toronto's historical climate.

Since the 1960s, climate modelling has become more sophisticated over time, with improvements in how climate models simulate the transfer of energy and matter between the ocean, atmosphere, and land. With increasing model complexity, spatial resolution is also improving over time. Since the first Intergovernmental Panel on Climate Change (IPCC) report in 1990, spatial resolution has improved from 500 km to today's higher resolution models that typically range from 20-100 km (IPCC, 2021). With improved resolution, models are better able to capture distinctions between land and water processes. This is particularly important for the Great Lakes region because despite the size of the Great Lakes, many global climate models do not recognize the Great Lakes as water bodies (Great Lakes Integrated Sciences and Assessments Center, 2021). Therefore, spatial resolution and the ability to account for lake processes are important in the Great Lakes region in which Toronto is located.

Despite ongoing improvements, 100 km is still too large to be useful for local and regional planning, which is why we need to downscale global climate projections at a smaller scale for a specific region or area of interest such as Toronto. Common downscaling approaches include dynamical downscaling and statistical downscaling (Government of Canada, 2023; Copernicus Climate Change Service, 2021):

- **Dynamical downscaling** uses higher resolution Regional Climate Models (RCMs) that typically range from 10-50 km in resolution. These models may also include additional local processes not captured in Global Climate Models (GCMs). These models are run over a smaller area of interest instead of the entire globe and rely on information from GCMs to simulate the boundary conditions for the area of interest. The results can be further adjusted based on observed historical climate data.
- **Statistical downscaling** is based on statistical relationships that have been observed historically between local climate variables and large-scale variables. Statistical downscaling generally takes less computing power and has typically been used to derive projections at 10 km or less. In Canada, country-wide climate projections are now available through national climate portals, including ClimateData.ca, Climate Atlas, and PAVICS at approximately 10-km resolution (Government of Canada, 2021).

Two climate scenarios were selected to illustrate two possible climate futures for Toronto. These include the medium emissions scenario (SSP2-4.5) and very high emissions scenario (SSP5-8.5), which translate to approximately 2.7°C and 4.4°C of global warming by the end of the century, respectively (IPCC, 2021; Figure B2).

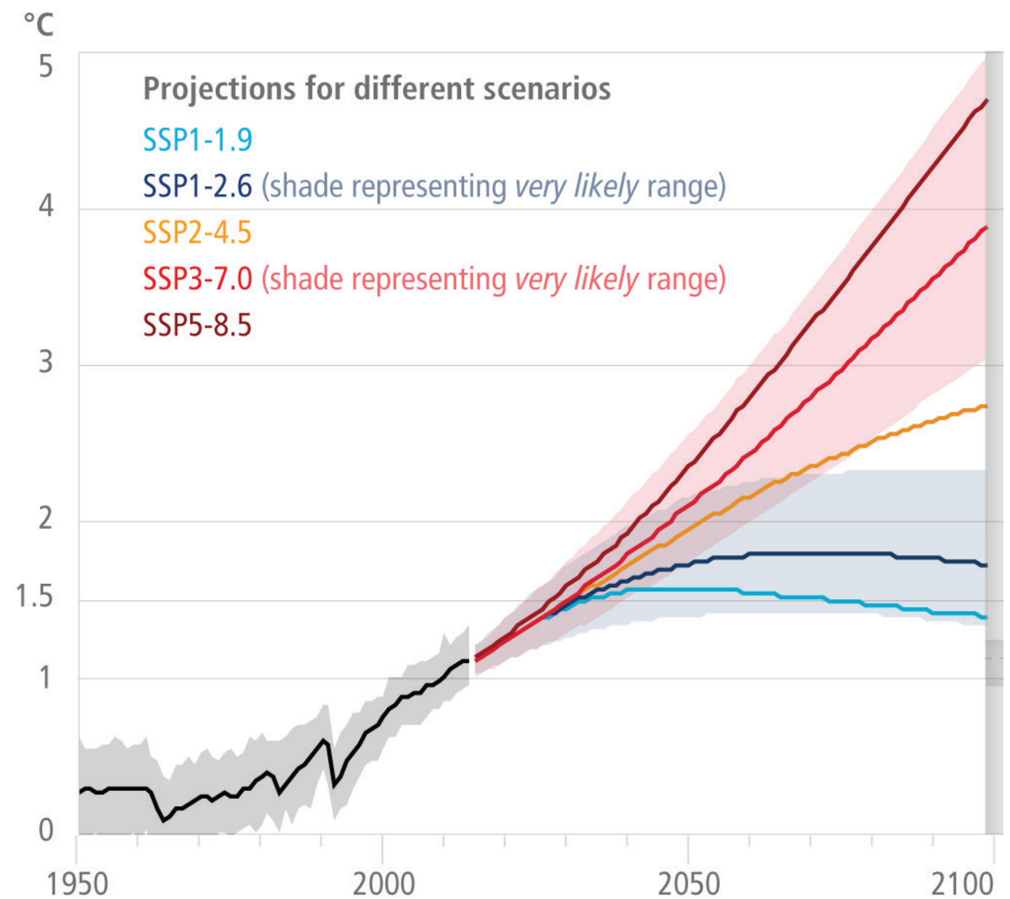

Figure B2. Projected changes in global surface temperature (°C) compared to 1850-1900 under five illustrative climate scenarios: very low emissions (SSP1-1.9), low emissions (SSP1-2.6), medium emissions (SSP2-4.5), high emissions (SSP3-7.0), and very high emissions scenario (SSP5-8.5). Source: IPCC Sixth Assessment Report, Working Group II, Technical Summary

These scenarios illustrate two possible future socio-economic and technological development pathways (i.e., Shared Socio-economic Pathways, or SSPs) and differing greenhouse gas (GHG) emissions reduction targets (IPCC, 2021; Riahi et al., 2017):

- **SSP2-4.5** illustrates a "middle of the road" socio-economic development pathway that looks similar to historical development patterns. Global population growth is moderate and levels off in the second half of the century. Income growth is experienced unevenly across different countries. There is some but limited cooperation between countries. Environmental systems face some degradation and there is slow progress in achieving Sustainable Development Goals. Carbon dioxide (CO2) emissions are expected to peak around 2040 and decline over the remainder of the century.
- **SSP5-8.5** illustrates a fossil-fueled development pathway that sees intensive exploitation of fossil fuels with a high percentage of coal use and energy-intensive lifestyles worldwide. Global markets are increasingly integrated, leading to innovations and technological progress. Some local environmental problems are being tackled successfully such as air pollution. CO2 emissions are expected to continue to climb and peak around 2090 before they start to decline.

For this report, modelled historical and future daily projections were obtained through PAVICS (Power Analytics and Visualization for Climate Science). Climate data for the latest SSP climate scenarios as used in the IPCC's most recent Sixth Assessment Report were added to PAVICS in January 2023. Statistically downscaled daily data from 26 GCMs were used to derive almost all of the 54 climate variables included in this study, except for the humidex variables which were based on 19 GCMs. Daily climate projections were obtained from PAVICS and then exported to R Studio to produce summary data tables for one historical reference period (1971-2000) and three future periods (2015-2040, 2041-2070, and 2071-2100).

The short-term future period starts in 2015 because this is the year that the future projections begin for the latest SSP climate scenarios. Although 2015-2040 is slightly less than 30 years, it aligns with when the modelling of future emissions begins. The short, medium, and long-term projected future are compared against the historical 1980s period to help characterize the extent, direction, and magnitude of change that we may see in the future.

The following table presents more information on these climate variables, why they are important, and how they were calculated.

Climate Parameter	Climate Variable	Unit	Description	Calculation	Why this Variable is Important
Mean Temperature	Annual Mean Temperature	°C	Mean temperature (°C) is defined as the average of the maximum and minimum temperature at a location for a specified time interval	func=atmos.tg_mean, invars=-dict(tas="tg"), args=dict(freq="YS")	Annual mean temperature characterizes average temperature conditions over a year. It describes how hot, temperate, or cold a place generally is, which drives what plants and animals may grow and thrive and the general temperature conditions that people may experience. Temperature is a direct indicator of climate change as a result of the rise in greenhouse gas concentrations from human activities. Changes in temperature affect agriculture, infrastructure, people's health, water availability, energy use, recreation, and ecosystem health.
	Winter Mean Temperature	°C	Winter months include: December, January, and February	func=atmos.tg_mean, invars=-dict(tas="tg"), args=dict(freq="QS-DEC")	Seasonal mean temperature characterizes average temperature conditions within a season. It describes how different seasons may feel, which may in turn influence energy management and recreation. It can also influence agriculture, infrastructure, the spread of pests and diseases, water availability, and ecosystem health.
	Spring Mean Temperature	°C	Spring months include: March, April, and May	func=atmos.tg_mean, invars=-dict(tas="tg"), args=dict(freq="QS-MAR")	
	Summer Mean Temperature	°C	Summer months include: June, July, and August	func=atmos.tg_mean, invars=-dict(tas="tg"), args=dict(freq="QS-JUN")	
	Fall Mean Temperature	°C	Fall months include: September, October, and November	func=atmos.tg_mean, invars=-dict(tas="tg"), args=dict(freq="QS-SEP")	
Maximum Temperature	Annual Maximum Temperature	°C	The average of daily maximum temperatures (°C) at a location for a specified time interval	func=atmos.tx_mean, invars=dict(tasmax-="tasmax"), args=dict(freq="YS")	Annual maximum temperature characterizes the highest daily temperature conditions over a year. It describes how hot, temperate, or cold a place generally is, which drives what plants and animals may grow and thrive and the general temperature conditions that people may experience. Temperature is a direct indicator of climate change as a result of the rise in greenhouse gas concentrations from human activities. Changes in temperature affect agriculture, infrastructure, people's health, water availability, energy use, recreation, and ecosystem health.
	Winter Maximum Temperature	°C	Winter months include: December, January, and February	func=atmos.tx_mean, invars=dict(tasmax-="tasmax"), args=dict(freq="QS-DEC")	Seasonal maximum temperature characterizes the highest daily temperature conditions within a season. It describes how different seasons may feel, which may in turn influence energy management and recreation. It can also influence agriculture, infrastructure, the spread of pests and diseases, water availability, and ecosystem health.
	Spring Maximum Temperature	°C	Spring months include: March, April, and May	func=atmos.tx_mean, invars=dict(tasmax-="tasmax"), args=dict(freq="QS-MAR")	
	Summer Maximum Temperature	°C	Summer months include: June, July, and August	func=atmos.tx_mean, invars=dict(tasmax-="tasmax"), args=dict(freq="QS-JUN")	
	Fall Maximum Temperature	°C	Fall months include: September, October, and November	func=atmos.tx_mean, invars=dict(tasmax-="tasmax"), args=dict(freq="QS-SEP")	

Climate Parameter	Climate Variable	Unit	Description	Calculation	Why this Variable is Important
Minimum Temperature	Annual Minimum Temperature	°C	The average of daily minimum temperatures (°C) at a location for a specified time interval	func=atmos.tn_mean, invars=dict (tasmin="tasmin"), args=dict(freq="YS")	Annual minimum temperature characterizes the lowest daily temperature conditions over a year. It describes how cold, temperate, or hot a place generally is, which drives what plants and animals may grow and thrive and the general temperature conditions that people may experience, typically at night when daily temperatures tend to be lowest. Temperature is a direct indicator of climate change as a result of the rise in greenhouse gas concentrations from human activities. Changes in temperature affect agriculture, infrastructure, people's health, water availability, energy use, recreation, and ecosystem health.
	Winter Minimum Temperature	°C	Winter months include: December, January, and February	func=atmos.tn_mean, invars=dict(tas-min="tasmin"), args=dict(freq="QS-DEC")	Seasonal minimum temperature characterizes the lowest daily temperature conditions within a season. It describes how different seasons may feel, which may in turn influence energy management and recreation. It can also influence agriculture, infrastructure, the spread of pests and diseases, water availability, and ecosystem health.
	Spring Minimum Temperature	°C	Spring months include: March, April, and May	func=atmos.tn_mean, invars=dict(tas-min="tasmin"), args=dict(freq="QS-MAR")	
	Summer Minimum Temperature	°C	Summer months include: June, July, and August	func=atmos.tn_mean, invars=dict(tas-min="tasmin"), args=dict(freq="QS-JUN")	
	Fall Minimum Temperature	°C	Fall months include: September, October, and November	func=atmos.tn_mean, invars=dict(tas-min="tasmin"), args=dict(freq="QS-SEP")	
Extreme Heat	Days Above 35°C	days/ year	The number of days in a year when daily maximum temperature exceeds 35˚C (or > 35˚C)	func=atmos.tx_days_above,invars=-dict(tasmax="tasmax"),args=dict(-thresh="35 degC", freq="YS")	Days above 35°C describes the number of extremely hot days in a year. Extreme heat puts everyone's health at risk, especially seniors, young children, people with pre-existing conditions, people with limited access to cooling, and people who must spend long hours outdoors. Extreme heat can also pose a risk to our built infrastructure such as buildings, transportation systems, and energy systems, depending on their design parameters. Extreme heat also poses a threat to plants and animals that are not adapted to the heat.
	Days Above 30°C	days/ year	The number of days in a year when daily maximum temperature exceeds 30˚C (or > 30˚C)	func=atmos.tx_days_above,invars=-dict(tasmax="tasmax"),args=dict(-thresh="30 degC", freq="YS")	Days above 30°C describes the number of very hot days in a year. Extreme heat puts everyone's health at risk, especially seniors, young children, people with pre-existing conditions, people with limited access to cooling, and people who must spend long hours outdoors. Extreme heat can also pose a risk to our built infrastructure such as buildings, transportation systems, and energy systems, depending on their design parameters. Extreme heat also poses a threat to plants and animals that are not adapted to the heat.

Climate Parameter	Climate Variable	Unit	Description	Calculation	Why this Variable is Important
	Days Above 25°C	days/ year	The number of days in a year when daily maximum temperature exceeds 25˚C (or > 25˚C)	func=atmos.tx_days_above,invars=-dict(tasmax="tasmax"),args=dict(-thresh="25 degC", freq="YS")	Days above 25°C describes the number of hot days in a year. Extreme heat puts everyone's health at risk, especially seniors, young children, people with pre-existing conditions, people with limited access to cooling, and people who must spend long hours outdoors. Extreme heat can also pose a risk to our built infrastructure such as buildings, transportation systems, and energy systems, depending on their design parameters. Extreme heat also poses a threat to plants and animals that are not adapted to the heat.
	Days Above 20°C (Tropical Nights)	days/ year	A tropical night occurs when daily minimum temperature stays above 20˚C (or > 20˚C)	func=atmos.tropical_nights, invars=-dict(tasmin="tasmin"), args=dict(-thresh="20 degC", freq="YS")	Days above 20°C describes the number of days with minimum temperature that stays above 20°C in a year, which typically describes hot nights. Extreme heat puts everyone's health at risk, especially seniors, young children, people with pre-existing conditions, people with limited access to cooling, and people who must spend long hours outdoors. Hot nights can be especially dangerous as they prevent people's body temperatures from cooling down. Extreme heat can also pose a risk to our built infrastructure such as buildings, transportation systems, and energy systems, depending on their design parameters. Extreme heat also poses a threat to plants and animals that are not adapted to the heat.
	Hottest Day Temperature	°C	The maximum of daily maximum temperatures (°C), representing the hottest daytime temperature at a location for a specified time interval	func=atmos.tx_max, invars=dict(tasmax-="tasmax"), args=dict(freq="YS")	Hottest day temperature represents the hottest daytime temperature that may occur in any year. Extreme heat puts everyone's health at risk, especially seniors, young children, people with pre-existing conditions, people with limited access to cooling, and people who must spend long hours outdoors. Extreme heat can also pose a risk to our built infrastructure such as buildings, transportation systems, and energy systems, depending on their design parameters. Extreme heat also poses a threat to plants and animals that are not adapted to the heat.
	Temperature-based Heat Warning Frequency	warnings/ year	A Heat Warning is issued for southern Ontario when there is a forecast of two or more consecutive days with daytime maximum temperatures of 31°C or warmer, together with nighttime minimum temperatures of 20°C or warmer or when there is a forecast of two or more consecutive days with humidex values expected to reach 40 or higher	func=atmos.tx_days_above,invars=-dict(tasmax="tasmax"),args=dict(-thresh="30 degC", freq="YS")	Days above 30°C describes the number of very hot days in a year. Extreme heat puts everyone's health at risk, especially seniors, young children, people with pre-existing conditions, people with limited access to cooling, and people who must spend long hours outdoors. Extreme heat can also pose a risk to our built infrastructure such as buildings, transportation systems, and energy systems, depending on their design parameters. Extreme heat also poses a threat to plants and animals that are not adapted to the heat.

Climate Parameter	Climate Variable	Unit	Description	Calculation	Why this Variable is Important
	Maximum Consecutive Temperature-based Heat Warning Days	days/ year	The maximum number of consecutive days when there is a forecast of two or more consecutive days with daytime maximum temperatures of 31°C or warmer, together with nighttime minimum temperatures of 20°C or warmer	func=atmos.heat_wave_total_length, invars=dict(tasmin="tasmin", tasmax="tasmax"), args=dict(thresh_tasmin="20.0 degC", thresh_tasmax="31 degC", window=2, freq="YS")	Maximum consecutive heat warning days describes the maximum length of a heat event that meets the established temperature thresholds for southern Ontario. Extreme heat puts everyone's health at risk, especially seniors, young children, people with pre-existing conditions, people with limited access to cooling, and people who must spend long hours outdoors. Prolonged heat events can be especially dangerous as it increases the risk of overheating, which may lead to heat-related illnesses and deaths. Extreme heat can also pose a risk to our built infrastructure such as buildings, transportation systems, and energy systems, depending on their design parameters. Extreme heat also poses a threat to plants and animals that are not adapted to the heat.
	Humidex > 30	days/ year	The number of days in a year when the maximum humidex exceeds 30, which would lead to some discomfort for the average person	*ECCC humidex dataset is used	Humidex > 30 characterizes the number of hot and humid days in a year with humidex above 30, which may lead to some discomfort for the average person. Extreme heat puts everyone's health at risk, especially seniors, young children, people with pre-existing conditions, people with limited access to cooling, and people who must spend long hours outdoors. Extreme heat can also pose a risk to our built infrastructure such as buildings, transportation systems, and energy systems, depending on their design parameters. Extreme heat also poses a threat to plants and animals that are not adapted to the heat.
	Humidex > 35	days/ year	The number of days in a year when the maximum humidex exceeds 35, which would lead to evident discomfort for the average person	*ECCC humidex dataset is used	Humidex > 35 characterizes the number of hot and humid days in a year with humidex above 30, which may lead to evident discomfort for the average person. Extreme heat puts everyone's health at risk, especially seniors, young children, people with pre-existing conditions, people with limited access to cooling, and people who must spend long hours outdoors. Extreme heat can also pose a risk to our built infrastructure such as buildings, transportation systems, and energy systems, depending on their design parameters. Extreme heat also poses a threat to plants and animals that are not adapted to the heat.
	Humidex > 40	days/ year	The number of days in a year when the maximum humidex exceeds 40, which would lead to intense discomfort for the average person	*ECCC humidex dataset is used	Humidex > 40 characterizes the number of hot and humid days in a year with humidex above 30, which may lead to intense discomfort for the average person. Extreme heat puts everyone's health at risk, especially seniors, young children, people with pre-existing conditions, people with limited access to cooling, and people who must spend long hours outdoors. Extreme heat can also pose a risk to our built infrastructure such as buildings, transportation systems, and energy systems, depending on their design parameters. Extreme heat also poses a threat to plants and animals that are not adapted to the heat.

Climate Parameter	Climate Variable	Unit	Description	Calculation	Why this Variable is Important
Extreme Cold	Days Below -20°C	days/ year	The number of days in a year when daily minimum temperature drops below -20˚C (or < -20˚C)	func=atmos.tn_days_below, invars=-dict(tasmin="tasmin"), args=dict(-thresh="-20 degC", freq="YS")	Days below -20°C describes the number of very cold days in a year. Cold weather conditions can directly impact people's health, especially seniors, young children, people with pre-existing conditions, people who must spend long hours outdoors, and people with limited access to electricity or heat. Extreme cold can also pose a risk to our built infrastructure such as buildings, transportation systems, and energy systems, depending on their design parameters. Extreme cold also poses a threat to plants and animals that are not adapted to the cold or require stable temperature conditions.
	Days Below -10°C	days/ year	The number of days in a year when daily minimum temperature drops below -10˚C (or < -10˚C)	func=atmos.tn_days_below, invars=-dict(tasmin="tasmin"), args=dict(-thresh="-10 degC", freq="YS")	Days below -10°C describes the number of cold days in a year. Cold weather conditions can directly impact people's health, especially seniors, young children, people with pre-existing conditions, people who must spend long hours outdoors, and people with limited access to electricity or heat. Extreme cold can also pose a risk to our built infrastructure such as buildings, transportation systems, and energy systems, depending on their design parameters. Extreme cold also poses a threat to plants and animals that are not adapted to the cold or require stable temperature conditions.
	Days Below 0°C (Frost Days)	days/ year	The number of days in a year when daily minimum temperature is lower than 0˚C (or < 0˚C). Under these conditions, frost may form on the ground or on cold surfaces	func=atmos.tn_days_below, invars=-dict(tasmin="tasmin"), args=dict(-thresh="0 degC", freq="YS")	Days below 0°C describes the number of frost days or below-freezing days in a year. It describes how cold, temperate, or hot a place generally is, which drives what plants and animals may grow and thrive and energy demand.
Heating and Cooling Degree Days	Heating Degree Days (HDDs)	degree days	The degree to which average daily temperatures are below 18°C (or < 18°C). This is often used to represent heating demand for buildings	func=atmos.heating_degree_days, in-vars=dict(tas="tg"), args=dict(thresh="18 degC",freq="YS")	Heating degree days is often used to characterize the amount of heating demand for buildings in a year. For every degree difference accumulated each day with mean temperatures below 18°C, more demand is anticipated for space heating.
	Cooling Degree Days (CDDs)	degree days	The degree to which average daily temperatures are above 18°C (or > 18°C). This is often used to represent air conditioning demand for buildings	func=atmos.cooling_degree_days, in-vars=dict(tas="tg"), args=dict(thresh="18 degC",freq="YS")	Cooling degree days is often used to characterize the amount of cooling demand for buildings in a year. For every degree difference accumulated each day with mean temperatures above 18°C, more demand is anticipated for air conditioning.

Climate Parameter	Climate Variable	Unit	Description	Calculation	Why this Variable is Important
Total Precipitation	Annual Total Precipitation	mm	The sum of the total rainfall and the water equivalent of the total snowfall (mm) at the location during a specified time interval	func=atmos.precip_accumulation, invars=dict(pr="pr"), args=dict(freq="YS")	Annual total precipitation characterizes the total amount of precipitation (rain or snow) that falls over a year. It describes how wet or dry a place generally is, which drives what plants and animals may grow and thrive and the general precipitation conditions that people may experience. Precipitation is a fundamental aspect of climate and a key indicator of how human-induced climate change is affecting the Earth's water cycle. Changes in precipitation affect agriculture, infrastructure, people's health, water availability, recreation, and ecosystem health.
	Winter Total Precipitation	mm	Winter months include: December, January, and February	func=atmos.precip_accumulation, invars=dict(pr="pr"), args=dict(freq="QS-DEC")	Seasonal total precipitation characterizes the total amount of precipitation (rain or snow) that falls within a season. It describes how wet or dry a place generally is in different seasons, which drives what plants and animals may grow and thrive and the general precipitation conditions that people may experience. Changes in precipitation affect agriculture, infrastructure, people's health, water availability, recreation, and ecosystem health.
	Spring Total Precipitation	mm	Spring months include: March, April, and May	func=atmos.precip_accumulation, invars=dict(pr="pr"), args=dict(freq="QS-MAR")	
	Summer Total Precipitation	mm	Summer months include: June, July, and August	func=atmos.precip_accumulation, invars=dict(pr="pr"), args=dict(freq="QS-JUN")	
	Fall Total Precipitation	mm	Fall months include: September, October, and November	func=atmos.precip_accumulation, invars=dict(pr="pr"), args=dict(freq="QS-SEP")	
Extreme Precipitation	Maximum 1-day Precipitation or Wettest Day Precipitation	mm	The maximum amount of precipitation (mm) in one day over a given period of time	func=atmos.max_1day_precipitation_amount, invars=dict(pr="pr"), args=dict(freq="YS")	Maximum 1-day precipitation describes the maximum amount of total precipitation (rain or snow) that falls in a single day (or wettest day). Extreme precipitation can increase the risk of flooding, which can directly affect people's health and safety. Extreme precipitation can also increase the amount of stormwater runoff that enters waterways, especially in urban areas, which may in turn affect the health of aquatic systems. Changes in extreme precipitation affect agriculture, infrastructure, people's health, water availability, recreation, and ecosystem health.
	Maximum 3-day Precipitation	mm	The maximum amount of precipitation (mm) in three days over a given period of time	func=atmos.max_n_day_precipitation_amount, invars=dict(pr="pr"), args=dict(window=3,freq="YS")	Maximum 3-day precipitation describes the maximum amount of total precipitation (rain or snow) that falls over three consecutive days. Extreme precipitation can increase the risk of flooding, which can directly affect people's health and safety. Extreme precipitation can also increase the amount of stormwater runoff that enters waterways, especially in urban areas, which may in turn affect the health of aquatic systems. Changes in extreme precipitation affect agriculture, infrastructure, people's health, water availability, recreation, and ecosystem health.

Climate Parameter	Climate Variable	Unit	Description	Calculation	Why this Variable is Important
	Simple Daily Intensity Index (SDII)	mm/ day	Average intensity (mm/day) over a given period of time, calculated as total wet day precipitation (> 0.2 mm) divided by the total number of wet days	func=atmos.wetdays, invars=dict(pr="pr"), args=dict(thresh="0.2 mm/day", freq="YS")* *This formula gives the number of days with precipitation. Annual total precipitation is then divided by wet days to determine SDII.	The Simple Daily Intensity Index describes the average intensity or rate of precipitation in millimetres per day. It characterizes how much and how fast precipitation may fall when it falls. Intense precipitation can increase the risk of flooding, which can directly affect people's health and safety. Intense precipitation can also increase the amount of stormwater runoff that enters waterways, especially in urban areas, which may in turn affect the health of aquatic systems. Changes in precipitation intensity affect agriculture, infrastructure, people's health, water availability, recreation, and ecosystem health.
	95th Percentile Precipitation	mm	Total precipitation when daily precipitation is greater than or equal to the 95th percentile (the value where 95% of all measurements are under it, and 5% of measurements are over it)	dataset=dataset.quantile(0.95)* *This calculates the 95th percentile.	95th percentile precipitation characterizes heavy precipitaion with daily amounts greater than or equal to 95% of all storms. 95% of the time, total daily precipitation will fall under this value. Above this value represents the top 5% in daily amounts. Extreme precipitation can increase the risk of flooding, which can directly affect people's health and safety. Extreme precipitation can also increase the amount of stormwater runoff that enters waterways, especially in urban areas, which may in turn affect the health of aquatic systems. Changes in extreme precipitation affect agriculture, infrastructure, people's health, water availability, recreation, and ecosystem health.
	99th Percentile Precipitation	mm	Total precipitation when daily precipitation is greater than or equal to the 99th percentile (the value where 99% of all measurements are under it, and 1% of measurements are over it)	dataset=dataset.quantile(0.99)* *This calculates the 99th percentile.	99th percentile precipitation characterizes very heavy precipitaion with daily amounts greater than or equal to 99% of all storms. 99% of the time, total daily precipitation will fall under this value. Above this value represents the top 1% in daily amounts. Extreme precipitation can increase the risk of flooding, which can directly affect people's health and safety. Extreme precipitation can also increase the amount of stormwater runoff that enters waterways, especially in urban areas, which may in turn affect the health of aquatic systems. Changes in extreme precipitation affect agriculture, infrastructure, people's health, water availability, recreation, and ecosystem health.
	Maximum Consecutive Wet Days	days/ year	The maximum number of consecutive days when precipitation was greater than 0.2 mm (or > 0.2)	func=atmos.maximum_consecutive_wet_days, invars=dict(pr="pr"), args=dict(-thresh="1 mm/day",freq="YS"))	Maximum consecutive wet days describes the maximum length of multi-day precipitation. Prolonged precipitation can increase the risk of flooding, which can directly affect people's health and safety. Prolonged precipitation can also increase the amount of stormwater runoff that enters waterways, especially in urban areas, which may in turn affect the health of aquatic systems. Changes in precipitation pattern affect agriculture, infrastructure, people's health, water availability, recreation, and ecosystem health.

Climate Parameter	Climate Variable	Unit	Description	Calculation	Why this Variable is Important
Dry Days	Annual Total Dry Days	days/ year	The number of days in a year when precipitation was less than 0.2 mm (or < 0.2)	func=atmos.dry_days, invars=-dict(pr="pr"), args=dict(thresh="0.2 mm/ day",freq="YS")	Annual total dry days characterizes the total number of days with virtually no precipitation in a year and is an indicator of drought risk. Changes in the number of dry days affect agriculture, infrastructure, people's health, water availability, recreation, and ecosystem health.
	Maximum Consecutive Dry Days	days/ year	The maximum number of consecutive days when precipitation was less than 0.2 mm (or < 0.2)	func=atmos.maximum_consecutive_dry_ days, invars=dict(pr="pr"), args=dict(-thresh="0.2 mm/day",freq="YS")	Maximum consecutive dry days describes the maximum length of a dry period that can extend over multiple days. Prolonged dry spells can affect agriculture, infrastructure, people's health, water availability, recreation, and ecosystem health.
Frost-free Season	Frost-free Season Start Date (Last Spring Frost)	date	The last date in a year when daily minimum temperature stays above 0°C after 5 consecutive days (before July 15)	dict(func=atmos.last_spring_frost, in-vars=dict(tasmin="tasmin"), args=dict(-thresh="0 degC",op='<',window=5, fre-q="YS",before_date='07-15')	Frost-free season start date marks the transition from colder to warmer weather and is an indicator of the start of the growing season. Changes in the length and timing of the growing season affect agriculture, energy use, recreation, and ecosystem health.
	Frost-free Season End Date (First Fall Frost)	date	The first date in a year when daily minimum temperature falls below 0˚C after 5 consecutive days (after July 15)	func=atmos.first_day_tn_below, in-vars=dict(tasmin="tasmin"), args=dict(-thresh="0 degC",op='<',window=5, fre-q="YS",after_date='07-15')	Frost-free season end date marks the transition from warmer to colder weather and is an indicator of the end of the growing season. Changes in the length and timing of the growing season affect agriculture, energy use, recreation, and ecosystem health.
	Frost-free Season Length	days/ year	The number of days in a year between the start of the frost-free season (when daily minimum temperature stays above 0°C after 5 consecutive days before July 15) and end of the frost-free season (when daily minimum temperature falls below 0˚C after 5 consecutive days after July 15)	dict(func=atmos.frost_free_season_ length, invars=dict(tasmin="tasmin"), args=dict(thresh="0 degC",op='>',win-dow=5, freq="YS",mid_date='07-15')	Frost-free season length describes the period in a year that is characterized by warmer weather. It is an indicator of the length of the growing season. Changes in the length and timing of the growing season affect agriculture, energy use, recreation, and ecosystem health.
Agricultural Variables	Corn Heat Units (CHUs)	degree days	Corn heat units (CHU) provides an index of the amount of heat available for the growth of corn with daily maximum temperature above 10˚C and nighttime temperature above 4.4˚C. Generally, at least 2200 CHUs are required to grow corn	func=atmos.corn_heat_units, invars=-dict(tasmin="tasmin", tasmax="tasmax"), args=dict(thresh_tasmin="4.4 degC", thresh_tasmax="10 degC")	Corn heat units (CHU) is a temperature-based index often used by farmers and agricultural researchers to estimate whether the climate is warm enough (but not too hot) to grow corn. Corn typically requires a daily maximum temperature of 10˚C, and daily minimum (or nighttime) temperature of 4.4˚C to grow.
	Growing Degree Days (Base 0°C)	degree days	Growing degree days (GDDs) provides an index of the amount of heat available for the growth and development of plants and insects. Different base temperatures (0, 4, 5, 10, 15°C) are used to capture results for organisms that demand different amounts of heat	func=atmos.growing_degree_days, in-vars=dict(tas="tg"), args=dict(thresh="0 degC",freq="YS"	Growing degree days (GDDs) accumulate whenever the daily mean temperature is above a specified threshold temperature. Generally, GDDs with a base temperature of 0°C supports the growth of winter wheat.

Climate Parameter	Climate Variable	Unit	Description	Calculation	Why this Variable is Important
	Canola Growing Degree Days (Base 4°C)	degree days		func=atmos.growing_degree_days, invars=dict(tas="tg"), args=dict(thresh="4 degC",freq="YS"	Growing degree days (GDDs) accumulate whenever the daily mean temperature is above a specified threshold temperature. Generally, GDDs with a base temperature of 4°C supports the growth of canola.
	Forage Crops Growing Degree Days (Base 5°C)	degree days		func=atmos.growing_degree_days, invars=dict(tas="tg"), args=dict(thresh="5 degC",freq="YS"	Growing degree days (GDDs) accumulate whenever the daily mean temperature is above a specified threshold temperature. Generally, GDDs with a base temperature of 5°C supports the growth of forage crops.
	Corn and Bean Growing Degree Days (Base 10°C)	degree days		func=atmos.growing_degree_days, invars=dict(tas="tg"), args=dict(thresh="10 degC",freq="YS"	Growing degree days (GDDs) accumulate whenever the daily mean temperature is above a specified threshold temperature. Generally, GDDs with a base temperature of 10°C supports the growth of corn and beans.
	Growing Degree Days - Risk of Presence of Pests (Base 15°C)	degree days		func=atmos.growing_degree_days, invars=dict(tas="tg"), args=dict(thresh="15 degC",freq="YS"	Growing degree days (GDDs) accumulate whenever the daily mean temperature is above a specified threshold temperature. Generally, GDDs with a base temperature of 15°C supports the growth and development of insects and pests.
Freeze-Thaw and Freezing Rain Potential	Freeze-thaw Cycles	cycles/year	A simple count of the number of days when temperature fluctuates between freezing and non-freezing temperatures - when daily minimum temperature is equal to or below -1°C and maximum temperature is above 0°C. Under these conditions, it is likely that some water at the surface was both liquid and ice at some point during the 24-hour period	func=atmos.daily_freezethaw_cycles, invars=dict(tasmin="tasmin", tasmax="tasmax"), args=dict(thresh_tasmin="-1 degC", thresh_tasmax="0 degC", freq="YS")	Freeze-thaw cycles can have major impacts on infrastructure. Water expands when it freezes, so the freezing, melting and re-freezing of water can cause significant damage to roadways, sidewalks, and other outdoor structures over time. Potholes that form during the spring or during mid-winter melt are good examples of the damage caused by this process.
	Freezing Rain Potential	days/year	The number of days in a year when daily minimum temperature is greater than -2˚C and daily maximum temperature is below 2˚C	func=atmos.daily_freezethaw_cycles, invars=dict(tasmin="tasmax", tasmax="tasmin"), args=dict(thresh_tasmin="2 degC", thresh_tasmax="-2 degC", freq="YS")	Freezing rain can create slippery road conditions that endanger people's health and safety. Changes in freezing rain pattern also affect infrastructure, recreation, and ecosystem health.

Appendix C: Relevant data sources

The following presents a description of some key publicly available and TRCA-owned data sources that may help inform the City's climate risk and vulnerability assessment and other adaptation planning work.

TRCA data related to natural systems, features, and areas

Name	Description	Open Data
TRCA's Updated Natural Heritage System (2022)	TRCA updated 2007 Terrestrial Natural Heritage System (TNHS) in 2022 using updated data and integrated approach to delineate TRCA's regional target NHS. TRCA's regional target NHS identifies Existing Natural Cover, Potential Natural Cover, and Contributing Areas that can inform strategic protection, enhancements, restoration, and green infrastructure implementation across the landscape. More than 30 aquatic and terrestrial ecology-based criteria representing natural heritage features and areas were used to identify TRCA's updated regional target NHS. For more information, visit: https://trca.ca/conservation/terrestrial-ecosystems/natural-heritage-system/	No – Available upon request
Natural Heritage Features-related Data		
Wetlands and coastal wetlands	As part of the NHS update, TRCA updated and completed QA/QC to develop this data by consolidating the following existing data layers: • Wetland vegetation communities derived from TRCA Ecological Land Classification (ELC) data (field collected) • MNRF wetlands (Provincially and Locally Significant, and Unevaluated Wetlands) • Natural cover data (orthophoto interpreted) • Other relevant data sources	No – Available upon request
Fish habitat	Existing TRCA mapped watercourses with a 10-m buffer are assumed to be important for fish habitat in NHS delineation. TRCA also modelled habitat suitability for four groups of fishes that provides high level information on stream reach quality.	No – Available upon request
Woodlands	As part of the NHS update, TRCA did not define significant woodlands. TRCA used orthophoto interpreted Natural Cover (2017) and field collected ELC Vegetation Communities to inform this component.	No – Available upon request
Valleylands	As part of the NHS update, TRCA did not define significant valleylands. TRCA used TRCA Crest of Slope data from the Generic Regulation Criteria layers to inform this component.	No – Available upon request

Name	Description	Open Data
Habitat and Endangered and Threatened Species	This is MNRF data and should be obtained from them directly.	No – Please request from MNRF
Wildlife Habitat	TRCA undertook a comprehensive and regional scale Significant Wildlife Habitat mapping exercise based on existing data for its entire jurisdiction. Criteria to identify SWH provided by MNRF include four broad categories that consider areas supporting: seasonal concentration areas of animals, rare vegetation communities or specialized habitat for wildlife, habitats for species of conservation concern, and animal movement corridors. Previously, as part of the NHS update, TRCA did not define significant wildlife habitat. TRCA used orthophoto interpreted Natural Cover (2017) and field collected Flora, Fauna, and ELC Vegetation Communities data to inform this component of NHS. For the City of Toronto, wildlife habitat includes Toronto Environmentally Significant Areas (ESA). In addition, modelled habitat connectivity, habitat suitability, and climate vulnerability data also informed this component.	No – Available upon request
Areas of Natural and Scientific Interest (ANSIs)	As part of the NHS update, this was identified using MNRF data layers.	Yes through Ontario GeoHub – Areas of Natural and Scientific Interest (ANSI)
Natural Heritage Features-related Data		
Natural Cover (2017)	Delineated using 2017 orthophoto interpretation that classified existing natural cover into broad 5 classes of forests, wetlands, successional forest, meadow, and beach/bluff. Also includes 18 land use classes: high density residential, medium density residential, estate residential, rural residential, cemetery, golf course, agriculture, commercial, industrial, institutional, recreational/open space, mixed commercial entertainment, airport, roads, railway, vacant lands, aggregate extraction, and landfill.	Yes – TRCA Landuse NaturalCover 2017

Name	Description	Open Data
Natural Cover Quality (Landscape Analysis Model)	The Landscape Analysis Model (LAM) was run using natural cover data from multiple conservation authorities to determine habitat quality within the Region of Durham for the Natural Systems – Climate Change Vulnerability Assessment (CCVA). LAM ranks habitat patch quality based on a scoring and ranking system that classifies patches from "poor" to "excellent" quality based on their size, shape, and matrix influence.	No – Available upon request
Fauna, Flora, ELC Vegetation Communities Diversity (alpha and beta)	TRCA's field collected regional inventory data on bird species, plant species, and vegetation community types was used to calculate alpha and beta diversity. Data points collected between 2007 and 2017 were used to assess species richness (alpha diversity) and species turnover (beta diversity). The raw data was analyzed to calculate six data layers representing species richness and species turnover of birds, plants, and ELC vegetation community types.	No – Available upon request
Terrestrial Fauna – L1-L4 Species of Conservation Concern	TRCA species inventory points of fauna and flora (L1-L4 rank) (last 10 years for fauna, last 15 years). For more information, visit: https://trca.ca/conservation/terrestrial-ecosystems/ranks-and-scores/	No – Available upon request
Terrestrial Flora – L1-L4 Species of Conservation Concern	TRCA species inventory points of fauna and flora (L1-L4 rank) (last 10 years for fauna, last 15 years). For more information, visit: https://trca.ca/conservation/terrestrial-ecosystems/ranks-and-scores/	No – Available upon request
ELC Vegetation Communities – L1-L4 Vegetation Communities of Conservation Concern	Ecological Land Classification (ELC) vegetation community scores (L1-L4). For more information, visit: https://trca.ca/conservation/terrestrial-ecosystems/ranks-and-scores/	No – Available upon request
Habitat Connectivity Priorities	Regional and local level priorities for habitat connectivity were identified during the development of TRCA's Crossings Guideline for Valley and Stream Corridors (2015). This includes: • Priority areas for regional connectivity among high quality habitat patches to ensure that regional linkages for wildlife movement across high quality patches are protected/mitigated. This was done using TRCA's natural cover data and Circuitscape model software. • Priority areas for regional connectivity for specific wildlife movement groups to ensure that linkages required for these groups are protected/mitigated over long term. • Priority areas for local connectivity among species requiring movement between wetland and forest and between forests to ensure that local linkages for species movement across these patches are protected/mitigated.	No – Available upon request
Habitat Suitability Priorities	Habitat suitability mapping was developed using the following approach: • Identifying habitat needs of multiple bird and amphibian groups according to scientific literature and TRCA field data. • Mapping the predicted habitat suitability of each group across the landscape using spatial and statistical modelling with existing data layers (field data on birds, amphibians, fish, land cover and land use data, urban tree canopy data) • Identifying a gradation of high to low functioning habitat areas across the landscape that support multiple wildlife groups, beyond existing natural cover and including built-up areas.	No – Available upon request
Climate Vulnerabilities	These data layers will be identified based on the approach developed by TRCA for terrestrial ecosystem climate change vulnerability assessments, which involves mapping and ranking five key indicators: • Ground surface temperature • Climate sensitivity of native vegetation • Habitat patch score • Soil drainage rating • Wetland hydrological stability	No – Available upon request
Watershed Boundary	Identifies the TRCA watershed boundaries derived from Digital Elevation Model (DEM).	Yes – TRCA Watersheds DEM
Subwatershed Boundary	Identifies the subwatersheds for TRCA jurisdiction. Subwatershed boundaries for the TRCA watershed are created from a Digital Elevation Model (2002) and ArcHydro.	Yes – Subwatersheds TRCA

Name	Description	Open Data
TCRA Water Resource System (WRS)	A Water Resource System (WRS) is a system of groundwater features and areas and surface water features, and their hydrologic functions. Hydrologic functions are the natural processes that provide the water needed to sustain healthy aquatic and terrestrial ecosystems and drinking water for humans. Both water quantity and water quality are important to the WRS. The Toronto and Region Conservation Authority (TRCA) has mapped the WRS components across its jurisdiction, which supports the Natural Heritage System (NHS). The WRS system includes: 1. Four Key Hydrologic Features (KHFs): • Lakes are bodies of water, such as Lake Ontarion or inland lakes, like Bond Lake in Richmond Hill. • Wetlands are areas that are covered by shallow water seasonally or permanently. The four major types of wetlands in Ontario include marshes, swamps, bogs, and fens. By retaining water and releasing it slowly, wetlands provide many benefits to people and nature, such as helping to improve water quality and reducing flooding. Given their transient characteristics between land and water, they are considered components of both NHS and WRS. • Permanent streams, or perennial streams, flow year-round because of groundwater flow. • Intermittent streams are small streams that may dry up at certain times of the year, such as during the summer. • Seepage areas and springs are areas where cold, clean groundwater is bubbling up to the surface, as groundwater discharge. This water is usually high quality and important for certain fish communities. 2. Four Key Hydrologic Areas (KHAs): • Water that seeps into the ground can provide an important source of water (groundwater discharge) to aquifers, streams, and wetlands, and is known as groundwater recharge. • Where rates of recharge are relatively high and are connected to drinking water sources, these areas are called Significant Groundwater Recharge Areas (SGRAs). • Where recharge areas are important to maintaining ecosystem functions of streams and wetlands, these areas are called Ecologically For more information, visit: https://trca.ca/conservation/aquatic-ecosystems/water-resource-system/	Yes – TRCA Water Resource System

Name	Description	Open Data
Riparian Buffer	Identifies the 30-m riparian buffer by including estimated stream width from field observations associated with a stream order and then averaged among the same stream orders within a watershed. Stream order was based on Strahler order, which is a hierarchical system with stream order 1 as the headwaters and the highest order as the main stem. The stream network was reconstructed accounting for these estimated stream widths using the stream order.	No – Available upon request
Water Quality	Water Quality Data from monthly grab samples collected across the TRCA's jurisdiction. Samples are collected monthly following the Provincial Water Quality Monitoring Network (PWQMN) protocol and are analyzed at various private and partner laboratories. Parameters include nutrients, general chemistry, and selected metals.	Yes – Regional Watershed Monitoring Program Water Quality Data
Regional Watershed Monitoring Program (RWMP) - Fish Data	Fish Community records from sites sampled throughout nine watersheds in TRCA'S jurisdiction. Data is from TRCA's Regional Watershed Monitoring Program and Fisheries Assessments and other aquatic project monitoring activities. Sampling methods may vary between programs/projects. Data includes species names, number of individuals found and total weights. SAR Data has been removed from the dataset.	Yes – Regional Watershed Monitoring Program Fish Community Data
Regional Watershed Monitoring Program (RWMP) - Benthic Data (2013-2021)	The data contained in the dataset were collected from 2013 - 2021 following The Ontario Benthos Biomonitoring Network (OBBN) standard sampling protocols. The dataset contains the necessary information for the calculations of biological metrics to assess stream health (not included; to be calculated at the discretion of dataset user).	Yes – Regional Watershed Monitoring Program Benthic Macroinvertebrate Data, 2013-2021
Aquatic In-stream Barriers	Locations of aquatic barriers that have been identified across TRCA's jurisdictions. Many of these have been assessed for their passability to help prioritize their removal to restore in-stream habitat connectivity.	No – Available upon request
TRCA Stream Climate Vulnerability Assessment (2020)	A geospatial analysis was conducted by TRCA to assess potential changes to in-stream thermal regimes under different climate change and land use scenarios. The assessment also investigated the potential vulnerabilities of cold, cool, and warm water fish communities. Over one thousand Reach Contributing Areas (or reach-based catchments) were assessed and prioritized RCAs at the most risk of disappearing in the future. The outputs of this assessment have helped to inform watershed and sub-watershed planning, natural heritage system planning, and restoration planning.	No – Available upon request

Name	Description	Open Data
Nature-Based Climate Solutions Siting Tool (2024)	The Nature-based Climate Solutions Siting Tool is a high-level screening tool that can help identify strategic locations to focus efforts to protect, restore, and enhance natural features and areas within TRCA's jurisdiction at a 1-ha resolution. This tool brings together a wide range of ecological and socio-economic considerations to prioritize areas that offer the greatest benefits to people, plants, and animals. For more information, visit: https://trca.ca/nature-based-climate-solutions-siting-tool/	No – Available upon request
Carruthers Creek Watershed Plan Layers	Various layers that were developed as part of the Carruthers Creek Watershed Plan are available through TRCA's Open Data Portal, including: • Wetlands • Watercourse • Inland Lakes • Road Priorities • Aquatic Monitoring • Priority Neighborhoods • Wetland Priorities • Groundwater Monitoring • Existing 2015 Land Use • Highly Vulnerable Aquifers • Land Use Scenario 1 • Land Use Scenario 2 • Priority Securement Areas • Carruthers Creek Watershed Boundary • Parks in Priority Neighbourhoods • Forest-to-Forest Connectivity Priorities • Forest-to-Wetland Connectivity Priorities • Restoration Opportunity Priority Areas • Priority Ecological Connectivity Areas • Erosion Priority Restoration Sites • Priority Hydrological Crossings Improvement Areas For more information, visit: https://trca.ca/conservation/watershed-management/carruthers-creek/watershed-plan/	Yes – Search: CCWP

Name	Description	Open Data
Etobicoke Creek Watershed Plan Layers	Various layers that were developed as part of the Etobicoke Creek Watershed Plan are available through TRCA's Open Data Portal, including: • Monitoring Stations • Baseflow • Riparian Buffer • Riparian Cover • Brampton Esker • Aquatic Barriers • Priority Barriers • 2002 Land Use • 2012 Land Use • 2019 Land Use • Natural Cover • Regional Connectivity • Fluvial Geomorphologic Reaches • Seepage Areas and Springs • Flood Vulnerable Clusters • Highly Vulnerable Aquifers • Percent Impervious Cover • Directly Connected Impervious Area • Local Connectivity – Forest-to-Forest • Local Connectivity – Forest-to-Wetland • Permanent and Intermittent Streams • Aquatic Stream Connectivity • Canopy Cover Characterization • Watercourse • Waterbodies • Wetlands • Future Management Land Use Scenarios • LD Water Quality Station • Subwatershed Boundary • Water Quality Modelling Subcatchments • Surface Water Contributing Areas • Significant Groundwater Recharge Areas • Watershed Catchments • Watershed-refined Natural Heritage System	Yes – Search: ECWP

Name	Description	Open Data
	• Headwater Drainage Features • Current Water Quality Conditions Stations • Ecologically Significant Groundwater Recharge Areas • Regional Connectivity with top 50% data • Fluvial Sites where TOE was evaluated • Fluvial Sites where CEW was evaluated • CEW and TOE Differential Values • Inflow locations to Flood Vulnerable Clusters • Priority Road Crossings • Top Tree Planting Priorities • 10-year Plan for Locations of Natural Channel Works in Peel (Brampton) For more information, visit: https://trca.ca/conservation/watershed-management/etobicoke-creek-watershed-plan/	
Humber River Watershed Plan Layers	Various layers that were developed as part of the Humber River Watershed Plan are available through TRCA's Open Data Portal, including: • Wetlands • Waterbodies • 2002 Land Use • 2012 Land Use • 2020 Land Use • In-stream Barriers • Natural Cover • Fluvial Monitoring Sites • Percent Canopy Cover • Seepage Areas and Springs • Headwater Drainage Features • Permanent and Intermittent Streams • Highly Vulnerable Aquifers • Landscape Analysis Model • Flood Vulnerable Areas • Woodbridge Flood Vulnerable Area • Flood Vulnerable Areas Excluding Woodbridge • Rapids Clubtail Contributing Habitat • Rapids Clubtail Occupied Habitat • Groundwater Recharge Areas • Local Connectivity – Forest-to-Wetland	Yes – Search: HRWP

Name	Description	Open Data
	• Density of Erosion Control Structures • Percent Impervious Cover • Ecologically Significant Groundwater Recharge Areas • Long-term Water Quality Stations • Fluvial Sites with Monitoring Results • Percent Canopy Cover by Subwatershed • Integrated Restoration Prioritization Scores • Percent Impervious Cover Reach Contributing Area • Regional Connectivity with top 50% • Active Groundwater Sourced Permits to Take Water • TRCA-owned or Managed Erosion Control Structures • Terrestrial Areas Highly Vulnerable to Potential Climate Impacts • Fluvial Geomorphic Reaches with Erosion Stability • Average Family Biotic Index (FBI) Ratings for Benthic Invertebrates • Mean Index of Biotic Integrity (BI) Health Ratings for Fish Communities • Natural Heritage System Comparison • Average Annual Streamflow Associated with Stream Gauges For more information, visit: https://trca.ca/conservation/watershed-management/humber-river-watershed-plan/	

TRCA data related to natural hazards

Name	Description	Open Data
Regulation Mapping	Mapping that shows TRCA Regulated Area across its jurisdiction. This mapping is updated annually. For more information, visit: https://trca.ca/regulation-mapping-update/	Yes – Regulatory Area Search Tool
Flood Plain Mapping	Identifies the location of the regulatory flood plain in the watershed. These are the areas on normally dry land that may be covered by water during flood events. Defines the flooding hazard limit to help with the implementation of land use planning policies for managing flood risk. Helps to characterize and understand flood risk and inform emergency management.	Yes – Polygon and Floodline
Flood Vulnerable Clusters	Areas identified as vulnerable to riverine flooding. For more information, visit: https://trcaca.s3.ca-central-1.amazonaws.com/app/uploads/2021/04/13132621/TRCA-FloodRiskAssessment_forweb-updated04_13_2021.pdf	No – Available upon request
Hydrometric Flow Station Data	TRCA operates a network of flood monitoring gauges which continually monitor precipitation and water levels at TRCA's dams and river stations.	Yes – Data Explorer
Flood Warning Records	TRCA provides local agencies and the public with notice, information, and advice so that they can respond during severe rainfall events with the potential for flooding, and during flood-related emergencies. For more information, visit: https://trca.ca/conservation/flood-risk-management/flood-forecasting-warning/	No – Available upon request
Characterization Reports of Select Past Flood Events	Characterization reports may be available for select past flood events.	No – Available upon request
Riverine Erosion	TRCA has erosion control site locations that are based on existing funding programs and not recommended for use. More comprehensive erosion hazard mapping is currently being developed by our Erosion Risk Management team.	No – TBD

Other TRCA data

Name	Description	Open Data
TRCA Impervious Cover (2017)	Using the existing 2017 Landuse layer, TIMP values are associated to each land use category and an impervious value table is created.	Yes – TRCA Impervious Landuse 2017
Ground Surface Temperature (2020)	Ground surface temperature prepared for TRCA by Toronto Metropolitan University (TMU) Geographic Analysis student group during Fall 2022. Two July 2, 2020 Landsat 8 images covering TRCA's jurisdiction were used to create this raster.	Yes – Average Surface Temperature 2020
Ground Surface Temperature (2014)	Average ground surface temperature from June 18, 2014 Landsat 8 images prepared for TRCA by Toronto Metropolitan University.	Yes – Average Surface Temperature 2014
STEP Green Infrastructure Map	STEP offers a Green Infrastructure Map that highlights Green Infrastructure projects in and around the GTA, but this may not be comprehensive.	Yes – Green Infrastructure Map
TRCA's Watershed and Ecosystems Reporting Hub	The Reporting Hub enables users to interactively explore information about watersheds and the waterfront in the Toronto region. The Hub identifies current conditions by theme and explains the importance of different environmental indicators for understanding watershed and ecosystem health. It illustrates how conditions are changing over time and provides insights into TRCA's progress and how this relates to our goals.	Yes – Watershed and Ecosystems Reporting Hub
TRCA West Nile Virus Risk Assessment	In 2003, Toronto and Region Conservation Authority (TRCA) initiated the West Nile Virus Surveillance and Monitoring Program as a measure of due diligence and in cooperation with our Regional Public Health partners in Durham, Peel, York and the City of Toronto. Monitoring reports are available online. For more information, visit: https://trca.ca/conservation/aquatic-ecosystems/west-nile-virus/	Yes – Monitoring Reports

Other datasets that may be of interest

Name	Description	Open Data
Ontario Marginalization Index (2021)	ON-Marg 2021 was developed jointly by researchers in the MAP Centre for Urban Health Solutions at St. Michael's Hospital (Unity Health Toronto) and Public Health Ontario using 2021 Census data. It captures 4 dimensions of deprivation: • Households and dwellings • Material resources • Age and labour force • Racialized and newcomer populations Data is available for Toronto neighbourhoods. For more information, visit: https://www.publichealthontario.ca/en/Data-and-Analysis/Health-Equity/Ontario-Marginalization-Index	Yes through Ontario Community Health Profiles Partnership (OCHPP) – Data – Neighbourhoods in City of Toronto
Adult Health and Disease and Other Health-related Data	Adult health and disease (e.g., diabetes, asthma, high blood pressure, mental health and addiction-related visits, chronic obstructive pulmonary disease, congestive heart failure, etc.) and other health-related data are available through Ontario Community Health Profiles Partnership (OCHPP).	Yes through Ontario Community Health Profiles Partnership (OCHPP) – Data – Neighbourhoods in City of Toronto
Climate Atlas of Canada	The Climate Atlas of Canada is part of a national suite of climate data portals. It combines climate science, mapping, and storytelling together with Indigenous Knowledges and community-based research and video to inspire awareness and action.	Yes – Climate Atlas of Canada
ClimateData.ca	ClimateData.ca is part of a national suite of climate data portals. It provides up to date climate data in easy-to-use formats and visualizations.	Yes – ClimateData.ca
Ontario Provincial Climate Change Impact Assessment	In 2020, Ontario launched its first-ever climate change impact assessment to help government and public and private institutions better understand where and how climate change is likely to affect communities, critical infrastructure, economies and the natural environment so we can make more informed decisions on planning and investments to keep our communities healthy and safe. For more information, visit: https://www.ontario.ca/page/ontario-provincial-climate-change-impact-assessment	Yes – Report and Appendices
Financial Accountability Office of Ontario's Costing Climate Change Impacts to Public Infrastructure Project	This project analyzes the costs that climate change impacts could impose on Ontario's provincial and municipal infrastructure, and how those costs could impact the long-term budget outlook of the province. For more information, visit: https://www.fao-on.org/en/cipi	Yes – Reports and Climate Change Data Spreadsheet

ame	Description	Open Data
nadian mate Indices	Projections are available for Core climate extreme indices (Climdex) variables and agroclimatic indices. For more information about Climdex, visit: https://climate-scenarios.canada.ca/?page=climdex-indices For more information about agroclimatic indices, visit: https://climate-scenarios.canada.ca/?page=downscaled-indices-definition	Yes – Download Page
k University's tario Climate ta Portal CDP)	Developed by the Climate Change and Climate Impacts Research Group at York University. It provides high-resolution climate data, maps, figures, and reports. For more information, visit: https://lamps.math.yorku.ca/OntarioClimate/	Yes – Ontario Climate Data Portal (OCDP)
aptWest rrent and jected mate Data for rth America	Gridded current and projected climate data for North America at 1-km resolution is available through AdaptWest – a climate adaptation conservation planning database for North America. For more information, visit: https://adaptwest.databasin.org/pages/adaptwest-climatena/	Yes – Current and projected climate data for North America (CMIP6 scenarios generated using ClimateNA v7.3)
rldClim	WorldClim is a database of high spatial resolution global weather and climate data, ranging from ~18 to 1-km resolution. This data can be used for mapping and spatial modeling. For more information, visit: https://www.worldclim.org/data/index.html	Yes – WorldClim
-CORDEX	The NA-CORDEX data archive contains output from regional climate models (RCMs) run over a domain covering most of North America. Currently dynamically downscaled climate projections under RCP climate scenarios are available. For more information, visit: https://na-cordex.org/	Yes – NA-CORDEX
tario Ministry nsportation's Curve okup Tool	IDF Curve Lookup is a web-based application provided by the Ontario Ministry of Transportation (MTO) for the purpose of retrieving Intensity-Duration-Frequency (IDF) curves. The time trend analysis was done using observations from 1960 to 2014. A linear trend was observed and extrapolated from this period to 2060. Significantly less sources were available for data after 2010, so 2010 is the reference year used in this tool. IDF curve projections are extrapolated from the 2010 base year. For more information, visit: https://www.eng.uwaterloo.ca/~dprincz/mto_site/terms.shtml	Yes – IDF Curve Lookup Tool

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