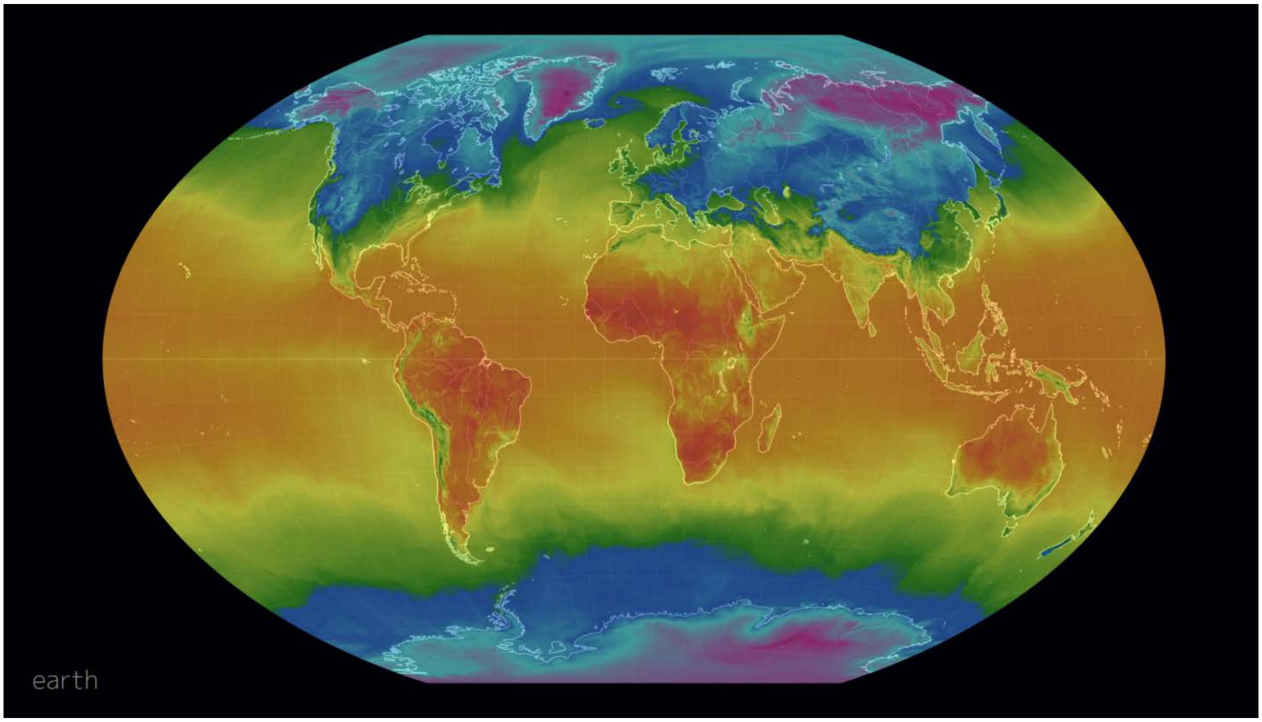

NVCA Climate Change Strategy and Action Plan 2016-2018

Milestone 2 — Research

December 16, 2016

Nottawasaga Valley
Conservation Authority

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Cover Image: Earth Surface Temperatures on November 30, 2016, from earth: a visualization of global weather conditions (earth.nullschool.net)

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Introduction

As projected, the local impacts of global climate change are becoming more prevalent. Climate data observations within the Nottawasaga Valley watershed confirm that temperatures have been climbing steadily, particularly in winter months, and annual precipitation has been increasing. Recent extreme weather events such as flash flooding, heat waves, drought, and tornadoes illustrate the extent to which weather can impact daily life. They also emphasize the need to be prepared for changing weather regimes where such events are expected to become more commonplace.

The intention of this report is to provide a basic overview of climatic changes projected to occur in the Nottawasaga Valley from present until the turn of the century. Projected temperature and precipitation changes are emphasized, while attention is also provided to increasing stream temperatures, and extreme rainfall intensity, duration and frequency. These changes can be expected to have wide ranging impacts for the people and ecology of the Nottawasaga Valley.

This report presents efforts taken on behalf of the Nottawasaga Valley Conservation Authority (NVCA) to fulfill Milestone 2 of its ***Climate Change Strategy and Action Plan: Initiate Research on Climatic Changes.*** It will be used as a resource to guide future research, actions and measures to be taken in mitigating and adapting to climate change.

Background

The climate projection data used in this report comes primarily from emissions scenarios and climate models included in Intergovernmental Panel on Climate Change (IPCC) Assessment Reports 4 and 5 (AR4 & AR5). The most current AR5 projections were used to present changes that are projected for Canada and the province of Ontario. Examining climate change specifically within the Nottawasaga Valley required climate model data that had been downscaled – a process of using global data to make projections on a local scale. Downscaled AR5 climate model data was not available at the time this report was written, so AR4 climate model data was used in its place.

Almost all climate change data included in this report was gathered from Environment Canada's Canadian Climate Data and Scenarios website (2016). The intensity duration frequency (IDF) curve information and charts were gathered from the Computerized Tool for the Development of Intensity-Duration-Frequency Curves under Climate Change website (2016).

Before examining expected climatic changes in the Nottawasaga Valley, one should be aware of the uncertainty inherent with the exercise of developing a climate change model scenario. Atmospheric composition, specifically regarding greenhouse gases (GHG), plays a significant role in climate modelling. Future GHG concentrations will depend heavily on whether society, on a global scale, continues to increase emissions or whether efforts to mitigate those emissions will be successful. Emission scenarios reflecting a range of plausible future concentrations are used in climate modelling to include this uncertainty into the process – each based on a range of assumptions regarding future emissions levels.

Aside from GHG concentrations, the response of Earth's climate to those concentrations must also be simulated. Climate models – specifically general circulation models (GCMs) – are the most advanced tools available for predicting the response of Earth's climate to the complex interactions taking place between increasing GHG concentrations and our oceans, atmosphere, glaciers and land surfaces. It is common practice in climate modelling to take into consideration the average of many climate models in preference to relying on any one particular model as it is assumed that the average will possess a smaller degree of error (IPCC, 2007). In the case of national and provincial climate projections, the range of scenarios provided in the AR5 series of models was considered. Where an ensemble approach was not available the CGCM3T47 model, created by the Canadian Centre for Climate Modelling and Analysis, and the NCARPCM, created by the National Center for Atmospheric Research, were used as they have been used extensively in IPCC climate modelling studies.

Emissions Scenarios

As mentioned, central to the process of modelling future climate change is developing a range of plausible futures regarding the level of anthropogenic GHG emissions. These futures provide a qualitative description of how human demographic, technological and socio-economic systems may develop in the future and attempt to provide a plausible quantification of the GHG emissions that might result from such developments. GHGs are a significant driving force of how Earth's climate will change in the future.

Both the AR4 and AR5 climate models use a variety of emissions scenarios including:

- scenarios with an early peak in GHG emissions followed by a decline thereafter;
- stabilizing scenarios where emissions are assumed to stay relatively close to present-day levels; and
- scenarios where emissions levels continue to climb as they have in the past.

More information is available regarding the AR5 emissions scenarios through the *Towards New Scenarios for Analysis of Emissions, Climate Change, Impacts and Response Strategies*, *IPCC Expert Meeting Report (2007).* Information on the AR4 emissions scenarios is available through the *IPCC Special Report: Emissions Scenarios* (2000).

Temperature Change

Canada

Like much of the Northern Hemisphere, Canada as a nation has warmed faster than the global average — about 1.5°C over the last 60 years (Government of Canada, 2014). The tables below show the median of projections aggregated from the AR5 climate models and illustrate the temperature change expected on a national level from the average temperature of the baseline years (1986 to 2005) extending outward as far as the years 2081-2100.

One table is presented for each Representative Concentration Pathway (RCP) included in the AR5 climate modelling process. RCP 2.6 assumes that global GHG concentrations will peak before 2020 and substantially decline thereafter. RCP 4.5 assumes GHG concentrations will not peak until the 2040s, but will then decline and RCP 8.5 assumes that GHG concentrations will continue to rise throughout the 21st century (Meinshausen, et al., 2011).

The information was gathered from the Environment Canada's Canadian Climate Data and Scenarios web site. Temperature values are displayed in degrees Celsius of change from the baseline. Negative values are displayed in brackets.

Table 1: Seasonal and annual change in temperature based on RCP 2.6 nationwide (°C)

RCP 2.6 National	2020s Median	2020s Range	2050s Median	2050s Range	2080s Median	2080s Range
Spring	1.2	0.8 – 1.6	1.6	1.1 – 2.3	1.5	1.0 – 2.3
Summer	1.0	0.7 – 1.5	1.5	0.9 – 2.0	1.4	0.8 – 2.0
Autumn	1.3	1.0 – 2.0	1.8	1.5 – 3.0	1.8	1.3 – 3.0
Winter	1.4	0.9 – 2.1	2.2	1.6 – 3.1	2.4	1.5 – 3.4
Annual	**1.2**	**0.9 – 1.7**	**1.8**	**1.3 – 2.5**	**1.8**	**1.1 – 2.5**

Table 2: Seasonal and annual change in temperature based on RCP 4.5 nationwide (˚C)

RCP 4.5 National	2020s Median	2020s Range	2050s Median	2050s Range	2080s Median	2080s Range
Spring	1.1	0.7 – 1.7	2.1	1.7 – 3.0	2.8	2.1 – 4.0
Summer	1.1	0.7 – 1.4	2.0	1.4 – 2.6	2.6	1.7 – 3.4
Autumn	1.3	1.0 – 2.0	2.5	2.3 – 3.7	3.1	2.9 – 4.8
Winter	1.5	1.0 – 2.2	3.2	2.5 – 4.3	4.2	3.2 – 5.7
Annual	**1.2**	**0.9 – 1.7**	**2.4**	**2.0 – 3.2**	**3.2**	**2.5 – 4.2**

Table 3: Seasonal and annual change in temperature based on RCP 8.5 nationwide (°C)

RCP 8.5 National	2020s Median	2020s Range	2050s Median	2050s Range	2080s Median	2080s Range
Spring	1.3	0.9 – 1.9	2.9	2.5 – 3.9	5.4	4.8 – 7.1
Summer	1.2	0.9 – 1.6	2.9	2.2 – 3.6	5.4	4.2 – 6.6
Autumn	1.5	1.3 – 2.2	3.6	3.4 – 5.0	6.1	6.0 – 8.6
Winter	1.8	1.2 – 2.4	4.4	3.7 – 5.7	8.2	7.2 – 10.8
Annual	**1.4**	**1.1 – 1.9**	**3.5**	**3.0 – 4.3**	**6.3**	**5.6 – 7.7**

Ontario

Ontario is expected to warm at a rate very similar to the national average. This rate of warming is approximately twice the global average reported during the years 1950 to 2010 (Warren & Lemmen, 2014). As above, model runs from AR5 were gathered and the median values presented below. The information was gathered from the Environment Canada's Canadian Climate Data and Scenarios website.

Table 4: Seasonal and annual change in temperature based on RCP 2.6 for the Province of Ontario (°C)

RCP 2.6 Ontario	2020s Median	2020s Range	2050s Median	2050s Range	2080s Median	2080s Range
Spring	1.1	0.7 – 1.4	1.6	1 – 2.1	1.4	0.8 – 1.9
Summer	1.1	0.8 – 1.5	1.4	1 – 2.2	1.3	0.9 – 2.0
Autumn	1.2	0.9 – 1.5	1.7	1.2 – 2.5	1.6	1.0 – 2.3
Winter	1.4	0.8 – 1.9	2.2	1.5 – 2.8	2.4	1.4 – 3.0
Annual	**1.4**	**1.4 – 1.8**	**1.7**	**1.2 – 2.3**	**1.7**	**1.0 – 2.1**

Table 5: Seasonal and annual change in temperature based on RCP 4.5 for the Province of Ontario (°C)

RCP 4.5 Ontario	2020s Median	2020s Range	2050s Median	2050s Range	2080s Median	2080s Range
Spring	1.1	0.6 – 1.6	2.0	1.4 – 2.6	2.5	1.8 – 3.7
Summer	1.1	0.8 – 1.4	2.1	1.6 – 2.8	2.9	1.8 – 3.6
Autumn	1.3	0.9 – 1.6	2.2	1.8 – 2.9	2.8	2.4 – 3.8
Winter	1.6	0.9 – 2.0	3.2	2.4 – 4.1	4.4	3.1 – 5.3
Annual	**1.3**	**0.8 – 1.6**	**2.4**	**1.8 – 2.8**	**3.2**	**2.3 – 3.8**

Table 6: Seasonal and annual change in temperature based on RCP 8.5 for the Province of Ontario (˚C)

RCP 8.5 Ontario	2020s Median	2020s Range	2050s Median	2050s Range	2080s Median	2080s Range
Spring	1.2	0.8 – 1.7	3.0	2.3 – 3.4	5.2	4.5 – 6.3
Summer	1.3	1.0 – 1.6	3.1	2.6 – 3.9	6.0	4.7 – 6.9
Autumn	1.4	1.1 – 1.8	3.3	2.8 – 4.0	5.8	4.9 – 7.0
Winter	1.9	1.2 – 2.2	4.6	3.4 – 5.4	8.2	6.9 – 9.7
Annual	**1.4**	**1.0 – 1.9**	**3.5**	**2.8 – 4.0**	**6.3**	**5.3 – 6.9**

The Nottawasaga Valley Watershed

The Nottawasaga Valley watershed covers approximately 3,700 square kilometres of Southern Ontario and is comprised of a number of physiographically and socio-economically diverse areas. To ensure that the information below was representative of the entire watershed locations in the four corners of the watershed were included in the analysis: Collingwood, Innisfil, Shanty Bay, and Shelburne. The data is presented in 1 degree latitude by 1 degree longitude cells, which divides the Nottawasaga Valley into four separate study cells. Despite this, the difference between cells was in almost all circumstances less than 0.1˚C, so the values from all four locations have been condensed into one set of tables that are reflective of the entire watershed as a whole.

The tables report a departure from baseline conditions, however the reference period for the tables below was the average from 1971 to 2000. All tables are in degrees Celsius and negative values are shown in brackets.

Table 7: Seasonal and annual change in temperature based on AR4 emissions scenarios A1B, A2 and B1 for the Nottawasaga Valley watershed (˚C)

	2020s			2050s			2080s		
Emissions Scenario	**A1B**	**A2**	**B1**	**A1B**	**A2**	**B1**	**A1B**	**A2**	**B1**
Spring	1.5	1.6	1.2	2.9	3.0	2.2	3.7	4.7	2.7
Summer	1.4	1.5	1.3	2.9	2.9	2.1	3.7	4.8	2.6
Autumn	1.3	1.3	1.3	2.6	2.8	2.0	3.4	4.6	2.5
Winter	1.7	1.6	1.3	3.1	3.3	2.3	3.9	4.8	2.9
Annual	**1.5**	**1.5**	**1.3**	**2.8**	**3.0**	**2.2**	**3.7**	**4.7**	**2.7**

Precipitation Change

Canada

Canada's rainfall has increased by about 13% in the last 59 years (Warren & Lemmen, 2014) but Bush and others (2014) comment that detecting trends in precipitation is inherently more difficult than for temperature. Similarly, future projections of precipitation range much more greatly than for temperature, owing to the complexity and smaller spatial scale of precipitation events.

For these tables the AR5 model was used. The information was gathered from the Environment Canada's Canadian Climate Data and Scenarios website. The information is displayed in percent change (% change) and negative values are displayed in brackets.

Table 8: Seasonal and annual change in precipitation based on RCP 2.6 nationwide (% change)

RCP 2.6 National	2020s Median	2020s Range	2050s Median	2050s Range	2080s Median	2080s Range
Spring	4.3	(1.2) – 10.1	6.1	0.0 – 12.8	6.6	0.3 – 13.5
Summer	2.8	(3.2) – 8.9	5.0	(1.5) – 12.0	5.2	(1.4) – 12.4
Autumn	4.4	(1.4) – 10.3	7.0	0.9 – 13.9	7.4	0.8 – 14.4
Winter	5.4	(0.5) – 12.4	9.1	1.9 – 17.0	9.1	2.0 – 17.3
Annual	**4.3**	**(1.6) – 10.4**	**6.8**	**0.3 – 13.9**	**7.1**	**0.4 – 14.4**

Table 9: Seasonal and annual change in precipitation based on RCP 4.5 nationwide (% change)

RCP 4.5 National	2020s Median	2020s Range	2050s Median	2050s Range	2080s Median	2080s Range
Spring	4.3	(1.6) – 10.6	8.6	2.1 – 15.9	10.6	3.5 – 19.1
Summer	2.2	(3.4) – 8.5	2.1	(1.7) – 12.6	6.5	(0.4) – 14.5
Autumn	4.8	(0.8) – 10.6	10.1	3.7 – 17.1	11.9	5.1 – 19.9
Winter	5.9	0.1 – 12.1	12.9	6.2 – 20.2	17.6	9.1 – 26.4
Annual	**4.3**	**(1.4) – 10.4**	**9.2**	**2.6 – 16.5**	**11.6**	**4.3 – 20.0**

Table 10: Seasonal and annual change in precipitation based on RCP 8.5 nationwide (% change)

RCP 8.5 National	2020s Median	2020s Range	2050s Median	2050s Range	2080s Median	2080s Range
Spring	5.3	(0.4) – 11.3	11.7	4.9 – 19.4	23.3	13.6 – 34.6
Summer	3.0	(2.9) – 9.3	6.4	(0.6) – 14.2	10.6	0.7 – 21.3
Autumn	5.2	(0.4) – 10.9	13.7	6.8 – 21.3	24.9	15.7 – 36.1
Winter	7.2	0.4 – 13.9	18.1	10.5 – 26.7	37.8	24.8 – 52.8
Annual	**5.2**	**(0.8) – 11.4**	**12.5**	**5.4 – 20.4**	**24.2**	**13.7 – 36.2**

Ontario

Ontario is not exempt from the expectation of a wetter Canada, though it is not projected to experience as strong of an increase as is projected throughout the rest of the nation. It should also be noted that while annual values are likely to increase, the increase is not distributed equally between seasons, and comparatively drier summers are expected across all emissions scenarios.

For these tables the AR5 model data were used. The information was gathered from the Environment Canada's Canadian Climate Data and Scenarios website. The information is displayed in percent change (% change) and negative values are displayed in brackets.

Table 11: Seasonal and annual change in precipitation based on RCP 2.6 province-wide (% change)

RCP 2.6 Ontario	2020s Median	2020s Range	2050s Median	2050s Range	2080s Median	2080s Range
Spring	3.7	(1.6) – 8.4	6.5	0.7 – 12.8	5.5	0.1 – 11.2
Summer	0.5	(3.8) – 4.6	2.6	(2.6) – 7.9	1.2	(3.4) – 7.6
Autumn	3.6	(1.4) – 8.2	5.0	0.8 – 9.7	6.0	0.2 – 11.1
Winter	5.3	0.2 – 10.8	8.9	3.2 – 14.9	7.9	2.7 – 13.4
Annual	**3.3**	**(1.6) – 8.0**	**5.7**	**0.5 – 11.3**	**5.2**	**(0.1) – 10.8**

Table 12: Seasonal and annual change in precipitation based on RCP 4.5 province-wide (% change)

RCP 4.5 Ontario	2020s Median	2020s Range	2050s Median	2050s Range	2080s Median	2080s Range
Spring	3.7	(0.9) – 10.1	8.5	3.8 – 14.2	10.7	4.0 – 18.8
Summer	0.4	(4.5) – 5.3	2.7	(3.0) – 7.4	3.3	(2.0) – 8.3
Autumn	3.3	(1.6) – 9.0	7.8	3.3 – 13.2	7.7	3.1 – 13.5
Winter	5.7	1.8 – 11.2	12.9	7.6 – 18.2	16.4	10.0 – 23.5
Annual	**3.3**	**(1.3) – 8.9**	**8.0**	**2.9 – 13.3**	**8.5**	**3.8 – 16**

Table 13: Seasonal and annual change in precipitation based on RCP 8.5 province-wide (% change)

RCP 8.5 Ontario	2020s Median	2020s Range	2050s Median	2050s Range	2080s Median	2080s Range
Spring	4.0	(0.8) – 9.7	13.1	5.3 – 21.5	24.2	14.1 – 36.9
Summer	0.7	(3.5) – 5.1	1.3	(3.8) – 6.2	(0.5)	(8.2) – 5.9
Autumn	3.1	(1.1) – 7.9	7.7	1.7 – 13.6	13.6	6.3 – 19.9
Winter	6.6	1.6 – 12.1	17.5	10.9 – 23.9	31.8	21.6 – 41.7
Annual	**3.6**	**(0.9) – 8.7**	**9.9**	**3.5 – 16.3**	**17.3**	**8.5 – 26.1**

The Nottawasaga Valley Watershed

The Nottawasaga Valley has experienced a 13 millimetre per year (1.4%) increase in rainfall over the 40 year period of 1965 to 2006. This observation is in accordance with the trend of small positive changes in the amount of precipitation received in the Northern Hemisphere. Similar to projections for the province of Ontario, the Nottawasaga Valley watershed is projected to experience only a small increase in annual precipitation. What is noteworthy is that across all emissions scenarios, the consensus in current modelling is that drier hotter summers are to be expected along with notably wetter, warmer winter and spring seasons.

The tables report a departure from baseline conditions, which in this case refer to the period of 1971 to 2000. The information is displayed in percent change (% change) and negative values are displayed in brackets.

Table 14: Seasonal and annual change in precipitation based on AR4 emissions scenarios A1B, A2 and B1 for the Nottawasaga Valley watershed (% change)

		2020s			2050s			2080s		
Season	**Baseline**	**A1B**	**A2**	**B1**	**A1B**	**A2**	**B1**	**A1B**	**A2**	**B1**
Spring	274 mm	3.1	5.0	5.1	11.1	13.6	9.7	17.9	22.3	13.1
Summer	243 mm	(3.2)	(2.9)	(2.8)	(2.9)	(6.3)	(3.0)	(5.2)	(5.2)	(4.4)
Autumn	237 mm	2.0	1.2	3.2	4.1	8.2	3.0	7.0	4.9	4.8
Winter	243 mm	5.6	9.3	4.1	13.4	17.6	10.4	21.2	27.9	14.1
Annual	997 mm	**1.9**	**3.2**	**2.5**	**6.6**	**8.4**	**5.2**	**10.5**	**12.8**	**7.1**

Stream Temperature Change

In addition to changes in air temperature, stream temperatures will also be impacted by climate change. Changes in stream temperature can have many environmental, recreational and water quality impacts. Rising water temperatures are likely to negatively impact cold- and cool-water fisheries and macro-invertebrates that are sensitive to warm temperatures while simultaneously increasing algae growth and the occurrence of water quality issues (Dodson, 2005), (Eaton & Scheller, 1996).

After conducting a brief analysis of air temperature and stream temperature in a groundwater-rich system in the upper reaches of the Nottawasaga River, it was found that an increase in air temperature of 1°C was correlated with a 0.65°C increase in stream temperature. This observation was supported in the literature where multiple journal articles mention groundwater-fed streams being observed to increase 0.6°C for every 1.0°C increase in air temperature and surface water systems increasing on a 1-to-1 basis. (Kurylyk, MacQuarrie & Voss, 2013; Menberg, Blum, Kurylyk & Bayer, 2014; Snyder, Hitt &Young, 2015).

The table below show the increases of stream temperature over time based on air temperature increases projected by AR4 climate models. Streams that are fed primarily from groundwater discharge (seeps and springs) respond more slowly to changes in air temperature than streams that get their water from surface water runoff. In the table below, the lower values would be more applicable to a groundwater fed stream, whereas the upper values would be more accurate for a surface-water fed stream.

Table 15: Estimated stream temperature change in response to a warming climate, based on AR4 projections. (°C)

Stream Temperature Change	2020s Range	2050s Range	2080s Range
SR-A1B	0.9 – 1.5	1.7 – 2.8	2.2 – 3.7
SR-A2	0.9 – 1.5	1.8 – 3.0	2.8 – 4.7
SR-B1	0.8 – 1.3	1.3 – 2.2	1.6 – 2.7

Extreme Rainfall

The intensity, duration and frequency of intense rain events are projected, "with an associated increased risk of flooding" (Warren & Lemmen, 2014). This is of particular concern to NVCA as this increases the risk of loss of life and property due to storm-related flooding and erosion.

The Facility for Intelligent Decision Support (FIDS) based out of the University of Western Ontario has assembled a web-based tool to develop Intensity-Duration-Frequency curves corresponding to precipitation changes projected in AR5 climate models. The reference period for these curves is the 1979 to 2007 period, and change values have been calculated for the 2020s, 2050s and 2080s periods using RCPs 2.6, 4.5 and 8.5. Storm intensities are listed in millimetres per hour (mm/h).

The tables show a consistent trend toward higher intensity (mm/h) for the various durations and return frequency storms. As an example, currently in Barrie a storm lasting one full hour with a precipitation rate of 49 mm/hr, would be expected to have a 1% chance of happening any given year and be referred to as a 100-year storm event. The AR5 climate models forecast that by the 2080s the 100-year storm event will have precipitation rates of 56 to 65 mm/hr.

These tables can be found in the Appendix of this report. Following from the methodology listed previously, four locations were selected as representative of the Nottawasaga Valley Watershed: Barrie Water Pollution Control Plant (WPCC), Collingwood, Egbert and Shelburne. The baseline data in these figures is based on historic weather gauge data.

Other Climatic Change

There are numerous metrics to account for the climatic changes that are projected in the Nottawasaga Valley watershed between present and the end of the 21st century. The following chart briefly mentions other projected changes that may have significant outcomes or impacts on the environment and residents of the watershed. The figures were prepared utilizing AR4 climate model data using Special Report Emissions scenarios A1B, A2 and B1. The information for these charts was gathered from Environment Canada's Canadian Climate Data and Scenarios website and baseline data from 1979-2007. Data from the CGCM3T47 and NCARPCM climate models were used to assemble the following tables.

Table 16: Assorted climatic changes projected using AR4 scenarios A1B

Climatic Changes Projected – Scenarios A1B	Current	2080s	Difference
Daily Extreme Air Temp Range (°C)	67.6	64.0	-3.6
Mean Max Air Temp (°C)	12.4	16.1	3.7
Mean Min Air Temp (°C)	2.5	6.4	3.9
Mean Min Air Temp Winter (°C)	(9.6)	(4.7)	4.9
Days of Frost (Days)	165.5	146.0	(19.5)
Max Consecutive Dry Days (Days)	15.6	15.4	(0.2)
Growing Season (Days)	191.6	207.1	15.5
Max Heat Wave (Consecutive Days)	7.3	11.4	4.1

Table 17: Assorted climatic changes projected using AR4 scenarios A2

Climatic Changes Projected – Scenarios A2	Current	2080s	Difference
Daily Extreme Air Temp Range (°C)	67.6	64.3	(3.3)
Mean Max Air Temp (°C)	12.4	17.2	4.8
Mean Min Air Temp (°C)	2.5	7.5	5.0
Mean Min Air Temp Winter (°C)	(9.6)	(3.7)	5.9
Days of Frost (Days)	165.5	143.1	(22.4)
Max Consecutive Dry Days (Days)	15.6	15.5	(0.1)
Growing Season (Days)	191.6	207.7	16.1
Max Heat Wave (Consecutive Days)	7.3	12.3	5.0

Table 18: Assorted climatic changes projected using AR4 scenarios B1

Climatic Changes Projected – Scenarios B1	Current	2080s	Difference
Daily Extreme Air Temp Range (°C)	67.6	65.0	(2.6)
Mean Max Air Temp (°C)	12.4	15.1	2.7
Mean Min Air Temp (°C)	2.5	5.3	2.8
Mean Min Air Temp Winter (°C)	(9.6)	(6.0)	3.6
Days of Frost (Days)	165.5	152.4	(13.1)
Max Consecutive Dry Days (Days)	15.6	15.6	0.0
Growing Season (Days)	191.6	200.0	8.4
Max Heat Wave (Consecutive Days)	7.3	10.8	3.5

Conclusion

This report provides a brief overview of the immense number of ways that the climate of the Nottawasaga Valley is anticipated to change in the coming years. Over the course of the next century temperatures are projected to climb between 2.7 to 4.7°C, and annual precipitation is projected to increase somewhere between 71 and 128 mm (7.1 to 12.8%). The increase in annual precipitation will likely occur primarily in the spring and winter seasons; summers are expected to become drier. Stream temperatures can be expected to increase between 1.6 and 4.7°C although this response will not be uniform; it will vary significantly from stream to stream.

Changing temperature and precipitation regimes and the numerous outcomes that arise as a result – such as rising stream temperatures – are going to have major impacts to the environmental, physical, and socio-economic systems for the communities situated within the watershed.

The next phase of research will be to identify the risks and impacts that are associated with climate change that is observable today and projected to come in future years. This is meant to be the beginning of the research that NVCA will be doing in regards to climate change and will also be a stepping stone for the authority, our partners, stakeholders and residents. As more information comes to light and more sophisticated models and projections are made available it will be incorporated into the NVCA's Climate Change Strategy and Action Plan, but uncertainty will not be used as an excuse for inaction.

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Appendix: Storm Intensity and Duration Curves

The information in the following tables was generated using the IDF CC Tool for deriving rainfall Intensity-Duration-Frequency Curves for Future Climate Scenarios (2016).

Table A1: Historical IDF Curve information for the Barrie WPCC location. All values are displayed in mm/h.

Barrie WPCC-Baseline						
	2 Year Storm Event	5 Year Storm Event	10 Year Storm Event	25 Year Storm Event	50 Year Storm Event	100 Year Storm Event
5 min	102	132	151	176	194	212
10 min	74	98	114	134	149	164
15 min	61	82	95	112	125	138
30 min	39	51	60	70	78	85
1 hr	23	30	35	41	45	49
2 hr	14	20	23	28	31	35
6 hr	6	9	10	12	14	15
12 hr	4	5	6	7	7	8
24 hr	2	3	3	4	4	5

Table A2: 2020s IDF Curve projections for the Barrie WPCC location. All values are displayed in mm/h.

Barrie WPCC-2020s																		
	2 Year Storm Event			5 Year Storm Event			10 Year Storm Event			25 Year Storm Event			50 Year Storm Event			100 Year Storm Event		
Scenario	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5
5 min	112	116	116	142	146	150	161	166	172	185	191	197	203	210	216	221	230	235
10 min	82	85	85	107	110	113	122	126	131	142	147	152	157	163	168	172	179	183
15 min	67	71	71	89	91	95	102	105	109	119	123	127	132	136	141	144	150	154
30 min	43	45	45	56	57	59	64	66	68	74	77	79	82	85	87	89	93	95
1 hr	25	26	26	32	33	34	37	38	40	43	44	46	47	49	50	52	54	55
2 hr	16	17	17	22	22	23	25	26	27	30	31	32	33	34	36	37	38	39
6 hr	7	7	7	10	10	10	11	11	12	13	14	14	15	15	16	16	17	17
12 hr	4	4	4	5	5	5	6	6	6	7	7	7	8	8	8	8	9	9
24 hr	2	2	2	3	3	3	3	4	4	4	4	4	4	5	5	5	5	5

Table A3: 2050s IDF Curve projections for the Barrie WPCC location. All values are displayed in mm/h.

Barrie WPCC-2050s																		
	2 Year Storm Event			5 Year Storm Event			10 Year Storm Event			25 Year Storm Event			50 Year Storm Event			100 Year Storm Event		
Scenario	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5
5 min	116	121	128	149	154	161	171	174	185	198	200	215	219	219	238	238	239	262
10 min	85	89	95	112	117	122	130	133	142	153	154	167	170	170	186	186	186	205
15 min	70	74	79	94	97	102	109	111	119	128	129	140	142	142	156	156	156	172
30 min	45	47	50	59	61	64	68	69	74	80	80	87	88	88	96	96	97	106
1 hr	26	27	29	34	35	37	39	40	43	46	46	50	51	51	56	56	56	61
2 hr	17	17	19	23	24	25	27	28	30	32	33	35	36	36	40	39	40	44
6 hr	7	8	8	10	11	11	12	12	13	14	14	15	16	16	17	17	17	19
12 hr	4	4	5	5	6	6	6	6	7	7	8	8	8	8	9	9	9	10
24 hr	2	2	3	3	3	3	4	4	4	4	4	5	5	5	5	5	5	6

Table A4: 2080s IDF Curve projections for the Barrie WPCC location. All values are displayed in mm/h.

Barrie WPCC-2080s																		
	2 Year Storm Event			5 Year Storm Event			10 Year Storm Event			25 Year Storm Event			50 Year Storm Event			100 Year Storm Event		
Scenario	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5
5 min	116	122	141	148	155	179	171	178	203	199	204	233	218	223	255	240	242	276
10 min	85	91	106	112	117	137	131	136	157	153	158	181	170	173	199	187	189	217
15 min	70	75	88	93	98	115	109	114	131	128	132	152	142	145	167	157	159	182
30 min	45	48	55	59	61	71	68	71	81	80	82	94	88	90	103	97	98	112
1 hr	26	28	32	34	35	41	39	41	47	46	47	54	51	52	60	56	57	65
2 hr	17	18	21	23	24	29	27	28	33	32	33	39	36	37	43	40	41	47
6 hr	7	8	9	10	11	13	12	12	14	14	15	17	16	16	19	18	18	20
12 hr	4	4	5	5	6	7	6	7	8	7	8	9	8	8	10	9	9	11
24 hr	2	3	3	3	3	4	4	4	4	4	5	5	5	5	6	5	5	6

Table A5: Historical IDF Curve information for the Collingwood location. All values are displayed in mm/h.

Collingwood-Baseline						
	2 Year Storm Event	5 Year Storm Event	10 Year Storm Event	25 Year Storm Event	50 Year Storm Event	100 Year Storm Event
5 min	89	111	126	145	159	173
10 min	66	86	99	115	127	139
15 min	52	68	78	91	101	110
30 min	34	43	49	56	61	67
1 hr	21	27	31	35	39	42
2 hr	13	16	19	21	24	26
6 hr	6	8	9	11	12	14
12 hr	3	4	5	6	7	7
24 hr	2	2	3	3	3	4

Table A6: 2020s IDF Curve projections for the Collingwood location. All values are displayed in mm/h.

Collingwood-2020s																		
	2 Year Storm Event			5 Year Storm Event			10 Year Storm Event			25 Year Storm Event			50 Year Storm Event			100 Year Storm Event		
Scenario	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5
5 min	95	99	99	118	122	124	133	136	141	153	155	161	167	169	175	182	184	190
10 min	72	75	75	91	95	97	105	107	112	122	124	129	134	136	142	147	149	155
15 min	57	59	59	72	75	77	83	85	89	96	98	102	106	108	112	116	118	122
30 min	37	38	38	45	47	48	51	53	55	59	60	62	64	65	68	70	71	73
1 hr	23	24	24	28	29	30	32	33	34	37	38	39	41	41	43	44	45	46
2 hr	14	14	14	17	18	18	20	20	21	23	23	24	25	25	26	27	28	29
6 hr	6	7	7	8	9	9	10	10	11	12	12	12	13	13	14	14	15	15
12 hr	4	4	4	5	5	5	5	6	6	6	7	7	7	7	7	8	8	8
24 hr	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	4	4	4

Table A7: 2050s IDF Curve projections for the Collingwood location. All values are displayed in mm/h.

Collingwood-2050s																		
	2 Year Storm Event			5 Year Storm Event			10 Year Storm Event			25 Year Storm Event			50 Year Storm Event			100 Year Storm Event		
Scenario	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5
5 min	100	103	111	125	129	138	140	146	155	159	168	176	174	185	193	188	200	209
10 min	76	78	85	97	101	109	111	116	124	128	135	143	140	150	157	153	163	171
15 min	60	62	67	77	80	86	88	92	98	101	107	113	111	118	124	121	129	135
30 min	38	40	43	48	50	53	54	56	60	61	65	68	67	71	74	73	77	81
1 hr	24	25	27	30	31	33	34	36	38	39	41	43	42	45	47	46	49	51
2 hr	14	15	16	18	19	20	21	22	23	24	25	26	26	28	29	28	30	31
6 hr	7	7	8	9	9	10	10	11	12	12	13	14	14	15	15	15	16	17
12 hr	4	4	4	5	5	6	6	6	7	7	7	8	7	8	8	8	9	9
24 hr	2	2	2	3	3	3	3	3	3	3	4	4	4	4	4	4	4	5

Table A8: 2080s IDF Curve projections for the Collingwood location. All values are displayed in mm/h.

Collingwood-2080s																		
	2 Year Storm Event			5 Year Storm Event			10 Year Storm Event			25 Year Storm Event			50 Year Storm Event			100 Year Storm Event		
Scenario	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5
5 min	99	104	120	124	130	148	141	146	167	163	167	191	180	182	208	197	197	225
10 min	75	79	93	97	102	118	112	116	134	131	134	155	146	148	170	160	161	185
15 min	59	63	74	77	81	93	89	92	106	104	106	123	116	117	135	127	127	146
30 min	38	40	46	48	50	57	55	56	64	63	64	73	70	70	80	76	76	87
1 hr	24	25	29	30	31	36	34	36	41	40	41	47	44	44	51	48	48	55
2 hr	14	15	18	18	19	22	21	22	25	24	25	29	27	27	31	30	30	34
6 hr	7	7	9	9	10	11	11	11	13	13	13	15	14	14	17	16	16	18
12 hr	4	4	5	5	5	6	6	6	7	7	7	8	8	8	9	8	9	10
24 hr	2	2	3	3	3	3	3	3	4	4	4	4	4	4	4	4	4	5

Table A9: Historical IDF Curve information for the Egbert CS location. All values are displayed in mm/h.

Egbert CS-Baseline						
	2 Year Storm Event	5 Year Storm Event	10 Year Storm Event	25 Year Storm Event	50 Year Storm Event	100 Year Storm Event
5 min	97	126	145	169	186	204
10 min	69	90	104	122	135	148
15 min	55	73	85	100	111	123
30 min	34	44	50	57	63	69
1 hr	22	30	35	42	47	51
2 hr	13	17	20	24	27	30
6 hr	5	7	8	10	11	12
12 hr	3	4	4	5	6	6
24 hr	2	2	2	3	3	3

Table A10: 2020s IDF Curve projections for the Egbert CS location. All values are displayed in mm/h.

Egbert CS-2020s																		
	2 Year Storm Event			5 Year Storm Event			10 Year Storm Event			25 Year Storm Event			50 Year Storm Event			100 Year Storm Event		
Scenario	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5
5 min	107	111	110	137	139	144	157	160	166	181	186	191	199	205	209	217	225	228
10 min	76	79	79	98	100	104	113	115	120	131	134	138	144	149	152	157	164	166
15 min	61	63	63	80	81	84	93	94	98	108	111	114	119	124	126	131	136	138
30 min	37	39	39	47	48	49	54	54	56	61	63	64	67	69	70	73	76	77
1 hr	25	26	26	33	34	35	39	39	41	45	46	48	50	52	53	55	57	58
2 hr	14	15	15	19	20	20	22	23	24	26	27	28	29	30	31	32	34	34
6 hr	6	6	6	8	8	8	9	9	10	10	11	11	12	12	12	13	13	13
12 hr	3	3	3	4	4	4	5	5	5	6	6	6	6	6	6	7	7	7
24 hr	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4

Table A11: 2050s IDF Curve projections for the Egbert CS location. All values are displayed in mm/h.

Egbert CS-2050s																		
	2 Year Storm Event			5 Year Storm Event			10 Year Storm Event			25 Year Storm Event			50 Year Storm Event			100 Year Storm Event		
Scenario	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5
5 min	111	115	122	143	148	155	164	169	177	191	194	206	211	213	228	229	230	251
10 min	79	82	87	103	107	111	118	122	128	138	141	150	153	155	166	167	168	183
15 min	63	66	70	84	87	91	97	100	106	114	116	124	127	128	138	139	140	152
30 min	39	40	42	49	51	53	56	58	60	65	66	70	71	72	77	77	77	84
1 hr	26	27	29	35	36	38	40	42	44	48	49	52	53	54	58	58	59	64
2 hr	15	16	17	20	21	22	24	24	26	28	29	31	31	32	34	34	34	38
6 hr	6	6	7	8	8	9	9	10	10	11	11	12	12	12	13	13	14	15
12 hr	3	3	4	4	5	5	5	5	5	6	6	6	6	6	7	7	7	8
24 hr	2	2	2	2	3	3	3	3	3	3	3	3	3	4	4	4	4	4

Table A12: 2080s IDF Curve projections for the Egbert CS location. All values are displayed in mm/h.

Egbert CS-2080s																		
	2 Year Storm Event			5 Year Storm Event			10 Year Storm Event			25 Year Storm Event			50 Year Storm Event			100 Year Storm Event		
Scenario	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5
5 min	111	117	135	143	149	172	165	170	195	193	197	226	215	216	246	236	235	267
10 min	79	83	97	103	107	125	119	123	141	140	143	165	156	157	179	172	171	195
15 min	63	67	79	83	87	102	98	101	117	116	118	137	130	130	150	143	142	163
30 min	39	41	47	49	51	59	56	58	66	65	67	76	72	73	82	79	79	89
1 hr	26	27	32	35	36	43	41	42	49	48	49	57	54	55	63	60	60	69
2 hr	15	16	19	20	21	25	24	25	29	28	29	34	32	32	37	35	35	40
6 hr	6	6	8	8	8	10	10	10	11	11	11	13	13	13	15	14	14	16
12 hr	3	4	4	4	5	5	5	5	6	6	6	7	7	7	8	7	7	8
24 hr	2	2	2	2	3	3	3	3	3	3	3	4	4	4	4	4	4	4

Table A13: Historical IDF Curve information for the Shelburne location. All values are displayed in mm/h.

Shelburne-Baseline						
	2 Year Storm Event	5 Year Storm Event	10 Year Storm Event	25 Year Storm Event	50 Year Storm Event	100 Year Storm Event
5 min	76	114	139	170	193	217
10 min	58	84	101	123	139	155
15 min	49	70	84	101	114	127
30 min	35	49	59	72	81	90
1 hr	23	32	38	46	52	58
2 hr	15	21	24	29	33	36
6 hr	8	10	11	13	14	16
12 hr	5	6	6	7	8	9
24 hr	3	3	4	4	4	5

Table A14: 2020s IDF Curve projections for the Shelburne location. All values are displayed in mm/h.

Shelburne-2020s																		
	2 Year Storm Event			5 Year Storm Event			10 Year Storm Event			25 Year Storm Event			50 Year Storm Event			100 Year Storm Event		
Scenario	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5
5 min	91	87	89	133	128	131	161	157	158	196	192	194	221	217	219	246	241	244
10 min	68	65	67	97	94	96	117	114	114	141	138	139	158	156	157	176	172	174
15 min	57	55	57	81	78	80	96	94	94	115	113	114	129	127	128	143	140	142
30 min	40	39	40	57	55	56	68	66	67	82	80	81	91	90	91	101	99	101
1 hr	26	26	26	37	36	36	44	43	43	53	52	52	59	58	58	65	64	65
2 hr	17	16	17	23	23	23	28	27	27	33	33	33	37	37	37	41	40	41
6 hr	9	8	9	11	11	11	13	12	12	15	14	14	16	16	16	17	17	17
12 hr	5	5	5	6	6	6	7	7	7	8	8	8	9	9	9	10	9	9
24 hr	3	3	3	3	3	3	4	4	4	4	4	4	5	5	5	5	5	5

Table A15: 2050s IDF Curve projections for the Shelburne location. All values are displayed in mm/h.

Shelburne-2050s																		
	2 Year Storm Event			5 Year Storm Event			10 Year Storm Event			25 Year Storm Event			50 Year Storm Event			100 Year Storm Event		
Scenario	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5
5 min	94	98	106	135	140	152	163	169	178	198	202	217	223	225	243	248	250	269
10 min	69	73	78	99	102	110	118	122	129	142	145	155	160	161	174	177	178	191
15 min	59	61	66	82	84	91	97	100	106	116	118	127	130	131	141	144	145	155
30 min	41	43	46	58	60	64	69	71	75	82	84	90	92	93	100	102	103	110
1 hr	27	28	30	38	39	42	44	46	48	53	54	58	59	60	64	66	66	71
2 hr	17	18	19	24	25	26	28	29	31	34	34	37	37	38	41	41	42	45
6 hr	9	9	10	11	11	12	13	13	14	15	15	16	16	16	17	18	18	19
12 hr	5	5	5	6	6	7	7	7	8	8	8	9	9	9	9	10	10	10
24 hr	3	3	3	3	4	4	4	4	4	4	4	5	5	5	5	5	5	5

Table A16: 2080s IDF Curve projections for the Shelburne location. All values are displayed in mm/h.

Shelburne-2080s																		
	2 Year Storm Event			5 Year Storm Event			10 Year Storm Event			25 Year Storm Event			50 Year Storm Event			100 Year Storm Event		
Scenario	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5	2.6	4.5	8.5
5 min	94	103	118	138	153	167	166	185	199	199	224	241	224	252	272	249	281	302
10 min	70	76	87	100	111	120	120	133	143	143	160	172	160	180	194	177	200	216
15 min	60	64	72	83	92	99	99	110	117	117	131	140	131	146	158	144	162	175
30 min	42	45	51	59	65	70	70	78	83	83	93	100	93	104	112	102	115	124
1 hr	27	30	33	38	42	45	45	50	53	53	60	64	60	67	72	66	74	79
2 hr	18	19	21	24	27	29	29	32	34	34	38	40	38	42	45	41	46	50
6 hr	9	9	10	11	12	13	13	14	15	15	16	17	16	18	19	18	19	21
12 hr	5	5	6	6	7	7	7	8	8	8	9	9	9	10	10	10	11	11
24 hr	3	3	3	4	4	4	4	4	4	4	5	5	5	5	5	5	6	6

The information in the following figures was generated using the IDF CC Tool for deriving rainfall Intensity-Duration-Frequency Curves for Future Climate Scenarios (2016).

Figure 1: 2020s IDF Curve Changes projected for the Barrie WPCC location under RCP 2.6 (AR5)

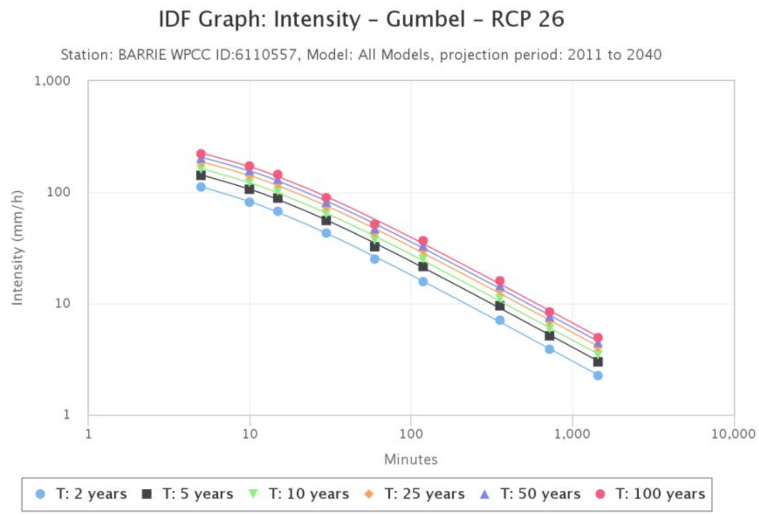

Figure 2: 2020s IDF Curve Changes projected for the Barrie WPCC location under RCP 4.5 (AR5)

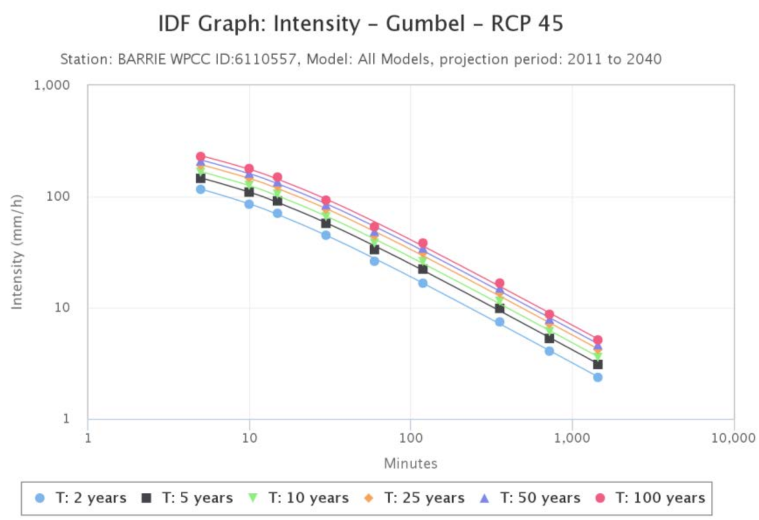

Figure 3: 2020s IDF Curve Changes projected for the Barrie WPCC location under RCP 8.5 (AR5)

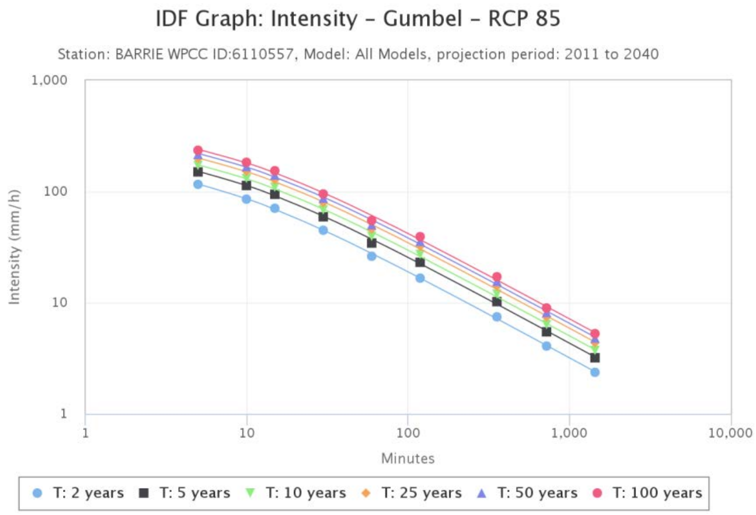

Figure 4: 2050s IDF Curve Changes projected for the Barrie WPCC location under RCP 2.6 (AR5)

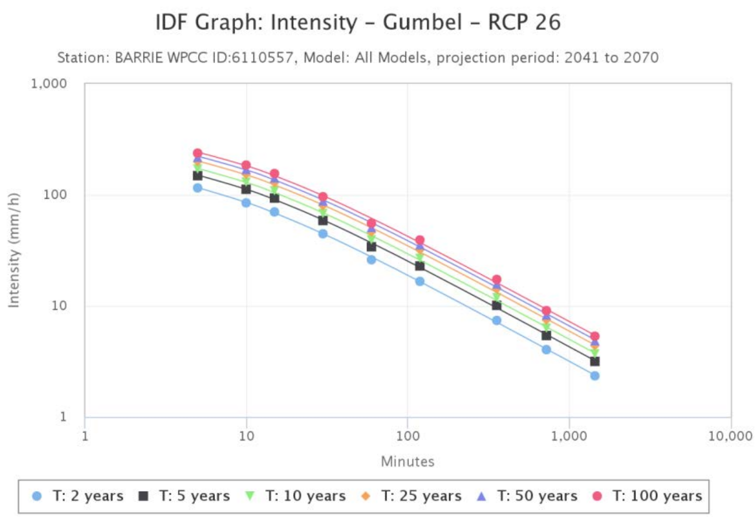

Figure 5: 2050s IDF Curve Changes projected for the Barrie WPCC location under RCP 4.5 (AR5)

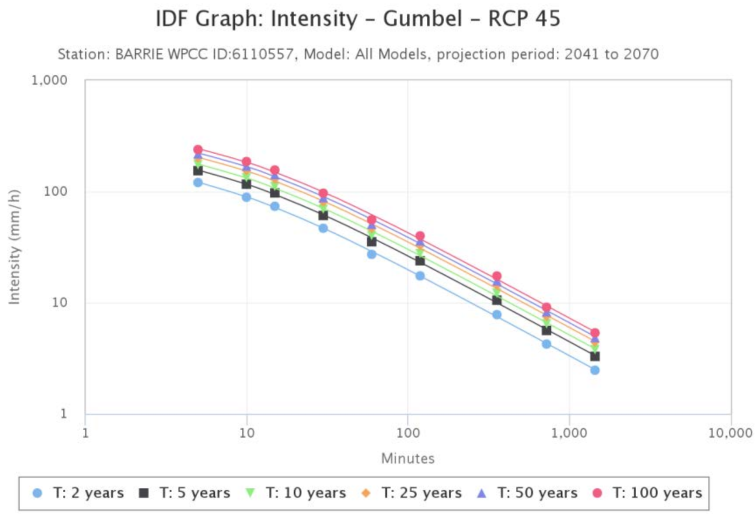

Figure 6: 2050s IDF Curve Changes projected for the Barrie WPCC location under RCP 8.5 (AR5)

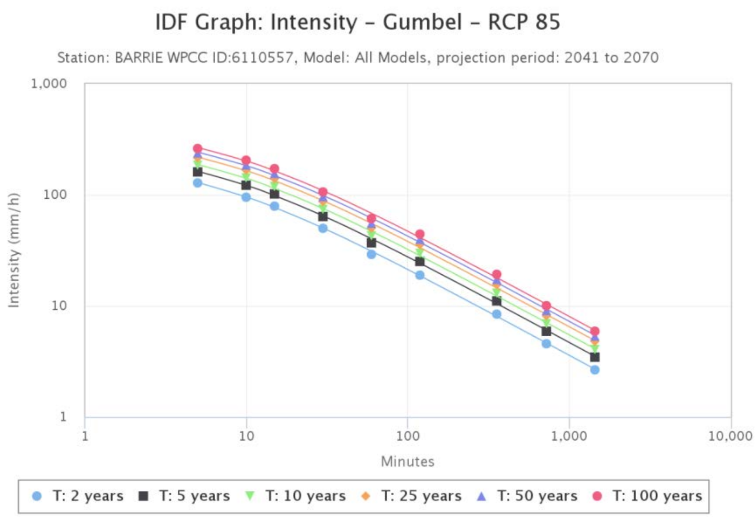

Figure 7: 2080s IDF Curve Changes projected for the Barrie WPCC location under RCP 2.6 (AR5)

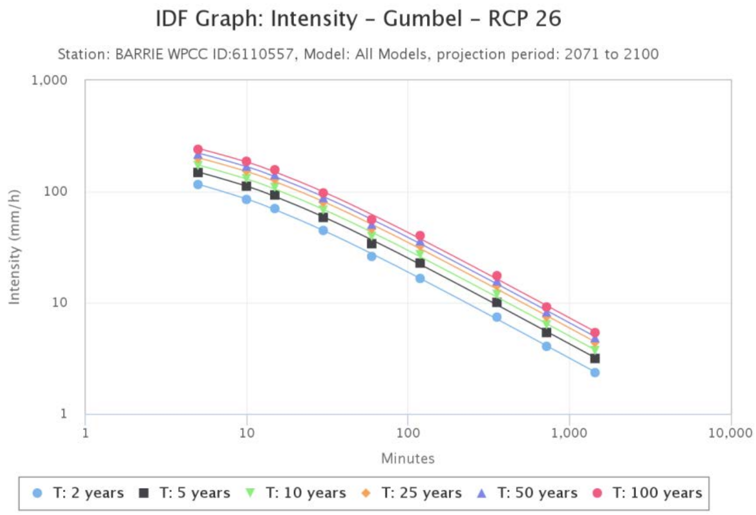

Figure 8: 2080s IDF Curve Changes projected for the Barrie WPCC location under RCP 4.5 (AR5)

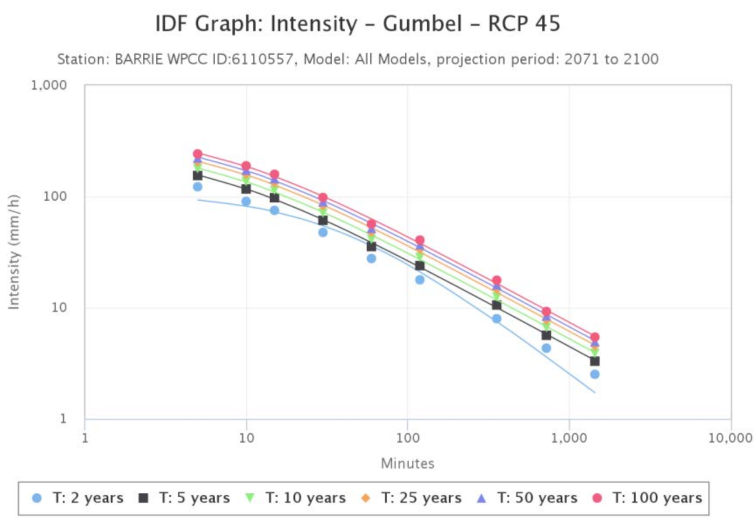

Figure 9: 2080s IDF Curve Changes projected for the Barrie WPCC location under RCP 8.5 (AR5)

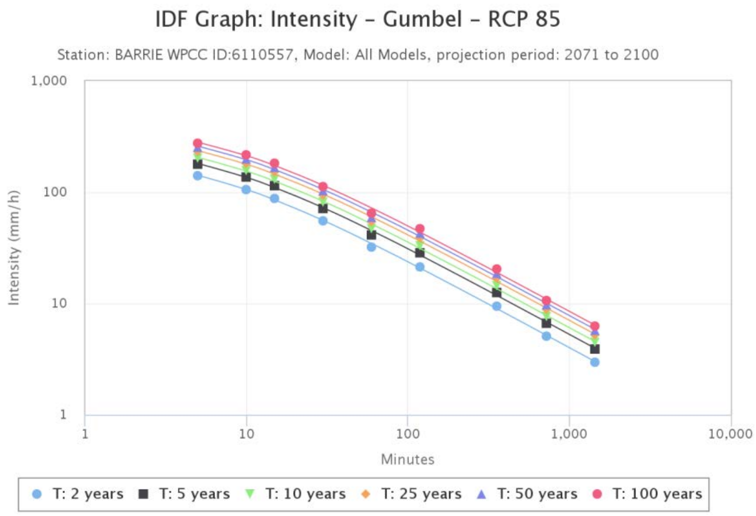

Figure 10: 2020s IDF Curve Changes projected for the Collingwood location under RCP 2.6 (AR5)

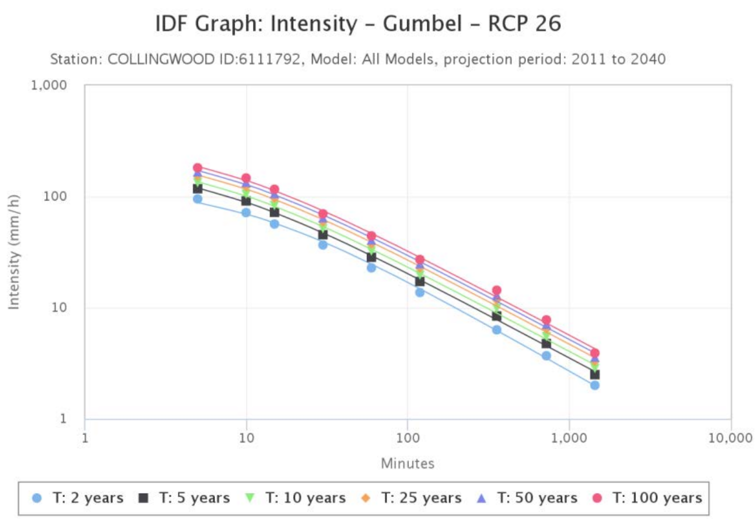

Figure 11: 2020s IDF Curve Changes projected for the Collingwood location under RCP 4.5 (AR5)

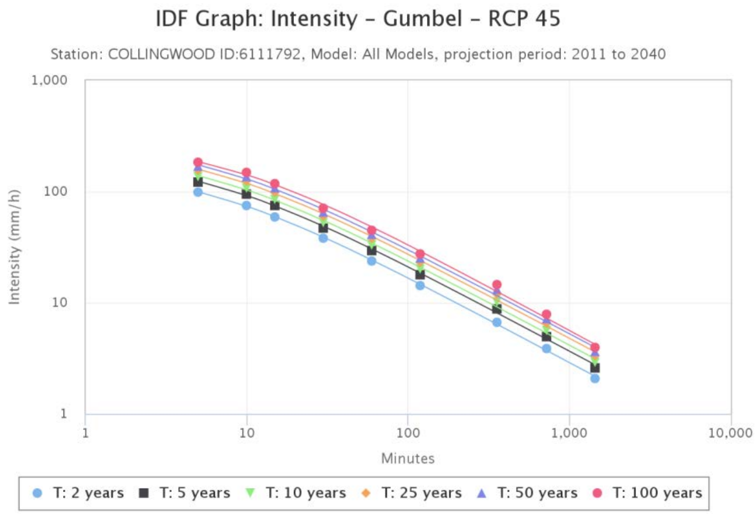

Figure 12: 2020s IDF Curve Changes projected for the Collingwood location under RCP 8.5 (AR5)

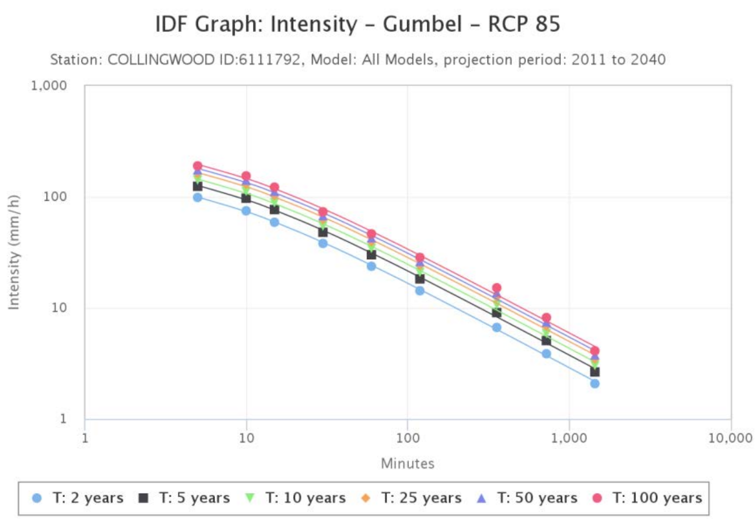

Figure 13: 2050s IDF Curve Changes projected for the Collingwood location under RCP 2.6 (AR5)

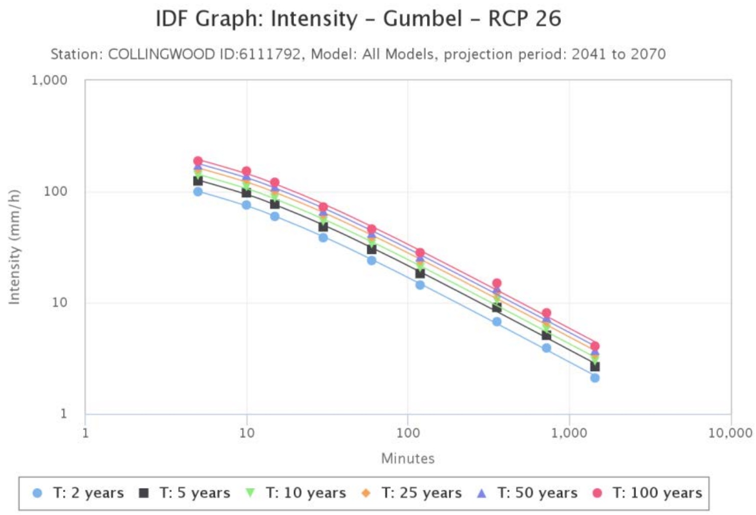

Figure 14: 2050s IDF Curve Changes projected for the Collingwood location under RCP 4.5 (AR5)

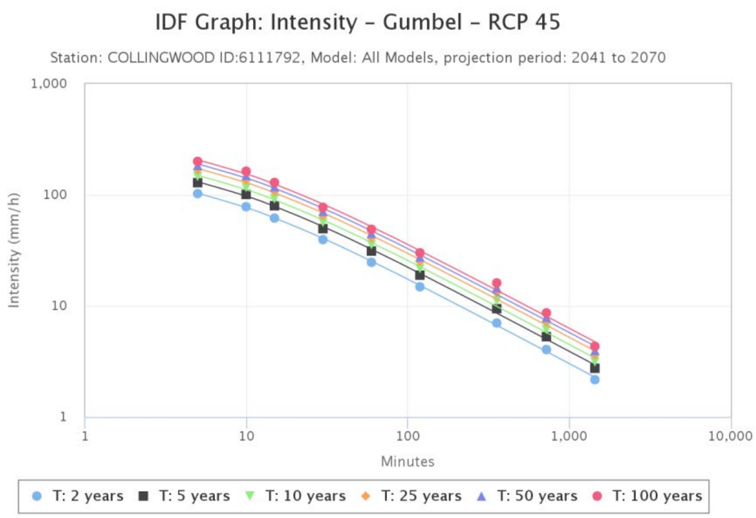

Figure 15: 2050s IDF Curve Changes projected for the Collingwood location under RCP 8.5 (AR5)

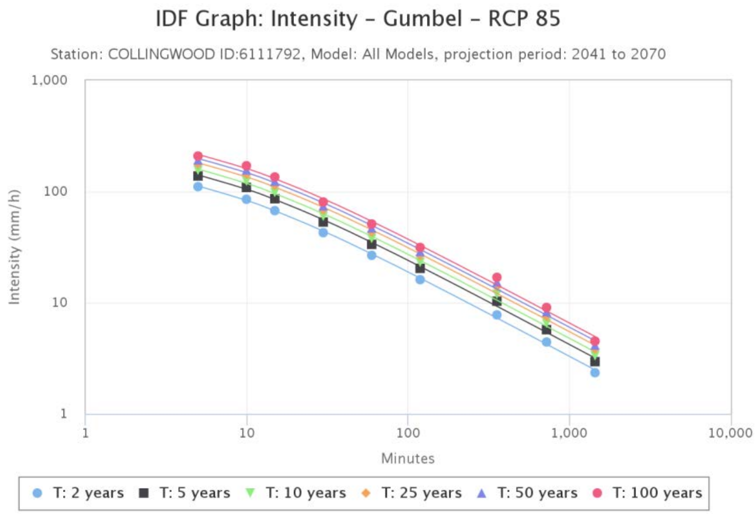

Figure 16: 2080s IDF Curve Changes projected for the Collingwood location under RCP 2.6 (AR5)

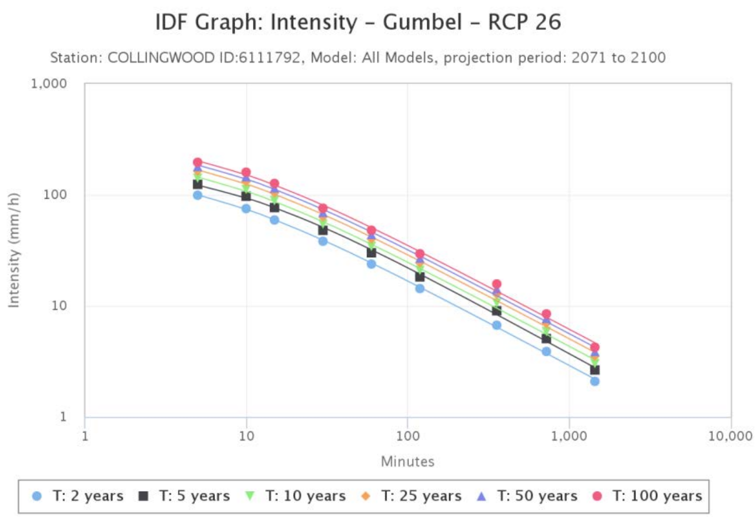

Figure 17: 2080s IDF Curve Changes projected for the Collingwood location under RCP 4.5 (AR5)

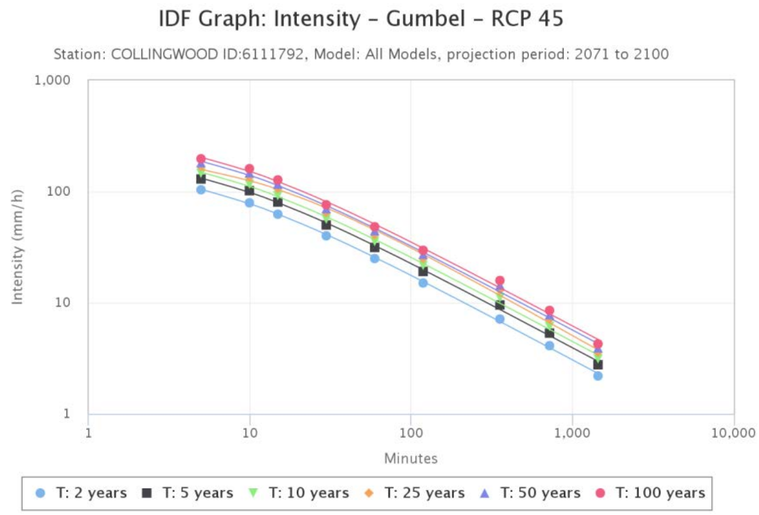

Figure 18: 2080s IDF Curve Changes projected for the Collingwood location under RCP 8.5 (AR5)

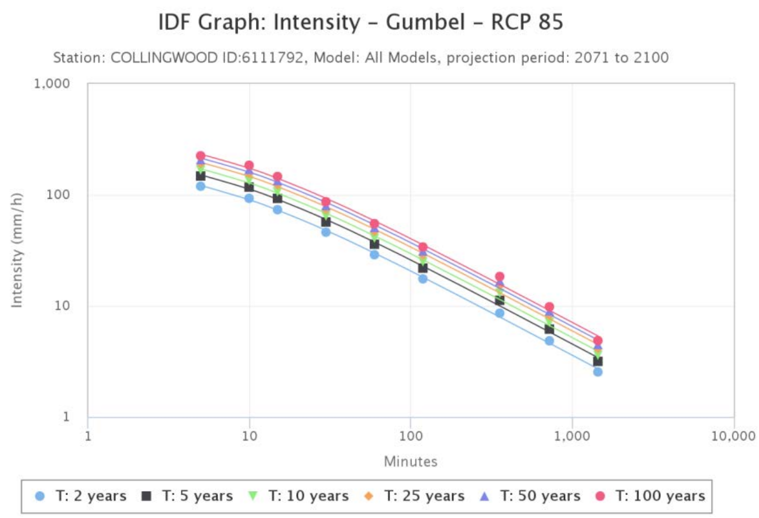

Figure 19: 2020s IDF Curve Changes projected for the Egbert CS location under RCP 2.6 (AR5)

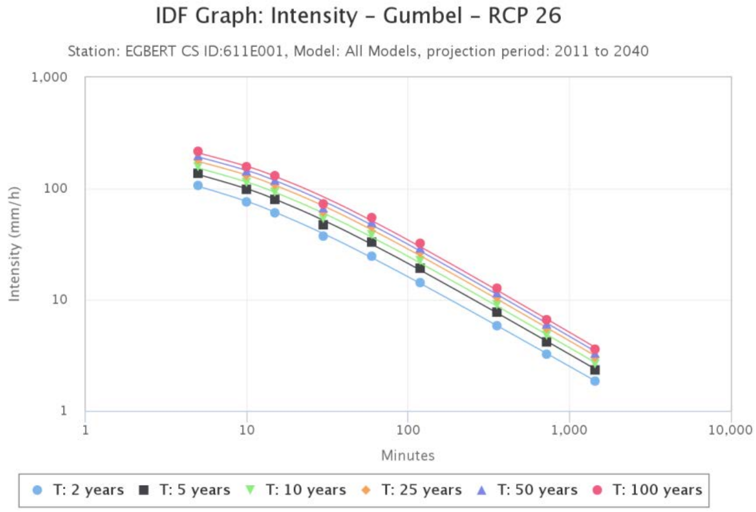

Figure 20: 2020s IDF Curve Changes projected for the Egbert CS location under RCP 4.5 (AR5)

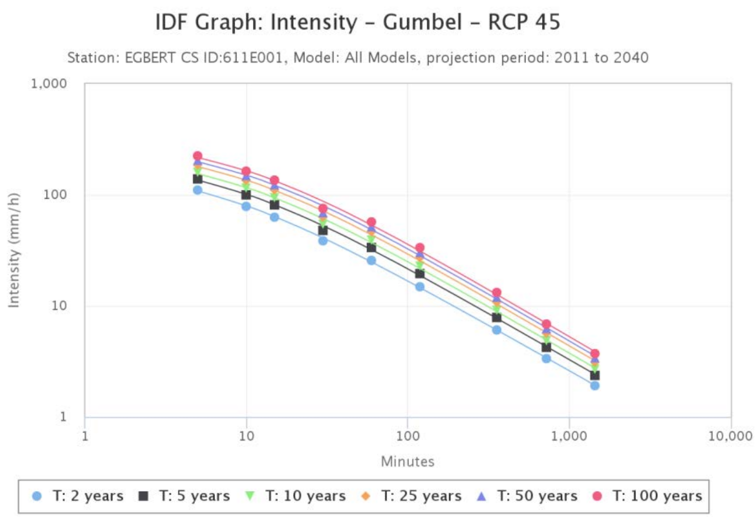

Figure 21: 2020s IDF Curve Changes projected for the Egbert CS location under RCP 8.5 (AR5)

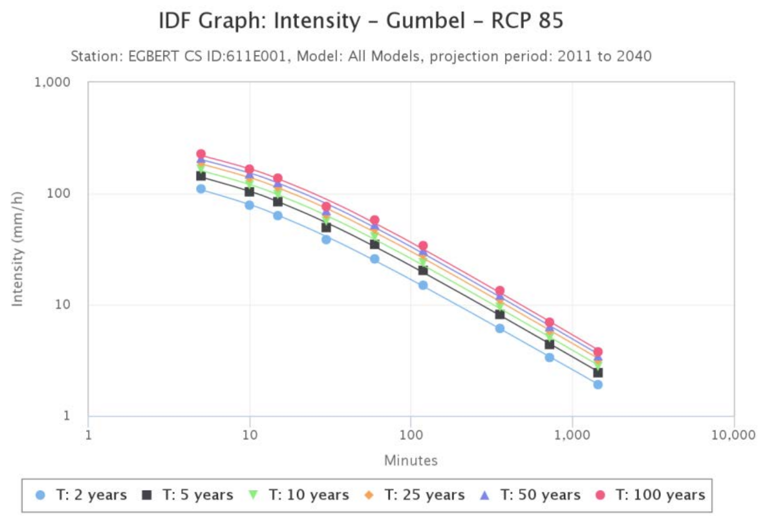

Figure 22: 2050s IDF Curve Changes projected for the Egbert CS location under RCP 2.6 (AR5)

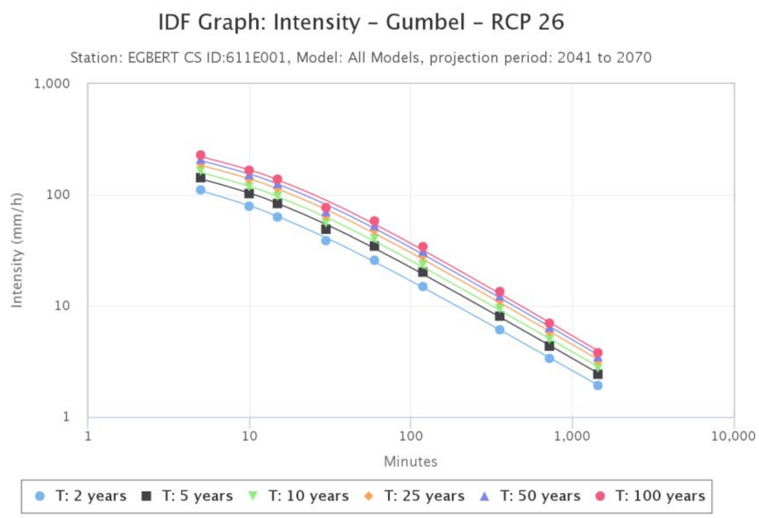

Figure 23: 2050s IDF Curve Changes projected for the Egbert CS location under RCP 4.5 (AR5)

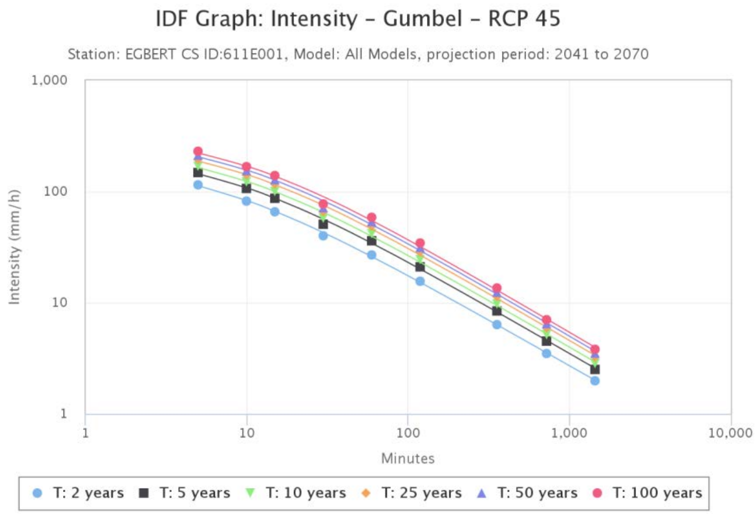

Figure 24: 2050s IDF Curve Changes projected for the Egbert CS location under RCP 8.5 (AR5)

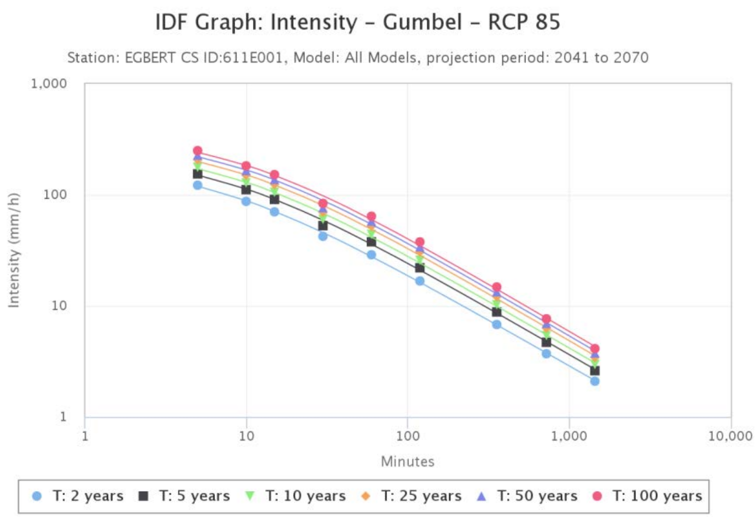

Figure 25: 2080s IDF Curve Changes projected for the Egbert CS location under RCP 2.6 (AR5)

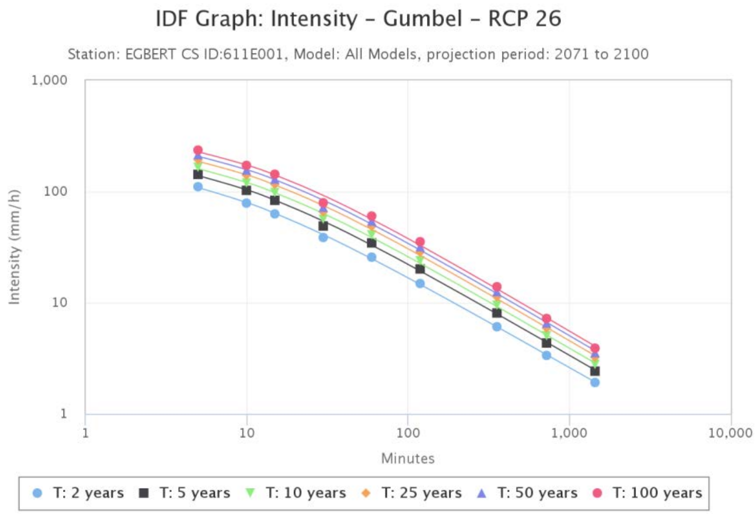

Figure 26: 2080s IDF Curve Changes projected for the Egbert CS location under RCP 4.5 (AR5)

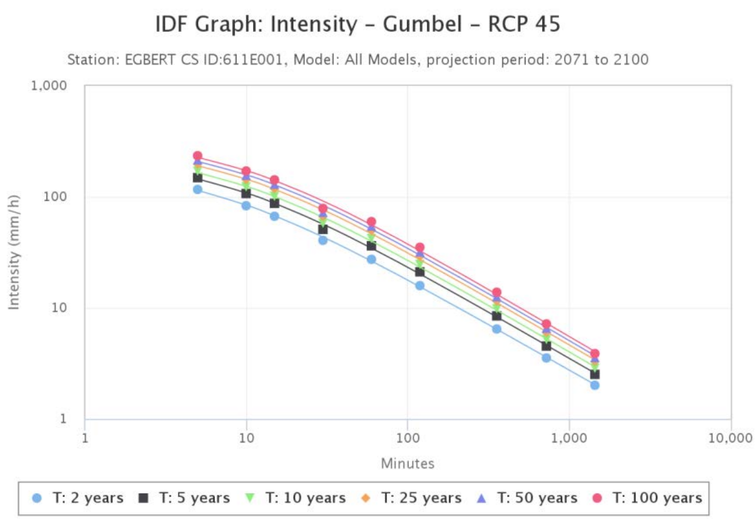

Figure 27: 2080s IDF Curve Changes projected for the Egbert CS location under RCP 8.5 (AR5)

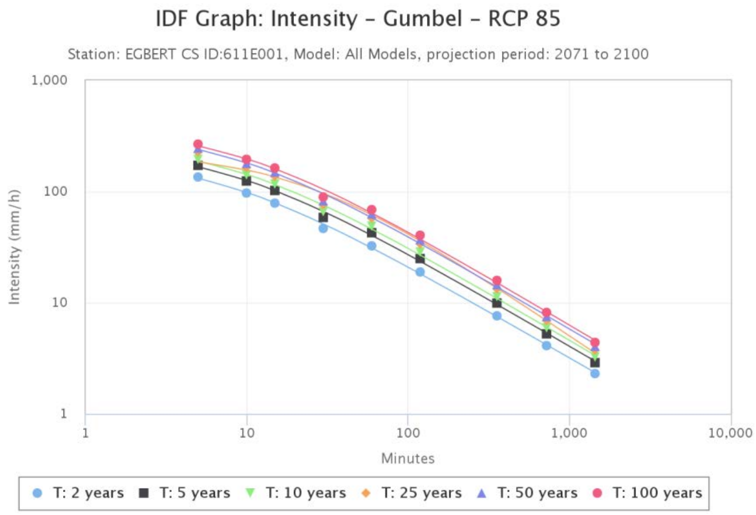

Figure 28: 2020s IDF Curve Changes projected for the Shelburne location under RCP 2.6 (AR5)

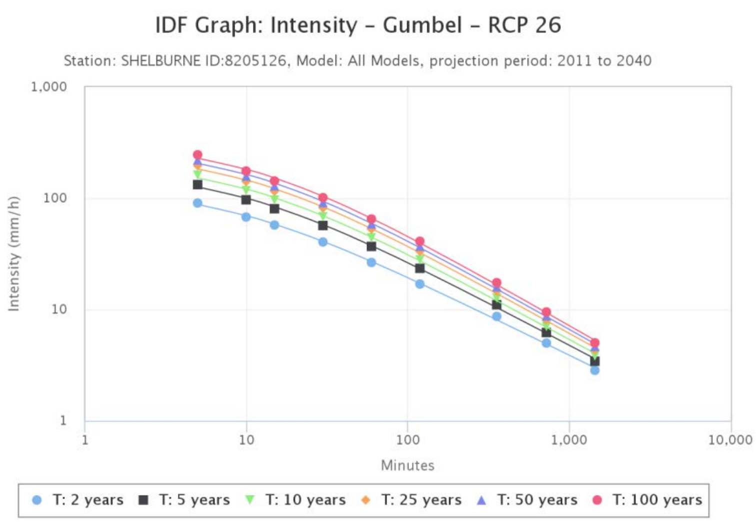

Figure 29: 2020s IDF Curve Changes projected for the Shelburne location under RCP 4.5 (AR5)

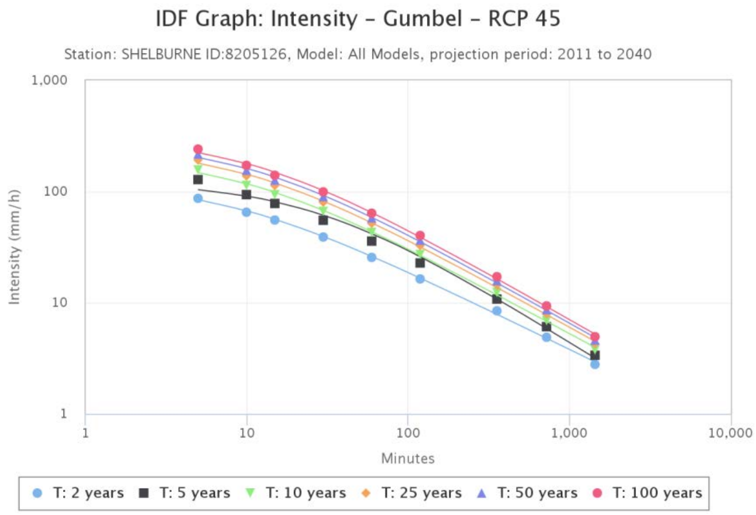

Figure 30: 2020s IDF Curve Changes projected for the Shelburne location under RCP 8.5 (AR5)

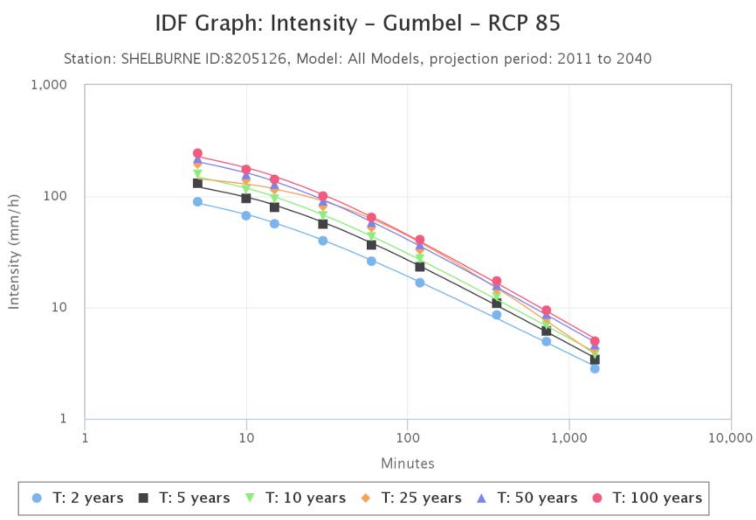

Figure 31: 2050s IDF Curve Changes projected for the Shelburne location under RCP 2.6 (AR5)

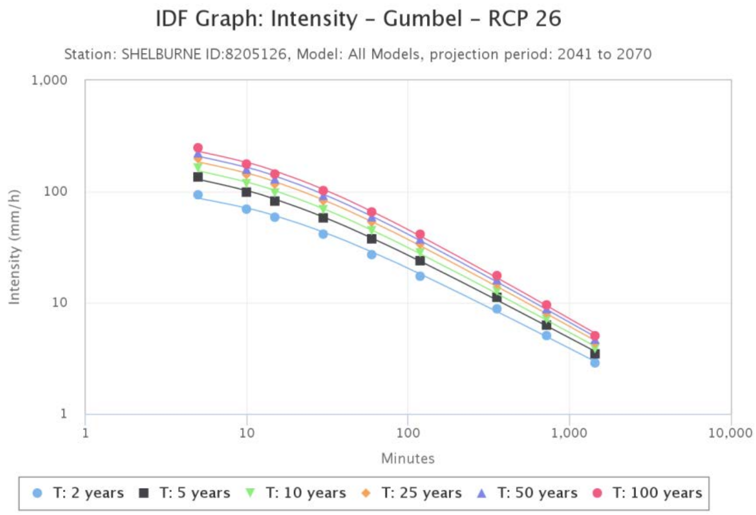

Figure 32: 2050s IDF Curve Changes projected for the Shelburne location under RCP 4.5 (AR5)

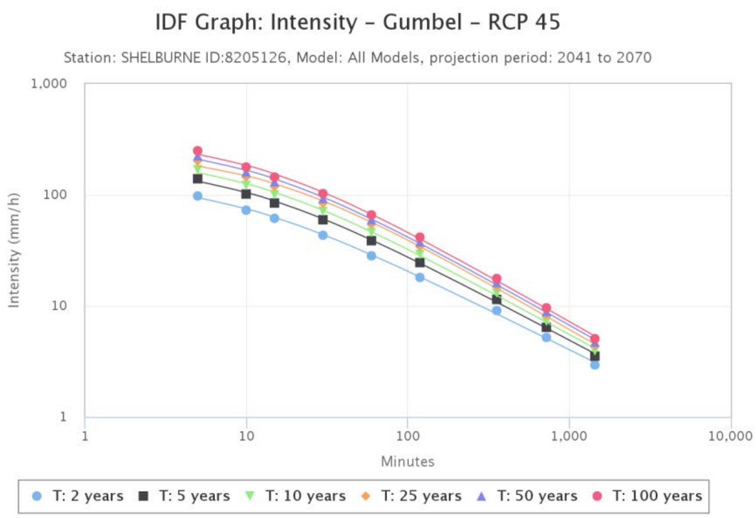

Figure 33: 2050s IDF Curve Changes projected for the Shelburne location under RCP 8.5 (AR5)

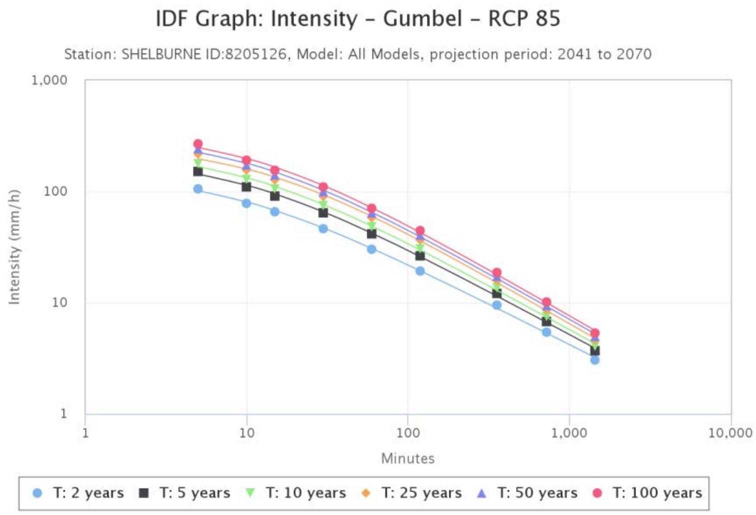

Figure 34: 2080s IDF Curve Changes projected for the Shelburne location under RCP 2.6 (AR5)

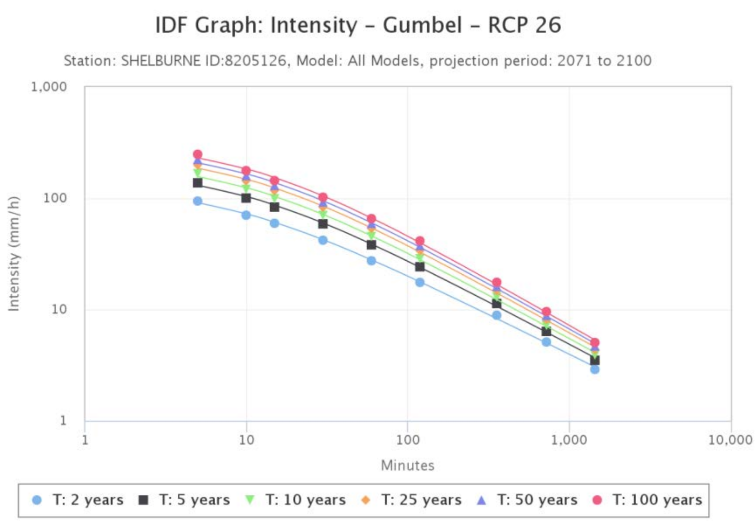

Figure 35: 2080s IDF Curve Changes projected for the Shelburne location under RCP 4.5 (AR5)

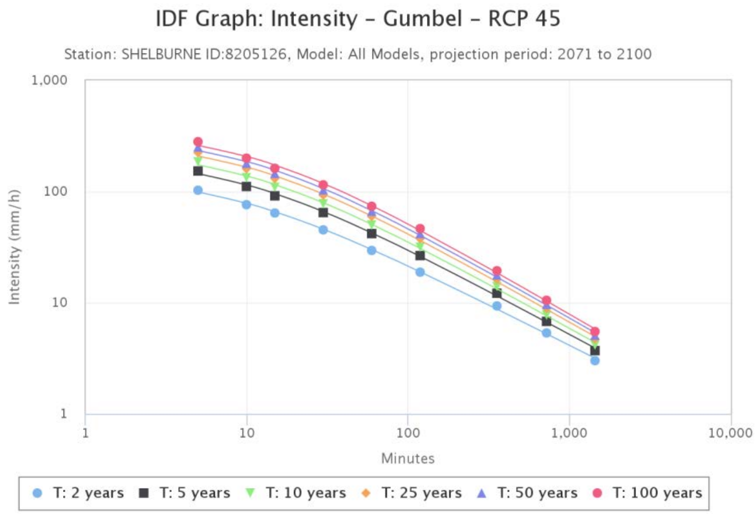

Figure 36: 2080s IDF Curve Changes projected for the Shelburne location under RCP 8.5 (AR5)