Appendix A: Hydrology File Note

Tonkin+Taylor

File Note

To:	**Sarah Basheer**	**Job No:**	**19883.1702**
From:	**John Hansford**	**Date:**	**1 September 2017**
Subject:	**Tauranga Taupo River Flood hydrographs**		

1 Introduction

This memo addresses the tasks requested with respect to flood hydrographs in the Tauranga Taupo River, namely:

- Review the hydrograph shape proposed by Waikato Regional Council (WRC) for the Tauranga Taupo River at Te Kono
- Determine 1% AEP rainfall for the catchment for present day and projected climate change to 2090
- Generate flood hydrographs for the Te Kono Catchment using HEC-HMS and compare the shape to the proposed WRC hydrograph and select an appropriate storm duration
- Generate design hydrographs using HEC-HMS for a present day storm rainfall and storm rainfall projected to 2090 to allow for climate change, and
- Prepare a report that presents the work done (this memo).

2 Tauranga Taupo River: Revised design hydrograph shape

WRC used the hydrographs from the six largest observed flood events at the streamflow gauge in the Tauranga Taupo River at Te Kono (catchment area 197.5 km^2) as a basis for generating a design hydrograph shape that could also be used for the full 217.8 km^2 catchment. Frequency analysis were carried out on the observed annual maxima at Te Kono to gain perspective on the magnitude of the largest observed floods. Figure 2.1 shows the observed maxima plotted using a Gringorten plotting position together with some commonly used frequency distributions.

These six largest events, peak discharges and average recurrence interval (ARI), based on the frequency distributions, are summarised in Table 2.1.

Table 2.1: Events used by WRC to generate a design hydrograph for the Tauranga Taupo River

Date of peak discharge	Hydrograph peak (m^3/s)	ARI (years) based on frequency distributions
10 March 1990	225	9
2 July 1998	263	20
10 July 1998	240	12
2 October 2000	271	23
7 December 2001	296	40

20 June 2015	248	15

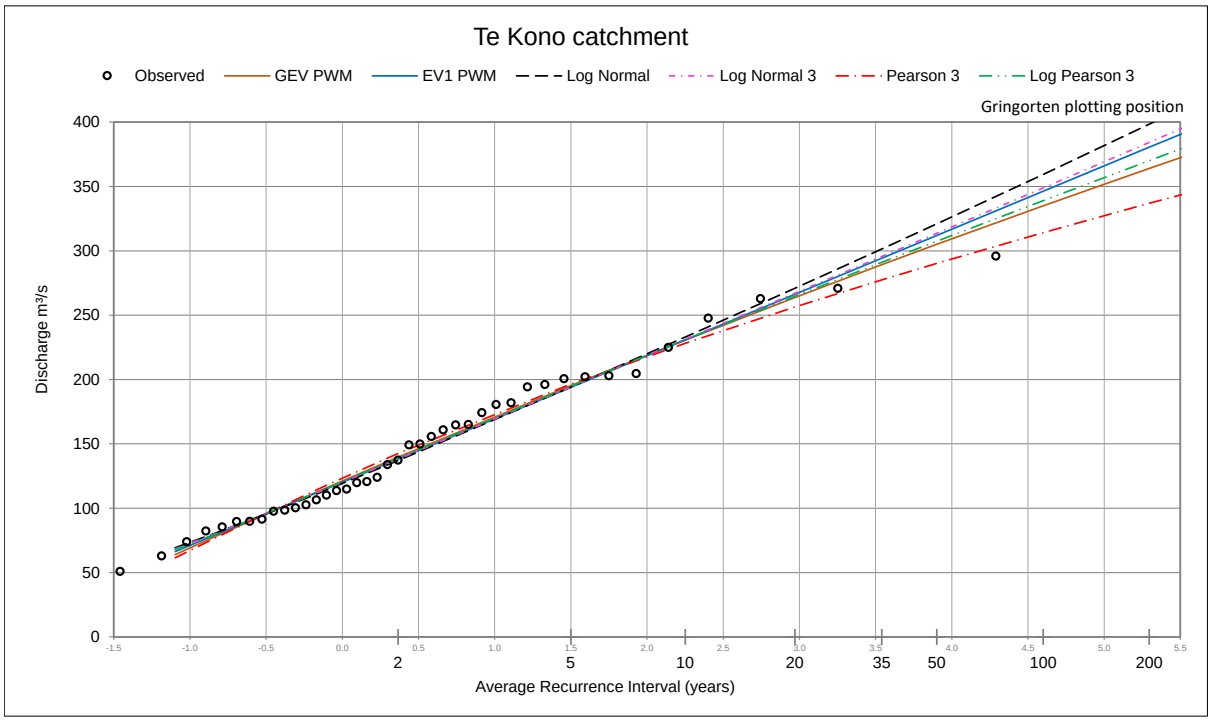

Figure 2.1: Tauranga Taupo River at Te Kono: Frequency distributions

The six largest observed flood hydrographs measured at Te Kono are shown in Figure 2.2.

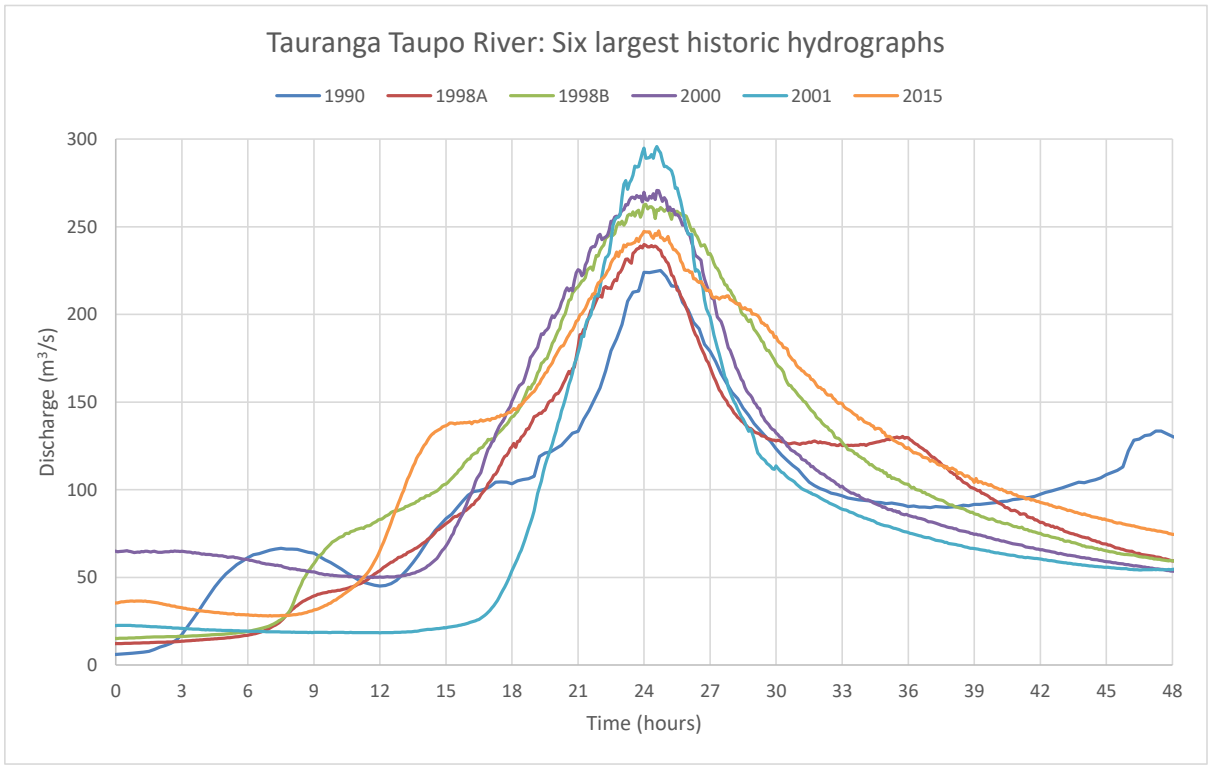

Figure 2.2: Tauranga Taupo River at Te Kono: Six largest historic hydrographs

WRC generated a design hydrograph by normalising the observed hydrographs by dividing flows by the hydrograph peak and then averaging the normalised hydrographs. Inspection of the hydrographs shown in Figure 2.2 shows that the 1990 hydrograph is not a typical single event hydrograph and could be excluded from calculation of the design hydrograph. Normalised hydrographs for the six events as well as the WRC Average (all six events) and T+T Average (excluding 1990 event) are shown in Figure 2.3.

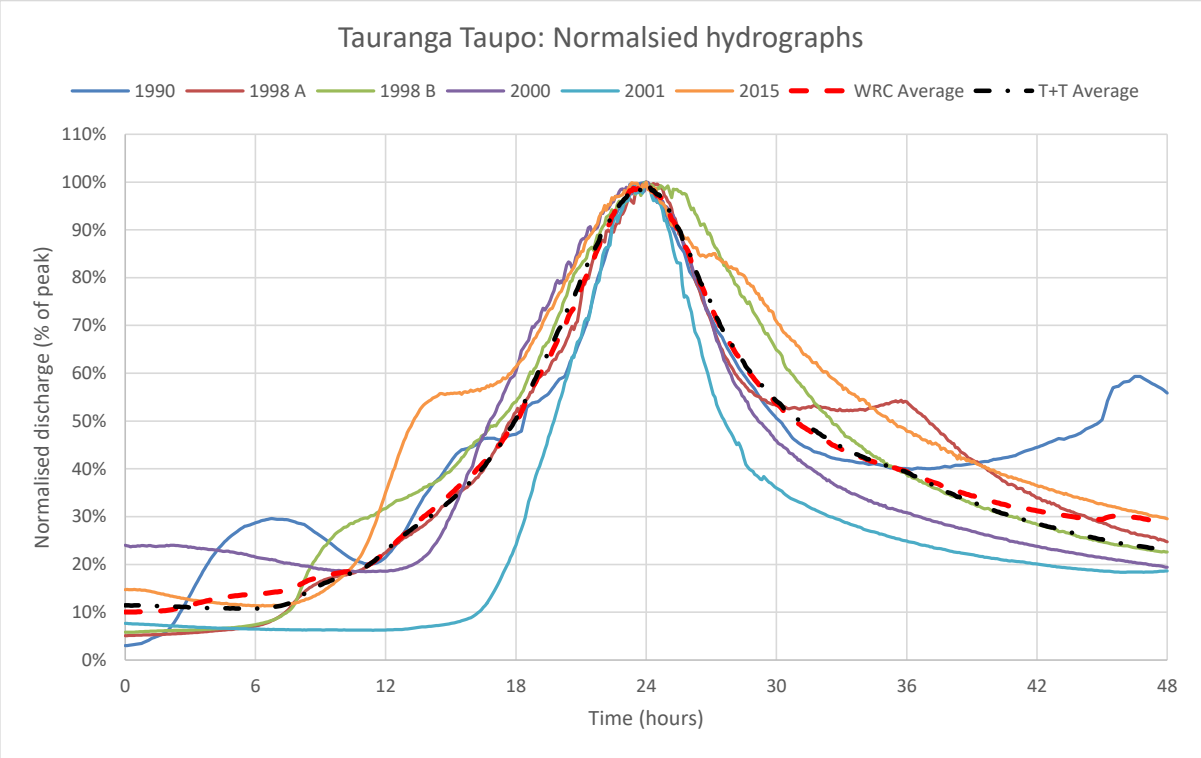

Figure 2.3: Tauranga Taupo River at Te Kono: Normalised hydrographs

The T+T Average hydrograph is preferred because it is less affected by secondary rainfall occurring before and after the 1990 event cause elevated flows.

3 Storm rainfall

Storm rainfall was estimated based on the HIRDS V3 database for present day and projected climate change to 2090 (2.1°C increase in temperature) for a location near the centroid of the catchment. These data are shown in Table 3.1

Table 3.1: HIRDS V3 data for Tauranga Taupo Catchment

High Intensity Rainfall System V3											
Depth-Duration-Frequency results (produced on Tuesday 29th of August 2017)											
Sitename: Tauranga Taupo Catchment											
Coordinate system: NZTM2000											
Easting: 1863700											
Northing: 5677200											
Rainfall depths (mm)											
		Duration									
ARI (y)	AEP	10m	20m	30m	60m	2h	6h	12h	24h	48h	72h
1.58	0.633	8.7	12.3	15.2	21.7	30.0	50.2	69.4	96.1	117.9	132.9

2	0.5	9.6	13.6	16.8	23.9	32.9	54.6	75.1	103.3	126.8	142.9
5	0.2	13.0	18.5	22.8	32.5	43.9	70.8	95.6	129.2	158.6	178.7
10	0.1	15.9	22.7	27.9	39.8	53.1	84.0	112.2	149.9	183.9	207.3
20	0.05	19.3	27.5	33.9	48.3	63.7	99.0	130.8	172.7	212.0	238.9
30	0.033	21.6	30.8	37.9	54.0	70.8	108.9	142.9	187.4	230.0	259.3
40	0.025	23.3	33.3	41.0	58.4	76.3	116.4	152.0	198.5	243.6	274.6
50	0.02	24.8	35.4	43.5	62.0	80.7	122.6	159.5	207.6	254.7	287.1
60	0.017	26.1	37.2	45.7	65.2	84.6	127.9	165.9	215.3	264.2	297.8
80	0.012	28.2	40.2	49.4	70.5	91.1	136.6	176.5	227.9	279.7	315.3
100	0.01	29.9	42.7	52.5	74.9	96.4	143.8	185.1	238.3	292.4	329.6
Projected temperature change: 2.1 degree Celsius											
Rainfall depths (mm)											
		Duration									
ARI (y)	AEP	10m	20m	30m	60m	2h	6h	12h	24h	48h	72h
1.58	0.633	10.2	14.3	17.5	24.8	33.9	55.8	76.4	104.8	127.3	142.7
2	0.5	11.2	15.8	19.3	27.3	37.2	60.7	82.7	112.6	136.9	153.4
5	0.2	15.2	21.5	26.3	37.3	50.1	79.9	107.2	143.9	175.3	196.7
10	0.1	18.6	26.4	32.4	46.0	61.1	96.0	127.5	169.7	207.5	233.0
20	0.05	22.5	32.1	39.5	56.1	73.9	114.4	150.9	198.8	243.6	274.0
30	0.033	25.2	36.0	44.3	63.1	82.7	127.2	166.9	218.9	267.7	301.2
40	0.025	27.2	38.9	47.9	68.2	89.1	136.0	177.5	231.8	284.0	319.9
50	0.02	29.0	41.3	50.8	72.4	94.3	143.2	186.3	242.5	297.5	335.3
60	0.017	30.5	43.4	53.4	76.2	98.8	149.4	193.8	251.5	308.6	347.8
80	0.012	32.9	47.0	57.7	82.3	106.4	159.5	206.2	266.2	326.7	368.3
100	0.01	34.9	49.9	61.3	87.5	112.6	168.0	216.2	278.3	341.5	385.0

The data in Table 3.1 were used to determine storm rainfall data for input to the frequency storm module in HEC-HMS. The HEC-HMS frequency storm module requires 3 hour, 15 minute and 5 minute rainfall that are not included in the HIRDS table so these depths were estimated by graphical interpolation with care taken to preserve the shape of the curves.

Analysis of the storm rainfall shows that the impact of climate change is to reduce a 1% AEP to 2% AEP.

4 Design hydrographs

Hydrograph peaks, determined in the frequency analysis (Section 2) are summarised in Table 4.1.

Table 4.1: Summary of flood frequency analysis results

AEP (%)	Discharge (m^3/s)
50	140
20	195
10	231
5	264
2	305
1	335
0.5	364

Design hydrographs for a 1% AEP design storm were generated using HEC-HMS. Initial model parameters were estimated based on land use, soil permeability, catchment slope and longest water course. These parameters were adjusted to improve the comparison between the simulated hydrograph and the design hydrograph generated as the average of five of the largest historic

hydrographs (1990 was excluded) and scaled to the 1% AEP peak. The simulated hydrograph for a 48 hour design storm together with the T+T Average hydrograph scaled to 1% AEP peak and the six largest observed hydrographs at Te Kono are shown in Figure 4.1. Figure 4.1 shows that there are differences between 1% AEP HEC-HMS hydrograph and the T+T Average, but the observed hydrographs included in Figure 4.1 indicate that the HEC-HMS hydrograph is a suitable design hydrograph for the catchment.

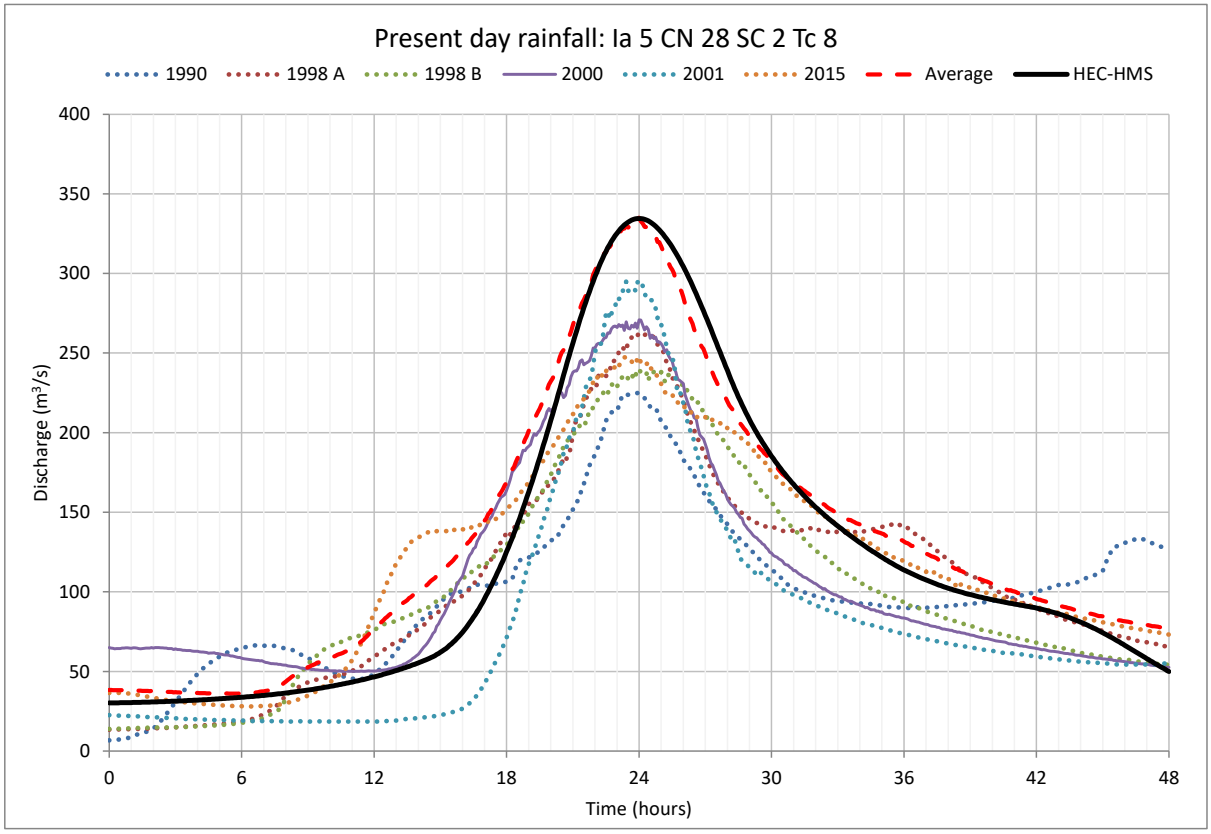

Figure 4.1: Tauranga Taupo River at Te Kono: Simulated and observed hydrographs

The calibrated model was used to generate 1% AEP hydrographs for the full catchment for present and projected 2090 storm rainfall. These hydrographs are shown in Figure 4.2.

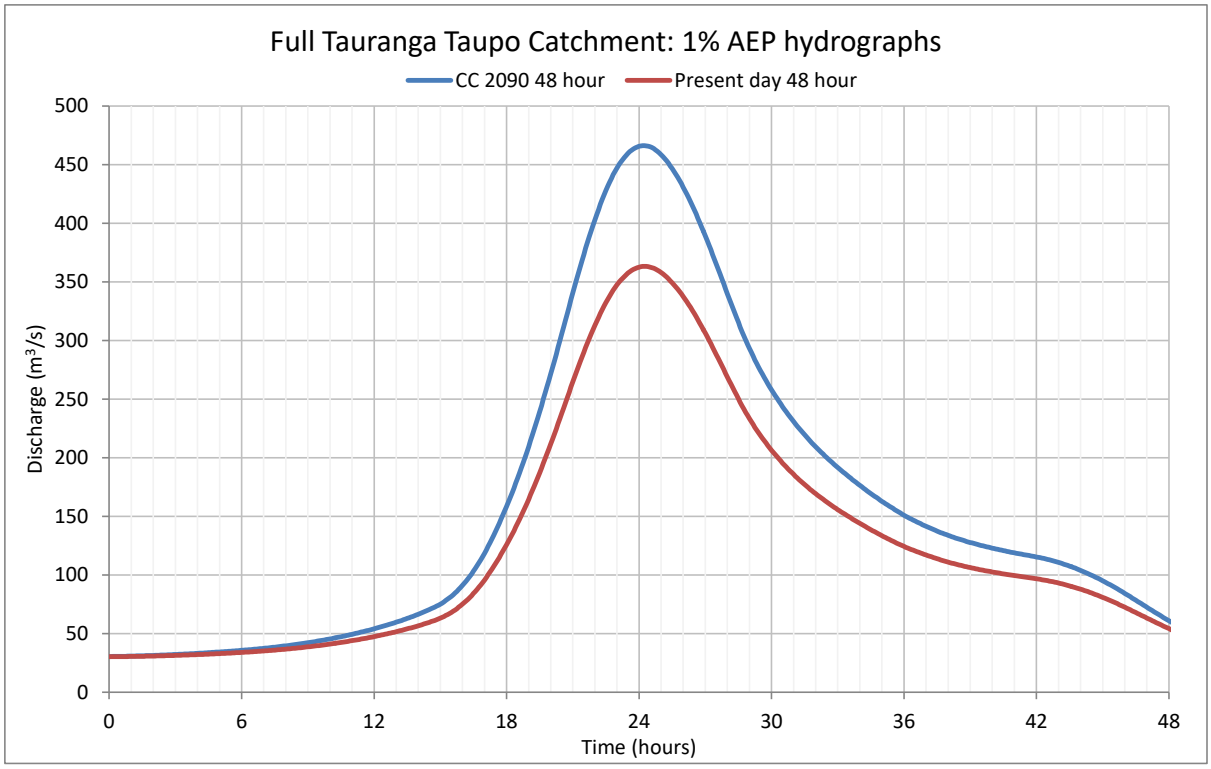

Figure 4.2: Tauranga Taupo Catchment: 48 hour design hydrographs

16-Feb-18
t:\auckland\projects\19883\19883.1702\workingmaterial\report\appendices\a\180216 file note.docx