Herbertville – Flood Risk Assessment

horizons
regional council

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Author
Jon Bell, Design Engineer
Peter Blackwood, Manager Investigations and Design

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CONTACT	**24hr Freephone 0508 800 800**	**help@horizons.govt.nz**	**www.horizons.govt.nz**

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POSTAL ADDRESS	Horizons Regional Council, Private Bag 11025, Manawatu Mail Centre, Palmerston North 4442 | **F** 06 9522 929

FOREWORD

This Flood Risk Assessment has looked at the potential sources and extent of flooding to Herbertville.

The two sources of flooding that have been identified are the Wainui River and surface water run off from the hills behind Herbertville.

Flood Maps have been produced which show the extent of flooding likely to be experienced from a number of possible flood events. These maps are based on the output from a HEC-RAS computer model which was built on the Wainui River through Herbertville. They represent the best hydrological information available and hence can be used to inform planning decisions.

The model outputs include flood levels at numerous points across the flood plain which can be applied to give flood hazard advice on proposed building developments.

This Flood Risk Assessment has also recommended that a Flood Action Plan be drawn up for Herbertville to help protect people and property from future flood events.

The second recommendation is that all future flood levels are recorded so as to improve the knowledge base of flood events in Herbertville.

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Herbertville Flood Risk Assessment

1. Introduction

The purpose of this flood risk assessment is to identify potential sources of, and the extent of, flooding to Herbertville. The objective is to produce a number of flood maps which will show this flooding, and can be used to inform planning decisions.

2. Potential sources of flooding

Photographic evidence of past flooding events in Herbertville, as well as anecdotal evidence from a number of residents identified the Wainui River as the main source of flooding as well as a number of drainage channels which help to convey surface water through the township.

It was noted, during a site visit, that whilst the river is likely to be the largest contributor to flooding in Herbertville, the surface water drains are also likely to be inundated in the event of a local heavy rainfall.

3. Hydrology

3.1 Records of Annual Maxima

There are no flood flow records available for the Wainui River catchment. Consequently, an alternative analysis was employed as described following.

3.2 Flood Analysis Methodology

The following parametric methods were carefully applied:

- Technical Memorandum 61
- Rational Method
- Regional Method

These methods are based on an examination of catchment parameters (slope, length, shape, catchment cover and soil type), rainfall intensities and (in the case of the Regional Method) flood frequency data from nearby catchments. The rainfall intensities were based on the NIWA software HIRDS Version 3. The data from this method has been tested and accepted by Horizons Regional Council.

In order to confirm the validity of these methods, an at-site flood frequency analysis for the neighbouring Akitio at Weber catchment was applied to the continuous series of annual maxima (1980 to 2000). The frequency estimates from this analysis were compared with estimates obtained from the equivalent parametric methods applied to the catchment.

Akitio at Weber Validation

The catchment area upstream of Weber is 126 km^2 and the mean catchment slope is 1.0. The soils are moderately impervious to impervious and around 30% of the catchment is covered in bush. The selected W_{IC} reflecting the infiltration and cover characteristics is 0.97.

The following 1% AEP (100 Year) flood estimates were derived for the Akitio River:

- Technical Memorandum 61 638 cumecs
- Rational Method 444 cumecs
- Regional Method 452 cumecs

Equal weighting was applied to the Technical Memorandum 61 and Regional Method to yield a design parametric 1% AEP estimate of 545 cumecs.

An L-Moments extreme value statistical fitting methodology was applied to the continuous series for both the Extreme Value Type One and General Extreme Value distributions – the latter resulted in an Extreme Value Type Three distribution. The Log Pearson 3 Method was also applied. Inspection of the frequency curve shows that the data conforms to an Extreme Value Type One distribution and this was adopted and yielded a 1% AEP estimate of 594 cumecs. The Akitio flood frequencies estimates are presented in Table 3.1 and Figure 3.1.

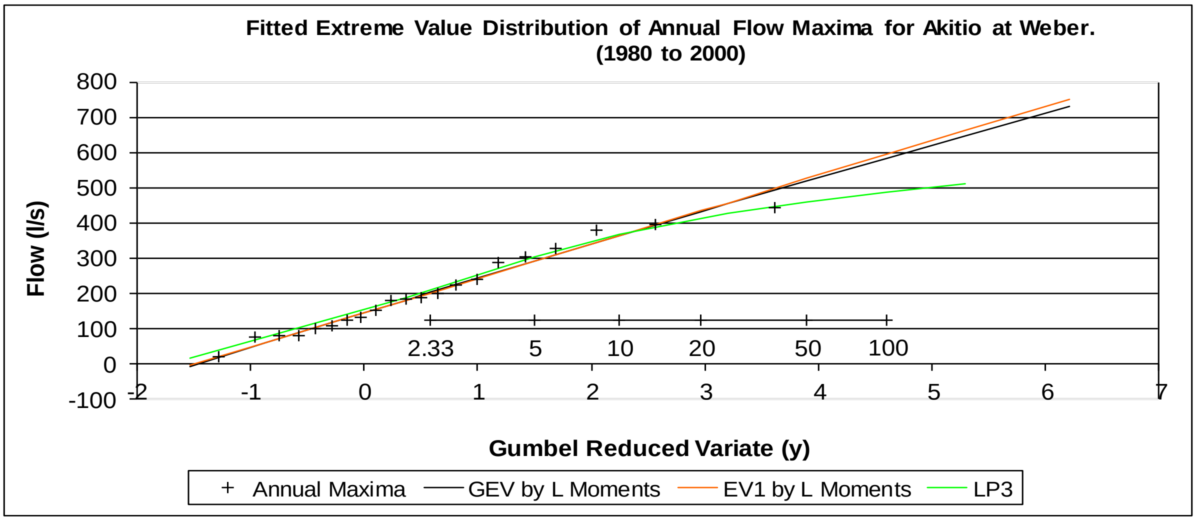
The design estimates are all relatively high for a 126 km^2 eastern catchment. They reflect the extremely compact nature of the catchment which focusses flows to above average sizes. Furthermore, the mean catchment slope is relatively high.

The at-site flood frequency analysis yields a 1% AEP flow some 9% greater than the parametric methods. However, as there are unusual catchment characteristics the parametric methods do appear to give a sound result. Thus they can be applied to the Wainui at Herbertville site with a reasonable degree of confidence.

Table 3.1- Akitio at Weber Flood Frequency Estimates (cumecs)

Return Period		EV1	GEV	LogPearson3	
T	**Y_T**	**Q_{T1}**	**Q_{T2}**	**K**	**Q_{T3}**
1.01	-1.5293	-4	-8	-3.107	17
1.1	-0.8746	59	58	-	-
1.5	-0.0940	136	136	-	-
2	0.3665	181	182	0.185	188
2.33	0.5786	201	203	-	-
5	1.4999	291	292	0.847	304
10	2.2504	364	364	1.100	366
20	2.9702	435	433	-	-
25	3.1985	457	454	1.310	427
50	3.9019	526	520	1.417	461
100	4.6001	594	584	1.495	489
200	5.2958	662	647	1.555	510
500	6.2136	751	729	-	-

Figure 3.1 - Akitio at Weber Flood Frequency Estimates (cumecs)

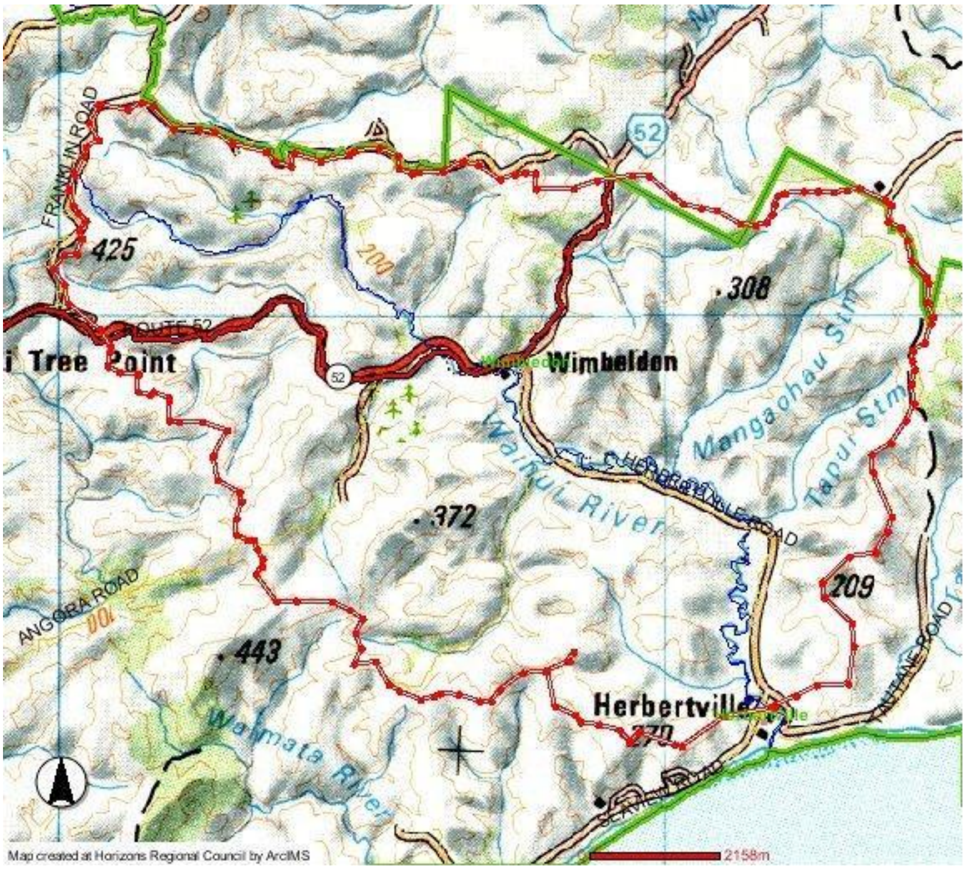


3.3 Flood Frequency Estimates for Wainui River at Herbertville

The Wainui at Herbertville has a catchment area of 94.6 km^2 and mean catchment slope of 0.45%. The soils are moderately impervious to impervious and just under 10% of the catchment is covered in bush. The selected W_{IC} reflecting the infiltration and cover characteristics is 1.05.

The catchment is shown in Figure 3.2

Figure 3.2 - Wainui at Herbertville Catchment



To apply the Regional Method it was necessary to update the flood contours in the publication "*Flood Frequency in New Zealand*", 1989, A.I.McKerchar and C.P.Pearson, Publication No 20 of the Hydrology Centre, Christchurch (FFINZ). Values for the mean annual flood were obtained at three neighbouring sites:

- Akitio River at Weber — 201 cumecs (1980-2000)
- Taurekaitai Stream at Wallingford — 183 cumecs (1981-2011)
- Whareama at Waiteko — 350 cumecs (1971-2012 includes a large flood 2012)

From these sites the calculated ratios of the mean annual flood to the catchment area to the power of 0.8 ($\bar{Q}/A^{0.8}$) were as follows:

- Akitio River at Weber 4.20
- Taurekaitai Stream at Wallingford 1.99
- Whareama at Waiteko 2.90

After examining this data and the original FFINZ contour map, a figure of 3.0 was selected for the Wainui catchment. The ratio of the 1% AEP flood to the mean annual flood (q_{100}) was determined as 2.95, based on the slope of the Akitio at Weber frequency curve. This closely corroborates the original FFINZ map.

The following 1% AEP (100 Year) flood estimates were consequently derived for the Wainui River:

- Technical Memorandum 61 272 cumecs
- Rational Method 288 cumecs
- Regional Method 336 cumecs

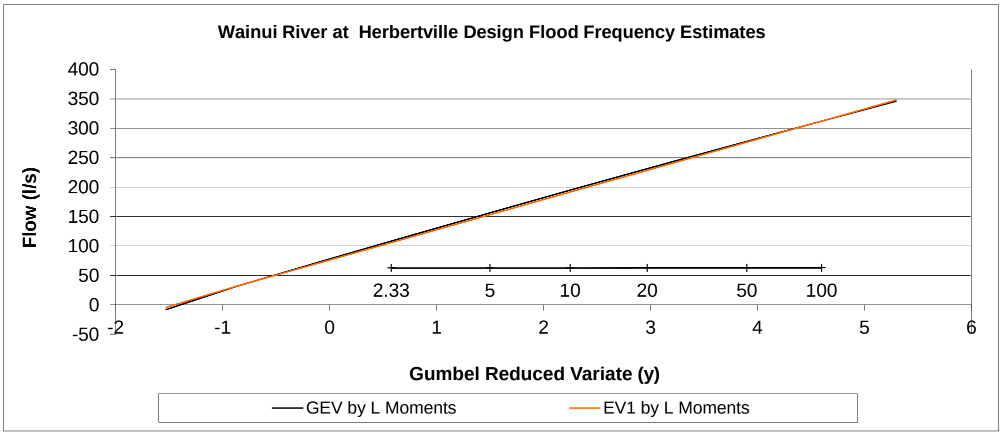
Equal weighting was applied to the Rational and Regional Method to yield a design parametric 1% AEP estimate of 312 cumecs. Refer details in Appendix A.

The design flood frequency estimates are based on the 1% AEP estimate combined with the slope of the Akitio at Weber frequency curve. They are presented in Table 3.2 and Figure 3.3.

Table 3.2 - Whanganui at Paetawa Flood Frequency Estimates (cumecs)

Return Period	Y_T	EV1	GEV
1.1	0.8746	31	31
1.5	0.0940	71	73
2	0.3665	95	97
2.33	0.5786	106	108
5	1.4999	153	156
10	2.2504	192	195
20	2.9702	229	231
25	3.1985	240	243
50	3.9019	276	278
100	4.6001	312	312
200	5.2958	348	346

Figure 3.3 - Wainui at Herbertville Flood Frequency



3.4 Coastal Catchment Flood Frequency Estimates

In addition to the flood flows in the Wainui River, it was identified that Herbertville could also be subject to surface water flooding from the rain falling on the hills behind Herbertville. An analysis of the topography of the area revealed that this water would enter Herbertville via two potential routes. These being via the golf course creek and the township drain (as shown in Figure 4.1).

Estimates of the flows that would be seen at each of these locations were estimated using the Technical Memorandum 61, Rational Method and the FFINZ method as previously discussed. Using a topographic map of the area the catchment areas that feed the two sources were calculated to be 0.18 km^2 and 0.09 km^2 for the golf course creek and the township drain respectively.

The results, which can be seen in Appendix B, provided estimates of the 5% AEP and 1% AEP flows for each of these sources.

4. Computer model of the Wainui River at Herbertville

To analyse the flood risk to Herbertville, a computer model was built to show how flooding from both the Wainui River and the drainage channels could affect the township.

The computer model was built using HEC-RAS modelling software, as it has the capability to perform an unsteady analysis of river flows.

The model was built up using cross-sectional information obtained from a survey of the Wainui River conducted in June 2012, as well as information obtained from a LiDAR survey of the area. The locations of these cross sections can be seen in Appendix C.

The use of the LiDAR data allowed the river cross sections to be extended, so that an accurate flood map across the flood plain could be produced.

Figure 4.1 shows a marked up aerial image of Herbertville showing the channels that were built into the model.

Figure 4.1 - Computer model channels

4.1 Modelled structures and flow paths

To accurately represent flows around Herbertville a number of structures were included in the model. These structures are described in the following subsections.

4.1.1 Road Bridge over Wainui River

The most significant structure to be included in the model was the road bridge over the Wainui River that leads to Herbertville itself. This bridge was included in the model as it is likely to be a significant hydraulic structure when the river is in flood.

The bridge was modelled as a flat decked bridge supported by two piers. The elevations of the deck were determined by the survey of the site, and the pier widths are taken from a visual estimation. In the model an allowance was made for debris loading on the piers as may well occur in a flood event.

4.1.2 Structures at the Upstream End of the Golf Course Creek

As Figure 4.1 shows this creek passes under the road (at point A), through a 600 mm culvert, at its upstream end. This culvert has been included in the model as it acts as a throttle to flows. The site visit identified the fact that any flows that could not pass through this culvert would flow along a roadside drain to meet up with the township drain at point B. This overflow into the roadside drain was also included in the model.

4.1.3 Culverts on the Township drain

There are two culverts on the drain through the township which have been included in the model.

The first of these culverts is a 600 mm culvert which carries the drain under the road. This culvert was modelled as such, using the culvert modelling capability of HEC-RAS.

The second culvert is a long 600 mm culvert which carries low flows underneath the campsite to the Wainui River just downstream of the road bridge. This culvert has a flap gate at the river end. This culvert was modelled as a diversion structure in HEC-RAS.

Any flows that could not be carried by the culvert to the Wainui River were modelled as flowing through the township drain to meet the golf course creek.

4.2 Model Inputs

The inputs to the model were

- Flows at the upstream end of the Wainui River reach. These were inputted as flow hydrographs, the peaks of which corresponded to the flows calculated from the catchment hydrology, and fitted to flood hydrographs from the adjacent Akitio catchment.
- Flows at the upstream end of the golf course creek and township drain. These were inputted as hydrographs with a peak calculated from the catchment hydrology, and staged so as to coincide with peak river flows.
- A downstream river level of 1.3 m which represents a high sea level with a storm surge.

4.3 Model Calibration

The model was calibrated by using a known flood level in the campsite, which was associated with a flood that was assumed to be a 1 in 20 year event. The Manning's n values used to describe the roughness of the river channel were altered until the 20 year flood flow reached the correct flood level. This meant that a Manning's n value of 0.048 was used to describe the channel roughness. This value is a little higher than theory suggests for the channel, although it is similar to values used for similar rivers in other computer models.

The value of Manning's n for the other channels and culverts was taken from theoretical values as there was no information with which to calibrate flood depths from these sources.

5. Results

The model was run for the following scenarios, and corresponding flood maps were produced from the results:

1. 20 year flood flow in the Wainui River and 20 year surface water flow in creek and drain,

2. 50 year flood flow in the Wainui River and 20 year surface water flow in creek and drain,
3. 100 year flood flow in the Wainui River and 20 year surface water flow in creek and drain,
4. 200 year flood flow in the Wainui River and 20 year surface water flow in creek and drain, and
5. 20 year flood flow in the Wainui River and 100 year surface water flow in creek and drain.

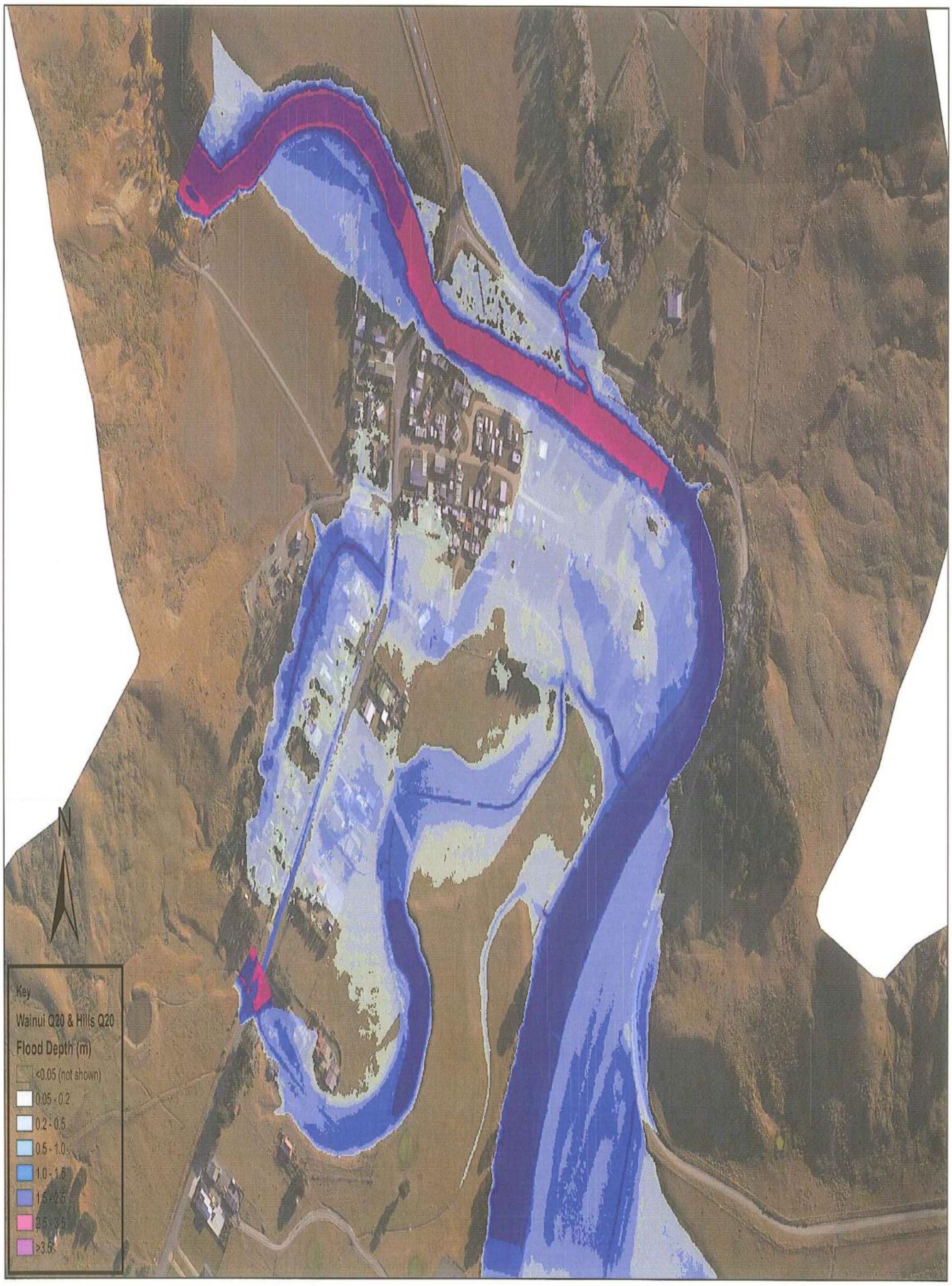
The maps that were produced can be seen on the following pages.

As the maps show, the main source of flooding is from the Wainui River. This is evident from maps 1 and 5. Both of these maps show the flooding that could be caused by a 1 in 20 year flood event in the Wainui River, but with different surface water flows. As can be seen, the increase in flood depths caused by a 1 in 100 year surface water flow compared by that caused by a 1 in 20 year event is minimal. This is not a surprising result when one considers the small volumes of water involved compared with the volumes from the Wainui River.

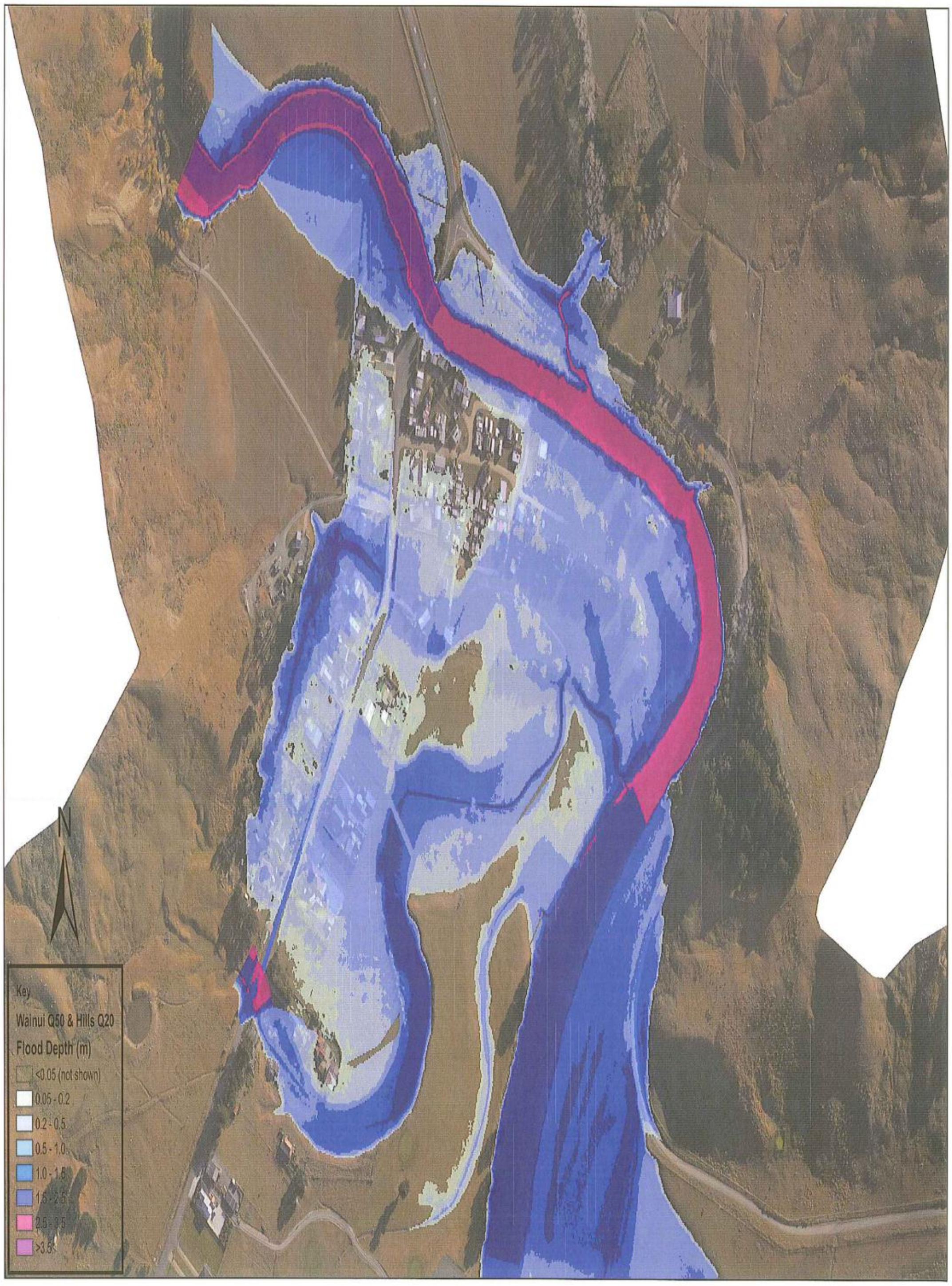
5.1 Errors

When looking at the flood maps there are two parts of the flood outline that should be ignored. Firstly, there is the area of deep water shown at the end of the golf course creek. This is an outline that the model produces early in its run before it has balanced the water levels around the culvert under the road. It also appears that water flows along the road, however this flow is contained within the roadside drain.

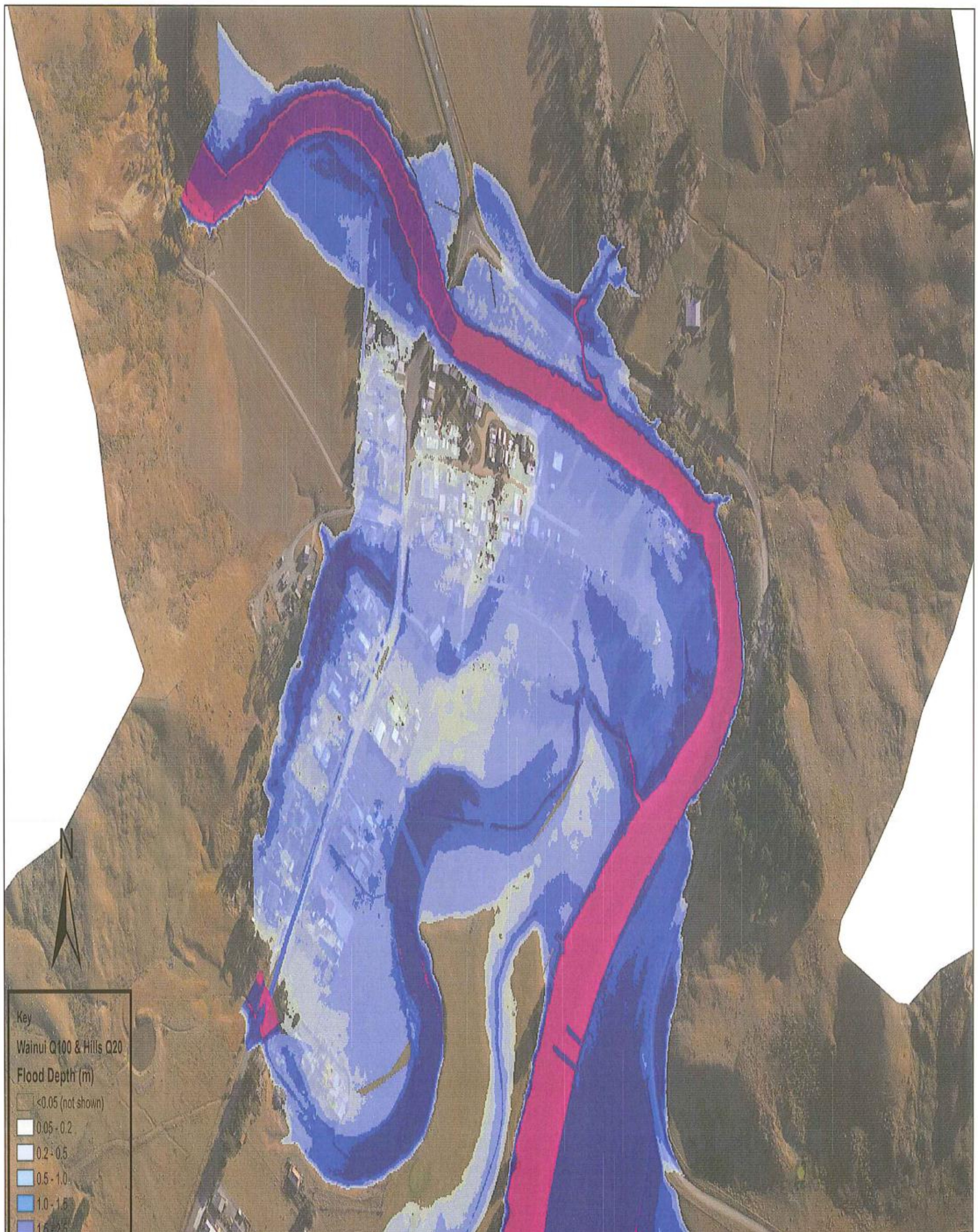
Herbertville Flood Map 1 - Wainui River 5% AEP flow & 5% AEP surface water flows



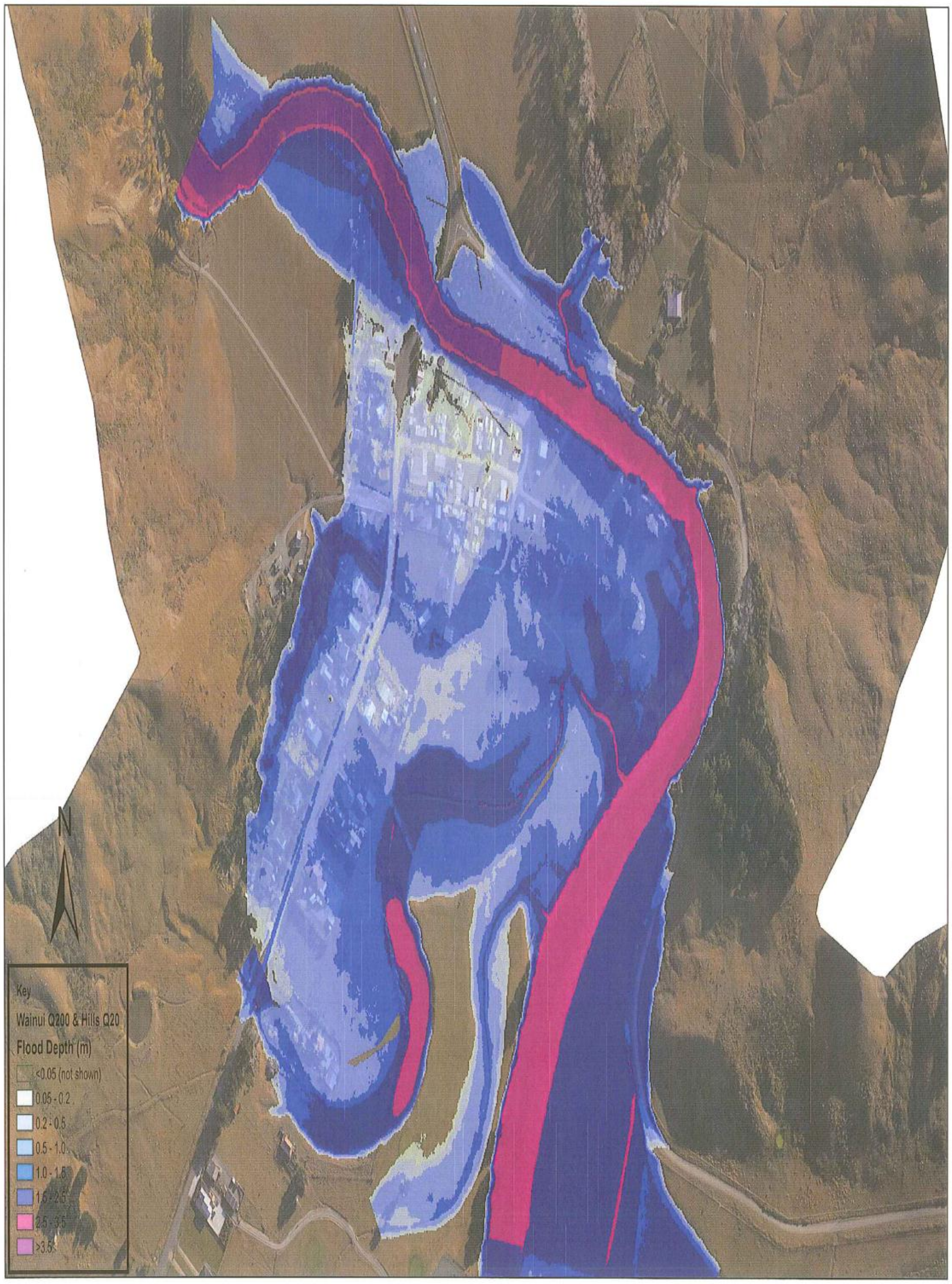
Herbertville Flood Map 2 - Wainui River 2% AEP flow & 5% AEP surface water flows



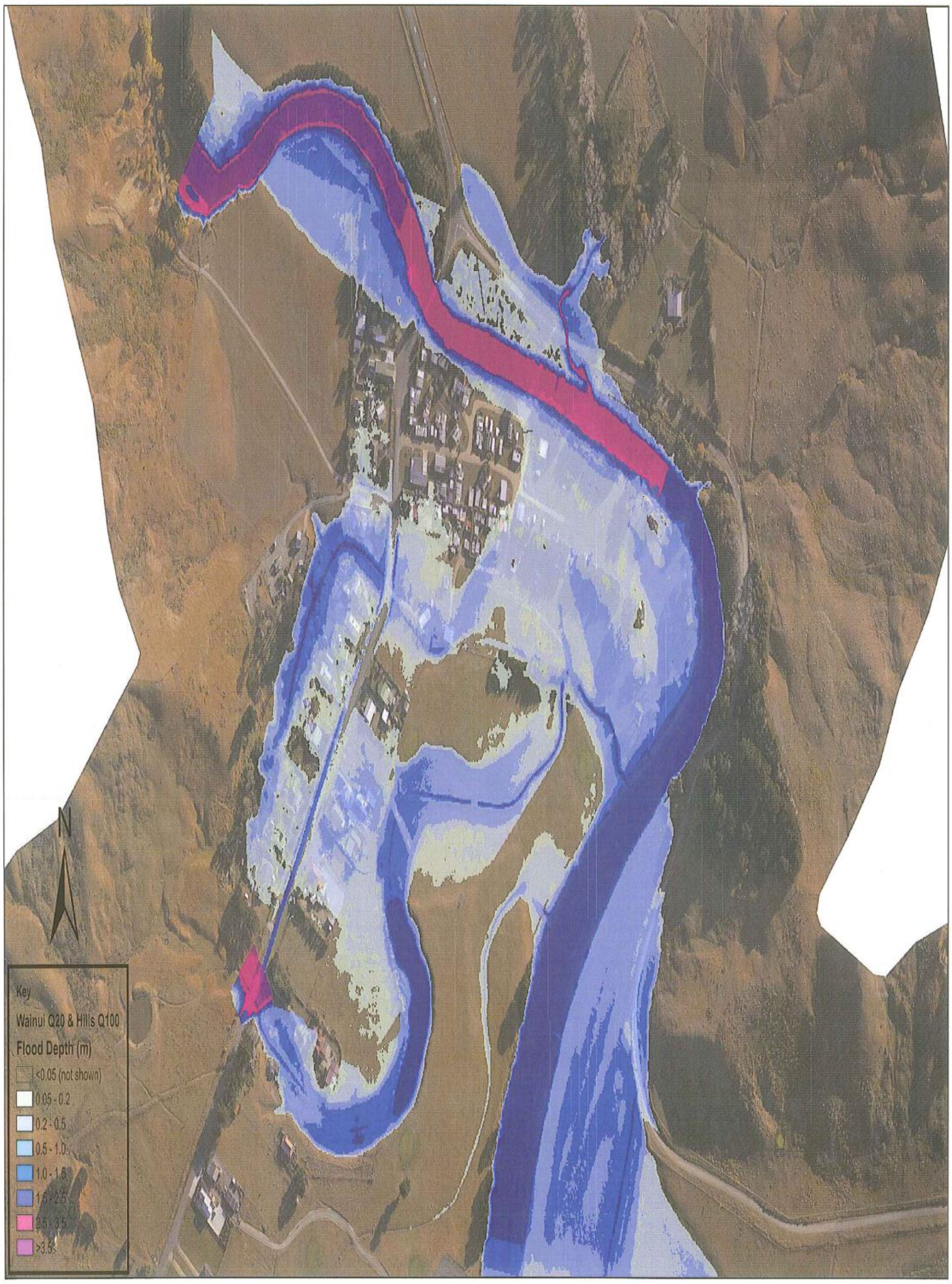
Herbertville Flood Map 3 - Wainui River 1% AEP flow & 5% AEP surface water flows



Herbertville Flood Map 4 - Wainui River 0.5% AEP flow & 5% AEP surface water flows



Herbertville Flood Map 5 - Wainui River 5% AEP flow & 1% AEP surface water flows



6. Recommendations

This Flood Risk Assessment has produced a number of flood maps which show the areas of Herbertville which are likely to be inundated during flood events.

These maps have been produced from a computer model using the best available information relating to flood frequencies and corresponding flood levels. The maps are hence the best available information with which to inform planning decisions.

The model outputs include flood levels at numerous points across the flood plain which can be applied to give flood hazard advice on proposed building developments.

It is recommended that a Flood Action Plan be devised for the Herbertville township to help protect people and property from future flood events.

It is further recommended to continue to record flood levels in future events to improve the knowledge base around flooding from the Wainui River.

Appendix A: Wainui at Herbertville Frequency Estimates

Technical Memorandum 61, MWD

Stream name	Wainui at Herbertville			Date	30-May-12					
Return period, years	10,100									
				h	distance	slope				
Area, km^2	A	94.3	Slope	1	0			61240	n	n * l
Direct length, km	Ld	14.7		20	10976	0.002	263809	72216	0.0335	368.041
Stream length, km	L	27.36		120	22490	0.009	123549	83730	0.0447	514.471
Ave slope, m/m	Sa	0.0045		160	23220	0.055	3119	84460	0.0620	45.274
Height difference, m	H	424		180	23382	0.123	461	84622	0.0717	11.610
Time of concentration, mins	Tc	408.1		240	25174	0.033	9793	86414	0.0568	101.809
	Tc	573.9		340	26668	0.067	5775	87908	0.0643	96.017
	Tc	253.0		380	27042	0.107	1144	88282	0.0699	26.128
McKerchar & Griffiths 2012	Tc	323.0	n= 0.0413	420	27241	0.201	444	88481	0.0782	15.555
	Ave	389.5		425	27360	0.042	581	88600	0.0592	7.040
	Use	360	Average slope				0.0045			0.0433
Chart 1, from Sa, L	Ws	48								
	Wic	1.05								
	W	50.4								
Chart 2 from W	C	1060								
Design/Standard rainfall	R10	0.36			R100	0.65				
Shape factor, chart 3	S	0.94	K=A/Ld^2	0.436392						
Area	A	94.3								
Flow rate, m^3/s	Q10	150.9			Q100	272.4				

Rational Method

Area, km^2	A	94.3		
Runoff Coefficient	C	0.5	(0.20+0+0.10+0.10+0.10)	
Rainfall Intensity, mm/hr	I	12.2		22
Flow rate, m^3/s	Q	159.8		288.1

FFINZ

Area, km^2	A	94.3		**McKerchar & Griffiths 2012**				
Mean Annual Flood Contour		3	FFINZ	P2=	7.6		C2=	0.5
Mean Annual Flood, cumecs	Qmean	114.0		Qmean	99.5			
Q100 Flood Contour		2.95	(Akitio Data)		2.95	(Akitio Data)		
Q100, cumecs	Q100	336.2		Q100	293.6			

Design Method Selected:

Average Rational & FFINZ

Q2,cumecs	**95.1**	**(Applying Slope of Akitio Frequency Curve)**
Q5, cumecs	**152.9**	
Q10, cumecs	**191.3**	
Q20, cumecs	**228.6**	
Q50, cumecs	**276.4**	
Q100, cumecs	**312.2**	
Q200, cumecs	**347.9**	

Appendix B: Frequency Analysis for the Golf Course Creek and Township Drain

Technical Memorandum 61, MWD

Stream name	Herbertville - Golf Course Creek				Date	22-Jun-12	
Return period, years	20,100						
Area, km^2	A	0.18					
Direct length, km	Ld	0.545					
Stream length, km	L	0.585					
Ave slope, m/m	Sa	0.124					
Height difference, m	H	72.5					
Time of concentration, mins	Tc	5.9					
	Tc	15.1					
	Tc	5.9					
	Ave	9.0					
	Use	9					
Chart 1, from Sa, L	Ws	89					
	Wic	1.05					
	W	93.45					
Chart 2 from W	C	3500					
Design/Standard rainfall	R10	0.36				R100	0.65
Shape factor, chart 3	S	1.09		K=A/Ld^2	0.60601		
Area	A	0.18					
Flow rate, m^3/s	Q20	5.3				Q100	9.5

Rational Method

Area, km^2	A	0.18		
Runoff Coefficient	C	0.55	*Assumed*	
Rainfall Intensity, mm/hr	I	12.2		22
Flow rate, m^3/s	Q	0.3		0.6

FFINZ

Area, km^2	A	0.18	
Mean Annual Flood Contour		3	
Mean Annual Flood, cumecs	Qmean	0.8	
Q100 Flood Contour		2.95	(Atikio Data)
Q100, cumecs	Q100	2.2	

Design Method Selected:

Average TM61 & FFINZ

Q20, cumecs	3.3
Q100, cumecs	5.9

Technical Memorandum 61, MWD

Stream name	Herbertville - Township Drain				Date	22-Jun-12	
Return period, years	20,100						
Area, km^2	A	0.087					
Direct length, km	Ld	0.545					
Stream length, km	L	0.585					
Ave slope, m/m	Sa	0.124					
Height difference, m	H	72.5					
Time of concentration, mins	Tc	5.9					
	Tc	16.3					
	Tc	5.9					
	Ave	9.4					
	Use	9					
Chart 1, from Sa, L	Ws	89					
	Wic	1.05					
	W	93.45					
Chart 2 from W	C	3500					
Design/Standard rainfall	R10	0.36				R100	0.65
Shape factor, chart 3	S	1.09	K=A/Ld^2	0.292905			
Area	A	0.087					
Flow rate, m^3/s	Q20	3.1				Q100	5.5

Rational Method

Area, km^2	A	0.087		
Runoff Coefficient	C	0.55	*Assumed*	
Rainfall Intensity, mm/hr	I	12.2		22
Flow rate, m^3/s	Q	0.2		0.3

FFINZ

Area, km^2	A	0.087	
Mean Annual Flood Contour		3	
Mean Annual Flood, cumecs	Qmean	0.4	
Q100 Flood Contour		2.95	(Atikio Data)
Q100, cumecs	Q100	1.3	

Design Method Selected:

Average TM61 & FFINZ

Q20, cumecs	**1.9**
Q100, cumecs	**3.4**

Appendix C: Cross Section Locations

V:\Coastal\120530HERBERT\DepthSounder\HERBERTVILLE.dwg Printed: 15.06.2012 15:22

ISSUE	AMENDMENT	BY	DATE
0	ISSUE FOR SURVEY INFORMATION	QG	JUN 12

	NAME	DATE
SURVEYED	W DE JONGE	JUN 2012
DESIGNED		
DRAWN	Q GILKISON	JUN 2012
TRACED	AutoCAD	JUN 2012
CHECKED		

APPROVED

DATE

LEVEL FIELD BOOK

FILE REF

horizons regional council

HERBERTVILLE
RIVER CROSS SECTIONS AND EXISTING CULVERT LOCATIONS

SCALES:
ORIGINAL DRAWING SIZE A1
1:2,000

DRAWING No.

SHEET 1 OF SHEETS