REVIEW OF RAILTON FLOOD MITIGATION OPTIONS

30 June 2014 - Project No: 1171.009/1171.008

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1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

Kentish Council received funding under the under the Natural Disaster Resilience Program (NDRP) to review previous flooding reports, investigate and recommend solutions and benefits, prepare information for residents and consider an early warning system for the Railton township. The Council engaged SEMF to carry out the project in accordance with the agreed scope of works outlined below:

1. Undertake a peer review of the 2005 report by Thompson and Brett / Cardo Willing in light of the January 2011 flooding and gauge any benefits that may have been realised if the recommendation(s) were implemented in part or in full.
2. Review all records held by Council in relation to flooding in Railton including minutes from follow up meetings, works undertaken, works programmed, relevant newspaper articles and events that led up to the January 2011 flooding including BoM data and photographs etc., and discuss the flooding and follow up works with relevant Council staff and property owners.
3. Shortlist recommendations for high Benefit to Cost Ratio projects for detailed investigation that will enhance flood intelligence, reduce the potential for flooding in the township and reduce potential damage including damage to public assets, property, health and wellbeing. Include recommendations on a community flood alert system and a flood education and awareness program.
4. Identify works that should be undertaken within the catchment as part of annual operational maintenance as well as approximate costing and frequency of such including the review of any such commitments that already exist.
5. Provide a report of the above findings, benefits and recommendations. Hold point.
6. On approval from Council
    - Undertake further hydrological analysis/modelling to verify the flood estimates developed in the Thompson & Brett 2002 report and used in the 2005 studies and provide inputs to hydraulic models.
    - Determine if a discharge can be associated with the flow from January 2011 flood data collected in item 2 and field assessment for the purpose of calibrating a hydraulic model.
    - Develop a 1D/2D GIS based hydraulic model to develop floodplain maps, assess the recommendations shortlisted in item 3 and develop concept designs and (if authorised) detailed designs for a forward capital works program.
7. Develop a proposal for a community flood alert system working with the BoM, SES and others as required. This may include an additional rain gauge and a new stream gauging station in Redwater Creek.
8. Develop and implement a flood education and awareness program. Undertake an investigation of communication methods that will be most effective in the event of a flood so that emergency workers and Council will be able to appropriately communicate with stakeholders.
9. Develop a community flood action plan in consultation with the SES that identifies appropriate evacuation centres and outlines triggers and response steps for Council, volunteer emergency workers and the community in the event of a flood.
10. Develop a community information pack to be delivered to all properties identified in the potential flood plain. It is anticipated that these will be linked to the education and awareness program and issued every two years, prior to impending floods if they can be predicted and on changes of ownership.

2. HISTORY OF FLOODING

25th January 1876	First Recorded Flood in Railton
1894	Damage to roads and crops
Aug/Sept 1970	Flood event in Railton
Dec 1970 – March 1971	Council minutes consider a re-alignment of Redwater Creek.
January 14 2011	Flood approximately equal to or just exceeding 100 year ARI flood occurred, affecting 60 houses and 14 businesses. The details of this event are recorded in greater detail in section 4.0

3. PREVIOUS WORK & REPORTS

3.1 PHYSICAL WORKS

In 1971 a Flood Mitigation Scheme was implemented by Kentish Council along 2.5km of Redwater Creek at Railton under the provisions of the Water Act 1957.

The cost of the project was approximately $20,000 and it was fully funded by the State and Commonwealth Governments. Council accepted responsibility for the stream in its improved condition.

It is understood that this work included channel widening and straightening and anecdotal sources suggest that the works did result in a reduction of the frequency of flooding incidents.

When the Water Management Act 1999 was established the opportunity was provided to transfer existing schemes set up under the Water Act 1957 to the new Act, and establish them as 'River Works Districts'. Enquires were made to DPIPWE if this had occurred but they have no record of this happening; therefore the scheme effectively terminated on 1st January 2000.

Prior to and following the 2011 flood some vegetation management work had been carried out commencing in 1971 with the flood mitigation scheme. Ongoing scheme maintenance is known to have occurred in the late 1980's to early 1990's.

Council documents reference works being carried out around 2005 when funding was offered by the Commonwealth Government for a flood mitigation scheme at Railton. The Scheme did not proceed as the Council could not fund its contribution and the Grant was returned to the Commonwealth.

Following the 2011 flood New Bed Rd Bridge was reconstructed, the old abutments were used and a new deck was installed and further vegetation management occurred. Several roads had to be repaired as a result of flood damage.

There appears to be a pattern of cyclic vegetation management every 10 years or so, which is a common pattern across Tasmania where reactive maintenance is practiced in creeks for flood mitigation purposes.

A comparison was carried out to determine how much vegetation management had occurred post flood. Comparison of satellite imagery for 2010 and 2013 indicates that the scope of this work was targeted but limited. Appendix A contains a satellite image for 2013; the areas ringed in red show locations where willows have been removed since the 2011 flood.

3.2 PREVIOUS REPORTS

Council understood that a strategic approach was required to find a suitable flood mitigation solution and commissioned two previous reports to determine a strategic direction namely:

- Redwater Creek Detention Storage Study May 2002, Thompson & Brett and Cardno Willing
- Redwater Creek at Railton Floodplain Risk Management Study January 2005, Thompson & Brett and Cardno Willing

3.2.1 Redwater Creek Detention Storage Study May 2002

The May 2002 Detention Storage Study examined the engineering feasibility of constructing a detention storage. The study found that a detention storage of 355ML sited 2.5 km upstream of Railton could reduce the size of a 50 year ARI flood peak down to a 5 year ARI flood, a 42% reduction in peak discharge.

The study estimated the cost of the detention storage at $534,000, a cost which was unaffordable for Council at the time.

Consequently some time later an external grant was acquired and a second study was commissioned, which resulted in the 2005 Report. The hydrological analysis from the 2002 study was used as an input to the hydraulic assessments carried out in the 2005 Report.

3.2.2 Redwater Creek at Railton Floodplain Risk Management Study January 2005

This report took a much wider approach than the 2002 study and examined five alternative options, which were costed and compared in terms of their flood mitigation benefits. Each of the proposed options is discussed below.

3.3 MEASURE A: VEGETATION MANAGEMENT (OPERATIONS AND MAINTENANCE)

In the previous report produced by Thompson and Brett January 2005, five flood mitigation options were considered and compared. Option A, 'Vegetation Management' appears to have been considered as an alternative 'capital works' option.

We have a fundamental problem with consideration of vegetation management as a capital works mitigation option for three principal reasons. First of all no asset is created that can be defined, measured or valued and secondly it is a recurrent activity that clearly falls under operations and maintenance. The third reason is that it is not independent of the other options considered in the Thompson and Brett report.

The absence of vegetation management in the four other options considered: crossings (bridge) reconstruction, levee construction, levee plus channel widening works and flood detention dams, all depend on the existence of open fully functional channels sized for each option.

With no vegetation management to maintain adequate hydraulic conveyance capacity a natural or modified creek channel such as Red Water Creek will experience a significant reduction in hydraulic capacity within 10 to 20 years. This is because invasive species such as willows in particular can completely block a channel in a relatively short period either directly or indirectly by creating blockages and snags.

Consequently we recommend that an annual vegetation management program be commenced at the earliest opportunity and that an allocation is made every year in the Council's Operations and Maintenance budget for vegetation management along Red Water Creek. The scope of works should cover the area from downstream of the Native Plains Rd bridge to just upstream New Bed Rd. We can advise on targeting areas within this defined length if required.

There are varying methodologies for achieving vegetation management outcomes. The existing willows should be cut, removed from the waterway and the stumps painted immediately with a suitable weed killer. Ideally this is carried out in autumn as the plant sap withdraws into the roots but this is not essential. Whenever it is done regrowth will occur, so a follow up bi-annual regrowth spot spraying program carried out in December and February will avoid the much larger future costs associated with removing mature trees and avoid some flood damage. After some time a single annual spot spraying operation may be sufficient.

Poisoned stumps should be left in place to avoid bank erosion in high flows. This will allow grasses and native vegetation to establish itself taking over the erosion control function that the willows perform.

3.4 MEASURE B: INCREASED CAPACITY OF CREEK CROSSINGS (BRIDGES)

The following crossings were not considered for upgrading: New Bed Rd, King St and Native Plains Rd.

Dowbiggin was found to have only one house upstream of the crossing and this was not affected by the predicted flood levels. The report suggested that it may be beneficial to allow water to be detained behind the Dowbiggin road embankment. The report also suggested a flood wall could be considered in this area

to prevent water entering on to the affected properties land. In the January 2011 flood it is noted that flood waters exceed the road causeway level flooding down and behind (i.e. North East) of Morrison St.

The report identified benefits associated with upgrading the water-way area or bridge opening at Foster St, Kimberly Rd (Railton Rd) and the Railway Bridge. The report noted that 50% of the benefit was derived from upgrading Railway Bridge. The measure was ultimately not recommended on the grounds of cost. The reduction in flood level resulting from doubling the size of the Railway Bridge was estimated at 0.34 m. It is noted that in the January 2011 flood the drop in water level across the Railway Bridge appears to be in the vicinity of 1.4m, which would indicate a significantly undersized bridge or a blockage, or both.

While it was not adopted by the 2005 Report, for future reference all of these bridges should be upgraded, as and when they are replaced, as elements of a long term flood mitigation plan for Railton. This is discussed further in sections 8 and 9.

3.5 MEASURE C: LEVEE

The report suggested a possible concrete block flood wall 490 metres long varying in height from 0.75 m to 1.76 m between Dowbiggin St and Giblin St and for 3 properties upstream of Foster St. The levee was estimated to increase flood levels by up to 0.07m in places. The report also suggested a levee east of Foster St, but west of the creek and linking to Kimberly Rd (Railton Rd) would provide a defence against flood flows breaking out from the creek, but not from overland flow along Foster St.

A proposed levee along the south side of Giblin St across the bridge and for three houses upstream was found to raise flood levels by 1.0 m and was not considered further.

In the 2011 flood, water appears to have flowed down Giblin St and re-entered the creek at the bridge at one point during the flood. However this may have been as the flood receded and it could equally be a break out point.

3.6 MEASURE D: CHANNEL WIDENING

The report refers to 1970's River Improvement Scheme work, which included channel widening and straightening, and mentions that it appeared that the works did result in a reduction in the frequency of flooding incidents.

Measure D proposed further widening of the channel by 3 meters between Dowbiggin St and Giblin St in combination with a flood wall. The combination reduced flood levels in the 5 and 20 year ARI floods and reduced the rise to 0.01 m for the 100 year ARI flood.

3.7 MEASURE E: FLOOD DETENTION BASIN

Studied in detail in the 2002 Report, a detention basis was found to reduce the 50 year ARI flood flows to that estimated for a 5 year ARI flood and reduce a 100 year to a 20 year ARI flood, but still resulted in 20 houses being flooded.

3.8 NON-STRUCTURAL MEASURES

The report provides sound advice on non-structural measures particularly in relation to building and development controls, landfill, fencing, new development and redevelopment. Planning controls do not form part of this present study other than through the provision of flood maps and the Council is currently providing appropriate advice based on the January 2011 flood.

Insurance, flood warning and public education will be considered later in this report.

Flood proofing may be an option for some houses that cannot be protected by other means and grants may be available to property owners through Commonwealth programs. However Council instigated flood mitigation measures on private land are generally fraught with difficulties relating to ownership and ongoing maintenance. Some of these measures such as house raising can cost $40,000 to $70,000 per property.

3.9 SUMMARY OF MEASURES AND DISCUSSION

Flood Frequency in Years ARI	Number of houses flooded after each option has been implemented. The figure in brackets is the number of houses saved from flooding				
	'A' Vegetation Management	'B' Creek Crossing (Bridge reconstruction)	'C' Levee	Combined 'C & D' Levee plus channel works	'E' Detention Basin
100	22 [-2]	22 [-2]	5 [-19]	5 [-19]	20 [-4]
50	20 [-2]	14 [-8]	4 [-18]	**3 [-19]**	8 [-14]
20	18 [-2]	9 [-11]	3 [-17]	3 [-17]	3 [-17]
5	4 [-4]	6 [-2]	0 [-8]	0 [-8]	3 [-5]
Capital cost (2005)	$34,125	$770,825	$279,513	$327,184	$834,000
Recurrent cost (2005)	$3,413	$13,017	$2,795	$3,272	$5,340
Capital cost (2013)	$42,656	$963,531	$349,391	$408,980	$1,042,500
Recurrent cost (2013)	$4,266	$16,271	$3,494	$4,090	$6,675

Table 1

Table 1 compares the mitigation benefits and costs of the various options. As stated above. Measure A is not independent of the other options as it is required to make the other options viable in the long term. Consequently the need for vegetation management is a given.

Option B was dismissed on the grounds of cost but, as stated earlier in Section 3.4, the bridges identified should be upgraded to have a greater hydraulic capacity as they come up for replacement. If competing structures are being considered with equal 'asset condition scores' then the hydraulically under-capacity bridges, such as Foster St, Railton Rd and Dowbiggin, should be flagged with a high priority.

In the case of infrastructure owned by others such as the Railway Bridge, which was identified in 2005 as having the greatest benefit if upgraded for flood mitigation reasons, it is clear that the State Government as the asset owner should be approached to bring the upgrading of this bridge forward even without carrying out further hydraulic analysis. Communications with TASRAIL indicate that this bridge is currently not on the TASRAIL forward replacement program.

Further consideration will be given to this bridge in the hydraulic analysis.

Options C & D seem to have an error in the report 'highlighted in bold' and corrected here. It is thought that the author meant to state the number of houses saved from flooding in brackets for the 50 year ARI event as 19 rather than the total number affected without the measure which would be 22; in the report this entry is shown as 3[-22].

Review of the information provided in the report prior to carrying out further hydrological and 2D hydraulic modelling indicates that Measures 'C' and 'C combined with D' are the most effective options in terms of mitigation and economics. We have updated the costs for CPI and the benefit-cost ratios in the previous report appear to be sound with the information available.

As stated previously, Measure 'A' Vegetation Management is required anyway and Measure 'B' should be implemented as and when bridge assets are replaced, when the additional cost will be far less significant.

An alternative flood mitigation strategy was developed in Stage 2, details of which are contained in Section 9.

4. FLOOD EVENT OF JANUARY 2011

From discussions with the Bureau of Meteorology (BoM), the Bureau indicated that during the 2011 flood event they advised that a 25mm alert for following 24 hours would have been issued at 2:00am and a 50mm alert would have been issued at 4:00am, which would have provided 7 and 5 hours additional preparation time to the Council respectively.

However, in the absence of previously developed flood warning documentation, including Railton specific emergency escalation triggers based on modelled results, rainfall depth information by itself would probably be meaningless even to a hydraulic engineer with significant experience in flood warning.

4.1 FLOOD RESPONSE BY COUNCIL, EMERGENCY SERVICES AND CEMENT AUSTRALIA

In the absence of a specific warning the entire community responded to the emergency. On 14th January five of Council's ten outdoor staff assisted in sand bagging and assisting local residents. Two of these had to leave to defend their own homes. The remainder of the outdoor staff responded to road closures, other flood emergencies and assisted the Police across the municipality, which was widely affected.

Two of Council's indoor staff assisted Department of Health and Human Services once the emergency evacuation centre was opened. One indoor staff member attended the Regional Emergency Management Centre in Burnie as liaison with the emergency services and all other indoor staff members were requested to take phone calls on flood related matters.

The State Government provided assistance through SES, Tasmanian Police, Tasmanian Fire Brigade and the Department of Health and Human Services. An Emergency Evacuation Centre was opened at the Railton Primary School. Table 2 shows the Tasmania Police advice at the time of the flood.

Tasmania Police issued the following notifications
Closed
Foster Street, Railton (between Dowbigging & King Street)
Railton - all roads in and out of Railton are closed
Railway at Railton closed due to flooding.
Railton Road at Caroline Creek
Caution
Railton Road, Railton - Sheets of water on the road

Table 2

The Emergency Evacuation Centre operated for approximately three hours; during this period 62 residents were evacuated to the centre on the advice of the SES.

Cement Australia provided significant help to the community.

4.2 IMPACTS AND DAMAGES

Across the Municipality 73 homes and 16 businesses suffered significant inundation with Railton being the hardest hit with 60 homes and 14 businesses affected.

The Council have estimated the damage bill across the Municipality for public infrastructure such as roads and bridges at $2.3M. A separate estimate for Railton is not available at present. No estimate is available for the damage to private homes in Railton. Of the 60 homes affected it is not clear which properties were subjected to water damage over the floors and which suffered damages to the grounds only.

It would be useful send out a questionnaire to determine:

1. Which property addresses were affected
2. Which properties experienced water above their floor level
3. The level of the inundation in metres AHD
4. The estimated cost of damages or insurance pay out if they are willing to disclose this information

This information would be useful in calibrating a two dimensional hydrodynamic model and for the purpose of determining accurate benefit-cost ratios for proposed future works at the detailed design stage.

Foster St Bridge during and after the flood

Foster St Dowbiggin Bridge

If the 2005 flood mitigation project had been carried out, the damages experienced at Railton in 2011 may have been less significant although the Stage 2, 2D hydrodynamic modelling suggests the defences may have been out-flanked.

4.3 MEDIA

Media coverage was given in the Examiner, Advocate and the Mercury to a lesser extent. Most of the general information provided during in the days following the event obviously came directly from Council and the Emergency Services and is covered in the previous paragraphs.

Where it differed from the official accounts was in the human interest stories of persons directly affected. The media also reported the fact that in 2005 Council had received a grant for flood mitigation works under the Regional Flood Mitigation Programme (RFMP) 2005 - 06 but had returned the grant; comparisons with other areas of Council expenditure were noted. The same article drew attention to the abundance of vegetation in the drainage channels.

The report to Council in relation to the RFMP grant at the time had recommended that Council decline the Regional Flood Mitigation Program funding and proceed no further with the project. The Council report cites the reasons for the recommendation as a conservative model, cost and competing projects.

Other media reports commented on Commonwealth emergency grants to individuals.

The plight of the Riley family in their disputed claim for damages with AAMI received a lot of attention. The disputed claim arose over the definition of the source of flood waters; this is discussed further under Flood Insurance. The claim was finally resolved in favour of the family.

The Riley family appear again in a report in 2012 entitled *'Clogged creek still a risk to Railton home'*. In this article Mr Paul Riley draws attention to the fact that although the Council had cleared some of the creek, 30 metres downstream of his property it was still blocked.

5. RAINFALL DATA

5.1 RECORDED DATA & ARI ESTIMATES

A very good source of rainfall data which also included a temporal pattern was provided by Cement Australia from their rain gauge at Railton. The rainfall pattern is shown in Figure 1. Full details are available in Appendix B, which also includes a section of this record that was selected for estimating the 2011 flood peak using a RORB hydrological model, calibrated against flood frequency data, and also the record from Sheffield Farm School gauge.

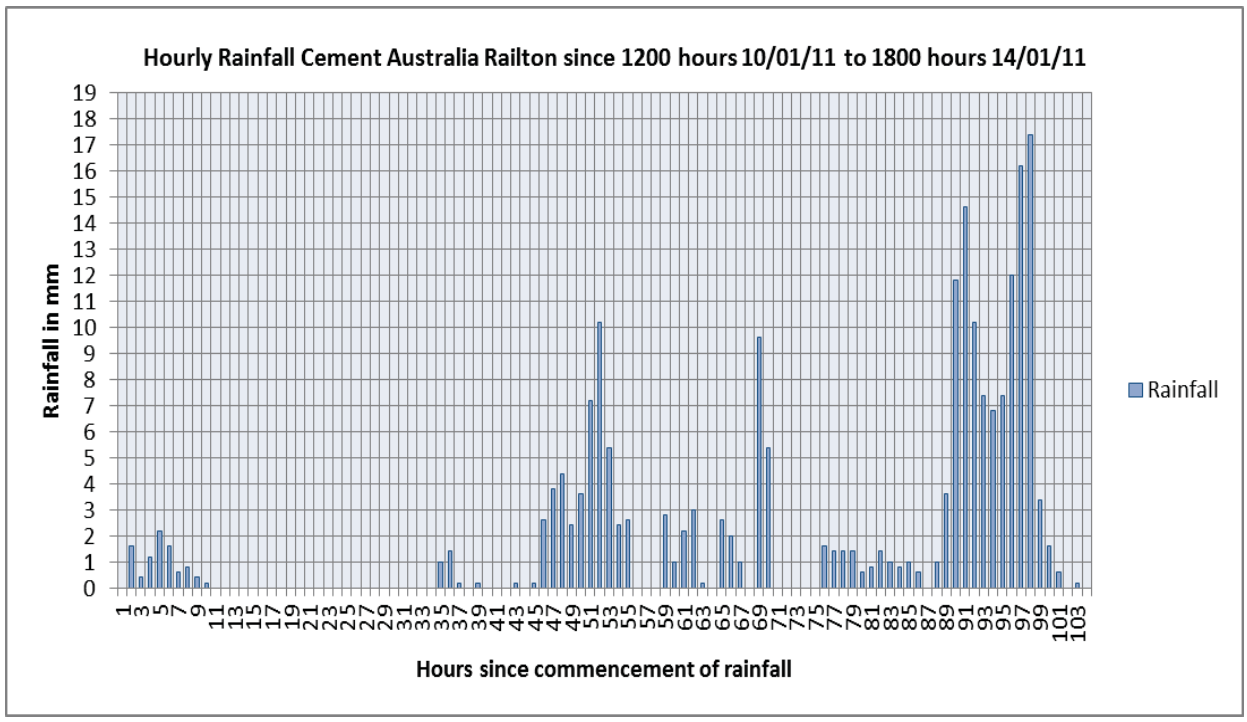


Figure 1

Daily rainfall records for several BoM gauges were also obtained to get a feel for how daily rainfall totals were distributed across the catchment. The results for the three days ending at 9.00AM on the 13th, 14th and 15th January 2011 are also included in Appendix B.

5.2 RAINFALL AVERAGE RECURRENCE INTERVALS

The rainfall record recorded at Cement Australia was sampled for storm intensity for durations of 1 hour to 72 hours to identify the period ending with the highest total and consequently the greatest ARI. ARIs were assigned to these maximum values through the BoM IFD tool. The results are shown in the table below.

From table 3, it can be seen that storm durations for the 9, 12, 48 and 72 hours equalled or exceeded the 100 year ARI intensity at the recording site at Cement Australia Railton.

It should be noted that the IFD values generated for the Cement Australia gauge to determine the ARIs in Table 3 below are slightly different to those in section 5.3, as the latter is based in the centre of the catchment. For reference the IFD table and IFD chart which align with the Cement Australia gauge are included in Appendix B.

Critical Storm Duration ARI & Intensity													
Duration	1 Hr	2 hr	3 hr	4 hr	5 hr	6 hr	9 hr	12 hr	18 hr	24 hr	36 hr	48hr	72hr
Duration total	17.4	33.6	45.6	53	59.8	67.2	103.8	112.4	116.8	123.8	146	178	203.8
Intensity mm/hr	17.4	16.8	15.2	13.25	11.96	11.2	11.53	9.37	6.49	5.16	4.06	3.71	2.83
Estimated ARI in Years	2 - 5	10 - 20	20 - 50	20 - 50	20 - 50	20 - 50	Greater than or = 100	Greater than or = 100	50 - 100	50 - 100	50 - 100	Greater than or = 100	Greater than or = 100
Time when critical duration ended on 14/01/2011	13:00	13:00	13:00	13:00	13:00	13:00	13:00	15:00	15:00	14:00	15:00	13:00	18:00

Table 3

Figure 2, below shows the temporal distribution of the storm recorded at the two sites Cement Australia and Sheffield Farm School. The critical storm periods end at 1300 to 1500 hours on the 14/01/2013, which corresponds with the 23rd hour or later on the graph.

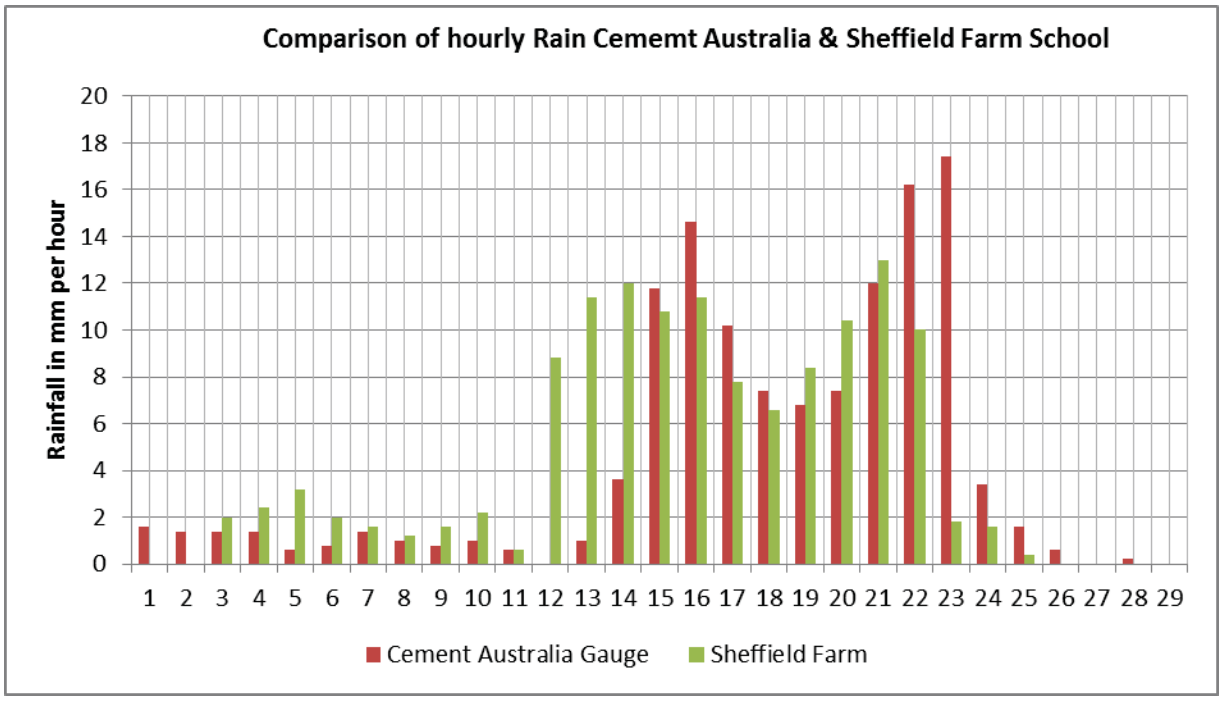


Figure 2

5.3 GENERATED IFD DATA

The following inputs (Table 4) were determined to generate the IFD Table 5.

THE INPUT DATA WAS	
Skewness Coefficient	0.69
2 Yr Geographical Factor	4.02
50 Yr Geographical Factor	15.01
2 Yr, 1 Hour RF Intensity	18.36
50 Yr, 1 Hour RF Intensity	32.08
2 Yr, 12 Hour RF Intensity	4.51
50 Yr, 12 Hour RF Intensity	7.52
2 Yr, 72 Hour RF Intensity	1.36
50 Yr, 72 Hour RF Intensity	2.22

Table 4

Intensity-Frequency-Duration Table

Location: 41.375S 146.400E NEAR.. Railton Catchment Centre Issued: 20/10/2013

Rainfall intensity in mm/h for various durations and Average Recurrence Interval

	Average Recurrence Interval						
Duration	1 YEAR	2 YEARS	5 YEARS	10 YEARS	20 YEARS	50 YEARS	100 YEARS
5Mins	41.3	55.9	77.5	94.0	117	151	182
6Mins	38.8	52.4	72.6	87.8	109	141	170
10Mins	32.2	43.1	58.7	70.2	86.1	110	132
20Mins	23.9	31.6	41.5	48.7	58.8	73.7	86.6
30Mins	19.6	25.7	33.3	38.6	46.1	57.1	66.6
1Hr	13.6	17.7	22.3	25.6	30.1	36.8	42.4
2Hrs	9.31	12.0	15.0	17.0	19.9	24.0	27.5
3Hrs	7.42	9.57	11.9	13.4	15.7	18.9	21.6
6Hrs	5.03	6.47	7.99	9.01	10.5	12.6	14.4
12Hrs	3.37	4.33	5.33	6.00	6.98	8.38	9.54
24Hrs	2.20	2.82	3.46	3.88	4.50	5.39	6.12
48Hrs	1.38	1.77	2.15	2.41	2.79	3.32	3.77
72Hrs	1.03	1.31	1.60	1.79	2.07	2.47	2.80

(Raw data: 18.36, 4.51, 1.36, 32.08, 7.52, 2.22, skew=0.69, F2=4.02, F50=15.01)

Table 5

The data in Table 5, which is also represented as an IFD Chart (Figure 3) on the next page, is generated for a point at near the catchment centre (E 4494400; N 5419500). This data was used in the RORB model described in section 7.

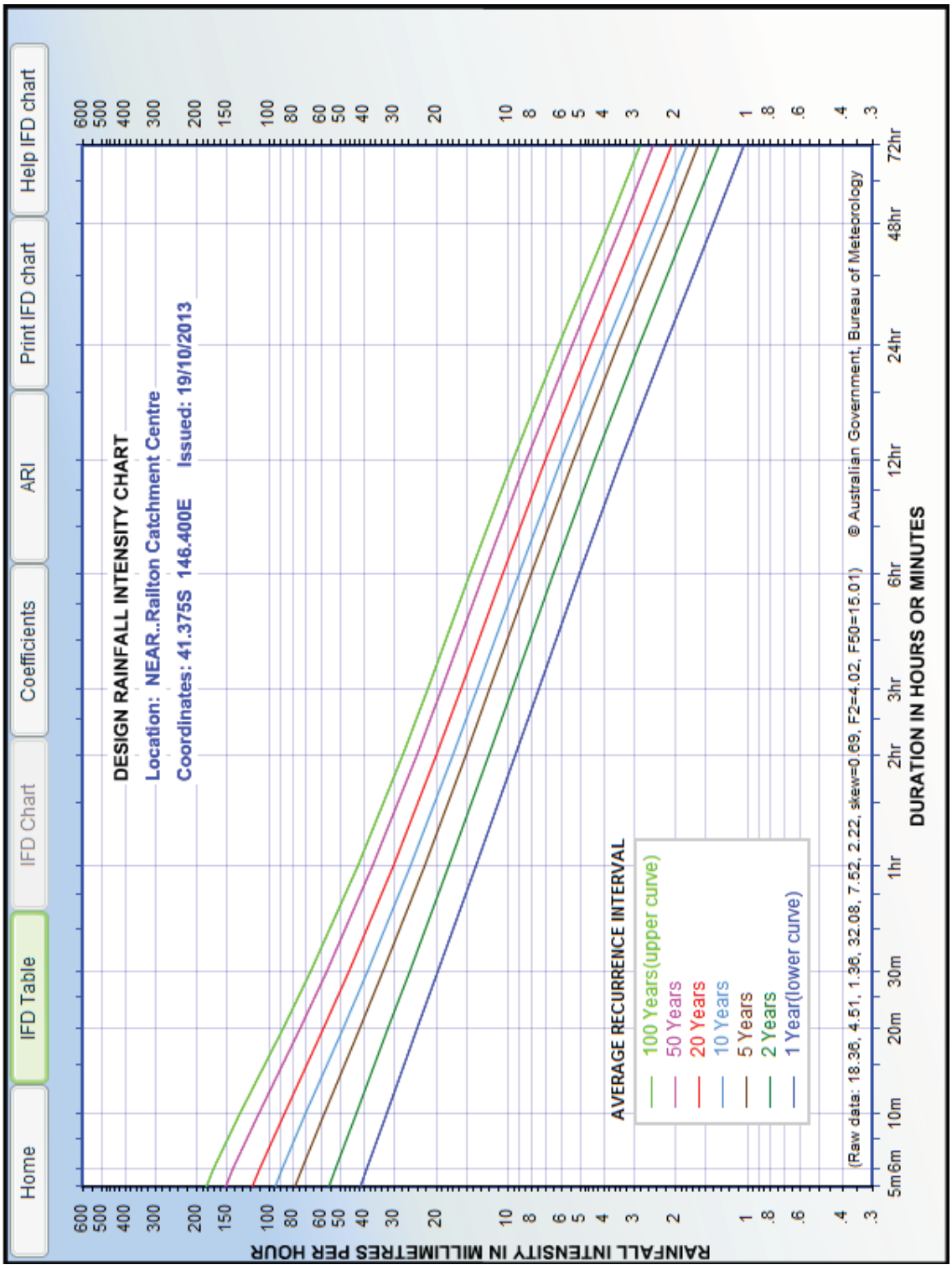

Home
IFD Table
IFD Chart
Coefficients
ARI
Print IFD chart
Help IFD chart
DESIGN RAINFALL INTENSITY CHART
Location: NEAR..Railton Catchment Centre
Coordinates: 41.375S 146.400E Issued: 19/10/2013
AVERAGE RECURRENCE INTERVAL
100 Years(upper curve)
50 Years
20 Years
10 Years
5 Years
2 Years
1 Year(lower curve)
RAINFALL INTENSITY IN MILLIMETRES PER HOUR
DURATION IN HOURS OR MINUTES
600 500 400 300 200 150 100 80 60 50 40 30 20 10 8 6 5 4 3 2 1 .8 .6 .4 .3
5m 6m 10m 20m 30m 1hr 2hr 3hr 6hr 12hr 24hr 48hr 72hr
(Raw data: 18.36, 4.51, 1.38, 32.08, 7.52, 2.22, skew=0.69, F2=4.02, F50=15.01) © Australian Government, Bureau of Meteorology

Figure 3

6. FLOOD FREQUENCY ANALYSIS

The analysis carried out in the previous reports was performed with an un-calibrated model. The consultants indicated that they did not have or could not find suitable rainfall records or estimates or gauging of the stream flow. Consequently they developed flood peak estimates by applying Australian Rainfall & Runoff IFD estimates and standard temporal patterns to a RAFT's model of the catchment and later a SWMM model.

However it is possible to make an independent estimate of the likely flood peaks that can be expected at Railton through catchment scaling of flow records from nearby catchments. This is done by carrying out a flood frequency analysis on the annual peak stream-flow data of suitable catchments and scaling the resultant discharges by the ratio of the annual average rainfall for source and target catchments and the ratio of catchment areas to the power of 0.8 to account for non-linearity, i.e.

If

Area of gauged catchment	= AG
Area of Study catchment	= AS
Average annual rainfall gauged catchment	= AARG
Average annual rainfall Study catchment	= AARS
Gauged catchment flood frequency estimate	= QFF(Gauged)
Study catchment flood frequency estimate	= QFF(Study)

then the discharge estimates of the gauged catchment are transposed to the study catchment by:

$$QFF(Study) = QFF(Gauged) \times [(AS / AG)^{0.8} \times (AARS / AARG)]$$

6.1 GAUGED CATCHMENTS

Four gauged catchments were investigated and the data acquired. Three had good data and were used to derive flood frequency estimates at the Rail Bridge, the fourth data series for the Arm yielded a very low estimate and its data is classified as 'unverified to poor' so it was not used in the final estimate. The catchments selected are shown in the Table 6 below.

River	Years of Record	Catchment area in Km^2	Average annual Rainfall (mm)	Scaling Factor $[(A_S / A_G)^{0.8} \times (AAR_S / AAR_G)]$
Don (16200)	29	128.46	1090	0.2656
Rubicon (17200)	45	264	953	0.1708
Franklin (17201)	18	122	1125	0.2519
Arm	40	86.3	1886	0.2111
Railton	-	25.37	1060	1

Table 6

The record for the Don and Rubicon spanned the period 1968 to 2012 but the Don record has 16 years missing between 1991 and 2006. The record for the Franklin Rivulet spans the period 1974 to 1992 and the Arm from 1973 to 2012.

For the purposes of flood frequency analysis the 16 years of missing data was derived from the Rubicon for the Don and spliced into its record to give 45 years of continuous data.

The rule of thumb in flood frequency analysis is that the estimates are generally considered to provide good estimates for return periods equal to twice the length of the record. This means that if you have 50 years of good data you can develop a 100 year ARI flood peak estimate in which a reasonable amount of confidence can be placed in stable climatic conditions.

6.2 FLOOD FREQUENCY FLOW ESTIMATES FOR RAILTON

Flood frequency peak flow estimates (Table 7) were developed for Railton at the Rail Bridge using GEV L2 frequency analysis applied to the annual maximum flow peak data sets for the Don, Rubicon and Franklin Rivulet. For the Don estimates were developed with and without the spliced data.

ARI in Years	Don (m^3/s) Spliced	Don (m^3/s) 29 years of data	Rubicon (m^3/s)	Franklin Riv (m^3/s)	Railton FF estimates (Average of Column 2, 4, 5)
2	11.6	10.0	13.8	12.7	**12.7**
5	21.9	17.4	23.8	20.9	**22.2**
10	28.6	22.7	29.6	26.6	**28.3**
20	35.1	28.2	34.7	32.2	**34.0**
50	43.3	35.9	40.7	39.8	**41.3**
100	**49.5**	**42.1**	**44.8**	**45.7**	**46.7**
200	55.6	48.8	48.5	51.7	**51.9**

Table 7

The best 100 year ARI estimate from a single data source would be obtained from the Rubicon data set as it has 45 years of continuous data giving 44.8 m^3/s. The spliced data set for the Don actually produces the highest of the four 100 ARI estimates.

At first glance it might be thought the Rubicon data series might be skewing the Don results slightly, but it should be noted that for the missing 16 years of Don data 7 of the highest values in the spliced Don data series are in the top 25% of the Don record and 6 of the top 25% of the Rubicon record including the highest 4 values occur in the 16 year period due to the fact that these were wet years. To ignore these would be a mistake as wet years drive the results of frequency analysis.

So the flood frequency estimates for Railton at the Rail Bridge shown in column 6 have been derived by averaging the results from the Don (spliced), Rubicon and Franklin Rivulet. The primary data is included in Appendix C.

6.3 COMPARISON OF PREVIOUS STUDY RESULTS WITH FLOOD FREQUENCY ANALYSIS

In Table 8, the results from the Thompson and Brett 2005 Study at the Railway Bridge are compared with the results of the present flood frequency analysis.

Comparison of Flood Discharges at the Railway Bridge from previous RAFT's, SWMM and the current Flood Frequency analysis all values in m^3/s			
ARI in Years	**RAFT's**	**SWMM**	**FLOOD FREQUENCY**
5	27.8	26.3	22.2
20	42.4	41.4	34.0
50	52.7	46.6	41.3
100	62.4	59.0	46.7

Table 8

The first thing that becomes apparent from the results is that the SWMM result from the 2005 Study (which is allegedly more accurate than the RAFT's result as it more accurately accounts for flood plain storage) is 26% higher than the value derived from flood frequency analysis.

Data derived estimates are generally considered to be the more reliable estimation method especially if the record period is of adequate length, as it is here. Furthermore it should be remembered that neither the SWMM model nor the RAFT's model used in the previous studies were calibrated in any way.

7. HYDROLOGICAL MODELLING

In the absence of stream flow and associated real-time rainfall data for Railton it is proposed to build a hydrological RORB model and calibrate it to the 100 year ARI flood frequency estimate using standard BoM / Australian Rainfall & Runoff (AR&R) intensity, frequency duration rainfalls and temporal patterns.

The purpose of the model is to develop inputs to the Hydraulic model and for the purpose of estimating the size of January 2011 Railton flood.

7.1 HYDROLOGICAL MODELLING

As stated a RORB model was constructed, Appendix D contains a catchment plan depicting the sub-catchment delineation used in the RORB model.

The schematic below Figure 4 shows the conceptual model network.

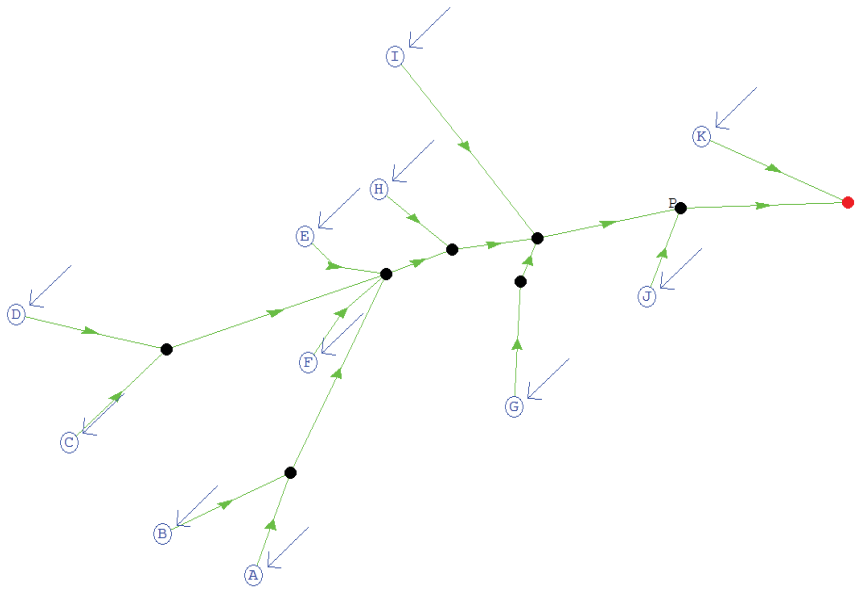


Figure 4

7.2 CALIBRATION TO FLOOD FREQUENCY PEAK DATA

In Section 6 the average value derived from flood frequency analysis and catchment scaling for the 100 year ARI flood event was 46.7 m^3/s.

The RORB model was calibrated by running multiple 100 year ARI storms of varying durations through the model and adjusting the principal calibration parameter Kc until the flood event from the critical storm event matched the peak value of 46.7 m^3/s. The rainfall patterns and intensities where generated using the BoM IFD tool for the centre of the catchment (see section 5.3). The exponent 'm' which accounts for non-linearity was selected as 0.8 and kept constant for all runs. The critical storm duration which produces the greatest flood peak matching the flood frequency estimate was given by the 12 hour storm.

Figure 5 below shows the output hydrographs for Kc = 13.36 and m = 0.8 and an initial loss of 20mm and an estimated continuing loss of 2.5 mm/hour.

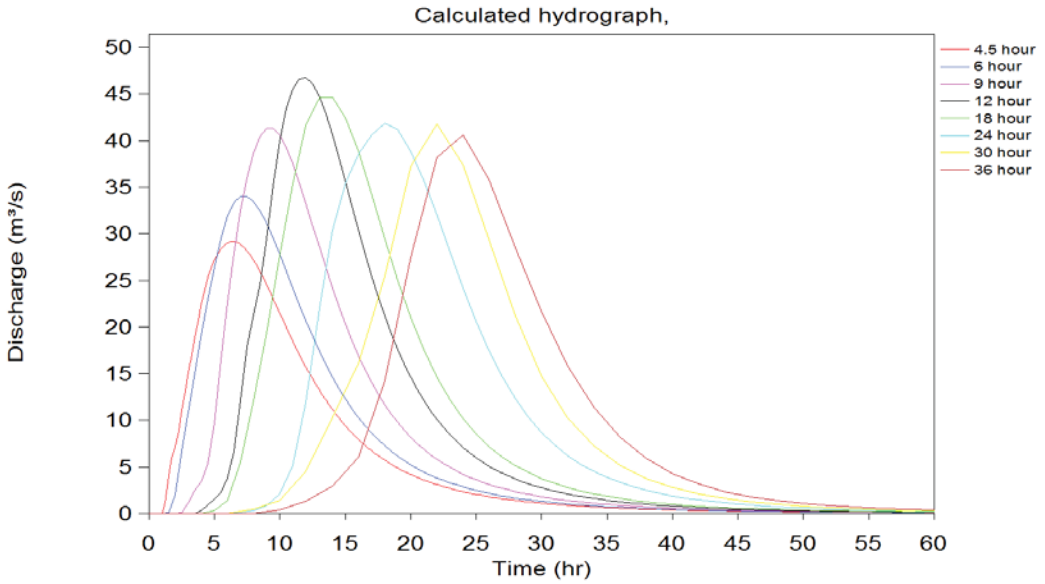


Figure 5

7.3 MODELLING THE FLOOD THE EVENT 13TH / 14TH JANUARY 2011

As no stream gauging was carried during the January 2011 flood event, recorded rainfalls have been applied to the model to make an estimate of likely flood peaks. The model was run over 72 hours with an assumed initial loss of 20mm and continuing loss of 2.5 mm/hour. The RORB outputs are shown in Figure 6, Figure 7, and Figure 8 and the flood peak values are shown in Table 9.

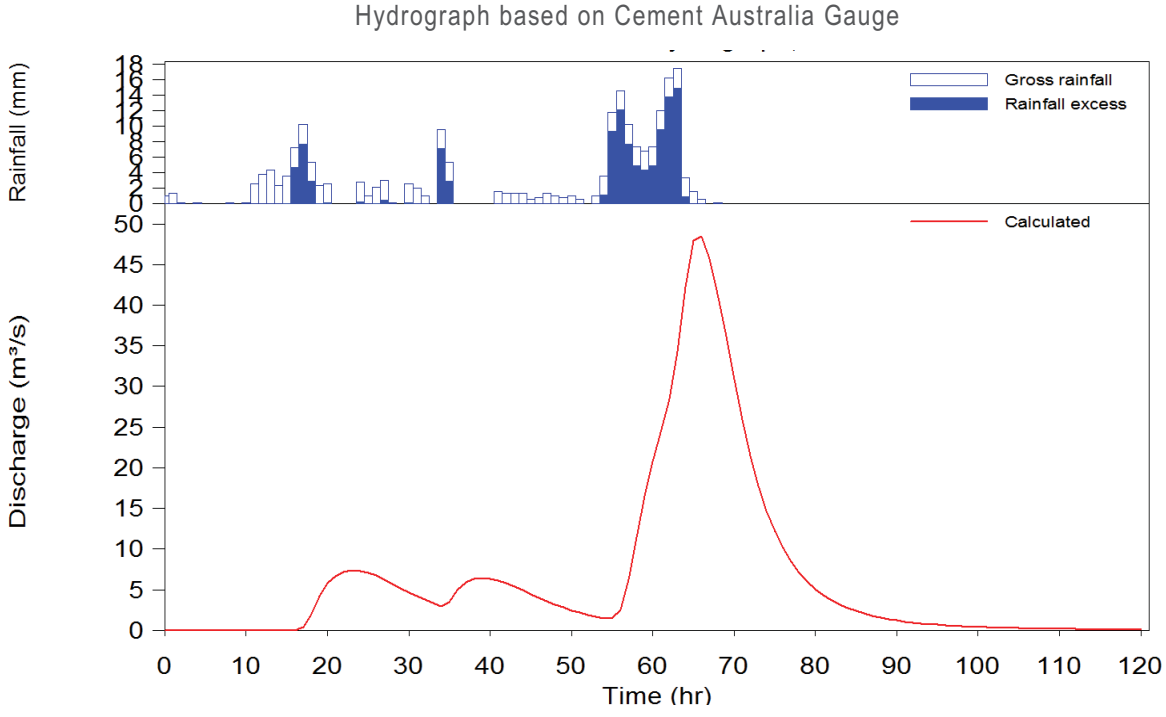


Figure 6

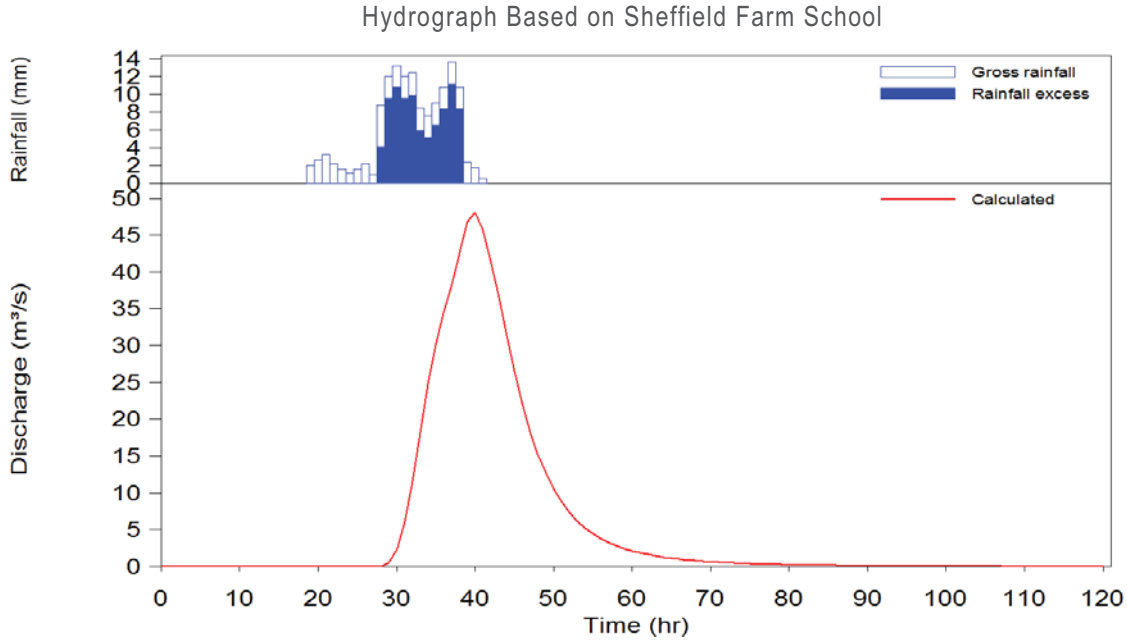


Figure 7

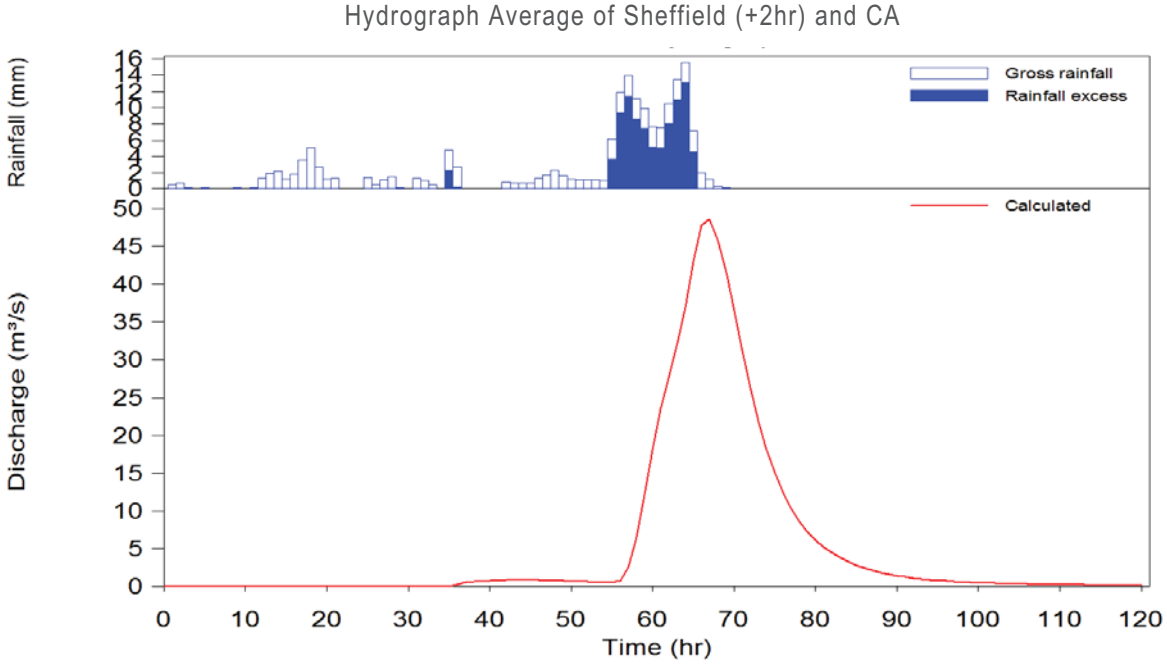


Figure 8

The storms used were the storms as recorded at Cement Australia and Sheffield Farm School. A storm averaging the two was also applied; in this case the record for Sheffield was shifted by 2 hours so that the peak values in the temporal pattern aligned Figure 8 above shows the storms as recorded but offset.

Storm temporal Pattern & total record	Peak discharge at Railway Bridge m³/s
Based on gauge at Cement Australia Railton	48.45
Based on gauge at Sheffield Farm School	48.04
Average of Railton & Sheffield (+2hours)	48.62

Table 9 Flood Peak Estimates

Flood Peak Estimates

As can be observed from information supplied in Section 5 the critical storm duration rainfall intensity was equal to or greater than the 100 year ARI rainfall intensity.

As discussed in Section 6.0 a good flood peak estimate can be derived from flood frequency analysis from a data series if the record is say half the length of the target ARI in years. So the records used are considered good for the 100 year ARI estimates and less reliable as the ARI increases but, having said that, the average of the flood peak estimates (Table 9) is 48.4 m³/s; based on the information available this value just exceeded the 100 year event.

7.4 CLIMATE CHANGE

Climate Change Rainfall Estimates for the 100 year ARI Event

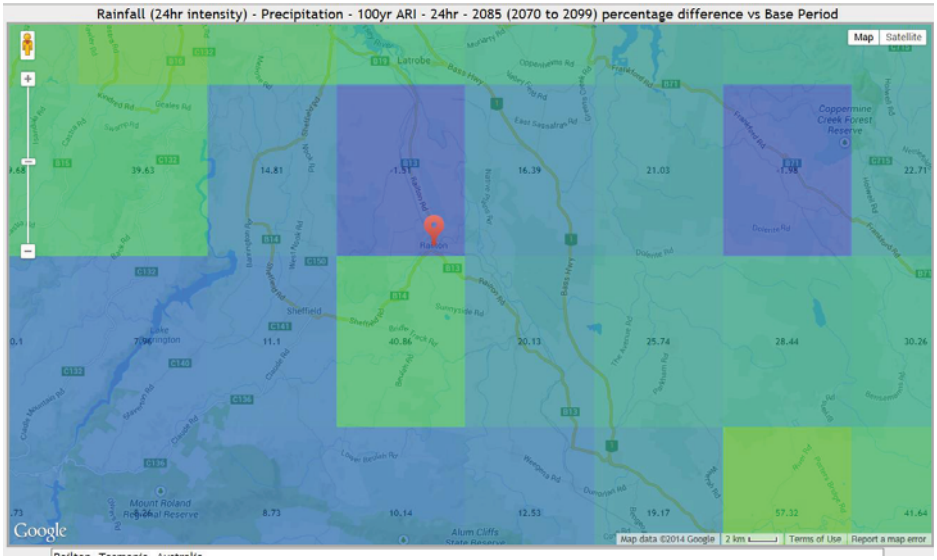


Figure 9

The image (figure 9) shows a snap shot of the climate assist tool. In this case the view shows the percentage change from the base period to 2085.

The Average Climate Change % for 24 hour duration rainfall for six squares surrounding the Railton catchment is 16.96%. Estimates for durations less than 24 hours are currently not available so current practice is to apply this percentage to lesser durations. However it should be stressed that at shorter durations the percentage increase could be larger.

This percentage rainfall increase was applied to the critical 12 hour 100 year storm duration and run through the RORB model. The total rainfall for the event increased from 112.84 mm to 131.98 mm, table 10 shows the change in flows and figure 10 the climate change hydrograph.

Calculated hydrograph, Rail Bridge	Current 12 hour 100 yr ARI event	Climate Change 12 hour (2085) 100 yr ARI event
Peak discharge m^3/s	46.72	59.96
Time to Peak hours	12	11.5
Volume m^3	1.86×10^6	2.31×10^6

Table 10

Interestingly although the estimated percentage rainfall increase is about 17%, by 2085 the flood discharge at the Railway Bridge increases from 46.7 m^3/s to 60 m^3/s, which is an increase of over 28%.

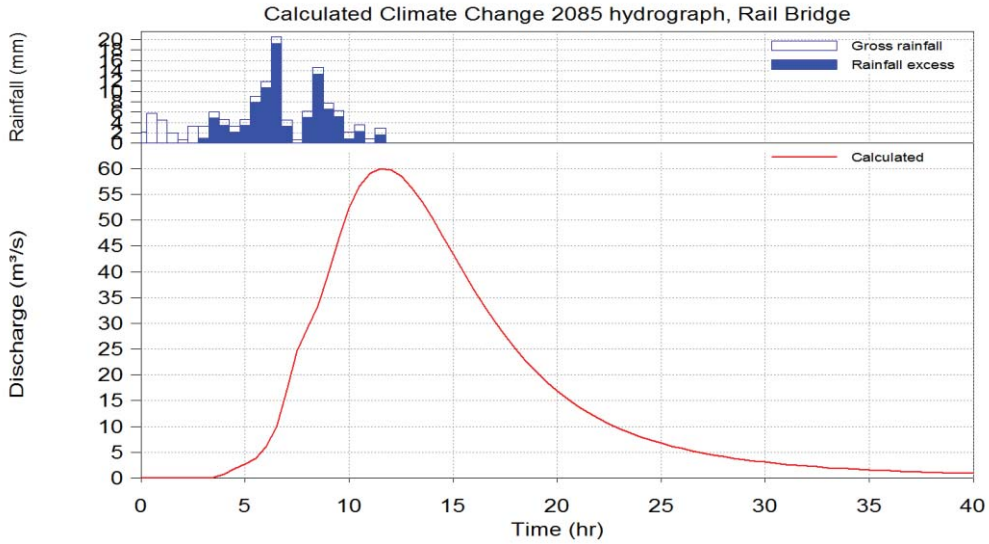


Figure 10

RORB modelling of the catchment using currently accepted rainfall intensities indicates that the current 200 year ARI flood peak would be approximately 57 m^3/s. From this we can conclude that the 2085, 100 year ARI flood peak will be slightly greater than the current 200 year ARI flood peak.

8.1 1D MODEL SETUP

As the 100 year discharge estimate of 46.7 m³/s is significantly less than the 2005 estimate, it was decided to build an hydraulic 1D (one dimensional) model of Red Water Creek to test the recommended mitigation option i.e. channel improvements combined with a levee. Given the lesser 100 year design flow estimate we were particularly interested in what may be achieved with channel works alone, an option which was not examined in isolation in the previous report.

The model selected was HecRas v 4.1 developed by the United States Corps of Engineers. Being a 1D model it cannot easily represent all the two dimensional flows which occurred in January 2011. However an approximation of what was happening in the main channel can be made and recorded flood levels were used to calibrate the model.

A model cross section location map and the Council's excellent flood record map from which flood levels were extracted are include in Appendix E.

As the objective was to look at the main channel, the hydrological RORB model was used to generate likely flows for input at the top end of the model at cross section 29 and the inflow from sub catchment G which was added at cross section 23. The flows are shown in table 11.

Cross section Number	Calibration flows m³/s	100 Year ARI flow m³/s
29	38.3	37.9
23	48.4	46.7

Table 11

The urbanised area was represented with various strategies which included using a high Manning's 'n' hydraulic roughness factor, designating the areas as 'ineffective flow' areas so it is used as storage but not in hydraulic calculations and designating some areas of high ground as de-facto 'levees' which meant that water did not enter the area behind them until over-topped. Using these and hydraulically 'rough' channels to represent the trees and willows a reasonable calibration was achieved.

Where the calibration was not great was upstream of Dowbiggin St at cross section 22 [Recorded 72.95 m AHD; modelled 71.90 M AHD] and cross section 23 [Recorded 77.04 m AHD; modelled 76.56 M AHD]. Generally if the calibration differs by less than 200mm it is considered reasonable but if it is less than 100mm is considered good.

The deviations in modelled level may be because higher water levels than predicted were caused by debris on fences or because the cross section supplied for this area were not truly representative. However for the purpose of the modelling exercise this area was not as important as the downstream areas where works have been proposed.

Table12 shows selected observed water levels and those predicted by the HecRas model for the January 2011 flood event. Note that the energy elevation 'EG' often represents the observed flood level as the water reaches this level when still or impacting on a solid object. The water elevation 'WS' is the level of water moving at the average cross section velocity. So to provide a range both have been quoted, either of these levels or an intermediate value can apply depending on the physical circumstances.

Cross section	W.S. Elevation in m	E.G. Elevation in m	Observed Flood	Difference between energy line and observed	Difference between water level and observed
29	101.81	101.93			
28	97.34	97.51	97.61	-0.1	-0.27
27	87.51	87.64	87.46	0.18	0.05
26	81.98	82.26	82.61	-0.35	-0.63
25	80.29	80.3			
24	79.37	80.01	80.16	-0.15	-0.79
23	76.49	76.56	77.04	-0.48	-0.55
22	71.65	71.9	72.95	-1.05	-1.3
21.7	71.35	71.35			
21.6	71.33	71.33	71.32	0.01	0.01
21.4	70.91	70.94			
21	70.56	70.61	70.66	-0.05	-0.1
20	68.73	68.89	69.23	-0.34	-0.5
19	67.15	67.19	67.36	-0.17	-0.21
18.15	66.51	66.52	66.02	0.5	0.49
17.85	65.66	66.05	66.02	0.03	-0.36
17	64.43	64.53	64.21	0.32	0.22
16	64.1	64.11	63.87	0.24	0.23
14	63.33	63.41			
13	62.78	62.8			
12	62.76	62.76	62.85	-0.09	-0.09
10	61.31	61.37	61.42	-0.05	-0.11
9	60.61	60.64			
8	59.79	59.83	59.91	-0.08	-0.12
7	59.4	59.42	59.61	-0.19	-0.21
6	59.16	59.23	59.39	-0.16	-0.23

Table 12

If this model were to be used for detailed design we would hope to refine it but as the second stage involve using a 2D model that effort is not warranted during Stage 1 or 2.

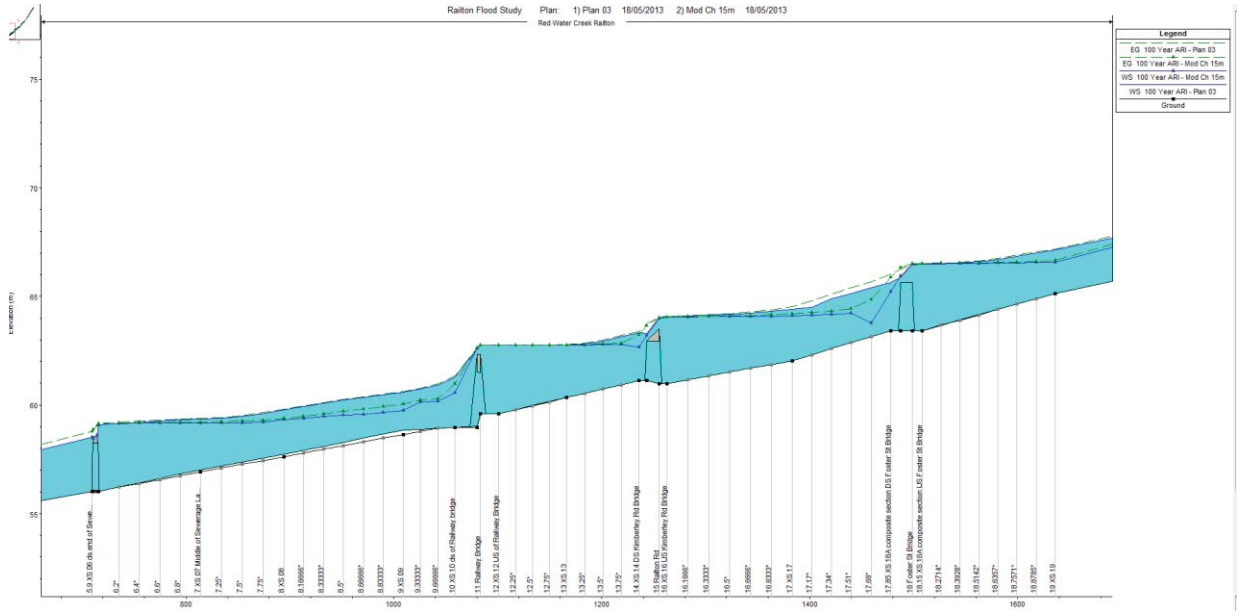


Figure 11

To test the benefits of channel modification the model was run twice, with the existing channel and with a 15 metre wide channel from cross section XS19 to XS6. In figure 11 the water surface lowered by the channel modification can be seen as a blue line which diverges after each bridge and then converges with the water level predicted for the unmodified channel (defined by the blue fill) at the next upstream bridge. An output table containing the actual level differences is included in Appendix E.

As can be seen, channel modification has an increasingly significant effect as the observer moves upstream from a bridge but the water levels immediately upstream of the bridges is dominated by the bridges hydraulic capacity.

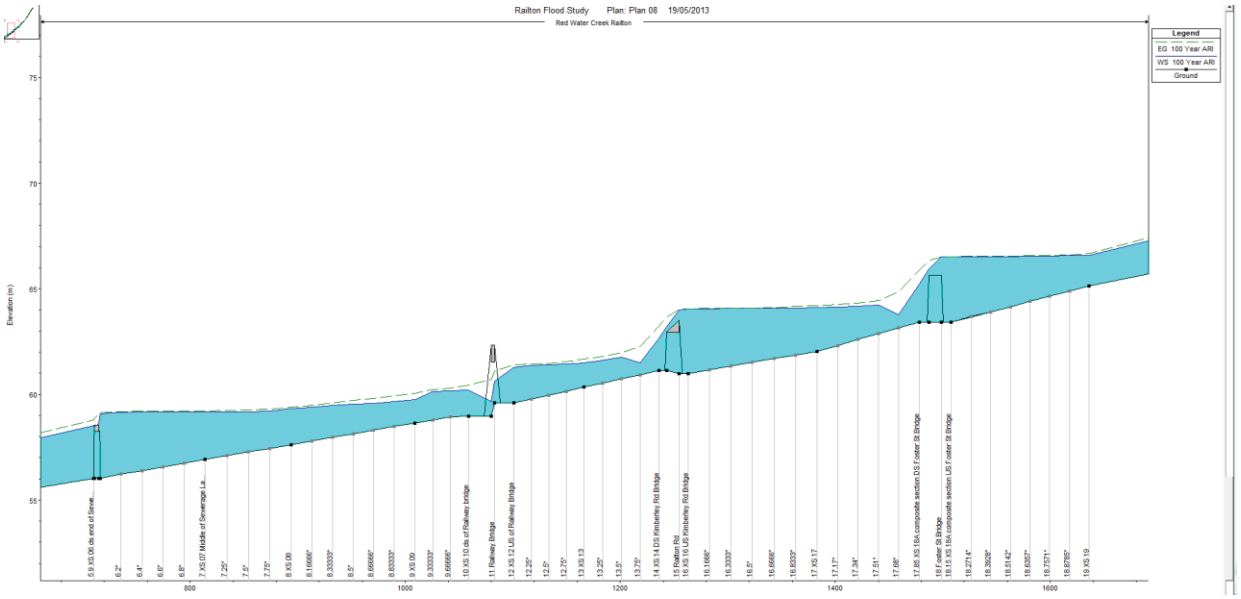


Figure 12

To demonstrate the bridges dominating influence, figure 12 shows the effect of upgrading the Railway bridge to a 15 metre clear span to match the enhanced channel. Replacing the bridge effectively drops the water level upstream of the bridge by 1.46 metres, much more than was predicted in the 2005 Report. Obviously improvements are possible at all bridges in the lower reaches.

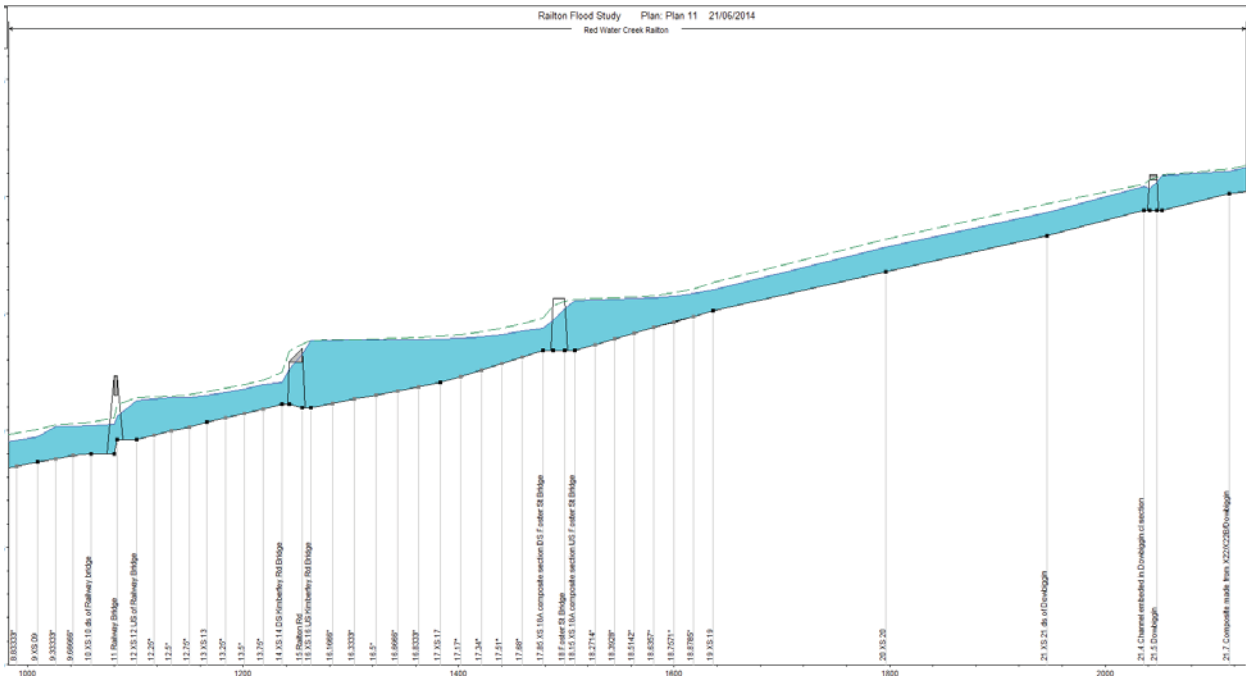


Figure 13

Figure 13 shows the water surface profile which results from enhancing the channel to 15 metres wide all the way from the Railway Bridge to and just beyond Dowbiggin St Bridge. In this profile the Rail Bridge has been enhanced to provide a waterway area of approximately 30 m^2 and Dowbiggin to 25 m^2.

In the case of Dowbiggin this would require a second bridge to be built next to the existing one and the construction of a floodway across the current bend in the location indicated in the Google Earth image by the green polygon. Floodway enhancements would also be beneficial at the entrance to Railton Rd Bridge as part of the 15 m wide floodway. Both the Foster St and Railton Rd bridged still struggle in these high flows so in the longer term their waterway areas (spans) should be increased.

Figure 14, Floodway Enhancements at Dowbiggin and Railton Rd

The 15 m wide floodway discussed above could be cut into the banks 0.5 m above the channel to maintain its environmental values.

In summarising the consideration of channel hydraulics we can conclude that water levels can be reduced by channel enhancements, but associated levees will be require to protect some properties. However a long term strategy should also be put in place to increase the size of most of the bridges as and when they are upgraded and this may eliminate the need for levees in most areas.

Where the bridges are owned by Council the need to upgrade their hydraulic capacity should be recorded in any asset management plans. Where the bridges are owned by others such as the Railway Bridge the need to upgrade the bridge for flood mitigation reasons should be brought to the attention of the asset owner. In 2013 TASRAIL was granted $120M for track upgrades by the Commonwealth Government, so now would be a good time to bring the need for the upgrade of this bridge to the attention of those with influence over forward planning.

The King Street Bridge leading to the Water Corporations Water Treatment Plant has some OH&S issues and will need upgrading at some point. Again the need to upgrade the waterway area should be brought to the Corporations attention. The present bridge is obviously vulnerable to flood damage and the Corporation could easily lose access to the lagoons. Consequently it would be worth suggesting to the Corporation that they may want to consider developing an alternative access off Native Plains Rd. This will obviate the need to construct a much more expensive bridge, eliminate the threat of the bridge being washed away and allow Council to upgrade the waterway, which will provide a greater level of flood protection to the Water Corporations lagoon asset and the waterway.

King St Bridge with the sewerage lagoon in the background

Fig 15

9. HYDRODYNAMIC 2D MODELLING

9.1 2D MODELLING

Following the acceptance of our Stage 2 proposal an ISIS 2D (two-dimensional hydro-dynamic model) was constructed and used to develop concept designs for an alternative mitigation option and to develop multi-discharge flood plain maps for emergency management and planning.

The model constructed was in fact a 1D-2D Hydrodynamic model. ISIS allows for a 1D model to be embedded within a 2D domain with a dynamic linkage between the two. This allows for the bridges to be modelled efficiently in 1D and the complex, and often unpredictable, two dimensional floodplain flows to be modelled simultaneously.

9.2 2D MODEL CALIBRATION

Buildings in the floodplain built into topography in an ASCII grid and another ASCII grid was constructed to represent the floodplain roughness as Manning's 'n'. The area immediately adjacent to the 1D channel was hydraulically roughened partially to represent the stream bank vegetation but also to improve stability between the 1D and 2D models. The Manning's n values adopted for the model are shown in the table 13.

Area or feature	Manning's value
Roads	0.014
Floodplain upstream of Dowbiggin St	0.05
General Urban Area	0.035
1D stream buffers	0.15

Table 13

The RORB model developed in Stage 2 was used to generate hydrographs which were applied to the 1D model at cross section 10, a separate hydrograph was applied to represent the sub-catchment which joins Redwater Creek above Dowbiggin, and a third hydrograph was applied between Foster St Bridge and Railton Rd Bridge to represent the Urban area inflow.

A poly-line Shape file representing the extent of the flood that occurred on the 14th January 2011 together with a file that held the recorded or estimated flood levels were load into the model to aid calibration.

The calibrated model replicated the flood extent very well in the urbanised area and flood levels were generally matched to with +/-300mm. Table 14 shows recorded and modelled flood levels at twelve randomly selected street addresses. The model under-predicts flood level where the differences are negative and red and over-predicts flood level for the positive black differences.

In some less important areas where the flood foot print was estimated the match was not as good but these areas were all rural areas where the topography was developed from 10 metre contours. In the area immediately upstream of the Kings Bridge some flood levels diverged by more than 200mm where land gradients were steep but this did not occur near properties.

As a further check, the recorded and modelled flood levels for the January 2011 flood event of eleven randomly select blocks were plotted against the floor levels of the buildings, see figure 16. For each block the maximum, minimum and average flood level on the block was extracted to compare with the recorded level. As can be seen, the recorded and mean flood levels fall between the maximum and minimum modelled levels in all cases.

We are satisfied that the model adequately represents flood levels given the topographic data available and the methods used to estimate the flood discharge of 14th January 2011.

Street Address	Modelled level	Recorded Flood level	Difference
3 Latrobe Rd	61.620	61.686	-0.066
8 Latrobe St	60.736	60.528	0.208
18-20 Foster St	64.232	64.537	-0.305
32-34 Foster St	65.850	66.020	-0.17
48 Foster St	67.519	67.356	0.163
60 Foster St	68.982	68.960	0.022
5 Morrison St	63.449	63.508	-0.059
28 Morrison St	67.620	67.459	0.161
39 Morrison St	68.546	68.485	0.061
47 Morrison St	69.212	69.454	-0.242
14A Kimberley Rd	64.442	64.212	0.230
17 Kimberley Rd	62.890	66.790	0.100

Table 14

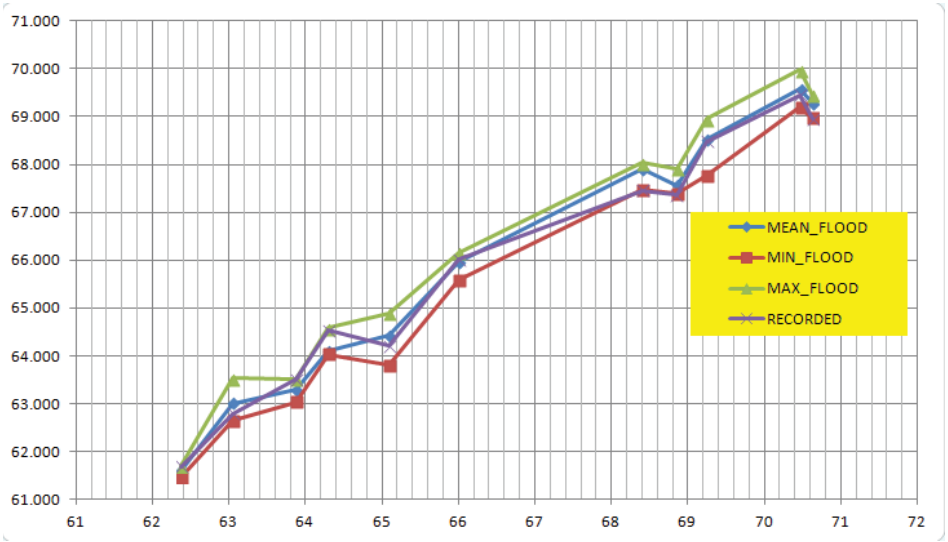


Figure 16, Recorded plotted against modelled flood levels

9.3 FLOOD MAPS

As no model can represent a flood surface as well as recorded flood elevation data for the same discharge and ARI, where event data is available it should take precedence over modelled data. Consequently as we have determined that the flood recorded on 14th January 2011 was the current 100 year ARI we recommend a flood map based on the recoded levels and subsequent GIS work should be used for planning purposes.

Other maps have been derived for the 10, 20, 50 and 200 year ARI flood surfaces. The 100 year modelled flood levels have been reserved for calibration modelling flood mitigation options. Appendix G contains the flood maps for all ARI's including the 100 year Flood Planning Map and for the recommended flood mitigation scheme.

Table 15 shows the number of properties which, according to the modelling and the 100 year recorded flood level, will be inundated by the maximum water level column 2. Column 3 shows the number of

properties that fall below the maximum flood level plus 300 mm free board. A full set of flood inundation tables are included in Appendix H.

ARI Flood Event	Max flood level > Floor level	Max flood level + 0.3 m > Floor level
10 Year	1	3
20 Year	18	42
50 Year	34	76
200 Year	58	92
100 Year 2011 Flood	54	87
100 Year Flood Mitigation scheme without the Rail Bridge upgrade	6	10
100 Year Flood Mitigation scheme with the Rail Bridge upgrade	1	3

Table 15

9.4 ALTERNATIVE FLOOD MITIGATION OPTION

As soon as we started to model the floods in 2D it became apparent that the behaviour of the floods was quite different to the scenario assumed in the 2005 Report, particularly with regard to the proposed levees.

This is best understood by reference to the composite 1D-2D flood map for the 10 year ARI event.

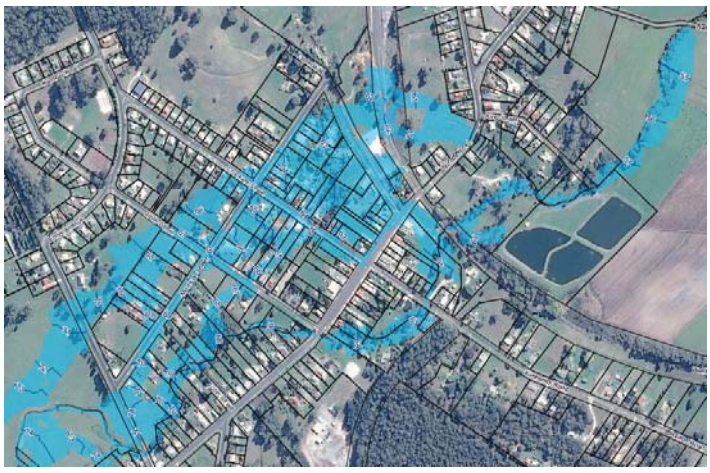


Figure 17

As can be seen from Figure 17, which depicts the 10 year AEP flood, significant flows can be seen breaking out across the urbanised floodplain north, south and along Morrison St.

Consequently, referring back to the flood mitigation levees proposed in sections 3.5 and 3.6 i.e. measures C and D, neither of these options would have been completely effective as even a moderately small flood would have outflanked the proposed defences flooding many parts of the town. The Council's instincts to avoid the use of levees on private residential blocks were justified with regard to the proposed mitigation options.

Alternative mitigation options were investigated using the 1D/2D ISIS model. As discussed earlier the option of upgrading the bridges or crossing was investigated further in combination with channel enhancement or enlargement.

Several options were investigated the most influential bridges turned out to be Railway Bridge and the Dowbiggin St Bridge. It was also essential to address the tendency for the flood to pass through the northern part of the town with a bank. The final alternative flood mitigation configuration we developed consisted of:

- Upgrading the Railway Bridge to a minimum waterway area of 30 square metres
- Upgrading the Dowbiggin St Bridge to a minimum waterway area of 25 square metres by the addition of another 15m bridge and floodway to supplement the existing bridge.
- Enhancing the main Redwater Creek channel to 15 metres wide by cutting benches into the side of the waterway say 0.5 metres above bed level.
- Construction of a flood defence levee along the upstream side of Dowbiggin St to 73.00 m AHD.

Figure 18, 100 Year ARI flood with flood mitigation options in place.

Figure 18 shows the benefit of the proposed flood mitigation options. Although major improvement can be gained without upgrading Foster St Bridge and Railton Rd Bridge immediately, in the longer term they should be upgraded to provide a larger waterway area as funds become available.

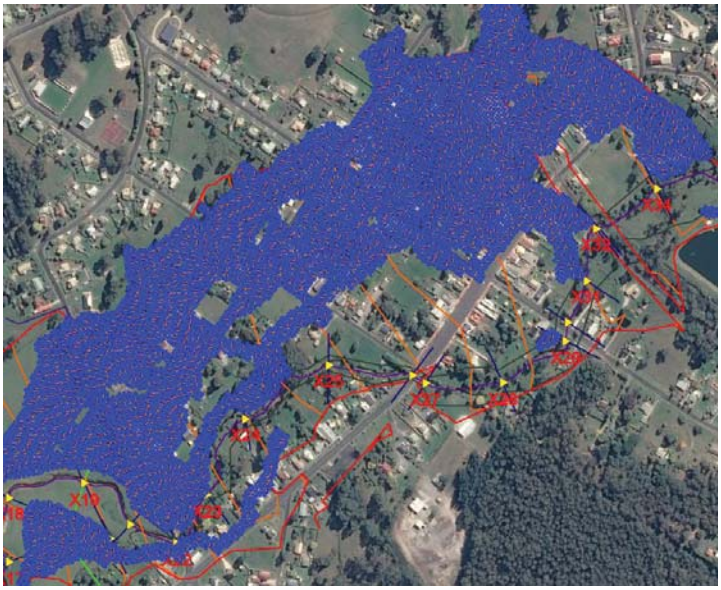


Figure 19, Mitigation without the Dowbiggin Levee

To demonstrate the significance of the Dowbiggin St levee the model was also run with enlarged bridges for Dowbiggin St Bridge and the Railway Bridge with the Redwater Creek channel enlarged to 15 metres width but without the Dowbiggin St levee. As can be seen in figure 19, which shows the flooding represented in the 2D model, the level of protection provided by bridge and channel enhancements alone are of limited benefit without the levee.

Finally, to demonstrate the effect of not upgrading the Railway Bridge but including all other measures, the model was run with the January 2011 flood a 15 metres wide enhanced channel from the Railway Bridge to Dowbiggin St, the Dowbiggin St Bridge enlarged and a levee constructed along the upstream side of Dowbiggin St to 73.00 m AHD.

Figure 20 shows the inundation caused by the Railway Bridge with all proposed mitigation options in place except the upgraded Railway Bridge. The Railway Bridge is highly susceptible to blockage and indeed it did block on 14th January 2011. The image only reflects a minor blockage and more sever inundation is possible and a greater number of properties can be flooded than are indicated in table 14 if the bridge was subject to a serious blockage.

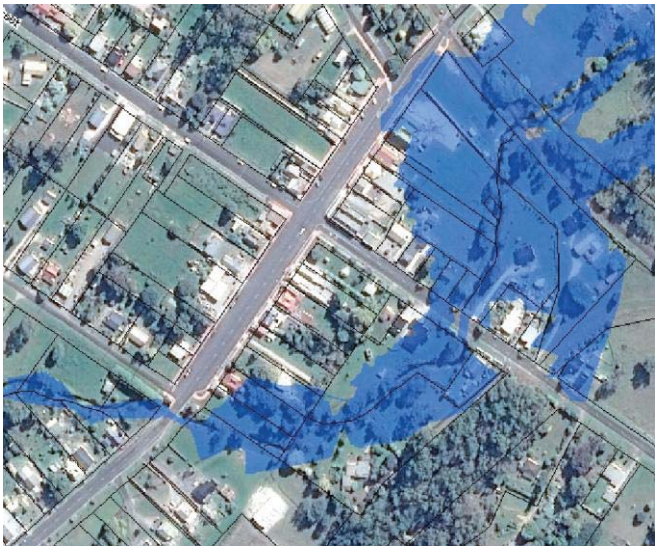


Fig 20, Inundation resulting directly from Railway Bridge

9.5 STORMWATER SYSTEM MODELLING

Modelling of Railton storm water system does not form part of the brief or the project. However from reading background documentation and from discussions with Council staff it is apparent that local nuisance flooding occurs from the drainage system.

To help identify and address these issues we would recommend that Council considers modelling the Railton storm water system to identify under-capacity conduits and channels for say the 5 year ARI storm event with multiple durations.

Once constructed, the model could then be used to define a forward capital works program and to assess the impact of future proposed developments on Council's existing storm water system and as a result place conditions on Development Applications if appropriate. Suitable models for this exercise would be Drains or Infoworks; we would be happy to provide further advice if required.

10. FLOOD WARNING SYSTEMS

10.1 BUREAU OF METROLOGY (BOM)

BoM are the primary agency for issuing flood warnings. Currently the BoM have no specific flood warning models in place for Railton Catchment. It is also desirable to place a real-time 'BoM quality' rain gauge somewhere near the centre of the catchment.

Discussions with Dr. Carlos Velasco-Forero, acting Regional Hydrology Manager BoM indicate that if Council asks the BoM to help them install a new network, determine forecast requirements, display the data on the BoM website, develop flood forecasting models or set up a flood warning or a rainfall alert service then the BoM will have to charge for these activities. Once established the BoM does not charge for the ongoing issuing and delivery of warnings or alerts as this is part of their basic service. However if Council asks the BoM to carry on with the ongoing maintenance of new Flood Warning Stations (rain-gauges) then the BoM will charge for these activities.

10.2 ESTIMATED COSTS BOM

1. The estimated capital cost and installation fee for one real-time rainfall station is in the range of $10K – $15K, with the ongoing maintenance in the range of $1K - 2K per site per annum. These costs may vary depending of the particular requirements and location of the stations.
2. Developing a new hydrological forecasting model for the Red Water Creek for flood warning could cost around $25K - $35K but the BoM do not recommend this because of the small size of the catchment.
3. As an alternative the BoM suggest that an automatic alert based on accumulated rainfall could be more useful and reliable for the Council. The cost to set up this alert may be in the order of $9K to $12K.

So the two BoM alternatives are:

- A rain gauge and model at an estimated cost of $35K to $50K.
- A rain gauge and alert system at an estimated cost of $19K to $27K

The BoM recommend a rain gauge and an alert but emphasise that all the figures provided are only an indication of the possible costs and therefore are not an official quote. Once the scope of the project has been defined, the BoM can provide a better estimate of the possible fee and costs to the Council.

As part of the stage 2 investigation the BoM were approach to determine if they could provide an alert based on their predicted Gridded Rainfall product. Dr. Carlos Velasco-Forero indicated that it was theoretically achievable but that the BoM were unable to provide that service currently and he suggested we contacted a third party software programmer to covert the data product to site-specific information.

10.3 ENTURA (HYDRO TAS)

Entura have quoted on a Stream Gauging Station and provision of the ADMS system. An initial quote was provided on the 20th June 2013 and re-issued with cost savings of $2,635 on the 18th October 2013. Entura's quote is included in Appendix F.

Entura are offering three distinct products or assets in their proposal which are as follows:

1. Part A proposes to establish a stream gauging and rainfall station based on the old BoM site upstream of the Railway bridge. The cost of this is quoted at $23,887 including all materials and labour.

On top of this there could be some additional field visits by Entura, which we would recommend. Discussions with Entura indicate that the annual costs might be $4,150.

This is based on an O&M visit every 6 months to perform any calibrations and a gauging each time plus general maintenance/clearing and say one gauge board/control survey per annum. Gauging, surveys and calibrations would be recorded onto the database and reported to client in a brief email. Cost per annum for this would be $3,700; if the Council require a flow rating to be constructed and reviewed annually then add on say $450.00. In summary the costs for the stream gauging station are:

Construction cost	$23,887
Operations & maintenance	$4,150

Part B, the second part of the quote, proposes two web sites: the ADMS site and a public web site. Although quoted together these sites are really separable parts and Entura will be happy to provide one or both. The costs of the two sites are separated below.

2. The Ajenti Data Management System (ADMS) has been developed by Entura and is used widely in their network operations and by various other agencies such as Councils. This web based application is offered as an internal flood warning and monitoring site for Council personnel. However Council can allow access to other relevant agencies such as the SES via a password system. Note that data will be automatically transferred to the BoM as this is a legal requirement under the Commonwealth Water Act 2007.

ADMS set up cost (less the cost of the public web site)	$13,808
Annual O&M costs for ADMS system	$4,455

3. The third part of the proposal relates to a public web site. This web site can contain links from the ADMS system, public information notices and educational material. It can be used by Council, its officers and the public. Maintenance costs would be included in Item 2 and have not been separated at this stage.

Public web site	$6,920.00.

Discussion of benefits

Item 1 or Part A relating to the gauging station has a significant cost but the benefits can be summarised as follows:

- In the longer term it will provide Railton specific flood frequency data, which can be used to directly estimate flood magnitude and its associated ARI.
- In the intermediate time frame it will provide flood event data for the calibration of hydraulic and hydrological models leading to better flood risk assessment and consequently better estimation of discharge, level and ARI.
- During flood emergencies, provided a flood rating curve is developed, it will provide near real time flood flow information on level and discharge and indicate if the flood is rising or falling. This will be of use directly to Council for local emergency response and regionally with respect to resource allocation by the Police and SES.

Item 2, the ADMS system, allows the Council to monitor catchment condition from rain gauges and river / stream gauging stations, existing and proposed. It can also be set up to issue alerts based on rainfall and river level making it a potentially invaluable tool for flood warning and response.

One of the most useful of the proposed deliverables is the Gridded Rainfall Data. This is data generated for up to 7 days prior to possible rainfall. The projected rainfalls are updated twice daily with improving accuracy as the proximity to the current time approaches. In flashy catchments with short critical durations this should prove to be an invaluable tool for flood warning, response and preparedness.

On consideration of our stage 1 recommendations, Council found that the ongoing costs would be difficult to service in the current financial climate. The stage 1 recommendation was that:

'Council proceed with implementing the ADMS flood warning enhancement through its own budgetary processes or by sourcing grant funds as soon as possible as it will provide access to local data and the BoM Gridded Data sets at an early stage. The ADMS system capital cost is $13,808, with O&M costs of $4,455 p.a.'

Alternative reduced cost possibilities

As an alternative approach to reduce costs we proposed that Kentish Council approach Launceston City Council with a view sharing a portion of their ADMS site. The author has also discussed the idea of ADMS site / cost sharing with Northern Midlands Council and they have independently approached Launceston City Council.

Ongoing discussions with Entura indicate that if we can reach an agreement with Launceston then the cost of modifying the site to meet Kentish Council's needs may be as indicated in the table below.

Site	Annual cost	Capital
Sheffield Farm	$ 270.00	$ 260.00
Cement Aust	$ 270.00	$ 260.00
Alarm Sheffield Farm		$ 265.00
Alarm Cement Aust		$ 265.00
Gridded data programming		$ 2,500.00
Gridded Data annual fee Estimate	$ 500.00	
Cement Australia telemetry		$ 2,000.00
Total	**$ 1,040.00**	**$ 5,550.00**

Table 16

It must be emphasised that the costs in table 16 are estimates only. If Council is interested in progressing this concept to a formal quote from Entura it will be necessary to first reach an agreement with Launceston on resource sharing and then contact Lukas Salkeld at Entura to request a formal quote.

Public Web Site

The establishment of a dedicated flood education and emergency web site was not recommended at the end of Stage 1 for cost and maintenance reasons. However for a much smaller cost it would be beneficial to dedicate a section of Kentish Council's existing web site to flood awareness training. This section could include the flood educational literature and the flood maps produced during this study. During an event it would be very useful to contain links to Police/SES/BoM warnings plus a notice indicating the status of evacuation centres and the roads.

11. EMERGENCY MANAGEMENT AND COMMUNITY EDUCATION

A request was made by Kentish Council to utilise Launceston City Council's emergency management documentation as a template for documents to be adapted to the needs of Railton. Launceston City Council agreed to this request and Railton specific documentation has been developed during Stage 2. Foot and Playsted had printed the Launceston documents and they were engaged to rework the base documents.

An additional item was included for the purposes of flood education in the form of a Flood Risk Disc. This is a simple calculator which is helpful in conveying the concepts of flood risk and in particular how the chance of flooding increases with time. The disc copyright lay with Molino Stewart who kindly agreed to our reuse of the disk concept.

The documentation which is included in Appendix I consists of the following:

- The flood Risk Disc, three parts.
- A Flood Evacuation Standby by Notice.
- A Fridge Magnet with key critical information.
- Brochure: Flooding in Railton; Tips to protect you, your family, pets and property.

The Flood Risk Disc should prove very useful in the education of school children and adults alike. It will also be a useful resource for Council and SES staff when trying to communicate flood risk.

The Flood Evacuation Standby notice is useful in a flood emergency as Council and SES personnel will be too busy to start producing documents in the middle of an event. Consequently when the appropriate triggers are reached and the decision to evacuate has been made the leaflets containing all the critical information are ready for distribution.

The fridge magnet will serve as a readily available check list for the population at risk. Often other more detailed documents may be lost but if they retain nothing more than this they will at least have the basic information to hand.

The brochure forms the backbone of the flood education material. It details what to do before, during and after a flood.

We would recommend that the documents are issued and reissued to the population at risk every two years to help maintain the community in a prepared state. The documents should also be issued when properties change ownership and landlords should be encouraged to inform new tenants that they can pick up documents from the Council Offices.

Education of local school children in flood awareness is beneficial not only for their own safety but because they can also help to raise the general level of preparedness in the community.

Flood Response Resources

In the event of a flood, human resources are often stretched by concurrent and competing demands. Often workers may have family commitments or have to respond to flooding of their own homes or might find it difficult to get to work. As a rule of thumb in emergency planning, organisations should not depend on more than 50% of the normal work force being available for emergency response activities.

Only 27% of flood emergencies occur during normal business hours. This leads to the obvious conclusion that 73% of flood peaks will arrive at a time when the community at large is least prepared to respond.

The Council's Maximum Potential Emergency Response establishment consists of:

Emergency Management Coordinator (Engineering Manger)
Deputy Emergency Management Coordinator(Works Depot Coordinator)
EM Recovery Co-ordinator
Two Deputy EM Recovery Coordinators.
Works Manager
Works Supervisor
12.5 FTE outdoor workers

During business hours this force would be stretch to respond to the concurrent and competing demands of normal call outs and a flood response. As recorded in Section 4 the Council and local business responded magnificently to the emergency which occurred on 13th/14th January 2011. The 14th was a Friday and according to the BoM

> *'50mm alert would have been issued at 4:00am which would have provide 5 hours additional preparation time to the Council'*

This essentially meant that the work force turned up for work on Friday as the emergency was developing. If the BoM warning, which was a bit opaque without a flood study, had been issued at 10PM on the Saturday it would have created additional difficulties.

The conclusion to be drawn from this is that it is essential for the Council to be able to call on additional resources at all times. These would include the SES, Police (and Fire Brigade if available) as first responders. During the event of 14th January 2011 Cement Australia also responded generously with their work force and time, but out of hours it is unlikely that they would be available.

Consequently as part of the Emergency Action Plan it would be beneficial to hold emergency training exercises with the stake holders including those involved in running evacuation centres and early recovery. This could take the form of lectures and familiarisation with the vulnerable areas of the town, evacuation centres and the availability of road access or otherwise during an event together with the usual flood emergency safety training. Now that Council has flood maps available, it should be easier to convey the nature and the extent of the potential problems which will face them.

We have produced an embryonic flood warning chart showing the escalation triggers, consequences, actions and notifications. This document needs to be fleshed out with input from the Council and SES, so it should be considered a starting point rather than a definitive document. Ultimately Council and the SES will need to be happy with the documentation and take ownership of it for its forward development.

Emergency management documentation is never really finalised and should be considered as living documents which will evolve separately to this report but hopefully may be informed by it.

The Flood Waring Escalation Chart is included in Appendix J.

12. FLOOD INSURANCE

To test if there would be quantifiable community benefits for Railton by reducing the flood risk and consequently the local insurance premiums, several properties were investigated for Home & Contents insurance costs via anonymous on-line quotations in 2013. Typical figures were in the order of $1,300 to $1,400. It appears insurance cover costs are about $1,000 more than in parts of Launceston which are known to be flood free and $800 more than Sheffield.

I enquired if flood insurance was optional:

- The RACT said no it was automatically included with no opt-out.
- AAMI had similar prices but have an opt-out option if the area is known to be flood prone however this option did not appear to be available for Railton.

This may mean the flood risk is not understood by parts of the insurance industry. However the higher premiums compared to parts of Launceston and Sheffield could indicate there is an acknowledgment of a higher risk associated with the town.

Unfortunately we could not establish easily that premiums would drop if flood mitigation options were implemented so this may or may not be the case. However if Council does manage to significantly reduce risk it would be worth letting the insurance industry know that the flood risk has been reduced.

In the aftermath of the January 2011 flood a dispute developed between one family and AAMI. This was based on definition of flooding and the source of the water. Apparently the AAMI policy covered the residents Mr & Mrs Riley for storm water damage but not riverine flooding. Eventually AAMI did pay out but only after a 7 month battle had ensued involving lawyers. Any flood education package must emphasise the need for property owners to check their policies carefully with their Insurer and determine that it specifically covers riverine or main river flood damage.

13. RECOMMENDATIONS AND FINDINGS

The Final Report makes the following recommendations and observations.

1. The flood peak which occurred on 14th January 2011 at Railton just exceeded a 100 year ARI event. The associated rainfall busts also exceed the 100 year ARI intensity over several durations including the critical 12 hour event. The flood caused significant damage and showed that Railton is one of the most exposed communities in Tasmania to large floods.
2. Council recorded the extent and elevation of the 2011 flood event, this information has been converted into a formal flood plain planning map and can be used with confidence as 'the highest recorded flood level exceeding or equalling the 100 year ARI event'.
3. From a detailed review of the previous reports and through analysis of primary data it would appear that the 2002 & 2005 Reports over-estimated the 100 year ARI flood peak by 26%. The 2005 Report estimates the 100 year ARI flood peak discharge at the Rail bridge at 59 m^3/s while we found that it is currently more likely to be 46.7 m^3/s.
4. The Stage 2 analysis, which included 2D hydraulic modelling of the flood plain, indicated that the conclusion reached in the 2005 report as to which mitigation option should be progressed was less than optimal. An alternative option suggested itself as a result of our analysis which comprises upgrading two bridges, namely the Railway Bridge and augmentation of the Dowbiggin St Bridge. This would involve enhancement of the main channel from at least the Railway Bridge to Dowbiggin and construction of a levee along Dowbiggin St on the upstream side to an elevation of 73.00 m AHD.
5. The Railway Bridge is not owned by Council but it floods private homes. We recommend that this fact is brought to the attention of the asset own with a request that they upgrade the bridge water way area as soon as possible. Although not mentioned in item 4, the bridges at Railton Rd and Foster St are also hydraulically challenged in a 100 year flood event and should be upgraded when the opportunity for asset replacement presents itself.
6. We also recommend that Council engage with the other bridge asset owner TASWATER and request that they upgrade their asset as part of any flood mitigation scheme. In recommending this we assume the King St Bridge is owned by TASWATER
7. We also disagree with the previous report in treating willow and general vegetation management as a potential capital option and considering it to be independent from the other options. Channel vegetation management clearly falls under operations and maintenance and is required with all other options including the do nothing capital expenditure option. Consequently, we recommend that Council commence an active annual program of vegetation control and regrowth spraying as early as possible. This will help the existing channels to convey as much flood water as possible for its current size but it will also be good for public relations.
8. We used the RORB model to study the potential impacts of climate change on Railton's flood peak discharges. We found that the future flow estimate for the 100 Year ARI flood peak will exceed the current flood peak estimate for the 200 Year ARI flood peak by 2085. That is to say the flood peak estimate at the Rail Bridge in the 100 Year ARI event will increase from 46.72 m^3/s to 59.96 m^3/s.
9. Permission was granted by Launceston City Council to use their emergency management documentation as a template for Railton. These documents have been developed in Stage 2 and we recommend that, once Council has approved the content, they be used as part of the flood education program, in general emergency management and that they are placed on the Council web site.
10. Providing Council can reach an agreement with Launceston City Council on resource sharing, it is recommended Council enhances its flood warning and monitoring capabilities in stages. As a first step we recommend commissioning Entura to modify Launceston's ADMS application to include

rain gauges at Sheffield Farm School Cement Australia. The latter site will require the addition of telemetry to make the data available. Through the ADMS site it is also proposed that both the rain gauges are alarmed and that Gridded BoM rain data predictions are included to give the Council officers more lead time given the rapid response of the catchment to intense rainfall.

14. REFERENCES

References:

1. Railton Floodplain Risk Management Study, version 2.0, Cardno Willing, January 2005 (*S Konica Sca12032110130.pdf*).
2. Redwater Creek Detention Storage Study, Thompson & Brett, May 2002.
3. Australian Rainfall and Runoff 1999 and 1987.
4. RORB Manual
5. HecRas manual US Corp of Engineers
6. ISIS Manuals CHM2MHILL

APPENDIX A


New Bed Road
Ramsay Road
Esplanade
Native Rock Road
Native Plains Road
King Street
Latrobe Road
Crockers Street
Giblin Street
Ennis Avenue
Morrison Street
Dowbiggin Street
Foster Street
Calder Street
Leake Street
Kimberley Road
Western Line
Railton Road
0 25 50 75 100 200 300 400 500
Metres
Legend
Willow Removal
Watercourse
2011 Flood Levels
Cadastre
Easements
RAILTON FLOOD STUDY
Redwater Creek Willow Removal
Post March 2011
Prepared by:
esk mapping GIS
www.eskmapping.com.au

APPENDIX B

Intensity-Frequency-Duration Table

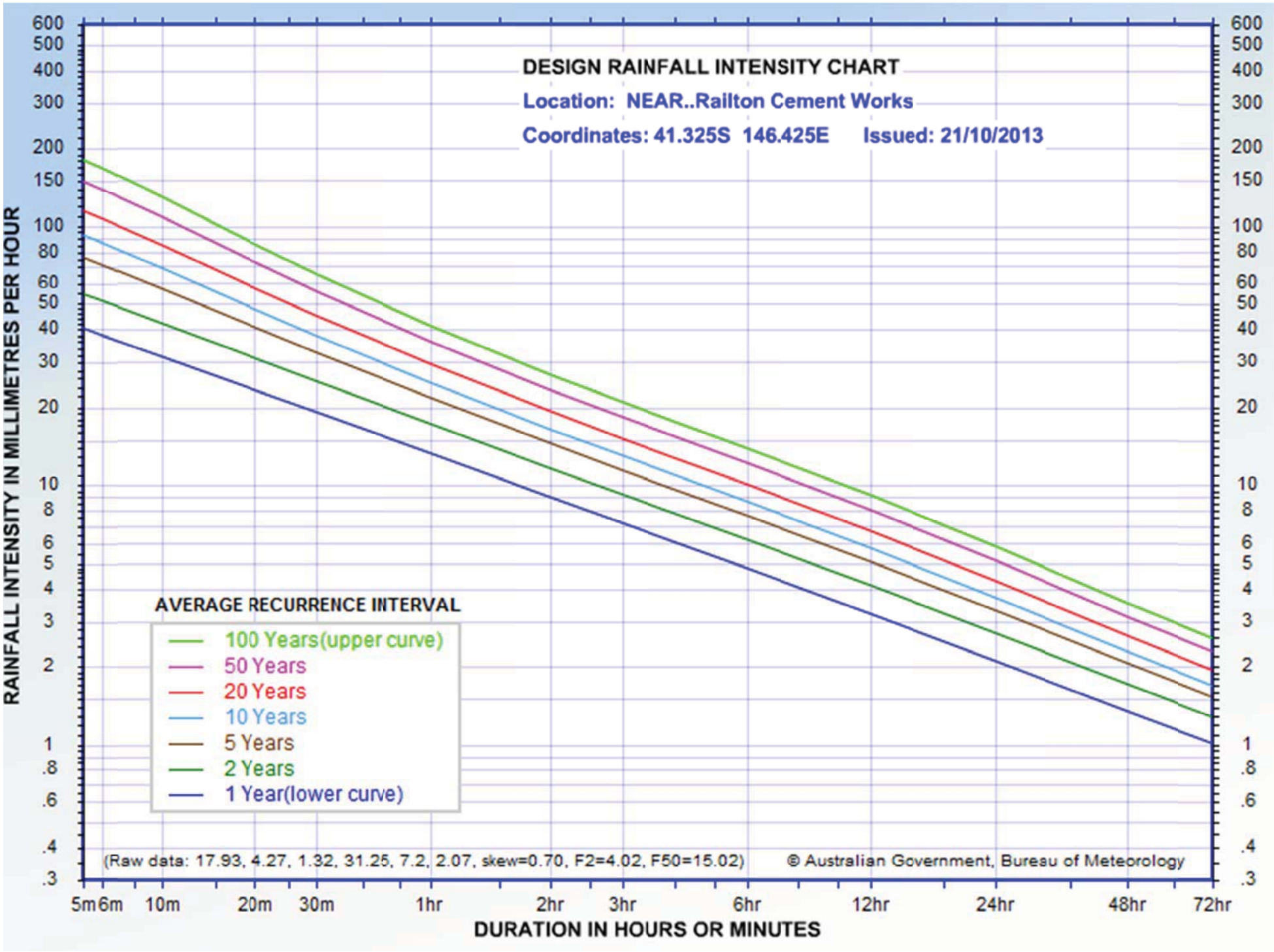
Location: 41.325S 146.425E NEAR.. Railton Cement Works Issued: 21/10/2013

Rainfall intensity in mm/h for various durations and Average Recurrence Interval

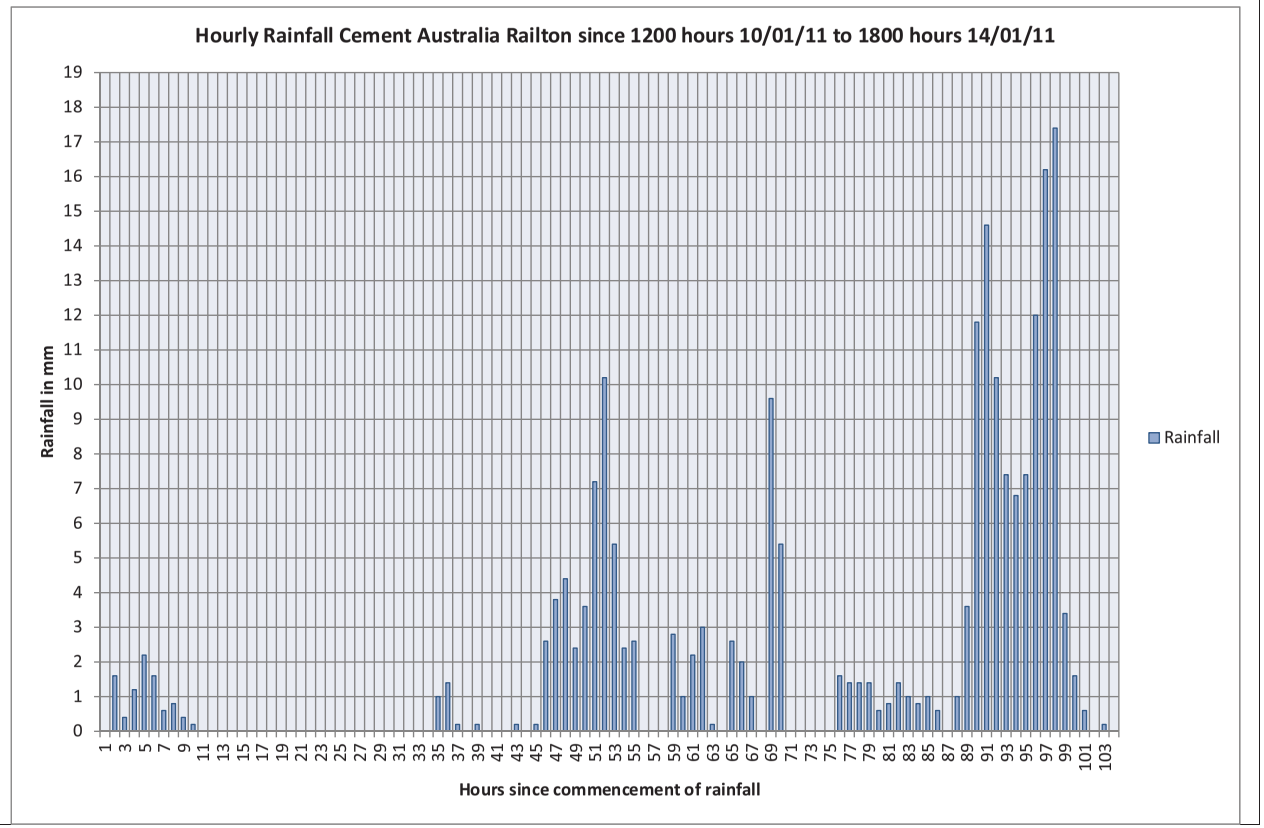
Average Recurrence Interval

Duration	1 YEAR	2 YEARS	5 YEARS	10 YEARS	20 YEARS	50 YEARS	100 YEARS
5Mins	40.4	54.7	76.1	92.4	115	150	181
6Mins	37.9	51.4	71.2	86.3	107	139	168
10Mins	31.4	42.2	57.4	68.9	84.7	109	130
20Mins	23.3	30.9	40.7	47.7	57.6	72.4	85.2
30Mins	19.2	25.2	32.5	37.7	45.1	55.9	65.2
1Hr	13.3	17.3	21.8	24.9	29.4	35.9	41.3
2Hrs	9.01	11.6	14.5	16.4	19.3	23.3	26.7
3Hrs	7.13	9.22	11.4	13.0	15.1	18.3	20.9
6Hrs	4.78	6.17	7.64	8.65	10.1	12.2	13.9
12Hrs	3.19	4.11	5.07	5.73	6.67	8.03	9.17
24Hrs	2.10	2.69	3.29	3.69	4.27	5.12	5.81
48Hrs	1.34	1.71	2.06	2.28	2.63	3.11	3.51
72Hrs	1.01	1.28	1.53	1.69	1.94	2.29	2.58

(Raw data: 17.93, 4.27, 1.32, 31.25, 7.2, 2.07, skew=0.70, F2=4.02, F50=15.02)

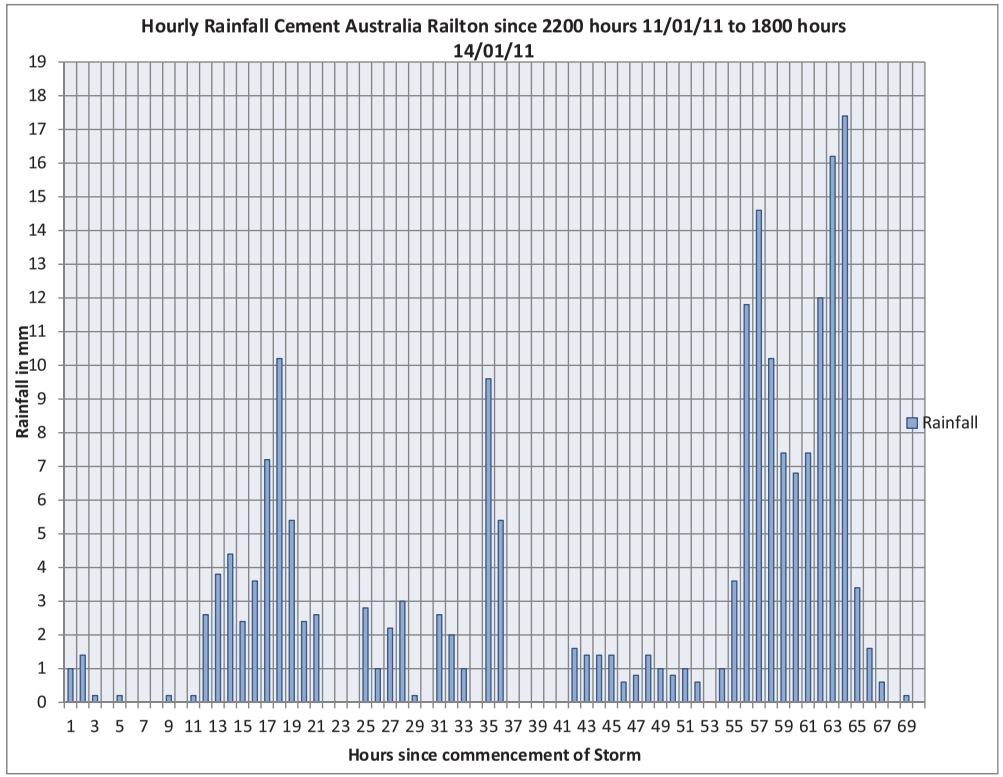

DESIGN RAINFALL INTENSITY CHART
Location: NEAR..Railton Cement Works
Coordinates: 41.325S 146.425E
Issued: 21/10/2013
RAINFALL INTENSITY IN MILLIMETRES PER HOUR
600
500
400
300
200
150
100
80
60
50
40
30
20
10
8
6
5
4
3
2
1
.8
.6
.4
.3
AVERAGE RECURRENCE INTERVAL
100 Years(upper curve)
50 Years
20 Years
10 Years
5 Years
2 Years
1 Year(lower curve)
(Raw data: 17.93, 4.27, 1.32, 31.25, 7.2, 2.07, skew=0.70, F2=4.02, F50=15.02)
© Australian Government, Buresu of Meteorology
5m
6m
10m
20m
30m
1hr
2hr
3hr
6hr
12hr
24hr
48hr
72hr
DURATION IN HOURS OR MINUTES

Date	Time	Hours since start	Rainfall	Date	Time	Hours since start	Rainfall
10/01/2011	12:00:00	1	0	12/01/2011	19:00:00	56	0
10/01/2011	13:00:00	2	1.6	12/01/2011	20:00:00	57	0
10/01/2011	14:00:00	3	0.4	12/01/2011	21:00:00	58	0
10/01/2011	15:00:00	4	1.2	12/01/2011	22:00:00	59	2.8
10/01/2011	16:00:00	5	2.2	12/01/2011	23:00:00	60	1
10/01/2011	17:00:00	6	1.6	13/01/2011	0:00:00	61	2.2
10/01/2011	18:00:00	7	0.6	13/01/2011	1:00:00	62	3
10/01/2011	19:00:00	8	0.8	13/01/2011	2:00:00	63	0.2
10/01/2011	20:00:00	9	0.4	13/01/2011	3:00:00	64	0
10/01/2011	21:00:00	10	0.2	13/01/2011	4:00:00	65	2.6
10/01/2011	22:00:00	11	0	13/01/2011	5:00:00	66	2
10/01/2011	23:00:00	12	0	13/01/2011	6:00:00	67	1
11/01/2011	0:00:00	13	0	13/01/2011	7:00:00	68	0
11/01/2011	1:00:00	14	0	13/01/2011	8:00:00	69	9.6
11/01/2011	2:00:00	15	0	13/01/2011	9:00:00	70	5.4
11/01/2011	3:00:00	16	0	13/01/2011	10:00:00	71	0
11/01/2011	4:00:00	17	0	13/01/2011	11:00:00	72	0
11/01/2011	5:00:00	18	0	13/01/2011	12:00:00	73	0
11/01/2011	6:00:00	19	0	13/01/2011	13:00:00	74	0
11/01/2011	7:00:00	20	0	13/01/2011	14:00:00	75	0
11/01/2011	8:00:00	21	0	13/01/2011	15:00:00	76	1.6
11/01/2011	9:00:00	22	0	13/01/2011	16:00:00	77	1.4
11/01/2011	10:00:00	23	0	13/01/2011	17:00:00	78	1.4
11/01/2011	11:00:00	24	0	13/01/2011	18:00:00	79	1.4
11/01/2011	12:00:00	25	0	13/01/2011	19:00:00	80	0.6
11/01/2011	13:00:00	26	0	13/01/2011	20:00:00	81	0.8
11/01/2011	14:00:00	27	0	13/01/2011	21:00:00	82	1.4
11/01/2011	15:00:00	28	0	13/01/2011	22:00:00	83	1
11/01/2011	16:00:00	29	0	13/01/2011	23:00:00	84	0.8
11/01/2011	17:00:00	30	0	14/01/2011	0:00:00	85	1
11/01/2011	18:00:00	31	0	14/01/2011	1:00:00	86	0.6
11/01/2011	19:00:00	32	0	14/01/2011	2:00:00	87	0
11/01/2011	20:00:00	33	0	14/01/2011	3:00:00	88	1
11/01/2011	21:00:00	34	0	14/01/2011	4:00:00	89	3.6
11/01/2011	22:00:00	35	1	14/01/2011	5:00:00	90	11.8
11/01/2011	23:00:00	36	1.4	14/01/2011	6:00:00	91	14.6
12/01/2011	0:00:00	37	0.2	14/01/2011	7:00:00	92	10.2
12/01/2011	1:00:00	38	0	14/01/2011	8:00:00	93	7.4
12/01/2011	2:00:00	39	0.2	14/01/2011	9:00:00	94	6.8
12/01/2011	3:00:00	40	0	14/01/2011	10:00:00	95	7.4
12/01/2011	4:00:00	41	0	14/01/2011	11:00:00	96	12
12/01/2011	5:00:00	42	0	14/01/2011	12:00:00	97	16.2
12/01/2011	6:00:00	43	0.2	14/01/2011	13:00:00	98	17.4
12/01/2011	7:00:00	44	0	14/01/2011	14:00:00	99	3.4
12/01/2011	8:00:00	45	0.2	14/01/2011	15:00:00	100	1.6
12/01/2011	9:00:00	46	2.6	14/01/2011	16:00:00	101	0.6
12/01/2011	10:00:00	47	3.8	14/01/2011	17:00:00	102	0
12/01/2011	11:00:00	48	4.4	14/01/2011	18:00:00	103	0.2
12/01/2011	12:00:00	49	2.4	14/01/2011	19:00:00	104	0
12/01/2011	13:00:00	50	3.6				
12/01/2011	14:00:00	51	7.2				
12/01/2011	15:00:00	52	10.2				
12/01/2011	16:00:00	53	5.4				
12/01/2011	17:00:00	54	2.4				
12/01/2011	18:00:00	55	2.6				

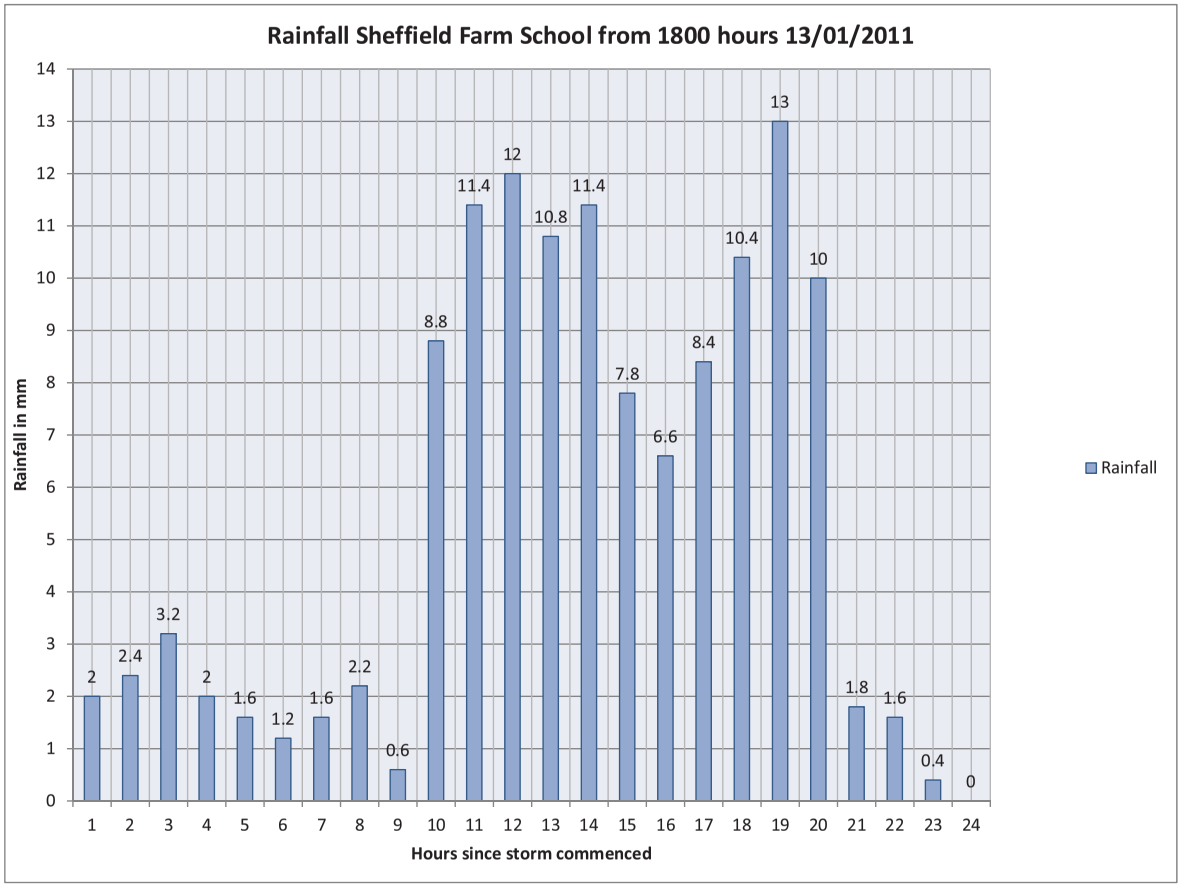


Date	Time	Hours since start	Rainfall	%	Date	Time	Hours since start	Rainfall	%
11/01/2011	22:00:00	1	1	1.1	14/01/2011	0:00:00	51	1	1.1
11/01/2011	23:00:00	2	1.4	1.6	14/01/2011	1:00:00	52	0.6	0.7
12/01/2011	0:00:00	3	0.2	0.2	14/01/2011	2:00:00	53	0	0.0
12/01/2011	1:00:00	4	0	0.0	14/01/2011	3:00:00	54	1	1.1
12/01/2011	2:00:00	5	0.2	0.2	14/01/2011	4:00:00	55	3.6	4.1
12/01/2011	3:00:00	6	0	0.0	14/01/2011	5:00:00	56	11.8	13.4
12/01/2011	4:00:00	7	0	0.0	14/01/2011	6:00:00	57	14.6	16.6
12/01/2011	5:00:00	8	0	0.0	14/01/2011	7:00:00	58	10.2	11.6
12/01/2011	6:00:00	9	0.2	0.2	14/01/2011	8:00:00	59	7.4	8.4
12/01/2011	7:00:00	10	0	0.0	14/01/2011	9:00:00	60	6.8	7.7
12/01/2011	8:00:00	11	0.2	0.2	14/01/2011	10:00:00	61	7.4	8.4
12/01/2011	9:00:00	12	2.6	3.0	14/01/2011	11:00:00	62	12	13.6
12/01/2011	10:00:00	13	3.8	4.3	14/01/2011	12:00:00	63	16.2	18.4
12/01/2011	11:00:00	14	4.4	5.0	14/01/2011	13:00:00	64	17.4	19.8
12/01/2011	12:00:00	15	2.4	2.7	14/01/2011	14:00:00	65	3.4	3.9
12/01/2011	13:00:00	16	3.6	4.1	14/01/2011	15:00:00	66	1.6	1.8
12/01/2011	14:00:00	17	7.2	8.2	14/01/2011	16:00:00	67	0.6	0.7
12/01/2011	15:00:00	18	10.2	11.6	14/01/2011	17:00:00	68	0	0.0
12/01/2011	16:00:00	19	5.4	6.1	14/01/2011	18:00:00	69	0.2	0.2
12/01/2011	17:00:00	20	2.4	2.7	14/01/2011	19:00:00	70	0	0.0
12/01/2011	18:00:00	21	2.6	3.0			**Total**	**88**	**100.0**
12/01/2011	19:00:00	22	0	0.0					
12/01/2011	20:00:00	23	0	0.0					
12/01/2011	21:00:00	24	0	0.0					
12/01/2011	22:00:00	25	2.8	3.2					
12/01/2011	23:00:00	26	1	1.1					
13/01/2011	0:00:00	27	2.2	2.5					
13/01/2011	1:00:00	28	3	3.4					
13/01/2011	2:00:00	29	0.2	0.2					
13/01/2011	3:00:00	30	0	0.0					
13/01/2011	4:00:00	31	2.6	3.0					
13/01/2011	5:00:00	32	2	2.3					
13/01/2011	6:00:00	33	1	1.1					
13/01/2011	7:00:00	34	0	0.0					
13/01/2011	8:00:00	35	9.6	10.9					
13/01/2011	9:00:00	36	5.4	6.1					
13/01/2011	10:00:00	37	0	0.0					
13/01/2011	11:00:00	38	0	0.0					
13/01/2011	12:00:00	39	0	0.0					
13/01/2011	13:00:00	40	0	0.0					
13/01/2011	14:00:00	41	0	0.0					
13/01/2011	15:00:00	42	1.6	1.8					
13/01/2011	16:00:00	43	1.4	1.6					
13/01/2011	17:00:00	44	1.4	1.6					
13/01/2011	18:00:00	45	1.4	1.6					
13/01/2011	19:00:00	46	0.6	0.7					
13/01/2011	20:00:00	47	0.8	0.9					
13/01/2011	21:00:00	48	1.4	1.6					
13/01/2011	22:00:00	49	1	1.1					
13/01/2011	23:00:00	50	0.8	0.9					

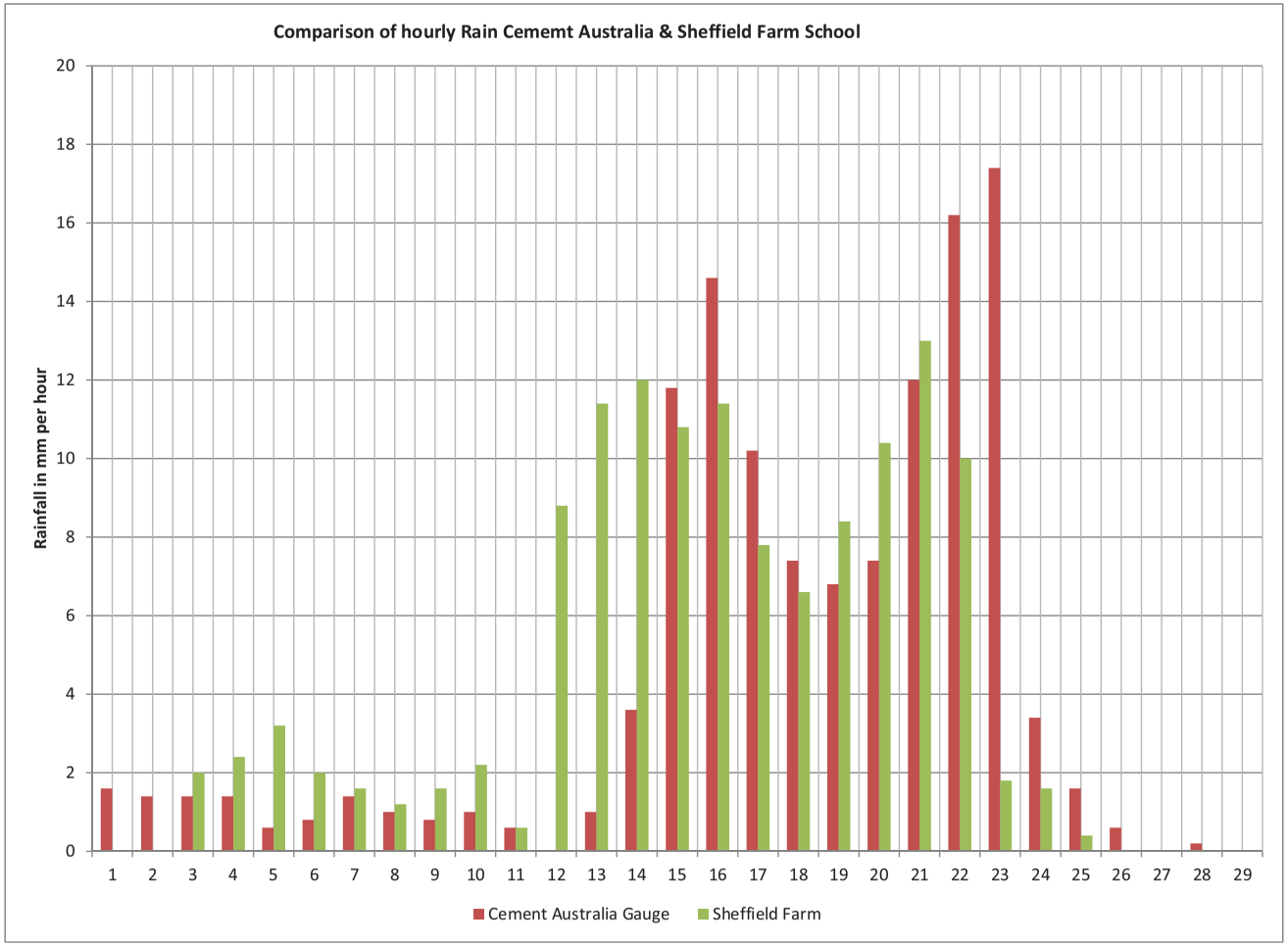
Storm Record used in RORB Model Calibration to estimated Peak

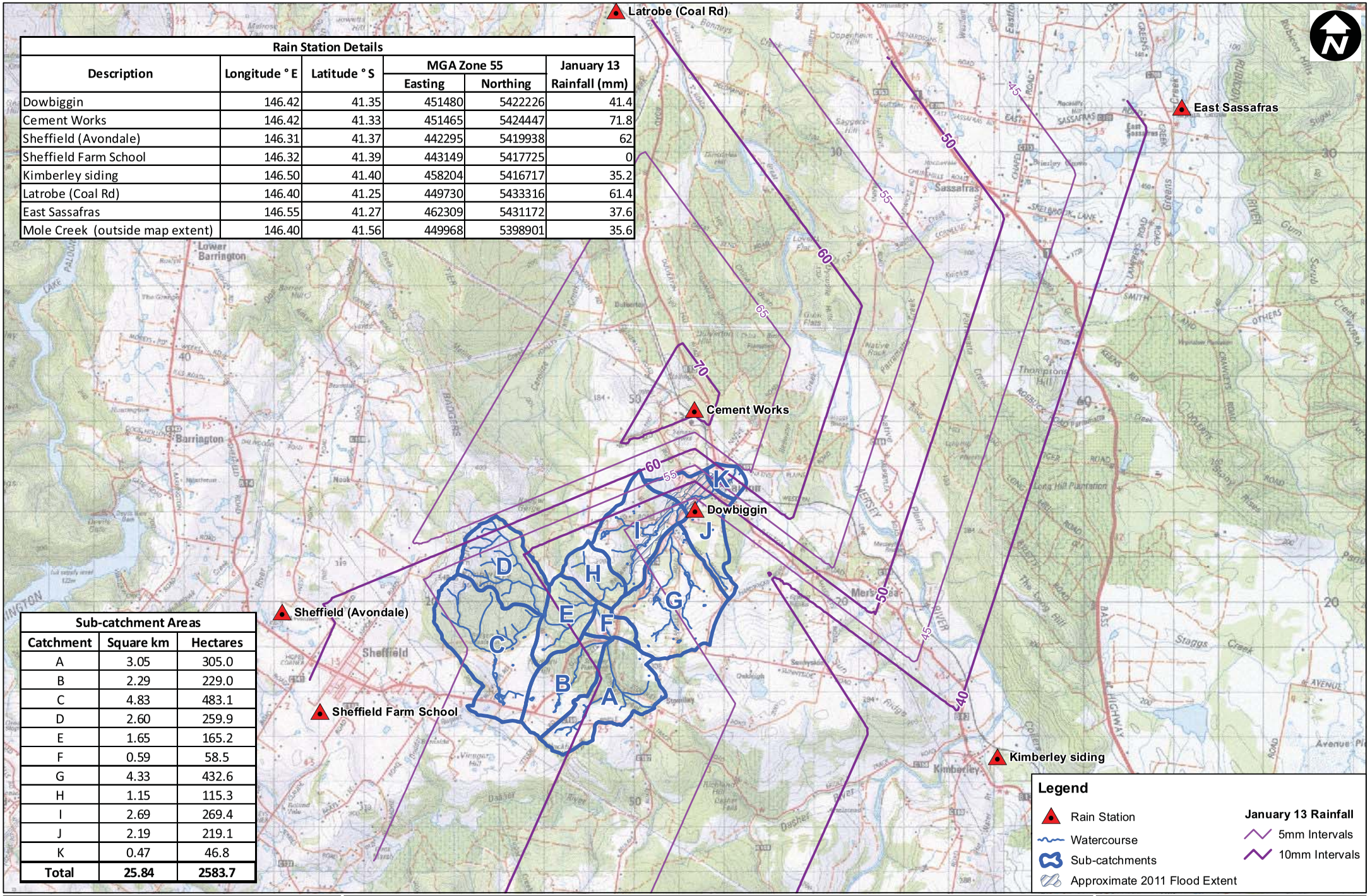


DATE & Time	Rainfall	%
13/01/2011 17:00	2	1.5
13/01/2011 18:00	2.4	1.8
13/01/2011 19:00	3.2	2.4
13/01/2011 20:00	2	1.5
13/01/2011 21:00	1.6	1.2
13/01/2011 22:00	1.2	0.9
13/01/2011 23:00	1.6	1.2
14/01/2011 12:00	2.2	1.7
14/01/2011 1:00	0.6	0.5
14/01/2011 2:00	8.8	6.7
14/01/2011 3:00	11.4	8.7
14/01/2011 4:00	12	9.1
14/01/2011 5:00	10.8	8.2
14/01/2011 6:00	11.4	8.7
14/01/2011 7:00	7.8	5.9
14/01/2011 8:00	6.6	5
14/01/2011 9:00	8.4	6.4
14/01/2011 10:00	10.4	7.9
14/01/2011 11:00	13	9.9
14/01/2011 12:00	10	7.6
14/01/2011 13:00	1.8	1.4
14/01/2011 14:00	1.6	1.2
14/01/2011 15:00	0.4	0.3
14/01/2011 16:00	0	0



Date	Time		Cement Australia Gauge	Shefield Farm School
13/01/2011	15:00:00	1	1.6	
13/01/2011	16:00:00	2	1.4	
13/01/2011	17:00:00	3	1.4	2
13/01/2011	18:00:00	4	1.4	2.4
13/01/2011	19:00:00	5	0.6	3.2
13/01/2011	20:00:00	6	0.8	2
13/01/2011	21:00:00	7	1.4	1.6
13/01/2011	22:00:00	8	1	1.2
13/01/2011	23:00:00	9	0.8	1.6
14/01/2011	0:00:00	10	1	2.2
14/01/2011	1:00:00	11	0.6	0.6
14/01/2011	2:00:00	12	0	8.8
14/01/2011	3:00:00	13	1	11.4
14/01/2011	4:00:00	14	3.6	12
14/01/2011	5:00:00	15	11.8	10.8
14/01/2011	6:00:00	16	14.6	11.4
14/01/2011	7:00:00	17	10.2	7.8
14/01/2011	8:00:00	18	7.4	6.6
14/01/2011	9:00:00	19	6.8	8.4
14/01/2011	10:00:00	20	7.4	10.4
14/01/2011	11:00:00	21	12	13
14/01/2011	12:00:00	22	16.2	10
14/01/2011	13:00:00	23	17.4	1.8
14/01/2011	14:00:00	24	3.4	1.6
14/01/2011	15:00:00	25	1.6	0.4
14/01/2011	16:00:00	26	0.6	0
14/01/2011	17:00:00	27	0	
14/01/2011	18:00:00	28	0.2	
14/01/2011	19:00:00	29	0	
	Total mm		**126.2**	**131.2**





Rain Station Details					
Description	Longitude ° E	Latitude ° S	MGA Zone 55		January 13
			Easting	Northing	Rainfall (mm)
Dowbiggin	146.42	41.35	451480	5422226	41.4
Cement Works	146.42	41.33	451465	5424447	71.8
Sheffield (Avondale)	146.31	41.37	442295	5419938	62
Sheffield Farm School	146.32	41.39	443149	5417725	0
Kimberley siding	146.50	41.40	458204	5416717	35.2
Latrobe (Coal Rd)	146.40	41.25	449730	5433316	61.4
East Sassafras	146.55	41.27	462309	5431172	37.6
Mole Creek (outside map extent)	146.40	41.56	449968	5398901	35.6

Sub-catchment Areas		
Catchment	Square km	Hectares
A	3.05	305.0
B	2.29	229.0
C	4.83	483.1
D	2.60	259.9
E	1.65	165.2
F	0.59	58.5
G	4.33	432.6
H	1.15	115.3
I	2.69	269.4
J	2.19	219.1
K	0.47	46.8
Total	**25.84**	**2583.7**

Legend

- Rain Station
- Watercourse
- Sub-catchments
- Approximate 2011 Flood Extent

January 13 Rainfall

- 5mm Intervals
- 10mm Intervals

0 0.5 1 2 3 4

Kilometres

1:75,000 when printed on A3

Railton Catchment and Rainfall Map
January 13 2011

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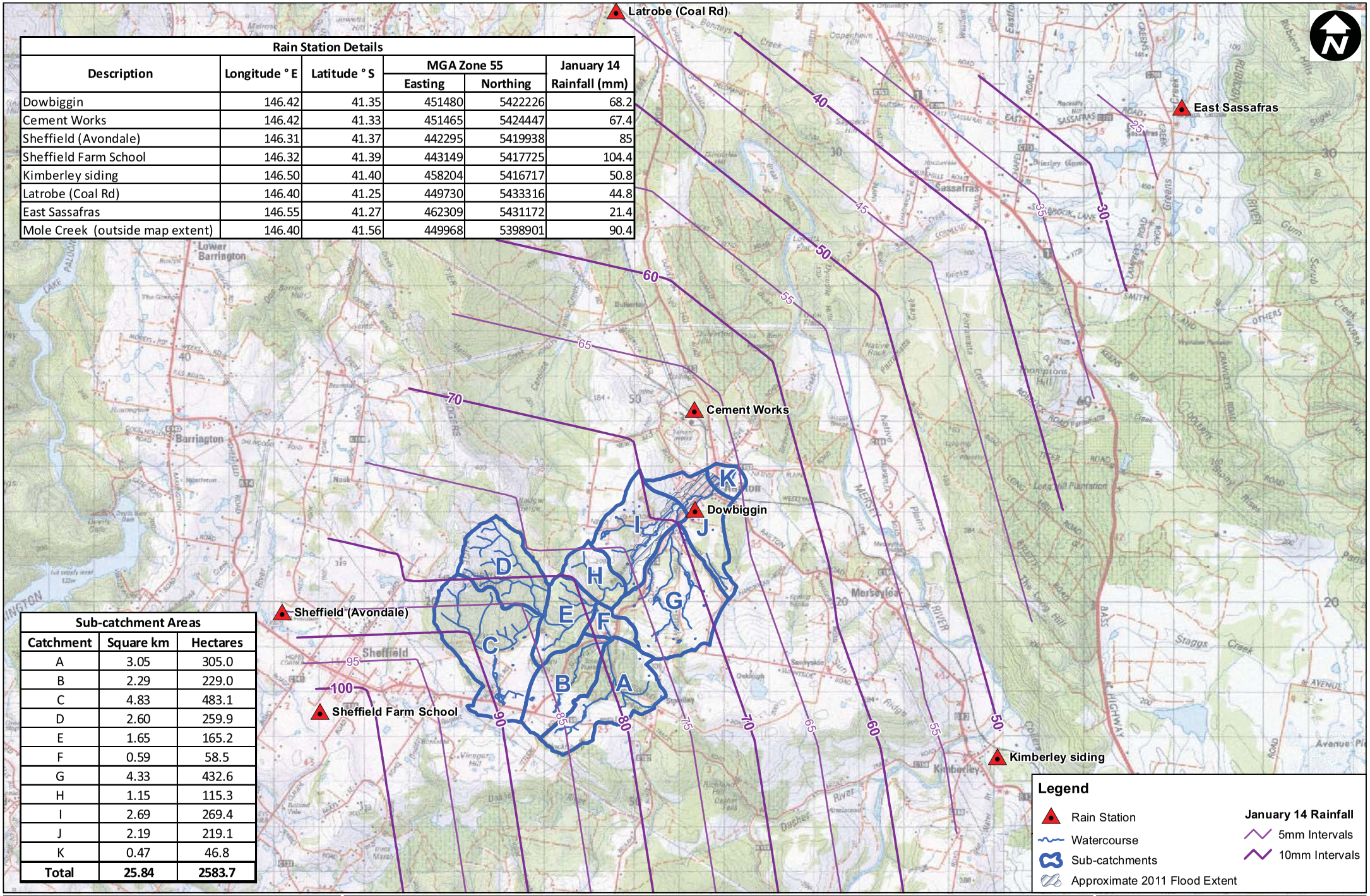
Created by : MMcG

Printed: 7/05/2013



Rain Station Details					
Description	Longitude ° E	Latitude ° S	MGA Zone 55		January 14
			Easting	Northing	Rainfall (mm)
Dowbiggin	146.42	41.35	451480	5422226	68.2
Cement Works	146.42	41.33	451465	5424447	67.4
Sheffield (Avondale)	146.31	41.37	442295	5419938	85
Sheffield Farm School	146.32	41.39	443149	5417725	104.4
Kimberley siding	146.50	41.40	458204	5416717	50.8
Latrobe (Coal Rd)	146.40	41.25	449730	5433316	44.8
East Sassafras	146.55	41.27	462309	5431172	21.4
Mole Creek (outside map extent)	146.40	41.56	449968	5398901	90.4

Sub-catchment Areas		
Catchment	Square km	Hectares
A	3.05	305.0
B	2.29	229.0
C	4.83	483.1
D	2.60	259.9
E	1.65	165.2
F	0.59	58.5
G	4.33	432.6
H	1.15	115.3
I	2.69	269.4
J	2.19	219.1
K	0.47	46.8
Total	**25.84**	**2583.7**

Legend

- Rain Station
- Watercourse
- Sub-catchments
- Approximate 2011 Flood Extent

January 14 Rainfall

- 5mm Intervals
- 10mm Intervals

0 0.5 1 2 3 4

Kilometres

1:75,000 when printed on A3

Railton Catchment and Rainfall Map
January 14 2011

esk mapping & GIS

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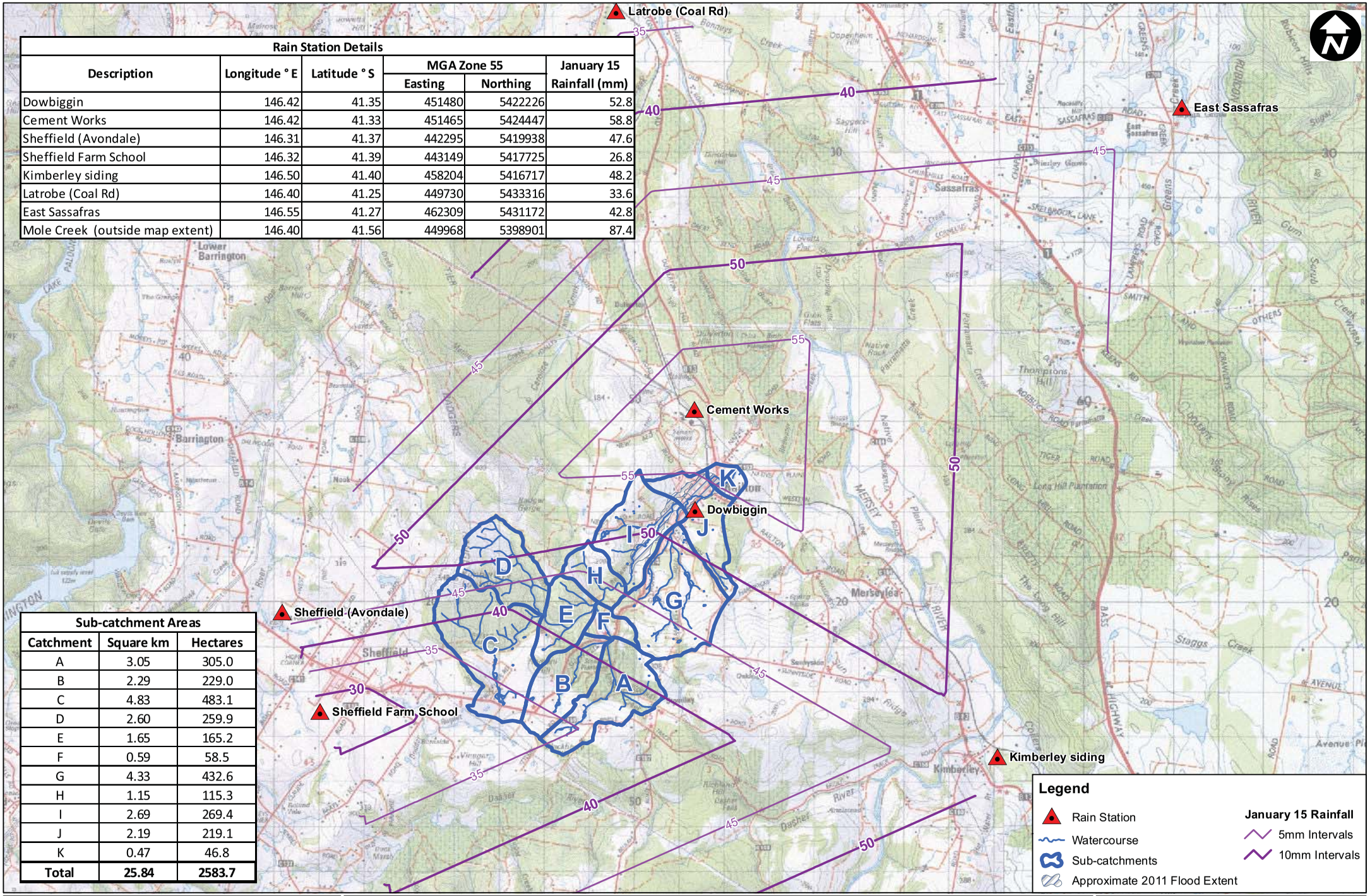
Created by : MMcG

Printed: 7/05/2013



Rain Station Details					
Description	Longitude ° E	Latitude ° S	MGA Zone 55		January 15
			Easting	Northing	Rainfall (mm)
Dowbiggin	146.42	41.35	451480	5422226	52.8
Cement Works	146.42	41.33	451465	5424447	58.8
Sheffield (Avondale)	146.31	41.37	442295	5419938	47.6
Sheffield Farm School	146.32	41.39	443149	5417725	26.8
Kimberley siding	146.50	41.40	458204	5416717	48.2
Latrobe (Coal Rd)	146.40	41.25	449730	5433316	33.6
East Sassafras	146.55	41.27	462309	5431172	42.8
Mole Creek (outside map extent)	146.40	41.56	449968	5398901	87.4

Sub-catchment Areas		
Catchment	Square km	Hectares
A	3.05	305.0
B	2.29	229.0
C	4.83	483.1
D	2.60	259.9
E	1.65	165.2
F	0.59	58.5
G	4.33	432.6
H	1.15	115.3
I	2.69	269.4
J	2.19	219.1
K	0.47	46.8
Total	**25.84**	**2583.7**

Legend

- Rain Station
- Watercourse
- Sub-catchments
- Approximate 2011 Flood Extent

January 15 Rainfall

- 5mm Intervals
- 10mm Intervals

0 0.5 1 2 3 4

Kilometres

1:75,000 when printed on A3

Railton Catchment and Rainfall Map
January 15 2011

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Printed: 7/05/2013

APPENDIX C

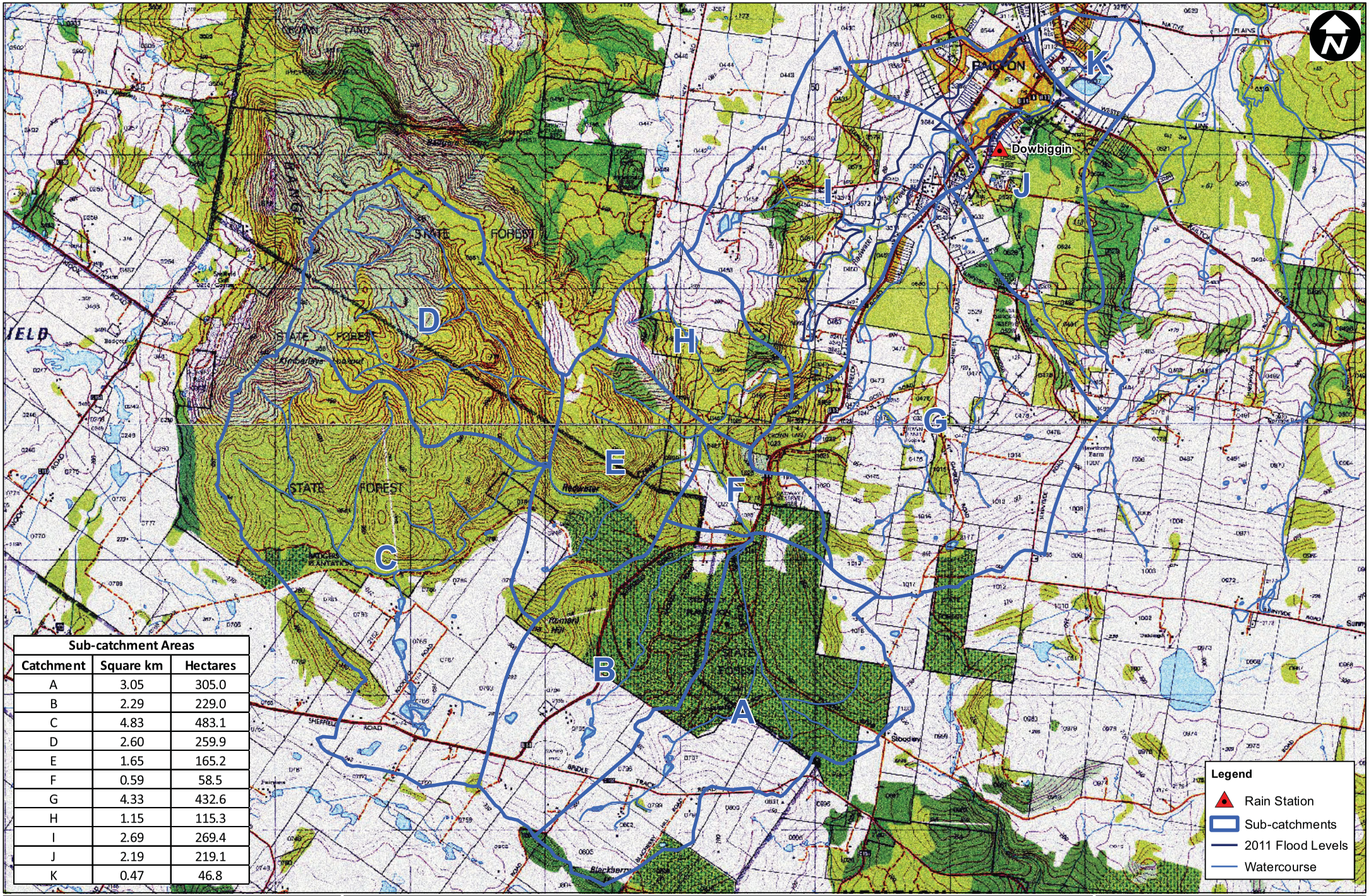
APPENDIX C

Flood Frequency data for the Don, Rubicon and Franklin Rivulet

Note that the values in red for the Don record were derived from the Rubicon data set by scaling catchment and annual average rainfalls.

Year	Don (16200)	Rubicon (17200)	Franklin (17201)
1968	41.69	132.29	
1969	45.13	130.90	
1970	97.18	176.50	
1971	62.45	104.56	
1972	47.47	81.14	
1973	66.34	106.79	
1974	69.09	142.26	61.90
1975	73.21	118.66	11.33
1976	24.13	40.57	42.39
1977	26.65	35.12	47.82
1978	19.09	43.32	50.61
1979	42	110.97	30.94
1980	36.71	61.79	51.41
1981	50.8	59.72	12.58
1982	8.64	18.22	14.93
1983	12.66	28.85	93.05
1984	46.52	100.39	51.31
1985	13.69	44.78	89.65
1986	38.29	93.40	18.52
1987	10.69	22.46	84.58
1988	58.49	181.00	119.73
1989	58.38	118.01	54.82
1990	10.28	106.40	
1991	41.28	64.18	138.70
1992	145.65	226.48	51.42
1993	65.10	101.24	
1994	7.17	11.14	
1995	39.03	60.70	
1996	88.24	137.22	
1997	56.66	88.11	
1998	132.90	206.67	
1999	27.01	42.00	
2000	137.58	213.94	
2001	48.92	76.07	
2002	12.02	18.68	
2003	93.41	145.24	
2004	50.76	78.93	
2005	138.37	215.17	
2006	3.77	5.87	
2007	11.18	24.61	
2008	4.23	8.34	
2009	97.01	66.25	
2010	39.64	86.79	
2011	147.53	55.46	
2012	14.54	36.01	

APPENDIX D



Sub-catchment Areas		
Catchment	Square km	Hectares
A	3.05	305.0
B	2.29	229.0
C	4.83	483.1
D	2.60	259.9
E	1.65	165.2
F	0.59	58.5
G	4.33	432.6
H	1.15	115.3
I	2.69	269.4
J	2.19	219.1
K	0.47	46.8

0 0.25 0.5 1 1.5 2

Kilometres

1:25,000 when printed on A3

Railton Flood Mapping
Catchment Plan

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Created by : MMcG

Base image from theLIST
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Printed: 24/04/2013

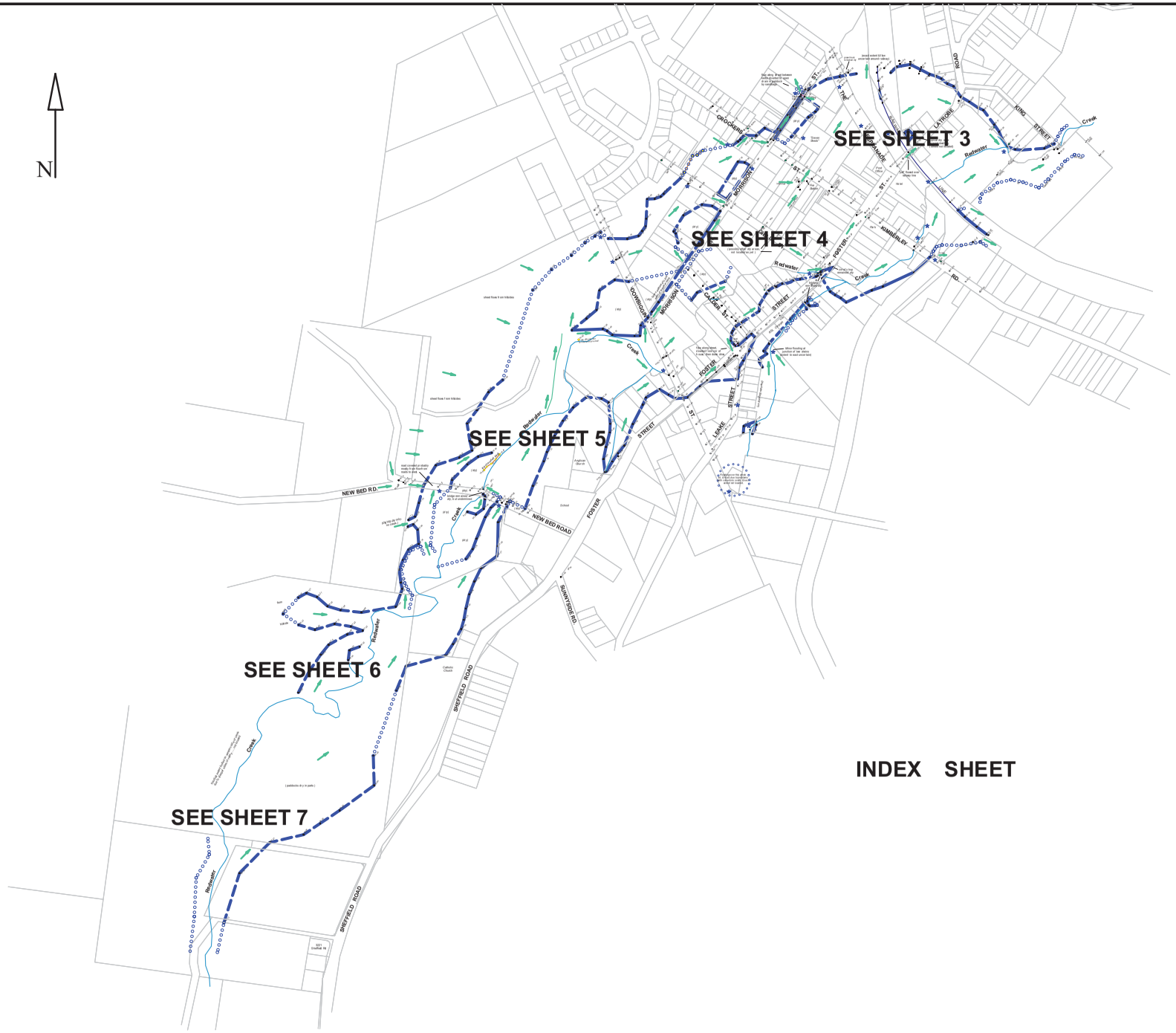
APPENDIX E

Comparison of the existing channel and the channel modified to be a minimum of 15 metres wide.				
Cross section Number '*' denotes an interpolated section	Flood Profile	Plan Mod Ch 15m is the modified channel and Plan 03 is the existing channel	Water Surface Elevation in metres	Energy Grade line Elevation in metres
19	100 Year ARI	Mod Ch 15m	66.57	66.66
19	100 Year ARI	Plan 03	67.13	67.18
18.8785*	100 Year ARI	Mod Ch 15m	66.56	66.61
18.8785*	100 Year ARI	Plan 03	66.99	67.05
18.7571*	100 Year ARI	Mod Ch 15m	66.54	66.58
18.7571*	100 Year ARI	Plan 03	66.83	66.9
18.6357*	100 Year ARI	Mod Ch 15m	66.53	66.56
18.6357*	100 Year ARI	Plan 03	66.69	66.76
18.5142*	100 Year ARI	Mod Ch 15m	66.53	66.55
18.5142*	100 Year ARI	Plan 03	66.59	66.65
18.3928*	100 Year ARI	Mod Ch 15m	66.52	66.54
18.3928*	100 Year ARI	Plan 03	66.54	66.57
18.2714*	100 Year ARI	Mod Ch 15m	66.52	66.53
18.2714*	100 Year ARI	Plan 03	66.49	66.52
18.15	100 Year ARI	Mod Ch 15m	66.52	66.52
18.15	100 Year ARI	Plan 03	66.48	66.49
18				
17.85	100 Year ARI	Mod Ch 15m	65.21	65.88
17.85	100 Year ARI	Plan 03	65.64	66.02
17.68*	100 Year ARI	Mod Ch 15m	63.77	64.85
17.68*	100 Year ARI	Plan 03	65.39	65.68
17.51*	100 Year ARI	Mod Ch 15m	64.23	64.44
17.51*	100 Year ARI	Plan 03	65.12	65.4
17.34*	100 Year ARI	Mod Ch 15m	64.17	64.33
17.34*	100 Year ARI	Plan 03	64.88	65.11
17.17*	100 Year ARI	Mod Ch 15m	64.13	64.25
17.17*	100 Year ARI	Plan 03	64.51	64.8
17	100 Year ARI	Mod Ch 15m	64.1	64.19
17	100 Year ARI	Plan 03	64.41	64.51
16.8333*	100 Year ARI	Mod Ch 15m	64.08	64.15
16.8333*	100 Year ARI	Plan 03	64.31	64.39
16.6666*	100 Year ARI	Mod Ch 15m	64.08	64.12
16.6666*	100 Year ARI	Plan 03	64.23	64.29
16.5*	100 Year ARI	Mod Ch 15m	64.07	64.09
16.5*	100 Year ARI	Plan 03	64.17	64.21
16.3333*	100 Year ARI	Mod Ch 15m	64.07	64.08
16.3333*	100 Year ARI	Plan 03	64.13	64.15
16.1666*	100 Year ARI	Mod Ch 15m	64.06	64.07
16.1666*	100 Year ARI	Plan 03	64.09	64.11
16	100 Year ARI	Mod Ch 15m	64.04	64.06

16	100 Year ARI	Plan 03	64.07	64.08
15				
14	100 Year ARI	Mod Ch 15m	62.67	63.23
14	100 Year ARI	Plan 03	63.31	63.4
13.75*	100 Year ARI	Mod Ch 15m	62.79	62.83
13.75*	100 Year ARI	Plan 03	63.13	63.21
13.5*	100 Year ARI	Mod Ch 15m	62.77	62.8
13.5*	100 Year ARI	Plan 03	62.93	63
13.25*	100 Year ARI	Mod Ch 15m	62.76	62.78
13.25*	100 Year ARI	Plan 03	62.81	62.85
13	100 Year ARI	Mod Ch 15m	62.75	62.76
13	100 Year ARI	Plan 03	62.76	62.78
12.75*	100 Year ARI	Mod Ch 15m	62.75	62.76
12.75*	100 Year ARI	Plan 03	62.75	62.76
12.5*	100 Year ARI	Mod Ch 15m	62.75	62.75
12.5*	100 Year ARI	Plan 03	62.75	62.75
12.25*	100 Year ARI	Mod Ch 15m	62.74	62.75
12.25*	100 Year ARI	Plan 03	62.74	62.75
12	100 Year ARI	Mod Ch 15m	62.74	62.75
12	100 Year ARI	Plan 03	62.74	62.75
11				
10	100 Year ARI	Mod Ch 15m	60.56	60.99
10	100 Year ARI	Plan 03	61.28	61.35
9.66666*	100 Year ARI	Mod Ch 15m	60.18	60.27
9.66666*	100 Year ARI	Plan 03	60.93	60.97
9.33333*	100 Year ARI	Mod Ch 15m	60.15	60.24
9.33333*	100 Year ARI	Plan 03	60.74	60.77
9	100 Year ARI	Mod Ch 15m	59.76	60.06
9	100 Year ARI	Plan 03	60.6	60.63
8.83333*	100 Year ARI	Mod Ch 15m	59.65	59.91
8.83333*	100 Year ARI	Plan 03	60.48	60.51
8.66666*	100 Year ARI	Mod Ch 15m	59.57	59.8
8.66666*	100 Year ARI	Plan 03	60.36	60.39
8.5*	100 Year ARI	Mod Ch 15m	59.53	59.71
8.5*	100 Year ARI	Plan 03	60.22	60.25
8.33333*	100 Year ARI	Mod Ch 15m	59.48	59.61
8.33333*	100 Year ARI	Plan 03	60.07	60.11
8.16666*	100 Year ARI	Mod Ch 15m	59.39	59.48
8.16666*	100 Year ARI	Plan 03	59.92	59.96
8	100 Year ARI	Mod Ch 15m	59.31	59.38
8	100 Year ARI	Plan 03	59.77	59.81
7.75*	100 Year ARI	Mod Ch 15m	59.22	59.3
7.75*	100 Year ARI	Plan 03	59.61	59.65
7.5*	100 Year ARI	Mod Ch 15m	59.18	59.26
7.5*	100 Year ARI	Plan 03	59.48	59.52

7.25*	100 Year ARI	Mod Ch 15m	59.18	59.23
7.25*	100 Year ARI	Plan 03	59.4	59.43
7	100 Year ARI	Mod Ch 15m	59.18	59.21
7	100 Year ARI	Plan 03	59.36	59.38
6.8*	100 Year ARI	Mod Ch 15m	59.17	59.21
6.8*	100 Year ARI	Plan 03	59.32	59.35
6.6*	100 Year ARI	Mod Ch 15m	59.17	59.2
6.6*	100 Year ARI	Plan 03	59.27	59.31
6.4*	100 Year ARI	Mod Ch 15m	59.16	59.19
6.4*	100 Year ARI	Plan 03	59.22	59.26
6.2*	100 Year ARI	Mod Ch 15m	59.16	59.19
6.2*	100 Year ARI	Plan 03	59.15	59.21
6	100 Year ARI	Mod Ch 15m	59.08	59.16
6	100 Year ARI	Plan 03	59.08	59.16


Legend
Floor Levels - 2013 Survey
Building Floor Levels (2002-04)
Cross Sections - 2013 Survey
Cross Sections - 2002/04
Stormwater
Stormwater Manholes
Major Arterial Road
Arterial Road
Feeder
Access Road
Railway
Railway Siding
Vehicular Track
Walking
Cadastre
Easements
Watercourse
2011 Flood Levels
0 25 50 75 100 200 300 400 500
Metres
RAILTON FLOOD STUDY
2013 Survey Cross Sections & Floor Levels
Prepared by:
esk mapping & GIS
www.eskmapping.com.au



NB: Please refer to the explanatory notes on sheet 2.

- Accurate Edge
- Approximate Edge
- Estimated Edge
- Denotes Reported Stormwater Problem

0 500m 1km

SCALE

TOWN OF RAILTON: Location Survey of the Perimeter Extent of the Flood and Stormwater Overflow of the Rainfall Event of 14th January 2011, for the Kentish Council.

Surveyed: 24 Feb 2011
Drawn: 26 Feb 2011

Job Ref: 1406

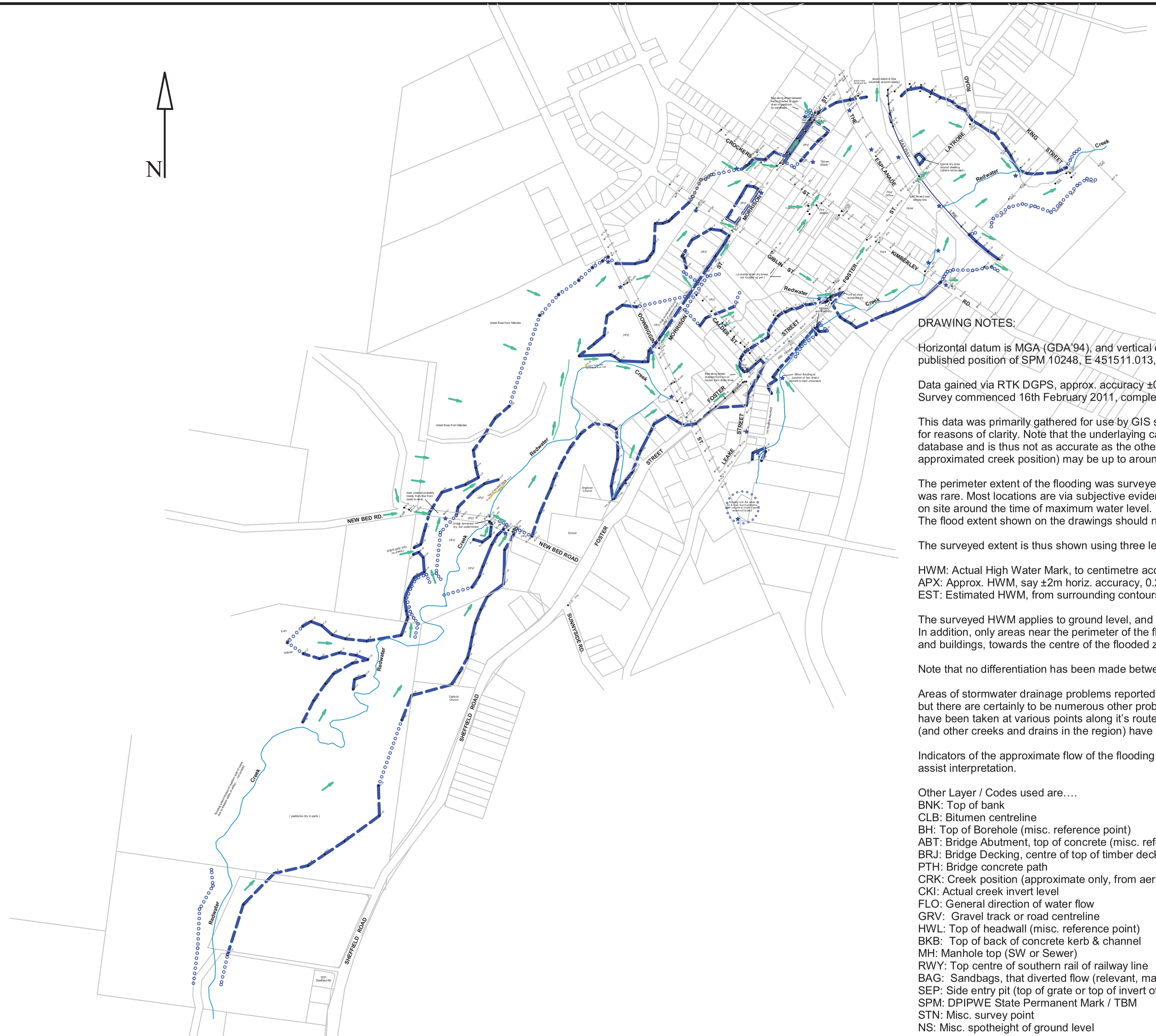
Horiz.Datum: MGA (GDA'94)
Vert.Datum: AHD

DWG No: 1406-D01

Sheet: 1 of 7

Scale (at A3 size) : 1 : 10,000

Land & Sea Surveys
391 Melrose Road, Eugenana, 7310
Michael Ward, Ph. 0419 878 830



DRAWING NOTES:

Horizontal datum is MGA (GDA'94), and vertical datum is AHD (Tas. 1983), both based on the Surcom published position of SPM 10248, E 451511.013, N 5422403.957, RL 70.998.

Data gained via RTK DGPS, approx. accuracy ±0.025m XYZ
Survey commenced 16th February 2011, completed 24th February 2011.

This data was primarily gathered for use by GIS software; all points, RL's, etc are not shown on this drawing for reasons of clarity. Note that the underlaying cadastral (lot boundary) layer is taken from the DPIPWE LIST database and is thus not as accurate as the other positional data shown hereon; the lot boundaries (and approximated creek position) may be up to around 5 metres out in places.

The perimeter extent of the flooding was surveyed 4-5 weeks after the event, thus objective ground evidence was rare. Most locations are via subjective evidence from those owners available for interview, and who were on site around the time of maximum water level. Not all affected landowners have been able to be contacted. The flood extent shown on the drawings should not be taken as being absolutely precise.

The surveyed extent is thus shown using three levels of accuracy, as follows…

HWM: Actual High Water Mark, to centimetre accuracy, from definite evidence…Solid Line
APX: Approx. HWM, say ±2m horiz. accuracy, 0.2-0.5m vertical accuracy…….Dashed Line
EST: Estimated HWM, from surrounding contours, etc… metres accuracy……Dotted Line

The surveyed HWM applies to ground level, and is not necessarily an indication of building inundation. In addition, only areas near the perimeter of the flood have been investigated thus far; there are areas, and buildings, towards the centre of the flooded zone that remained dry, and these have not yet been surveyed.

Note that no differentiation has been made between flood extent and stormwater extent.

Areas of stormwater drainage problems reported by the contacted landowners are indicated on the drawings, but there are certainly to be numerous other problem sites that are not shown. Invert levels of Redwater Creek have been taken at various points along it's route, but definitive locations and cross-sections of the Creek (and other creeks and drains in the region) have not yet been surveyed.

Indicators of the approximate flow of the flooding / stormwater overflow have been shown on the drawings to assist interpretation.

Other Layer / Codes used are….
BNK: Top of bank
CLB: Bitumen centreline
BH: Top of Borehole (misc. reference point)
ABT: Bridge Abutment, top of concrete (misc. reference point)
BRJ: Bridge Decking, centre of top of timber decking
PTH: Bridge concrete path
CRK: Creek position (approximate only, from aerial photography)
CKI: Actual creek invert level
FLO: General direction of water flow
GRV: Gravel track or road centreline
HWL: Top of headwall (misc. reference point)
BKB: Top of back of concrete kerb & channel
MH: Manhole top (SW or Sewer)
RWY: Top centre of southern rail of railway line
BAG: Sandbags, that diverted flow (relevant, major, positions only)
SEP: Side entry pit (top of grate or top of invert of kerb) (misc. reference point)
SPM: DPIPWE State Permanent Mark / TBM
STN: Misc. survey point
NS: Misc. spotheight of ground level

Accurate Edge
Approximate Edge
Estimated Edge
★ Denotes Reported Stormwater Problem

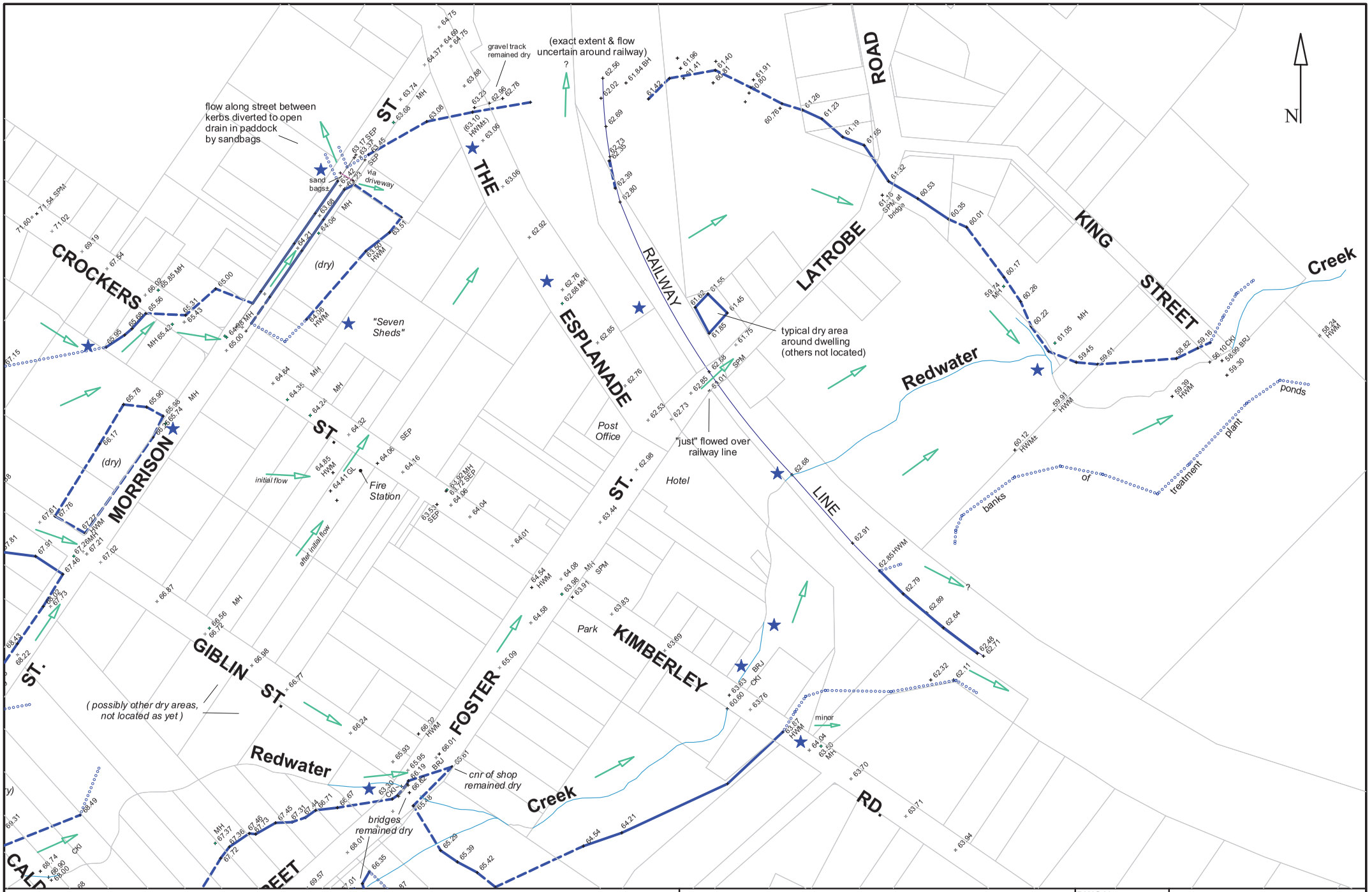
0 500m 1km
SCALE

TOWN OF RAILTON: Location Survey of the Perimeter Extent of the Flood and Stormwater Overflow of the Rainfall Event of 14th January 2011, for the Kentish Council.

Surveyed: 24 Feb 2011 Drawn: 26 Feb 2011	Job Ref: 1406	Horiz.Datum: MGA (GDA'94) Vert.Datum: AHD	

DWG No: 1406-D01
Sheet: 2 of 7
Scale (at A3 size): 1 : 10,000

Land & Sea Surveys
391 Melrose Road, Eugenana, 7310
Michael Ward, Ph. 0419 878 830



NB: Please refer to the explanatory notes on sheet 2.

- Accurate Edge
- Approximate Edge
- Estimated Edge
- Denotes Reported Stormwater Problem

0 125 250m

SCALE

TOWN OF RAILTON: Location Survey of the Perimeter Extent of the Flood and Stormwater Overflow of the Rainfall Event of 14th January 2011, for the Kentish Council.

DWG No: 1406-D01

Sheet: 3

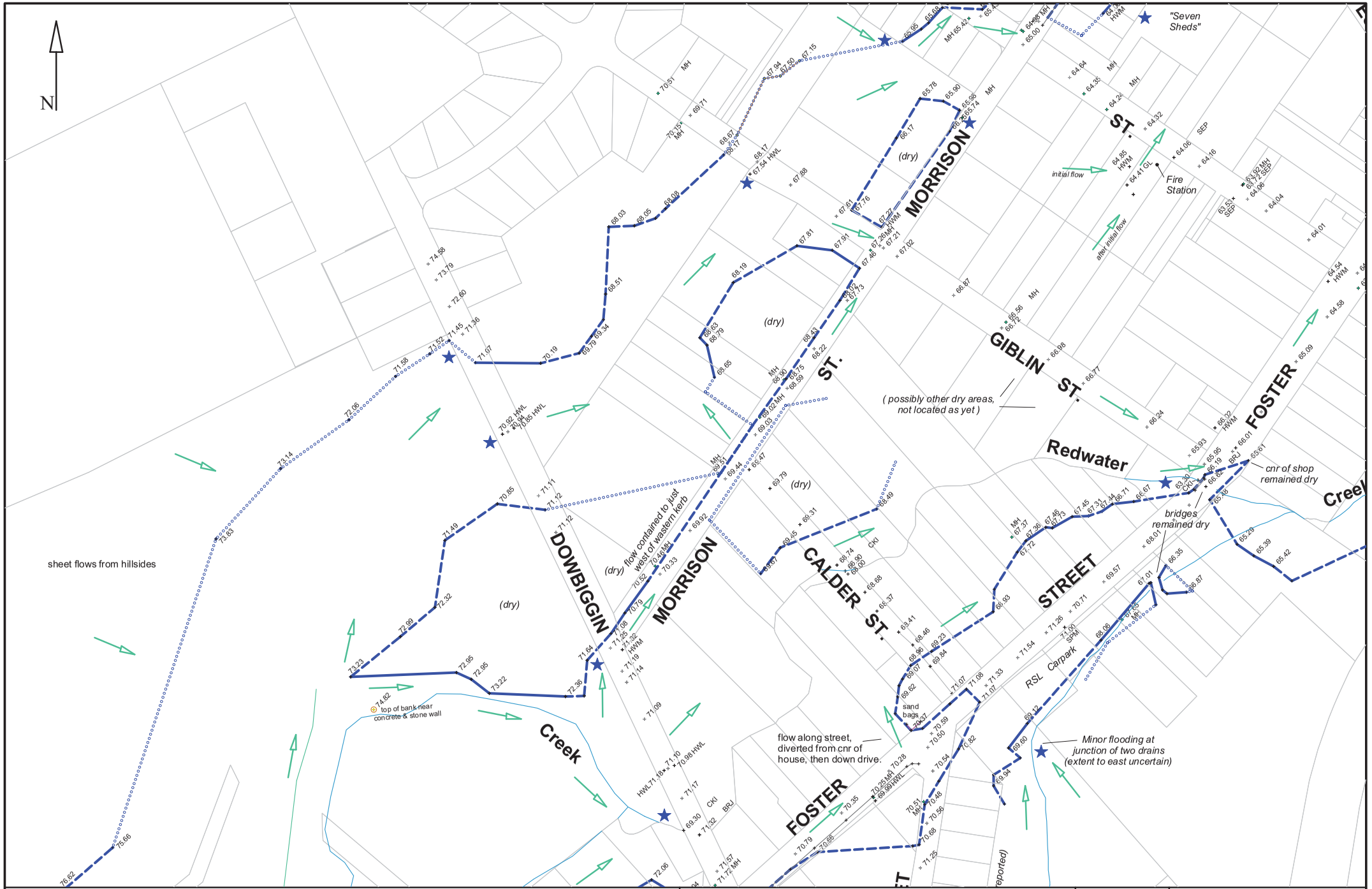
Surveyed: 24 Feb 2011
Drawn: 26 Feb 2011

Job Ref: 1406

Horiz.Datum: MGA (GDA'94)
Vert.Datum: AHD

Scale (at A3 size) : 1 : 2500

Land & Sea Surveys
391 Melrose Road, Eugenana, 7310
Michael Ward, Ph. 0419 878 830



NB: Please refer to the explanatory notes on sheet 2.

- Accurate Edge
- Approximate Edge
- Estimated Edge
- Denotes Reported Stormwater Problem

0 125 250m

SCALE

TOWN OF RAILTON: Location Survey of the Perimeter Extent of the Flood and Stormwater Overflow of the Rainfall Event of 14th January 2011, for the Kentish Council.

DWG No: 1406-D01

Sheet: 4

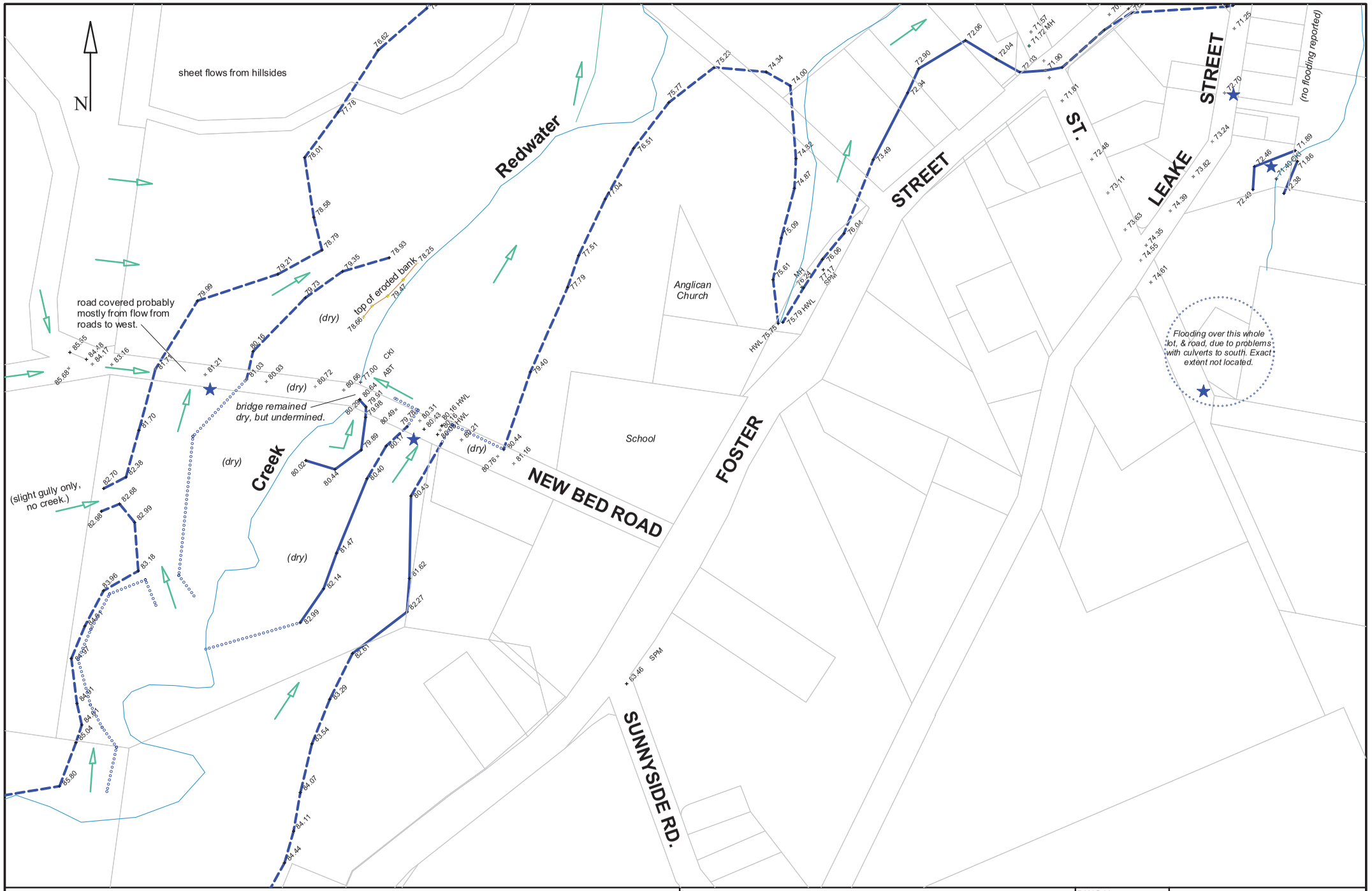
Surveyed: 24 Feb 2011
Drawn: 26 Feb 2011

Job Ref: 1406

Horiz.Datum: MGA (GDA'94)
Vert.Datum: AHD

Scale (at A3 size) : 1 : 2500

Land & Sea Surveys
391 Melrose Road, Eugenana, 7310
Michael Ward, Ph. 0419 878 830



NB: Please refer to the explanatory notes on sheet 2.

- Accurate Edge
- Approximate Edge
- Estimated Edge
- Denotes Reported Stormwater Problem

0 125 250m

SCALE

TOWN OF RAILTON: Location Survey of the Perimeter Extent of the Flood and Stormwater Overflow of the Rainfall Event of 14th January 2011, for the Kentish Council.

DWG No: 1406-D01

Sheet: 5

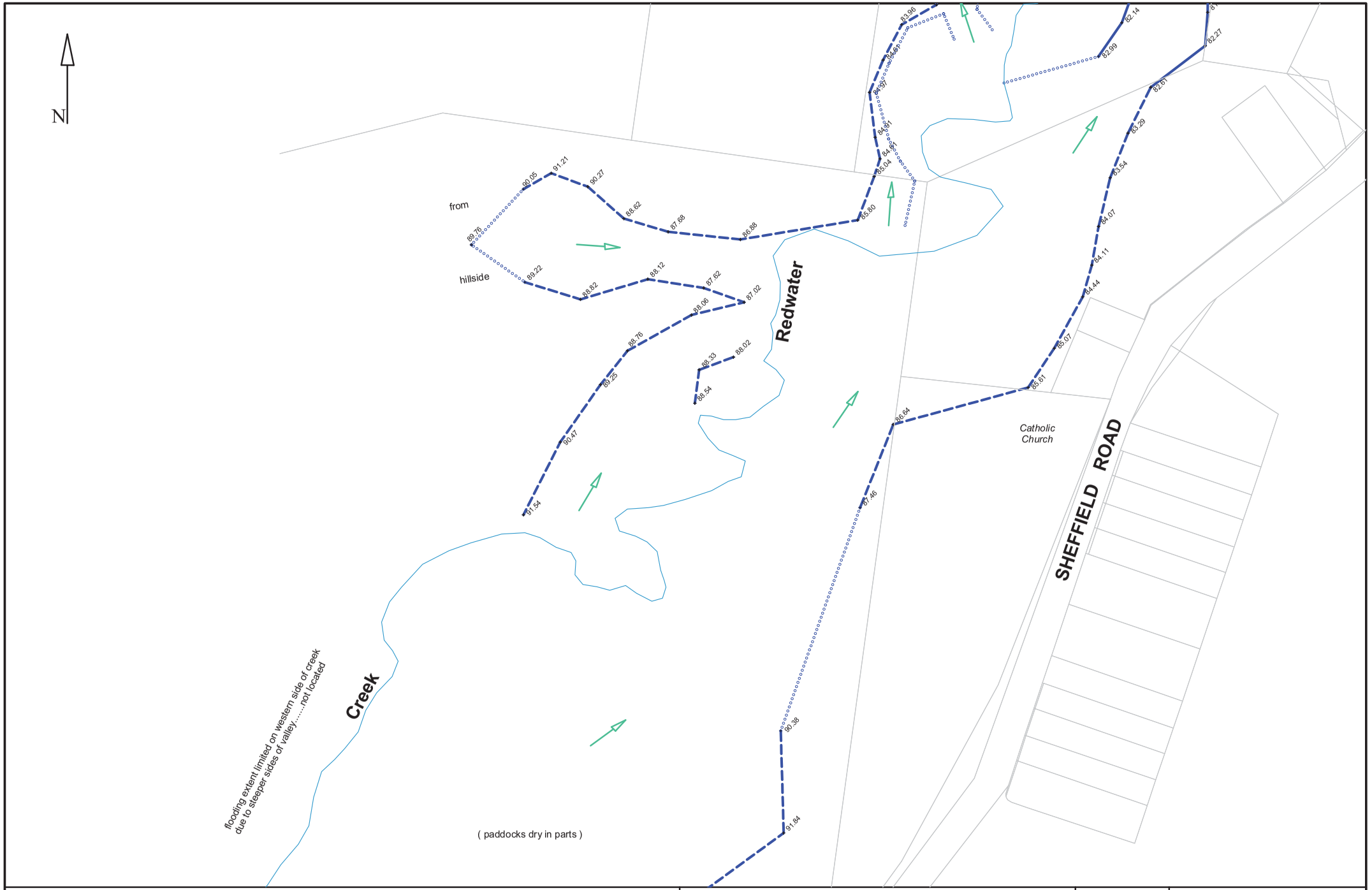
Surveyed: 24 Feb 2011
Drawn: 26 Feb 2011

Job Ref: 1406

Horiz.Datum: MGA (GDA'94)
Vert.Datum: AHD

Scale (at A3 size) : 1 : 2500

Land & Sea Surveys
391 Melrose Road, Eugenana, 7310
Michael Ward, Ph. 0419 878 830



NB: Please refer to the explanatory notes on sheet 2.

- Accurate Edge
- Approximate Edge
- Estimated Edge
- Denotes Reported Stormwater Problem

0 125 250m

SCALE

TOWN OF RAILTON: Location Survey of the Perimeter Extent of the Flood and Stormwater Overflow of the Rainfall Event of 14th January 2011, for the Kentish Council.

Surveyed: 24 Feb 2011 Drawn: 26 Feb 2011	Job Ref: 1406	Horiz.Datum: MGA (GDA'94) Vert.Datum: AHD	Scale (at A3 size) : 1 : 2500

DWG No: 1406-D01

Sheet: 6

Land & Sea Surveys
391 Melrose Road, Eugenana, 7310
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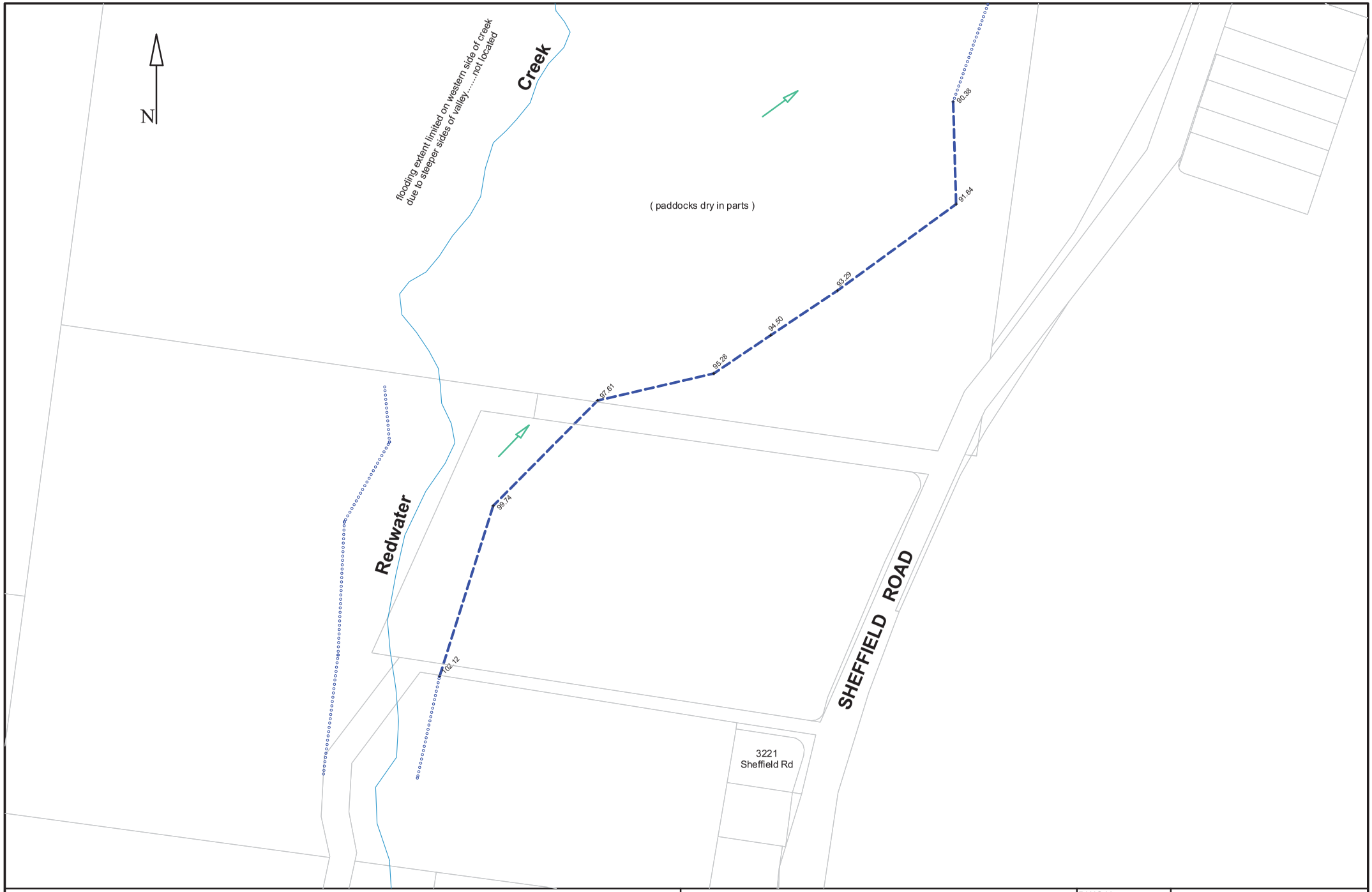


NB: Please refer to the explanatory notes on sheet 2.

- Accurate Edge
- Approximate Edge
- Estimated Edge
- Denotes Reported Stormwater Problem

0 125 250m

SCALE

TOWN OF RAILTON: Location Survey of the Perimeter Extent of the Flood and Stormwater Overflow of the Rainfall Event of 14th January 2011, for the Kentish Council.

DWG No: 1406-D01

Sheet: 7

Surveyed: 24 Feb 2011
Drawn: 26 Feb 2011

Job Ref: 1406

Horiz.Datum: MGA (GDA'94)
Vert.Datum: AHD

Scale (at A3 size) : 1 : 2500

Land & Sea Surveys
391 Melrose Road, Eugenana, 7310
Michael Ward, Ph. 0419 878 830

APPENDIX F

DATE: 18th of October 2013

Our ref: ENTURA-E303479

Kentish Council (KC)

Jonathan Magor
Engineering Services Manager
69 High St
SHEFFIELD
TAS 7306
Ph: 03 6491 2500

Contact:
Mr Lukas Salkeld / Mike Ross
Entura
89 Cambridge Park Drive
Cambridge
TAS 7170
Phone: 03 6245 4567 / 036245 4353
Email:
lukas.salkeld@entura.com.au /
michael.ross@entura.com.au

Dear Jonathan,

Flood Monitoring: River Level / Rain Gauge Installation, Telemetry & Monitoring and Web Database

Thank you, for this opportunity to provide you with our proposal for:

- Installing, monitoring and providing near time telemetry for river level and rainfall monitoring equipment at the Redwater Crk in Railton (previously closed BoM flood warning site); &
- Setup, provide access, and data display capabilities for Kentish Council nominated hydrometric sites in the Railton area (including the new monitoring site), on the Ajenti Data Management System (ADMS) web interface.
- Setup, provide access and data display for Kentish Council flood warning information and hydrometric data, on a website available to the public

1. Scope of the Works

Under this consultancy the following task breakdown details the scope of work to be delivered at the proposed monitoring sites and for the ADMS web database:

Provide, install, telemeter and commission a radar water level monitoring instrument and raingauge with Ajenti data logger/RTU, at the existing but closed BoM Flood warning site Redwater Crk at

Railton. All instruments and site infrastructure will be owned by Kentish Council (KC). Data will be telemetered or transferred to Entura via Telstra NextG network data services and IP communications (dial up and packet data), with data being stored on the Entura Ajenti Data Management System (ADMS) in Hobart. Raw & calculated data can be also supplied directly from the ADMS.

The scope of works will also include the transfer, collection, storage and display of approved river level, river flow, and rainfall data from other water authorities on the ADMS for use by KC. Data is transferred by FTP processes from the various water authorities (Hydro Tasmania, BoM, & DPIPWE) to the ADMS database where it can then be distributed for display on the public KC Flood Information website.

The proposed install schedule is:

A. River level and rainfall monitoring site

1. Upon acceptance of the proposal, procure all equipment, instruments and fabrication of infrastructure. Note that some instruments may take 6 weeks to arrive from time of procurement and that where possible, existing infrastructure already on site (swing-top enclosure) will be used to reduce costs. Schedule resources for installation and provide the Kentish Council with a proposed install date and commissioning timeline.

2. Install all equipment, infrastructure and instruments, including gauge boards. Commission site including telemetry to Hobart. Set up the ADMS database to accept and archive the data. Enable Kentish Council with access to the ADMS via log on and password. Set up an ADMS favourite for easy viewing of site data on the ADMS.

3. Provide periodic data downloads via telemetry (up to a half hourly data extraction rate can be provided).

4. Provide a brief email commissioning report with photos. After this, report on data performance and or any data issues to Kentish Council (KC) on a weekly basis.

NOTES:

1) Other services including spot flow measurements and the formation of site level flow ratings are discussed in Section 6.

2) Other ADMS functionality for the site will be discussed further below.

B. ADMS website / database and public website

1. Upon acceptance of the proposal, proceed to acquire data feeds for the following hydrometric sites (or combination of, includes asset owner):

    - Mersey Rv at Kimberly ñ Rainfall and River Level (BoM)

- Iris Rv at Middlesex Plains River Level and Rainfall (Hydro Tasmania)
- Sheffield Meteorological / AWS (BoM)
- Arm River ab Mersey Rv (Hydro Tasmania)
- Goliath Cement Works Pluvio (Goliath Cement Works)
- Cradle Valley Pluvio (Hydro Tasmania)
- Maggs Mountain Pluvio (Hydro Tasmania)
- Borridale Plains Pluvio (Hydro Tasmania)

NOTE: Data from other Water Collection Agencies - Data will not be run through QAQC procedures. Data FTP links and ADMS archives will be managed only. Refer to section 6 if QAQC services are required.

2. Setup ADMS data plot 'Favourites' web plots for Council nominated hydrometric sites.

   Refer to Appendix B to view an example ADMS 'Favourites' used by Launceston City Council.

3. ADMS dashboard:

   Refer to Appendix B to view an example ADMS dashboard used by Launceston City Council.

4. Flood Inundation Overlays:

   Refer to Appendix B to view an example ADMS overlay for flood inundation on North Esk Rv, provided and used by Launceston City Council (GIS).

5. ADMS data alarming:

   Email alarms on threshold exceedence - water level (alarm level) and or rainfall (total in defined period), 5 sites to have alarming can be chosen initially.

6. At the direction and approval of KC, Entura will proactively monitor the ADMS, associated databases and FTP links to ensure data intake is maintained during a nominated flood event(s).

7. Data supply to BoM in WDTF format. Supply of Data to BoM in WDTF format: Provision has been made in this contract to monitor and maintain the data FTP to BoM for KC catchment site, Red Water Crk at Railton. Detailed below is a description of this FTP process:

   Entura manages the Launceston City Council (LCC) client data in an ADMS database with web interface. Within the ADMS, the WDTF publisher needs to know when the

relevant LCC data is required, through legislation, to deliver data when it arrives to Entura servers.
Currently for LCC, Category 1a sites are configured to deliver WDTF hourly and Category 1b sites are configured to report twice a day. These configurations can be changed if required.

8. Development of a public website for dispersing flood information (based on an existing web template developed for Launceston City Council ñ refer Appendix B). The website content needs to be easily managed by Council staff without requiring significant IT knowledge.
   Entura will need to rebrand the website to match Kentish Council logos and style guides. Some layout features will need to be customised to match the catchments and available monitoring stations.

   The website can contain the following:

   - Flood level Indicators for a local and regional catchment within Kentish Council (KC) boundaries
   - Flood Emergency Contacts
   - Flood warning or emergency noticeboard
   - General flood information
   - Community information including links to existing council flood information for the public i.e. What to do in a flood
   - Collation of flood warning and information links to other water authorities and councils
   - Customised river x-sections can be created to match the Council monitoring sites
   - Link to the Kids play centre (courtesy of Vic SES)

   In this proposal, changes to this website will be capped at what can be completed in 3 days. KC can prioritise the changes required as detailed above.

9. KC Flood Information website and ADMS training (1 Day).For nominated Council staff requiring direct access to the public website and or ADMS. It will provide basic training on access, functionality, reporting and a broad overview on data management.

2. Delivery Team

Lukas Salkeld (project management) and Michael Ross (IT specialist)

3. Entura Project Deliverables

The following deliverables will be provided under this consultancy:

A. River level and rainfall monitoring site

1. Tested and calibrated (to approved standards) Ajenti data logger and tipping bucket raingauge (TBR).
2. Qualified resources, inducted to work at KC sites and assets, to install and commission the instrumentation and associated equipment / infrastructure on the dates requested by KC.
3. Rainfall Data to be transmitted from the Ajenti logger on site via 3G telemetry and stored in the Entura Ajenti Data Management System (ADMS) web database in Cambridge, TAS.
4. Enable KC staff access to the ADMS on the web to view at their discretion, the data captured during the monitoring.
5. Weekly: Data & therefore site performance will be checked once weekly ñ typically early in the week by Entura staff. Any faults will be detailed to Council staff via email.
6. Work days: Telemetry, Web FTP & Site performance will be monitored daily on a normal Hobart business working day basis.
7. Annually: A site visit will be made to Redwater Crk to perform calibration checks of river level and rainfall equipment.

B. ADMS website / database and public website

1. Qualified resources available at specified times to offer support as requested by KC.
2. ADMS website access ñ username and login.
3. Access to all nominated data sets
4. Setup of Favourites in the ADMS
5. Setup of Dashboards in the ADMS
6. Generation of flood inundation overlays. Configuration of the ADMS to use the overlays
7. Setup of applicable alarms in the ADMS
8. Creation of automatic FTP of WDTF files to BoM as per statutory requirements
9. Work days: Telemetry, Web FTP & Site performance will be monitored daily on a normal Hobart business working day basis.

NOTE: As detailed previously, data from other Water Collection Agencies, the data will not be run through QAQC procedures. Data FTP links and ADMS archives will be managed only. Refer to section 6 if QAQC services are required.

4. Assumptions

- KC supply access and or keys to locked access areas and yards.
- All weather access to the nominated monitoring site.
- KC will provide all text content, including links and references materials for public website.

5. Exclusions

- Changes to and/or the unavailability of the Entura data and/or computer networks that impact the functionality of the services as currently provided by this proposal. Entura can guarantee a greater than 95% availability of its networks and systems.
- Significant changes by KC or property owners to, or restrictions on, the access to the sites and assets associated with this proposal.
- The re-establishment of sites that have been damaged or destroyed as a result of incidents outside the control of Entura. These events include, but shall not be limited to, vandalism, theft, flood, storm damage and bushfire.
- Inaction by third parties that affect the operation of aspects of the site that are not the responsibility of Entura. This includes network failures affecting either telecommunications networks or other computer networks.
- For instruments requiring specialised maintenance, calibration and / or replacement by instrument manufacturers and outside normal routine maintenance, then this cost will be payable by the KC.
- Any claim by the Bureau of Meteorology or any third party arising from the Service Provider's failure to provide the Bureau of Meteorology with data in accordance with any time restrictions required of it provided such failure was due to reasons beyond the control of the Service Provider.

Where possible, Entura will take all reasonable steps to ensure the incidence and impact of any of the above is minimised.

Where possible, Entura will work cooperatively with, and be supportive of; parties whose responsibilities interact with or impact the responsibilities of this proposal with the objective of ensuring KC's objectives and requirements are best served.

Where information describing the operation and/or responsibility for the monitoring site is not explicitly stated in this proposal but which is otherwise understood, acknowledged and agreed to by both KC and Entura this information shall apply as though it were stated in this proposal.

6. Additional Services Available

These additional services can be supplied upon request, including a cost quote:

1. Field Services:

    - Hydrometric sites can be visited at a predetermined rate for basic maintenance purposes, routine calibrations, gaugings and checks on site performance. Council staff can be utilized where applicable to provide maintenance support. Entura will complete the work in conjunction with other work in the area to minimise costs;
    - Basic maintenance - minor or major works;
    - A predetermined number of routine gaugings can be carried out per annum. After collection of these and entry to an appropriate database, a level to flow rating curve can be developed for the site.
    - A predetermined number of routine rainfall calibrations can be carried out at each rain-gauge site per annum.

2. On Occurrence Telemetry & Minor Fault Field Services

    - Provision can be made to fix telemetry / other minor fault fixes on site that impact on a site performance. Nominated KC staff can be utilised to provide maintenance support where possible.

3. Data Management, Web FTP Services & Databases

    - A full suite of data management, data analysis and data reporting services can be carried out on hydrometric and associated data sets i.e. provision can be made for site faults, gaugings, calibration checks & ratings to be entered, calculated, checked and reported on an 'on occurrence' basis. This includes provision of basic advice, data transfer via FTP (Web) and Web / database related issues. Data transfer can be made via email &/or Web FTP process.
    - Hydrological and or Hydraulic data analysis and reporting

7. Terms and Conditions of Contract

Our offer is based on:

- Entura's standard terms and conditions of contract (refer Appendix A) unless otherwise agreed
- Standard working days (7am-5pm, Monday to Friday excluding public holidays). Note that Entura, on the direction and approval of KC, can supply after hours service in flood situations and or as part of any additional services (detailed above) as required.
- A Defects Liability will be provided on the Redwater Crk site installation. This is to deliver: 1) A high quality service to Kentish Council for any upgraded equipment or associated workmanship; 2) A system that will operate trouble free for the 12 month period.

8. Price

It is proposed that the following price schedule would be administered as a fixed fee with monthly invoicing.

A. River level and rainfall monitoring site

Deliverable	**Total**
Instrument procurement testing, calibration and setup	$2,233
Travel, Pack and Installation	$3,960
Sub total	**$6,193**
Brief Commissioning Report	$540
Project Management	$1,154
Defects Liability	$940
Total	**$8,827**

Expenses	**Total**
Sub-Contractor	$3,245
Instruments	$6,735
Infrastructure	$2,890
Consumables	$1,090
Travel & Accommodation (2 Resources for 4 Days)	$1,100
Total	**$15,060**

TOTAL for River level and rainfall monitoring site **$23,887**

B. ADMS website and database, Public website

Deliverable	Total
1. ADMS Data Feeds and setup: · Hydro Tasmania (per site) · BoM / Goliath Cement Works (per site)	 $ 450.00 $ 700.00
Total (Based on suggested list of sites - 5 HT, 1 GC & 2 BoM)	**$1,150.00**
2. ADMS Favourites	$ 360.00
3. ADMS Dashboard	$ 270.00
4. Alarms	$ 460.00
5. Flood inundation overlays: · GIS · ADMS	 $ 1,010.00 $ 460.00
6. Gridded Rainfall	$2,200.00
7. BoM WDTF Transfer	$ 90.00
8. Public Website	$ 6,920.00
Sub-total (for all Options 1 – 8)	**$12,920.00**
Training	$ 5,890.00
Project Management	$ 1,918.00
Total (Options 1 – 8, plus Training & PM)	**$20,728.00**

Ongoing Costs (per month after Commissioning)	Total
ADMS - O&M of FTP Links (Based on $275 per link per annum for nominated sites)	$ 206.25
Data Checks & Report	$ 165.00

On Occurrence	Total
ADMS IT & Data Uptake - Monitoring during KC nominated flood events (per day)	$ 60.00
IT Fault Fixes (faults outside control of Entura, Approved by Kentish Council - per hour)	$ 176.00
Hydrometric Field or Data Fault Fixes (faults outside control of Entura - per hour)	$ 134.00

9. Validity

Our offer is valid for 60 days from the date of this letter.

Yours sincerely,

Lukas Salkeld
Senior Technical Officer

APPENDIX A: SINGLE USE CONSULTANCY CONTRACT- GENERAL CONDITIONS OF CONTRACT

1. THE SERVICES

1.1 The Consultant shall perform the Services in accordance with the Contract.

1.2 The Consultant represents and warrants that:

(a) it has informed itself as to the general nature of the Services and the requirements of the Contract;

(b) it has examined the contents of the Contract and any other information provided by the Client (or anybody acting on behalf of the Client) to the Consultant prior to the execution of the Contract; and

(c) it shall perform the Services in a proper and workmanlike manner to the standard prescribed in the Contract and, to the extent that it is not so prescribed, to a standard consistent with good practice for carrying out services of a nature similar to the Services.

2. RESPONSIBILITIES AND OBLIGATIONS OF THE CONSULTANT

2.1 The Consultant shall:

(a) comply with all directions of the Client given pursuant to a provision of the Contract;

(b) employ staff with appropriate qualifications and experience to carry out the Services;

(c) as soon as practicable after becoming aware of any matter or circumstance which may adversely affect or has adversely affected the scope, timing or carrying out of the Services, give written notice to the Client detailing the matter or circumstance and its anticipated effect on the Services;

(d) comply with all legislative requirements of which it has been notified by the Client in carrying out the Services;

(e) when on the Client's premises, and when using the Client's facilities, comply with all directions, procedures and policies relating to occupational health, safety and security requirements relating to the Client's premises and facilities of which it has been notified by the Client;

(f) take reasonable care of the Client's property provided to the Consultant in connection with carrying out the Services; and

(g) commence the performance of the Services on the Commencement Date and provide the Services on the terms of this Contract until the End Date.

3. RESPONSIBILITIES AND OBLIGATIONS OF THE CLIENT

3.1 The Client shall:

(a) when and as required under the Contract, provide the Consultant with relevant documents, samples, patterns, moulds and other information in the possession or control of the Client sufficient to enable the Consultant to carry out the Services;

(b) give or cause to be given to the Consultant in writing timely directions, instructions, decisions and information sufficient to define the Services required and facilitate the provision of the Services by the Consultant;

(c) provide the Consultant with such access to premises or sites of the Client as is necessary for the Consultant to carry out the Services; and

(d) bear the cost of all fees and charges required to comply with legislative requirements incurred in connection with carrying out the Services.

4. INSURANCE

4.1 From the Commencement Date, the Consultant must effect and have in place the following insurances:

(a) a professional indemnity insurance policy for the Services with a total aggregate cover of not less than $2,000,000.00 which shall:

(i) include provision for loss of documents; and

(ii) be maintained until the End Date and thereafter for a period of 6 years;

(b) a public liability policy until the End Date for an amount in respect of any one claim or series of claims arising from the one original cause of not less than $20,000,000.00; and

(c) a workers' compensation policy until the End Date for the maximum amount permitted by law, covering the Consultant's liability under common law and statute for death or injury to any person employed by the Consultant.

5. PAYMENT

5.1 The Client shall pay the Consultant the Contract Sum in accordance with this Contract.

5.2 The Consultant shall submit to the Client claims for payment progressively in accordance with the Contract Particulars.

5.3 All monies due and payable by the Client to the Consultant must be paid within 14 days of the receipt by the Client of a properly prepared tax invoice from the Consultant in accordance with clause 6.4.

5.4 If the Client does not pay the amount of the claim the Client shall, either with the payment or not later than the time for payment, provide the Consultant with a written statement of the reason for any difference between the amount claimed and the amount paid or to be paid.

5.5 If any moneys due and payable to either party remain unpaid after the date upon which or the expiration of the period within which they should have been paid, then interest shall be payable thereon at the then current benchmark interest rate applicable to Division 7A of Part III of the Income Tax Assessment Act 1936 (TM) from (but excluding) the date upon which or the expiration of the period within which they should have been paid to and including the date upon which the moneys are paid.

6. GST

6.1 Words or expressions used in this clause 6 which are defined in A New Tax System (Goods and Services Tax) Act 1999 (TM) have the same meaning in this clause.

6.2 All amounts stated in and payable under or in connection with this Contract excludes GST unless otherwise indicated.

6.3 If a payment to a party under this Contract is a reimbursement or indemnification, calculated by reference to a loss, cost or expense incurred by that party, then the payment will be reduced by the amount of any input tax credit to which that party is entitled for that loss, cost or expense.

6.4 The recipient will not be liable to pay the supplier for a taxable supply made under or in connection with this Contract until the supplier has given the recipient a tax invoice for the supply to which the payment relates.

6.5 Where an adjustment event occurs in relation to a supply made by the supplier under or in connection with this Contract, the supplier will issue an adjustment note to the party providing consideration in respect of that supply within 28 days after becoming aware of the relevant adjustment.

7. VARIATIONS

7.1 The Client may, by written notice to the Consultant, direct the Consultant to vary the Services and, provided that the variation does not change the general scope of the Services, the Consultant shall be bound to comply with that direction ("**Variation**").

7.2 The parties must use their best endeavours to agree in writing on the value of a Variation, but in the event that the parties are unable to agree within 7 days of the issue of the direction, then the value of the Variation shall be determined using reasonable rates and prices.

7.3 If a new legislative requirement or a change in a legislative requirement after the date of the Contract could not reasonably have been anticipated at the date of the Contract, then the extent to which the Services are changed by that legislative requirement shall be deemed to be a Variation pursuant to clause 7.1.

7.4 Where, due to circumstances beyond the reasonable control or anticipation of the Consultant, the Consultant is required to alter, add to or delete documents or other things previously submitted and which otherwise would have complied with the Contract, the Consultant shall inform the Client and seek directions and any subsequent alteration, addition or deletion shall be deemed to be a Variation pursuant to clause 7.1.

8. DELAYS

8.1 The Consultant shall proceed with the work under the Contract with due expedition and without delay.

8.2 When it becomes evident to a party that an act or omission of the Client, or an employee, other consultant, contractor or agent of the Client, may delay carrying out the Services, that party shall promptly notify the other party in writing with details of the possible delay and the cause.

8.3 The Client may direct the Consultant in what order and at what time the Services shall be performed and if:

(a) the Consultant:

(i) can reasonably comply with the direction the Consultant shall do so; and

(ii) cannot reasonably comply with the direction the Consultant shall so notify the Client in writing, giving reasons; and

(b) compliance with the direction causes the Consultant to incur more or less cost than otherwise would have been incurred had the Consultant not been given the direction, the difference shall be valued pursuant to clause 7.2 as though the direction was a Variation.

9. CONFIDENTIALITY

9.1 Except as required by law, the Consultant and the Client will keep confidential information which is so designated in writing by the party providing the information, or which should reasonably be known by the recipient party to be confidential. This clause 9 will survive the expiry or termination of the Contract.

10. LIABILITY OF THE CONSULTANT

10.1 The maximum liability of the Consultant arising out of the performance or non-performance of the Contract or the Services whether under the law of contract, tort or otherwise, shall be limited to 500% of the Contract Sum.

10.2 To the maximum extent permitted by law and notwithstanding any other provision of the Contract, the Consultant is not liable to the Client, whether under contract, in tort, in equity, in restitution, under statute or otherwise, in respect of any:

a. business interruption loss;
b. loss of actual or anticipated profit, revenue, production, opportunity or anticipated savings;
c. loss of use; or
d. exemplary damages.

10.3 This clause 10 shall not apply to claims in respect of personal injury or death.

11. CONSULTANT'S INDEMNITY

11.1 Subject to clause 10, the Consultant shall indemnify the Client against:

(a) loss of or damage to property of the Client; and

(b) claims by any person against the Client in respect of personal injury or death or loss of or damage to any other property,

arising out of or in consequence of carrying out the Services by the Consultant.

11.2 The Consultant's liability to indemnify the Client under clause 11.1 shall be reduced proportionally to the extent that the act or omission of the Client or the employees, agents or other contractors of the Client contributed to the loss, damage, death or injury.

12. DISPUTES

12.1 If a dispute arises between the Consultant and the Client in respect of any fact, matter or thing arising out of, or in any way in connection with, the Contract or the Services, either party may give a notice in writing ("**Notice of Dispute**") to the other party specifying the nature of the dispute, the particulars of the party's reasons for being dissatisfied and the position that the party believes is correct.

12.2 The parties must meet within 14 days of the date of the Notice of Dispute and undertake genuine and good faith negotiations with a view to resolving the dispute. Unless the parties agree otherwise, the meeting must take place in Hobart, Tasmania.

12.3 If the parties are unable to resolve the dispute in accordance with clause 12.2 within 14 days of first meeting under clause 12.2, the dispute may be referred, by written notice of either party, to mediation, which is to be conducted in accordance with the Institute of Arbitrators and Mediators Australia Mediation Rules.

13. INTELLECTUAL PROPERTY

13.1 Unless the Contract otherwise provides, the Consultant retains all Intellectual Property Rights in the Services and in any design, materials, documents and methods of working used or produced in relation to the Services. The Consultant grants to the Client an irrevocable, royalty free, non-exclusive, transferable, perpetual licence to exercise all rights of the owner of the Intellectual Property Rights associated with the Services, for any business purpose of the Client, including additions or alterations or entering into any agreement with any third party which is associated with or uses the Services or things produced in the course of performing the Services.

14. NOTICES

14.1 A notice (and other documents) must be in writing, legible, in English and delivered in person, by facsimile, by email or by post.

14.2 A notice (and other documents) shall be deemed to have been given and received:

(a) if addressed or delivered to the relevant address listed in the Contract Particulars or last communicated in writing to the person giving the notice; and

(b) on the earliest date of:

(i) actual receipt if delivered in person;
(ii) confirmation of correct transmission of fax;
(iii) the notice being recorded as having been first received at the electronic mail destination; or
(iv) 3 days after posting.

15. TERMINATION

15.1 The Contract may be terminated:

(a) at any time by mutual agreement;

(b) for the conveniences of the Client, upon the giving of not less than 7 day notice, in which case the Client shall pay the Consultant:

(i) that portion of the Contract Sum payable to the date of termination;
(ii) any direct costs incurred by the Consultant to the date of termination; and
(iii) an amount equal to 2% of the Contract Sum;

(c) upon a substantial breach of the Contract by either party which is not remedied within a reasonable time (and in any case within 7 days) of notice by the non-breaching party of the substantial breach; or

(d) immediately by either party in the event the other party becomes insolvent or financially unable to proceed with the Contract.

15.2 Upon termination of the Contract, the Consultant shall, as soon as possible, return to the Client the Client's property provided to the Consultant in carrying out the Services.

15.3 If a party breaches (including repudiates) the Contract, nothing in this clause 15 shall prejudice the right of the other party to recover damages or exercise any other right or remedy.

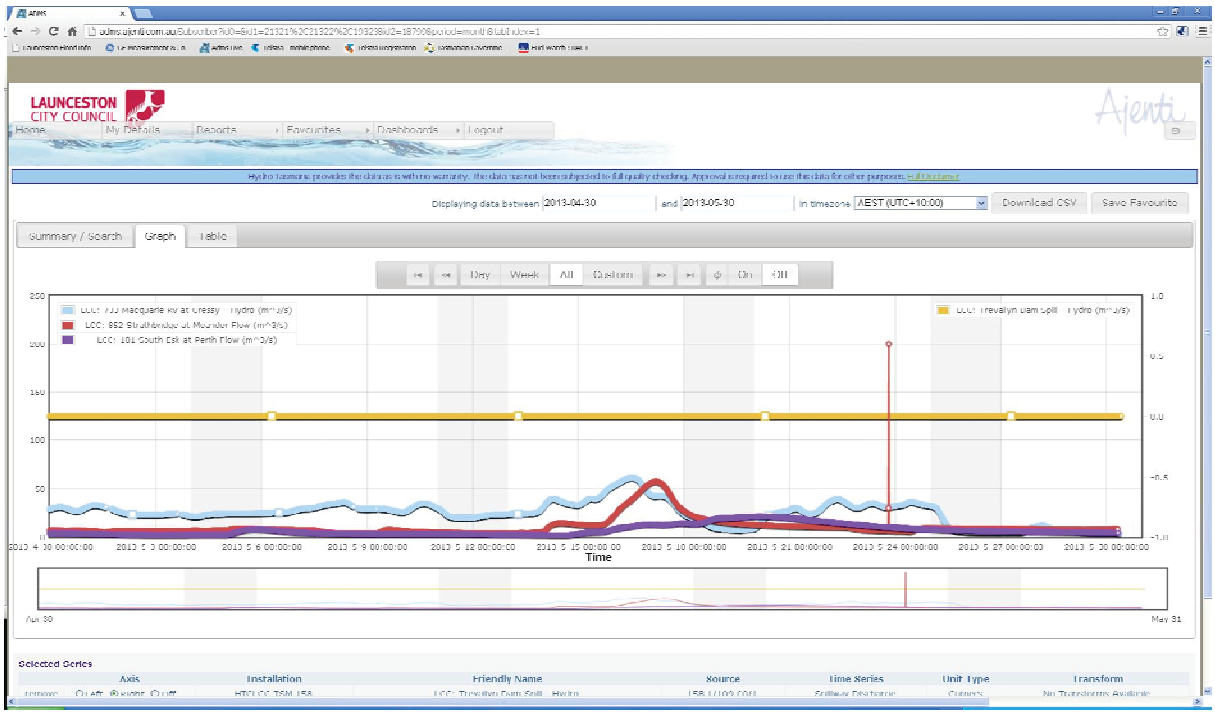
16. GOVERNING LAW

16.1 This Contract is governed by and construed with reference to the laws stated in the Contract Particulars.

ATTACHMENT B: Photos of Redwater Crk, Examples of ADMS, & Public Website

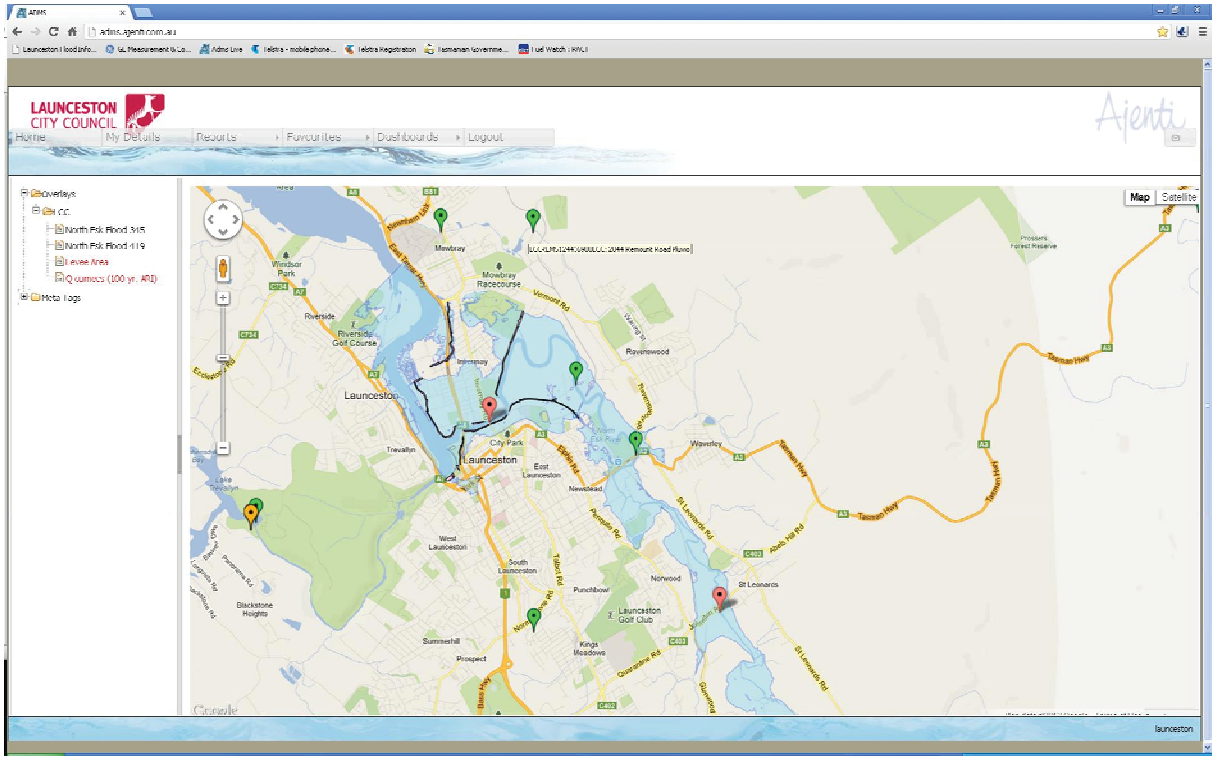
A: Redwater Crk: Showing Existing Old BoM Flood Warning Site. This also partially shows the rock and cobble low flow control and bridge structure (high flow control/restriction) in the background.

B: Screenshot of the ADMS showing a typical data plot 'Favourite' for hydrometric sites



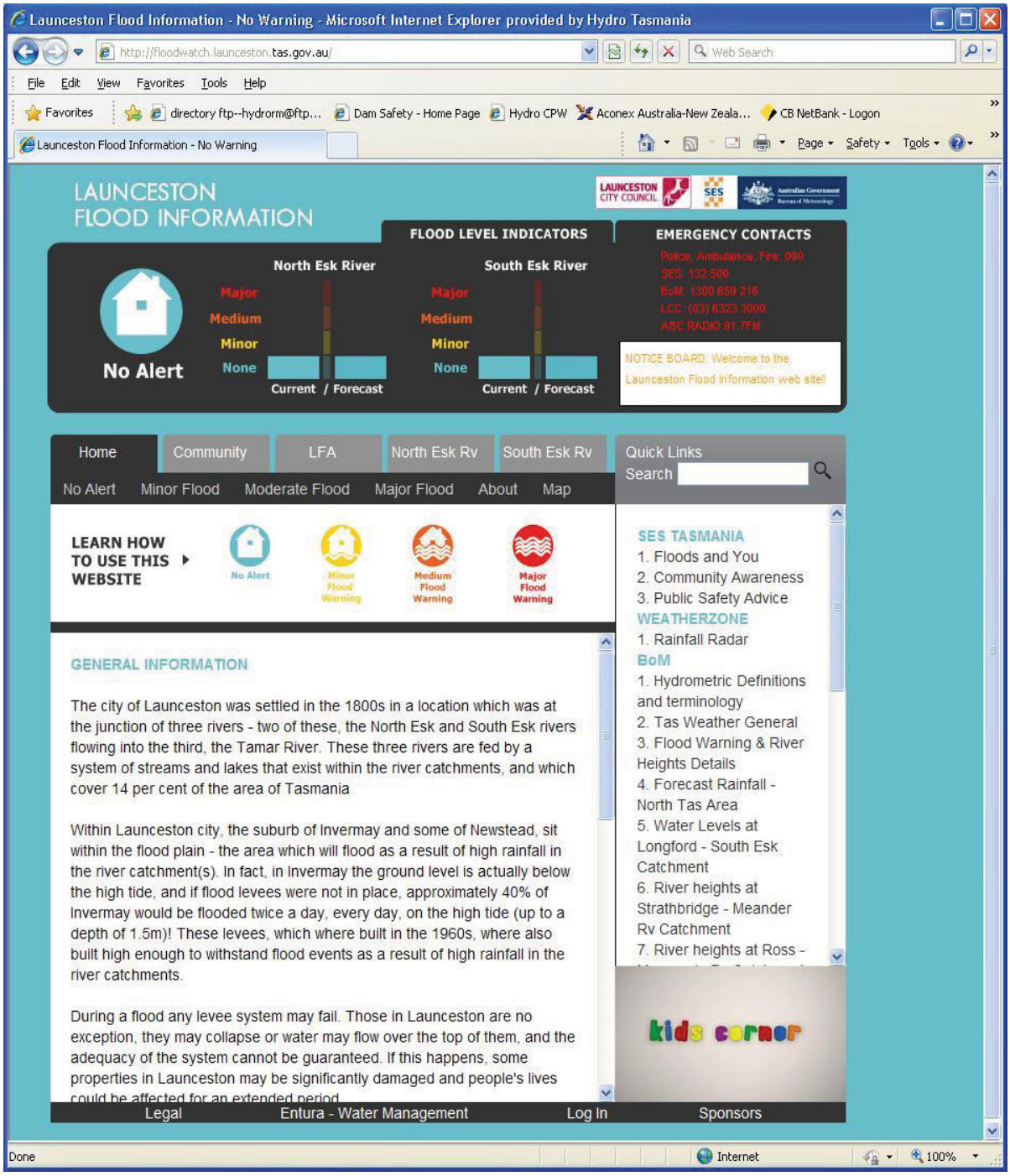
C: Screenshot of the ADMS showing a typical dashboard for hydrometric sites plots, alarms and notifications

D: Screenshot of the ADMS showing location of hydrometric sites and a flood inundation overlay.

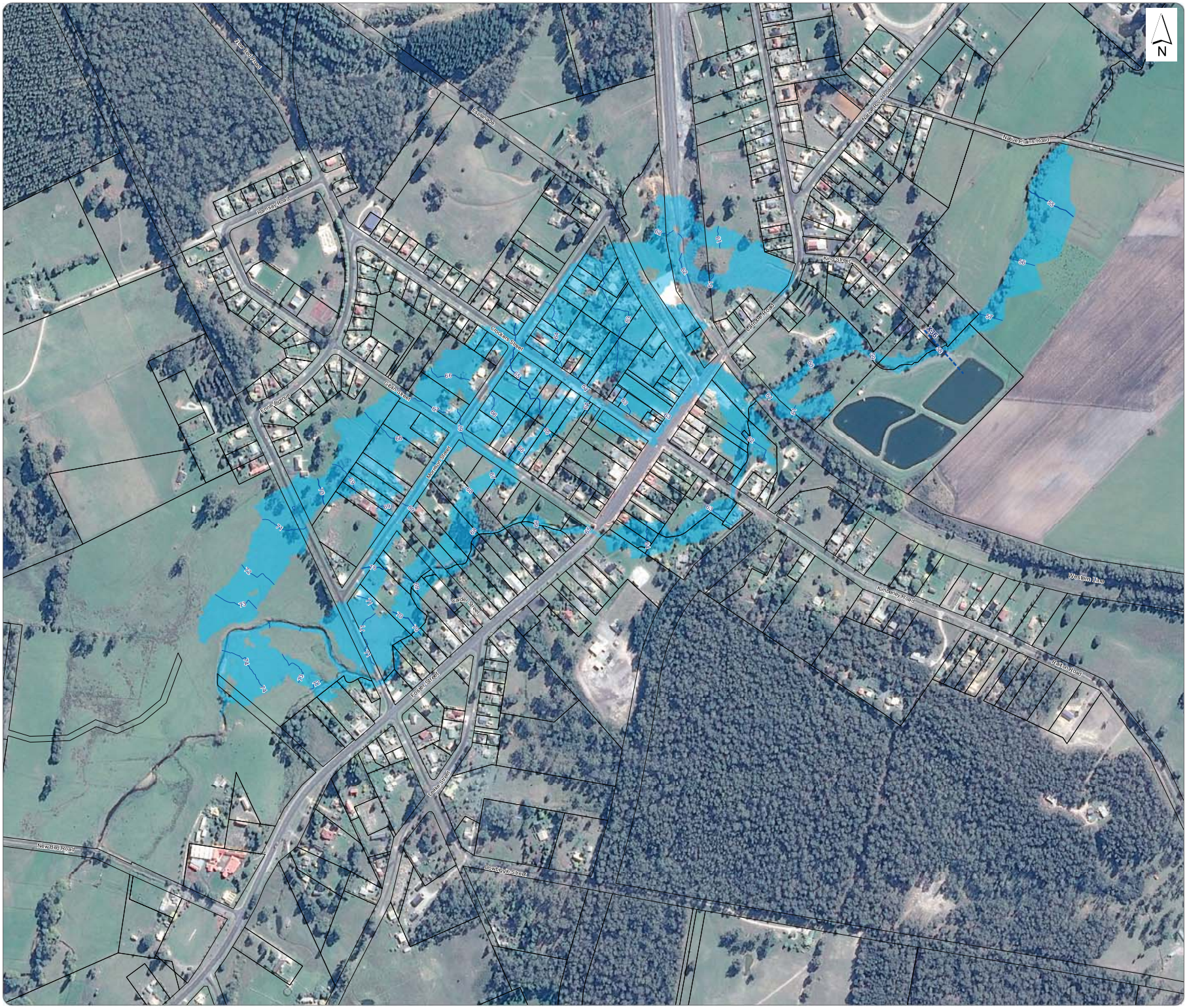


C: Screenshot of the template for the public flood information website. This is an example of the one used for Launceston City Council:

http://floodwatch.launceston.tas.gov.au/



APPENDIX G



REDWATER CREEK RAILTON

10 Year Annual Exceedance Probability Map

General

The map shows the flood extent of a 1:10 AEP event flood surface.

Flood Frequencies

An AEP of 1:10 is the probability on average that a given flood height will be equalled or exceeded in any one year. A 1:10 AEP event flood height has a 10% chance of being exceeded in any one year.
Another term is ARI or Average Recurrence Interval; this is the average period between events of a nominated size.

The table shows the chance of a 1:10 AEP event occurring in a nominated period.

Annual Exceedance Probability (AEP)	Probability of flood magnitude being exceeded in a 20 or 50 year period	
	20 Year Period	50 Year Period
1:10	88%	99.5%
1:20	64%	92%
1:50	33%	64%
1:100	18%	39%
1:200	10%	22%

Flood Surface

A hydrological model of the catchment was developed using RORB (v 6.15).
This catchment model was calibrated to the flood discharge which has been estimated for the flood event which occurred on the 14th January 2011.

The RORB hydrological model was used to derive input hydrographs to the hydraulic model which replicated the January 2011 flood together with hydrographs resulting from the application of standard Australian Rainfall & Runoff rainfall estimates and temporal patterns.

The flood surfaces have been estimated using the hydrodynamic model ISIS 2D (v 3.7) linked to a 1D ISIS model. The ISIS 2D model was calibrated to the flood levels recorded on 14th January 2011.

For further details of the modelling process please refer to the report by SEMF: Review of Railton Flood Mitigation Options June 2014.

Flood extent downstream of cross section X36 is approximate due to limited topographic information.

Map Created by **M.McGovern (Esk Mapping & GIS)**
Hydraulic and hydrological analysis by **S.Ratcliffe (SEMF)**

Legend

- Property Titles
- 10 Year Flood Surface

Water Surface Contours

- Index Contour
- Intermediate Contour

Australian Government

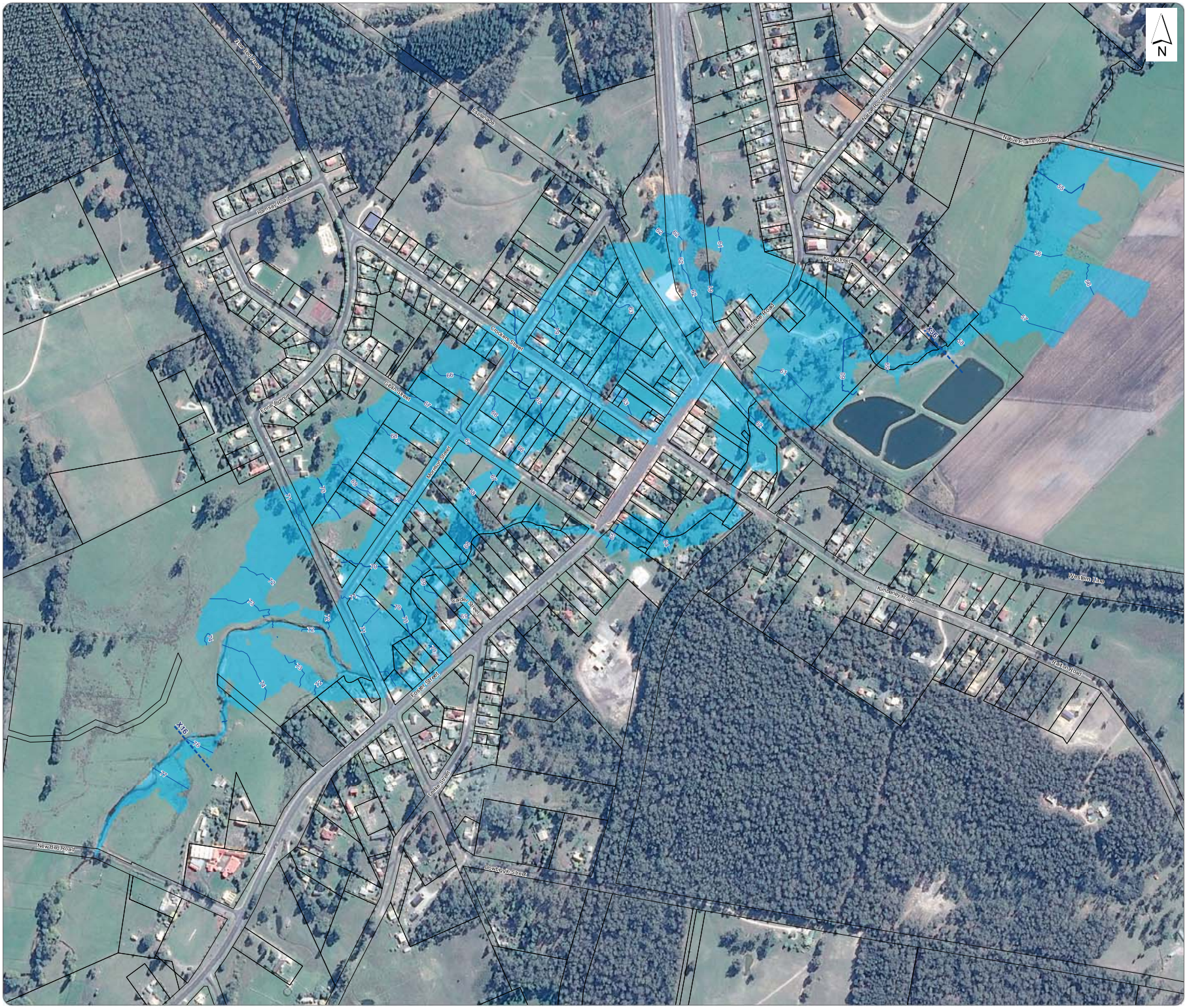
0 100 200 300

Metres

1:3,000 when printed at A1
1 centimetre = 30 metres

Map Version: **FINAL**
Image Source: **Spotimage**
Image Date: **May 2013**
Map Date: **25 June 2014**

esk mapping &GIS



REDWATER CREEK RAILTON

20 Year Annual Exceedance Probability Map

General

The map shows the flood extent of a 1:20 AEP event flood surface.

Flood Frequencies

An AEP of 1:20 is the probability on average that a given flood height will be equalled or exceeded in any one year. A 1:20 AEP event flood height has a 5% chance of being exceeded in any one year.
Another term is ARI or Average Recurrence Interval; this is the average period between events of a nominated size.

The table shows the chance of a 1:20 AEP event occurring in a nominated period.

Annual Exceedance Probability (AEP)	Probability of flood magnitude being exceeded in a 20 or 50 year period	
	20 Year Period	50 Year Period
1:10	88%	99.5%
1:20	64%	92%
1:50	33%	64%
1:100	18%	39%
1:200	10%	22%

Flood Surface

A hydrological model of the catchment was developed using RORB (v 6.15).
This catchment model was calibrated to the flood discharge which has been estimated for the flood event which occurred on the 14th January 2011.

The RORB hydrological model was used to derive input hydrographs to the hydraulic model which replicated the January 2011 flood together with hydrographs resulting from the application of standard Australian Rainfall & Runoff rainfall estimates and temporal patterns.

The flood surfaces have been estimated using the hydrodynamic model ISIS 2D (v 3.7) linked to a 1D ISIS model. The ISIS 2D model was calibrated to the flood levels recorded on 14th January 2011.

For further details of the modelling process please refer to the report by SEMF: Review of Railton Flood Mitigation Options June 2014.

Flood extent downstream of cross section X36 and upstream of X16 is approximate due to limited topographic information.

Map Created by **M.McGovern (Esk Mapping & GIS)**
Hydraulic and hydrological analysis by **S.Ratcliffe (SEMF)**

Legend

- Property Titles
- 20 Year Flood Surface

Water Surface Contours

- Index Contour
- Intermediate Contour

Australian Government

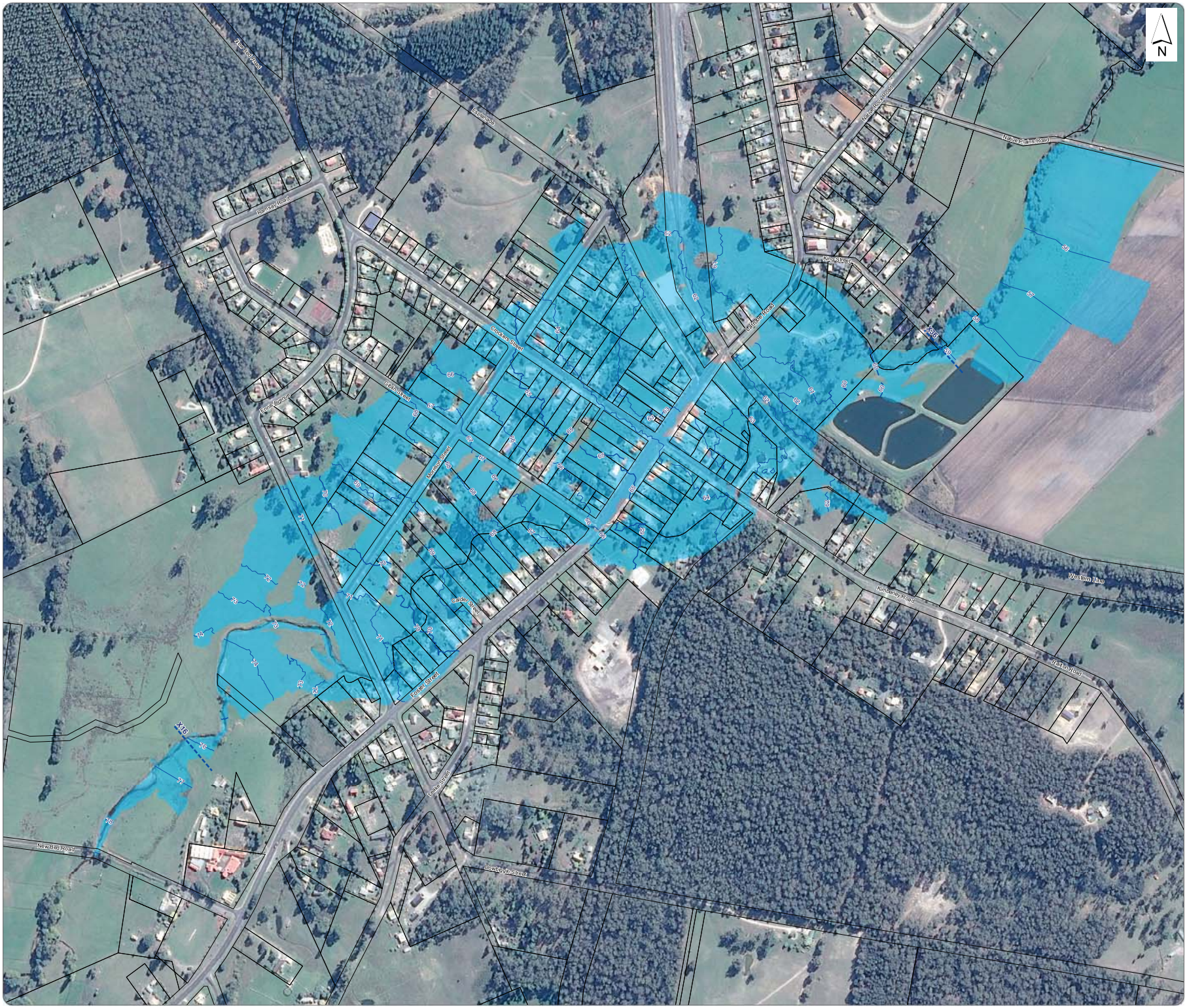
0 100 200 300

Metres

1:3,000 when printed at A1
1 centimetre = 30 metres

Map Version: **FINAL**
Image Source: **Spotimage**
Image Date: **May 2013**
Map Date: **25 June 2014**

esk mapping &GIS



REDWATER CREEK RAILTON

50 Year Annual Exceedance Probability Map

General

The map shows the flood extent of a 1:50 AEP event flood surface.

Flood Frequencies

An AEP of 1:50 is the probability on average that a given flood height will be equalled or exceeded in any one year. A 1:50 AEP event flood height has a 2% chance of being exceeded in any one year.
Another term is ARI or Average Recurrence Interval; this is the average period between events of a nominated size.

The table shows the chance of a 1:50 AEP event occurring in a nominated period.

Annual Exceedance Probability (AEP)	Probability of flood magnitude being exceeded in a 20 or 50 year period	
	20 Year Period	50 Year Period
1:10	88%	99.5%
1:20	64%	92%
1:50	33%	64%
1:100	18%	39%
1:200	10%	22%

Flood Surface

A hydrological model of the catchment was developed using RORB (v 6.15).
This catchment model was calibrated to the flood discharge which has been estimated for the flood event which occurred on the 14th January 2011.

The RORB hydrological model was used to derive input hydrographs to the hydraulic model which replicated the January 2011 flood together with hydrographs resulting from the application of standard Australian Rainfall & Runoff rainfall estimates and temporal patterns.

The flood surfaces have been estimated using the hydrodynamic model ISIS 2D (v 3.7) linked to a 1D ISIS model. The ISIS 2D model was calibrated to the flood levels recorded on 14th January 2011.

For further details of the modelling process please refer to the report by SEMF: Review of Railton Flood Mitigation Options June 2014.

Flood extent downstream of cross section X36 and upstream of X16 is approximate due to limited topographic information.

Map Created by **M.McGovern (Esk Mapping & GIS)**
Hydraulic and hydrological analysis by **S.Ratcliffe (SEMF)**

Legend

- Property Titles
- 50 Year Flood Surface

Water Surface Contours

- Index Contour
- Intermediate Contour

Australian Government

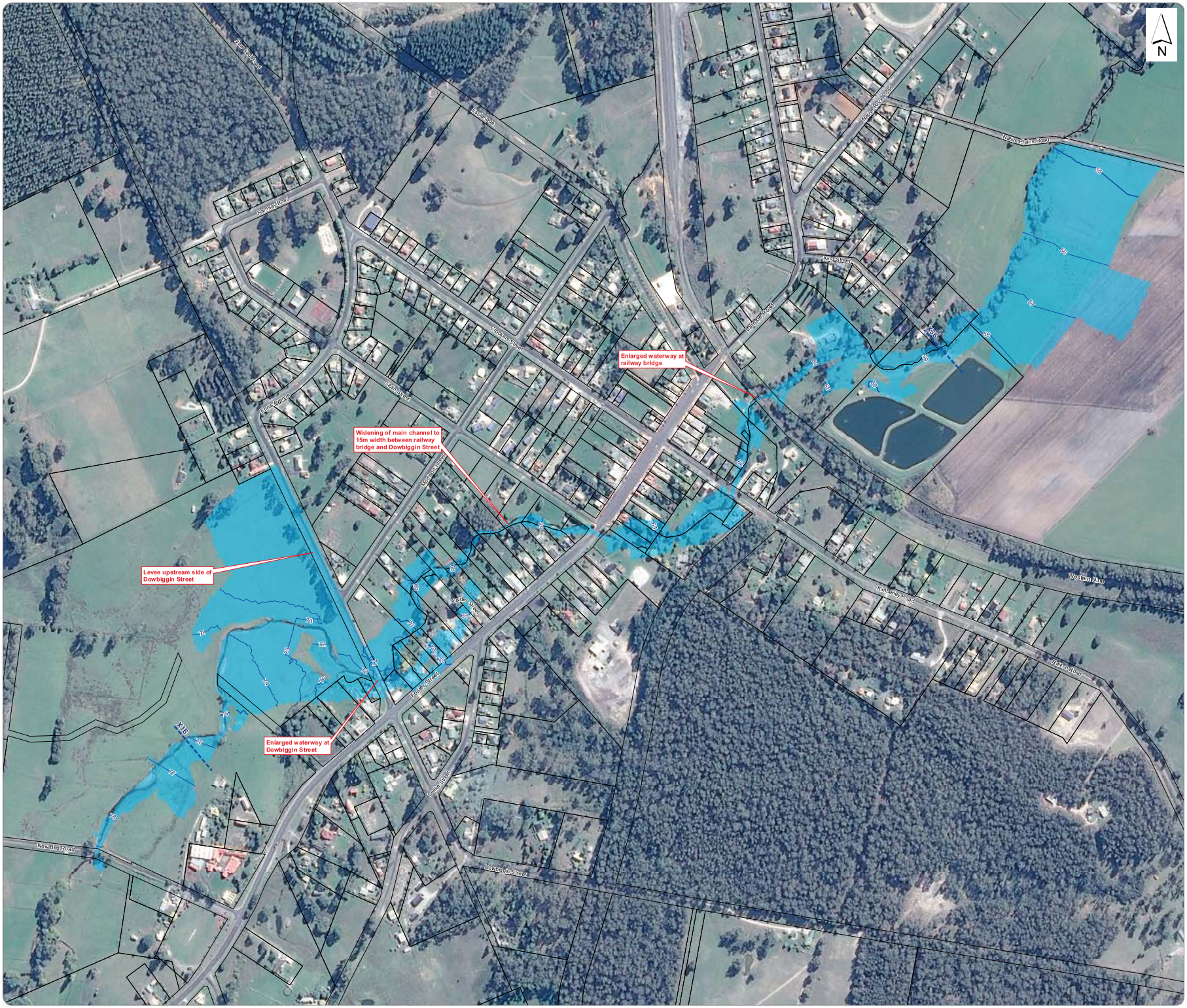
0 100 200 300

Metres

1:3,000 when printed at A1
1 centimetre = 30 metres

Map Version: **FINAL**
Image Source: **Spotimage**
Image Date: **May 2013**
Map Date: **25 June 2014**

esk mapping & GIS



REDWATER CREEK RAILTON

100 Year Annual Exceedance Probability Map

with flood mitigation measures in place

General

The map shows the flood inundation resulting from a 100 year flood event with:

- A levee on the upstream side of Dowbiggin Street
- The main channel enhanced to 15m width between the Railway Bridge and Dowbiggin Street
- Enlarged Bridge waterways at Dowbiggin Street and the Railway Bridge

Flood Frequencies

An AEP of 1:100 is the probability on average that a given flood height will be equalled or exceeded in any one year. A 1:100 AEP event flood height has a 1% chance of being exceeded in any one year.
Another term is ARI or Average Recurrence Interval; this is the average period between events of a nominated size.

The table shows the chance of a 1:100 AEP event occurring in a nominated period.

Annual Exceedance Probability (AEP)	Probability of flood magnitude being exceeded in a 20 or 50 year period	
	20 Year Period	50 Year Period
1:10	88%	99.5%
1:20	64%	92%
1:50	33%	64%
1:100	18%	39%
1:200	10%	22%

Flood Surface

A hydrological model of the catchment was developed using RORB (v 6.15).
This catchment model was calibrated to the flood discharge which has been estimated for the flood event which occurred on the 14th January 2011.

The RORB hydrological model was used to derive input hydrographs to the hydraulic model which replicated the January 2011 flood together with hydrographs resulting from the application of standard Australian Rainfall & Runoff rainfall estimates and temporal patterns.

The flood surfaces have been estimated using the hydrodynamic model ISIS 2D (v 3.7) linked to a 1D ISIS model. The ISIS 2D model was calibrated to the flood levels recorded on 14th January 2011.

For further details of the modelling process please refer to the report by SEMF: Review of Railton Flood Mitigation Options June 2014.

Flood extent downstream of cross section X36 and upstream of X16 is approximate due to limited topographic information.

Map Created by **M.McGovern (Esk Mapping & GIS)**
Hydraulic and hydrological analysis by **S.Ratcliffe (SEMF)**

Legend

- Property Titles
- 100 Year Flood Surface

Water Surface Contours

- Index Contour
- Intermediate Contour

Australian Government

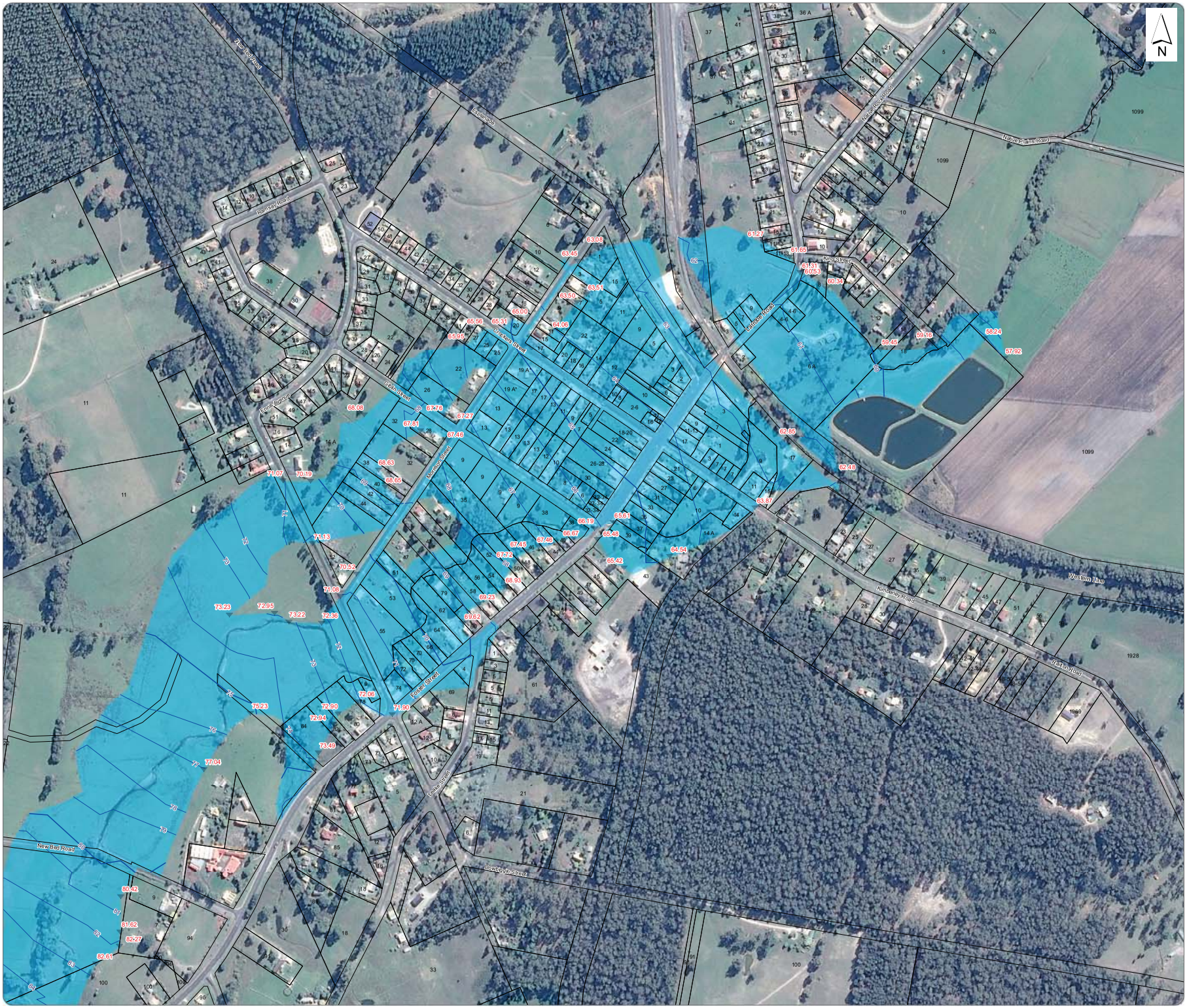
0 100 200 300

Metres

1:3,000 when printed at A1
1 centimetre = 30 metres

Map Version: **FINAL**
Image Source: **Spotimage**
Image Date: **May 2013**
Map Date: **25 June 2014**

esk mapping & GIS



REDWATER CREEK RAILTON

100 Year Annual Exceedance Probability Planning Map

Based on the January 2011 Flood

General

This map shows the extent of flood experienced at Railton on the 14th January 2011. Analysis has determined that this flood's Annual Exceedance Probability (AEP) was equal to 1% AEP flood or a 1 in 100 year event. As such this map may be used for Planning assessments as the best information available at the time of publication.

Flood Frequencies

An AEP of 1:100 is the probability on average that a given flood height will be equalled or exceeded in any one year. A 1:100 AEP event flood height has a 1% chance of being exceeded in any one year.
Another term is ARI or Average Recurrence Interval; this is the average period between events of a nominated size.

The table shows the chance of a 1:100 AEP event occurring in a nominated period.

Annual Exceedance Probability (AEP)	Probability of flood magnitude being exceeded in a 20 or 50 year period	
	20 Year Period	50 Year Period
1:10	88%	99.5%
1:20	64%	92%
1:50	33%	64%
1:100	18%	39%
1:200	10%	22%

Flood Surface

Flood surface levels can be determined from direct measurement by surveying in the levels in the aftermath of a flood and then assigning an AEP to the flood surface or by hydraulic modelling with mathematical models. Both approaches require flood frequency analysis or hydrological modelling to determine the floods AEP.

It is unusual for an actual flood event to match a standard AEP or ARI but in the case of the January 2011 event, flood frequency analysis and hydrological modelling together have shown that it can be equated to the 1:100 AEP flood event.

Flood levels were determined by surveying in flood levels recorded by Council staff after the flood, in some areas levels have been estimated and averaged.
Council will continue to refine the map as more information becomes available, but for now it is the best estimate available for the 1:100 AEP flood surface.

Map Created by **M.McGovern (Esk Mapping & GIS)**
Hydraulic and hydrological analysis by **S.Ratcliffe (SEMF)**

Legend

- Property Titles
- 2011 Flood Extent
- 2011 Water Level Height

Water Surface Contours

- Index Contour
- Intermediate Contour

Australian Government

SES

0 100 200 300

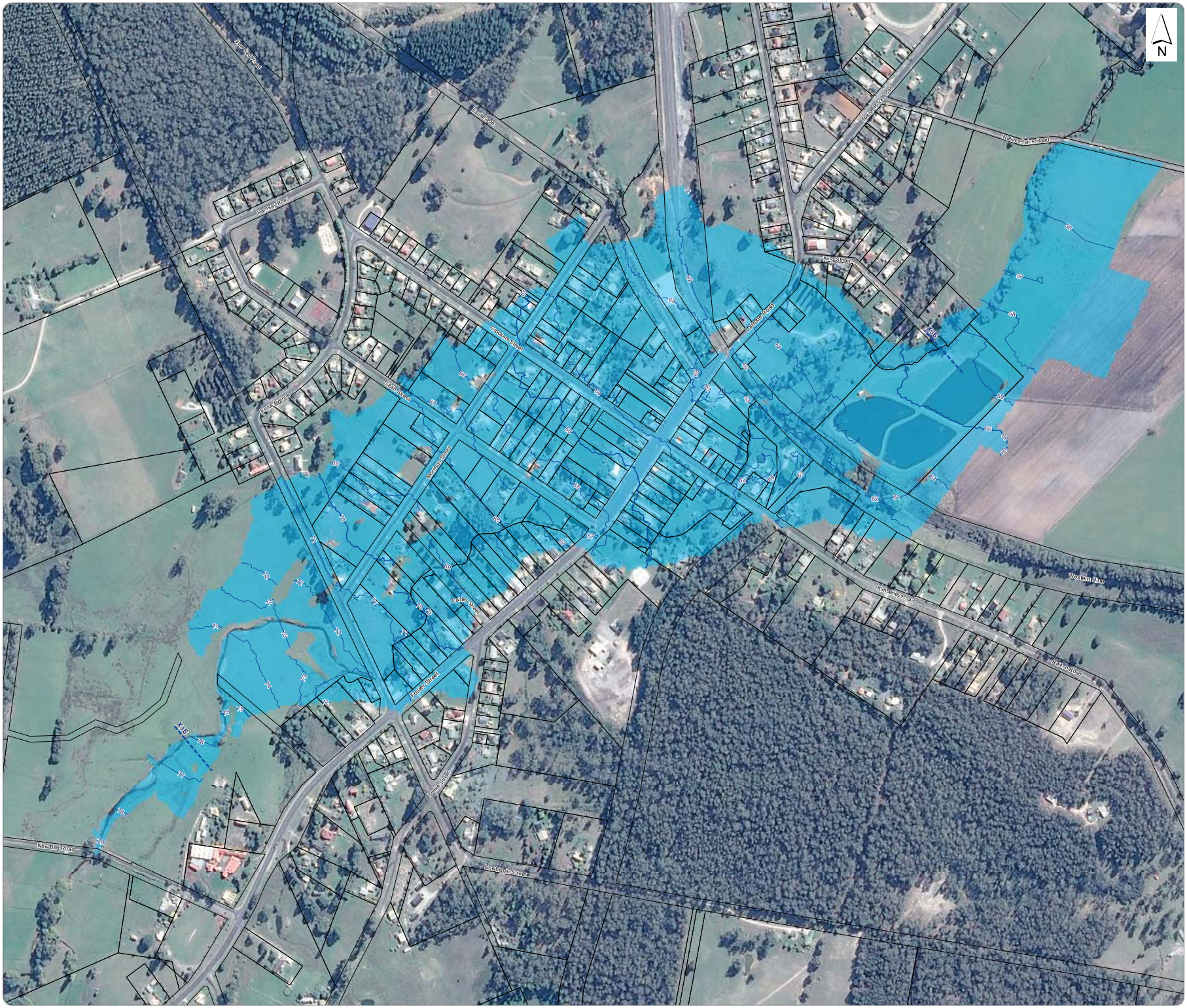
Metres

1:3,000 when printed at A1
1 centimetre = 30 metres

Map Version: **FINAL**
Image Source: **Spotimage**
Image Date: **May 2013**
Map Date: **25 June 2014**

SEMF GDA

esk mapping & GIS



REDWATER CREEK RAILTON

200 Year Annual Exceedance Probability Map

General

The map shows the flood extent of a 1:200 AEP event flood surface.

Flood Frequencies

An AEP of 1:200 is the probability on average that a given flood height will be equalled or exceeded in any one year. A 1:200 AEP event flood height has a 0.5% chance of being exceeded in any one year.
Another term is ARI or Average Recurrence Interval; this is the average period between events of a nominated size.

The table shows the chance of a 1:200 AEP event occurring in a nominated period.

Annual Exceedance Probability (AEP)	Probability of flood magnitude being exceeded in a 20 or 50 year period	
	20 Year Period	50 Year Period
1:10	88%	99.5%
1:20	64%	92%
1:50	33%	64%
1:100	18%	39%
1:200	10%	22%

Flood Surface

A hydrological model of the catchment was developed using RORB (v 6.15).
This catchment model was calibrated to the flood discharge which has been estimated for the flood event which occurred on the 14th January 2011.

The RORB hydrological model was used to derive input hydrographs to the hydraulic model which replicated the January 2011 flood together with hydrographs resulting from the application of standard Australian Rainfall & Runoff rainfall estimates and temporal patterns.

The flood surfaces have been estimated using the hydrodynamic model ISIS 2D (v 3.7) linked to a 1D ISIS model. The ISIS 2D model was calibrated to the flood levels recorded on 14th January 2011.

For further details of the modelling process please refer to the report by SEMF: Review of Railton Flood Mitigation Options June 2014.

Flood extent downstream of cross section X36 and upstream of X16 is approximate due to limited topographic information.

Map Created by **M.McGovern (Esk Mapping & GIS)**
Hydraulic and hydrological analysis by **S.Ratcliffe (SEMF)**

Legend

Property Titles

200 Year Flood Surface

Water Surface Contours

Index Contour

Intermediate Contour

KENTISH

Australian Government

SES

0 100 200 300

Metres

1:3,000 when printed at A1
1 centimetre = 30 metres

SEMF

GDA

esk mapping & GIS

Map Version: **FINAL**
Image Source: **Spotimage**
Image Date: **May 2013**
Map Date: **25 June 2014**

APPENDIX H

10 Year ARI Event

	CT REF	IMPROVEMENT	FLOOR HEIGHT	MEAN_FLOOD	MIN_FLOOD	MAX_FLOOD	Max Flood - Floor		Max Flood + 0.3 - Floor	
1 KIMBERLEY RD	22129/3	HOUSE	63.69	62.133	62.072	62.298	-1.392		-1.092	
1 MORRISON ST	60290/1	HOUSE	63.32	63.061	62.953	63.349	0.029	1	0.329	1
10 CROCKERS ST	144440/1	House incomplete	63.9704	63.019	62.751	63.824	-0.146		0.154	1
10 FOSTER ST	246742/1		#N/A	62.757	62.748	63.013	#N/A			
11 CROCKERS ST	60290/35	FIRE STATION	64.6	64.675	64.201	64.949	0.349	1	0.649	1
11 ESPLANADE	219852/17	HOUSE	63.266	63.016	62.916	63.261	-0.005		0.295	1
11 MORRISON ST	61512/1	HOUSE	64.885	64.120	63.869	64.434	-0.451		-0.151	
11-13 LATROBE RD	232854/2	HOUSE	#N/A	60.475	60.475	60.475	#N/A			
12 CROCKERS ST	210547/1	HOUSE	64.1619	63.066	62.748	63.861	-0.301		-0.001	
12 FOSTER ST	202156/1	Shop	#N/A	62.826	62.749	63.053	#N/A			
12 FOSTER ST	241656/1	Shop	63.5116	63.168	63.168	63.168	-0.344		-0.044	
12 GIBLIN ST	215051/36	HOUSE	66.78	64.917	64.917	64.917	-1.863		-1.563	
13 CROCKERS ST	60290/26	5 Dwellings & Garage	66.52	65.907	65.612	66.312	-0.208		0.092	1
13 CROCKERS ST	60290/27	5 Dwellings & Garage	67.14	66.418	66.015	66.847	-0.293		0.007	1
13 CROCKERS ST	60290/28	5 Dwellings & Garage	66.63	65.783	65.443	66.252	-0.378		-0.078	
13 CROCKERS ST	60290/30	5 Dwellings & Garage	67.24	65.760	65.297	66.402	-0.838		-0.538	
13 CROCKERS ST	60290/32	5 Dwellings & Garage	66.34	65.874	65.051	66.450	0.110	1	0.410	1
13 CROCKERS ST	60290/33	5 Dwellings & Garage	64.9	64.748	64.312	65.051	0.151	1	0.451	1
13 CROCKERS ST	60290/34	5 Dwellings & Garage	66.95	65.369	64.919	66.182	-0.768		-0.468	
14 CROCKERS ST	60290/8	HOUSE	64.3582	63.456	63.040	63.999	-0.359		-0.059	
14A DOWBIGGIN ST	133335/2	HOUSE	71.52	68.953	67.919	70.786	-0.734		-0.434	
15 ESPLANADE	127081/1	House	63.4345	62.968	62.954	63.157	-0.277		0.023	1
15 MORRISON ST	63535/1	HOUSE	64.9199	64.225	64.005	64.727	-0.193		0.107	1
16 CROCKERS ST	83096/3	HOUSE	64.2624	63.756	63.534	64.032	-0.230		0.070	1
16 FOSTER ST	220495/1	2 SHOPS + FLAT	63.8651	63.004	62.751	63.434	-0.431		-0.131	
17 CROCKERS ST	60290/29	HOUSE	#N/A	64.845	64.398	65.565	#N/A			
17 CROCKERS ST	60290/31	HOUSE	#N/A	64.864	64.346	65.299	#N/A			
17 MORRISON ST	72957/1	HOUSE	64.9389	64.347	64.029	64.728	-0.211		0.089	1
18 CROCKERS ST	83096/2	HOUSE	64.2807	63.694	63.611	63.769	-0.512		-0.212	
18 MORRISON ST	79388/6	HOUSE	65.3933	64.569	64.525	64.627	-0.766		-0.466	
18-20 FOSTER ST	222258/17	SHOP	64.2915	63.911	63.894	63.913	-0.379		-0.079	
19AD CROCKERS ST	60290/24	4 HOME UNITS	65.27	64.676	64.401	65.284	0.014	1	0.314	1
19AD CROCKERS ST	60290/25	4 HOME UNITS	#N/A	65.460	64.429	65.826	#N/A			
2 FOSTER ST	12259/1	PST OFF. SHP & HOUSE	62.687	62.748	62.747	62.748	0.061	1	0.361	1
20 CROCKERS ST	221612/1	HOUSE	64.3808	63.880	63.752	64.034	-0.347		-0.047	
20 MORRISON ST	79388/7	HOUSE	65.5413	65.022	64.627	65.229	-0.312		-0.012	
22 CROCKERS ST	61512/2	HOUSE	63.3366	63.521	63.155	64.023	0.686	1	0.986	1
22 FOSTER ST	216657/41	HOUSE	#N/A	63.912	63.912	63.913	#N/A			
22 MORRISON ST	231659/1	HOUSE	66.2327	65.935	65.705	66.564	0.331	1	0.631	1
25 CROCKERS ST	79247/4	HOUSE	#N/A	65.641	65.433	65.705	#N/A			
25 CROCKERS ST	79247/5	HOUSE	65.89	65.288	65.100	65.601	-0.289		0.011	1
2-6 CROCKERS ST	241657/1		#N/A	62.874	62.749	63.617	#N/A			
26 MORRISON ST	217184/1	HOUSE	67.6528	66.659	66.112	67.204	-0.449		-0.149	
27 CROCKERS ST	79247/3	HOUSE	66.3	65.669	65.633	65.706	-0.594		-0.294	
28 MORRISON ST	120655/1	HOUSE	68.3967	67.844	67.434	67.915	-0.482		-0.182	
3 ESPLANADE	240697/1	EXCHANGE	62.5957	62.748	62.748	62.749	0.153	1	0.453	1
3 FOSTER ST	128977/1	HOTEL	62.9276	62.199	61.987	62.561	-0.367		-0.067	
3 MORRISON ST	81952/3	HOUSE	63.34	63.282	63.111	63.350	0.010	1	0.310	1
32 MORRISON ST	120656/1	HOUSE	#N/A	67.920	67.889	68.035	#N/A			
32 MORRISON ST	222007/1	HOUSE	68.9577	68.290	67.923	68.672	-0.286		0.014	1
35 MORRISON ST	40640/27	HOUSE	68.6753	68.233	67.769	68.296	-0.379		-0.079	
38 MORRISON ST	230106/4	HOUSE	69.0748	68.729	68.562	68.840	-0.235		0.065	1
39 MORRISON ST	40640/26	HOUSE	69.2498	68.276	67.769	68.646	-0.604		-0.304	
4 FOSTER ST	79774/1	HOUSE	63.14	62.749	62.747	62.752	-0.388		-0.088	
40 MORRISON ST	74775/1	HOUSE	69.5051	68.786	68.706	68.942	-0.563		-0.263	
42 MORRISON ST	215827/2	House	69.14	68.934	68.746	69.255	0.115	1	0.415	1
43 MORRISON ST	40640/24	HOUSE	#N/A	68.849	68.694	69.154	#N/A			
43 MORRISON ST	40640/25	HOUSE	69.4272	68.572	68.292	69.013	-0.414		-0.114	
44 MORRISON ST	215720/3	House	69.9407	69.237	68.939	69.541	-0.400		-0.100	
47 MORRISON ST	40640/22	HOUSE	70.4696	69.148	68.972	69.746	-0.724		-0.424	
5 CROCKERS ST	161462/1	House	#N/A	63.938	63.912	63.995	#N/A			
5 ESPLANADE	155469/1	House	62.4765	62.749	62.748	62.750	0.273	1	0.573	1
5 MORRISON ST	127081/2	HOUSE	63.88	63.217	62.967	63.431	-0.449		-0.149	
51 MORRISON ST	40640/21	HOUSE	70.0657	69.392	68.978	70.034	-0.032		0.268	1
52 FOSTER ST	40640/9	CLUB	71.9913	68.277	68.277	68.277	-3.714		-3.414	
53 MORRISON ST	153676/1	Dwelling	70.7025	70.121	69.210	70.944	0.242		0.542	1
55 MORRISON ST	153676/2	Dwelling	71.5864	70.751	70.174	71.100	-0.486		-0.186	
6 FOSTER ST	79774/2	HOUSE	63.2	62.750	62.748	62.752	-0.448		-0.148	
62 FOSTER ST	40640/13	HOUSE	70.0032	69.540	69.540	69.540	-0.463		-0.163	

64 FOSTER ST	40640/14	House	69.8524	69.569	69.569	69.569	-0.283		0.017	1
6A LATROBE RD	100717/1	House	60.01	60.563	60.314	61.281	1.271		1.571	1
7 CROCKERS ST	161462/2	Vacant land	#N/A	64.008	63.941	64.105	#N/A			
7 FOSTER ST	246358/3	SHOP HOUSE	63.1491	62.136	62.067	62.335	-0.814		-0.514	
7 MORRISON ST	81952/1	HOUSE	64.43	63.487	63.354	63.860	-0.570		-0.270	
70 FOSTER ST	40640/16	HOUSE	#N/A	70.332	70.296	70.380	#N/A			
70 FOSTER ST	40640/17	HOUSE	70.7661	70.420	70.407	70.434	-0.332		-0.032	
72 FOSTER ST	40640/18	HOUSE	70.9946	70.619	70.619	70.619	-0.376		-0.076	
8 CROCKERS ST	144440/2	House	63.9744	63.194	62.751	63.728	-0.246		0.054	1
8 FOSTER ST	248634/1	PLAY GROUP CENTRE	#N/A	62.750	62.748	62.752	#N/A			
8 NEW BED RD	34958/1	HOUSE & SHEDS	#N/A	72.343	70.994	74.507	#N/A			
80 FOSTER ST	217893/1	HOUSE	73.09	71.851	71.851	71.853	-1.237		-0.937	
9 CROCKERS ST	60290/37	HOUSE	#N/A	64.273	63.987	64.867	#N/A			
9 ESPLANADE	60290/16		#N/A	62.791	62.748	62.982	#N/A			
9 GIBLIN ST	60290/48	HOUSE	#N/A	67.290	66.886	67.798	#N/A			
9 GIBLIN ST	60290/49	HOUSE	#N/A	67.329	66.731	67.992	#N/A			
9 GIBLIN ST	60290/50	HOUSE	67.68	66.816	66.731	67.337	-0.343		-0.043	
9 KIMBERLEY RD	143878/2	Dwelling	63.05	62.037	61.778	62.179	-0.871		-0.571	
9 MORRISON ST	60290/3	HOUSE	64.76	63.868	63.505	64.181	-0.579		-0.279	
ESPLANADE	155469/2	WORKSHOP	62.2701	62.749	62.748	62.751	0.481		0.781	1
ESPLANADE	43485/1	GROUND IMPROVEMENTS	#N/A	62.748	62.740	62.750	#N/A			
ESPLANADE	43485/2	GROUND IMPROVEMENTS	#N/A	62.383	61.746	62.874	#N/A			
FOSTER ST	128977/2	PUMP HOUSE PASTURE	#N/A	62.113	62.027	62.193	#N/A			
FOSTER ST	16794/1		#N/A	62.310	62.217	62.536	#N/A			
KING ST	8882/1	Sewerage Treatment	61.2	60.350	60.350	60.350	-0.850		-0.550	
LATROBE RD	198825/1	GARAGE	#N/A	60.594	60.474	61.533	#N/A			
MORRISON ST	229914/1		#N/A	69.588	69.364	69.913	#N/A			
								12		**29**

20 Year ARI Event

ADDRESS	CT REF	IMPROVEMENT	FLOOR HEIGHT	MEAN_FLOOD	MIN_FLOOD	MAX_FLOOD	Max Flood - Floor		Max Flood + 0.3 - Floor	
1 KIMBERLEY RD	22129/3	HOUSE	63.69	62.446	62.337	62.715	-0.975		-0.675	
1 MORRISON ST	60290/1	HOUSE	63.32	63.089	62.978	63.379	0.059	1.000	0.359	1
10 CROCKERS ST	144440/1	House incomplete	63.9704	63.207	62.854	63.790	-0.180		0.120	1
10 FOSTER ST	246742/1		#N/A	62.841	62.828	63.031				
1099 NATIVE PLAINS RD	109761/4	FARM IMP	#N/A	56.011	55.966	56.228				
11 CROCKERS ST	60290/35	FIRE STATION	64.6	64.692	64.214	64.966	0.366	1.000	0.666	1
11 ESPLANADE	219852/17	HOUSE	63.266	63.036	62.942	63.245	-0.021		0.279	1
11 MORRISON ST	61512/1	HOUSE	64.885	64.137	63.878	64.482	-0.403		-0.103	
11-13 LATROBE RD	232854/2	HOUSE	#N/A	60.870	60.870	60.870				
11-13 LATROBE RD	55819/3	HOUSE	#N/A	60.870	60.870	60.870				
12 CROCKERS ST	210547/1	HOUSE	64.1619	63.167	62.830	63.871	-0.291		0.009	1
12 FOSTER ST	202156/1	Shop	#N/A	62.904	62.845	63.069			0.300	1
12 FOSTER ST	241656/1	Shop	63.5116	63.182	63.182	63.182	-0.330		-0.030	
12 GIBLIN ST	215051/36	HOUSE	66.78	65.021	64.957	65.148	-1.632		-1.332	
12 KING ST	100717/2	HOUSE	#N/A	60.140	59.938	60.169				
13 CROCKERS ST	60290/26	5 Dwellings & Garage	66.52	65.933	65.627	66.376				
13 CROCKERS ST	60290/27	5 Dwellings & Garage	67.14	66.447	66.033	66.903	-0.237		0.063	1
13 CROCKERS ST	60290/28	5 Dwellings & Garage	66.63	65.852	65.455	66.372	-0.258		0.042	1
13 CROCKERS ST	60290/30	5 Dwellings & Garage	67.24	65.636	65.295	66.407	-0.833		-0.533	
13 CROCKERS ST	60290/32	5 Dwellings & Garage	66.34	65.730	65.059	66.458	0.118	1.000	0.418	1
13 CROCKERS ST	60290/33	5 Dwellings & Garage	64.9	64.798	64.349	65.178	0.278	1.000	0.578	1
13 CROCKERS ST	60290/34	5 Dwellings & Garage	66.95	65.395	64.922	66.186	-0.764		-0.464	
14 CROCKERS ST	60290/8	HOUSE	64.3582	63.482	63.061	64.033	-0.325		-0.025	
14 MORRISON ST	79388/2	HOUSE	65.2608	63.984	63.898	64.107	-1.154		-0.854	
14A DOWBIGGIN ST	133335/2	HOUSE	71.52	69.008	67.967	70.824	-0.696		-0.396	
15 ESPLANADE	127081/1	House	63.4345	62.993	62.978	63.079	-0.356		-0.056	
15 MORRISON ST	63535/1	HOUSE	64.9199	64.244	64.005	64.742	-0.178		0.122	1
16 CROCKERS ST	83096/3	HOUSE	64.2624	63.809	63.596	64.084	-0.178		0.122	1
16 FOSTER ST	220495/1	2 SHOPS + FLAT	63.8651	63.032	62.846	63.451	-0.414		-0.114	
17 CROCKERS ST	60290/29	HOUSE	#N/A	64.886	64.444	65.574				
17 CROCKERS ST	60290/31	HOUSE	#N/A	64.850	64.378	65.313				
17 KIMBERLEY RD	16794/2	HOUSE & UNIT	63.05	62.236	62.205	62.358	-0.692		-0.392	
17 MORRISON ST	72957/1	HOUSE	64.9389	64.398	64.122	64.779	-0.160		0.140	1
18 CROCKERS ST	83096/2	HOUSE	64.2807	63.883	63.692	64.113	-0.168		0.132	1
18 MORRISON ST	79388/6	HOUSE	65.3933	64.862	64.522	65.035	-0.358		-0.058	
18-20 FOSTER ST	222258/17	SHOP	64.2915	63.926	63.900	63.929	-0.362		-0.062	
19AD CROCKERS ST	60290/24	4 HOME UNITS	65.27	64.714	64.456	65.306	0.036	1.000	0.336	1
19AD CROCKERS ST	60290/25	4 HOME UNITS	#N/A	65.480	64.525	65.845				
2 FOSTER ST	12259/1	PST OFF. SHP & HOUSE	62.687	62.821	62.815	62.829	0.142	1.000	0.442	1

20 CROCKERS ST	221612/1	HOUSE	64.3808	63.964	63.804	64.138	-0.243		0.057	1
20 MORRISON ST	79388/7	HOUSE	65.5413	65.038	64.661	65.255	-0.286		0.014	1
22 CROCKERS ST	61512/2	HOUSE	63.3366	63.551	63.183	64.119	0.782	1.000	1.082	1
22 FOSTER ST	216657/41	HOUSE	#N/A	63.929	63.928	63.929				
22 MORRISON ST	231659/1	HOUSE	66.2327	65.975	65.772	66.607	0.374	1.000	0.674	1
25 CROCKERS ST	79247/4	HOUSE	#N/A	65.696	65.481	65.773				
25 CROCKERS ST	79247/5	HOUSE	65.89	65.421	65.127	65.773	-0.117		0.183	1
2-6 CROCKERS ST	241657/1		#N/A	62.948	62.835	63.660				
26 MORRISON ST	217184/1	HOUSE	67.6528	66.676	66.160	67.238	-0.415		-0.115	
27 CROCKERS ST	79247/3	HOUSE	66.3	65.731	65.690	65.774	-0.526		-0.226	
28 MORRISON ST	120655/1	HOUSE	68.3967	67.862	67.445	67.956	-0.441		-0.141	
3 ESPLANADE	240697/1	EXCHANGE	62.5957	62.828	62.824	62.832	0.236	1.000	0.536	1
3 FOSTER ST	128977/1	HOTEL	62.9276	62.357	62.082	62.749	-0.179		0.121	1
3 LATROBE RD	118540/1	HOUSE	62.38	61.462	61.457	61.473	-0.907		-0.607	
3 MORRISON ST	81952/3	HOUSE	63.34	63.301	63.105	63.381	0.041	1.000	0.341	1
30 CROCKERS ST	79388/4	HOUSE	#N/A	64.105	64.105	64.105				
31 CROCKERS ST	79247/2	HOUSE	#N/A	65.774	65.774	65.774				
32 MORRISON ST	120656/1	HOUSE	#N/A	67.962	67.921	68.035				
32 MORRISON ST	222007/1	HOUSE	68.9577	68.323	67.968	68.717	-0.241		0.059	1
35 MORRISON ST	40640/27	HOUSE	68.6753	68.206	67.673	68.377	-0.298		0.002	1
38 FOSTER ST	40640/2		#N/A	66.517	66.515	66.544				
38 MORRISON ST	230106/4	HOUSE	69.0748	68.769	68.594	68.873	-0.202		0.098	1
39 MORRISON ST	40640/26	HOUSE	69.2498	68.382	67.769	68.875	-0.375		-0.075	
4 FOSTER ST	79774/1	HOUSE	63.14	62.828	62.817	62.843	-0.297		0.003	1
40 MORRISON ST	74775/1	HOUSE	69.5051	68.844	68.751	69.112	-0.393		-0.093	
42 MORRISON ST	215827/2	House	69.14	69.005	68.801	69.292	0.152	1.000	0.452	1
43 MORRISON ST	40640/24	HOUSE	#N/A	68.860	68.679	69.212				
43 MORRISON ST	40640/25	HOUSE	69.4272	68.630	68.308	69.066	-0.361		-0.061	
44 MORRISON ST	215720/3	House	69.9407	69.311	69.071	69.588	-0.353		-0.053	
4-6 LATROBE RD	81417/1	HOUSE	60.7	60.463	60.257	60.673	-0.027		0.273	1
4-6 LATROBE RD	81417/2	HOUSE	#N/A	60.391	60.304	60.486				
47 MORRISON ST	40640/22	HOUSE	70.4696	69.320	68.997	69.793	-0.677		-0.377	
5 CROCKERS ST	161462/1	House	#N/A	63.979	63.929	64.021				
5 ESPLANADE	155469/1	House	62.4765	62.831	62.828	62.835	0.358	1.000	0.658	1
5 MORRISON ST	127081/2	HOUSE	63.88	63.238	62.993	63.450	-0.430		-0.130	
51 MORRISON ST	40640/21	HOUSE	70.0657	69.468	69.023	70.101	0.035	1.000	0.335	1
52 FOSTER ST	40640/9	CLUB	71.9913	68.277	68.277	68.277	-3.714		-3.414	
52 MORRISON ST	204677/1	HOUSE	71.0595	70.272	69.984	70.692	-0.367		-0.067	
53 MORRISON ST	153676/1	Dwelling	70.7025	70.182	69.232	70.890	0.187	1.000	0.487	1
55 MORRISON ST	153676/2	Dwelling	71.5864	70.859	70.243	71.281	-0.305		-0.005	
56 FOSTER ST	40640/11	HOUSE	72.1992	67.238	67.238	67.238	-4.961		-4.661	
58 FOSTER ST	40640/12	HOUSE	71.9429	67.839	67.238	68.429	-3.514		-3.214	
6 FOSTER ST	79774/2	HOUSE	63.2	62.833	62.817	62.843	-0.357		-0.057	
60 FOSTER ST	240626/1	HOUSE	70.6266	68.969	68.717	69.078	-1.549		-1.249	
62 FOSTER ST	40640/13	HOUSE	70.0032	69.161	68.938	69.540	-0.463		-0.163	
64 FOSTER ST	40640/14	House	69.8524	69.534	69.159	69.975	0.123	1.000	0.423	1
66 FOSTER ST	40640/15	HOUSE	70.7161	69.956	69.640	70.191	-0.525		-0.225	
6A LATROBE RD	100717/1	House	60.01	60.502	59.868	61.833	1.823	1.000	2.123	1
7 CROCKERS ST	161462/2	Vacant land	#N/A	64.043	63.992	64.117				
7 FOSTER ST	246358/3	SHOP HOUSE	63.1491	62.453	62.337	62.760	-0.389		-0.089	
7 KIMBERLEY RD	83111/2	HALL	#N/A	62.513	62.498	62.522				
7 KIMBERLEY RD	83111/3	HALL	63.2405	62.534	62.524	62.540	-0.700		-0.400	
7 MORRISON ST	81952/1	HOUSE	64.43	63.512	63.392	63.879	-0.551		-0.251	
70 FOSTER ST	40640/16	HOUSE	#N/A	70.225	69.983	70.476				
70 FOSTER ST	40640/17	HOUSE	70.7661	70.507	70.200	70.669	-0.097		0.203	1
72 FOSTER ST	40640/18	HOUSE	70.9946	70.710	70.496	70.846	-0.149		0.151	1
74 FOSTER ST	40640/19	House	71.6281	70.972	70.709	71.215	-0.413		-0.113	
78 FOSTER ST	49544/5	HOUSE	#N/A	71.576	71.420	71.636				
79 CALDER ST	14469/1	House	69.4858	68.889	68.615	68.981	-0.505		-0.205	
8 CROCKERS ST	144440/2	House	63.9744	63.258	62.841	63.789	-0.185		0.115	1
8 FOSTER ST	248634/1	PLAY GROUP CENTRE	#N/A	62.833	62.818	62.843				
8 LATROBE RD	81497/1	HOUSE	#N/A	60.542	60.270	60.655				
8 NEW BED RD	34958/1	HOUSE & SHEDS	#N/A	72.426	71.023	74.642				
80 FOSTER ST	217893/1	HOUSE	73.09	71.783	71.636	71.854	-1.236		-0.936	
9 CROCKERS ST	60290/37	HOUSE	#N/A	64.336	64.005	64.889				
9 DOWBIGGIN ST	219805/1	HOUSE	72.0821	71.483	71.420	71.536	-0.546		-0.246	
9 ESPLANADE	60290/16		#N/A	62.855	62.829	62.994				
9 GIBLIN ST	40640/1	HOUSE	#N/A	66.654	66.515	66.803				
9 GIBLIN ST	60290/48	HOUSE	#N/A	67.338	66.888	67.955				
9 GIBLIN ST	60290/49	HOUSE	#N/A	67.352	66.742	67.994				
9 GIBLIN ST	60290/50	HOUSE	67.68	66.830	66.742	67.399	-0.281		0.019	1
9 KIMBERLEY RD	143878/2	Dwelling	63.05	62.429	62.206	63.175	0.125	1.000	0.425	1

9 LATROBE RD	243127/1	Dwelling	61.15	60.870	60.870	60.870	-0.280		0.020	1
9 MORRISON ST	60290/3	HOUSE	64.76	63.882	63.520	64.219	-0.541		-0.241	
ESPLANADE	155469/2	WORKSHOP	62.2701	62.831	62.827	62.839	0.569	1.000	0.869	1
ESPLANADE	43485/1	GROUND IMPROVEMENTS	#N/A	62.825	62.799	62.831				
ESPLANADE	43485/2	GROUND IMPROVEMENTS	#N/A	62.442	61.821	62.911				
FOSTER ST	128977/2	PUMP HOUSE PASTURE	#N/A	62.614	62.554	62.671				
FOSTER ST	16794/1		#N/A	62.376	62.234	62.601				
GIBLIN ST	148657/4		#N/A	66.420	65.843	66.655				
KING ST	8882/1	Sewerage Treatment	61.2	60.493	59.938	60.802	-0.398		-0.098	
LATROBE RD	198825/1	GARAGE	#N/A	60.919	60.868	61.597				
MORRISON ST	229914/1		#N/A	69.867	69.353	70.718				
								18		**42**

50 Year ARI Event

ADDRESS	CT REF	IMPROVEMENT	FLOOR HEIGHT	MEAN_FLOOD	MIN_FLOOD	MAX_FLOOD	Max Flood - Floor		Max Flood - Floor	
1 KIMBERLEY RD	22129/3	HOUSE	63.69	63.176	62.850	63.611	-0.079		0.221	1
1 MORRISON ST	60290/1	HOUSE	63.32	63.115	63.005	63.411	0.091	1.000	0.391	1
10 CROCKERS ST	144440/1	House incomplete	63.9704	63.426	62.957	63.910	-0.060		0.240	1
10 FOSTER ST	246742/1		#N/A	62.953	62.927	63.253				
10 GIBLIN ST	216909/38	GARAGE	#N/A	65.971	65.328	66.632				
10 KIMBERLEY RD	158986/2	House	63.97	64.208	63.719	64.960	0.990	1.000	1.290	1
10 MORRISON ST	222566/1		#N/A	63.421	63.418	63.440				
1099 NATIVE PLAINS RD	109761/4	FARM IMP	#N/A	56.593	56.543	57.180				
11 CROCKERS ST	60290/35	FIRE STATION	64.6	64.725	64.223	64.979	0.379	1.000	0.679	1
11 ESPLANADE	219852/17	HOUSE	63.266	63.054	62.959	63.261	-0.005		0.295	1
11 KIMBERLEY RD	143878/1	HOUSE	63.5	63.177	62.948	63.429	-0.071		0.229	1
11 MORRISON ST	61512/1	HOUSE	64.885	64.154	63.888	64.525	-0.360		-0.060	
11-13 FOSTER ST	216903/1	SHOP	63.2523	63.190	63.115	63.269	0.017	1.000	0.317	1
11-13 LATROBE RD	232854/2	HOUSE	#N/A	60.977	60.976	60.977				
11-13 LATROBE RD	55819/3	HOUSE	#N/A	60.977	60.976	60.978				
12 CROCKERS ST	210547/1	HOUSE	64.1619	63.274	62.924	63.871	-0.291		0.009	1
12 FOSTER ST	202156/1	Shop	#N/A	63.024	62.954	63.220				
12 FOSTER ST	241656/1	Shop	63.5116	63.484	63.484	63.484	-0.028		0.272	1
12 GIBLIN ST	215051/36	HOUSE	66.78	65.287	64.967	65.607	-1.173		-0.873	
12 KING ST	100717/2	HOUSE	#N/A	60.390	59.996	60.421				
12 MORRISON ST	79388/1	House	64.5819	63.660	63.660	63.660	-0.922		-0.622	
13 CROCKERS ST	60290/26	5 Dwellings & Garage	66.52	65.966	65.644	66.453	-0.067		0.233	1
13 CROCKERS ST	60290/27	5 Dwellings & Garage	67.14	66.487	66.063	66.964	-0.176		0.124	1
13 CROCKERS ST	60290/28	5 Dwellings & Garage	66.63	65.947	65.476	66.545	-0.085		0.215	1
13 CROCKERS ST	60290/30	5 Dwellings & Garage	67.24	65.782	65.304	66.485	-0.755		-0.455	
13 CROCKERS ST	60290/32	5 Dwellings & Garage	66.34	65.753	65.073	66.475	0.135	1.000	0.435	1
13 CROCKERS ST	60290/33	5 Dwellings & Garage	64.9	64.827	64.362	65.183	0.283	1.000	0.583	1
13 CROCKERS ST	60290/34	5 Dwellings & Garage	66.95	65.485	64.936	66.218	-0.732		-0.432	
14 CROCKERS ST	60290/8	HOUSE	64.3582	63.496	63.075	64.054	-0.304		-0.004	
14 KIMBERLEY RD	60699/1	HOUSE	63.95	63.795	63.672	63.910	-0.040		0.260	1
14 MORRISON ST	79388/2	HOUSE	65.2608	64.008	63.903	64.151	-1.110		-0.810	
14A DOWBIGGIN ST	133335/2	HOUSE	71.52	69.031	68.010	70.866	-0.654		-0.354	
14A KIMBERLEY RD	158986/3	Houser	65.0903	64.289	63.696	64.842	-0.248		0.052	1
15 ESPLANADE	127081/1	House	63.4345	63.017	63.004	63.078	-0.357		-0.057	
15 KIMBERLEY RD	214459/1	HOUSE	63.51	62.939	62.922	62.956	-0.554		-0.254	
15 MORRISON ST	63535/1	HOUSE	64.9199	64.263	64.014	64.752	-0.168		0.132	1
16 CROCKERS ST	83096/3	HOUSE	64.2624	63.828	63.613	64.112	-0.150		0.150	1
16 FOSTER ST	220495/1	2 SHOPS + FLAT	63.8651	63.334	62.961	63.797	-0.068		0.232	1
16 MORRISON ST	79388/5	HOUSE	65.3676	64.775	64.190	65.028	-0.340		-0.040	
17 CROCKERS ST	60290/29	HOUSE	#N/A	64.913	64.474	65.591				
17 CROCKERS ST	60290/31	HOUSE	#N/A	64.862	64.389	65.331				
17 FOSTER ST	243026/1	SHOP	63.7878	63.536	63.314	63.717	-0.071		0.229	1
17 KIMBERLEY RD	16794/2	HOUSE & UNIT	63.05	62.823	62.433	63.113	0.063	1.000	0.363	1
17 MORRISON ST	72957/1	HOUSE	64.9389	64.416	64.130	64.821	-0.118		0.182	1
18 CROCKERS ST	83096/2	HOUSE	64.2807	63.907	63.729	64.153	-0.128		0.172	1
18 MORRISON ST	79388/6	HOUSE	65.3933	64.917	64.459	65.055	-0.338		-0.038	
18-20 FOSTER ST	222258/17	SHOP	64.2915	64.026	64.002	64.533	0.241	1.000	0.541	1
19 KIMBERLEY RD	226538/1	HOUSE	63.27	61.957	61.487	62.263	-1.007		-0.707	
19AD CROCKERS ST	60290/24	4 HOME UNITS	65.27	64.755	64.501	65.334	0.064	1.000	0.364	1
19AD CROCKERS ST	60290/25	4 HOME UNITS	#N/A	65.501	64.629	65.860				
2 FOSTER ST	12259/1	PST OFF. SHP & HOUSE	62.687	62.913	62.901	62.935	0.248	1.000	0.548	1
2 LATROBE RD	118540/2	HOUSE	62.16	61.625	61.274	62.146	-0.014		0.286	1
20 CROCKERS ST	221612/1	HOUSE	64.3808	63.989	63.829	64.161	-0.220		0.080	1
20 MORRISON ST	79388/7	HOUSE	65.5413	65.080	64.699	65.282	-0.259		0.041	1
21 FOSTER ST	155084/1	TOILETS	#N/A	63.998	63.778	64.102				

22 CROCKERS ST	61512/2	HOUSE	63.3366	63.569	63.198	64.119	0.782	1.000	1.082	1
22 FOSTER ST	216657/41	HOUSE	#N/A	64.357	64.009	64.708				
22 MORRISON ST	231659/1	HOUSE	66.2327	66.006	65.418	66.605	0.372	1.000	0.672	1
23 FOSTER ST	217333/88	HOUSE	64.5423	64.138	64.064	64.346	-0.196		0.104	1
23 KIMBERLEY RD	54960/1	HOUSE	#N/A	61.487	61.487	61.487				
24 FOSTER ST	60290/42	HOUSE POLICE STATION	#N/A	64.746	64.328	65.166				
25 CROCKERS ST	79247/4	HOUSE	#N/A	65.739	65.514	65.826				
25 CROCKERS ST	79247/5	HOUSE	65.89	65.460	65.161	65.789	-0.101		0.199	1
25 KIMBERLEY RD	225195/1	HOUSE	#N/A	61.487	61.487	61.487				
2-6 CROCKERS ST	241657/1		#N/A	63.081	62.941	63.752				
26 MORRISON ST	217184/1	HOUSE	67.6528	66.724	66.225	67.456	-0.197		0.103	1
26-28 FOSTER ST	132434/1	SERVICE STATION	65.21	65.194	64.671	65.670	0.460	1.000	0.760	1
27 CROCKERS ST	79247/3	HOUSE	66.3	65.778	65.734	65.830	-0.470		-0.170	
27 FOSTER ST	60290/89	House	64.6241	64.219	64.139	64.574	-0.050		0.250	1
27 KIMBERLEY RD	206306/1	HOUSE	#N/A	61.487	61.487	61.487				
28 MORRISON ST	120655/1	HOUSE	68.3967	67.884	67.445	67.996	-0.401		-0.101	
3 ESPLANADE	240697/1	EXCHANGE	62.5957	62.923	62.912	62.939	0.343	1.000	0.643	1
3 FOSTER ST	128977/1	HOTEL	62.9276	62.896	62.667	63.849	0.921	1.000	1.221	1
3 KIMBERLEY RD	83111/1	HOUSE	63.71	63.248	62.947	63.601	-0.109		0.191	1
3 LATROBE RD	118540/1	HOUSE	62.38	61.547	61.496	61.598	-0.782		-0.482	
3 MORRISON ST	81952/3	HOUSE	63.34	63.323	63.107	63.420	0.080	1.000	0.380	1
30 CROCKERS ST	79388/4	HOUSE	#N/A	64.626	64.150	65.101				
30 FOSTER ST	60290/45	House	65.884	65.555	65.337	65.997	0.113	1.000	0.413	1
31 CROCKERS ST	79247/2	HOUSE	#N/A	65.803	65.777	65.830				
31 FOSTER ST	60290/90	HOUSE	65.215	64.319	64.187	64.712	-0.503		-0.203	
32 MORRISON ST	120656/1	HOUSE	#N/A	67.999	67.894	68.042				
32 MORRISON ST	222007/1	HOUSE	68.9577	68.345	68.010	68.912	-0.046		0.254	1
32-34 FOSTER ST	216485/3	WORKSHOP	#N/A	65.990	65.932	66.023				
32-34 FOSTER ST	221486/1	WORKSHOP	#N/A	65.567	65.389	65.856				
32-34 FOSTER ST	221545/2	WORKSHOP	65.9987	65.855	65.548	66.001	0.002	1.000	0.302	1
33 FOSTER ST	60290/91	SHOP	65.116	64.554	64.339	64.920	-0.196		0.104	1
35 FOSTER ST	60290/92	HOUSE	65.0643	64.770	64.509	65.008	-0.056		0.244	1
35 MORRISON ST	40640/27	HOUSE	68.6753	68.221	67.581	68.442	-0.233		0.067	1
37 FOSTER ST	60290/93	HOUSE	65.6943	64.939	64.870	65.138	-0.556		-0.256	
38 FOSTER ST	40640/2		#N/A	66.698	66.383	67.124				
38 FOSTER ST	40640/3		#N/A	66.338	66.052	66.460				
38 MORRISON ST	230106/4	HOUSE	69.0748	68.807	68.622	68.912	-0.163		0.137	1
39 FOSTER ST	85938/1	SHOP	65.6057	65.086	64.876	65.433	-0.173		0.127	1
39 MORRISON ST	40640/26	HOUSE	69.2498	68.438	67.759	68.935	-0.315		-0.015	
4 FOSTER ST	79774/1	HOUSE	63.14	62.928	62.906	62.952	-0.188		0.112	1
4 MORRISON ST	57997/1	House	64.1869	63.418	63.418	63.418	-0.769		-0.469	
40 FOSTER ST	40640/4	HOUSE	67.8303	66.638	66.440	67.036	-0.794		-0.494	
40 MORRISON ST	74775/1	HOUSE	69.5051	68.895	68.796	69.140	-0.365		-0.065	
42 MORRISON ST	215827/2	House	69.14	69.049	68.859	69.356	0.216	1.000	0.516	1
43 FOSTER ST	138691/1	HOUSE	66.18	65.333	64.839	66.285	0.105	1.000	0.405	1
43 MORRISON ST	40640/24	HOUSE	#N/A	68.889	68.697	69.251				
43 MORRISON ST	40640/25	HOUSE	69.4272	68.670	68.374	69.088	-0.339		-0.039	
44 FOSTER ST	40640/5	HOUSE	68.92	66.980	66.395	67.161	-1.759		-1.459	
44 MORRISON ST	215720/3	House	69.9407	69.354	69.097	69.641	-0.300			
46 FOSTER ST	40640/6	HOUSE	69.14	67.190	67.017	67.344	-1.796		-1.496	
4-6 LATROBE RD	81417/1	HOUSE	60.7	60.573	60.423	60.809	0.109	1.000	0.409	1
4-6 LATROBE RD	81417/2	HOUSE	#N/A	60.574	60.495	60.702				
47 MORRISON ST	40640/22	HOUSE	70.4696	69.433	69.054	69.829	-0.641		-0.341	
48 FOSTER ST	40640/7	House	68.85	67.377	67.184	67.738	-1.112		-0.812	
5 CROCKERS ST	161462/1	House	#N/A	64.071	64.010	64.136				
5 ESPLANADE	155469/1	House	62.4765	62.923	62.918	62.929	0.453	1.000	0.753	
5 MORRISON ST	127081/2	HOUSE	63.88	63.259	63.017	63.469	-0.411		-0.111	
50 FOSTER ST	40640/8	HOUSE	71.6768	67.856	67.332	68.161	-3.516		-3.216	
51 MORRISON ST	40640/21	HOUSE	70.0657	69.618	69.162	70.227	0.161	1.000	0.461	1
52 FOSTER ST	40640/9	CLUB	71.9913	68.335	68.084	68.603	-3.388		-3.088	
52 MORRISON ST	204677/1	HOUSE	71.0595	70.299	70.043	70.715	-0.345		-0.045	
53 MORRISON ST	153676/1	Dwelling	70.7025	70.292	69.303	70.923	0.220	1.000	0.520	1
54 FOSTER ST	40640/10	HOUSE	72.1168	68.588	68.166	68.661	-3.456		-3.156	
55 MORRISON ST	153676/2	Dwelling	71.5864	71.000	70.324	71.294	-0.292		0.008	1
56 FOSTER ST	40640/11	HOUSE	72.1992	68.631	68.342	68.670	-3.529		-3.229	
58 FOSTER ST	40640/12	HOUSE	71.9429	68.651	68.342	68.841	-3.102		-2.802	
6 FOSTER ST	79774/2	HOUSE	63.2	62.941	62.909	62.963	-0.237		0.063	1
6 GIBLIN ST	215765/1	HOUSE	66.3422	65.957	65.607	66.298	-0.044		0.256	1
6 KIMBERLEY RD	148660/1	House	64.2946	63.985	63.745	64.126	-0.169		0.131	1
6 MORRISON ST	221030/1	Main building	63.9123	63.418	63.418	63.419	-0.493		-0.193	
60 FOSTER ST	240626/1	HOUSE	70.6266	69.171	68.844	69.317	-1.310		-1.010	
62 FOSTER ST	40640/13	HOUSE	70.0032	69.294	68.932	69.588	-0.415		-0.115	

64 FOSTER ST	40640/14	House	69.8524	69.721	69.384	70.205	0.353	1.000	0.653	1
66 FOSTER ST	40640/15	HOUSE	70.7161	70.153	69.979	70.457	-0.259		0.041	1
6A LATROBE RD	100717/1	House	60.01	60.749	59.989	62.334	2.324	1.000	2.624	1
7 CROCKERS ST	161462/2	Vacant land	#N/A	64.785	64.080	65.288				
7 FOSTER ST	246358/3	SHOP HOUSE	63.1491	63.064	62.730	63.816	0.667	1.000	0.967	1
7 KIMBERLEY RD	83111/2	HALL	#N/A	63.102	62.918	63.541				
7 KIMBERLEY RD	83111/3	HALL	63.2405	63.216	62.996	63.481	0.240	1.000	0.540	1
7 KIMBERLEY RD	83111/4	HALL	#N/A	63.304	63.294	63.310				
7 MORRISON ST	81952/1	HOUSE	64.43	63.513	63.433	63.904	-0.526		-0.226	
70 FOSTER ST	40640/16	HOUSE	#N/A	70.409	70.187	70.662				
70 FOSTER ST	40640/17	HOUSE	70.7661	70.601	70.417	70.752	-0.014		0.286	1
72 FOSTER ST	40640/18	HOUSE	70.9946	70.814	70.578	71.066	0.071	1.000	0.371	1
74 FOSTER ST	40640/19	House	71.6281	71.073	70.762	71.414	-0.214		0.086	1
78 FOSTER ST	49544/5	HOUSE	#N/A	71.591	71.513	71.643				
79 CALDER ST	14469/1	House	69.4858	68.949	68.690	69.431	-0.055		0.245	1
8 CROCKERS ST	144440/2	House	63.9744	63.361	62.944	63.910	-0.064		0.236	1
8 FOSTER ST	248634/1	PLAY GROUP CENTRE	#N/A	62.939	62.929	62.963				
8 GIBLIN ST	202912/1	HOUSE	66.4512	66.274	65.625	66.594	0.143	1.000	0.443	1
8 LATROBE RD	81497/1	HOUSE	#N/A	60.586	60.401	60.709				
8 NEW BED RD	34958/1	HOUSE & SHEDS	#N/A	72.493	71.041	74.974				
80 FOSTER ST	217893/1	HOUSE	73.09	71.788	71.643	71.859	-1.231		-0.931	
9 CROCKERS ST	60290/37	HOUSE	#N/A	64.498	64.089	65.249				
9 DOWBIGGIN ST	219805/1	HOUSE	72.0821	71.560	71.513	71.602	-0.480		-0.180	
9 ESPLANADE	60290/16		#N/A	62.930	62.918	63.005				
9 FOSTER ST	243025/1	SURGERY	63.2058	62.957	62.802	63.125	-0.081		0.219	1
9 GIBLIN ST	40640/1	HOUSE	#N/A	67.186	66.763	67.939				
9 GIBLIN ST	60290/48	HOUSE	#N/A	67.538	66.899	68.003				
9 GIBLIN ST	60290/49	HOUSE	#N/A	67.389	66.770	68.015				
9 GIBLIN ST	60290/50	HOUSE	67.68	67.126	66.771	67.857	0.177	1.000	0.477	1
9 KIMBERLEY RD	143878/2	Dwelling	63.05	63.455	62.898	67.088	4.038	1.000	4.338	1
9 LATROBE RD	243127/1	Dwelling	61.15	60.976	60.975	60.979	-0.171		0.129	1
9 MORRISON ST	60290/3	HOUSE	64.76	63.898	63.537	64.261	-0.499		-0.199	
ESPLANADE	155469/2	WORKSHOP	62.2701	62.927	62.917	62.944	0.674	1.000	0.974	1
ESPLANADE	43485/1	GROUND IMPROVEMENTS	#N/A	62.912	62.862	62.946				
ESPLANADE	43485/2	GROUND IMPROVEMENTS	#N/A	62.511	61.865	62.951				
FOSTER ST	128977/2	PUMP HOUSE PASTURE	#N/A	63.680	63.601	63.725				
FOSTER ST	16794/1		#N/A	62.611	62.358	62.713				
GIBLIN ST	148657/4		#N/A	66.303	65.916	66.670				
KIMBERLEY RD	16794/3		#N/A	62.054	61.487	62.606				
KING ST	8882/1	Sewerage Treatment	61.2	60.032	59.206	61.517	0.317	1.000	0.617	1
LATROBE RD	198825/1	GARAGE	#N/A	61.019	60.966	61.601				
MORRISON ST	229914/1		#N/A	69.927	69.369	70.790				
								34		**76**

100 Year Flood Record Event

ADDRESS	CT REF	IMPROVEMENT	FLOOR HEIGHT	MEAN_FLOOD	MIN_FLOOD	MAX_FLOOD	Max flood - floor		Max flood + 0.3 - floor	
1 KIMBERLEY RD	22129/3	HOUSE	63.69	63.440	63.048	63.926	0.236	1	0.536	1
1 MORRISON ST	60290/1	HOUSE	63.32	63.136	63.030	63.457	0.137	1	0.437	1
10 CROCKERS ST	144440/1	House incomplete	63.9704	63.556	63.087	64.010	0.040	1	0.340	1
10 FOSTER ST	246742/1		#N/A	63.060	63.025	63.345				
10 GIBLIN ST	216909/38	GARAGE	#N/A	66.051	65.336	66.682				
10 KIMBERLEY RD	158986/2	House	63.97	64.457	63.847	65.248	1.278	1	1.578	1
10 MORRISON ST	222566/1		#N/A	63.469	63.468	63.470				
1099 NATIVE PLAINS RD	109761/4	FARM IMP	#N/A	57.805	56.823	61.471				
11 CROCKERS ST	60290/35	FIRE STATION	64.6	64.800	64.264	65.053	0.453	1	0.753	1
11 ESPLANADE	219852/17	HOUSE	63.266	63.075	63.004	63.281	0.015	1	0.315	1
11 KIMBERLEY RD	143878/1	HOUSE	63.5	63.312	63.170	63.530	0.030	1	0.330	1
11 MORRISON ST	61512/1	HOUSE	64.885	64.177	63.899	64.587	-0.298		0.002	1
11-13 FOSTER ST	216903/1	SHOP	63.2523	63.261	63.183	63.353	0.101	1	0.401	1
11-13 LATROBE RD	232854/2	HOUSE	#N/A	61.086	61.084	61.087				
11-13 LATROBE RD	55819/3	HOUSE	#N/A	61.086	61.084	61.087				
12 CROCKERS ST	210547/1	HOUSE	64.1619	63.351	63.012	63.991	-0.171		0.129	1
12 FOSTER ST	202156/1	Shop	#N/A	63.137	63.080	63.311				
12 FOSTER ST	241656/1	Shop	63.5116	63.615	63.615	63.615	0.103	1	0.403	1
12 GIBLIN ST	215051/36	HOUSE	66.78	65.790	65.109	66.579	-0.201		0.099	1
12 KING ST	100717/2	HOUSE	#N/A	60.870	60.606	61.887				
12 MORRISON ST	79388/1	House	64.5819	63.677	63.677	63.677	-0.905		-0.605	
13 CROCKERS ST	60290/26	5 Dwellings & Garage	66.52	65.998	65.663	66.532	0.012	1	0.312	1
13 CROCKERS ST	60290/27	5 Dwellings & Garage	67.14	66.530	66.100	67.029	-0.111		0.189	1
13 CROCKERS ST	60290/28	5 Dwellings & Garage	66.63	65.979	65.498	66.566	-0.064		0.236	1
13 CROCKERS ST	60290/30	5 Dwellings & Garage	67.24	65.901	65.334	66.696	-0.544		-0.244	

13 CROCKERS ST	60290/32	5 Dwellings & Garage	66.34	65.841	65.136	66.591	0.251	1	0.551	1
13 CROCKERS ST	60290/33	5 Dwellings & Garage	64.9	64.873	64.382	65.220	0.320	1	0.620	1
13 CROCKERS ST	60290/34	5 Dwellings & Garage	66.95	65.710	65.045	66.534	-0.416		-0.116	
14 CROCKERS ST	60290/8	HOUSE	64.3582	63.527	63.095	64.085	-0.273		0.027	1
14 KIMBERLEY RD	60699/1	HOUSE	63.95	63.932	63.769	64.151	0.201	1	0.501	1
14 MORRISON ST	79388/2	HOUSE	65.2608	64.025	63.910	64.171	-1.090		-0.790	
14A DOWBIGGIN ST	133335/2	HOUSE	71.52	69.075	68.058	70.884	-0.636		-0.336	
14A KIMBERLEY RD	158986/3	Houser	65.0903	64.431	63.810	64.897	-0.193		0.107	1
15 ESPLANADE	127081/1	House	63.4345	63.037	63.031	63.076	-0.358		-0.058	
15 KIMBERLEY RD	214459/1	HOUSE	63.51	63.244	63.119	63.376	-0.134		0.166	1
15 MORRISON ST	63535/1	HOUSE	64.9199	64.282	64.027	64.795	-0.125		0.175	1
16 CROCKERS ST	83096/3	HOUSE	64.2624	63.860	63.650	64.153	-0.109		0.191	1
16 FOSTER ST	220495/1	2 SHOPS + FLAT	63.8651	63.393	63.085	63.903	0.038	1	0.338	1
16 KING ST	231453/1	House	#N/A	61.264	60.998	61.670				
16 MORRISON ST	79388/5	HOUSE	65.3676	64.788	64.235	65.036	-0.332		-0.032	
17 CROCKERS ST	60290/29	HOUSE	#N/A	64.944	64.499	65.614				
17 CROCKERS ST	60290/31	HOUSE	#N/A	64.884	64.402	65.352				
17 FOSTER ST	243026/1	SHOP	63.7878	63.597	63.273	63.911	0.123	1	0.423	1
17 KIMBERLEY RD	16794/2	HOUSE & UNIT	63.05	63.011	62.647	63.534	0.484	1	0.784	1
17 MORRISON ST	72957/1	HOUSE	64.9389	64.453	64.178	64.894	-0.045		0.255	1
18 CROCKERS ST	83096/2	HOUSE	64.2807	63.948	63.773	64.214	-0.067		0.233	1
18 KING ST	64115/2	COTTAGE	62.86	60.489	60.243	61.027	-1.833		-1.533	
18 MORRISON ST	79388/6	HOUSE	65.3933	64.933	64.466	65.080	-0.313		-0.013	
18-20 FOSTER ST	222258/17	SHOP	64.2915	64.091	64.034	64.580	0.289	1	0.589	1
19 KIMBERLEY RD	226538/1	HOUSE	63.27	62.305	62.229	62.695	-0.575		-0.275	
19AD CROCKERS ST	60290/24	4 HOME UNITS	65.27	64.791	64.536	65.360	0.090	1	0.390	1
19AD CROCKERS ST	60290/25	4 HOME UNITS	#N/A	65.520	64.656	65.882				
2 FOSTER ST	12259/1	PST OFF. SHP & HOUSE	62.687	62.984	62.949	63.031	0.344	1	0.644	1
2 LATROBE RD	118540/2	HOUSE	62.16	61.759	61.360	62.271	0.111	1	0.411	1
20 CROCKERS ST	221612/1	HOUSE	64.3808	64.043	63.870	64.253	-0.128		0.172	1
20 MORRISON ST	79388/7	HOUSE	65.5413	65.119	64.745	65.324	-0.217		0.083	1
21 FOSTER ST	155084/1	TOILETS	#N/A	64.117	63.844	64.212				
22 CROCKERS ST	61512/2	HOUSE	63.3366	63.599	63.223	64.191	0.854	1	1.154	1
22 FOSTER ST	216657/41	HOUSE	#N/A	64.431	64.091	64.791				
22 MORRISON ST	231659/1	HOUSE	66.2327	66.040	65.387	66.607	0.374	1	0.674	1
23 FOSTER ST	217333/88	HOUSE	64.5423	64.265	64.157	64.606	0.064	1	0.364	1
23 KIMBERLEY RD	54960/1	HOUSE	#N/A	62.232	62.228	62.239				
24 FOSTER ST	60290/42	HOUSE POLICE STATION	#N/A	64.793	64.338	65.231				
25 CROCKERS ST	79247/4	HOUSE	#N/A	65.781	65.559	65.875				
25 CROCKERS ST	79247/5	HOUSE	65.89	65.480	65.193	65.815	-0.075		0.225	1
25 KIMBERLEY RD	225195/1	HOUSE	#N/A	62.232	62.229	62.241				
2-6 CROCKERS ST	241657/1		#N/A	63.199	63.045	63.837				
26 MORRISON ST	217184/1	HOUSE	67.6528	66.760	66.282	67.491	-0.162		0.138	1
26-28 FOSTER ST	132434/1	SERVICE STATION	65.21	65.253	64.789	65.661	0.451	1	0.751	1
27 CROCKERS ST	79247/3	HOUSE	66.3	65.825	65.775	65.881	-0.419		-0.119	
27 FOSTER ST	60290/89	House	64.6241	64.336	64.277	64.795	0.171	1	0.471	1
27 KIMBERLEY RD	206306/1	HOUSE	#N/A	62.233	62.216	62.243				
27 KIMBERLEY RD	206307/1	HOUSE	#N/A	62.194	62.145	62.233				
28 MORRISON ST	120655/1	HOUSE	68.3967	67.914	67.478	68.038	-0.359		-0.059	
3 ESPLANADE	240697/1	EXCHANGE	62.5957	63.014	62.985	63.045	0.449	1	0.749	1
3 FOSTER ST	128977/1	HOTEL	62.9276	63.200	62.888	64.192	1.264	1	1.564	1
3 KIMBERLEY RD	83111/1	HOUSE	63.71	63.424	63.072	63.831	0.121	1	0.421	1
3 LATROBE RD	118540/1	HOUSE	62.38	61.606	61.454	61.695	-0.685		-0.385	
3 MORRISON ST	81952/3	HOUSE	63.34	63.355	63.104	63.469	0.129	1	0.429	1
30 CROCKERS ST	79388/4	HOUSE	#N/A	64.663	64.186	65.141				
30 FOSTER ST	60290/45	House	65.884	65.622	65.409	66.058	0.174	1	0.474	1
31 CROCKERS ST	79247/2	HOUSE	#N/A	65.844	65.825	65.863				
31 FOSTER ST	60290/90	HOUSE	65.215	64.448	64.319	64.944	-0.271		0.029	1
32 MORRISON ST	120656/1	HOUSE	#N/A	68.043	67.918	68.084				
32 MORRISON ST	222007/1	HOUSE	68.9577	68.380	68.060	68.951	-0.007		0.293	1
32-34 FOSTER ST	216485/3	WORKSHOP	#N/A	66.134	66.093	66.161				
32-34 FOSTER ST	221486/1	WORKSHOP	#N/A	65.666	65.525	65.968				
32-34 FOSTER ST	221545/2	WORKSHOP	65.9987	65.962	65.587	66.158	0.159	1	0.459	1
33 FOSTER ST	60290/91	SHOP	65.116	64.662	64.450	65.099	-0.017		0.283	1
35 FOSTER ST	60290/92	HOUSE	65.0643	64.898	64.583	65.109	0.045	1	0.345	1
35 MORRISON ST	40640/27	HOUSE	68.6753	68.263	67.684	68.517	-0.158		0.142	1
37 FOSTER ST	60290/93	HOUSE	65.6943	65.091	64.984	65.361	-0.333		-0.033	
38 FOSTER ST	40640/2		#N/A	66.880	66.534	67.391				
38 FOSTER ST	40640/3		#N/A	66.592	66.273	66.801				
38 MORRISON ST	230106/4	HOUSE	69.0748	68.845	68.658	68.952	-0.123		0.177	1
39 FOSTER ST	85938/1	SHOP	65.6057	65.214	65.014	65.510	-0.096		0.204	1
39 MORRISON ST	40640/26	HOUSE	69.2498	68.520	67.770	68.947	-0.303		-0.003	

4 FOSTER ST	79774/1	HOUSE	63.14	63.020	62.983	63.083	-0.057		0.243	1
4 LEAKE ST	38247/1	House	#N/A	69.576	69.576	69.576				
4 MORRISON ST	57997/1	House	64.1869	63.467	63.467	63.467	-0.720		-0.420	
40 FOSTER ST	40640/4	HOUSE	67.8303	66.801	66.460	67.224	-0.606		-0.306	
40 MORRISON ST	74775/1	HOUSE	69.5051	68.938	68.835	69.167	-0.338		-0.038	
42 MORRISON ST	215827/2	House	69.14	69.087	68.901	69.391	0.251	1	0.551	1
43 FOSTER ST	138691/1	HOUSE	66.18	65.457	64.866	66.523	0.343	1	0.643	1
43 MORRISON ST	40640/24	HOUSE	#N/A	68.962	68.751	69.271				
43 MORRISON ST	40640/25	HOUSE	69.4272	68.741	68.484	69.136	-0.291		0.009	1
44 FOSTER ST	40640/5	HOUSE	68.92	67.203	66.640	67.443	-1.477		-1.177	
44 MORRISON ST	215720/3	House	69.9407	69.388	69.136	69.688	-0.253		0.047	1
46 FOSTER ST	40640/6	HOUSE	69.14	67.432	67.276	67.632	-1.508		-1.208	
4-6 LATROBE RD	81417/1	HOUSE	60.7	60.774	60.646	61.018	0.318	1	0.618	1
4-6 LATROBE RD	81417/2	HOUSE	#N/A	60.787	60.676	60.986				
47 MORRISON ST	40640/22	HOUSE	70.4696	69.587	69.206	69.982	-0.488		-0.188	
48 FOSTER ST	40640/7	House	68.85	67.566	67.399	67.909	-0.941		-0.641	
5 CROCKERS ST	161462/1	House	#N/A	64.221	64.087	64.472				
5 ESPLANADE	155469/1	House	62.4765	63.011	62.993	63.033	0.557	1	0.857	1
5 LATROBE RD	243865/1		#N/A	61.361	61.314	61.419				
5 MORRISON ST	127081/2	HOUSE	63.88	63.286	63.035	63.518	-0.362		-0.062	
50 FOSTER ST	40640/8	HOUSE	71.6768	67.995	67.551	68.273	-3.404		-3.104	
51 MORRISON ST	40640/21	HOUSE	70.0657	69.763	69.414	70.178	0.112	1	0.412	1
52 FOSTER ST	40640/9	CLUB	71.9913	68.454	68.079	68.721	-3.270		-2.970	
52 MORRISON ST	204677/1	HOUSE	71.0595	70.431	70.117	70.966	-0.093		0.207	1
53 MORRISON ST	153676/1	Dwelling	70.7025	70.377	69.501	70.959	0.256	1	0.556	1
54 FOSTER ST	40640/10	HOUSE	72.1168	68.742	68.110	68.860	-3.257		-2.957	
55 MORRISON ST	153676/2	Dwelling	71.5864	71.109	70.430	71.517	-0.069		0.231	1
56 FOSTER ST	40640/11	HOUSE	72.1992	68.802	68.320	68.873	-3.326		-3.026	
58 FOSTER ST	40640/12	HOUSE	71.9429	68.860	68.320	69.174	-2.769		-2.469	
6 FOSTER ST	79774/2	HOUSE	63.2	63.056	63.002	63.103	-0.097		0.203	1
6 GIBLIN ST	215765/1	HOUSE	66.3422	66.058	65.675	66.449	0.107	1	0.407	1
6 KIMBERLEY RD	148660/1	House	64.2946	64.118	63.857	64.324	0.029	1	0.329	1
6 MORRISON ST	221030/1	Main building	63.9123	63.467	63.466	63.470	-0.442		-0.142	
60 FOSTER ST	240626/1	HOUSE	70.6266	69.284	68.967	69.447	-1.180		-0.880	
62 FOSTER ST	40640/13	HOUSE	70.0032	69.459	69.115	69.849	-0.154		0.146	1
64 FOSTER ST	40640/14	House	69.8524	69.862	69.499	70.380	0.528	1	0.828	1
66 FOSTER ST	40640/15	HOUSE	70.7161	70.271	70.049	70.668	-0.048		0.252	1
69 FOSTER ST	159311/1	House	#N/A	69.892	69.576	70.327				
6A LATROBE RD	100717/1	House	60.01	60.918	60.133	62.475	2.465	1	2.765	1
7 CROCKERS ST	161462/2	Vacant land	#N/A	64.778	64.180	65.300				
7 FOSTER ST	246358/3	SHOP HOUSE	63.1491	63.340	62.932	64.198	1.049	1	1.349	1
7 KIMBERLEY RD	83111/2	HALL	#N/A	63.336	63.182	63.650				
7 KIMBERLEY RD	83111/3	HALL	63.2405	63.528	63.256	63.711	0.470	1	0.770	1
7 KIMBERLEY RD	83111/4	HALL	#N/A	63.714	63.560	63.799				
7 LATROBE RD	223226/1	HOUSE	61.64	61.132	61.075	61.275	-0.365		-0.065	
7 MORRISON ST	81952/1	HOUSE	64.43	63.553	63.463	63.838	-0.592		-0.292	
70 FOSTER ST	40640/16	HOUSE	#N/A	70.513	70.277	70.872				
70 FOSTER ST	40640/17	HOUSE	70.7661	70.699	70.451	70.867	0.101	1	0.401	1
72 FOSTER ST	40640/18	HOUSE	70.9946	70.952	70.633	71.363	0.368	1	0.668	1
74 FOSTER ST	40640/19	House	71.6281	71.209	70.868	71.616	-0.012		0.288	1
78 FOSTER ST	49544/5	HOUSE	#N/A	71.686	71.575	71.756				
79 CALDER ST	14469/1	House	69.4858	69.170	68.897	69.708	0.222	1	0.522	1
8 CROCKERS ST	144440/2	House	63.9744	63.472	63.053	64.010	0.036	1	0.336	1
8 FOSTER ST	248634/1	PLAY GROUP CENTRE	#N/A	63.045	63.026	63.096				
8 GIBLIN ST	202912/1	HOUSE	66.4512	66.325	65.763	66.671	0.220	1	0.520	1
8 LATROBE RD	81497/1	HOUSE	#N/A	60.708	60.615	60.833				
8 NEW BED RD	34958/1	HOUSE & SHEDS	#N/A	72.578	71.053	75.732				
80 FOSTER ST	217893/1	HOUSE	73.09	71.800	71.701	71.888	-1.202		-0.902	
82 FOSTER ST	122648/1	HOUSE	#N/A	72.143	72.062	72.225				
9 CROCKERS ST	60290/37	HOUSE	#N/A	64.639	64.182	65.261				
9 DOWBIGGIN ST	219805/1	HOUSE	72.0821	71.711	71.580	71.804	-0.278		0.022	1
9 ESPLANADE	60290/16		#N/A	63.009	62.999	63.025				
9 FOSTER ST	243025/1	SURGERY	63.2058	63.106	63.044	63.209	0.003	1	0.303	1
9 GIBLIN ST	40640/1	HOUSE	#N/A	67.300	66.862	68.043				
9 GIBLIN ST	60290/48	HOUSE	#N/A	67.569	66.981	68.043				
9 GIBLIN ST	60290/49	HOUSE	#N/A	67.409	66.843	68.055				
9 GIBLIN ST	60290/50	HOUSE	67.68	67.310	66.862	67.936	0.256	1	0.556	1
9 KIMBERLEY RD	143878/2	Dwelling	63.05	64.171	63.154	68.365	5.315	1	5.615	1
9 LATROBE RD	243127/1	Dwelling	61.15	61.086	61.075	61.146	-0.004		0.296	1
9 MORRISON ST	60290/3	HOUSE	64.76	63.920	63.556	64.303	-0.457		-0.157	
ESPLANADE	155469/2	WORKSHOP	62.2701	63.021	62.996	63.048	0.778	1	1.078	1
ESPLANADE	43485/1	GROUND IMPROVEMENTS	#N/A	62.983	62.901	63.040				

ESPLANADE	43485/2	GROUND IMPROVEMENTS	#N/A	62.565	61.953	63.037				
FOSTER ST	128977/2	PUMP HOUSE PASTURE	#N/A	64.145	63.992	64.256				
FOSTER ST	16794/1		#N/A	62.883	62.668	63.191				
GIBLIN ST	148657/4		#N/A	66.407	65.991	66.755				
KIMBERLEY RD	16794/3		#N/A	62.436	62.229	62.893				
KING ST	8882/1	Sewerage Treatment	61.2	59.898	58.028	61.554	0.354	1	0.654	1
LATROBE RD	198825/1	GARAGE	#N/A	61.123	61.073	61.648				
MORRISON ST	229914/1		#N/A	69.968	69.401	70.813				
								54.000		**87**

100 Year Flood Mitigation with Rail Bridge enhanced

ADDRESS	CT REF	IMPROVEMENT	FLOOR HEIGHT	MEAN_FLOOD	MIN_FLOOD	MAX_FLOOD	Max Flood - Floor		Max Flood + 0.3 - Floor	
10 KIMBERLEY RD	158986/2	House	63.97	63.390	63.122	63.502	-0.468		-0.168	
1099 NATIVE PLAINS RD	109761/4	FARM IMP	#N/A	56.479	56.454	56.888	#N/A			
11 DOWBIGGIN ST	66078/1	HOUSE	#N/A	72.541	72.538	72.545	#N/A			
43 MORRISON ST	40640/24	HOUSE	#N/A	68.790	68.790	68.790	#N/A			
47 MORRISON ST	40640/22	HOUSE	70.4696	68.892	68.790	69.043	-1.427		-1.127	
51 MORRISON ST	40640/21	HOUSE	70.0657	69.123	68.959	69.598	-0.468		-0.168	
53 MORRISON ST	153676/1	Dwelling	70.7025	69.785	69.204	70.091	-0.611		-0.311	
55 MORRISON ST	153676/2	Dwelling	71.5864	70.522	69.965	71.239	-0.347		-0.047	
56 FOSTER ST	40640/11	HOUSE	72.1992	68.107	68.107	68.108	-4.091		-3.791	
58 FOSTER ST	40640/12	HOUSE	71.9429	68.107	68.107	68.108	-3.835		-3.535	
60 FOSTER ST	240626/1	HOUSE	70.6266	68.963	68.718	69.084	-1.543		-1.243	
62 FOSTER ST	40640/13	HOUSE	70.0032	69.168	69.083	69.544	-0.459		-0.159	
64 FOSTER ST	40640/14	House	69.8524	69.522	69.165	69.980	0.128	1	0.428	1
66 FOSTER ST	40640/15	HOUSE	70.7161	70.007	69.876	70.190	-0.526		-0.226	
70 FOSTER ST	40640/16	HOUSE	#N/A	70.297	70.108	70.476	#N/A			
70 FOSTER ST	40640/17	HOUSE	70.7661	70.533	70.337	70.669	-0.097		0.203	1
72 FOSTER ST	40640/18	HOUSE	70.9946	70.706	70.496	70.845	-0.150		0.150	1
74 FOSTER ST	40640/19	House	71.6281	70.972	70.709	71.221	-0.407		-0.107	
78 FOSTER ST	49544/5	HOUSE	#N/A	71.582	71.423	71.646	#N/A			
79 CALDER ST	14469/1	House	69.4858	68.702	68.617	68.788	-0.698		-0.398	
8 NEW BED RD	34958/1	HOUSE & SHEDS	#N/A	73.024	71.285	77.696	#N/A			
80 FOSTER ST	217893/1	HOUSE	73.09	71.791	71.636	71.892	-1.198		-0.898	
82 FOSTER ST	122648/1	HOUSE	#N/A	72.164	72.063	72.225	#N/A			
9 DOWBIGGIN ST	219805/1	HOUSE	72.0821	71.490	71.423	71.544	-0.538		-0.238	
KING ST	8882/1	Sewerage Treatment	61.2	59.460	59.100	60.473	-0.727		-0.427	
NEW BED RD	5316/1	GROUND IMPROVEMENTS	#N/A	79.857	79.857	79.857	#N/A			
								1		3

100 Year Flood Mitigation without Rail bridge upgrade

ADDRESS	CT REF	IMPROVEMENT	FLOOR HEIGHT	MEAN_FLOOD	MIN_FLOOD	MAX_FLOOD	Max flood -Floor		Max flood +0.3 -Floor	
6A LATROBE RD	100717/1	House	60.01	60.417	59.590	61.351	1.341	1	1.641	1
11 KIMBERLEY RD	143878/1	HOUSE	63.5	62.763	62.756	62.769	-0.731		-0.431	
9 KIMBERLEY RD	143878/2	Dwelling	63.05	62.949	62.694	64.465	1.415	1	1.715	1
55 MORRISON ST	153676/2	Dwelling	71.5864	70.498	70.311	71.274	-0.312		-0.012	
10 KIMBERLEY RD	158986/2	House	63.97	63.547	63.307	63.652	-0.318		-0.018	
9 DOWBIGGIN ST	219805/1	HOUSE	72.0821	71.490	71.423	71.543	-0.539		-0.239	
11 DOWBIGGIN ST	66078/1	HOUSE	#N/A	72.542	72.539	72.545	#N/A			
82 FOSTER ST	122648/1	HOUSE	#N/A	72.148	72.068	72.229	#N/A			
80 FOSTER ST	217893/1	HOUSE	73.09	71.791	71.636	71.890	-1.200		-0.900	
74 FOSTER ST	40640/19	House	71.6281	70.972	70.708	71.221	-0.407		-0.107	
72 FOSTER ST	40640/18	HOUSE	70.9946	70.706	70.496	70.846	-0.149		0.151	1
70 FOSTER ST	40640/17	HOUSE	70.7661	70.551	70.337	70.670	-0.096		0.204	1
70 FOSTER ST	40640/16	HOUSE	#N/A	70.300	70.109	70.476	#N/A			
66 FOSTER ST	40640/15	HOUSE	70.7161	70.007	69.877	70.190	-0.526		-0.226	
64 FOSTER ST	40640/14	House	69.8524	69.521	69.165	69.980	0.128	1	0.428	1
62 FOSTER ST	40640/13	HOUSE	70.0032	69.124	69.083	69.165	-0.838		-0.538	
60 FOSTER ST	240626/1	HOUSE	70.6266	68.963	68.717	69.083	-1.544		-1.244	
79 CALDER ST	14469/1	House	69.4858	68.702	68.617	68.788	-0.698		-0.398	
58 FOSTER ST	40640/12	HOUSE	71.9429	68.113	68.113	68.113	-3.830		-3.530	
56 FOSTER ST	40640/11	HOUSE	72.1992	68.113	68.113	68.113	-4.086		-3.786	
FOSTER ST	128977/2	PUMP HOUSE PASTURE	#N/A	63.292	63.245	63.348	#N/A			
3 FOSTER ST	128977/1	HOTEL	62.9276	62.800	62.607	63.363	0.435	1	0.735	1
7 FOSTER ST	246358/3	SHOP HOUSE	63.1491	62.862	62.651	63.258	0.109	1	0.409	1
9 FOSTER ST	243025/1	SURGERY	63.2058	62.692	62.691	62.693	-0.513		-0.213	
15 KIMBERLEY RD	214459/1	HOUSE	63.51	62.746	62.746	62.746	-0.764		-0.464	

7 KIMBERLEY RD	83111/2	HALL	#N/A	62.677	62.659	62.707	#N/A			
7 KIMBERLEY RD	83111/3	HALL	63.2405	62.872	62.652	63.287	0.046	1	0.346	1
7 KIMBERLEY RD	83111/4	HALL	#N/A	63.064	62.743	63.302	#N/A			
3 KIMBERLEY RD	83111/1	HOUSE	63.71	62.736	62.707	62.766	-0.944		-0.644	
12 KING ST	100717/2	HOUSE	#N/A	60.037	59.902	60.046	#N/A			
KING ST	8882/1	Sewerage Treatment	61.2	59.538	59.119	60.473	-0.727		-0.427	
4-6 LATROBE RD	81417/2	HOUSE	#N/A	60.324	60.226	60.398	#N/A			
4-6 LATROBE RD	81417/1	HOUSE	60.7	60.138	60.138	60.138	-0.562		-0.262	
2 LATROBE RD	118540/2	HOUSE	62.16	61.552	61.295	62.035	-0.125		0.175	1
NEW BED RD	5316/1	GROUND IMPROVEMENTS	#N/A	79.857	79.857	79.857	#N/A			
1 KIMBERLEY RD	22129/3	HOUSE	63.69	62.792	62.671	63.092	-0.598		-0.298	
8 NEW BED RD	34958/1	HOUSE & SHEDS	#N/A	73.022	71.285	77.697	#N/A			
1099 NATIVE PLAINS RD	109761/4	FARM IMP	#N/A	56.487	56.460	56.896	#N/A			
17 KIMBERLEY RD	16794/2	HOUSE & UNIT	63.05	62.751	62.663	62.920	-0.130		0.170	1
FOSTER ST	16794/1		#N/A	62.696	62.606	62.881	#N/A			
78 FOSTER ST	49544/5	HOUSE	#N/A	71.582	71.423	71.646	#N/A			
								6		**10**

200 Year ARI Event

ADDRESS	CT REF	IMPROVEMENT	FLOOR HEIGHT	MEAN_FLOOD	MIN_FLOOD	MAX_FLOOD	Max flood - floor		Max flood + 0.3 - floor	
1 KIMBERLEY RD	22129/3	HOUSE	63.69	63.525	63.115	64.129	0.439	1	0.739	1
1 MORRISON ST	60290/1	HOUSE	63.32	63.156	63.063	63.480	0.160	1	0.460	1
10 CROCKERS ST	144440/1	House incomplete	63.9704	63.620	63.143	64.112	0.142	1	0.442	1
10 FOSTER ST	246742/1		#N/A	63.120	63.085	63.354				
10 GIBLIN ST	216909/38	GARAGE	#N/A	66.063	65.301	66.729				
10 KIMBERLEY RD	158986/2	House	63.97	64.541	63.900	65.729	1.759	1	2.059	1
10 MORRISON ST	222566/1		#N/A	63.492	63.491	63.495				
1099 NATIVE PLAINS RD	109761/4	FARM IMP	#N/A	58.099	56.888	61.477				
11 CROCKERS ST	60290/35	FIRE STATION	64.6	64.837	64.297	65.103	0.503	1	0.803	1
11 ESPLANADE	219852/17	HOUSE	63.266	63.101	63.050	63.301	0.035	1	0.335	1
11 KIMBERLEY RD	143878/1	HOUSE	63.5	63.753	63.297	65.112	1.612	1	1.912	1
11 MORRISON ST	61512/1	HOUSE	64.885	64.200	63.924	64.677	-0.208		0.092	1
11-13 FOSTER ST	216903/1	SHOP	63.2523	63.296	63.215	63.374	0.122	1	0.422	1
11-13 LATROBE RD	232854/2	HOUSE	#N/A	61.149	61.145	61.152				
11-13 LATROBE RD	55819/3	HOUSE	#N/A	61.145	61.143	61.147				
12 CROCKERS ST	210547/1	HOUSE	64.1619	63.400	63.068	64.059	-0.103		0.197	1
12 FOSTER ST	202156/1	Shop	#N/A	63.207	63.154	63.326				
12 FOSTER ST	241656/1	Shop	63.5116	63.618	63.618	63.618	0.106	1	0.406	1
12 GIBLIN ST	215051/36	HOUSE	66.78	65.875	65.154	66.672	-0.108		0.192	1
12 KING ST	100717/2	HOUSE	#N/A	60.938	60.562	61.842				
12 MORRISON ST	79388/1	House	64.5819	63.695	63.695	63.695	-0.887		-0.587	
13 CROCKERS ST	60290/26	5 Dwellings & Garage	66.52	66.025	65.681	66.595	0.075		0.375	1
13 CROCKERS ST	60290/27	5 Dwellings & Garage	67.14	66.568	66.130	67.063	-0.077		0.223	1
13 CROCKERS ST	60290/28	5 Dwellings & Garage	66.63	66.006	65.518	66.587	-0.043		0.257	1
13 CROCKERS ST	60290/30	5 Dwellings & Garage	67.24	65.928	65.356	66.746	-0.494		-0.194	
13 CROCKERS ST	60290/32	5 Dwellings & Garage	66.34	65.877	65.161	66.622	0.282	1	0.582	1
13 CROCKERS ST	60290/33	5 Dwellings & Garage	64.9	64.903	64.392	65.244	0.344	1	0.644	1
13 CROCKERS ST	60290/34	5 Dwellings & Garage	66.95	65.769	65.094	66.570	-0.380		-0.080	
14 CROCKERS ST	60290/8	HOUSE	64.3582	63.554	63.114	64.105	-0.253		0.047	1
14 KIMBERLEY RD	60699/1	HOUSE	63.95	64.026	63.860	64.208	0.258		0.558	1
14 MORRISON ST	79388/2	HOUSE	65.2608	64.429	63.920	64.940	-0.321		-0.021	
14A DOWBIGGIN ST	133335/2	HOUSE	71.52	69.078	68.099	70.902	-0.618		-0.318	
14A KIMBERLEY RD	158986/3	Houser	65.0903	64.488	63.864	64.965	-0.125		0.175	1
15 ESPLANADE	127081/1	House	63.4345	63.067	63.060	63.090	-0.344		-0.044	
15 KIMBERLEY RD	214459/1	HOUSE	63.51	63.375	63.149	63.836	0.326		0.626	1
15 MORRISON ST	63535/1	HOUSE	64.9199	64.303	64.054	64.822	-0.098		0.202	1
16 CROCKERS ST	83096/3	HOUSE	64.2624	63.883	63.679	64.183	-0.079		0.221	1
16 FOSTER ST	220495/1	2 SHOPS + FLAT	63.8651	63.431	63.156	63.933	0.068	1	0.368	1
16 KING ST	231453/1	House	#N/A	61.224	60.675	61.654				
16 MORRISON ST	79388/5	HOUSE	65.3676	64.850	64.271	65.032	-0.336		-0.036	
17 CROCKERS ST	60290/29	HOUSE	#N/A	64.965	64.507	65.634				
17 CROCKERS ST	60290/31	HOUSE	#N/A	64.901	64.410	65.376				
17 FOSTER ST	243026/1	SHOP	63.7878	63.641	63.308	63.970	0.182	1	0.482	1
17 KIMBERLEY RD	16794/2	HOUSE & UNIT	63.05	63.202	62.728	64.881	1.831	1	2.131	1
17 MORRISON ST	72957/1	HOUSE	64.9389	64.462	64.197	64.926	-0.013		0.287	1
18 CROCKERS ST	83096/2	HOUSE	64.2807	63.978	63.804	64.258	-0.023		0.277	1
18 KING ST	64115/2	COTTAGE	62.86	60.293	59.800	61.077	-1.783		-1.483	
18 MORRISON ST	79388/6	HOUSE	65.3933	64.952	64.486	65.108	-0.285		0.015	1
18-20 FOSTER ST	222258/17	SHOP	64.2915	64.116	64.049	64.612	0.320	1	0.620	1
19 KIMBERLEY RD	226538/1	HOUSE	63.27	62.520	62.271	63.227	-0.043		0.257	1
19AD CROCKERS ST	60290/24	4 HOME UNITS	65.27	64.827	64.560	65.387	0.117	1	0.417	1

19AD CROCKERS ST	60290/25	4 HOME UNITS	#N/A	65.536	64.710	65.901				
2 FOSTER ST	12259/1	PST OFF. SHP & HOUSE	62.687	63.031	62.988	63.089	0.402	1	0.702	1
2 LATROBE RD	118540/2	HOUSE	62.16	61.806	61.410	62.353	0.193	1	0.493	1
20 CROCKERS ST	221612/1	HOUSE	64.3808	64.067	63.896	64.280	-0.101		0.199	1
20 MORRISON ST	79388/7	HOUSE	65.5413	65.147	64.772	65.356	-0.185		0.115	1
21 FOSTER ST	155084/1	TOILETS	#N/A	64.154	63.881	64.251			0.300	1
22 CROCKERS ST	61512/2	HOUSE	63.3366	63.623	63.243	64.180	0.843	1	1.143	1
22 FOSTER ST	216657/41	HOUSE	#N/A	64.465	64.137	64.828				
22 MORRISON ST	231659/1	HOUSE	66.2327	66.086	65.436	66.609	0.376	1	0.676	1
23 FOSTER ST	217333/88	HOUSE	64.5423	64.310	64.217	64.697	0.155	1	0.455	1
23 KIMBERLEY RD	54960/1	HOUSE	#N/A	62.298	62.272	62.371				
24 FOSTER ST	60290/42	HOUSE POLICE STATION	#N/A	64.811	64.345	65.257				
25 CROCKERS ST	79247/4	HOUSE	#N/A	65.813	65.585	65.916				
25 CROCKERS ST	79247/5	HOUSE	65.89	65.506	65.219	65.836	-0.054		0.246	1
25 KIMBERLEY RD	225195/1	HOUSE	#N/A	62.290	62.270	62.320				
2-6 CROCKERS ST	241657/1		#N/A	63.276	63.111	63.883				
26 MORRISON ST	217184/1	HOUSE	67.6528	66.798	66.356	67.498	-0.155		0.145	1
26-28 FOSTER ST	132434/1	SERVICE STATION	65.21	65.286	64.832	65.686	0.476	1	0.776	1
27 CROCKERS ST	79247/3	HOUSE	66.3	65.861	65.807	65.920	-0.380		-0.080	
27 FOSTER ST	60290/89	House	64.6241	64.384	64.326	64.860	0.236	1	0.536	1
27 KIMBERLEY RD	206306/1	HOUSE	#N/A	62.296	62.246	62.333				
27 KIMBERLEY RD	206307/1	HOUSE	#N/A	62.207	62.097	62.287				
28 MORRISON ST	120655/1	HOUSE	68.3967	67.941	67.506	68.075	-0.322		-0.022	
3 ESPLANADE	240697/1	EXCHANGE	62.5957	63.067	63.029	63.110	0.514	1	0.814	1
3 FOSTER ST	128977/1	HOTEL	62.9276	63.285	62.964	64.323	1.395	1	1.695	1
3 KIMBERLEY RD	83111/1	HOUSE	63.71	63.525	63.146	63.918	0.208	1	0.508	1
3 LATROBE RD	118540/1	HOUSE	62.38	61.641	61.462	61.742	-0.638		-0.338	
3 MORRISON ST	81952/3	HOUSE	63.34	63.372	63.117	63.492	0.152	1	0.452	1
30 CROCKERS ST	79388/4	HOUSE	#N/A	64.879	64.215	65.157				
30 FOSTER ST	60290/45	House	65.884	65.663	65.428	66.088	0.204	1	0.504	1
31 CROCKERS ST	79247/2	HOUSE	#N/A	65.882	65.862	65.903				
31 FOSTER ST	60290/90	HOUSE	65.215	64.502	64.375	64.978	-0.237		0.063	1
32 MORRISON ST	120656/1	HOUSE	#N/A	68.080	67.925	68.115				
32 MORRISON ST	222007/1	HOUSE	68.9577	68.402	68.095	68.980	0.022	1	0.322	1
32-34 FOSTER ST	216485/3	WORKSHOP	#N/A	66.195	66.116	66.234				
32-34 FOSTER ST	221486/1	WORKSHOP	#N/A	65.710	65.569	66.025				
32-34 FOSTER ST	221545/2	WORKSHOP	65.9987	66.010	65.605	66.228	0.229	1	0.529	1
33 FOSTER ST	60290/91	SHOP	65.116	64.716	64.499	65.179	0.063	1	0.363	1
35 FOSTER ST	60290/92	HOUSE	65.0643	64.954	64.628	65.172	0.108	1	0.408	1
35 MORRISON ST	40640/27	HOUSE	68.6753	68.305	67.808	68.658	-0.017		0.283	1
37 FOSTER ST	60290/93	HOUSE	65.6943	65.155	65.042	65.506	-0.188		0.112	1
38 FOSTER ST	40640/2		#N/A	66.966	66.612	67.511				
38 FOSTER ST	40640/3		#N/A	66.744	66.342	67.451				
38 MORRISON ST	230106/4	HOUSE	69.0748	68.873	68.685	68.981	-0.094		0.206	1
39 FOSTER ST	85938/1	SHOP	65.6057	65.291	65.098	65.561	-0.045		0.255	1
39 MORRISON ST	40640/26	HOUSE	69.2498	68.555	67.857	68.960	-0.290		0.010	1
4 FOSTER ST	79774/1	HOUSE	63.14	63.076	63.025	63.139	-0.001		0.299	1
4 LEAKE ST	38247/1	House	#N/A	70.234	70.231	70.237				
4 MORRISON ST	57997/1	House	64.1869	63.492	63.491	63.492	-0.695		-0.395	
40 FOSTER ST	40640/4	HOUSE	67.8303	66.861	66.569	67.307	-0.523		-0.223	
40 MORRISON ST	74775/1	HOUSE	69.5051	68.971	68.870	69.187	-0.318		-0.018	
42 MORRISON ST	215827/2	House	69.14	69.111	68.939	69.408	0.268	1	0.568	1
43 FOSTER ST	138691/1	HOUSE	66.18	65.493	64.893	66.770	0.590	1	0.890	1
43 MORRISON ST	40640/24	HOUSE	#N/A	69.012	68.797	69.323				
43 MORRISON ST	40640/25	HOUSE	69.4272	68.770	68.502	69.157	-0.270		0.030	1
44 FOSTER ST	40640/5	HOUSE	68.92	67.289	66.578	67.573	-1.347		-1.047	
44 MORRISON ST	215720/3	House	69.9407	69.414	69.038	69.751	-0.190		0.110	1
46 FOSTER ST	40640/6	HOUSE	69.14	67.524	67.451	67.682	-1.458		-1.158	
4-6 LATROBE RD	81417/1	HOUSE	60.7	60.863	60.745	61.093	0.393	1	0.693	1
4-6 LATROBE RD	81417/2	HOUSE	#N/A	60.866	60.772	61.028				
47 MORRISON ST	40640/22	HOUSE	70.4696	69.618	69.254	69.985	-0.485		-0.185	
48 FOSTER ST	40640/7	House	68.85	67.652	67.479	68.018	-0.832		-0.532	
5 CROCKERS ST	161462/1	House	#N/A	64.275	64.128	64.501				
5 ESPLANADE	155469/1	House	62.4765	63.065	63.042	63.084	0.607	1	0.907	1
5 LATROBE RD	243865/1		#N/A	61.366	61.317	61.432				
5 MORRISON ST	127081/2	HOUSE	63.88	63.307	63.061	63.549	-0.331		-0.031	
50 FOSTER ST	40640/8	HOUSE	71.6768	68.064	67.657	68.399	-3.278		-2.978	
51 MORRISON ST	40640/21	HOUSE	70.0657	69.807	69.487	70.181	0.115	1	0.415	1
52 FOSTER ST	40640/9	CLUB	71.9913	68.492	68.054	68.769	-3.222		-2.922	
52 MORRISON ST	204677/1	HOUSE	71.0595	70.457	70.152	70.964	-0.096		0.204	1
53 MORRISON ST	153676/1	Dwelling	70.7025	70.454	69.635	71.010	0.308	1	0.608	1
54 FOSTER ST	40640/10	HOUSE	72.1168	68.785	68.041	68.916	-3.201		-2.901	

55 MORRISON ST	153676/2	Dwelling	71.5864	71.186	70.564	71.667	0.081	1	0.381	1
56 FOSTER ST	40640/11	HOUSE	72.1992	68.857	68.355	68.951	-3.248		-2.948	
58 FOSTER ST	40640/12	HOUSE	71.9429	68.928	68.376	69.255	-2.688		-2.388	
6 FOSTER ST	79774/2	HOUSE	63.2	63.113	63.074	63.160	-0.040		0.260	1
6 GIBLIN ST	215765/1	HOUSE	66.3422	66.110	65.747	66.514	0.172	1	0.472	1
6 KIMBERLEY RD	148660/1	House	64.2946	64.168	63.885	64.378	0.083	1	0.383	1
6 MORRISON ST	221030/1	Main building	63.9123	63.490	63.488	63.493	-0.419		-0.119	
60 FOSTER ST	240626/1	HOUSE	70.6266	69.343	69.023	69.508	-1.119		-0.819	
62 FOSTER ST	40640/13	HOUSE	70.0032	69.532	69.204	69.929	-0.074		0.226	1
64 FOSTER ST	40640/14	House	69.8524	69.924	69.560	70.457	0.605	1	0.905	1
66 FOSTER ST	40640/15	HOUSE	70.7161	70.321	70.081	70.742	0.026	1	0.326	1
69 FOSTER ST	159311/1	House	#N/A	70.262	70.233	70.641				
6A LATROBE RD	100717/1	House	60.01	61.010	60.239	62.679	2.669	1	2.969	1
7 CROCKERS ST	161462/2	Vacant land	#N/A	64.829	64.226	65.308				
7 FOSTER ST	246358/3	SHOP HOUSE	63.1491	63.431	63.011	64.399	1.250	1	1.550	1
7 KIMBERLEY RD	83111/2	HALL	#N/A	63.405	63.230	63.695				
7 KIMBERLEY RD	83111/3	HALL	63.2405	63.750	63.333	64.143	0.902	1	1.202	1
7 KIMBERLEY RD	83111/4	HALL	#N/A	63.926	63.809	64.141				
7 LATROBE RD	223226/1	HOUSE	61.64	61.169	61.135	61.281	-0.359		-0.059	
7 MORRISON ST	81952/1	HOUSE	64.43	63.577	63.480	63.958	-0.472		-0.172	
70 FOSTER ST	40640/16	HOUSE	#N/A	70.578	70.326	71.012				
70 FOSTER ST	40640/17	HOUSE	70.7661	70.758	70.473	70.985	0.219	1	0.519	1
72 FOSTER ST	40640/18	HOUSE	70.9946	71.029	70.682	71.523	0.528	1	0.828	1
74 FOSTER ST	40640/19	House	71.6281	71.286	70.930	71.730	0.102	1	0.402	1
78 FOSTER ST	49544/5	HOUSE	#N/A	71.768	71.644	71.925				
79 CALDER ST	14469/1	House	69.4858	69.264	68.972	69.894	0.408	1	0.708	1
8 CROCKERS ST	144440/2	House	63.9744	63.525	63.107	64.112	0.138	1	0.438	1
8 FOSTER ST	248634/1	PLAY GROUP CENTRE	#N/A	63.103	63.086	63.160				
8 GIBLIN ST	202912/1	HOUSE	66.4512	66.362	65.772	66.701	0.250	1	0.550	1
8 LATROBE RD	81497/1	HOUSE	#N/A	60.779	60.714	60.867				
8 NEW BED RD	34958/1	HOUSE & SHEDS	#N/A	72.863	71.075	77.707				
80 FOSTER ST	217893/1	HOUSE	73.09	71.830	71.748	71.936	-1.154		-0.854	
82 FOSTER ST	122648/1	HOUSE	#N/A	72.165	72.067	72.224				
9 CROCKERS ST	60290/37	HOUSE	#N/A	64.695	64.224	65.264				
9 DOWBIGGIN ST	219805/1	HOUSE	72.0821	71.816	71.716	71.982	-0.100		0.200	1
9 ESPLANADE	60290/16		#N/A	63.060	63.043	63.082				
9 FOSTER ST	243025/1	SURGERY	63.2058	63.169	63.115	63.274	0.068	1	0.368	1
9 GIBLIN ST	40640/1	HOUSE	#N/A	67.358	66.907	68.094				
9 GIBLIN ST	60290/48	HOUSE	#N/A	67.590	66.985	68.075				
9 GIBLIN ST	60290/49	HOUSE	#N/A	67.430	66.872	68.068				
9 GIBLIN ST	60290/50	HOUSE	67.68	67.351	66.898	67.961	0.281	1	0.581	1
9 KIMBERLEY RD	143878/2	Dwelling	63.05	65.290	63.265	84.401	21.351	1	21.651	1
9 LATROBE RD	243127/1	Dwelling	61.15	61.146	61.135	61.176	0.026	1	0.326	1
9 MORRISON ST	60290/3	HOUSE	64.76	63.937	63.574	64.359	-0.401		-0.101	
ESPLANADE	155469/2	WORKSHOP	62.2701	63.078	63.044	63.114	0.844	1	1.144	1
ESPLANADE	43485/1	GROUND IMPROVEMENTS	#N/A	63.028	62.848	63.111				
ESPLANADE	43485/2	GROUND IMPROVEMENTS	#N/A	62.611	62.021	63.147				
FOSTER ST	128977/2	PUMP HOUSE PASTURE	#N/A	64.201	64.185	64.210				
FOSTER ST	16794/1		#N/A	62.995	62.834	63.369				
GIBLIN ST	148657/4		#N/A	66.451	66.063	66.713				
KIMBERLEY RD	16794/3		#N/A	62.698	62.275	63.775				
KING ST	8882/1	Sewerage Treatment	61.2	60.105	58.114	61.662	0.462	1	0.762	1
LATROBE RD	198825/1	GARAGE	#N/A	61.180	61.110	61.688				
MORRISON ST	229914/1		#N/A	70.007	69.431	70.836				
MORRISON ST	79388/3		#N/A	64.800	64.612	65.020				
NEW BED RD	5316/1	GROUND IMPROVEMENTS	#N/A	80.109	79.908	80.212				
								58		**92**

APPENDIX I

EMERGENCY FLOOD KIT
WHAT YOU WILL NEED

- A food kit filled with foods that do not need to be refrigerated. Make sure it includes bottled water
- Baby food and baby care items (e.g. nappies, if applicable)
- A list of emergency telephone numbers (take this with you)
- A first aid kit and medications
- Your mobile phone and charger
- A portable radio with spare batteries tuned to **ABC 91.7FM**
- Candles and waterproof matches
- Torch with spare batteries
- Rubber gloves
- Toiletries, personal hygiene products and toilet paper
- Alcohol wipes and anti-bacterial gel
- Children's activities such as colouring books, pens and pencils (if applicable)
- A waterproof bag for clothing and valuables
- Important papers (including insurance documents), bank books, money and credit cards
- Valuables and cherished articles (jewellery, photos, etc)

Essential items

- Warm, waterproof clothing and a change of clothing
- Blankets/sleeping bag
- Rubber shoes and/or gumboots
- Pet food (if applicable)
- Hats, sunscreen
- Camping stove or small bbq

Your Emergency Kit should be kept in a waterproof storage box.

Check your kit contents regularly and restock any out-of-date items such as batteries.

Important websites & telephone numbers

Important Websites:
www.ses.tas.gov.au/
www.kentish.tas.gov.au/page.aspx
www.alert.tas.gov.au/Pages/Home.aspx

Tasmania Police
General enquiries 131 444
Emergency 000

State Emergency Service
General enquiries 6434 5333
Emergency 132 500

Ambulance
General enquiries 1300 303 196
Emergency 000

Tasmania Fire Service
General enquiries 6434 6700
Emergency 000

TasNetworks
Residential Customer 1300 132 003
Emergencies 132 004

Bureau of Meteorology 1300 659 216

Kentish Council
Business hours 6491 0200
After hours 6491 0200

Kentish Council acknowledge the assistance rendered by Launceston City Council and their EMO Bev Allen.

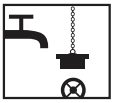
RAILTON
FLOOD EVACUATION STANDBY NOTICE

1 STANDBY

- Listen to radio – **ABC 91.7 FM.**
- Stack possessions on benches and tables.
- Check on neighbours.

- Register with Tasmania Police if you require assistance to evacuate. **PH: 131 444.**
- Start making plans to evacuate, contact friends and family to see if you can stay with them.

- Start self evacuation now if you wish.
- Prepare a water proof Emergency Kit (keep in mind the possibility of not being able to return to your home for some time).



- Ensure valuables, medications, prescriptions and important papers are placed in your Emergency Kit.
- Place plugs in sinks and weigh down with heavy objects.
- Place a sandbag or similar in the toilet, close and weigh down the lid.

2 EVACUATION

- A Police or Council siren will sound notifying you of the need to evacuate. **EVACUATE NOW.**
- **ABC 91.7 FM** – will provide regular advice and updates.

- Emergency personnel will be door knocking in the area.
- Tasmanian Legislation provides Tasmania Police with the authority to evacuate people in the event of an emergency.

- Take your pets (secured with a leash or in a pet container – dogs should be muzzled) and pet food with you.
- Turn off electricity, gas and water before you leave.

- If you are unable to stay with friends or family, you should go to an advertised evacuation centre.
- Take your Emergency Kit with you.

- Lock and secure your home.
- Once an evacuation has been called residents and the general public will not be able to return to the affected areas of Railton until Tasmania Police have deemed it safe to do so. This may be for some days.
- For additional information and updates contact Kentish Council on **6491 0200**.

3 EVACUATION CENTRES

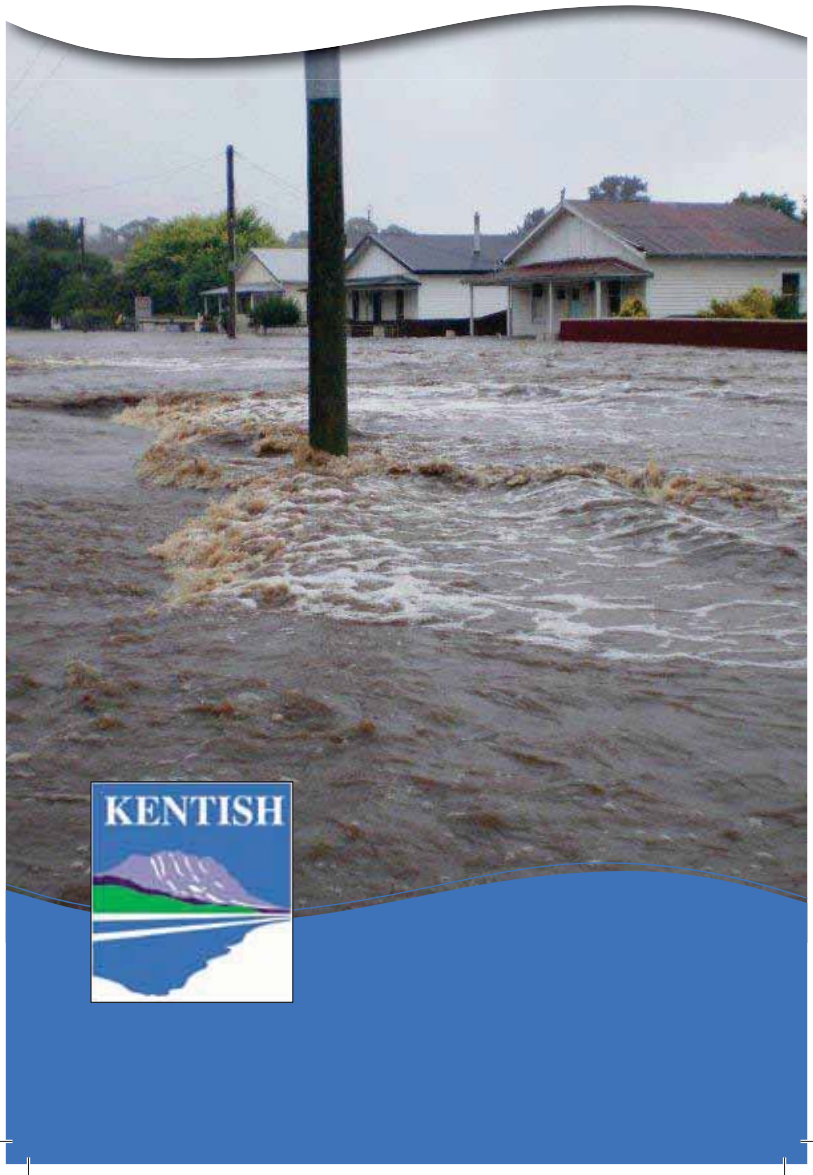
- Evacuation Centres may be advertised via radio, Tas Alert, emergency alert and on the following websites:
  www.ses.tas.gov.au/
  www.kentish.tas.gov.au/page.aspx
  www.alert.tas.gov.au/Pages/Home.aspx

KENTISH

Kentish Council acknowledge the assistance rendered by Launceston City Council and their EMO Bev Allen.

Flooding in Railton

Tips to protect you, your family, pets and property.



Railton is located on Redwater Creek a tributary of the Mersey River. At Railton Redwater Creek has a catchment area of 25.4Km² consisting largely of agricultural land and forest. Much of the urban development of Railton has occurred on the flood plain.

Railton has a history of flooding dating back to the first recorded flood in January 1876. On the 14th January 2011 Railton was subjected to a large flood which has been estimated at approximately equal to the 100 year flood event. During that flood 60 homes and 14 businesses were affected.

It is vital the community is educated about flood risk, preparedness, flood warnings, evacuation and recovery.

This brochure contains the following information on how to be better prepared for flooding -

BEFORE Learn • Plan • Prepare

DURING Protect • Evacuate • Travel

AFTER Insurance • Hazards • Cleaning

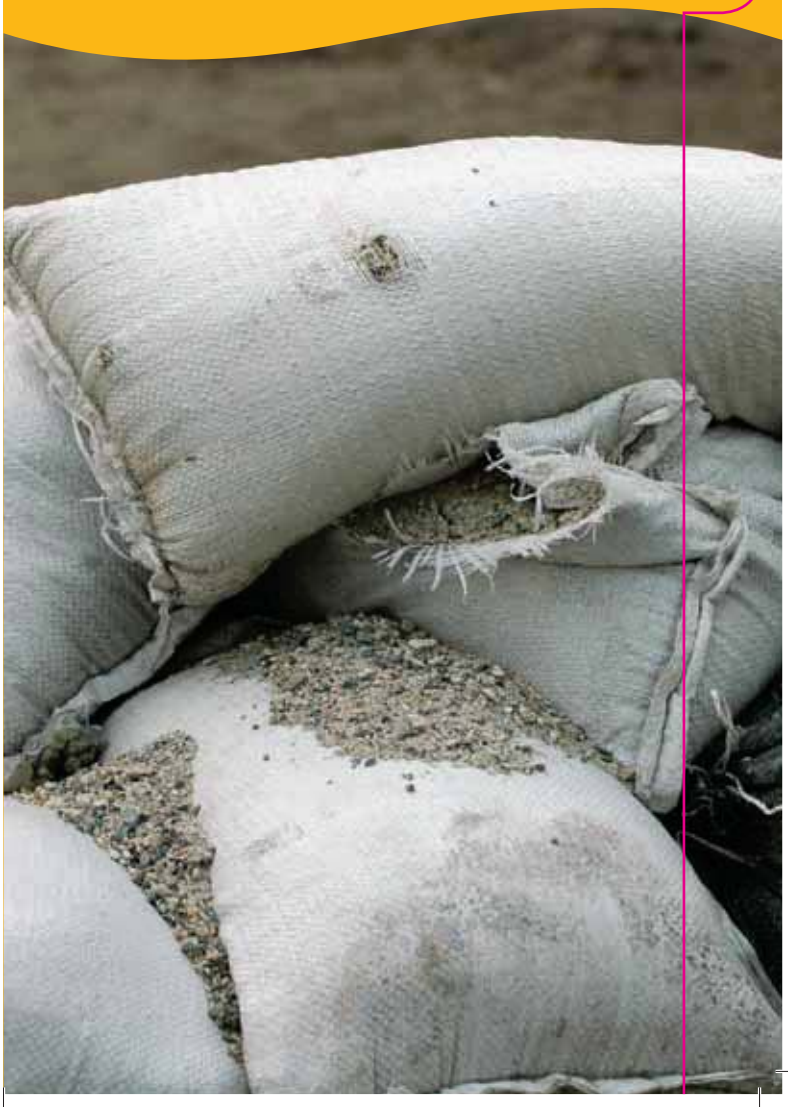
In the back of this brochure is a list of items you will need to put in an Emergency Kit, and on the back page we have listed important telephone numbers you may need in such an emergency.

Please place this brochure in your Emergency Kit.

This brochure was funded through the National Disaster Resilliance Program,
a partnership between Kentish Council and State and Commonwealth Goverments.

What to do BEFORE A FLOOD

BEFORE



Learn...

Don't wait for a flood to learn what to do. Know how the Flood Warning System works.

- The Bureau of Meteorology issues a **flood watch** if flood producing rain is expected to happen in the near future.
- The Bureau issues a **flood warning** when flooding is occurring or is expected to occur.
- Kentish Council and the SES receive flood warnings directly from the BoM.
- **ABC Radio 91.7FM** is the local emergency notification station. It will provide regular advice and updates on the current situation during a flood.

Flood categories

Minor Flooding
Low-lying areas can be inundated which may require the removal of stock and equipment. Some roads may need to be closed.

Moderate Flooding
The evacuation of some houses may be required. Some traffic routes may be covered and roads closed.

Major Flooding
Properties are likely to be isolated and major traffic routes likely to be closed. Evacuation of people from the flood affected areas may be required.

- If Tasmania Police, SES and the Council consider that Railton is at risk of major flooding and the area must be evacuated, **a siren will be activated**. Emergency Management personnel will patrol the area at risk of flooding and door knock some but not all properties.

Plan and prepare...

BEFORE

- **Prepare an Emergency Kit** with essential items (see inside back page).
- **Plan where you will evacuate to.** (The Council may have evacuation centres established, if you are unable to stay elsewhere.)
- **Check your insurance cover.**
  - Are you covered for river flooding rather than just storm?
  - Does your policy replace new for old, does it have a limit on repairs?
  - Check both building and contents cover; don't underestimate the value of contents.
- **Know how to turn off your water, gas and electricity.**
  - Ask your supplier how to do this.
  - Mark taps or switches with stickers to help you remember.
- **Know who to contact and how.**
  - Agree where you will go and how to contact each other.
  - Keep a list of important contacts with you.
  - The Council has arrangements in place for you to take your domestic pets with you to an evacuation centre.
- **Think about what you can move now.**
  - Don't wait for a flood. Move items of personal value such as photo albums, family videos and treasured items to a safe place (secured in plastic bags or waterproof containers).

- **Think about which items you will need to move to safety during a flood**
  - Pets (dogs need to be muzzled and you will need to put all pets on a lead, in a pet container or animal float)
  - Cars (you should never drive through floodwaters)
  - Furniture (should be placed on beds)
  - Electrical equipment (should be placed on furniture)
  - Garbage bins (should be tied and anchored)
  - Car oils, pesticides and chemicals (should be stored in plastic airtight containers in a higher location)

See the 'What to do During a Flood' section for more information.

If you have any questions or concerns in relation to possible flooding in your area, call 6491 0200.

Preparation and protection...

BEFORE

If people are asked how they would defend their property to prevent the inflow of water the initial response is sandbags. However, what is not generally understood is that sandbags are not waterproof.

Also, sandbags empty or full are not easily obtained. The State Emergency Service (SES) and the Council have limited stocks and these are usually required for public infrastructure or diverting flood flows.

The main points of water inflow to properties are:

- Back flow through toilets and sink plug holes
- Through the gaps around windows and door frames
- Through air bricks

To aid in preventing water coming in these main entry points the following techniques can be used when sandbags are not available or in preference to sandbags as they can be more effective:

- Insert the plug in sinks and baths, and weigh it down with a heavy object.
- For toilets fill a plastic bag or pillow case with dirt or sand and insert it in the bowl and weigh it down.
- Manhole covers within your property boundary should also be weighed down with earth or sand filled bags or heavy objects.

- The gaps around windows and door frames can be sealed with duct tape and plastic available from most hardware stores. Duct tape and plastic well applied on a dry surface is far more effective than sandbagging.
- Similarly air bricks can be sealed, duct tape placed over, or a sheet of plastic and duct taped. Do not permanently seal your air bricks.

Well in advance of any flood, and to increase the flood resilience of your property, it is recommended you seal gaps between door frames and brick work, or the structure with silicone or approved water resilient filler.

In preparation for a flood, assess your property and its vulnerability. To increase the flood resilience of your home think about using the methods described above, and have on hand stocks of plastic, duct tape, bags filled with sand or dirt and silicone sealant. This will assist with protecting your home in the event of flooding taking place.

Ask...

Questions for the Council:

- How deep will the water get in and around my property?
- Will my home become isolated?
- Do I have to evacuate and where do I evacuate to? What is the safest evacuation route?
- What flood advice will be given by local officials in addition to that given by the Bureau of Meteorology?

The Council has produced 'Flood Plain Maps' which will tell you the areas of inundation. These maps are based on previous floods and modelling work undertaken by the Council. Ask about the plans in place, warning systems and evacuation plans. This information will assist you in being prepared for flooding.

What to do DURING A FLOOD

DURING

What you can do to protect your home...

Listen to and act on the advice of the emergency services. Follow these simple steps to stay safe:

- Locate your Emergency Kit.
- Move small manageable furniture and items upstairs or to a high point in your home (e.g. ceiling space for light items).
- Place furniture on beds and then personal items on the furniture. Electrical equipment should be placed at the top.
- Secure all items that may become hazardous and cause damage if moved by floodwater, for example refrigerators and other large household items.
- If safe to do so, turn off gas, electricity and water supplies when floodwater is about to enter your home. **DO NOT touch sources of electricity when standing in floodwater.**
- Put plugs in sinks and baths. Weigh them down with a strong plastic bag filled with sand or earth.
- Place a strong plastic bag full of sand or earth in the toilet bowl to prevent sewage entering your property. Close the lid and weigh down.
- Disconnect any equipment that uses water (like washing machines and dishwashers).
- Leave all drawers, cabinet doors and room doors open. This makes sure they don't swell and stick shut.
- If possible, move any outside belongings to higher locations including car oils, pesticides and chemicals which can be very hazardous to the environment when mixed with floodwaters. These should be stored in plastic, airtight containers in a secure place away from the floodwaters.
- Cardboard boxes and newspapers, etc. should be placed in waterproof containers and moved to higher ground. If this is not done, they will disintegrate and clog drains.
- Tie and anchor outdoor garbage, recycling and wheelie bins to minimise the spread of disease.

Evacuate...

In the event of an evacuation please be aware of the following:

- Keep listening to **ABC Radio 91.7 FM**, which is the local emergency notification station for regular advice and updates and check websites.
- Emergency personnel will door knock in the area. Mobile public address warnings may also be activated.
- A Police or Council siren will be activated.
- Please leave your home if emergency services advise. Refusing to leave on their advice will put you, your family and those trying to help you at risk.
- Tasmanian Legislation provides Tasmania Police with the authority to evacuate people in the event of an emergency.
- Leave before floodwaters arrive. You may only have minutes to evacuate.
- Take your domestic pets (secured with a leash or in a pet container – dogs should be muzzled) or animal float and pet food with you. The evacuation centres may have resources available for your pets.
- Lock and secure your home.
- When you evacuate, you should go to family or friends or to an evacuation centre run by the Council.
- If you evacuate and stay with friends and family, Tasmania Police may request you register your details.
- Once an evacuation has been called, residents and the general public will not be able to return to the flood affected area until Tasmania Police have deemed it safe to do so. This may be for some days.

DURING

Travelling in flood conditions...

- The majority of flood-related deaths in Australia are a result of inexperienced people entering floodwaters either in boats, vehicles or on foot. Avoid entering floodwater on foot or by vehicle, it may be deeper or faster flowing than you think, manhole covers may have come off and floodwaters contain hidden snags and debris.
- Don't walk on the riverbanks or across bridges if possible. They may have been damaged and might even collapse.
- Don't swim in floodwater – it is usually contaminated and often contains hidden snags, strong currents and other hazards.
- Avoid wading, even in shallow water, for the above reasons.
- If you must enter shallow water, wear rubber shoes or gumboots to protect feet. Don't proceed beyond waist-depth unless absolutely necessary and only if there is no obvious current.
- Keep in contact with other people. Do things in pairs. Do not go anywhere alone.

Important! Floodwater is dangerous

- Avoid walking or driving through it
- Keep children and vulnerable people away from it
- Wash your hands thoroughly if you touch it
- Never drink floodwater in any circumstance; it may contain hazardous substances which can harm you.

Evacuation centres

Help available at evacuation centres may include:

- Emergency accommodation
- Financial assistance, if sanctioned by the Government
- Personal support
- Refreshments and meals
- Clothing and personal needs
- Arranging contact with family and friends

- Evacuation centres may be advised where and when established via radio, websites, Tas Alert or emergency alert

What to do AFTER A FLOOD

AFTER

Insurance...

- Call your building and contents insurance company as soon as possible.
- The insurance company will confirm what repairs and replacements are needed and covered by your policy.
- Ask the insurance company how long it will be before the loss adjustor visits.
- Ask the insurance company if you are to clean your property or if they will get a company to do it for you.
- If you rent your property, contact your landlord and your contents insurance company as soon as possible.
- Photograph and video record your damaged property. List the damage to your property and belongings.
- Use a permanent ink pen to mark on the wall the maximum height of the floodwater – do this in every room affected by flooding.
- Make a note of all phone calls. Record the date, name and what was agreed.
- Keep copies of all letters, emails and faxes you send and receive. Also keep all receipts.
- Don't throw anything away until told to (except ruined food).
- Kentish Council may be able to provide information on hardship grants or charities that may be able to assist you if you don't have insurance.

Temporary housing

Flood repairs can take weeks or months to complete, especially when there is widespread flooding and builders are scarce. It takes time to dry out a property and some buildings have to be gutted before repair. Accommodation options can be drawn from a number of providers internal and external to government if you are unable to stay with family or friends.

Hazards on entering your home...

Wait until authorities have declared the area safe before entering a flood zone.

- Take care as there may be hidden dangers in the floodwater like sharp objects and pollution.
- Wear rubber boots (or rubber soled shoes), long pants and sleeves and rubber or leather gloves. Floodwater can contain sewage, chemicals and animal waste – wear your rubber gloves at all times when cleaning up after a flood.
- Move slowly around and carry a torch to inspect for damage. Pay particular attention to any loose floor boards, holes in the floor, protruding nails and sagging ceiling areas that may be ready to fall.
- Also keep a look out for other flood 'victims' such as spiders and snakes.
- Check with TasNetworks to find out whether electricity supplies to your property have been affected and if they are safe to be turned on by you. **DO NOT touch sources of electricity when standing in floodwater. EVERY SOURCE OF ELECTRICITY CAN BE EXTREMELY DANGEROUS UNDER FLOOD CONDITIONS. DO NOT turn on any lights or appliances until a qualified electrician has checked your entire electrical distribution system.**
- If the water supply has been flooded, you must assume it is contaminated. Drink only boiled or bottled water until the normal supply has been declared safe by health authorities.

AFTER

Cleaning your property...

- When flood levels outside your property start to become lower than inside, you can begin using a pump and generator to remove water from your home. Position the generator outside in the open air as generators produce fumes that can cause harm or be fatal.
- Wash out mud, dirt and debris from your home. Start at the top or upper limit of the flooding and work downwards to the floor.
- If cleaning the house yourself, clean one room at a time and make sure you work in a well-ventilated area. Apply cleaner and give it time to work before you mop it up. After cleaning a room go over it again with a disinfectant to kill the germs and smell left by the floodwater.
- If you are drying your property naturally, keep doors and windows open as much as possible. Drying can also be assisted by the use of fans and heaters, but keep windows open and only use one heater per room (too much heat can cause timber to crack).
- Allow furniture to dry outdoors but keep it out of direct sunlight to prevent warping or fading.
- Don't rush into repairs until the timber and brickwork has had a chance to thoroughly dry (and check with your insurance company first).

- It's important to thoroughly wash and disinfect every item and part of your home that has come into contact with floodwaters because of contamination. To be on the safe side, consider all items exposed to floodwaters as contaminated.
- Thoroughly wash your hands with a disinfectant soap after handling any contaminated article.
- Use household or commercial disinfectants or sanitisers. A good disinfectant to use is a solution of a quarter of a cup of household laundry bleach to every four litres of water.
- Clean and disinfect dishwashers, washing machines and dryers with water that has been declared safe for drinking. Make sure the sewerage and stormwater lines are working before starting a dishwasher or washing machine. Hand wash crockery and cutlery in disinfectant and allow to air dry, or alternatively use a hot setting in your disinfected dishwasher.
- Any food touched by floodwater is ruined and should be thrown out (even jars, canned and bottled goods), including anything in your fridge or freezer ruined by loss of power.
- Fridges and freezers should be cleaned, disinfected and checked by a professional before use or replaced.

AFTER

- Mattresses soaked with floodwater are generally damaged beyond use and should be discarded (check with your insurance company before discarding).
- Wall to wall carpeting will be hard to dry. If you leave it on the floor it could cause wood decay, mildew and warpage of the flooring and hinder drying. However, if you remove the carpet you risk shrinkage – seek advice from a professional cleaner.
- Clean clothing by shaking, brushing or vacuuming loose dirt from the articles before washing or sending to the cleaners.
- Sanitise the washing machine occasionally after washing items contaminated by floodwater to kill bacteria on the interior surface. Pour a disinfectant into the empty machine, then complete a 15 minute cycle on a hot water setting.
- Don't let photos dry out, they will stick together. Try to get to flood damaged photos within two days to prevent mould. Place them in a tub of cold, clear water and gently separate any that are stuck together. Do not allow water from the tap to run directly on the photos, as this may further damage them. Place photos face up on a kitchen towel. Do not wipe the photograph.
- Place books on ends to dry and keep the pages apart. If books are very damp, sprinkle cornflour or talcum powder between the pages to take up the moisture, leave for several hours and then brush off. Repeat if necessary. After exposure to air for some time, pile and press them to keep the pages from crumpling. Continue the drying pressing procedure until they are dry to prevent mildew. Heat can be applied between the pages to prevent musty odours.

Cleaning your yard...

- Drain or remove standing water as soon as possible to prevent creating a breeding area for mosquitoes.
- Tip water out of barrels, old tyres and cans.
- Check gutters are clean and able to drain.
- Clean ditches and drains so they can carry stormwater away from your home.
- Clean and disinfect the BBQ plate and wash and rinse thoroughly. Have a plumber check the gas fittings before operating.
- Dispose of paints and poisons safely.

AFTER

Some suggestions for cleaning

PRODUCT / PROBLEM
Cleaners
Disinfectants
Mildew removers
To remove mildew on wood
To remove mildew on leather or suede
To remove mildew on upholstered articles
To remove rust stains from timber
Mud on walls
Locks and hinges
White salt growth on brickwork

flood damaged property...

RECOMMENDED SOLUTION
Household all purpose cleaner Laundry soap or detergent
Commercial disinfectants 1/4 cup of laundry bleach in 4 litres of water
Commercial mildew removers Washing soda, tri-sodium phosphate 1/4 cup of laundry bleach in 4 litres of water
4-6 tablespoons of baking soda in 5 litres of water. Dry away from sunlight in an airy place.
Wipe with cloth wrung out of diluted household bleach. Dry away from sunlight in an airy place. When dry, rub with saddle soap. Use fine steel wool (lightly) or a suede brush on suede when dry. Rinse leather and suede jackets in cold water and dry away from heat.
Sponge lightly with thick suds of soap or detergent and wipe with a clean, damp cloth. Use as little water as possible on the fabric.
Treat with bleach.
Water, detergent and a good stiff nylon or bristle brush.
Oil promptly to prevent rust.
Brush off with a bristle broom when completely dry.

AFTER

What you will need in your Emergency Kit

- Warm, waterproof clothing and a change of clothing

- Blankets/sleeping bag
- Rubber shoes and/or gumboots
- Hats, sunscreen

- Camping stove or small BBQ

- A food kit filled with foods that do not need to be refrigerated. Make sure it includes bottled water

- Baby food and baby care items (e.g. nappies, if applicable)
- Pet food (if applicable)
- A list of emergency telephone numbers (take this brochure with you)

- A first aid kit and medications
- Your mobile phone and charger

- A portable radio with spare batteries tuned to ABC 91.7FM
- Candles and waterproof matches

- Torch with spare batteries

- Rubber gloves
- Toiletries, personal hygiene products and toilet paper
- Alcohol wipes and anti-bacterial gel

- Children's activities such as colouring books, pens and pencils (if applicable)
- A waterproof bag for clothing and valuables
- Important papers (including insurance documents), bank books, money and credit cards
- Valuables and cherished articles (jewellery, photos, etc.)

Your Emergency Kit should be kept in a waterproof storage box. Check your Kit contents regularly and restock any out-of-date items such as batteries.

Your personalised list of emergency supplies

In the space below, take note of any specific requirements you may need to add to your Emergency Kit, e.g. medications or prescriptions.

Your personalised list of phone numbers

In the space below include telephone numbers for your doctor, insurance broker, bank and family members.

Important telephone numbers

Tasmania Police
General enquiries 131 444
Emergency 000

State Emergency Service
General enquiries 6434 5333
Emergency 132 500

Ambulance
General enquiries 1300 303 196
Emergency 000

Tasmania Fire Service
General enquiries 6434 6700
Emergency 000

TasNetworks 1300 132 003

Bureau of Meteorology 1300 659 216

Kentish Council
Business hours 6491 0200
After hours 6491 0200

Important Websites

www.ses.tas.gov.au/
www.kentish.tas.gov.au/page.aspx
www.alert.tas.gov.au/Pages/Home.aspx

Kentish Council acknowledge the assistance rendered by Launceston City Council and their EMO Bev Allen.

MY FLOOD RISK DISK

Use this Risk Disk to estimate the flood risks for your property.

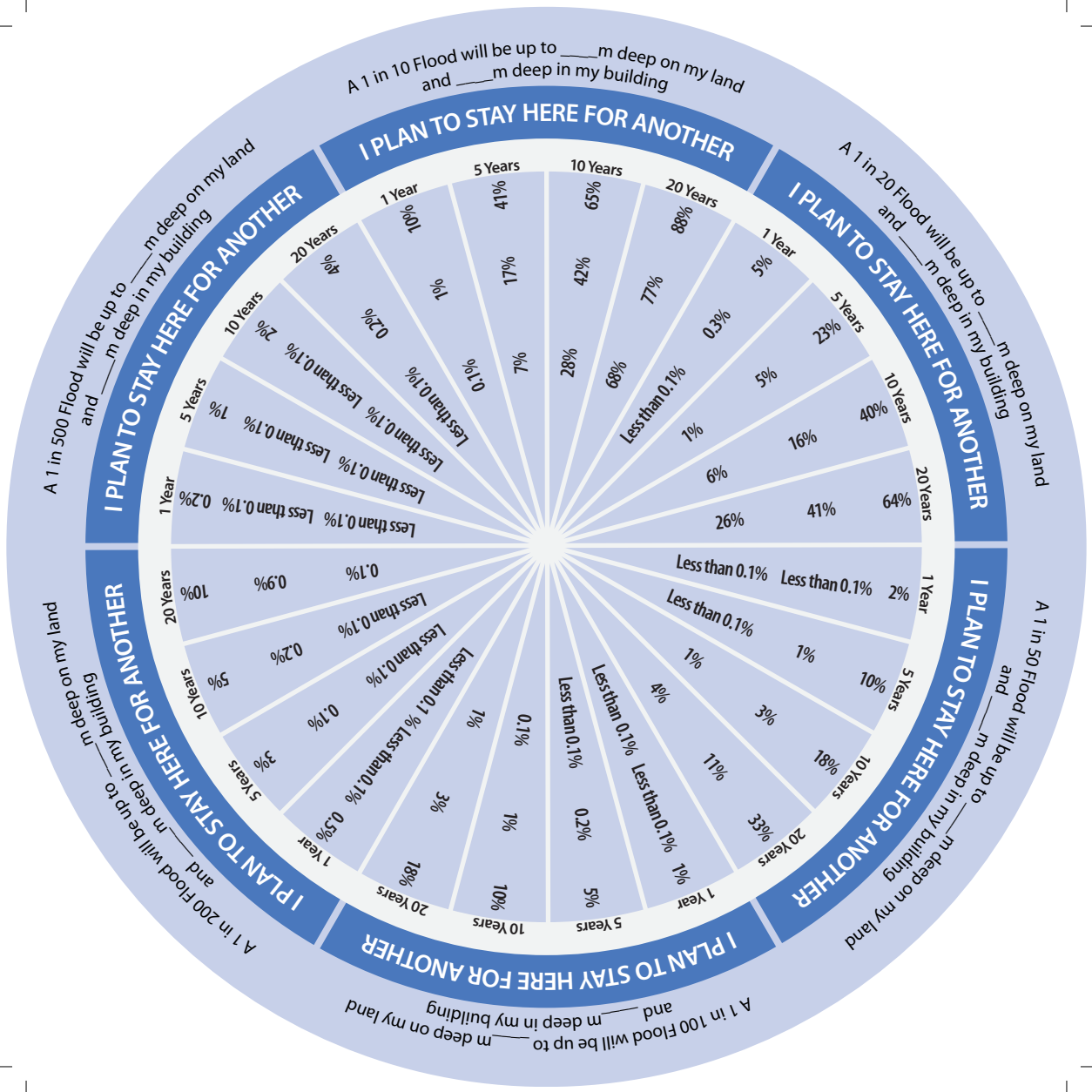
See back of disk for instructions

In this time the chance of my property being flooded to this depth at least

Three times is | Twice is | Once is

Ask your State Emergency Service for advice on how to reduce damages to your property and improve your safety during floods. Act on that advice

KENTISH



To estimate your flood risks follow these simple steps:

1. Ask your local council for the levels of the floods listed in the table below and write them in the spaces provided. Not all councils will have data on all of these floods.
2. Ask your local council for the minimum ground level of your land and write it in every space in that row of the table below. Make sure that it is measured on the same scale as the flood levels (eg metres above sea level or river gauge height).
3. If the ground level is lower than the flood level, subtract it from the flood level and write the result in the space in the table for each flood. This is how deep each flood could be on your property.

Flood	1 in 10	1 in 20	1 in 50	1 in 100	1 in 200	1 in 500
Flood Level (m)						
My ground level (m)						
Maximum flood depth on my land (m)						
Flood Level (m) (same as first row)						
My Floor level (m)						
Flood depth in my building (m)						

4. Write all of the flood levels from the first row again in the next row of the table.
5. Ask your council for the floor level of your building and write it in every space in that row of the table. Make sure that it is measured on the same scale as the flood levels
6. If the floor level is lower than the flood level, subtract it from the flood level and write the result in the space in the table for each flood. This is how deep each flood could be in your building.
7. Write the two sets of flood depths, from the table, in the spaces on the front of the disk for each flood which would affect your property. Note that if you are protected by a levee only floods which overtop the levee will affect your property
8. Decide how many more years you expect to occupy your property: 1; 5; 10; or 20 years. Turn the dial on the front of the disk to this number of years for any flood which could affect your property
9. Look up the chances* of your property experiencing such flood depths at least once, twice or three times in the time you expect to be there. Do this for each flood which could affect your property.
10. Ask your State Emergency Service for advice on how to reduce damages to your property and improve your safety during floods. Act on that advice.

* A 1% chance means the odds of the flood occurring in the chosen time are 100 to 1. A 20% chance means 5 to 1 and a 50% chance means 2 to 1. More than a 50% chance means that it is more likely than not that such a flood will occur.

APPENDIX J

Flood Warning Escalation Chart Redwater Creek Floods

Actions Conditions / Triggers and Responses relating to Redwater Creek floods

To determine flows see rating chart

	Consequence	Action	Notify / Contact
Predicted rainfal to exceed 70 mm in 12 hours possible 10 Year ARI Flood	10 Year ARI flood possible flooding 12 to 29 properties may be affected	Door knock properties deliver flood pack put owners on standby and request outside work force to monitor roads. Refer to list of properties affected by 10Year event	Police, SES and General Manager and DHSS
	Rainfall confirmed, flood starts to rise	Evacuate people affected who want to go to the Evacuation Centre	SES / Police / DHSS
		Monitor Dowbiggin St and New Bed Rd for flooding and Railway Bridge for blockage	Deputy Emergency Management Coordinator(Works Depot Coordinator)/Police
For floods exceeding 10 Year ARI	Consider opening emergency evacuation centres	Place approaprriate resource on standby and activate as required	EM Recovery Co-ordinator/DHSS/ SES / Police
Predicted rainfall to exceed 80 mm in 12 hours possible 20 Year ARI Flood	20 Year ARI flood possible flooding 18 to 42 properties may be affected	Door knock properties deliver flood pack put owners on standby and request outside work force to monitor roads. Refer to list of properties affected by 20Year event	Police, SES and General Manager and DHSS
	Rainfall confirmed, flood starts to rise	Evacuate people affected who want to go to the Evacuation Centre	SES / Police / DHSS
		Monitor Dowbiggin St, New Bed Rd, Foster St & Railton Rd Bridges for flooding and Railway Bridge for blockage	Deputy Emergency Management Coordinator(Works Depot Coordinator)/Police
Predicted rainfall to exceed 100 mm in 12 hours possible 50 Year ARI Flood ; greater than 112 mm = 100 Year event ;greater than 128 mm = 200 Year event	50 Year to 200 ARI flood possible flooding 34 to 92 properties may be affected and many roads cut by flood water	General evacuation of flood affected area	Police, SES and General Manager and DHSS
		Monitor Dowbiggin St, New Bed Rd, Foster St & Railton Rd Bridges for flooding and Railway Bridge for blockage when safe to do so	Deputy Emergency Management Coordinator(Works Depot Coordinator)/Police

ARI Flood Event	Max flood level > Floor level	Max flood level + 0.3 m > Floor level
10 Year	1	3
20 Year	18	42
50 Year	34	76
100 Year 2011 Flood	54	87
200 Year	58	92

Likely Tasmania Police Road closure notifications based on January 2011
Closed
Foster Street, Railton (between Dowbigging & King Street)
Railton - all roads in and out of Railton are closed
Railway at Railton closed due to flooding.
Railton Road at Caroline Creek
Caution
Railton Road, Railton - Sheets of water on the road

External Organisations

	Consequence	Action	Notify / Contact
For floods exceeding 10 Year ARI	Water on roads will present a hazard if electrity poles are damaged	Refer to appropriate Authority prepare to close road	Tasnetworks, Police, Works Depo
For floods exceeding a 50 Year Event notify TasWater to isolate and make safe any chlorination equipment	Water may enter and over top sewerage lagoons and access may be lost	Switch off chlorine cylinders	TasWater

ADDRESS	CT REF	IMPROVEMENT	FLOOR HEIGHT	MEAN_FLOOD	MIN_FLOOD	MAX FLOOD	Max Flood - Floor	Max Flood + 0.3 - Floor
1 MORRISON ST	60290/1	HOUSE	63.32	63.061	62.953	63.349	0.029	0.329
10 CROCKERS ST	144440/1	House incomplete	63.9704	63.019	62.751	63.824	-0.146	0.154
11 CROCKERS ST	60290/35	FIRE STATION	64.6	64.675	64.201	64.949	0.349	0.649
11 ESPLANADE	219852/17	HOUSE	63.266	63.016	62.916	63.261	-0.005	0.295
13 CROCKERS ST	60290/26	5 Dwellings & Garage	66.52	65.907	65.612	66.312	-0.208	0.092
13 CROCKERS ST	60290/27	5 Dwellings & Garage	67.14	66.418	66.015	66.847	-0.293	0.007
13 CROCKERS ST	60290/32	5 Dwellings & Garage	66.34	65.874	65.051	66.450	0.110	0.410
13 CROCKERS ST	60290/33	5 Dwellings & Garage	64.9	64.748	64.312	65.051	0.151	0.451
15 ESPLANADE	127081/1	House	63.4345	62.968	62.954	63.157	-0.277	0.023
15 MORRISON ST	63535/1	HOUSE	64.9199	64.225	64.005	64.727	-0.193	0.107
16 CROCKERS ST	83096/3	HOUSE	64.2624	63.756	63.534	64.032	-0.230	0.070
17 MORRISON ST	72957/1	HOUSE	64.9389	64.347	64.029	64.728	-0.211	0.089
19AD CROCKERS ST	60290/24	4 HOME UNITS	65.27	64.676	64.401	65.284	0.014	0.314
2 FOSTER ST	12259/1	ST OFF. SHP & HOUS	62.687	62.748	62.747	62.748	0.061	0.361
22 CROCKERS ST	61512/2	HOUSE	63.3366	63.521	63.155	64.023	0.686	0.986
22 MORRISON ST	231659/1	HOUSE	66.2327	65.935	65.705	66.564	0.331	0.631
25 CROCKERS ST	79247/5	HOUSE	65.89	65.288	65.100	65.601	-0.289	0.011
3 ESPLANADE	240697/1	EXCHANGE	62.5957	62.748	62.748	62.749	0.153	0.453
3 MORRISON ST	81952/3	HOUSE	63.34	63.282	63.111	63.350	0.010	0.310
32 MORRISON ST	222007/1	HOUSE	68.9577	68.290	67.923	68.672	-0.286	0.014
42 MORRISON ST	215827/2	House	69.14	68.934	68.746	69.255	0.115	0.415
5 ESPLANADE	155469/1	House	62.4765	62.749	62.748	62.750	0.273	0.573
51 MORRISON ST	40640/21	HOUSE	70.0657	69.392	68.978	70.034	-0.032	0.268
53 MORRISON ST	153676/1	Dwelling	70.7025	70.121	69.210	70.944	0.242	0.542
64 FOSTER ST	40640/14	House	69.8524	69.569	69.569	69.569	-0.283	0.017
6A LATROBE RD	100717/1	House	60.01	60.563	60.314	61.281	1.271	1.571
8 CROCKERS ST	144440/2	House	63.9744	63.194	62.751	63.728	-0.246	0.054
ESPLANADE	155469/2	WORKSHOP	62.2701	62.749	62.748	62.751	0.481	0.781

Properties at Risk in a 10 Year Flood Event

This list represents a minimum response if the flood has been underestimated flooding will affect more properties

ADDRESS	CT REF	IMPROVEMENT	FLOOR HEIGHT	MEAN_FLOOD	MIN_FLOOD	MAX_FLOOD	Max Flood - Floor	Max Flood + 0.3 - Floor
1 KIMBERLEY RD	22129/3	HOUSE	63.69	62.446	62.337	62.715	-0.975	-0.675
1 MORRISON ST	60290/1	HOUSE	63.32	63.089	62.978	63.379	0.059	0.359
10 CROCKERS ST	144440/1	House incomplete	63.9704	63.207	62.854	63.790	-0.180	0.120
11 CROCKERS ST	60290/35	FIRE STATION	64.6	64.692	64.214	64.966	0.366	0.666
11 ESPLANADE	219852/17	HOUSE	63.266	63.036	62.942	63.245	-0.021	0.279
12 CROCKERS ST	210547/1	HOUSE	64.1619	63.167	62.830	63.871	-0.291	0.009
12 FOSTER ST	202156/1	Shop	#N/A	62.904	62.845	63.069		0.300
13 CROCKERS ST	60290/27	5 Dwellings & Garage	67.14	66.447	66.033	66.903	-0.237	0.063
13 CROCKERS ST	60290/28	5 Dwellings & Garage	66.63	65.852	65.455	66.372	-0.258	0.042
13 CROCKERS ST	60290/32	5 Dwellings & Garage	66.34	65.730	65.059	66.458	0.118	0.418
13 CROCKERS ST	60290/33	5 Dwellings & Garage	64.9	64.798	64.349	65.178	0.278	0.578
15 MORRISON ST	63535/1	HOUSE	64.9199	64.244	64.005	64.742	-0.178	0.122
16 CROCKERS ST	83096/3	HOUSE	64.2624	63.809	63.596	64.084	-0.178	0.122
17 MORRISON ST	72957/1	HOUSE	64.9389	64.398	64.122	64.779	-0.160	0.140
18 CROCKERS ST	83096/2	HOUSE	64.2807	63.883	63.692	64.113	-0.168	0.132
19AD CROCKERS ST	60290/24	4 HOME UNITS	65.27	64.714	64.456	65.306	0.036	0.336
2 FOSTER ST	12259/1	ST OFF. SHP & HOUS	62.687	62.821	62.815	62.829	0.142	0.442
20 CROCKERS ST	221612/1	HOUSE	64.3808	63.964	63.804	64.138	-0.243	0.057
20 MORRISON ST	79388/7	HOUSE	65.5413	65.038	64.661	65.255	-0.286	0.014
22 CROCKERS ST	61512/2	HOUSE	63.3366	63.551	63.183	64.119	0.782	1.082
22 MORRISON ST	231659/1	HOUSE	66.2327	65.975	65.772	66.607	0.374	0.674
25 CROCKERS ST	79247/5	HOUSE	65.89	65.421	65.127	65.773	-0.117	0.183
3 ESPLANADE	240697/1	EXCHANGE	62.5957	62.828	62.824	62.832	0.236	0.536
3 FOSTER ST	128977/1	HOTEL	62.9276	62.357	62.082	62.749	-0.179	0.121
3 MORRISON ST	81952/3	HOUSE	63.34	63.301	63.105	63.381	0.041	0.341
32 MORRISON ST	222007/1	HOUSE	68.9577	68.323	67.968	68.717	-0.241	0.059
35 MORRISON ST	40640/27	HOUSE	68.6753	68.206	67.673	68.377	-0.298	0.002
38 MORRISON ST	230106/4	HOUSE	69.0748	68.769	68.594	68.873	-0.202	0.098
4 FOSTER ST	79774/1	HOUSE	63.14	62.828	62.817	62.843	-0.297	0.003
42 MORRISON ST	215827/2	House	69.14	69.005	68.801	69.292	0.152	0.452
4-6 LATROBE RD	81417/1	HOUSE	60.7	60.463	60.257	60.673	-0.027	0.273
5 ESPLANADE	155469/1	House	62.4765	62.831	62.828	62.835	0.358	0.658
51 MORRISON ST	40640/21	HOUSE	70.0657	69.468	69.023	70.101	0.035	0.335
53 MORRISON ST	153676/1	Dwelling	70.7025	70.182	69.232	70.890	0.187	0.487
64 FOSTER ST	40640/14	House	69.8524	69.534	69.159	69.975	0.123	0.423
6A LATROBE RD	100717/1	House	60.01	60.502	59.868	61.833	1.823	2.123
70 FOSTER ST	40640/17	HOUSE	70.7661	70.507	70.200	70.669	-0.097	0.203
72 FOSTER ST	40640/18	HOUSE	70.9946	70.710	70.496	70.846	-0.149	0.151
8 CROCKERS ST	144440/2	House	63.9744	63.258	62.841	63.789	-0.185	0.115
9 GIBLIN ST	60290/50	HOUSE	67.68	66.830	66.742	67.399	-0.281	0.019
9 KIMBERLEY RD	143878/2	Dwelling	63.05	62.429	62.206	63.175	0.125	0.425
9 LATROBE RD	243127/1	Dwelling	61.15	60.870	60.870	60.870	-0.280	0.020
ESPLANADE	155469/2	WORKSHOP	62.2701	62.831	62.827	62.839	0.569	0.869

Properties at Risk in a 20 Year Flood Event

This list represents a minimum response if the flood has been underestimated flooding will affect more properties