West Gippsland
Catchment Management Authority

WGCMA Floodplain Mapping Program

Floodplain Mapping for Merrimans Creek

March 2026

Document details

Project name	Floodplain mapping for Merrimans Creek
Priority system	Merrimans Creek and Monkey Creek
Priority township	Gormandale, Willung and Stradbroke
Author	
Hydrology consultant	
Hydraulics consultant	
Document status	Final
Version no.	Version no.1
Date last modified	5/06/2015
Hydrology software	Rorb – Version 6.15
Hydraulics software	Sobek – Version 2.14
Hydraulics dimensionality	1D/2D

Table of Contents

List of Figures

List of Tables

Glossary

TERM	DESCRIPTION
Annual Exceedance Probability (AEP)	Refers to the probability or risk of a flood of a given size occurring or being exceeded in any given year.
Australian Height Datum (AHD)	A common national surface level datum approximately corresponding to mean sea level. Introduced in 1971 to eventually supersede all earlier datum's.
Average Recurrence Interval (ARI)	The average or expected value of the period between exceedances of a given discharge or event.
Catchment	The area draining to a site.
Discharge	The rate of flow of water measured in terms of volume over time.
Discharge	The rate of flow of water measured in terms of volume over time.
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam.
Floodplain	Area of land which is subject to inundation by floods up to the probable maximum flood event
GDA94	The Geocentric Datum of Australia (GDA) is the new Australian coordinate system, replacing the Australian Geodetic Datum (AGD)
Geographical Information System (GIS)	A system of software and procedures designed to support the management, manipulation, analysis and display of spatially referenced data.
Hydraulics	The term given to the study of water flow in a river, channel or pipe.
Hydrograph	A graph that shows how the discharge changes with time at any particular location.
Hydrology	The term given to the study of the rainfall and runoff process as it relates to the derivation of hydrographs for given floods.
Hyetograph	
Intensity Frequency Duration	Intensity Frequency Duration, method of determining design rainfalls according to procedures in Australian Rainfall and Runoff. This includes total rainfall for a given design (ARI) storm event and the pre-determined temporal pattern over which this rainfall is distributed.
LIDAR	Light Detection and Ranging is an optical remote sensing technology that measures properties of scattered light to find range and/or other information of a distant target. The range to an object is determined by measuring the time delay between transmission of a pulse and detection of the reflected signal.
Peak discharge	The maximum discharge occurring during a flood event.
Probable maximum flood	The flood calculated to be the maximum that is likely to occur.

RORB	A rainfall-runoff hydrological modelling program
Runoff	The amount of rainfall that actually ends up as stream or pipe flow, also known as rainfall excess.
Sobek	A 1D/2D hydraulic modelling program
Topography	A surface which defines the ground level of a chosen area

Abbreviations

1D	One-Dimensional
2D	Two-Dimensional
AEP	Annual Exceedance Probability
AHD	Australian Height Datum
ARI	Average Recurrence Interval
AR&R	Australian Rainfall & Runoff
BoM	Bureau of Metrology
Cumec	Cubic metres per second
DEM	Digital Elevation Model
FFA	Flood Frequency Analysis
FO	Flood Overlay
GDA	Geographic Datum of Australia
GIS	Geographic Information System
IFD	Intensity – Frequency – Duration
LiDAR	Light Detection and Ranging
LSIO	Land Subject to Inundation Overlay
m^3/s	Metres cubed per second
WGCMA	West Gippsland Catchment Management Authority

1 Introduction

1.1 Purpose

The purpose of conducting floodplain mapping for the Merrimans Creek area above the Seaspray Township is to determine the nature and extent of flooding through the estimation of design flood flows, levels and velocities. The flood information produced by these investigations will be used by West Gippsland CMA for statutory planning purposes, planning schemes and emergency management purposes.

1.2 Objectives

The objectives of the Merrimans Creek floodplain mapping project as set out by the WGCMA were as follows:

- Derive a RORB model for the whole of the Merrimans Creek catchment area, using the Seaspray Flood Study conducted by WaterTech as a guide to ensure flow estimates correspond with the Seaspray Flood Study
- Calculate and tabulate expected design flow hydrographs for Merrimans Creek for 2, 5, 10, 20, 50, and 100 year ARI flood events.
- Derive a 1D/2D hydraulic model using Sobek
- Determine the 2, 5, 10, 20, 50, and 100 year ARI flood extents, depths and velocities
- Determine flood hazard based on peak flood velocity and depth
- Prepare maps corresponding to requirements for inclusion into the Victorian Flood Database

2 Study Area

The study area is the Merrimans Creek catchment, which is situated in the South Gippsland basin. The catchment area is approximately 500 square kilometres with a main stream length of approximately 100 kilometres, shown in Figure 1. Merrimans Creek begins at Balook and flows through the small rural towns of Gormandale, Willung and Stradbroke before reaching the township of Seaspray. However this study does not include the township of Seaspray as this is covered in a separate flood study conducted by Water Tech (2015).

Balook is elevated at approximately 680 metres AHD (Australian Height Datum), and has an annual average rainfall of approximately 1500 mm. The steep terrain is used predominately for logging or allocated as National Parks. The characteristics of Merrimans Creek at the top of the catchment consists of a creek bed predominately of large rocks with the overbank very overgrown with dense vegetation and large gum trees and minimal floodplain storage.

Merrimans Creek then flows through a small rural town of Gormandale, which is situated between Traralgon and Yarram and has a population of approximately 450 people. Gormandale is elevated at approximately 130 metres AHD. The characteristics of Merrimans Creek around the township of Gormandale consist of large well defined floodplains that are predominately used for farm land, with the creek bed loamy soil with grassed overbanks. The main industry in Gormandale is farming, which relies heavily on Merrimans Creek as a water source. The Merrimans Creek floodplain through the Gormandale Township was historical recorded as being swampy marsh land, unusable for farming purposes. This brought about the construction of the Merrimans Creek Drain in the late 1890's, which runs from the upstream side of the town to Timbs Crossing Road. The drain enabled the development of more productive farming land and has a major impact on flooding characteristics of the floodplain.

The Creek then flows through the small farming communities of Willung and Stradbroke. Willung is elevated at approximately 100 metres AHD, while Stradbroke West and Stradbroke are elevated at approximately 85 metres AHD and 40 metres AHD respectively. The annual average rainfall for this area is 670 mm. The main land use for this area is farming and pine plantations. The creek then flows to the coast at Seaspray. The mouth of the creek is elevated at approximately 1 metre AHD, and the average annual rainfall at the bottom of the catchment is 620 mm.

The catchment area has two major waterways, Merrimans Creek and Monkey Creek, there confluence is located downstream of Stradbroke. Monkey Creek has an approximate catchment area of 90 square kilometres with a predominant land use of forestry.

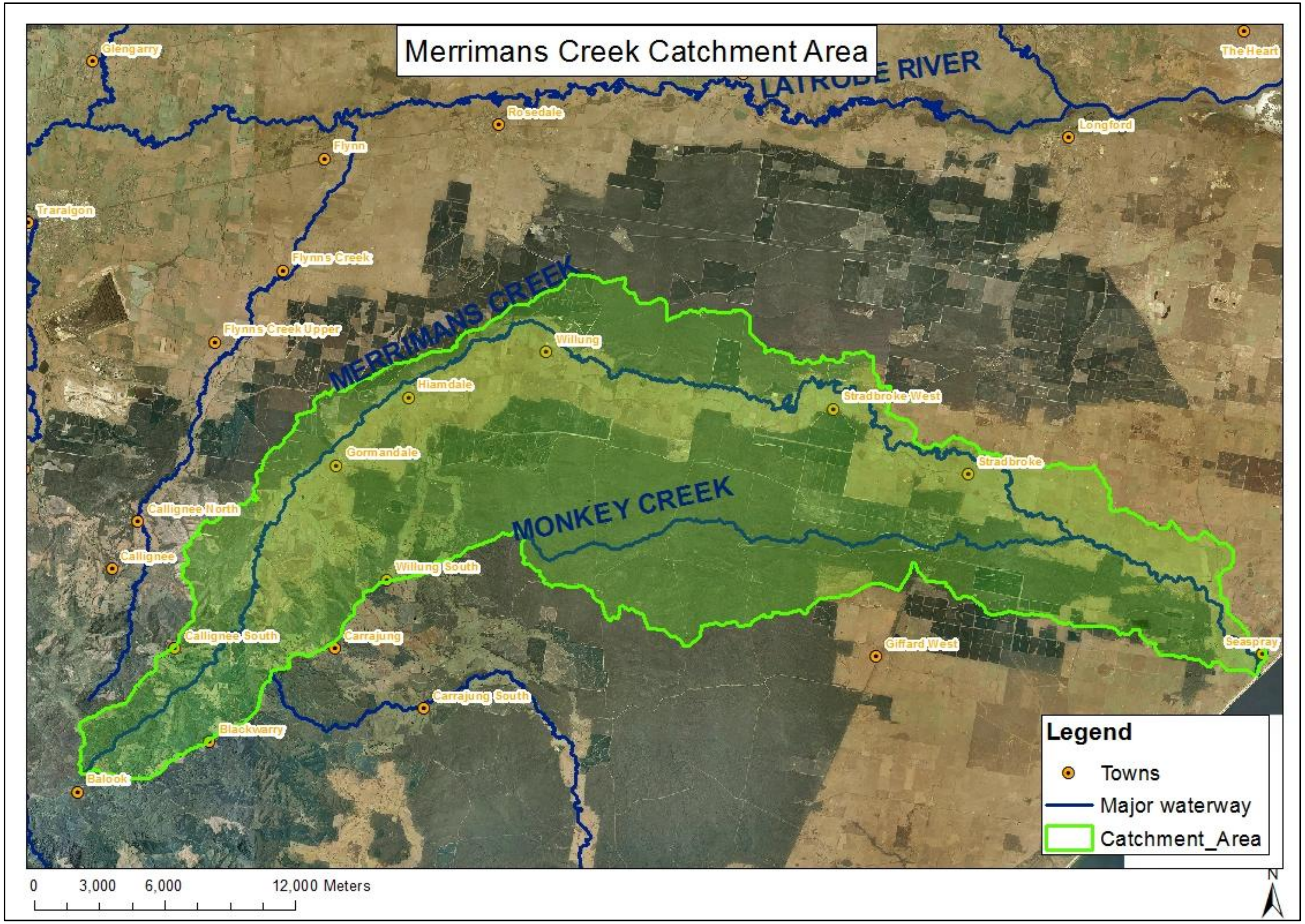


Figure 1Merrimans Creek Catchment Area

3 Previous Decision – Related Data

This section outlines the different types of information utilised within the study including referenced reports and documents as well as data, both previously available and collected specifically for this study.

1.1 Flood History

Information relating to the flood history for Merrimans Creek was obtained from the Wellington Shire Flood Emergency Plan (2013) document (State Emergency Services Victoria, 2013). This report outlined that Merrimans Creek has had at least 12 significant flood events between 1916 and 1980. Table 1 estimates the number of properties impacted in a 100 year ARI flood event.

Table 1 Estimated number of properties likely to be impacted by a 100 year ARI event

Estimated Number Of Properties Subject To Flooding In A 100 Year ARI Event					
Township	**Residential**	**Business**	**Industrial**	**Rural**	**Total**
Seaspray	7	0	0	18	25
Stradbroke	0	0	0	38	38
Gormandale	1	0	0	33	34
Willung	0	0	0	31	31

It was also recorded that the 1993 September Flood Event was considered to be a 2% AEP or 50yr ARI event. The recorded gauge heights for the three streamflow gauges located in the catchment for this flood event are listed in Table 2.

Table 2 Gauge heights for 2% AEP flood event

September 1993 Flood Event	
Gauge	**Gauge Height (m)**
MerrimansCk @ Callignee South 227205	3.54
MerrimansCk @ Stradbroke West 227239	8.32
MerrimansCk @ Prospect Rd Seaspray 227240	5.53

The following roads that are likely to be closed during flood events are:

- South Gippsland Highway – at Stradbroke
- Taylors Lane bridge over Merrimans Creek at Stradbroke

Further historical events are outlined in Appendix A.1, Table 20.

1.2 Related Flood Studies

Previous hydrologic and hydraulic studies relevant to floodplain mapping of Merrimans Creek are:

- Seaspray Flood Study Hydrology Report, (Water Tech 2015) – This study used RORB to estimate the design floods of Merrimans Creek for the Seaspray Township.

Water Technology developed a RORB hydrological model for the Merrimans Creek catchment area and this model has been utilised for the hydrology analysis for this project.

- Camp Scott Seaspray Flood Study 1980 – This study uses a RORB model to estimate the design floods for Seaspray.

Information from the related studies have been used for calibration purposes and to verify key parameters used.

1.3 Topographic Data

Overview

Topography data was used for the hydraulic modelling, mapping and validation against survey data. The topography data used consists of:

- Aerial Survey – LiDAR
- Digital Aerial Photography
- Field Surveying Data

Aerial Survey - LiDAR

The LiDAR dataset used for this study was supplied by the West Gippsland Catchment Management Authority. LiDAR surveying was conducted over the Merrimans Creek study area in February, 2010, by Fugro Spatial Solutions Pty Ltd. The results obtain identified the AHD vertical spatial accuracy is within the target specification, with 78% of the points analysed falling within +/-0.20 metres. A full Metadata report for the LiDAR data set is documented in (Furgo Spatial Solution Pty Ltd, 2010).

The LiDAR extent over Merrimans Creek is shown in Appendix A.2, Figure 21.

Digital Aerial Photography

Digital aerial photography used for this study was supplied by WGCMA and obtained in 2009. The aerial photography covers the whole West Gippsland Region and was used to provide base imagery for the Merrimans Creek catchment area.

Field Surveying Data

Field surveying was required to provide additional data to the LiDAR information at the location of key one-dimensional elements. Surveying was conducted during March 2015 using Leica surveying equipment and validated using benchmarks to ensure the appropriate accuracy was achieved.

The component of the survey consisted of bridge and culvert hydraulic structures that were assumed to have a significant influence on the floodplain flow and storage.

A total of 10 hydraulic structures, including two culverts, were surveyed with locations shown in Appendix A.3 and dimensions outlined in Appendix D.

Survey points were also taken for the cross section of the main channel at the location of the Merrimans Creek and Drain confluence to validate the accuracy of the LiDAR for channel cross sections. This location was chosen as it was easily accessible due to the narrow channel and low water depth. Comparisons showed using LiDAR resulted in a smaller cross sectional area, which will produce a more conservative approach to flood extents.

1.4 Hydrologic and Hydraulic Data

Streamflow Data

The hydrologic analysis and modelling requires streamflow data. Merrimans Creek catchment has three streamflow gauging stations, listed in Table 3, which will be used for this study. The location of the streamflow stations are shown in Figure 2.

Table 3 Stream flow Gauges

Station Number	Station Name	Catchment Area (km^2)	Period of Record
227205	Merriman Creek @ Calignee South	39.5	29/01/1975 to present
227239	Merriman Creek @ Stradbroke West	220.0	18/11/1983 to present
227240	Merriman Creek @ Prospect Rd Seaspray	236.5	26/08/1983 to present

Rainfall Data

Rainfall data was required for the hydrologic analysis, rain gauges stations used for this study are listed in Table 4. The locations of the rain gauge station are shown in Figure 2.

Table 4 Rain Gauge Stations

Site Number	Name
085072	East Sale Airport
085236	Calignee North
585186	Mount Tassie
227239	Stradbroke West

Existing LSIO and Flood Overlay

The existing Land Subject to Inundation Overlay (LSIO) and Flood Overlay (FO) for Merrimans Creek which are included in the current planning scheme are shown in Appendix A.4, Figure 23.

This study aims to refine the current overlays.

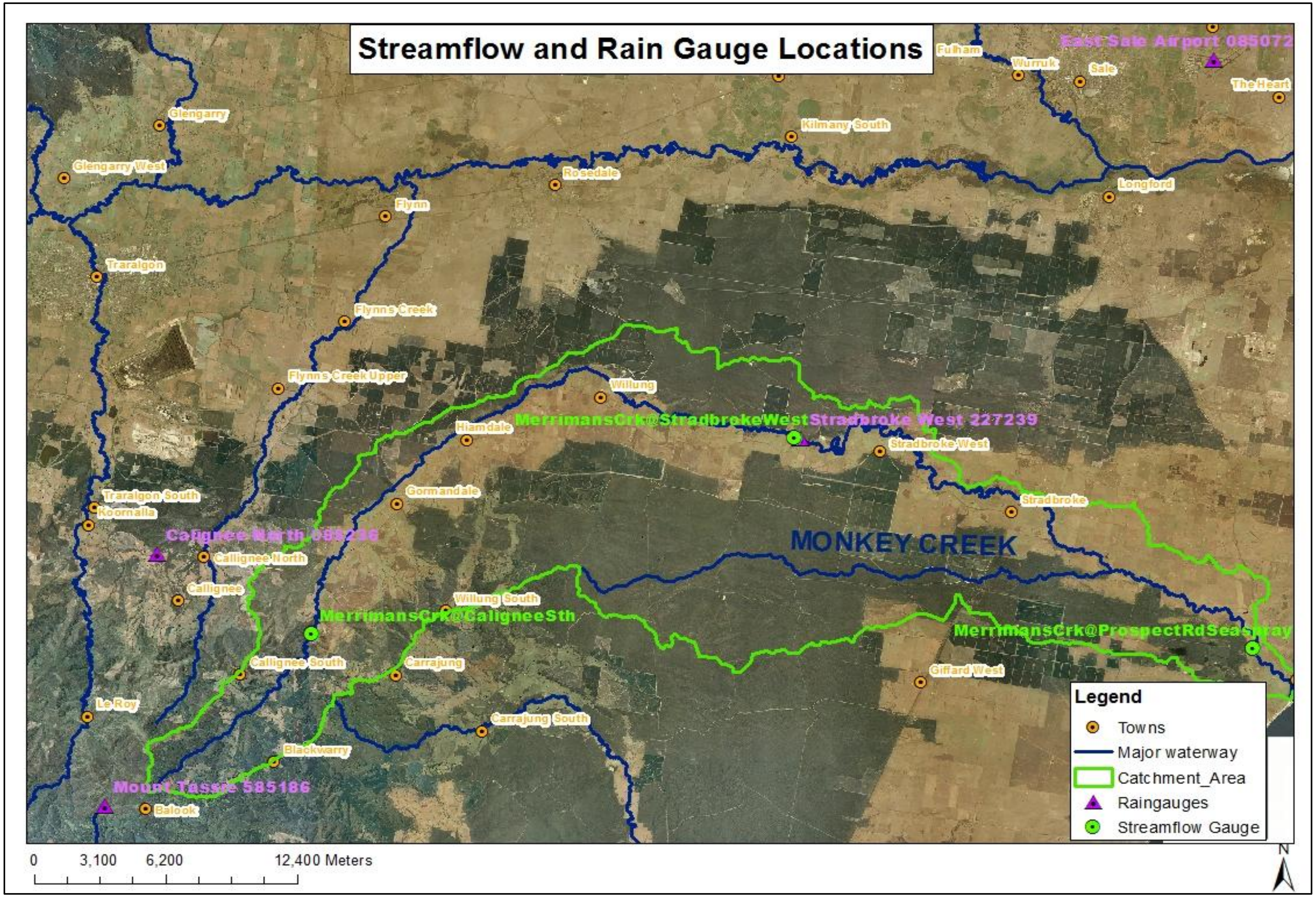


Figure 2 Streamflow and Rain Gauge Locations

4 Hydrology

4.1 Overview

The hydrological analysis of the Merrimans Creek catchment area consisted of a review of hydrological data, flow estimation calculation methods, flood frequency analysis, and hydrological modelling using RORB. RORB is a non-linear rainfall-runoff routing model for calculating flow hydrographs in stream networks. The hydrologic model will convert rain falling over the catchment into flow in the stream for various storm events and scenarios. The RORB model and parameters used in the model were calibrated using three gauged flood events and were validated against flood frequency analysis and compared to flow estimation methods. The purpose of the hydrological model is to determine flows to be used as the inflows for the hydraulic model.

4.2 Flow Estimation Methods

Three different flow estimation methods were used for comparison with design flows obtained from the RORB hydrologic model. The flow estimation equations are outlined below:

Nikolaou and Von't Steen Regional Estimate

The Nikolaou and Von't Steen regional estimate, which is an empirical equation developed by Nikolaou and Roelvon't Steen, which estimates the flow for a 100 year ARI flood event based on the area of the catchment using equation 3.1. Where A is the area in square kilometres (Km^2) and Q_{100} is the 100 year ARI flow in metres cubed per second (m^3/s).

$$Q_{100} = 4.67 \times (A^{0.763}) \qquad \text{Eq. 3.1}$$

Rational Method

The Rational method was used to estimate flows for a 2, 5, 10, 20, 50, and 100 year ARI flood event, using equation 3.2. Where C_Y is the runoff coefficient for the Y year ARI flood event, which will be determined using the Australian Rainfall and Runoff guidelines. $I_{tc,Y}$ is the rainfall intensity in mm per hour with a duration t_c and an ARI of Y years. The variable t_c is the time of concentration or duration used to select the appropriate rainfall intensity, which is calculated using the Adams equation (Eq. 3.3), which is used for Victorian and Eastern NSW catchments. The rainfall intensity will be determined using the Bureau of Meteorology Rainfall Intensity-Frequency-Duration (IFD) data system. The intensity will be determined using the old IFD data system which uses rainfall analysis published in 1987 and the new IFD data system which uses rainfall analysis published in 2013, enabling the comparison of results. Q_Y is the flow for the Y year ARI flood event.

$$Q_Y = 0.278 \times C_Y \times I_{tc,Y} \times A \qquad \text{Eq. 3.2}$$

$t_c = 0.76 \times (A^{0.38})$ Eq. 3.3

Zaman Flow Estimation Method

The Zaman flow estimation method, developed by Zaman, Haddad and Rahman (2013), uses equations 3.4 to 3.9 to determine the flow for the particular ARI flood event. The equations use the catchment area and Rainfall Intensity for the particular ARI flood event to determine the flow for 2, 5, 10, 20, 50 and 100 year ARI flood events.

$\log_{(10)}(Q_2) = -3.055 + 1.186\log_{10}(Area) + 2.103\log_{10}(I_{tc\_2})$ Eq. 3.4

$\log_{(10)}(Q_5) = -2.847 + 1.182\log_{10}(Area) + 2.0891\log_{10}(I_{tc\_5})$ Eq. 3.5

$\log_{(10)}(Q_{10}) = -2.476 + 1.13\log_{10}(Area) + 1.932\log_{10}(I_{tc\_10})$ Eq. 3.6

$\log_{(10)}(Q_{20}) = -2.766 + 1.173\log_{10}(Area) + 2.108\log_{10}(I_{tc\_20})$ Eq. 3.7

$\log_{(10)}(Q_{50}) = -2.793 + 1.169\log_{10}(Area) + 2.132\log_{10}(I_{tc\_50})$ Eq. 3.8

$\log_{(10)}(Q_{100}) = -2.789 + 1.159\log_{10}(Area) + 2.135\log_{10}(I_{tc\_100})$ Eq. 3.9

4.3 Flood Frequency Analysis

Flood Frequency Analysis (FFA) is a method used that involves the statistical analysis of recorded peak flows to statistically estimate probabilities associated with the frequency of future flood events and flood magnitude. Flood frequency analysis was undertaken using stream flow data at the Calignee South and Prospect Road, Seaspray gauging stations due to the availability of sufficient data obtained from the Water Measurement Information Systems website (State Government of Victoria, 2015). The analysis method used for FFA was Log Pearson III method of moments and FLIKE, a computer based program developed by the School of Civil Engineering at the University of Newcastle in Australia. FLIKE uses a Bayesian statistical approach for parameter fitting of the flood records in order to determine the return period of different magnitude floods. FLIKE allows a range of probability distributions to be used for FFA; however the Log Pearson III distribution was applied for this analysis to allow comparison with the Log Pearson III method of moments, with a log-normal plot scale. The Log Pearson III is the most common statistical distribution used in Australian practice as it provides acceptable approximations to the distribution of flood flows (Ladson, 2008). A large number of approaches for parameter fitting have also been developed and tested for the Log Pearson III distribution. The first approach used for this study was the method of moments which involves estimating the product moments, mean, standard deviation and skew from the annual flood data (Ladson, 2008). The approach used for FLIKE was the Bayesian fitting approach which is considered the most complete parameter estimation approach; however they are computationally intensive and require specialized software (Ladson, 2008).

The estimated peak flows of selected Average Recurrence Interval (ARI) events based on the statistical analysis carried out using FLIKE and the Log Pearson III method of moments were used to validate the parameters used for the RORB model and design flows obtained from the RORB hydrologic model.

4.4 RORB Model Design Flood Estimation

Overview of RORB Runoff Routing Model

RORB is a runoff-routing model developed by Laurenson and Mein in 1992, which is a runoff and streamflow routing program that calculates flood hydrographs from rainfall. The model requires the catchment to be divided into sub-catchments, which are connected by reach storages. Design rainfall is applied to the centroid of each sub-catchment and specified losses are then deducted with the excess rainfall routed through the reach network. Flow hydrographs are then produced at points of interest.

The RORB model was calibrated using hydrographs from three different recorded flood events which have corresponding streamflow and pluviograph data. Each flood event will be represented with temporal and spatial rainfall distribution patterns. The RORB model was run using the initial loss / continuing loss model, requiring storage and loss parameters m, kc, initial loss and continuing loss to be set to allow fitting of the RORB modelled hydrographs to the gauged hydrographs from the selected storm events. The m parameter determines the degree of non-linearity of the catchments response to rainfall and the k_c parameter determines the storage available within the catchment. The parameter kc is the main parameter used to calibrate the model, a number of regional equations for the calculation of kc are recommended by Australian Rainfall and Runoff guidelines (ARR) and the RORB manual, which were used as a guide for the selection of this parameter. The ARR suggest recommendations for initial loss and continuing loss parameters to be used for Victorian catchments south and east of the great dividing range, which are CL = 2.5 mm/hr and IL = 15 – 20 or 25 – 35mm/hr (Canterford, 1987 Edition). The ARR recommendations were used as a guide when selecting parameters. The parameters were set to give the best fit of shape, peak and timing to the gauged hydrographs, and justified with flood frequency analysis and the flow estimation methods.

RORB Model Development

The RORB hydrological model developed by Water Tech (2015) for the Merrimans Creek catchment area has been utilised for the hydrology analysis for this project. The RORB model from the Seaspray Flood Study was obtained to allow unity between the two flood studies, and to ensure the flow estimated at the end of this study is in agreement with the flow estimate at the inflow boundary of the Seaspray Flood Study hydraulic model.

The initial delineation of catchments, sub-catchments and drainage paths for the Water Tech RORB model was determined using the ArcHydro tool (Water Technology, 2015). The catchment was split into 49 sub catchments with areas ranging from 5.5 to 17.5km². Appendix B.4 Figure 28 shows the schematisation of the RORB catchment file.

The Seaspray Flood Study calibrated the RORB model using the Prospect Road gauge. The shape and volume of the fitted hydrographs at Prospect Road matched well with the gauge data. It was noted that the volume at the Stradbroke West gauge was low, and the peak was high, indicating that the routing parameters applied to the whole model may not be appropriate for predicting flow at Stradbroke West. The Seaspray Flood Study suggested this could be improved by use of an interstation area at Stradbroke West gauge, which would allow RORB to use separate routing parameters upstream and downstream of that point.

The aim of the Seaspray Flood Study's RORB model was to provide a reasonable flow estimate for the boundary to their hydraulic model, therefore matching the closest gauge to the boundary was the focus of the calibration. The aim of this flood study is to provide reasonable flow estimates for the whole Merrimans Creek catchment area. Therefore, interstation areas will be investigated for predicting flows at the Calignee South and Stradbroke West gauges for this project.

Streamflow Gauge Review

Merrimans Creek at Calignee South (227205)

The Merrimans Creek at Calignee South gauge has 69 years of flow data recorded between the years of 1946 and 2015 using a control of an artificial concrete and rock weir. The rating curve is based on a large number of high flow gauging measurements with minimal scatter, shown in Figure 3, and is therefore expected to be reasonably reliable for high flows.

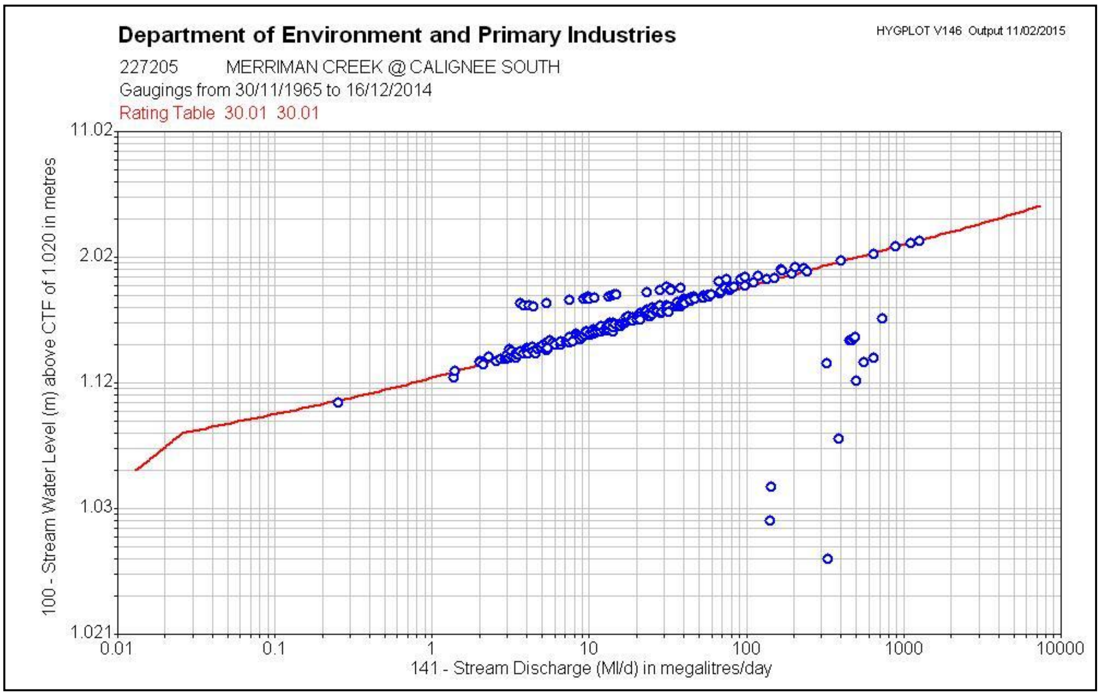


Figure 3 Rating Curve for Merrimans Creek @ Callignee South

Merrimans Creek at Stradbroke West (227239)

The Merrimans Creek at Stradbroke West gauge has 31 years of flow data recorded between 1983 and 2014. The rating curve is based on a small number of high flow gauging measurements with very little scatter, shown in Figure 4.

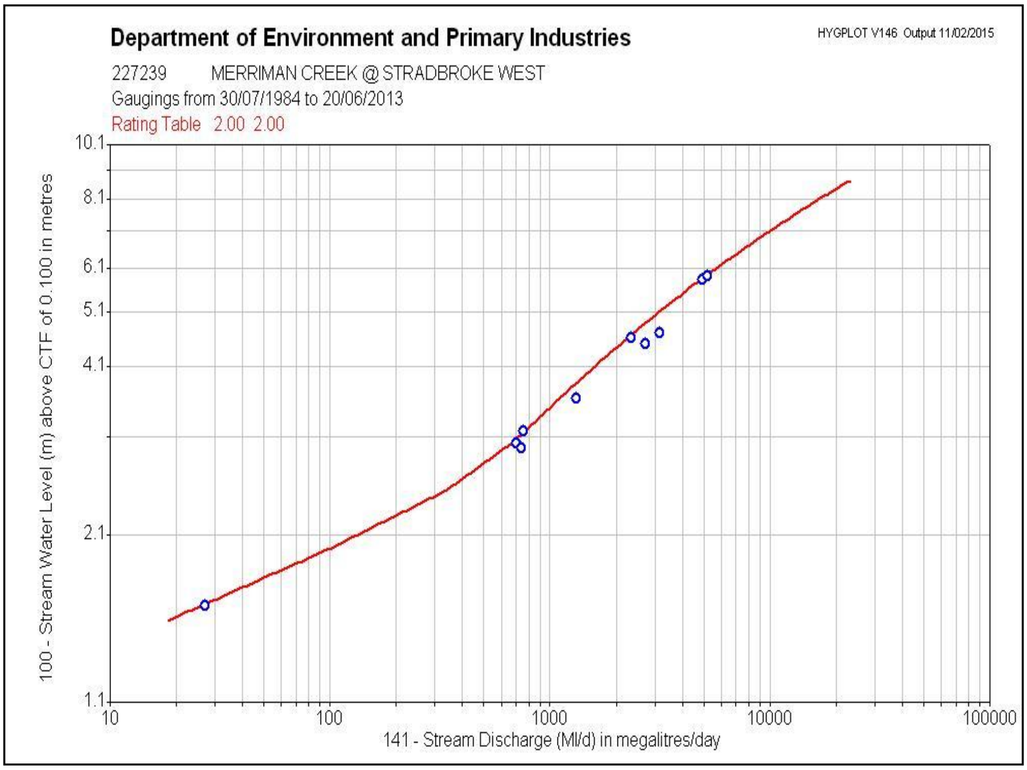


Figure 4 Rating Curve for Merrimans Creek @ Stradbroke West

Merrimans Creek at Prospect Road Seaspray (227240)

The Merriman Creek at Prospect Road gauge (227240) has 32 years of instantaneous flow data. The rating for the current gauge is officially considered reliable up to flows of 95 m^3/s, however the small number of physical gauging measurements show considerable scatter across the whole range, particularly for low flows, shown in Figure 5. Therefore flow estimates are likely to have a high degree of uncertainty (Water Technology, 2015).

The Water Tech report also states that a number of rating curves were used over the 32 year period of recording. This is due to the creek at this location having a sand bed which has been subject to significant instability over the recorded period. A changing water level /discharge relationship could be expected as the sand bed accretes and erodes (Water Technology, 2015).

Water Tech reviewed the long term water level record, identifying that following the 1993 event, gauged levels were elevated for a number of years, even during low flow periods.

They also found that after a sudden increase in 1993 the low flow water level slowly settled back to current levels over an approximate ten year period (Water Technology, 2015).

This is indicative of sand accretion in the channel after the 1993 event. The 1995 rating curve had a lower predicted flow for a given water level than the rating curve used in 1993, such that the recorded 1995 peak flow was lower than the 1993 peak, even though the water level was higher.

Water Tech undertook two dimensional hydraulic modelling of the gauge reach to verify the appropriateness of the rating curves for the calibration events. Determining a revised peak flow for 1993 of 350 m^3/s, compared to the previous estimate of 444 m^3/s (Water Technology, 2015).

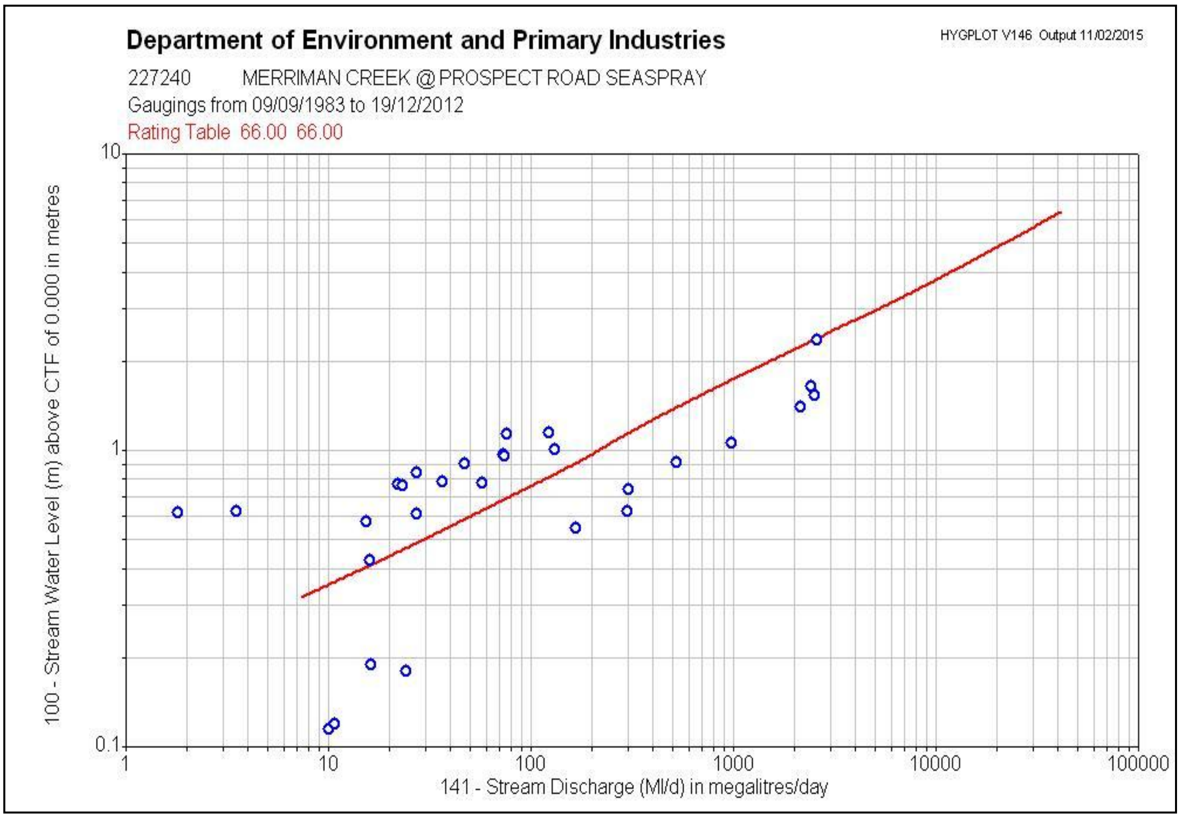


Figure 5Rating Curve for Merrimans Creek @ Prospect Rd Seaspray

Calibration Events

Three recorded storm events were selected to calibrate the RORB model, which occurred in September 1993, November 1995 and June 2012, outlined in Table 5. Figure 6 to Figure 10 show the aerial rainfall patterns used in each of the calibration runs, which were obtained from the Water Tech Seaspray Hydrology report. Figure 7 to Figure 11 show the rainfall hyetographs and recorded flows at all three gauges. The tabulated data relating to these plots is shown in Appendix B.4, Table 27 to Table 29.

Table 5 Storm events used for calibrating the RORB model

Event	Event Start & Finish Date	Recorded Peak Flow at Caligneee South Gauge (m³/s)	Recorded Peak Flow at Stradbroke West Gauge (m³/s)	Recorded Peak Flow at Prospect Road Seaspray Gauge (m³/s)
September 1993	14/09/1993 – 18/09/1993	82.4	279.0	348.1
November 1995	04/11/1995 – 13/11/1995	62.9	263.0	374.5
June 2012	03/06/2012 – 12/06/2012	63.7	112.8	71.3

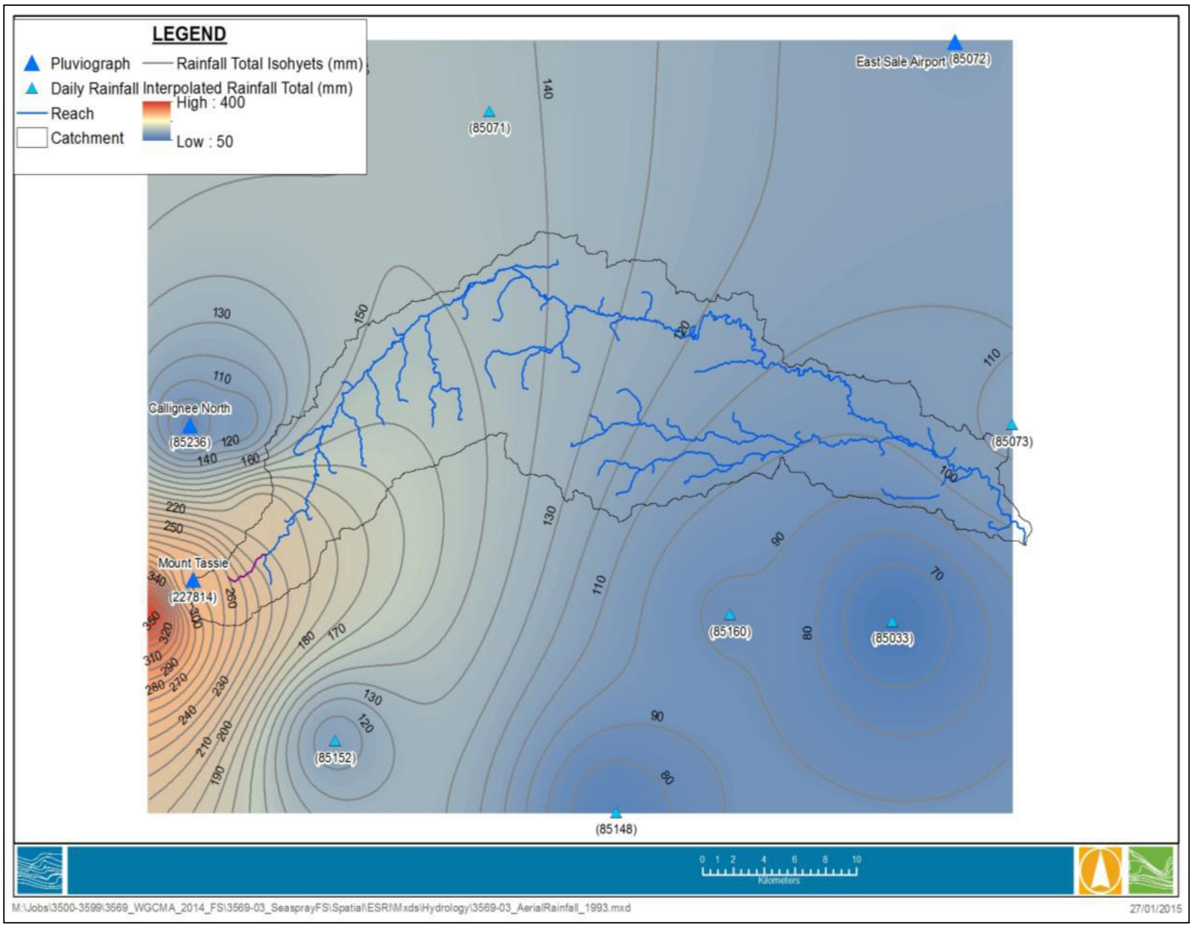


Figure 6 Total rainfall across the catchment for the September 1993 calibration event (Water Technology, 2015).

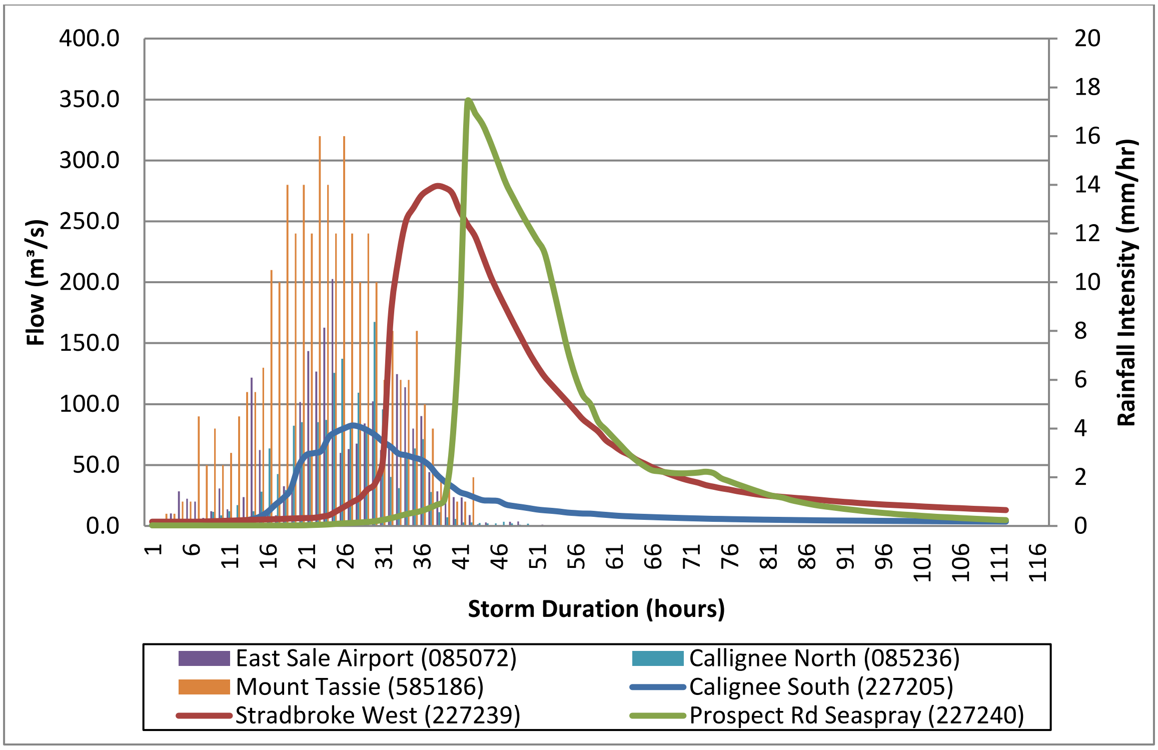


Figure 7 Hyetographs and Instantaneous Flow Hydrographs for the September 1993 Calibration Event

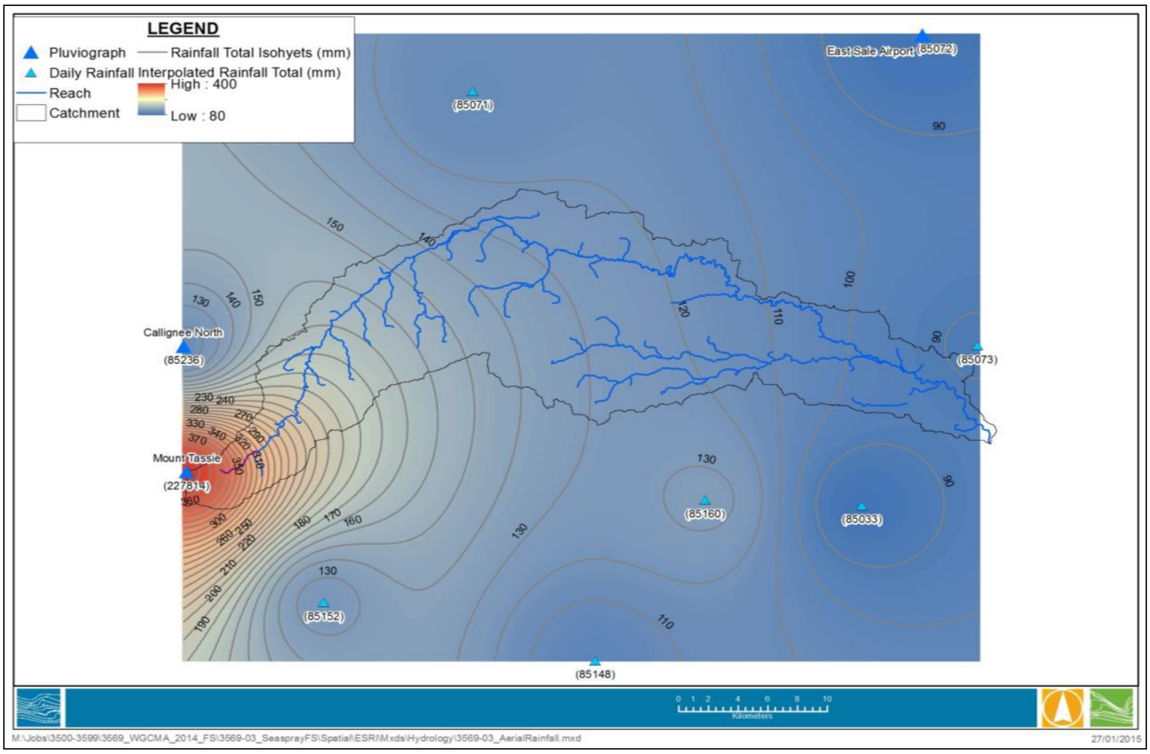


Figure 8 Total rainfall across the catchment for the November 1995 calibration event (Water Technology, 2015).

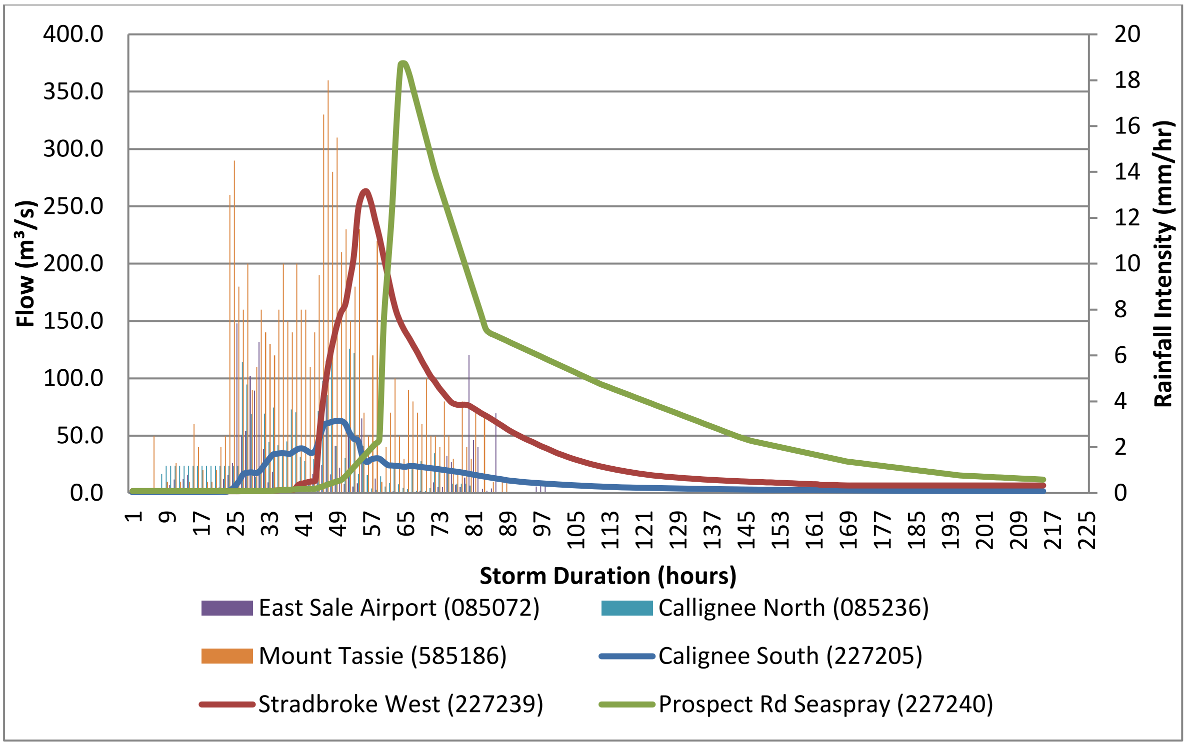


Figure 9 Hyetographs and Instantaneous Flow Hydrographs for the November 1995 Calibration Event

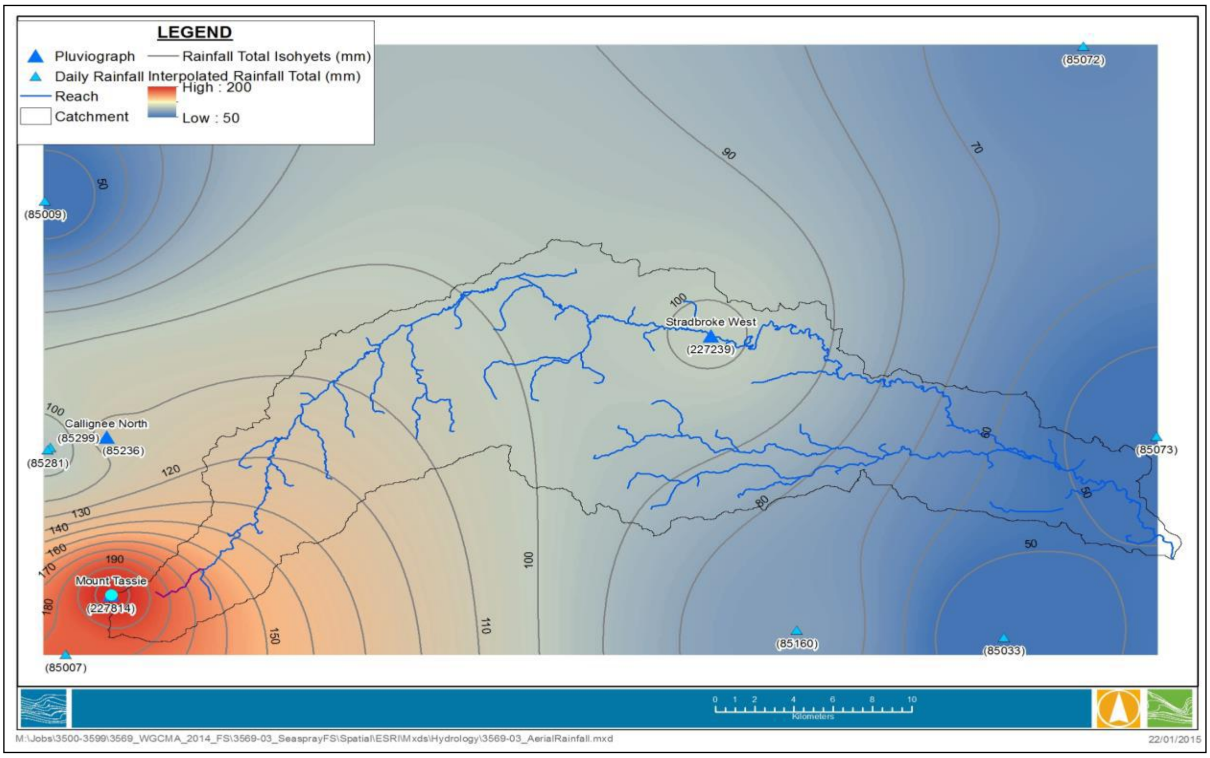


Figure 10 Total rainfall across the catchment for the June 2012 calibration event (Water Technology, 2015)

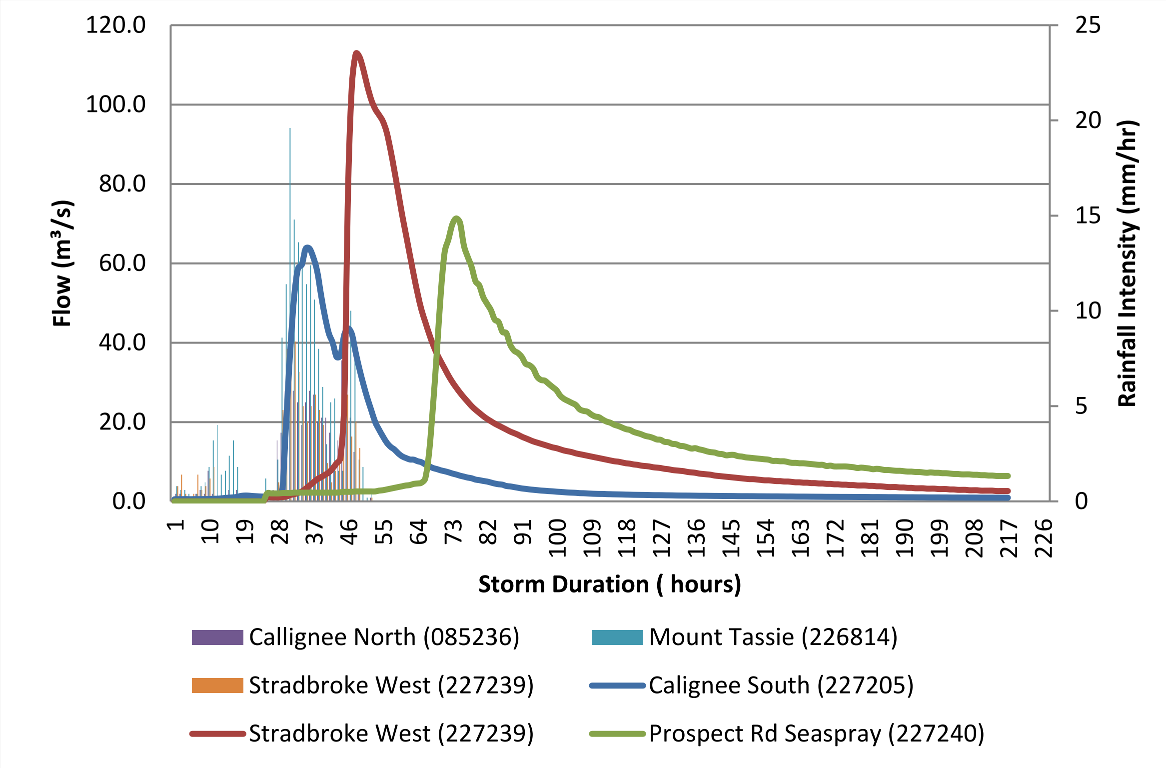


Figure 11 Hyetographs and Instantaneous Flow Hydrographs for the June 2012 Calibration Event

RORB Model Parameter Calibration

The RORB storage and loss parameters were fitted for each of the three calibration events to give the best fit to the actual hydrographs. The timing of the Prospect Road gauge was difficult to fit in all three calibration events, therefore priority was given to fitting the hydrograph peak and shape over the volume and timing of the hydrograph. The k_c parameter was determined using the regional equation estimates outlined in Table 6 as a guide for value selection. The m parameter was set to the RORB default value of 0.8.

Table 6 Regional equations for the calculation of Kc

Source	Callignee South	Stradbroke West	Prospect Rd Seaspray
Aust wide Yu (1989) (Pearse et al 2002)	52.61	52.61	52.61
Vic MAR>800mm – Eq 3.21 ARR87 (Book V)	13.44	29.11	30.07
Vic MAR<800mm – Eq 3.22 ARR87 (Book V)	5.35	16.32	17.11
Aust wide Dyer (1994) (Pearse et al 2002)	62.47	62.47	62.47
Victoria data (Pearse et al 2002)	68.50	68.50	68.50
Default RORB	13.83	32.63	33.83

RORB FIT Runs

The parameters selected during FIT runs for each of the calibration events using varying routing parameters by interstation area are shown in Table 7. Plots of the fitment for all three calibration events are shown in Figure 12 to Figure 14. FIT runs were also analysed using a single set of parameters with results shown in Appendix B.4, Figure 29 to Figure 31 and Table 31. However based on the fitting of the peak discharge being priority, and the requirement to match flows at the bottom of the catchment with the Seaspray flood study, varying routing parameters by interstation area were used.

Table 7 RORB calibration parameters using varying routing parameters by interstation area

Event	k_c	m	IL (mm)	CL (mm/hr)	Error for Peak discharge (%)	Lag to Peak (hours)	Error in Volume, m^3 (%)
Callignee South							
1993	14.0	0.8	28.0	2.90	0.3	0.0	-28.0
1995	16.5	0.8	28.0	2.90	0.2	0.0	-34.2
2012	12.0	0.8	38.0	2.80	0.3	2.0	-41.9
Stradbroke West							
1993	30.0	0.8	50.0	2.50	-0.2	1.0	-22.1
1995	20.0	0.8	75.0	0.50	-0.4	-2.0	-28.3
2012	30.0	0.8	55.5	2.65	0.1	7.0	-28.5
Prospect Rd Seaspray							
1993	14.0	0.8	85.0	0.0	-3.9	-1.0	27.3
1995	10.0	0.8	60.0	0.0	-7.6	-9.0	-35.0
2012	38.5	0.8	55.0	3.85	-0.10	5.0	-15.8

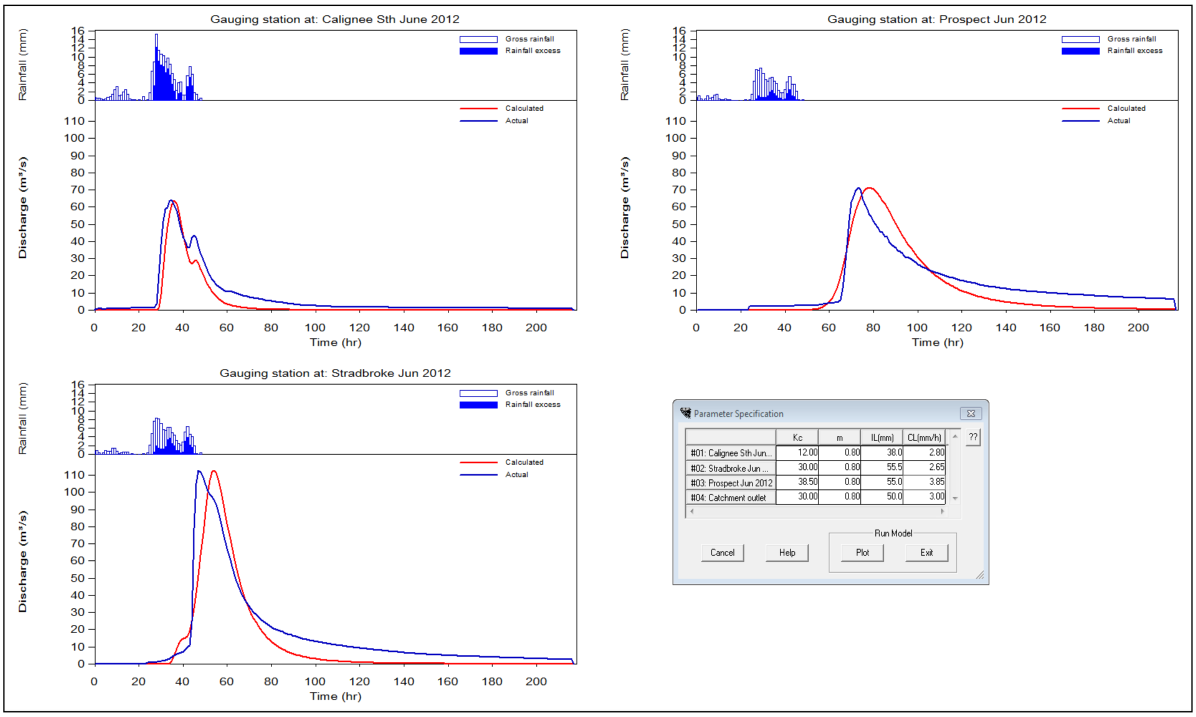


Figure 12 Calibration plots for June 2012

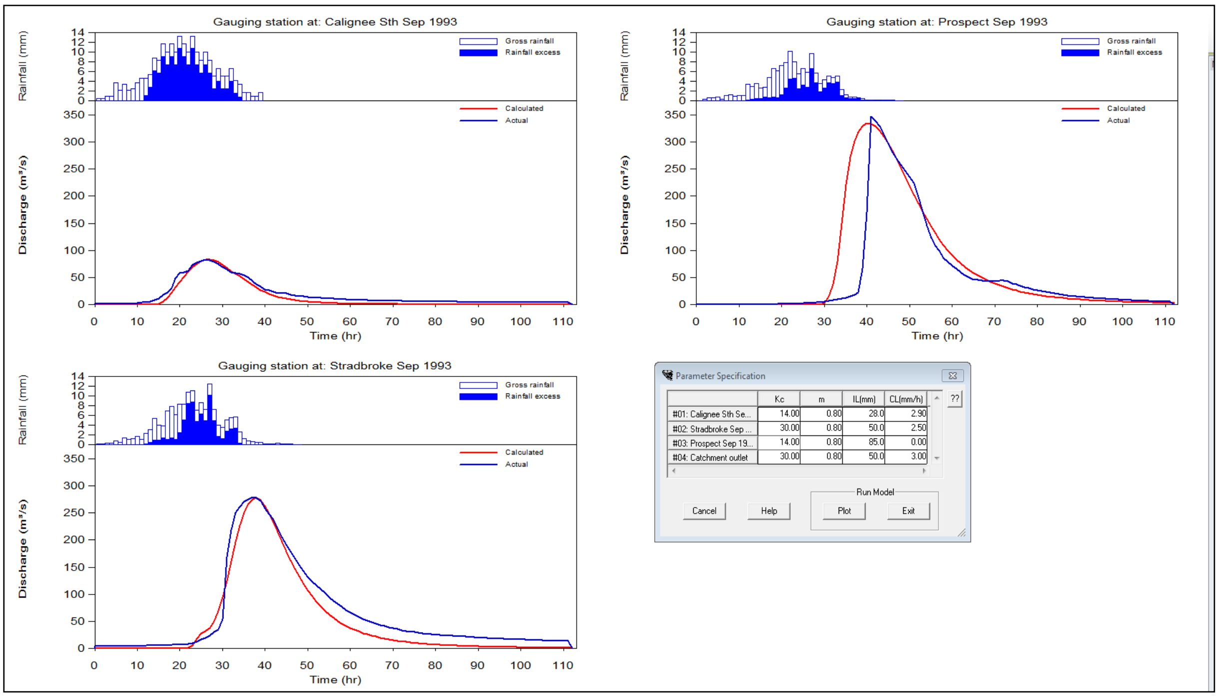


Figure 13 Calibration plots for September 1993

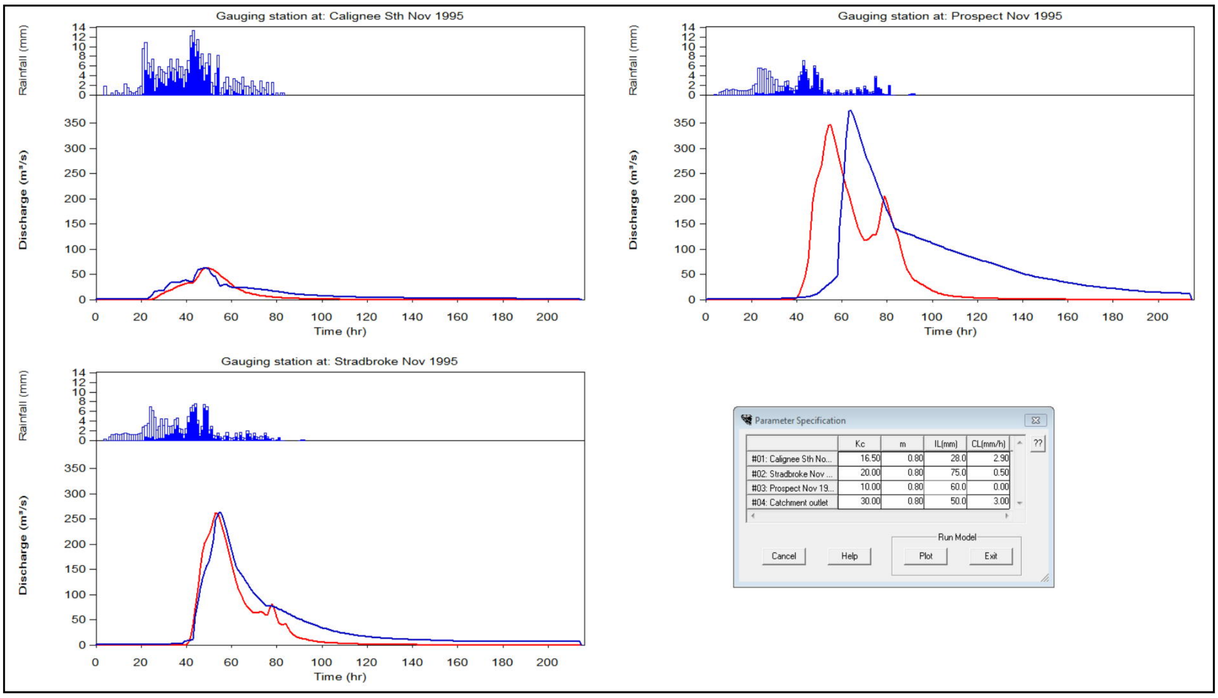


Figure 14 Calibration plots for November 1995

RORB DESIGN Runs

The RORB model design runs involved using design rainfall events for the centroid of the catchment and the parameters determined in the FIT runs to estimate design flows.

Design rainfall events were calculated using the Intensity Frequency Duration (IFD) analysis from AR&R (1987). The coefficients used are listed in Table 8, and were obtained from the Bureau of Meteorology (BoM) website for the catchment centroid.

Design rainfall specifications adopted for the design events were unfiltered temporal patterns with rainfall depths applied uniformly across the catchment. Areal reduction factors from Siriwardena and Weinmann were applied to the point design rainfall estimates. These areal reduction factors are recommended for use in Victoria (Hill, Graszkiewicz, Taylor, & Nathan, 2014).

Table 8 IFD Coefficients

IFD Coefficients	
2yr (50% AEP) 1hr rainfall intensity (mm/hr)	19.49
2yr (50% AEP) 12hr rainfall intensity (mm/hr)	4.42
2yr (50% AEP) 72hr rainfall intensity (mm/hr)	1.19
50yr (2% AEP) 1hr rainfall intensity (mm/hr)	40.02
50yr (2% AEP) 12hr rainfall intensity (mm/hr)	7.45
50yr (2% AEP) 72hr rainfall intensity (mm/hr)	2.49
Skew	0.36
F2	4.22
F50	15.22

Using the selected parameters for the three calibration events as a guide, one set of parameters were adopted to best represent all three events with results verified using the flood frequency analysis and flow estimation calculations. Based on the fitting of the peak discharge being priority, and the requirement to match flows at the bottom of the catchment with the Seaspray flood study, the results for the parameters selected for the calibration events are shown in Table 9 and the adopted parameters for the design runs are shown in Table 10.

Table 9 RORB parameter selection for DESIGN Runs using varying routing parameters by interstation area

Event	k_c	m	IL (mm)	CL (mm/hr)	Error for Peak discharge (%)	Lag to Peak (hours)	Error in Volume, m^3 (%)
Callignee South							
1993	12.0	0.8	30.0	2.85	7.1	0.0	-27.7
1995	12.0	0.8	30.0	2.85	13.6	-1.0	-33.9
2012	12.0	0.8	30.0	2.85	3.8	2.0	-39.1
Stradbroke West							
1993	28.0	0.8	55.0	2.25	10.9	0.0	-22.2
1995	28.0	0.8	55.0	2.25	-40.4	1.0	-46.4
2012	28.0	0.8	55.0	2.25	21.0	5.0	-19.3
Prospect Rd Seaspray							
1993	18.0	0.8	60.0	0.8	-8.9	2.0	38.2
1995	18.0	0.8	60.0	0.8	-56.1	-3.0	-53.4
2012	18.0	0.8	60.0	0.8	77.6	-12.0	28.1

Table 10 Adopted RORB parameters for the design run

INTERSTATION AREA	k_c	m	IL (mm)	CL (mm/hr)
Callignee South	12.0	0.8	30.0	2.85
Stradbroke West	28.0	0.8	55.0	2.25
Prospect Rd Seaspray	18.0	0.8	60.0	0.8

Assumptions

The assumptions made during the hydrology analysis were based on the data obtained from the Water Tech Seaspray Hydrology Report (2015) and are as follows:

- The fraction impervious values used in the Seaspray Flood study hydrologic model were used for the Merrimans Creek catchment study to ensure consisted results between the two studies. The fraction impervious value relates to the planning zone, the values chosen to represent each planning zone were adopted from Melbourne Water's MUSIC guidelines (2010) and are shown in Appendix B.4, Table 30.
- Flows reviewed by water tech determined a revised peak flow for the 1993 event at the Prospect Road, Seaspray gauge of 350 m^3/s.
- A wetland swamp with a large storage area is located east of Giffard Road; it was assumed these wetlands will not overflow into Merrimans Creek based on information obtained from the Water Tech Seaspray Hydrology report (2015).
- Flood frequency analysis using FLIKE involved using a historical peak threshold value as used in the Water Tech Seaspray Hydrology report (2015).

5 Hydrology Results and Discussion

5.1 Results

Flow Estimation Methods and Flood Frequency Analysis

The results obtained from the flow estimation methods and flood frequency analysis for 2, 5, 10, 20, 50 and 100 year ARI events, at all three gauges are outlined in Appendix B.1 to B.3. Plots obtained from the flood frequency analysis are shown in Appendix B.2.

The flow estimation results for the 100 year ARI event are shown in Table 11 below.

Table 11 Flow estimations for 100yr ARI event at gauging stations

FLOW ESTIMATIONs FOR 100 YEAR ARI EVENT AT GAUGING STATIONS						
Gauge Location	**Rational Method 1987 IFD**	**Rational Method 2013 IFD**	**Zaman**	**Nikolaou + von't Steen**	**Log-Pearson III (Method of Moments)**	**FLIKE**
Calignee South	74.54	78.86	152.76	77.18	119.00	125.13
Stradbroke West	237.01	274.31	287.48	324.57	-	-
Prospect Rd, Seaspray	378.80	438.00	415.72	532.10	572.81	457.70

RORB Design Flows

The design runs were analysed over a range of durations to achieve the critical duration for the peak flow at points of interest. The peak flows and critical durations for the three gauging stations are shown in Table 12, with Peak flows and critical duration times for all inflow points to the hydraulic model summarised in Appendix C.1, Table 32. Hydrographs of the design flow estimates for 2, 5, 10, 20, 50 and 100 year ARI events for the three gauging stations are shown in Figure 15 to Figure 17.

Table 12 Peak flows and critical durations for the catchments three gauging stations

STREAM FLOW GAUGES						
ARI (yrs)	**Calignee South**		**Stradbroke West**		**Prospect Road, Seaspray**	
	Critical Duration (hrs)	**Peak Flow (m3/s)**	**Critical Duration (hrs)**	**Peak Flow (m3/s)**	**Critical Duration (hrs)**	**Peak Flow (m3/s)**
2	48	13.75	72	11.93	72	46.52
5	36	27.75	48	42.54	72	95.16
10	36	36.21	48	73.76	48	148.79
20	48	50.22	48	130.75	48	241.54
50	48	64.24	48	196.51	48	361.88
100	48	79.21	48	264.43	48	471.34

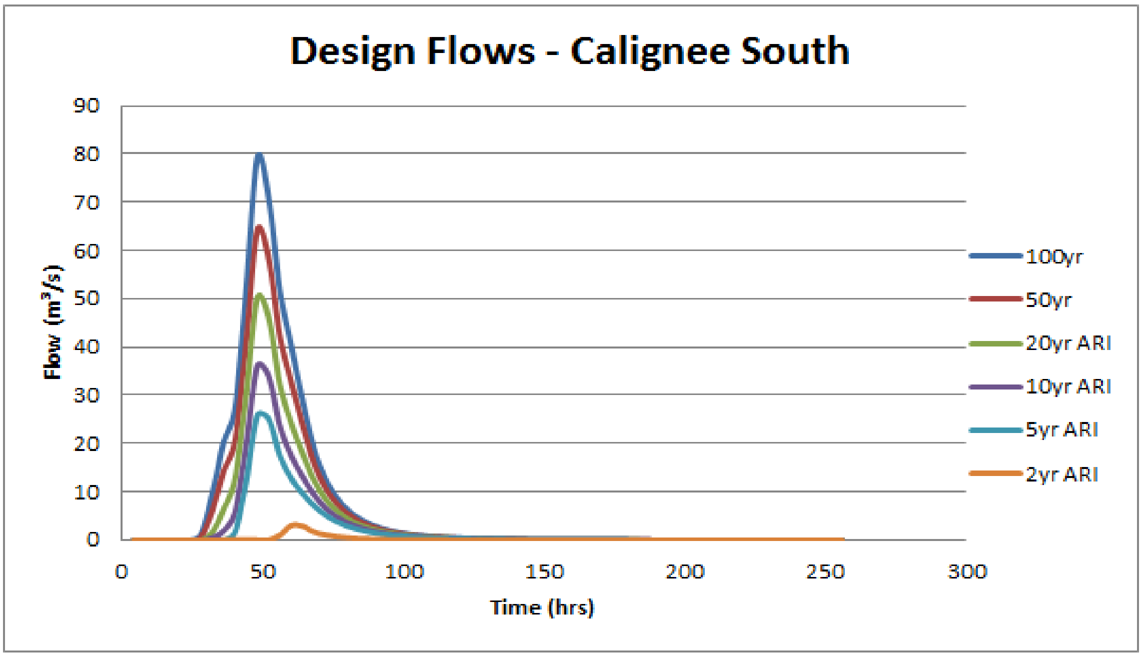


Figure 15 Design Flow Hydrographs at Calignee South Gauge

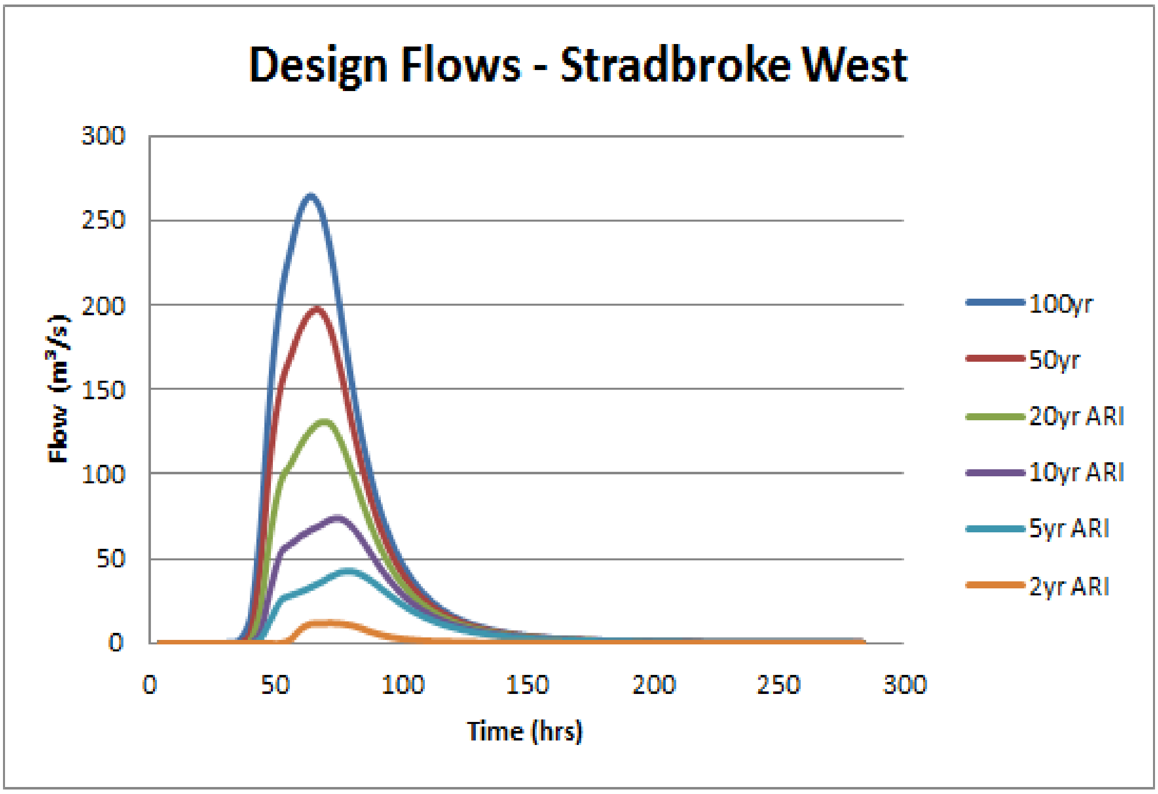


Figure 16 Design Flow Hydrographs at Stradbroke West Gauge

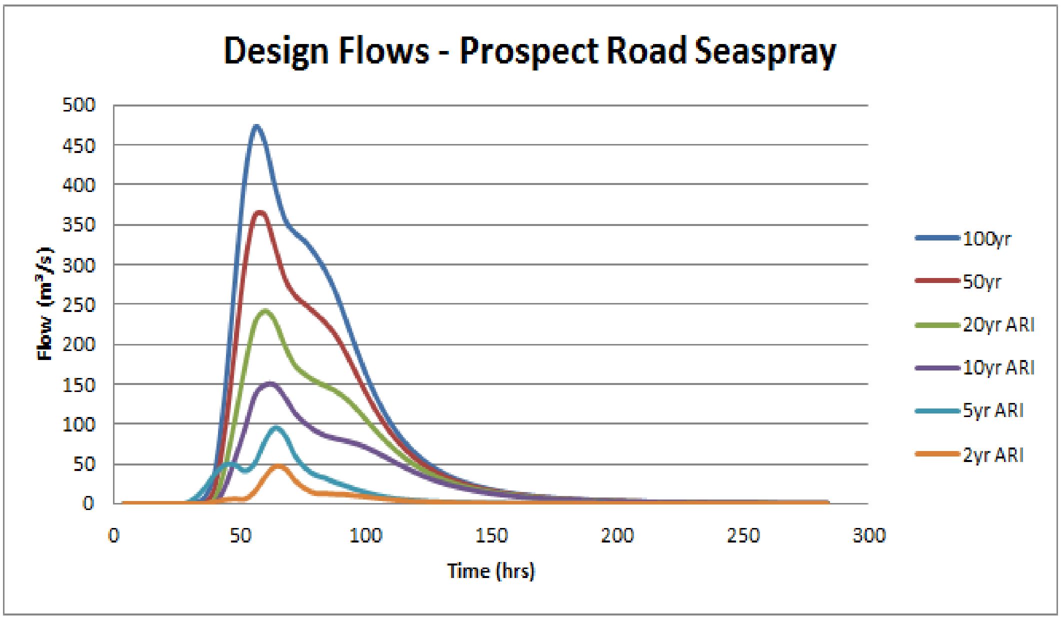


Figure 17 Design Flow Hydrographs at Prospect Road, Seaspray Gauge

RORB Model Verification

Design flood verification was achieved by trialling various kc and loss values in the RORB model and comparing the results with the flood frequency analysis, flow estimation calculations and the results obtained by the Water Tech Seaspray Hydrology Report. The results are shown in Figure 18 to Figure 20 by plots of all flow estimates at the three gauging stations. Design flood verification for the Calignee South and Prospect Road gauges are also shown in Table 13 and Table 14.

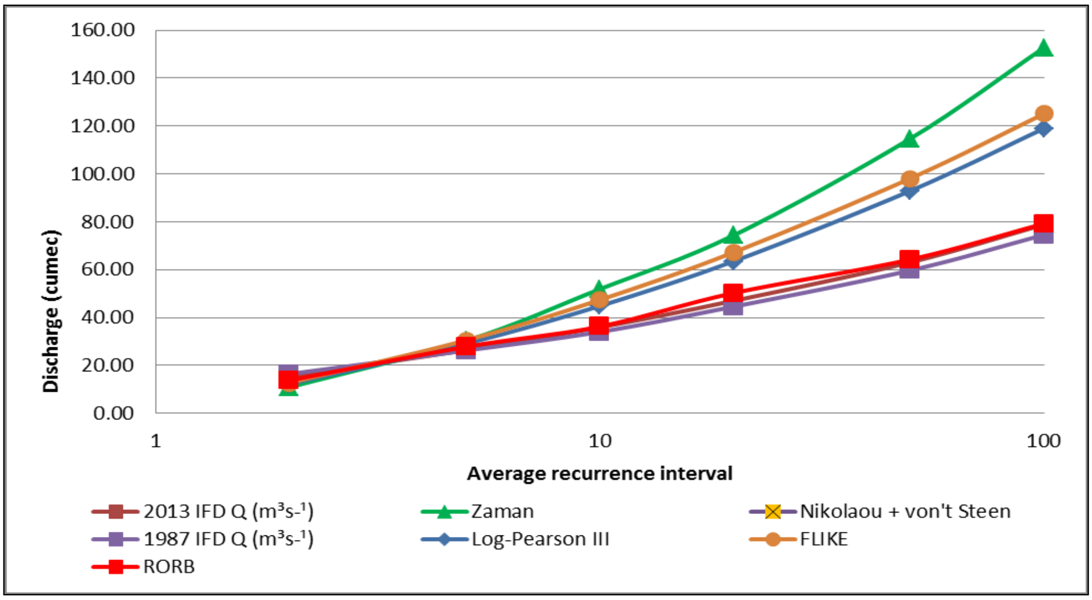


Figure 18 ARI flow estimations for the Calignee South gauge

Table 13 Flow estimations at the Calignee South gauge

Calignee South Gauge												
		Rational Method 1987 IFD	Rational Method 2013 IFD	Zaman	Nikolaou + von't Steen	Log-Pearson III (Method of Moments)			FLIKE		
ARI (Y)	CY	Q (m^3s^{-1})	Q (m^3s^{-1})	Q (m^3s^{-1})	Q (m^3s^{-1})	Q (m^3s^{-1})	Lower Confidence Limit	Upper Confidence Limit	Q (m^3s^{-1})	Lower Confidence Limit	Upper Confidence Limit
2	0.135	16.40	15.44	10.80		12.21	4.12	36.33	12.64	9.25	16.7
5	0.162	26.20	26.40	30.24		29.07	9.54	88.56	30.47	22.90	40.8
10	0.18	33.98	35.89	51.85		44.82	12.70	158.21	47.37	34.84	68.7
20	0.198	44.53	46.98	74.32		63.49	13.92	289.52	67.22	47.05	111.2
50	0.216	59.68	63.07	114.75		92.93	12.98	665.48	98.11	62.18	198.9
100	0.234	74.54	78.86	152.76	77.18	119.00	11.23	1261.14	125.13	72.31	309.0

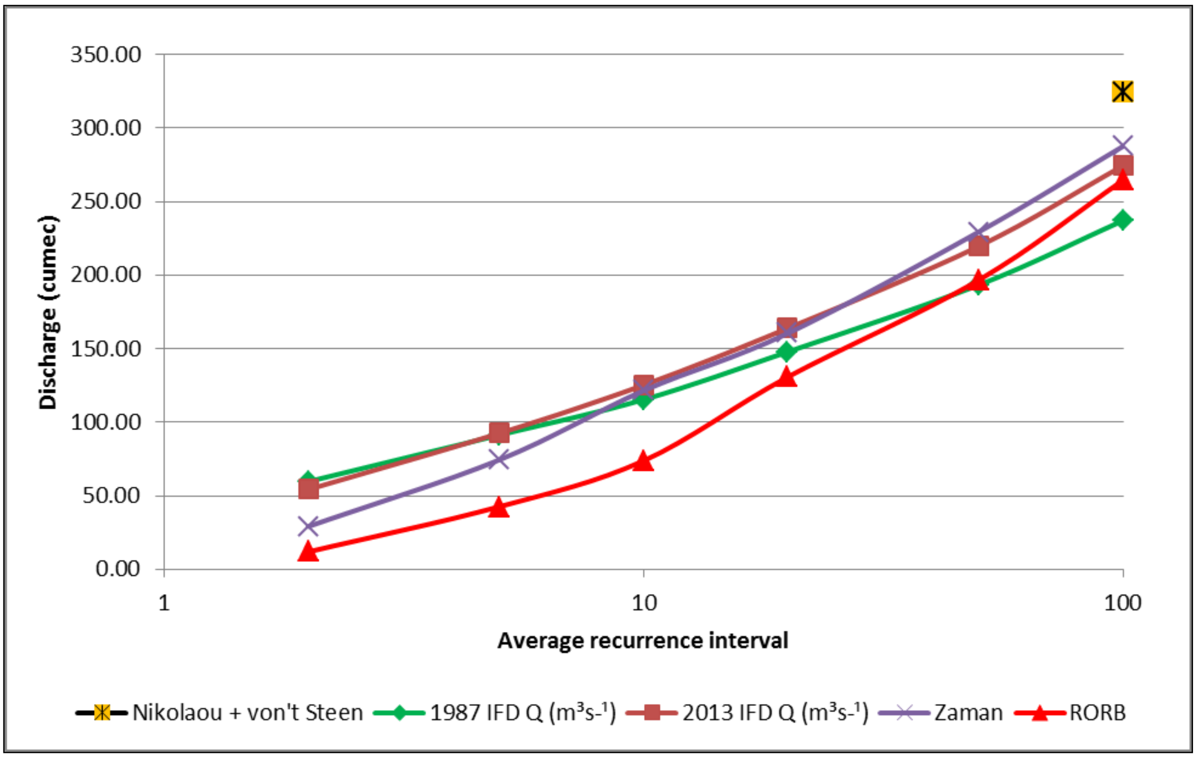


Figure 19 ARI flow estimation for Stradbroke West gauge

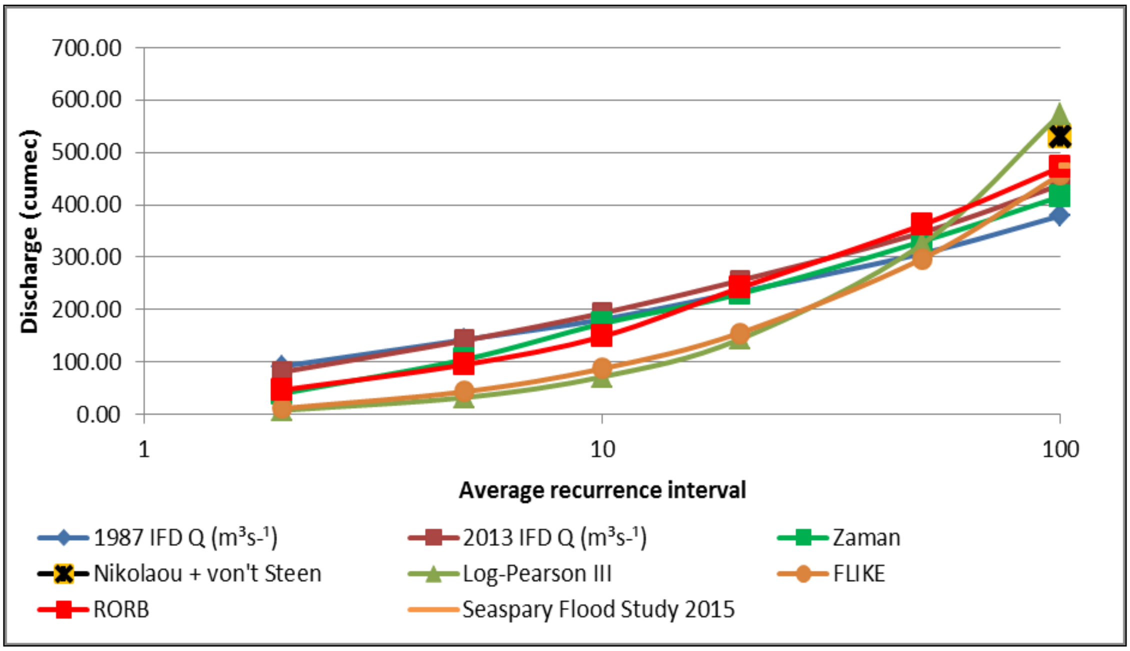


Figure 20 ARI flow estimation for Prospect Road, Seaspray gauge

Table 14 Flow estimations at the Prospect Road, Seaspray gauge

Prospect Rd Gauge											
		Rational Method 1987 IFD	Rational Method 2013 IFD	Zaman	Nikolaou + von't Steen	Log-Pearson III (Method of Moments)			FLIKE		
ARI (Y)	CY	Q (m^3s^{-1})	Q (m^3s^{-1})	Q (m^3s^{-1})	Q (m^3s^{-1})	Q (m^3s^{-1})	Lower Confidence Limit	Upper Confidence Limit	Q (m^3s^{-1})	Lower Confidence Limit	Upper Confidence Limit
2	0.135	91.96	81.06	39.88		7.89	1.454776	42.79515	11.46	7.44	17.8
5	0.162	142.52	141.19	104.79		32.34	4.383604	238.6186	43.58	29.21	64.6
10	0.18	181.43	193.63	173.37		72.01	5.834826	888.6867	87.53	59.16	129.3
20	0.198	233.98	255.79	230.42		143.82	5.638597	3668.449	155.64	102.18	243.6
50	0.216	307.37	347.23	330.51		325.38	3.988167	26545.95	297.34	181.51	551.0
100	0.234	378.80	438.00	415.72	532.1	572.81	2.646174	123994.2	457.70	257.18	991.8

5.2 Discussion

The results from the flow estimation methods and Flood Frequency Analysis all had considerable agreement with each other. However for the top gauge, Caligneee South, the Zaman method was considerably higher for the larger ARI events. For the bottom two gauges the Zaman method resulted in low flows for the lower ARI events compared to the other methods. Considering the Zaman method is calculated based on the area and the intensity-frequency-duration, from this study it could be said that the Zaman method could potentially over estimate on small catchment areas and under estimate for low intensity's. The flood frequency analysis using the Log Pearson III and FLIKE both resulted in similar flow estimates for all ARI events, although the Log Pearson III method resulted in a larger confidence limit.

Calibration of the RORB model resulted in difficulties occurring in fitting the calibration events to the calculated events, especially for the Prospect Road Seaspray gauge. This gauge is known to have a degree of unreliability, partial due to the characteristics of the creek at this location. The sand bed of the creek at this location causes erosion and accretion to continually occur changing the geometry of the cross section, which can results in a degree of uncertainty of recorded measurements. The timing and the volume of the tail of the hydrograph for the Prospect Road gauge was unable to be achieved; therefore priority was given to fitting the peak over the volume and the timing. The difficulties in accurately modelling the tail of the hydrographs are likely to be the result of a back storage or complex geometry of the creek upstream of the gauge. Therefore, ensuring flows determined from the RORB model were in agreement with the Water Tech Seaspray Report (2015), the results obtained from the FFA and flow estimation equations were highly regarded, along with parameters adopted by the Water Tech study.

6 Hydraulic Modelling

6.1 Sobek Model Description

A hydraulic model using the computer program Sobek, has been used to investigate the flood flow characteristics on the Merrimans Creek floodplain for the design 2, 5, 10, 20, 50 and 100 year ARI flow conditions. Sobek is a 1D/2D program developed by WL/Delft 1D/2D in the Netherlands, which is widely used in Australia and internationally.

6.2 Model Setup

The hydraulic model consisted of a 1D and 2D component. The 1D component was used to define the main stream flow and the 2D component defined the floodplain area.

The major component of the two-dimensional model is the grid that describes the topography of the area. The topography of the study area in the Merrimans Creek catchment was obtained from LiDAR data. The LiDAR data was resampled into a digital elevation model (DEM), which is constructed as a square grid of elevations. A 40 metre grid size was adopted for this model due to the large catchment area and time constraints for model runs. The grid was aligned in a north-south orientation, using a GDA 1994 MGA Zone 55 coordinate projection. The topography grid parameters used for the Sobek model are outlined in Table 15.

Table 15 Two-dimensional topography grid parameters

TOPOGRAPHY GRID PARAMETERS	
Parameters	**Value**
Grid Cells Size	40 metre x 40 metre
Grid Cells (x direction)	1332 columns
Grid Cells (y direction)	544 rows

Total Grid Cells	724,608

Cross sections were placed at approximately 1.0 kilometre intervals along the 1D channel plus a cross section upstream and downstream of every bridge and culvert in the model, to define the 1D channel. This equated to 109 cross-sections for the 1D channel, with cross sectional data extracted from LiDAR information.

Boundary Conditions

The hydraulic model consisted of 37 inflow boundaries to represent the contribution of water flow from surrounding tributaries shown in Appendix D, Figure 34. The inflows are in the form of streamflow hydrographs determined from the hydrologic analysis. The outflow boundary is down stream of the Prospect Road at Seaspray and consists of a water level determined from the topography of that area. The water level relating to the topography of that area was chosen to reduce the back flow of water into the model.

Roughness Coefficient

The manning's n roughness coefficient was used in the modelling process to account for factors such as channel irregularities, obstructions and vegetation. A roughness coefficient value was given to each element and vegetation type in the model to represent the frictional resistance to flow through the element and vegetation. The roughness values used in the model were determined by comparing actual site conditions observed from site investigations with published literature that describes roughness values for various stream and vegetation configurations (Brisbane City Council, November 2003). The adopted Manning's coefficient values are shown in Table 16 and allocation of floodplain roughness values shown in Appendix D, Figure 32.

Table 16 Adopted Roughness Values

Floodplain – 2D element	
Land Type	**Manning's n**
Thick Vegetation	0.1
Pine Plantations	0.09
Farm land	0.045
Main Channel – 1D element	
Channel Characteristics / Structure	**Manning's n**
Start of 1D channel to start of Merrimans drain inflow	0.07
Creek from start of drain to end of drain	0.07
Drain segment	0.05
End of drain to Monkey Creek confluence	0.08
Monkey Creek confluence to end of 1D channel	0.04
Bridge	0.040
Culverts – Steel	0.02
Culverts – Concrete	0.11

6.3 Key Hydraulic Features

Key hydraulic features that were including in the model consist of the 8 bridges and 2 culverts over the following major road crossings and locations in the catchment area:

- Merrimans Creek Road
- Drain inflow culvert
- Hyland Highway (Bridge and culvert)
- Willung Road
- Mertonvale Road
- Taylors Lane
- South Gippsland Highway
- Giffard Road
- Prospect Road

The inclusion of the hydraulic features enables the effect of the structure on the free flow of flood waters to be included in the model.

Using data obtained from site visits and schematics of the bridge plots obtained from VicRoads, all relevant hydraulic structures were replicated in the model.

6.4 Assumptions

Assumptions made for the hydraulic model are as follows:

- The floodplain was completely dry before the flood event
- The 1D channel has an initial depth of 1 metre of water before the storm event
- The bridge on the Hyland Highway over the floodplain will have minimal impact on the flow of flood waters and therefore was not included.

7 Hydraulic Results and Discussion

7.1 Results

The hydraulic model was used to determine the 2, 5, 10, 20, 50 and 100 year ARI flood events under existing conditions. The two-dimensional, overland flow results are recorded as depths (metres), water surface elevation (metres AHD), and velocities (m/s) for every grid cell at regular time intervals.

Mapping of results was broken down into six different zones for more definition; the zone breakdown is shown in Appendix E, Figure 46. Results of flood extents, depths, velocities and surface water elevation are shown in Appendix F to I.

7.2 Discussion

Sobek proved too have limitations of how bridge structures can be input into the model. Limitations included the input of dimensions and the representation of the structures features, such as piers and embankments. Therefore all bridge structures were replicated in a one-dimensional computer program Hec-Ras. Hec-Ras allows the bridge shape to be defined more accurately; therefore up-stream and downstream water surface elevations were compared at each structure using Sobek and Hec-Ras, with the same flow discharge through the structure. This determined the correct flow area was being simulated in the sobek model.

The bridge structure located across the floodplain on the Hyland Highway at Gormandale, was not included in the model as it does not cross a 1D channel and it is highly unlikely flood depths will exceed the height of the deck, therefore having little impact on the flow of floodwaters. The bridge and culvert located over the drain and creek at this location were included in the modelling as they are located on the 1D channel and may contribute to the flood behaviour. It should also be noted that an old bridge structure is located at Timbs Crossing Road which is partially collapsed with little existing decking. This structure was not included in the modelling as it highly unlikely flood levels would reach the deck height, therefore having little impact on the flow of flood waters.

The hydraulic model results identified that during a 100 year ARI event, the flood waters will over top the creeks banks along the majority of the creek. Appendix E, Figure 44, shows the long section of the 1D channel during a 100 year ARI event, which identifies small locations around Stradbroke where flood waters are unlikely to over top the creek banks due to the high banks and deep creek. Appendix E Figure 45, shows the long section of the 1D channel during a 2 year ARI event, which identifies the main break out point is around Gormandale, indicating this area is highly prone to flooding even during small ARI events. Analysing the different flood extents identified minimal variation between the 20 to 100 year ARI flood extents in most areas. This would suggest Merrimans Creek has a well-defined floodplain, which is likely to experience some degree of flooding during all magnitudes of ARI events.

8 Sensitivity Analysis

The sensitivity analysis aims to examine the impact that changes to the roughness parameters and the hydraulic structures have on the hydraulic model. The sensitivity was undertaken on the 100 year ARI design event.

Sensitivity to 1-Dimensional Roughness Parameters

The selected roughness parameters can have a marked effect on the flow behaviour and flooding depths present within the model. The sensitivity analysis was undertaken to see if the roughness parameters selected for the 1D channel impact the extent and depth of flooding on the floodplain. Roughness parameters were selected based on the characteristics of the reach; with the recommended roughness ranges obtained from (Brisbane City Council, November 2003), and are outlined in Table 17. The 100 year ARI design event was then analysed using the low, medium and high value. Results are outlined in Table 18, which show the change in the roughness only affected the velocity of the flood water.

Table 17 1D channel roughness parameters

Reach Segment Number	Reach Segment	Reach Description	Roughness Range Selected (Low – Mid – High)
1	Start of 1D channel to start of Merrimans drain inflow	Sluggish reach, weedy, deep pools	0.050 – 0.070 - 0.080
2	Creek from start of drain to end of drain	Sluggish reach, weedy, deep pools	0.050 – 0.070 - 0.080
3	Drain segment	Clean, winding, some weeds	0.045 – 0.050 - 0.060
4	End of drain to Monkey Creek confluence	Channel not maintained, dense weeds, high as flow depth in areas	0.050 – 0.080 - 0.120
5	Monkey Creek confluence to end of 1D channel	Wide, clean, winding, some pools	0.033 – 0.040 - 0.045

Table 18 Results using low, medium and high range of roughness parameters

<table>
<tr><th colspan="7">Results from using low, medium and high range of manning' n value</th></tr>
<tr><th>Value</th><th>Depth
(m)</th><th>Difference
(m)</th><th>Surface Water Elevation
(m AHD)</th><th>Difference
(m AHD)</th><th>Velocity
(m/s)</th><th>Difference
(m/s)</th></tr>
<tr><td>High</td><td>0 – 9.9427</td><td rowspan="3">0</td><td>25.2556 – 206.303</td><td rowspan="3">0</td><td>0 – 3.4729</td><td rowspan="3">4.8422</td></tr>
<tr><td>Mid</td><td>0 – 9.9427</td><td>25.2556 – 206.303</td><td>0 – 3.7579</td></tr>
<tr><td>Low</td><td>0 – 9.9427</td><td>25.2556 – 206.303</td><td>0 – 8.3151</td></tr>
</table>

It was determined that the model was not very sensitive to the roughness of the 1D channel, with only the velocity being affected.

Sensitivity to Partial Blockages of 1D Structures

The sensitivity of the flow area through the 1-dimensional structures was analysed by applying a 50% blockage to all structures during a 100 year ARI flood event. Applying a 50% blockage assumes that flow through the bottom 50% the structure is restricted. Results are outlined in Table 19, which shows that a 50% blockage to the flow path through 1D structures only effects the velocity of the flood water. It was determined that the model is not very sensitive to reductions in the flow area by 50% or less through the 1D structures.

Table 19 Comparison of flood characteristics for fully opened 1D structures and 50% blockages of 1D structures

<table>
<tr><th colspan="7">Results from 50% blockage of 1D structures</th></tr>
<tr><th>Degree of Blockage</th><th>Depth
(m)</th><th>Difference
(m)</th><th>Surface Water Elevation
(m AHD)</th><th>Difference
(m AHD)</th><th>Velocity
(m/s)</th><th>Difference
(m/s)</th></tr>
<tr><td>0%</td><td>0 – 9.9427</td><td rowspan="2">0</td><td>25.2556 – 206.303</td><td rowspan="2">0</td><td>0 – 3.4729</td><td rowspan="2">0.4669</td></tr>
<tr><td>50%</td><td>0 – 9.9427</td><td>25.2583 – 206.303</td><td>0 – 3.9398</td></tr>
</table>

While it was determined changes to the 1D channel have little impact on the flood extent and depth on the floodplain, further sensitivity analysis should be completed to investigate the effects of changes to the floodplain and boundary conditions.

9 Conclusion and Recommendations

9.1 Conclusion

The Merrimans Creek floodplain mapping provides an analysis and review of existing and future potential flood risks along Merrimans Creek.

Key outcomes from the study identify that Merrimans Creek has a fairly well defined floodplain, which is prone to flooding to some degree in all magnitude ARI events. Due to the land use of the catchment area being predominately farming, a large number of rural properties are subjected to flooding however minimal residential structures are likely to be impacted.

This study has identified the need for appropriate floodplain management in the Merrimans Creek catchment area to ensure appropriate planning and development occurs due to the high risk of flooding

10 References

Brisbane City Council. (November 2003). *Natural Channel Design Guidelines .* Australia: Brisbane City Council.

Camp Scott Furphy. (1980) *Seaspray Flood Study.* Report prepared for State Rivers and Water Supply Commission, Victoria.

Canterford, R., 1987 Edition. *Australian Rainfall and Runoff: A Guide to Flood Estimation.* Volume 2 ed. Australia: Engineers Australia.

Engineers Australia, 2012. *ARR Project 15: 2 Dimensional Modelling in Urban and Rural Fllod Plains,* Australia: Engineers Australia.

Furgo Spatial Solution Pty Ltd, 2010. *Metadata Report-22310301_DSE_West_Gippsland,* Queensland: Furgo Spatial Solution Pty Ltd.

Hill, P., Graszkiewicz, Z., Taylor, M. & Nathan, R., 2014. *Australian Rainfall and Runoff: Revision Project: Loss Models for Catchment Simulation,* s.l.: Institute of Engineers Australia.

Ladson, A., 2008. *Hydrology An Australian Introduction.* Victoria Australia: Oxford University Press.

State Emergency Services Victoria, 2013. *Wellington Shire Flood Emergency Plan - Version 1.4 Attachment 03 - Merrimans Creek.* [Online]
Available at: http://www.ses.vic.gov.au/prepare/your-local-flood-information/wellington-shire-council/wellington-shire-council-municipal-flood-emergency-plan.pdf)
[Accessed 5 3 2015].

State Government of Victoria, 2013. *About Planning Schemes.* [Online]
Available at: http://planningschemes.dpcd.vic.gov.au/
[Accessed 7 May 2015].

State Government of Victoria, 2015. *Water Monitoring.* [Online]
Available at: http://data.water.vic.gov.au/monitoring.htm
[Accessed 12 April 2015].

State Government Victoria, 2012. *Flood Victoria.* [Online]
Available at: http://www.floodvictoria.vic.gov.au/
[Accessed 9 March 2015].

Water Technology, 2015. *Seaspray Flood Study - Hydrology,* Notting Hill Vic: Water Technology Pty Ltd.

WGCMA, 2015. *West Gippsland Catchment Management Authority.* [Online]
Available at: http://www.wgcma.vic.gov.au/
[Accessed 7 March 2015].

Appendicces

Appendix A: Preliminary data collection

Appendix A.1 Flood History

Table 20 Historical flood events at the catchments three gauging stations

Gauge Name	Event	Gauge Height (m)
MerrimansCk @ Callignee Sth 227205	1993 Sep	3.54
	2012 Jun	3.31
	1995 Nov	3.30
	2011 Jul	3.23
	2001 Apr	3.12
	2007 Jun	3.02
	1988 Dec	3.01
	2005 Feb	2.98
	1990 Apr	2.76
	2007 Nov	2.69
MerrimansCk @ Stradbroke West 227239	1993 Sep	8.32
	1995 Nov	8.20
	2011 Jul	6.39
	2007 Jun	6.18
	1995 Oct	6.08
	1996 Aug	5.11
	1985 Dec	5.04
	1989 Oct	4.78
	1998 Nov	4.68
	2001 Apr	4.25

MerrimansCk @ Prospect Rd Seaspray 227240	1995 Nov	5.70
	1993 Sep	5.53
	1995 Oct	2.59
	2011 Jul	2.57
	2007 Jun	2.17
	2001 Aug	2.15
	1985 Dec	1.91
	1996 Sep	1.88
	1998 Nov	1.85
	1996 Aug	1.84

Appendix A.2 Aerial Survey Data Extent - (LiDAR)

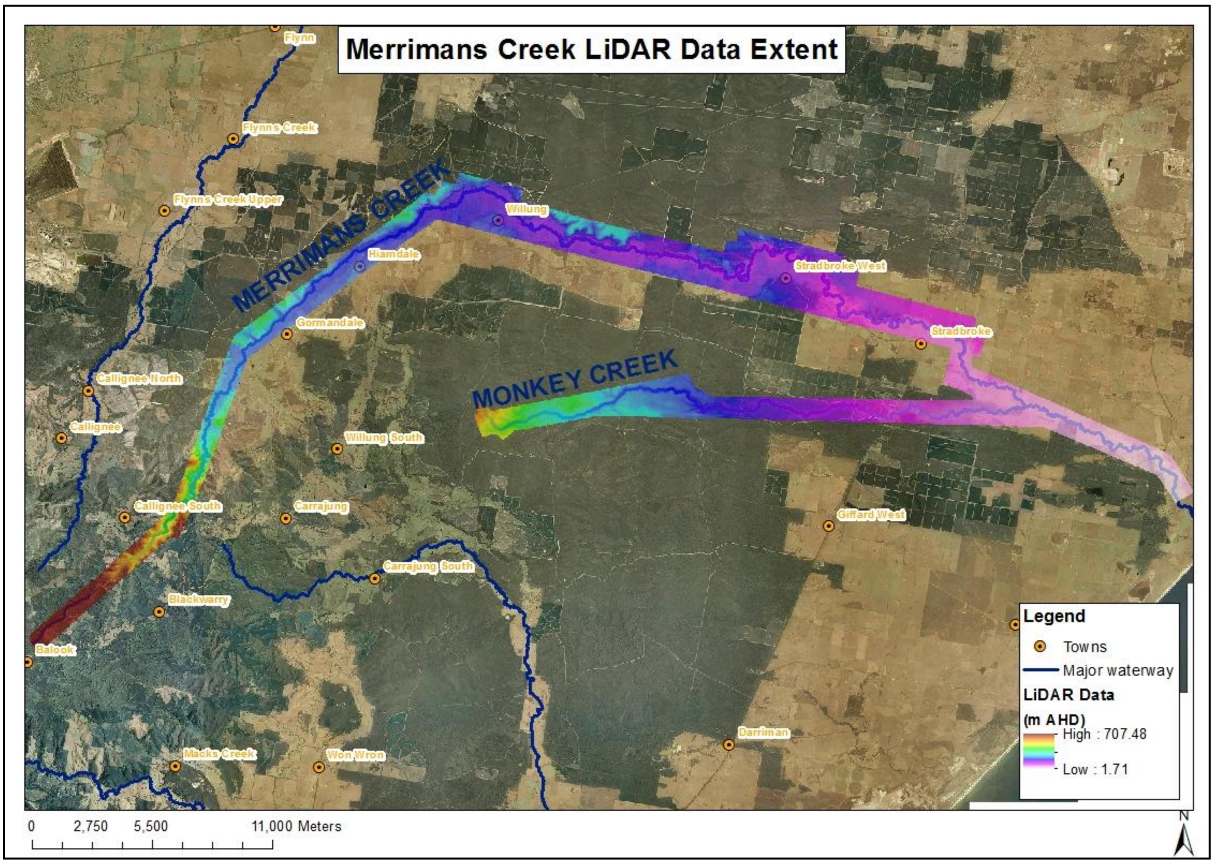


Figure 21 LiDAR extent for catchment area

Appendix A.3 Field Survey Data

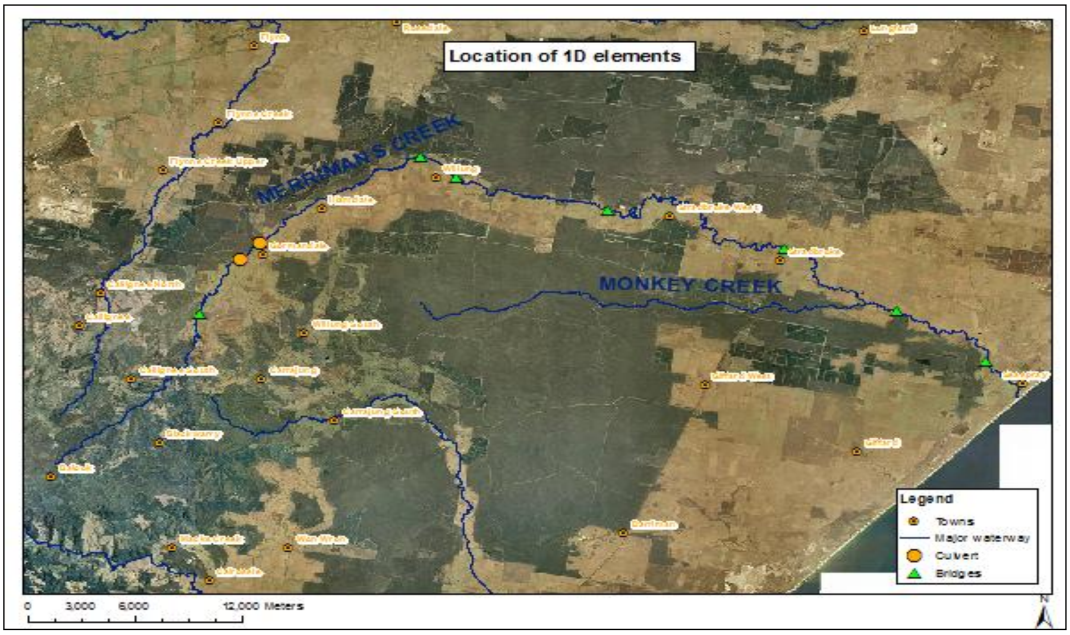


Figure 22 Location of 1D elements included in hydraulic model

Appendix A.4 Hydrologic and Hydraulic Data

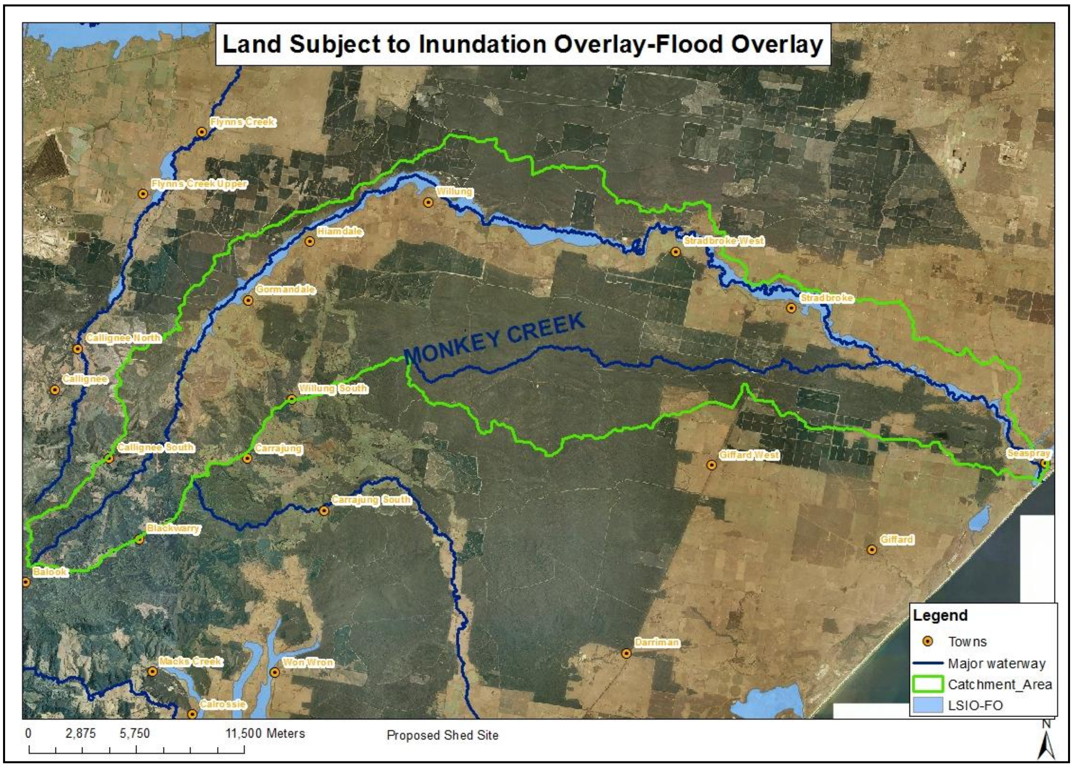


Figure 23 LSIO and FO Overlays in the Merrimans Creek Catchment Area

Appendix B: Hydrologic model input data

Appendix B.1 Flow Estimation Methods

Table 21 Flow estimations at Calignee South Gauge

Calignee South Gauge					
ARI (Y)	CY	1987 IFD Q (m^3s^{-1})	2013 IFD Q (m^3s^{-1})	Zaman Q (m^3s^{-1})	Nikolaou + von't Steen Q (m^3s^{-1})
2	0.135	16.40	15.44	10.80	
5	0.162	26.20	26.40	30.24	
10	0.18	33.98	35.89	51.85	
20	0.198	44.53	46.98	74.32	
50	0.216	59.68	63.07	114.75	
100	0.234	74.54	78.86	152.76	77.18

Table 22 Flow estimations at Stradbroke West Gauge

Stradbroke West Gauge					
ARI (Y)	CY	1987 IFD Q (m^3s^{-1})	2013 IFD Q (m^3s^{-1})	Zaman Q (m^3s^{-1})	Nikolaou + von't Steen Q (m^3s^{-1})
2	0.135	59.70028	54.2498	29.12	0.00
5	0.162	91.27424	92.44167	74.35	0.00
10	0.18	115.3102	125.2395	121.43	0.00
20	0.198	147.8386	163.9067	160.43	0.00
50	0.216	193.2225	219.4792	229.25	0.00
100	0.234	237.0092	274.3077	287.48	324.57

Table 23 Flow estimations at Prospect Rd Gauge

Prospect Rd Gauge					
ARI (Y)	CY	1987 IFD Q (m^3s^{-1})	2013 IFD Q (m^3s^{-1})	Zaman Q (m^3s^{-1})	Nikolaou + von't Steen Q (m^3s^{-1})
2	0.135	91.95751	81.06468	39.88	

5	0.162	142.5155	141.1915	104.79	
10	0.18	181.433	193.6288	173.37	
20	0.198	233.9766	255.7938	230.42	
50	0.216	307.3689	347.2348	330.51	
100	0.234	378.8004	437.9963	415.72	532.07

Table 24 Flow estimations at catchment outlet

Catchment Outlet					
ARI (Y)	**CY**	**1987 IFD Q (m^3s^{-1})**	**2013 IFD Q (m^3s^{-1})**	**Zaman Q (m^3s^{-1})**	**Nikolaou + von't Steen Q (m^3s^{-1})**
2	0.135	102.5665	87.43106	49.51	
5	0.162	153.453	150.0822	120.69	
10	0.18	191.407	204.1617	190.02	
20	0.198	242.961	268.4648	246.09	
50	0.216	313.1016	360.9453	338.99	
100	0.234	380.774	452.6155	414.41	538.04

Appendix B.2 Flood Frequency Log Pearson III – Method of Moments

Table 25 FFA - Log Pearson III for Calignee South

Calignee South – Log Pearson III method of moments						
Count	**AEP (%)**	**ARI**	**Flow (ML/Day)**	**Flow (m^3s^{-1})**	**UPPER 95% CL (ML/Day)**	**LOWER 95% CL (ML/Day)**
48	99	1.01	73.91714	0.855523	1541.363	3.54475
	95	1.05	167.7193	1.941196	1114.597	25.23761
Mean	90	1.11	256.1499	2.964698	1158.158	56.65268
3.01	80	1.25	422.2719	4.887406	1457.822	122.3151
	50	2	1055.297	12.21409	3139.276	354.7479
StDev	20	5	2511.623	29.06971	7651.916	824.4014
0.46093	10	10	3872.7	44.82292	13669.22	1097.195

	5	20	5485.281	63.48705	25014.31	1202.844
Skew (G)	2	50	8029.209	92.93065	57497.05	1121.243
-0.14997	1	100	10281.81	119.0024	108962.3	970.2032
	0.5	200	12848.86	148.7137	206732.8	798.5829
	0.2	500	16735.41	193.6968	479089.8	584.5957

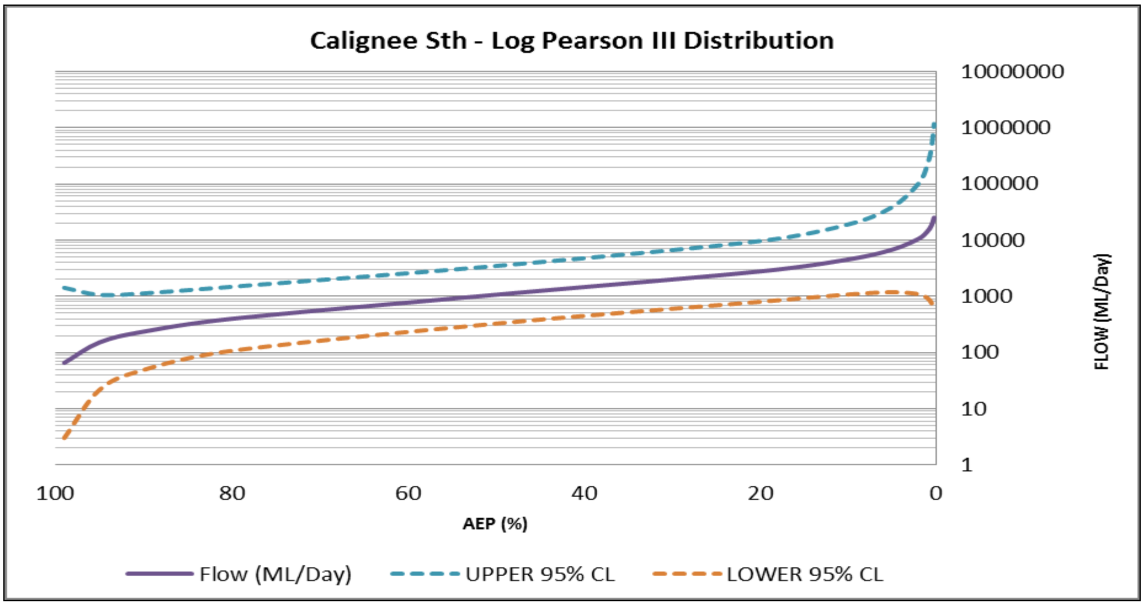


Figure 24 Log Pearson III Distribution curve for Calignee South

Table 26 FFA - Log Pearson III for Prospect Road

Prospect Road Seaspray – Log Pearson III method of moments						
Count	**AEP (%)**	**ARI**	**Flow (ML/Day)**	**Flow (m^3s^{-1})**	**UPPER 95% CL (ML/Day)**	**LOWER 95% CL (ML/Day)**
18	99	1.01	29.67	0.34	846.35	1.04
	95	1.05	66.48	0.77	546.19	8.09
Mean	90	1.11	106.16	1.23	617.06	18.26
2.88	80	1.25	193.58	2.24	971.38	38.58
	50	2	681.72	7.89	3697.50	125.69
StDev	20	5	2794.35	32.34	20616.65	378.74
0.69	10	10	6221.60	72.01	76782.53	504.13
	5	20	12426.26	143.82	316953.97	487.17
Skew (G)	2	50	28112.50	325.38	2293569.93	344.58

0.46	1	100	49490.70	572.81	10713096.67	228.63
	0.5	200	84386.03	976.69	51253125.17	138.94
	0.2	500	164288.57	1901.49	415802303.29	64.91

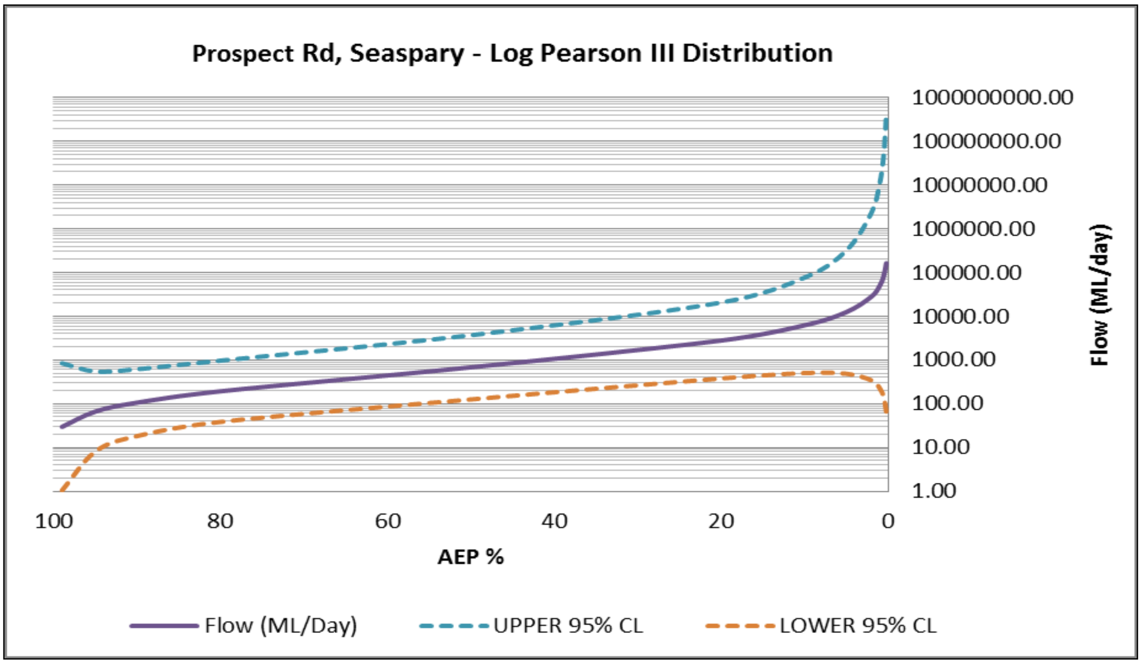


Figure 25 Log Pearson III Distribution curve for Prospect Road

Appendix B.3 Flood Frequency Analysis FLIKE

TUFLOW FLIKE program version 4.50

TUFLOW FLIKE file version 3.00

Title: Calignee South gauge

Input Data for Flood Frequency Analysis for Model: Log Pearson III

Recurrence interval yrs	Exp parameter quantile	Monte Carlo 90% quantile probability limits		Mean(log10(q))	Stdev(log10(q))
1.010	0.69	0.21	1.5	-0.1664	0.2650
1.100	2.56	1.55	3.8	0.4080	0.1195
1.250	4.68	3.31	6.5	0.6724	0.0894
1.500	7.61	5.62	10.3	0.8827	0.0809
1.750	10.13	7.54	13.7	1.0069	0.0791
2.000	12.40	9.24	16.7	1.0941	0.0782

3.000	19.83	14.85	26.5	1.2968	0.0761
5.000	30.47	22.90	40.8	1.4825	0.0767
10.000	47.37	34.84	68.7	1.6736	0.0897
20.000	67.22	47.05	111.2	1.8259	0.1156
50.000	98.11	62.18	198.9	1.9919	0.1614
100.000	125.13	72.31	309.0	2.0996	0.2003

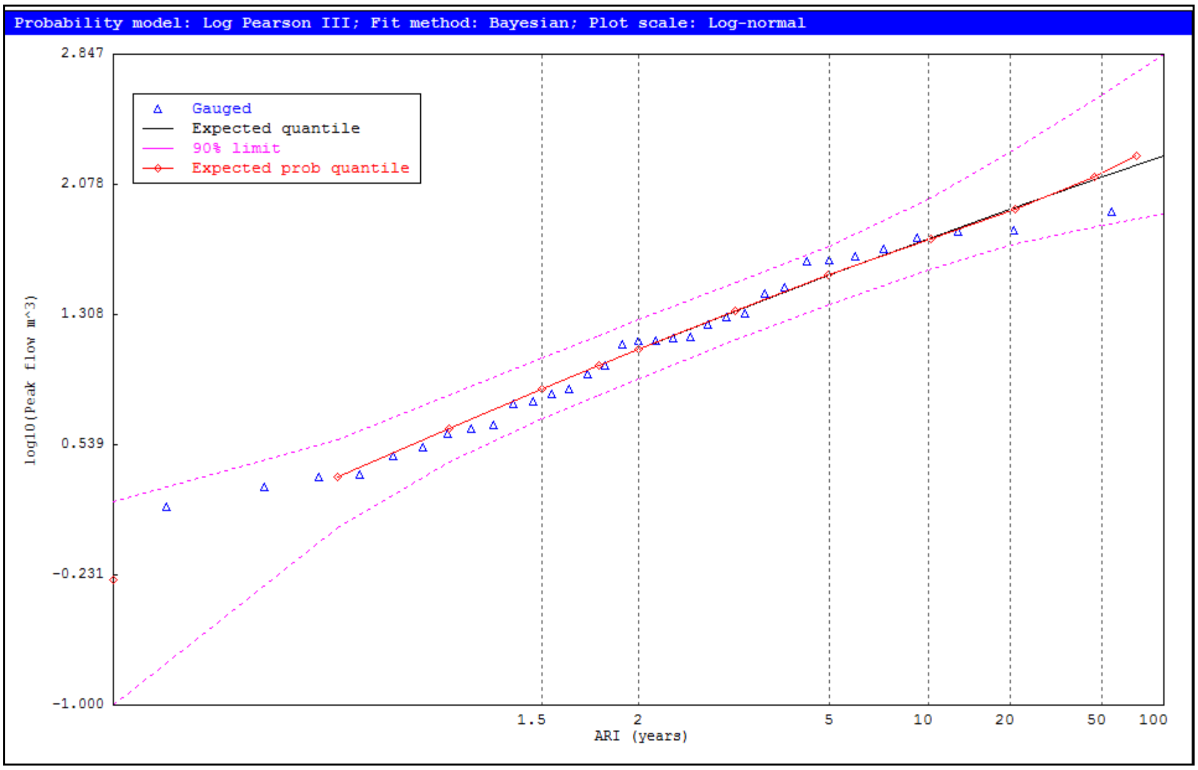


Figure 26 FLIKE plot for Merrimans Creek at Calignee South

Title: Prospect Road, Seaaspray

Input Data for Flood Frequency Analysis for Model: Log Pearson III

Recurrence interval yrs	Exp parameter quantile	Monte Carlo 90% quantile probability limits		Mean(log10(q))	Stdev(log10(q))
1.010	0.28	0.06	0.7	-0.5642	0.3315
1.100	1.37	0.66	2.4	0.1358	0.1725
1.250	3.01	1.76	4.9	0.4792	0.1358

1.500	5.78	3.65	9.2	0.7638	0.1224
1.750	8.61	5.53	13.5	0.9369	0.1184
2.000	11.46	7.44	17.8	1.0610	0.1163
3.000	22.71	14.94	34.6	1.3574	0.1114
5.000	43.58	29.21	64.6	1.6397	0.1060
10.000	87.53	59.16	129.3	1.9417	0.1048
20.000	155.64	102.18	243.6	2.1913	0.1158
50.000	297.34	181.51	551.0	2.4725	0.1488
100.000	457.70	257.18	991.8	2.6603	0.1831

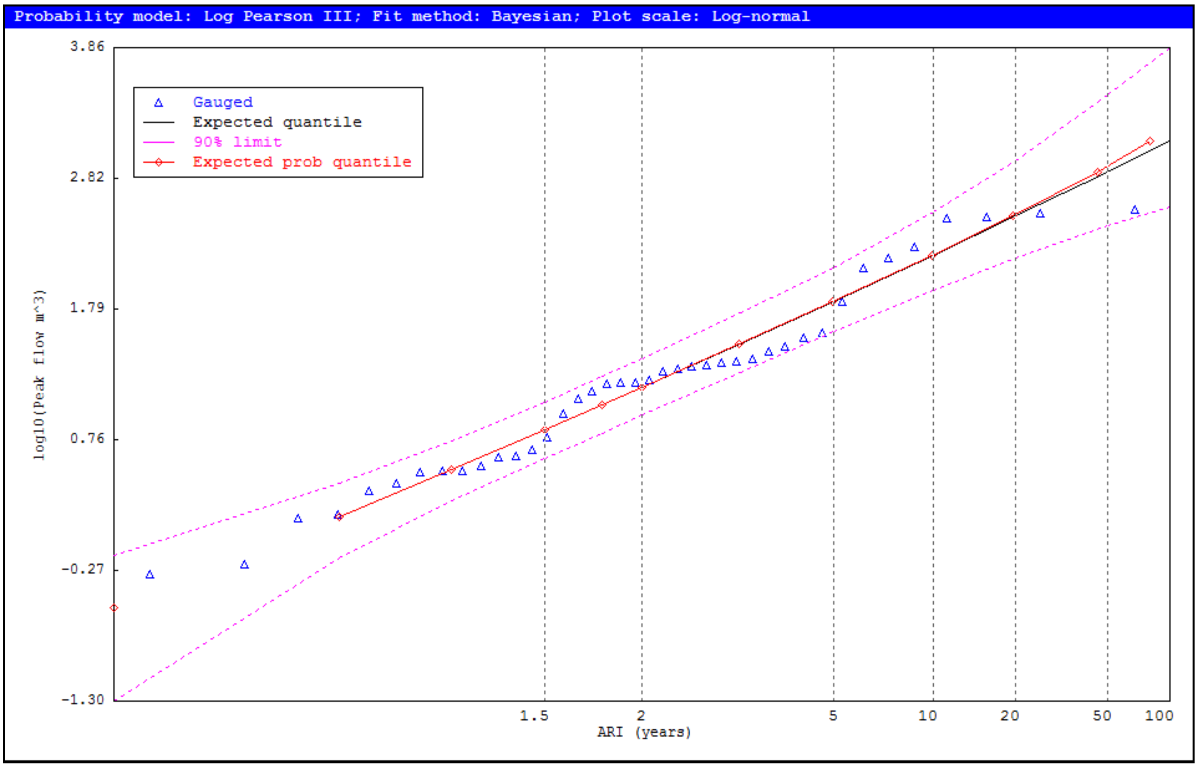


Figure 27FLIKE plot for Merrimans Creek at Prospect Rd Seaspray

Appendix B.4 RORB Model Inputs

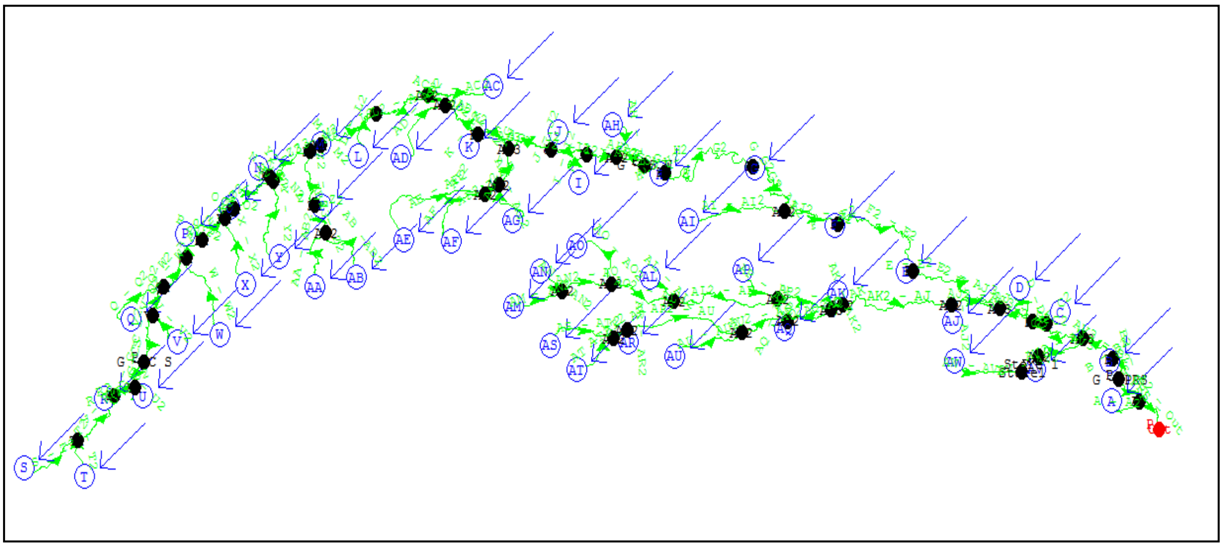


Figure 28 RORB model catchment setup

Table 27 September 1993 Storm Data

SEPTEMBER 1993 CALIBRATION EVENT								
STORM DURATION		HYDROGRAPHS (m³/s)			PLUVIOGRAPHS (mm/hr)			
HOURS	DATE	Calignee South (227205)	Stradbroke West (227239)	Prospect Rd Seaspray (227240)	East Sale Airport (085072)	Callignee North (085236)	Mount Tassie (585186)
1	14/09/1993 8:00	0.7	3.5	0.5	0	0	0
2	14/09/1993 9:00	0.7	3.5	0.4	0	0	0
3	14/09/1993 10:00	0.7	3.5	0.4	0	0	0.5
4	14/09/1993 11:00	0.7	3.5	0.4	0.51	0	0.5
5	14/09/1993 12:00	0.7	3.5	0.4	1.42	0	1
6	14/09/1993 13:00	0.7	3.5	0.4	1.12	0	1
7	14/09/1993 14:00	0.7	3.5	0.4	1	0	4.5
8	14/09/1993 15:00	0.8	3.7	0.3	0.33	0.04	2.5
9	14/09/1993 16:00	1.0	3.9	0.3	0.61	0.58	4
10	14/09/1993 17:00	1.6	4.1	0.3	1.54	0.44	2.5
11	14/09/1993 18:00	2.4	4.3	0.3	0.69	0.6	3
12	14/09/1993 19:00	3.6	4.5	0.3	0	0.86	4.5
13	14/09/1993 20:00	4.5	4.8	0.3	1.18	0.21	5.5
14	14/09/1993 21:00	5.6	5	0.3	6.09	0.61	5.5
15	14/09/1993 22:00	7.6	5.2	0.3	3.11	1.41	6.5

16	14/09/1993 23:00	11.5	5.4	0.3	0.56	3.18	10.5
17	15/09/1993 0:00	17.3	5.6	0.3	0.43	2.13	10
18	15/09/1993 1:00	22.6	5.8	0.4	1.63	1.47	14
19	15/09/1993 2:00	29.9	6.1	0.4	1.53	4.12	12
20	15/09/1993 3:00	48.4	6.3	0.5	5.09	4.26	14
21	15/09/1993 4:00	58.0	6.5	0.6	7.18	2.89	12
22	15/09/1993 5:00	59.8	6.7	0.8	6.34	4.26	16
23	15/09/1993 6:00	61.7	7.6	1	8.13	4.35	14
24	15/09/1993 7:00	73.2	8.8	1.3	10.13	6.28	12
25	15/09/1993 8:00	77.4	12.2	1.8	3	6.86	16
26	15/09/1993 9:00	80.2	15.8	2.2	3.15	4.11	12
27	15/09/1993 10:00	82.4	19.5	2.5	3.38	5.47	10
28	15/09/1993 11:00	81.3	23	2.9	4.21	4.08	12
29	15/09/1993 12:00	78.5	29.8	3.3	5.11	8.37	10
30	15/09/1993 13:00	74.6	34.9	3.9	3.12	4.78	6
31	15/09/1993 14:00	69.2	53.6	5	3.4	2.01	8
32	15/09/1993 15:00	65.1	169.4	6.3	6.23	1.55	6
33	15/09/1993 16:00	59.5	218.3	7.9	5.69	2.83	6
34	15/09/1993 17:00	58.0	250.2	9.6	4	3.18	8
35	15/09/1993 18:00	56.1	261.3	10.9	4.51	3.56	5
36	15/09/1993 19:00	54.3	271.2	12.3	2.21	1.4	4
37	15/09/1993 20:00	49.9	276	14.6	1.42	0.56	2
38	15/09/1993 21:00	42.3	279	17.4	0.95	0.35	2
39	15/09/1993 22:00	36.6	277.7	21.5	1.18	0.29	1
40	15/09/1993 23:00	32.4	273.2	65.9	1.17	0.14	1
41	16/09/1993 0:00	27.8	258.7	170	0.45	0.15	2
42	16/09/1993 1:00	25.7	247.3	348.1	0.07	0.12	0
43	16/09/1993 2:00	23.2	237.5	338.6	0.14	0.1	0
44	16/09/1993 3:00	21.1	221.3	329.1	0	0.1	0
45	16/09/1993 4:00	20.8	205	314.5	0	0.17	0
46	16/09/1993 5:00	20.4	191.3	297.8	0.17	0.1	0
47	16/09/1993 6:00	17.5	178.7	281.2	0.18	0.05	0
48	16/09/1993 7:00	16.4	166.2	268.7	0	0.09	0
49	16/09/1993 8:00	15.5	154.2	256.8	0	0.02	0

50	16/09/1993 9:00	14.6	142.3	245.7	0.05375	0	0
51	16/09/1993 10:00	13.5	131.9	235.1			
52	16/09/1993 11:00	12.9	122.7	224.4			
53	16/09/1993 12:00	12.4	115.5	199.7			
54	16/09/1993 13:00	11.8	108.6	172.1			
55	16/09/1993 14:00	11.0	101.7	144.9			
56	16/09/1993 15:00	10.6	94.6	123.3			
57	16/09/1993 16:00	10.2	87.5	107.3			
58	16/09/1993 17:00	10.1	82.5	99.8			
59	16/09/1993 18:00	9.6	77.5	85.5			
60	16/09/1993 19:00	9.1	70.3	78.9			
61	16/09/1993 20:00	8.6	65.9	72.2			
62	16/09/1993 21:00	8.2	61.5	65.6			
63	16/09/1993 22:00	7.9	58.4	59			
64	16/09/1993 23:00	7.7	54.3	53.6			
65	17/09/1993 0:00	7.5	51.3	49.1			
66	17/09/1993 1:00	7.3	48.2	45.7			
67	17/09/1993 2:00	7.1	45.6	44.8			
68	17/09/1993 3:00	6.9	43.1	43.9			
69	17/09/1993 4:00	6.7	40.8	43.3			
70	17/09/1993 5:00	6.5	38.7	43.2			
71	17/09/1993 6:00	6.3	37	43.4			
72	17/09/1993 7:00	6.1	35.5	43.8			
73	17/09/1993 8:00	6.0	33.5	44.5			
74	17/09/1993 9:00	5.8	32.2	43.3			
75	17/09/1993 10:00	5.7	30.9	39.1			
76	17/09/1993 11:00	5.6	29.9	36.8			
77	17/09/1993 12:00	5.5	28.6	34.4			
78	17/09/1993 13:00	5.4	27.6	32.2			
79	17/09/1993 14:00	5.3	26.5	30			
80	17/09/1993 15:00	5.2	25.6	27.9			
81	17/09/1993 16:00	5.1	24.9	25.8			
82	17/09/1993 17:00	5.0	24.4	24.3			
83	17/09/1993 18:00	5.0	23.8	23.2			

84	17/09/1993 19:00	4.9	23.3	21.3			
85	17/09/1993 20:00	4.8	22.8	19.9			
86	17/09/1993 21:00	4.7	22.4	18.6			
87	17/09/1993 22:00	4.6	21.8	17.4			
88	17/09/1993 23:00	4.6	21.3	16.4			
89	18/09/1993 0:00	4.5	20.7	15.6			
90	18/09/1993 1:00	4.5	20.2	14.8			
91	18/09/1993 2:00	4.4	19.7	14			
92	18/09/1993 3:00	4.4	19.3	13.3			
93	18/09/1993 4:00	4.3	18.8	12.6			
94	18/09/1993 5:00	4.3	18.4	11.9			
95	18/09/1993 6:00	4.2	18	11.3			
96	18/09/1993 7:00	4.2	17.6	10.7			
97	18/09/1993 8:00	4.1	17.3	10.2			
98	18/09/1993 9:00	4.1	17	9.6			
99	18/09/1993 10:00	4.0	16.7	9.2			
100	18/09/1993 11:00	4.0	16.4	8.8			
101	18/09/1993 12:00	4.0	16	8.3			
102	18/09/1993 13:00	3.9	15.7	7.9			
103	18/09/1993 14:00	3.9	15.4	7.5			
104	18/09/1993 15:00	3.8	15.1	7.2			
105	18/09/1993 16:00	3.8	14.8	6.9			
106	18/09/1993 17:00	3.8	14.6	6.5			
107	18/09/1993 18:00	3.7	14.3	6.2			
108	18/09/1993 19:00	3.7	14	5.9			
109	18/09/1993 20:00	3.7	13.8	5.6			
110	18/09/1993 21:00	3.6	13.5	5.3			
111	18/09/1993 22:00	3.6	13.3	5			
112	18/09/1993 23:00	3.6	13	4.8			

Table 28 November 1995 Storm Data

NOVEMBER 1995CALIBRATION EVENT		
STORM DURATION	HYDROGRAPHS (m^3/s)	PLUVIOGRAPHS (mm/hr)

HOURS	DATE	Calignee South (227205)	Stradbroke West (227239)	Prospect Rd Seaspray (227240)	East Sale Airport (085072)	Callignee North (085236)	Mount Tassie (585186)
1	4/11/1995 8:00	0.5	1.7	1.7	0	0	0
2	4/11/1995 9:00	0.5	1.7	1.7	0	0	0
3	4/11/1995 10:00	0.5	1.7	1.7	0	0	0
4	4/11/1995 11:00	0.5	1.7	1.7	0	0	0
5	4/11/1995 12:00	0.5	1.7	1.7	0	0	0
6	4/11/1995 13:00	0.5	1.7	1.7	0	0	2.5
7	4/11/1995 14:00	0.5	1.7	1.7	0	0	0
8	4/11/1995 15:00	0.5	1.7	1.7	0	0.83	0
9	4/11/1995 16:00	0.5	1.7	1.7	0	1.19	0.5
10	4/11/1995 17:00	0.5	1.7	1.7	0.35	1.19	0
11	4/11/1995 18:00	0.5	1.7	1.7	0.59	1.19	1.3
12	4/11/1995 19:00	0.5	1.7	1.7	0.07	1.19	0.5
13	4/11/1995 20:00	0.5	1.7	1.7	0.6	1.19	0
14	4/11/1995 21:00	0.5	1.7	1.7	0.8	1.19	0.5
15	4/11/1995 22:00	0.6	1.7	1.7	0.22	1.19	3
16	4/11/1995 23:00	0.6	1.7	1.7	0.14	1.19	2
17	5/11/1995 0:00	0.7	1.7	1.7	0.1	1.19	1
18	5/11/1995 1:00	0.7	1.7	1.7	0.15	1.19	0.5
19	5/11/1995 2:00	0.8	1.7	1.7	0.16	1.19	0.5
20	5/11/1995 3:00	0.8	1.7	1.7	0.13	1.19	1
21	5/11/1995 4:00	0.9	1.7	1.7	0.24	1.19	2
22	5/11/1995 5:00	1.0	1.7	1.7	0.62	1.19	2.5
23	5/11/1995 6:00	1.1	1.6	1.6	0.79	1.19	13
24	5/11/1995 7:00	2.6	1.6	1.6	1.3	1.19	14.5
25	5/11/1995 8:00	5.6	1.6	1.6	7.4	1.19	9
26	5/11/1995 9:00	10.4	1.6	1.6	2.53	5.72	8
27	5/11/1995 10:00	16.4	1.7	1.7	2.7	4.73	10
28	5/11/1995 11:00	17.7	1.7	1.7	5.09	3.44	4.5
29	5/11/1995 12:00	18.1	1.7	1.7	4.47	0.71	5.5
30	5/11/1995 13:00	17.3	1.7	1.7	6.59	0.87	8
31	5/11/1995 14:00	19.6	1.8	1.8	1.92	3.46	7
32	5/11/1995 15:00	24.6	1.8	1.8	0.47	2.24	6.5

33	5/11/1995 16:00	29.4	1.9	1.9	0.93	3.73	6
34	5/11/1995 17:00	33.6	2.1	2.1	0	2.08	8
35	5/11/1995 18:00	34.4	2.3	2.3	0	1.89	10
36	5/11/1995 19:00	34.7	2.6	2.6	0	2.25	7.5
37	5/11/1995 20:00	34.6	2.7	2.7	0	3.64	7
38	5/11/1995 21:00	34.2	2.9	2.9	0	3.52	10
39	5/11/1995 22:00	36.5	3.2	3.2	0	1.58	8
40	5/11/1995 23:00	38.6	7.2	3.4	0.1	1.4	8
41	6/11/1995 0:00	38.8	8.3	3.5	0.45	0.53	5.5
42	6/11/1995 1:00	36.9	9.3	3.6	0.83	1.48	7
43	6/11/1995 2:00	34.9	10.2	3.7	1.68	3.58	9.5
44	6/11/1995 3:00	37.5	11.3	3.8	1.23	4.9	16.5
45	6/11/1995 4:00	49.2	55.7	5	5.76	4.29	18
46	6/11/1995 5:00	59.5	86.8	6.3	0.82	6.01	14
47	6/11/1995 6:00	60.9	111.8	7.6	2.05	2.05	15.5
48	6/11/1995 7:00	62.3	130.3	8.9	1.11	0	10.5
49	6/11/1995 8:00	62.8	145.9	10.1	0.4	1.53	11.5
50	6/11/1995 9:00	62.9	157.6	11.4	2.6	6.29	7.5
51	6/11/1995 10:00	60.3	164.6	14.5	0.29	6.1	9
52	6/11/1995 11:00	52.5	184.8	18.5	0.42	0.84	11.5
53	6/11/1995 12:00	47.3	206.7	22.6	3.25	2.04	3.5
54	6/11/1995 13:00	45.6	246.5	26.6	0	0.78	2.5
55	6/11/1995 14:00	32.3	260.7	30.7	0	0.2	6
56	6/11/1995 15:00	27.1	263	34.7	0.64	0.15	11
57	6/11/1995 16:00	29.2	253.6	38.7	0	0.73	0.5
58	6/11/1995 17:00	30.2	238.2	42.8	0	0.28	2
59	6/11/1995 18:00	30.0	223.4	46.8	0.04	0.44	3.5
60	6/11/1995 19:00	27.1	205.8	146.2	0.07	1.15	5
61	6/11/1995 20:00	24.4	189.2	197.2	0	0.38	2.5
62	6/11/1995 21:00	24.0	172	248.2	0	0.23	1.5
63	6/11/1995 22:00	23.6	158	320.6	0	0.17	4.5
64	6/11/1995 23:00	23.3	148.5	373.6	0	1.04	4
65	7/11/1995 0:00	22.9	141.2	374.5	0	0.1	3.5
66	7/11/1995 1:00	23.5	135.2	365.3	0.1	1.38	3

67	7/11/1995 2:00	23.5	128.6	351.3	0.01	0.09	5
68	7/11/1995 3:00	23.1	122.2	337.4	0	0.21	2.5
69	7/11/1995 4:00	22.6	115	323.4	0.47	1.74	2.5
70	7/11/1995 5:00	22.2	108.6	309.4	0.26	1.18	2
71	7/11/1995 6:00	21.7	102.1	295.4	0.25	0	4
72	7/11/1995 7:00	21.3	97.4	281.5	1.63	1.05	2.5
73	7/11/1995 8:00	20.8	91.9	269.6	1.35	0.42	1.5
74	7/11/1995 9:00	20.2	87.4	258.1	0.37	0.42	1
75	7/11/1995 10:00	19.7	82.8	246.6	0.25	0.42	4
76	7/11/1995 11:00	19.2	78.9	235.1	0.68	0.42	2
77	7/11/1995 12:00	18.7	77.3	223.6	6.02	0.33	1.5
78	7/11/1995 13:00	18.2	76.7	212.1	2.31	0	3.5
79	7/11/1995 14:00	17.5	77.1	200.6	2	0	0
80	7/11/1995 15:00	16.8	76.3	189.1	0.19	0	3.5
81	7/11/1995 16:00	16.1	74.2	177.6	0.11	0	0
82	7/11/1995 17:00	15.5	71.9	166.2	0.2	0	0.5
83	7/11/1995 18:00	14.8	69.5	154.7	3.48	0	0
84	7/11/1995 19:00	14.2	67.5	143.2	0	0	0.5
85	7/11/1995 20:00	13.6	65.3	139.5	0	0	0.5
86	7/11/1995 21:00	13.0	63	137.8	0	0	0
87	7/11/1995 22:00	12.4	60.6	136.1	0	0	0
88	7/11/1995 23:00	11.8	58.3	134.4	0	0	0
89	8/11/1995 0:00	11.1	55.8	132.7	0	0	0
90	8/11/1995 1:00	10.7	53.6	130.9	0	0	0
91	8/11/1995 2:00	10.3	51.6	129.2	0	0	0
92	8/11/1995 3:00	9.9	49.7	127.5	0.28	0	0
93	8/11/1995 4:00	9.6	47.8	125.8	0.4	0	0
94	8/11/1995 5:00	9.3	46.1	124.1	0.39	0	0
95	8/11/1995 6:00	9.0	44.5	122.4	0	0	0
96	8/11/1995 7:00	8.7	42.7	120.7	0	0	0
97	8/11/1995 8:00	8.5	40.9	119	0	0	0
98	8/11/1995 9:00	8.2	39.4	117.2	0	0	0
99	8/11/1995 10:00	8.0	37.8	115.5	0	0	0
100	8/11/1995 11:00	7.8	36.1	113.8	0	0	0

101	8/11/1995 12:00	7.5	34.5	112.1	0	0	0
102	8/11/1995 13:00	7.3	33.2	110.4	0	0	0
103	8/11/1995 14:00	7.1	31.8	108.7	0	0	0
104	8/11/1995 15:00	6.9	30.5	107	0	0	0
105	8/11/1995 16:00	6.7	29.3	105.3	0	0	0
106	8/11/1995 17:00	6.5	28.2	103.5	0	0	0
107	8/11/1995 18:00	6.3	27.1	101.8	0	0	0
108	8/11/1995 19:00	6.1	26	100.1	0	0	0
109	8/11/1995 20:00	6.0	25	98.4	0	0	0
110	8/11/1995 21:00	5.8	24.1	96.7	0	0	0
111	8/11/1995 22:00	5.7	23.2	95	0	0	0
112	8/11/1995 23:00	5.5	22.4	93.6	0	0	0
113	9/11/1995 0:00	5.4	21.6	92.2	0	0	0
114	9/11/1995 1:00	5.2	20.9	90.7			
115	9/11/1995 2:00	5.1	20.1	89.3			
116	9/11/1995 3:00	5.0	19.5	87.9			
117	9/11/1995 4:00	4.9	18.8	86.5			
118	9/11/1995 5:00	4.8	18.2	85.1			
119	9/11/1995 6:00	4.7	17.6	83.6			
120	9/11/1995 7:00	4.6	17	82.2			
121	9/11/1995 8:00	4.6	16.5	80.8			
122	9/11/1995 9:00	4.5	16	79.4			
123	9/11/1995 10:00	4.4	15.5	78			
124	9/11/1995 11:00	4.3	15.1	76.5			
125	9/11/1995 12:00	4.3	14.8	75.1			
126	9/11/1995 13:00	4.2	14.4	73.7			
127	9/11/1995 14:00	4.1	14.1	72.3			
128	9/11/1995 15:00	4.1	13.8	70.9			
129	9/11/1995 16:00	4.0	13.5	69.5			
130	9/11/1995 17:00	3.9	13.2	68			
131	9/11/1995 18:00	3.9	12.9	66.6			
132	9/11/1995 19:00	3.8	12.7	65.2			
133	9/11/1995 20:00	3.7	12.4	63.8			
134	9/11/1995 21:00	3.7	12.2	62.4			

135	9/11/1995 22:00	3.6	11.9	60.9			
136	9/11/1995 23:00	3.6	11.7	59.5			
137	10/11/1995 0:00	3.5	11.5	58.1			
138	10/11/1995 1:00	3.4	11.3	56.7			
139	10/11/1995 2:00	3.4	11.1	55.3			
140	10/11/1995 3:00	3.3	10.9	53.8			
141	10/11/1995 4:00	3.3	10.7	52.4			
142	10/11/1995 5:00	3.2	10.5	51			
143	10/11/1995 6:00	3.2	10.4	49.6			
144	10/11/1995 7:00	3.2	10.2	48.3			
145	10/11/1995 8:00	3.1	10.1	47.1			
146	10/11/1995 9:00	3.1	9.9	45.9			
147	10/11/1995 10:00	3.0	9.7	45			
148	10/11/1995 11:00	3.0	9.6	44.2			
149	10/11/1995 12:00	2.9	9.5	43.4			
150	10/11/1995 13:00	2.9	9.3	42.6			
151	10/11/1995 14:00	2.8	9.3	41.8			
152	10/11/1995 15:00	2.8	9.1	41			
153	10/11/1995 16:00	2.7	9	40.2			
154	10/11/1995 17:00	2.7	8.8	39.4			
155	10/11/1995 18:00	2.7	8.6	38.6			
156	10/11/1995 19:00	2.6	8.5	37.8			
157	10/11/1995 20:00	2.6	8.3	37			
158	10/11/1995 21:00	2.6	8.1	36.2			
159	10/11/1995 22:00	2.6	8	35.4			
160	10/11/1995 23:00	2.6	7.8	34.6			
161	11/11/1995 0:00	2.5	7.7	33.8			
162	11/11/1995 1:00	2.5	7.6	33			
163	11/11/1995 2:00	2.5	7	32.2			
164	11/11/1995 3:00	2.5	7	31.4			
165	11/11/1995 4:00	2.4	7	30.6			
166	11/11/1995 5:00	2.4	7	29.8			
167	11/11/1995 6:00	2.4	6.8	29			
168	11/11/1995 7:00	2.4	6.7	28.2			

169	11/11/1995 8:00	2.3	6.6	27.4			
170	11/11/1995 9:00	2.3	6.6	27			
171	11/11/1995 10:00	2.3	6.6	26.5			
172	11/11/1995 11:00	2.3	6.6	26.1			
173	11/11/1995 12:00	2.3	6.6	25.6			
174	11/11/1995 13:00	2.2	6.6	25.1			
175	11/11/1995 14:00	2.2	6.6	24.7			
176	11/11/1995 15:00	2.2	6.6	24.2			
177	11/11/1995 16:00	2.2	6.6	23.8			
178	11/11/1995 17:00	2.1	6.6	23.3			
179	11/11/1995 18:00	2.1	6.6	22.8			
180	11/11/1995 19:00	2.1	6.6	22.4			
181	11/11/1995 20:00	2.1	6.6	21.9			
182	11/11/1995 21:00	2.1	6.6	21.5			
183	11/11/1995 22:00	2.0	6.6	21			
184	11/11/1995 23:00	2.0	6.6	20.5			
185	12/11/1995 0:00	2.0	6.6	20.1			
186	12/11/1995 1:00	2.0	6.6	19.6			
187	12/11/1995 2:00	2.0	6.6	19.2			
188	12/11/1995 3:00	1.9	6.6	18.7			
189	12/11/1995 4:00	1.9	6.6	18.3			
190	12/11/1995 5:00	1.9	6.6	17.8			
191	12/11/1995 6:00	1.9	6.6	17.3			
192	12/11/1995 7:00	1.9	6.6	16.9			
193	12/11/1995 8:00	1.9	6.6	16.4			
194	12/11/1995 9:00	1.9	6.6	16			
195	12/11/1995 10:00	1.8	6.6	15.5			
196	12/11/1995 11:00	1.8	6.6	15.2			
197	12/11/1995 12:00	1.8	6.6	15			
198	12/11/1995 13:00	1.8	6.6	14.8			
199	12/11/1995 14:00	1.8	6.6	14.7			
200	12/11/1995 15:00	1.8	6.6	14.5			
201	12/11/1995 16:00	1.8	6.6	14.3			
202	12/11/1995 17:00	1.8	6.6	14.1			

203	12/11/1995 18:00	1.8	6.6	13.9			
204	12/11/1995 19:00	1.7	6.6	13.7			
205	12/11/1995 20:00	1.7	6.6	13.6			
206	12/11/1995 21:00	1.7	6.6	13.4			
207	12/11/1995 22:00	1.7	6.6	13.2			
208	12/11/1995 23:00	1.7	6.6	13			
209	13/11/1995 0:00	1.7	6.6	12.8			
210	13/11/1995 1:00	1.7	6.6	12.6			
211	13/11/1995 2:00	1.7	6.6	12.5			
212	13/11/1995 3:00	1.7	6.6	12.3			
213	13/11/1995 4:00	1.6	6.6	12.1			
214	13/11/1995 5:00	1.6	6.6	11.9			
215	13/11/1995 6:00	1.6	6.6	11.7			

Table 29 June 2012 Storm Event

JUNE 2012 CALIBRATION EVENT							
STORM DURATION		HYDROGRAPHS (m^3/s)			PLUVIOGRAPHS (mm/hr)		
HOURS	DATE	Calignee South (227205)	Stradbroke West (227239)	Prospect Rd Seaspray (227240)	Callignee North (085236)	Mount Tassie (226814)	Stradbroke West (227239)
1	3/06/2012 8:00	0.5	0	0	0	0	0
2	3/06/2012 9:00	0.6	0	0	0.4	0.8	0.8
3	3/06/2012 10:00	0.6	0	0	0.4	0.6	1.4
4	3/06/2012 11:00	0.6	0	0	0.2	0.6	0.4
5	3/06/2012 12:00	0.5	0	0	0	0.4	0
6	3/06/2012 13:00	0.6	0	0	0.2	0.2	0.4
7	3/06/2012 14:00	0.6	0	0	0.4	0.4	1.4
8	3/06/2012 15:00	0.6	0	0	0.6	0.8	0.6
9	3/06/2012 16:00	0.6	0	0	0.4	1	0.8
10	3/06/2012 17:00	0.6	0	0	1.6	1.8	1.2
11	3/06/2012 18:00	0.6	0	0	0.4	3.2	1.8
12	3/06/2012 19:00	0.7	0	0	0.2	4	0.2
13	3/06/2012 20:00	0.7	0	0	0	1.4	0
14	3/06/2012 21:00	0.8	0	0	0.2	1.6	0
15	3/06/2012 22:00	0.9	0	0	0.6	2.4	0
16	3/06/2012 23:00	1.0	0	0	0.2	3.2	0

17	4/06/2012 0:00	1.1	0	0	0.6	1.8	0
18	4/06/2012 1:00	1.3	0	0	0	0.4	0
19	4/06/2012 2:00	1.4	0	0	0.2	0.2	0
20	4/06/2012 3:00	1.4	0	0	0	0.2	0
21	4/06/2012 4:00	1.4	0	0	0	0	0
22	4/06/2012 5:00	1.3	0	0	0	0.2	0
23	4/06/2012 6:00	1.2	0	0	0	0	0
24	4/06/2012 7:00	1.2	0	0	0	1.2	0
25	4/06/2012 8:00	1.2	1	2	0	0	0
26	4/06/2012 9:00	1.2	1	2	0.6	0.2	0
27	4/06/2012 10:00	1.2	1	2	3.2	2.2	1
28	4/06/2012 11:00	1.5	1	2	3.6	8.6	4.8
29	4/06/2012 12:00	3.3	1.1	2.1	5.8	11.4	8
30	4/06/2012 13:00	21.0	1.2	2.1	6.6	19.6	6.8
31	4/06/2012 14:00	38.0	1.6	2.1	5.8	14.8	8.4
32	4/06/2012 15:00	51.4	1.8	2.2	5.2	13.6	6.8
33	4/06/2012 16:00	58.6	2.1	2.2	4	13.2	5
34	4/06/2012 17:00	59.6	2.5	2.2	5.2	11.4	4.2
35	4/06/2012 18:00	63.7	3.2	2.2	5.8	12.4	5
36	4/06/2012 19:00	63.7	4	2.2	5.6	10.6	5.6
37	4/06/2012 20:00	61.4	4.8	2.2	4.2	8	4.8
38	4/06/2012 21:00	57.9	5.6	2.2	4.4	6	4
39	4/06/2012 22:00	51.9	6.1	2.2	4.4	3	2
40	4/06/2012 23:00	46.6	6.7	2.2	3.6	5.2	1
41	5/06/2012 0:00	42.3	7.3	2.2	1.6	5.4	1.6
42	5/06/2012 1:00	40.0	8.3	2.2	3.2	1.6	2.6
43	5/06/2012 2:00	36.4	9.6	2.2	7.4	1.6	4.2
44	5/06/2012 3:00	36.7	10.9	2.3	6.8	7.2	5.6
45	5/06/2012 4:00	42.0	24.6	2.4	4.4	10	3.4
46	5/06/2012 5:00	43.6	79.2	2.4	2.6	7.6	4.2
47	5/06/2012 6:00	42.1	105.2	2.4	0.6	2.2	2.8
48	5/06/2012 7:00	37.3	112.8	2.5	0	1.8	0
49	5/06/2012 8:00	33.1	111.9	2.5	0	0.2	0
50	5/06/2012 9:00	29.3	108.6	2.5	0.2	0.6	0.2

51	5/06/2012 10:00	26.0	104.6	2.5			
52	5/06/2012 11:00	23.0	101.2	2.5			
53	5/06/2012 12:00	20.0	98.9	2.5			
54	5/06/2012 13:00	18.1	97.4	2.7			
55	5/06/2012 14:00	16.4	95.8	2.8			
56	5/06/2012 15:00	14.8	93	3			
57	5/06/2012 16:00	13.8	88.5	3.2			
58	5/06/2012 17:00	13.1	83.3	3.4			
59	5/06/2012 18:00	12.1	77.8	3.6			
60	5/06/2012 19:00	11.3	72.2	3.8			
61	5/06/2012 20:00	10.9	67.2	4			
62	5/06/2012 21:00	10.6	62.1	4.1			
63	5/06/2012 22:00	10.5	57.1	4.4			
64	5/06/2012 23:00	10.1	52.4	4.5			
65	6/06/2012 0:00	9.9	48.3	4.7			
66	6/06/2012 1:00	9.3	45.2	5.8			
67	6/06/2012 2:00	8.9	42.2	12.4			
68	6/06/2012 3:00	8.4	39.5	24			
69	6/06/2012 4:00	8.1	37.2	37.7			
70	6/06/2012 5:00	7.8	35.3	52.2			
71	6/06/2012 6:00	7.6	33.5	62.7			
72	6/06/2012 7:00	7.3	31.7	66			
73	6/06/2012 8:00	7.0	30.1	69.8			
74	6/06/2012 9:00	6.8	28.7	71.3			
75	6/06/2012 10:00	6.5	27.4	70.2			
76	6/06/2012 11:00	6.2	26.2	64.5			
77	6/06/2012 12:00	6.0	25.1	61.6			
78	6/06/2012 13:00	5.8	24	59.1			
79	6/06/2012 14:00	5.5	23.1	55.5			
80	6/06/2012 15:00	5.3	22.3	54.4			
81	6/06/2012 16:00	5.1	21.5	51.5			
82	6/06/2012 17:00	5.0	20.8	49.8			
83	6/06/2012 18:00	4.7	20.2	48.2			
84	6/06/2012 19:00	4.5	19.6	45.8			

85	6/06/2012 20:00	4.3	19.1	45.2			
86	6/06/2012 21:00	4.2	18.6	42.7			
87	6/06/2012 22:00	3.9	18.1	42.4			
88	6/06/2012 23:00	3.8	17.6	39.5			
89	7/06/2012 0:00	3.6	17.2	38			
90	7/06/2012 1:00	3.4	16.8	37.4			
91	7/06/2012 2:00	3.3	16.3	36.4			
92	7/06/2012 3:00	3.1	15.9	34.7			
93	7/06/2012 4:00	3.0	15.5	34.3			
94	7/06/2012 5:00	2.9	15.1	33.4			
95	7/06/2012 6:00	2.8	14.8	31.4			
96	7/06/2012 7:00	2.7	14.5	30.6			
97	7/06/2012 8:00	2.7	14.2	30.4			
98	7/06/2012 9:00	2.6	13.9	29.6			
99	7/06/2012 10:00	2.5	13.6	28.8			
100	7/06/2012 11:00	2.4	13.4	28			
101	7/06/2012 12:00	2.4	13.1	26.6			
102	7/06/2012 13:00	2.3	12.8	25.8			
103	7/06/2012 14:00	2.2	12.6	25.3			
104	7/06/2012 15:00	2.2	12.4	24.8			
105	7/06/2012 16:00	2.1	12.1	24.3			
106	7/06/2012 17:00	2.1	11.9	23.2			
107	7/06/2012 18:00	2.0	11.7	22.8			
108	7/06/2012 19:00	2.0	11.5	22.6			
109	7/06/2012 20:00	1.9	11.3	21.9			
110	7/06/2012 21:00	1.9	11.1	21.4			
111	7/06/2012 22:00	1.9	10.9	21.2			
112	7/06/2012 23:00	1.9	10.7	20.6			
113	8/06/2012 0:00	1.8	10.5	20.1			
114	8/06/2012 1:00	1.8	10.3	19.8			
115	8/06/2012 2:00	1.8	10.1	19.3			
116	8/06/2012 3:00	1.8	10	19			
117	8/06/2012 4:00	1.7	9.8	18.6			
118	8/06/2012 5:00	1.7	9.6	18.2			

119	8/06/2012 6:00	1.7	9.5	18			
120	8/06/2012 7:00	1.7	9.3	17.5			
121	8/06/2012 8:00	1.6	9.2	17.2			
122	8/06/2012 9:00	1.6	9	16.9			
123	8/06/2012 10:00	1.6	8.9	16.5			
124	8/06/2012 11:00	1.6	8.8	16.3			
125	8/06/2012 12:00	1.6	8.6	16			
126	8/06/2012 13:00	1.6	8.5	15.6			
127	8/06/2012 14:00	1.6	8.4	15.5			
128	8/06/2012 15:00	1.5	8.2	15			
129	8/06/2012 16:00	1.5	8.1	14.9			
130	8/06/2012 17:00	1.5	7.9	14.5			
131	8/06/2012 18:00	1.5	7.8	14.4			
132	8/06/2012 19:00	1.5	7.7	14			
133	8/06/2012 20:00	1.5	7.6	13.9			
134	8/06/2012 21:00	1.5	7.4	13.6			
135	8/06/2012 22:00	1.4	7.3	13.3			
136	8/06/2012 23:00	1.4	7.2	13.4			
137	9/06/2012 0:00	1.4	7	13.1			
138	9/06/2012 1:00	1.4	6.9	12.9			
139	9/06/2012 2:00	1.4	6.8	12.6			
140	9/06/2012 3:00	1.4	6.7	12.4			
141	9/06/2012 4:00	1.4	6.5	12.3			
142	9/06/2012 5:00	1.4	6.4	12			
143	9/06/2012 6:00	1.4	6.3	11.9			
144	9/06/2012 7:00	1.3	6.2	11.6			
145	9/06/2012 8:00	1.3	6.1	11.7			
146	9/06/2012 9:00	1.3	6	11.7			
147	9/06/2012 10:00	1.3	5.9	11.4			
148	9/06/2012 11:00	1.3	5.8	11.3			
149	9/06/2012 12:00	1.3	5.7	11.1			
150	9/06/2012 13:00	1.3	5.6	11			
151	9/06/2012 14:00	1.3	5.6	10.9			
152	9/06/2012 15:00	1.3	5.5	10.8			

153	9/06/2012 16:00	1.3	5.4	10.7			
154	9/06/2012 17:00	1.3	5.3	10.6			
155	9/06/2012 18:00	1.3	5.3	10.5			
156	9/06/2012 19:00	1.3	5.2	10.2			
157	9/06/2012 20:00	1.3	5.1	10.2			
158	9/06/2012 21:00	1.2	5.1	10.1			
159	9/06/2012 22:00	1.2	5	10.1			
160	9/06/2012 23:00	1.2	5	9.9			
161	10/06/2012 0:00	1.2	4.9	9.7			
162	10/06/2012 1:00	1.2	4.8	9.7			
163	10/06/2012 2:00	1.2	4.8	9.6			
164	10/06/2012 3:00	1.2	4.7	9.6			
165	10/06/2012 4:00	1.2	4.7	9.5			
166	10/06/2012 5:00	1.2	4.6	9.4			
167	10/06/2012 6:00	1.2	4.6	9.3			
168	10/06/2012 7:00	1.2	4.5	9.2			
169	10/06/2012 8:00	1.2	4.5	9.2			
170	10/06/2012 9:00	1.1	4.4	8.9			
171	10/06/2012 10:00	1.1	4.4	9			
172	10/06/2012 11:00	1.1	4.3	8.8			
173	10/06/2012 12:00	1.1	4.3	8.8			
174	10/06/2012 13:00	1.1	4.2	8.8			
175	10/06/2012 14:00	1.1	4.2	8.8			
176	10/06/2012 15:00	1.1	4.1	8.7			
177	10/06/2012 16:00	1.1	4.1	8.6			
178	10/06/2012 17:00	1.1	4	8.4			
179	10/06/2012 18:00	1.1	4	8.5			
180	10/06/2012 19:00	1.1	4	8.4			
181	10/06/2012 20:00	1.1	3.9	8.3			
182	10/06/2012 21:00	1.1	3.9	8.1			
183	10/06/2012 22:00	1.1	3.8	8.2			
184	10/06/2012 23:00	1.1	3.8	8.1			
185	11/06/2012 0:00	1.1	3.7	7.9			
186	11/06/2012 1:00	1.1	3.6	7.9			

187	11/06/2012 2:00	1.1	3.6	7.8			
188	11/06/2012 3:00	1.1	3.6	7.7			
189	11/06/2012 4:00	1.0	3.5	7.7			
190	11/06/2012 5:00	1.0	3.5	7.6			
191	11/06/2012 6:00	1.0	3.4	7.5			
192	11/06/2012 7:00	1.0	3.4	7.5			
193	11/06/2012 8:00	1.0	3.3	7.4			
194	11/06/2012 9:00	1.0	3.3	7.4			
195	11/06/2012 10:00	1.0	3.3	7.3			
196	11/06/2012 11:00	1.0	3.2	7.2			
197	11/06/2012 12:00	1.0	3.2	7.3			
198	11/06/2012 13:00	1.0	3.2	7.2			
199	11/06/2012 14:00	1.0	3.1	7.2			
200	11/06/2012 15:00	1.0	3.1	7.1			
201	11/06/2012 16:00	1.0	3.1	7.1			
202	11/06/2012 17:00	1.0	3	7			
203	11/06/2012 18:00	1.0	3	6.9			
204	11/06/2012 19:00	1.0	2.9	6.9			
205	11/06/2012 20:00	1.0	2.9	6.8			
206	11/06/2012 21:00	1.0	2.9	6.8			
207	11/06/2012 22:00	1.0	2.8	6.8			
208	11/06/2012 23:00	1.0	2.8	6.7			
209	12/06/2012 0:00	0.9	2.8	6.7			
210	12/06/2012 1:00	0.9	2.7	6.6			
211	12/06/2012 2:00	0.9	2.7	6.6			
212	12/06/2012 3:00	0.9	2.7	6.5			
213	12/06/2012 4:00	0.9	2.7	6.5			
214	12/06/2012 5:00	0.9	2.6	6.4			
215	12/06/2012 6:00	0.9	2.6	6.4			
216	12/06/2012 7:00	0.9	2.6	6.4			
217	12/06/2012 8:00	0.9	2.6	6.4			

Table 30 Fraction Impervious for each planning zone

Zone Code	Zone Description	Fraction Impervious (FI)

B1Z – B5Z	Business (1 – 5) Zone	0.9
FZ	Farming Zone	0.1
FZ	Farming Zone - Forestry*	0.1
IN1Z – IN2Z	Industrial (1 – 2) Zone	0.9
LDRZ	Low Density Residential Zone	0.2
MUZ	Mixed Use Zone	0.7
PCRZ	Public Conservation and Resource Zone	0
PPRZ	Public Park and Recreation Zone	0.1
PUZ1	Public Use Zone - Service and Utility	0.05
PUZ2	Public Use Zone - Education	0.7
PUZ3	Public Use Zone - Health and Community	0.7
PUZ4	Public Use Zone - Transport	0.7
PUZ5	Public Use Zone - Cemetery/Crematorium	0.6
PUZ6	Public Use Zone - Local Government	0.7
PUZ7	Public Use Zone - Other Public Use	0.6
R1Z	Residential 1 Zone	0.45
R2Z	Residential 2 Zone	0.6
RCZ, RCZ1, RCZ2	Rural Conservation Zone	0
RDZ1	Road Zone - Category 1	0.7
RDZ2	Road Zone - Category 2	0.6
RLZ, RLZ2, RLZ4, RLZ6	Rural Living Zone	0.2
SUZ1, SUZ2, SUZ10	Special Use Zone (1, 2, 10)	0.6
TZ	Township Zone	0.55

Table 31 RORB single set of parameters for design runs

Event	k_c	m	IL (mm)	CL (mm/hr)	Error for Peak discharge (%)	Lag to Peak (hours)	Error in Volume, m^3 (%)
Callignee South							
1993	52.0	0.8	45.0	3.95	5.6	-1.0	-43.2
1995	52.0	0.8	50.0	3.90	19.2	-2.0	-53.4
2012	52.0	0.8	65.0	1.80	4.7	0	-56.8
Stradbroke West							
1993	52.0	0.8	45.0	3.95	2.5	-2.0	-40.4

1995	52.0	0.8	50.0	3.90	-52.6	3.0	-66.5
2012	52.0	0.8	65.0	1.80	-21.0	3.0	-52.9
Prospect Rd Seaspray							
1993	52.0	0.8	45.0	3.95	-27.3	5.0	0.4
1995	52.0	0.8	50.0	3.90	-69.8	6.0	-70.6
2012	52.0	0.8	65.0	1.80	5.2	-9.0	-28.5

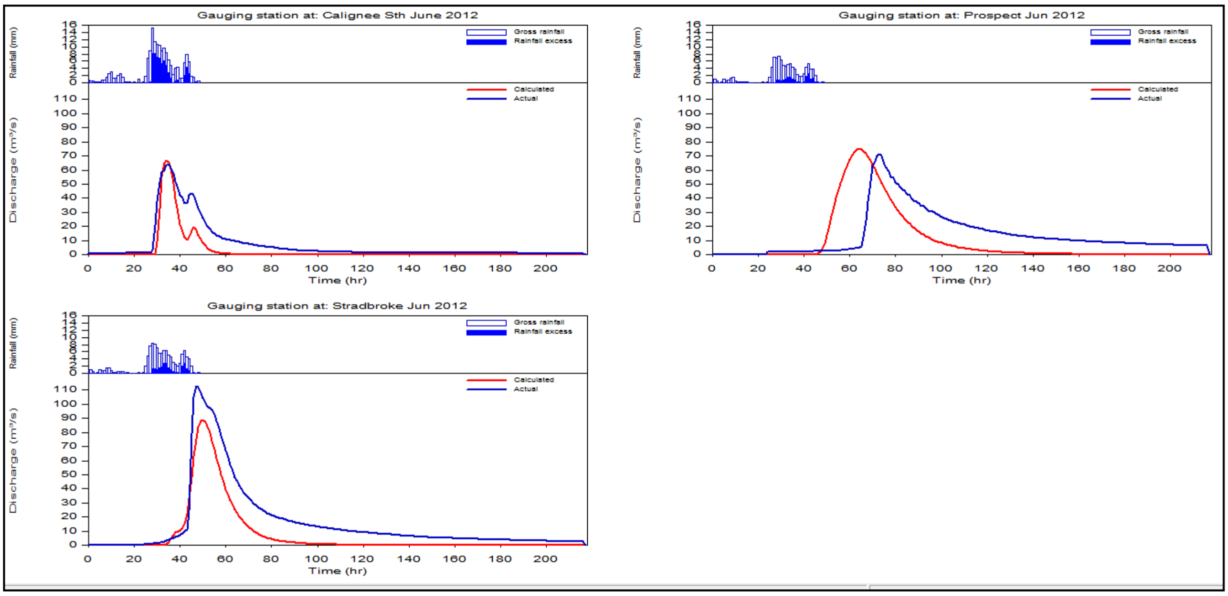


Figure 29 June 2012 storm event using a single set of parameters for design runs

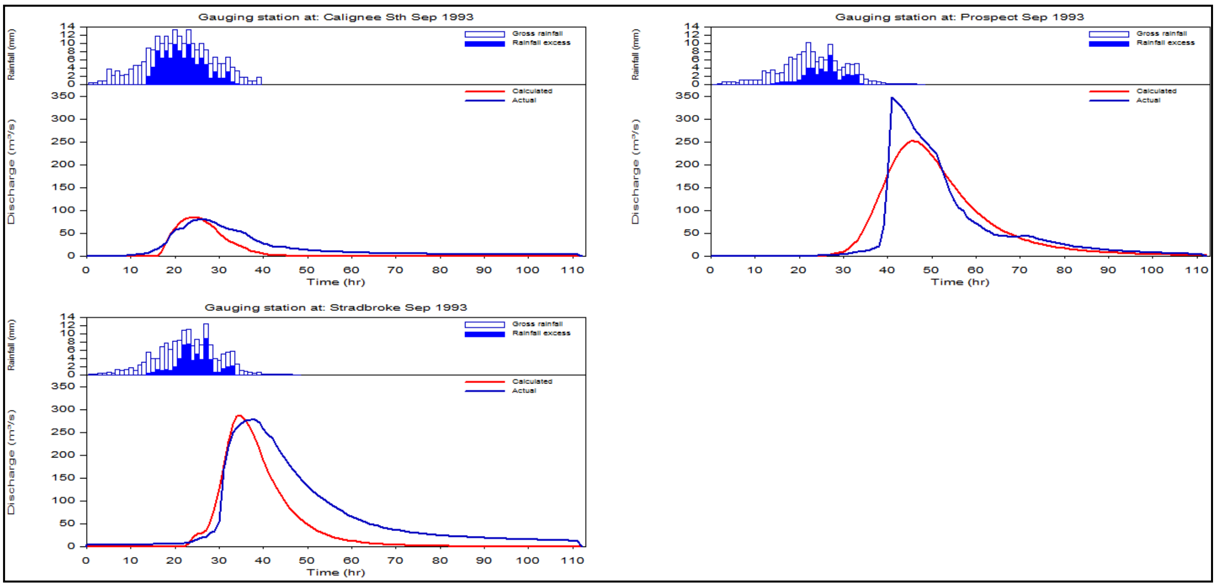


Figure 30 September 1993 storm event using a single set of parameters for design runs

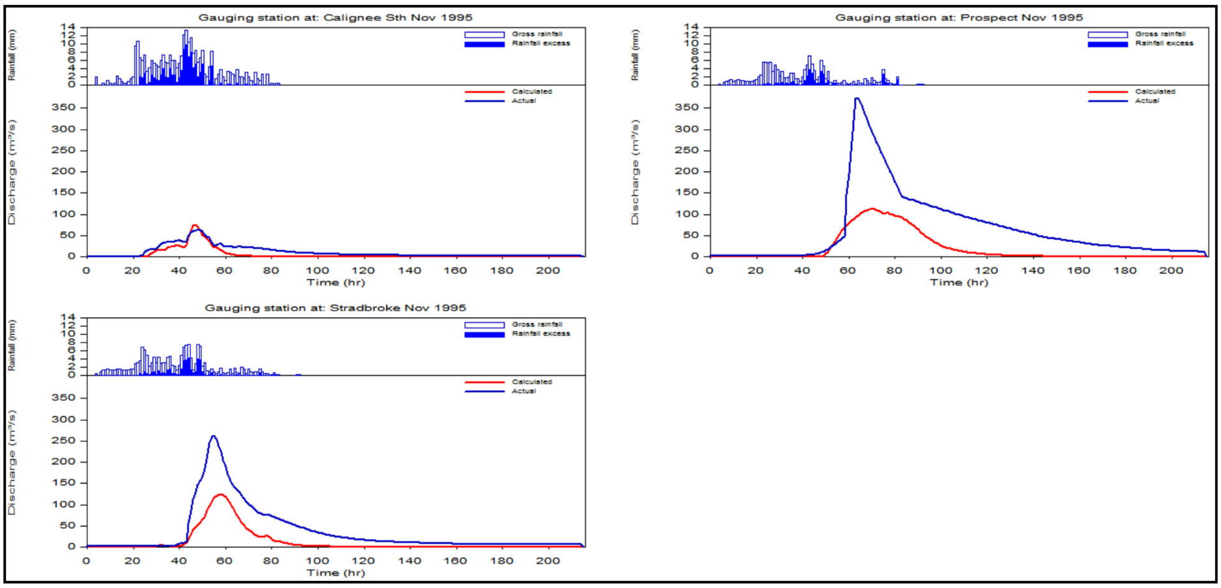


Figure 31 November 1995 storm event using a single set of parameters for design runs

Appendix C: Hydrologic model outputs

Appendix C.1 RORB outputs

RORBWin Batch Run Summary

****

Program version 6.15 (last updated 30th March 2010)

Copyright Monash University and Sinclair Knight Merz

Date run: 13 May 2015 22:10

Catchment file :
M:\GIS\ArcMap\WGCMA_Working\StatPlanning_flood_mapping_FLOOD_STUDIES_Merrimans_Creek_2014_Internal_Julie\data_Hydrology_Rorb_Files_Internal\3569-03_Seaspray_v13_edit2 - DESIGN.catg

Rainfall location: Seaspray

Temporal pattern : AR&R87 Volume 2 for zone 1 (unfiltered)

Spatial pattern : Uniform

Areal Red.Fact. : Based on Siriwardena and Weinmann formulation

Loss factors : Constant with ARI

Model parameters	Kc	m	Initial loss (mm)	Cont. loss (mm/h)
Interstation area above:				
Calignee South	12.00	0.80	30.00	2.85
Stradbroke West	28.00	0.80	55.00	2.25
Prospect Rd Seaspray	18.00	0.80	60.00	0.80

Peak Description

01 Calc. hyd. for ungauged interstation site at: Calignee South

02 Calc. hyd. for ungauged interstation site at: Stradbroke West

03 Calc. hyd. for ungauged interstation site at: Prospect Rd Seaspray

Run	Dur	ARI	Rain(mm)	ARF	Peak0001	Peak0002	Peak0003
1	24h	2y	64.31	0.88	4.4842	2.0747	2.6974
2	30h	2y	68.56	0.89	13.4893	6.8642	5.3809
3	36h	2y	72.03	0.91	12.1848	7.6235	6.5651
4	48h	2y	77.31	0.92	13.7526	7.3266	10.9550
5	72h	2y	83.56	0.94	2.9532	11.9313	46.5168
6	24h	5y	81.43	0.87	16.5391	19.2190	32.0680
7	30h	5y	87.78	0.89	24.3540	31.9971	54.7259
8	36h	5y	93.09	0.90	27.7508	37.9635	67.6440
9	48h	5y	101.44	0.92	25.8101	42.5422	81.6321
10	72h	5y	112.20	0.94	7.9596	39.3426	95.1587
11	24h	10y	92.30	0.87	22.4650	31.8574	69.9108
12	30h	10y	100.13	0.89	31.1532	61.0318	108.516
13	36h	10y	106.75	0.90	36.2132	58.0368	126.243
14	48h	10y	117.33	0.92	36.0524	73.7611	148.791
15	72h	10y	131.46	0.93	12.2821	55.4434	133.538
16	24h	20y	107.28	0.87	33.7378	66.3752	129.726
17	30h	20y	117.02	0.88	43.1301	98.3095	194.298
18	36h	20y	125.32	0.90	50.2148	107.327	209.002
19	48h	20y	138.76	0.91	50.2201	130.754	241.542

20	72h	20y	157.22	0.93	23.7448	76.6913	183.238
21	24h	50y	128.00	0.86	45.0804	116.264	218.186
22	30h	50y	140.50	0.88	57.3558	154.228	297.453
23	36h	50y	151.27	0.89	63.8253	181.671	325.080
24	48h	50y	168.96	0.91	64.2435	196.507	361.880
25	72h	50y	193.96	0.92	38.4590	130.928	237.483
26	24h	100y	144.63	0.86	58.0277	168.298	289.911
27	30h	100y	159.46	0.88	69.8600	211.488	390.908
28	36h	100y	172.31	0.89	78.4788	238.677	423.333
29	48h	100y	193.62	0.90	79.2103	264.433	471.341
30	72h	100y	224.30	0.92	48.1788	183.887	320.266

Elapsed Run Time (hh:mm:ss) = 00:00:01

Table 32 Critical durations and peak flows at all inflow points to the hydraulic model

	100yr ARI		50yr ARI		20yr ARI		10yr ARI		5yr ARI		2yr ARI	
Inflow Number	**Critical Duration**	**Peak Flow (m3/s)**	**Critical Duration**	**Peak Flow (m3/s)**	**Critical Duration**	**Peak Flow (m3/s)**	**Critical Duration**	**Peak Flow (m3/s)**	**Critical Duration**	**Peak Flow (m3/s)**	**Critical Duration**	**Peak Flow (m3/s)**
1	36	38.89	48	31.67	48	26.05	48	19.91	48	15.29	48	8.63
2	24	17.03	36	14.29	36	11.86	36	8.99	48	7.11	48	3.91
3	9	59.27	12	40.61	24	32.63	24	26.98	48	20.48	12	12.74
4	9	32.89	24	23.49	24	19.97	24	15.42	48	11.71	48	6.63
5	48	42.97	48	36.21	30	26.49	48	19.82	48	13.09	72	2.77
6	36	41.35	48	34.36	48	27.68	48	19.41	48	12.42	72	3.11
7	48	38.7	48	31.94	48	24.79	48	16.31	48	10.14	72	2.81
8	48	29.62	48	25.21	48	19.56	30	12.12	48	7.9	72	2.23
9	48	22.58	48	18.83	48	15	48	10.13	48	6.64	72	1.69
10	12	30.87	12	27.36	48	21.98	48	16.42	48	11.31	72	2.9
11	48	21.87	48	18.02	48	13.82	48	9.1	48	5.43	72	1.56
12	48	29.22	48	24.83	48	19.57	30	11.82	48	7.69	72	2.25
13	48	52.83	48	41.59	48	28.78	48	18.65	48	10.54	72	3.38
14	12	33.63	12	30.49	48	21.58	48	17.27	48	10.78	72	2.93
15	36	28.74	36	23.47	48	18.61	48	13.51	48	8.83	72	2.08
16	48	19.75	48	16.49	48	11.65	48	7.65	48	2.89	72	1.28
17	36	33.11	48	27.61	48	21.44	48	15.57	48	7.51	72	2.33

18	48	65.15	48	55.25	48	43.72	48	27.32	48	17.06	72	5.11
19	48	71.12	48	57.48	48	38.45	48	25.66	48	11.39	72	4.24
20	48	39.52	48	33.9	48	22.78	48	15.03	48	7.56	72	2.65
21	48	36.45	48	30.57	30	22.71	48	16.99	48	11.25	72	2.44
22	48	31.63	48	26.45	30	19.53	48	14.44	48	6.71	72	1.94
23	12	78.45	48	61.44	48	51.89	48	38.68	48	18.74	72	11.61
24	12	64.07	48	48.29	48	41.51	48	31.69	48	15.52	72	9.37
25	48	32.99	48	27.35	48	22.09	48	15.95	48	8.44	72	4.03
26	12	91.71	48	69.39	48	59.88	48	47.22	48	23.93	72	13.53
27	12	59.36	48	49.1	48	41	48	30.5	48	15.05	72	9.08
28	48	47.98	48	47.07	48	29.61	48	22.47	48	13.61	72	6.04
29	48	26.54	48	23.5	48	17.77	48	11.47	36	7.08	72	3.78
30	12	44.84	12	37.4	48	29.93	48	27.77	48	11.31	72	6.69
31	48	13.49	48	10.92	48	8.13	48	5.83	48	4.3	72	2.46
32	48	41.21	48	36.92	48	26.57	48	16.4	36	10.05	72	5.81
33	48	52.04	48	45.44	48	35.18	48	23.74	36	14.55	72	7.33
34	48	284.09	48	215.95	48	150.33	48	90.45	72	51.23	72	33.56
35	48	50.86	48	44.32	30	32.03	48	23.3	48	13.08	72	6.04
36	48	67.77	48	55.7	48	37.08	48	24.55	72	12.41	72	8.48
37	48	114.08	48	98.03	48	77.77	48	45.15	30	22.92	72	14.78

Appendix D: Hydraulic model input data

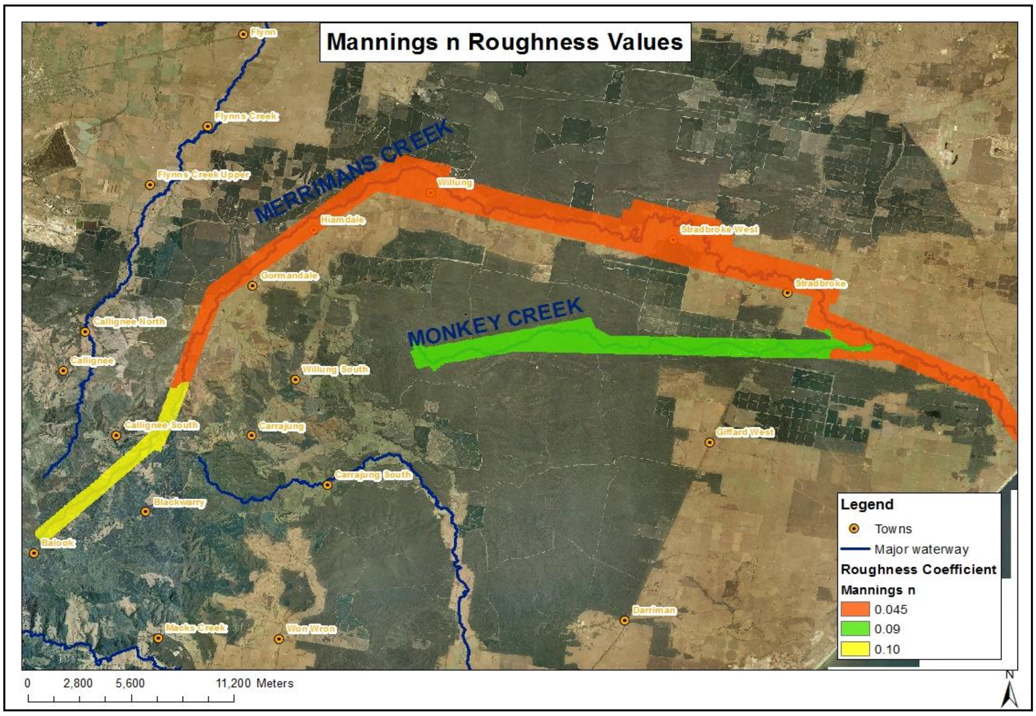


Figure 32 Adopted Manning's n roughness values for the floodplain

Parameter	**Roughness Manning's n value**
Thick Vegetation	0.1 (yellow area)
Pine Plantations	0.09 (green area)
Farm land	0.045 (red area)

Figure 33 Roughness values for the floodplain referring to Figure 29

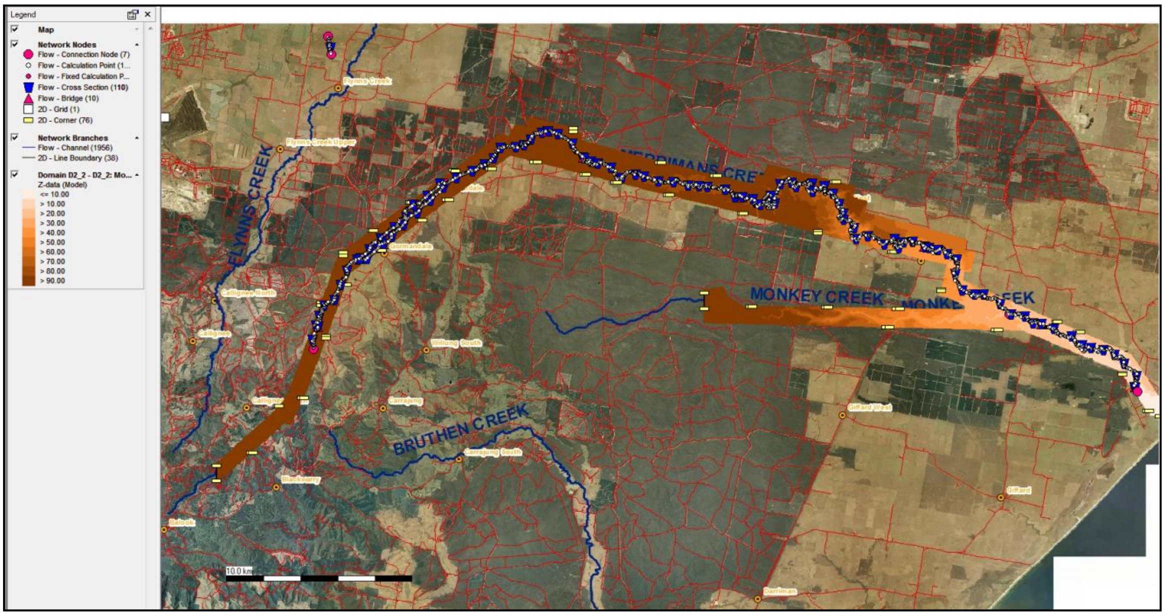


Figure 34 Hydraulic model schematisation, showing cross sections and 1D channel in blue, inflow locations in yellow and the 2D floodplain in brown/orange

BRIDGE PLOTS

Table 33 Data obtained from the Prospect Rd Bridge

Prospect Rd Bridge (Seaspary to Giffard)		2 Pillars 800mm		
	Distance (m) (East to West)	Vic Roads Data (1998)	Survey Data	LiDAR
Overall Deck Length (m)		53.95	54.6	54.4
Overall Deck Width (m)		5		5
Bridge Deck Elevations (m AHD)	-5.09		8.281	8.31
	1.47		8.228	6.82
	10.52		8.181	2.04
	22.2		8.125	2.21
	35.86		8.169	4
	52.44		8.129	6.08
	64.69		8.162	8.18
	77.61		8.234	8.22

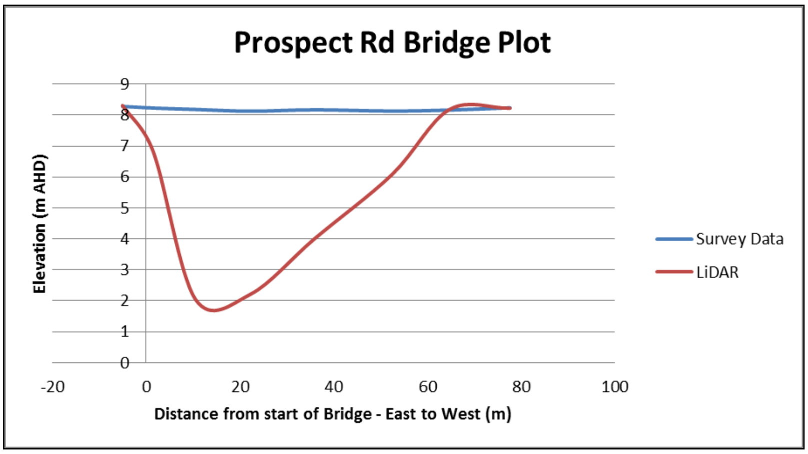


Figure 35 Prospect Rd Bridge Plot

Table 34 Data obtained from the Giffard Rd Bridge

Giffard Road Bridge	3 Piers 700mm				
	Distance (m) (South to North)	Vic Roads Data (1983)		Survey Data	LiDAR
Overall Deck Length (m)		48.09		49	49
Overall Deck Width (m)		8.45			
Deck Thickness (m)		0.9			
Bridge Deck Elevations (m AHD)		RL of deck	RL of footings		
	-66.69			27.174	27.12
	-15.07			26.417	26.37
	-4.83			26.243	26.3
	0	22.114	7.7		
	7.55			25.992	19.27
	11.986	21.875	12.75		
	22.81			25.696	17.83
	24.01	21.635	11.95		
	36.034	21.395	12.75		
	36.77			25.449	19.81
	45.32			25.28	25.06
	47.97	21.156			
	67.14			24.74	24.77

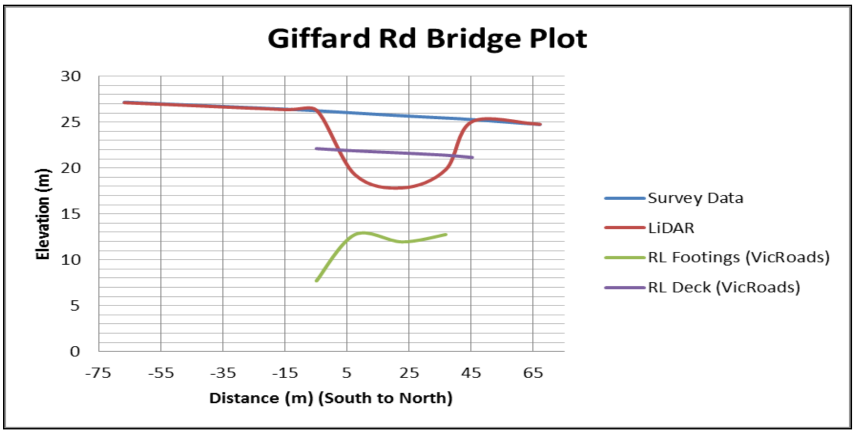


Figure 36 Giffard Road Bridge Plot

Table 35Data obtained from the South Gippsland Highway Bridge

South Gippsland Hwy Bridge	4 Pillars 600mm			
	Distance (m) (South to North)	Vic Roads Data (1937)	Survey Data	LiDAR
Overall Deck Length (m)			27.5	26.95
Bridge Deck Elevations (m AHD)	-25.29		45.028	44.95
	-12.07		45.035	44.98
	0		45.051	45.03
	11.56		45.091	42
	54.06		45.187	45.18

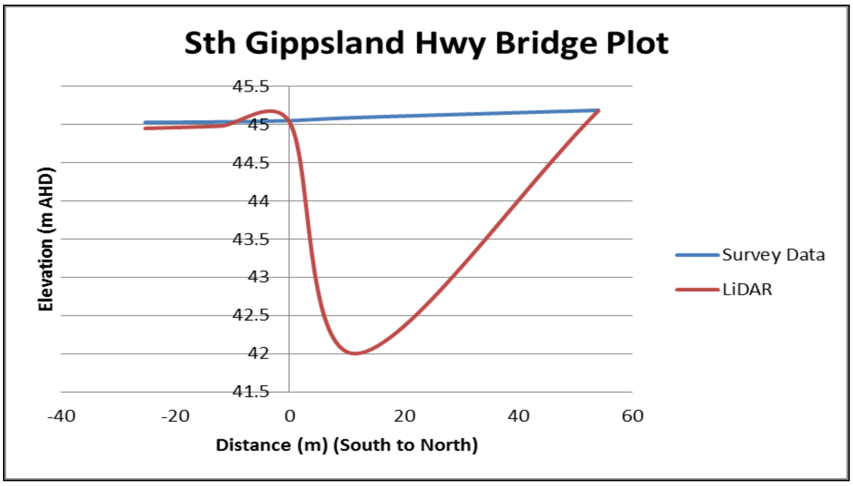


Figure 37 South Gippsland Highway Bridge Plot

Table 36 Data obtained from the Taylors Lane Bridge

Taylors Lane Bridge	No Pillars			
	Distance (m) (South to North)	Vic Roads Data	Survey Data	LiDAR
Overall Deck Length (m)		No data	10	9.92
Bridge Deck Elevations (m AHD)	-9.93		No Survey signal	74.68
	-4.1			74.14
	0			73.49
	2.75			71.91
	4.7			71.73
	5.97			71.76
	7.25			72.7
	11			73.97

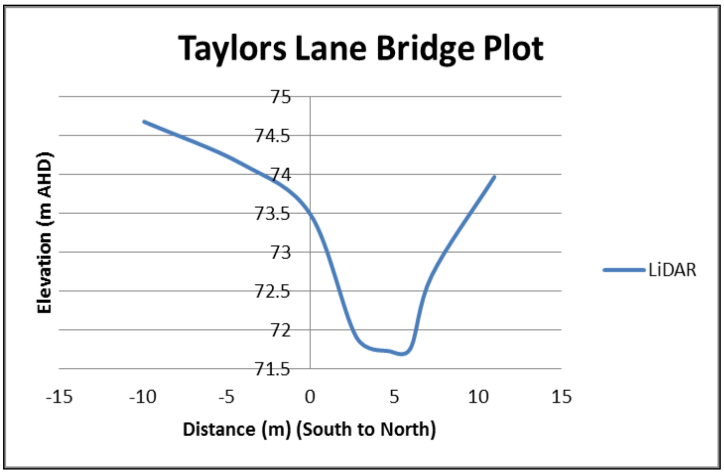


Figure 38 Taylors Lane Bridge Plot

Table 37 Data obtained from the Mertonvale Rd Bridge

Mertonvale Road Bridge	No Pillars			
	Distance (m) (South to North)	Vic Roads Data	Survey Data	LiDAR
Overall Deck Length (m)		11	No survey signal	
Overall Deck Width (m)		3.7		
Bridge Elevations (m AHD)		RL Deck (Adjusted up 67m)		
	0	97.75		97.17
	2.97	97.75		95.03
	6.37	97.75		94.9
	13.81	97.75		94.86
	20.71	97.75		94.88
	24.67	97.75		94.4
	29.38	97.75		94.5
	32.02	97.75		97.1
	37.54	97.75		97.77

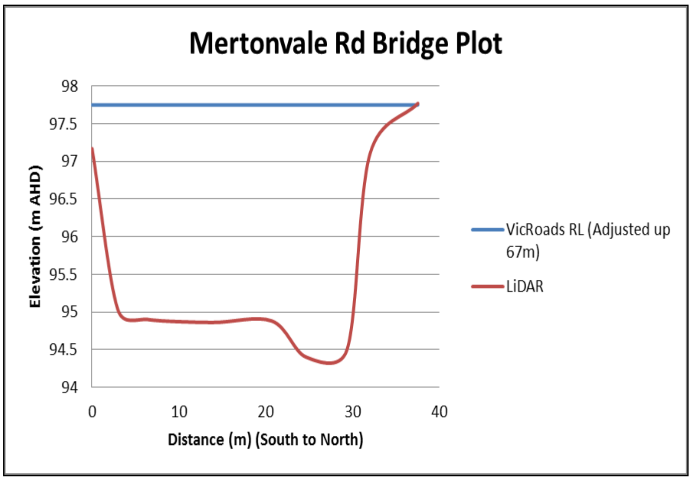


Figure 39 Mertonvale Rd Bridge Plot

Table 38 Data obtained from the Willung Rd Bridge

Willung Road Bridge (Points taken from Willung to Rosedale)	2 Pillars 800mm

	Vic Roads Data	Distance (m) (South to North)	Survey Data	LiDAR
Overall Deck Length (m)	(Plans 1978 new bridge since)		40	41
Bridge Depth (m)			0.65	
Bridge Deck Elevations (m AHD)		-32.15	102.931	102.89
		-18.92	103.123	103.13
		-4.13	103.386	101.13
		9.62	103.68	100.06
		20.8	103.993	101.39
		33.68	104.265	104.29

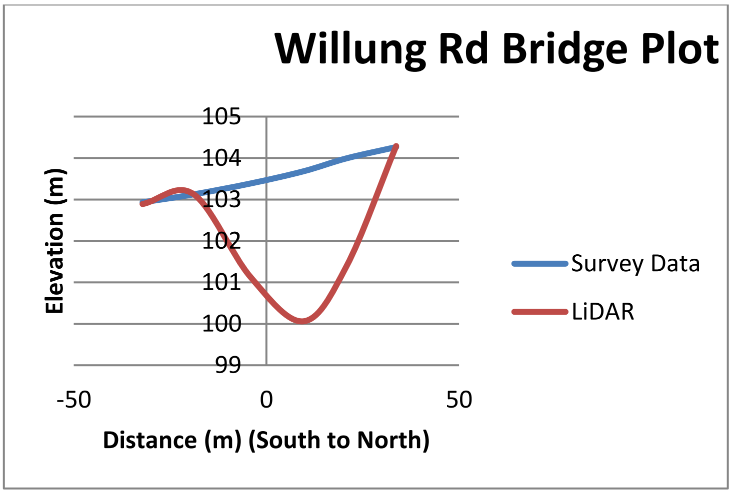


Figure 40 Willung Rd Bridge Plot

Table 39 Data obtained from the Hyland Hwy Bridge

Hyland Hwy Bridges				
Over Drain - (Yarram Side)				
	Vic Roads Data	**Distance**	**Survey Data**	**LiDAR**
Overall Deck Length (m)	72.38		71.5	
Deck Thickness	0.8		0.82	
5 Pillar - 600mm wide				
Bridge Deck Elevations (m AHD)	131.26	0	131.35	131.29
	131.26	8.27	131.36	127.84
	131.26	33.16	131.31	128.14

	131.268	53.01	131.33	128.52
	131.44	73.22	131.41	130.68
		89.04	131.64	131.55

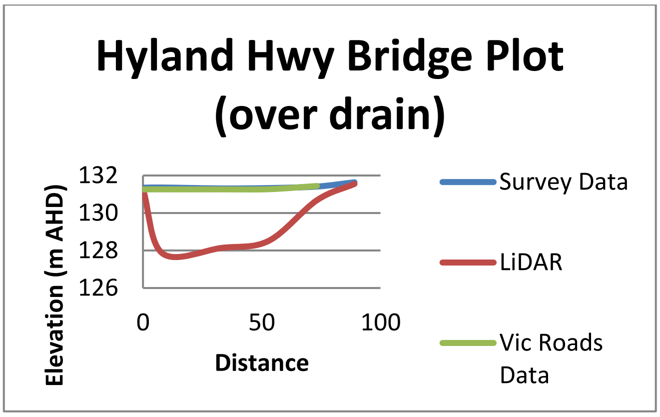


Figure 41 Hyland Hwy (over drain) Bridge Plot

Table 40 Data obtained from the Hyland Hwy Bridge (over floodplain)

Over Flood Plain - (Traralgon Side)				
	Vic Roads Data	Distance	Survey Data	LiDAR
Overall Deck Length (m)	24.38		24.5	
Deck Thickness	0.8		0.82	
1 Pillar - 600mm wide				
Bridge Deck Elevations (m AHD)	131.26	0	131.21	131.22
	131.26	13.56	131.35	131.31
	131.26	25.93	131.34	128.17
	131.26	38.09	131.36	130.25
		48.94	131.29	131.23
		63.34	131.21	131.2

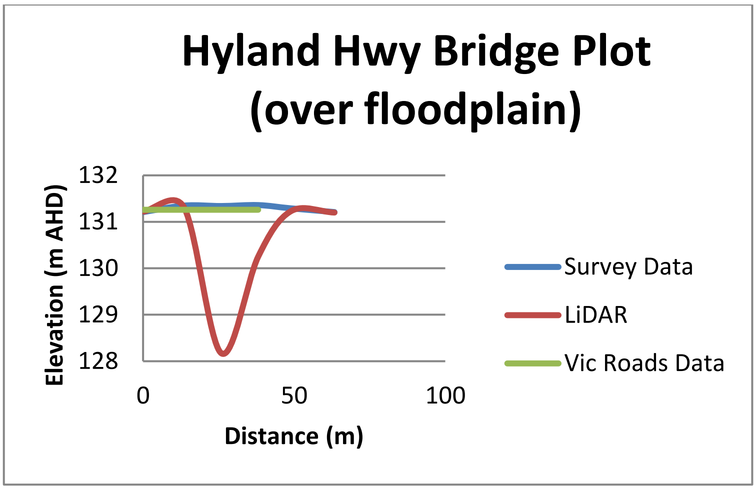


Figure 42 Hyland Hwy Bridge plot over floodplain

Table 41 Data obtained from the Hyland Hwy Culvert

Hyland Hwy Culvert		
At Creek	**Vic Roads Data**	**LiDAR**
Diameter	2.85 (m)	
Length	27.0 (m)	
Slope of Pipe	1 in 300	
Road centreline elevation	132.57 (m) RL	132.2 m AHD
Inlet elevation	127.45 (m) RL	128.6 m AHD
Outlet elevation	127.36 (m) RL	128.24 m AHD

Table 42 Data obtained from the Merrimans Creek Rd Bridge

Merrimans Creek Road Bridge		**2 Pillars 600mm**		
	Vic Roads Data	**Distance (m) (South to North)**	**Survey Data**	**LiDAR**
Overall Deck Length (m)			26	
Bridge Depth (m)				
Bridge Deck Elevations (m AHD)		0	152.82	152.69
		10.2	153.1	153.02
		17.01	153.23	151.35
		27.46	153.27	149.75
		38.62		152.23

		49.42		153.44

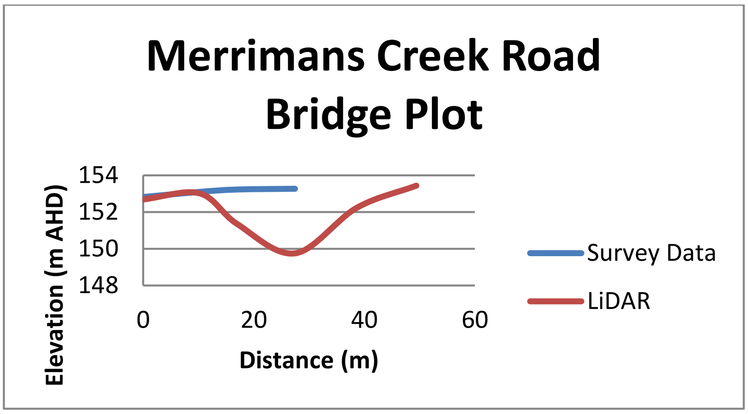


Figure 43 Merrimans Creek Road Bridge Plot

Appendix E: Output data from hydraulic model

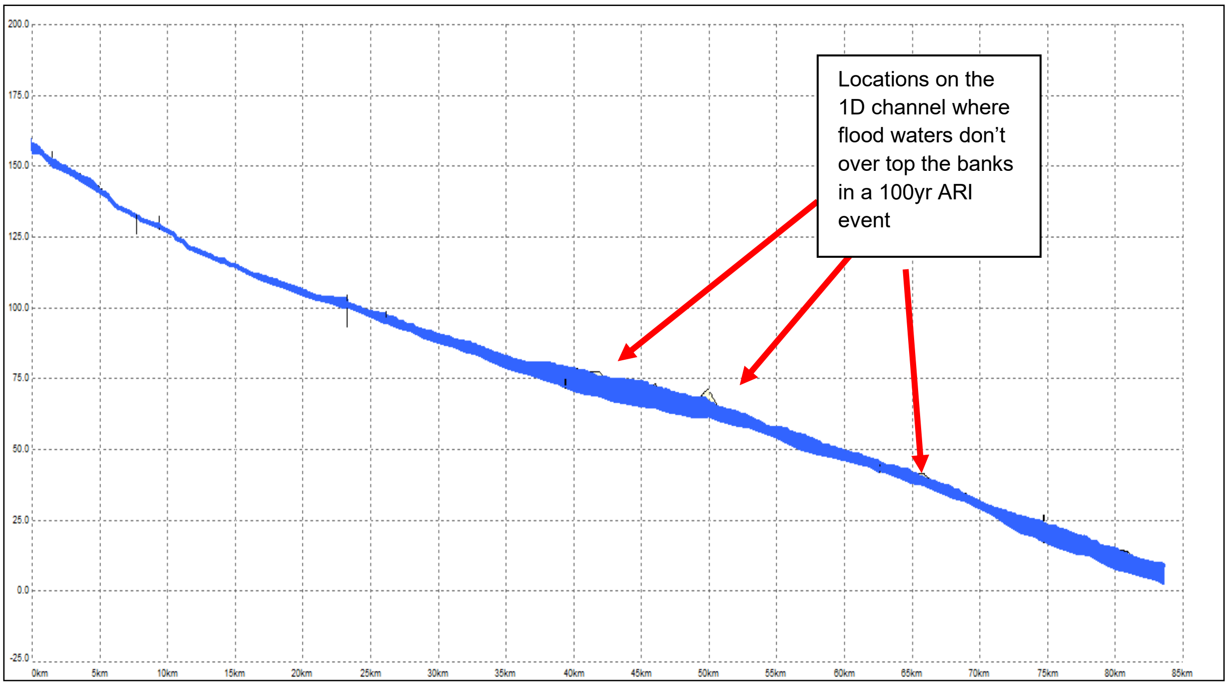


Figure 44 1D channel cross section showing flood water break outs during a 100 year ARI event

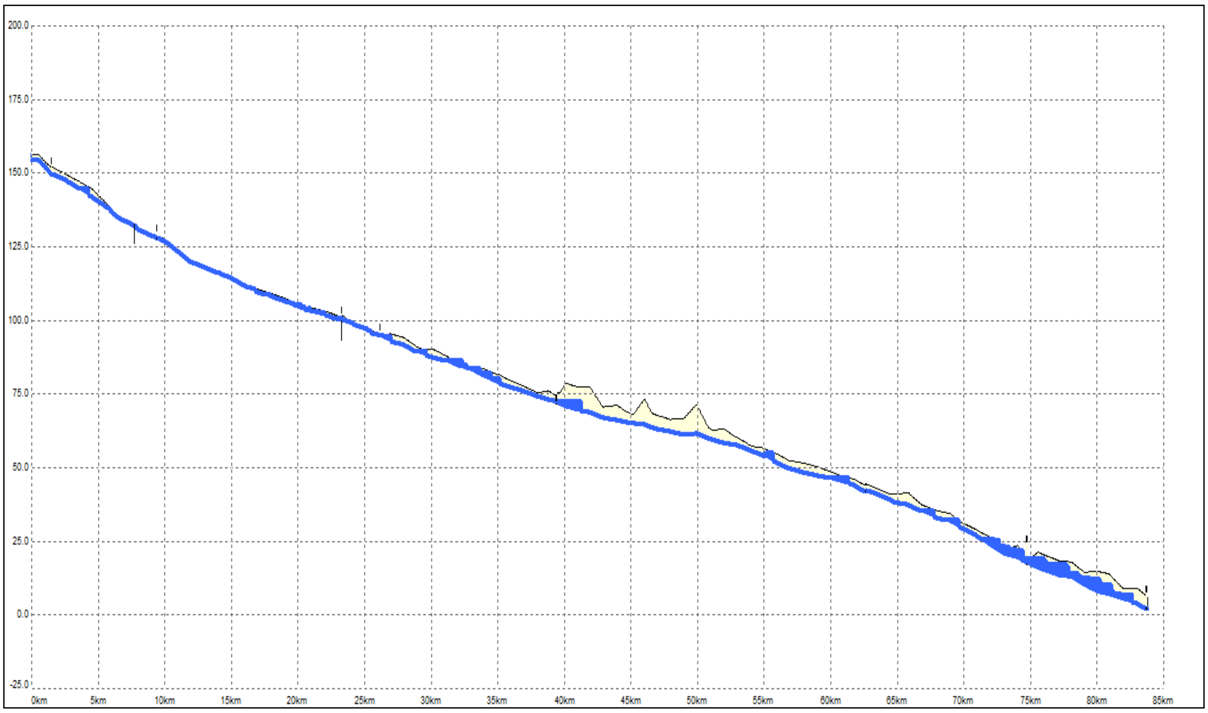


Figure 45 1D channel long section showing break out locations for a 2 year ARI event

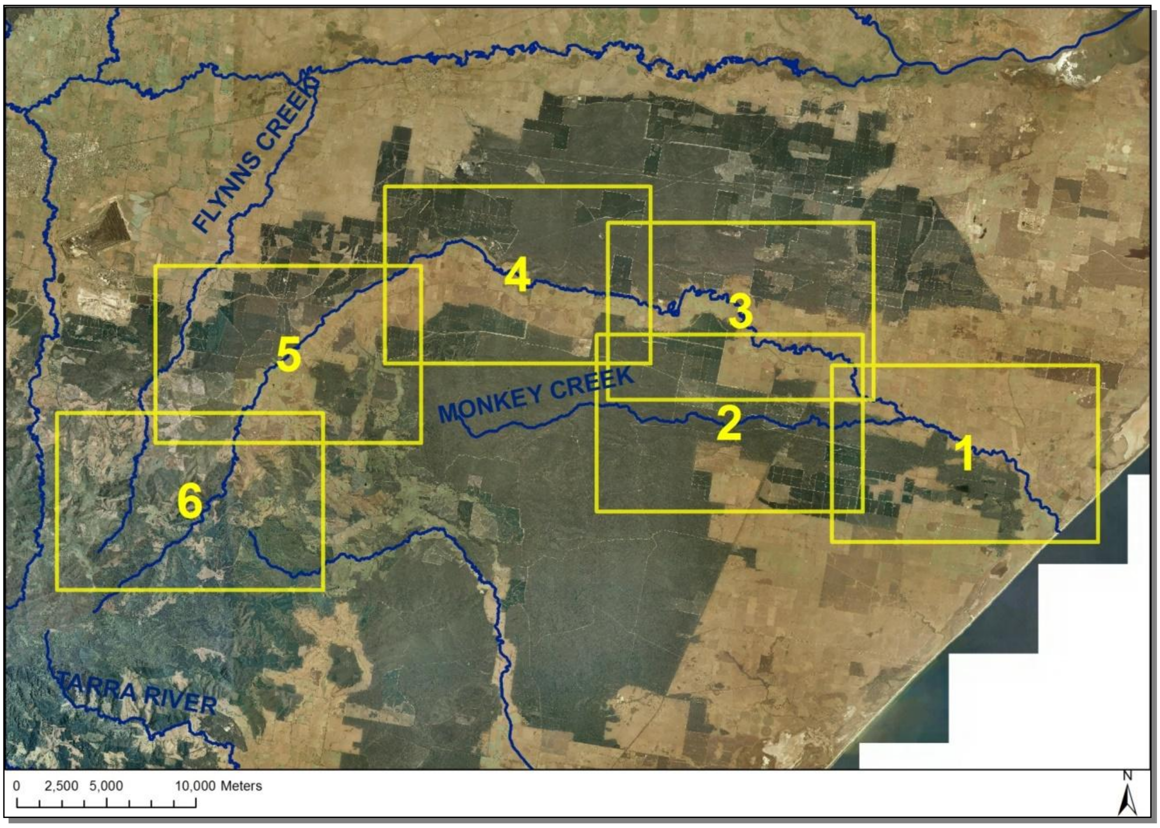


Figure 46 Zone locations for output maps

Appendix F: Flood extent maps

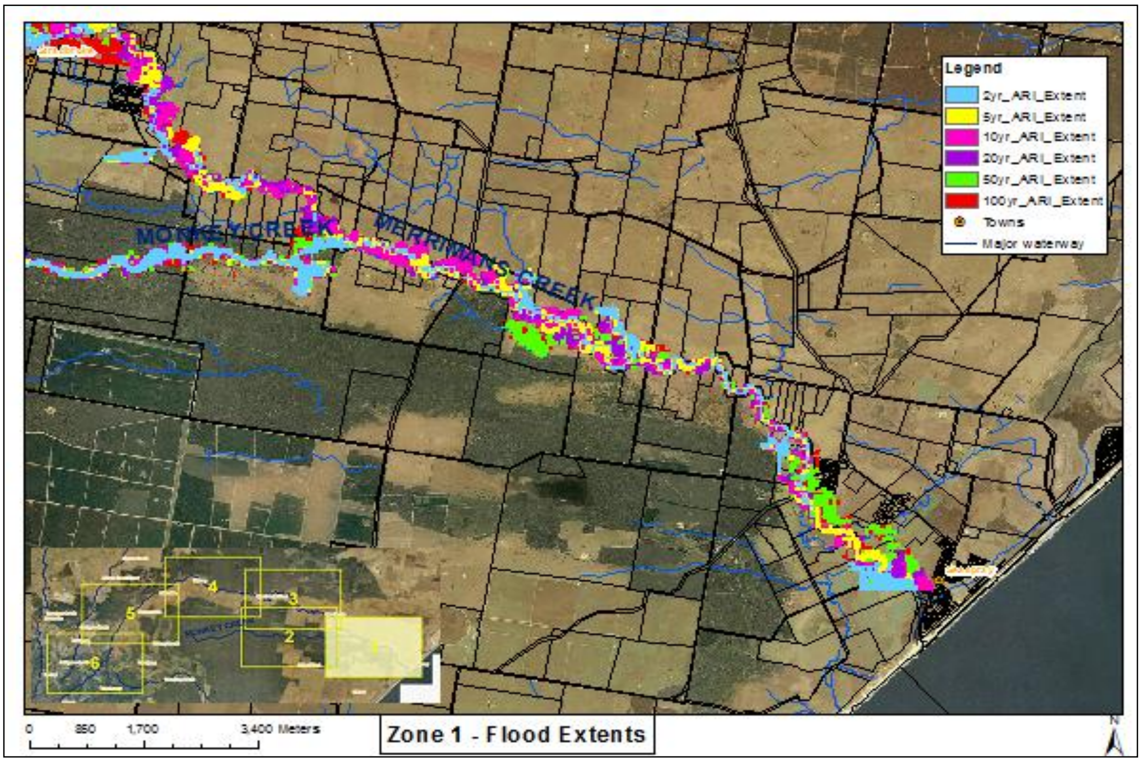


Figure 47 Zone 1 flood extents

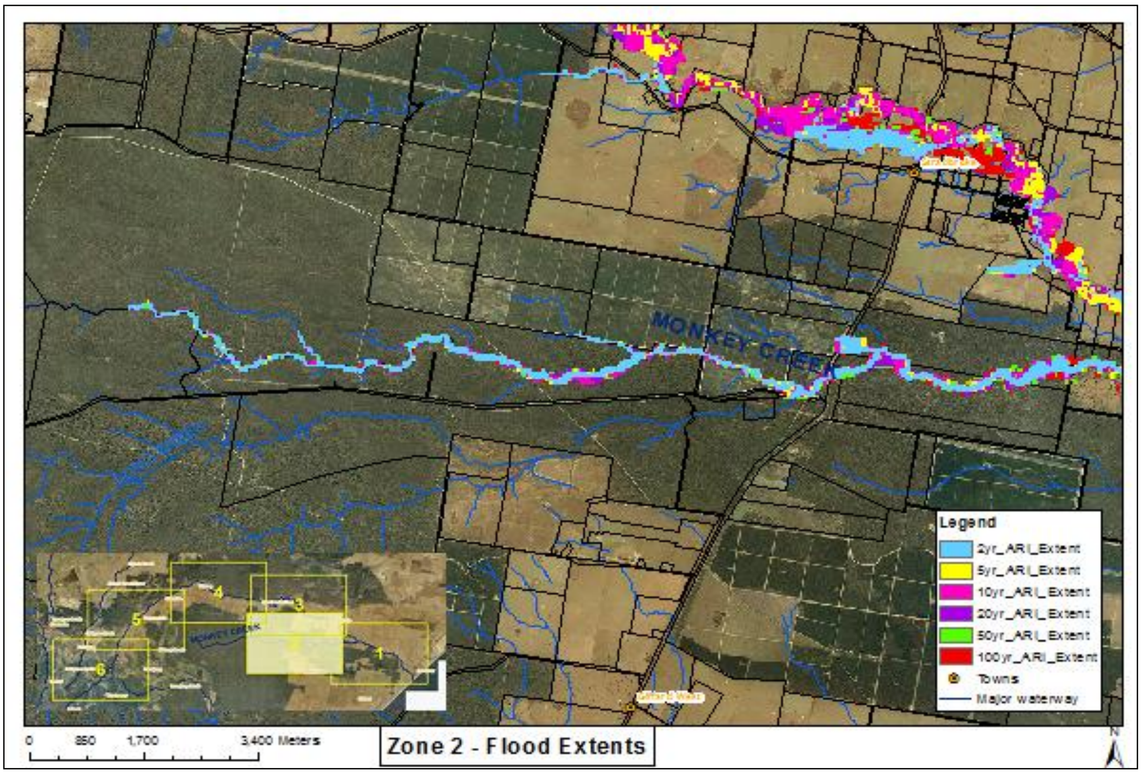


Figure 48 Zone 2 flood extents

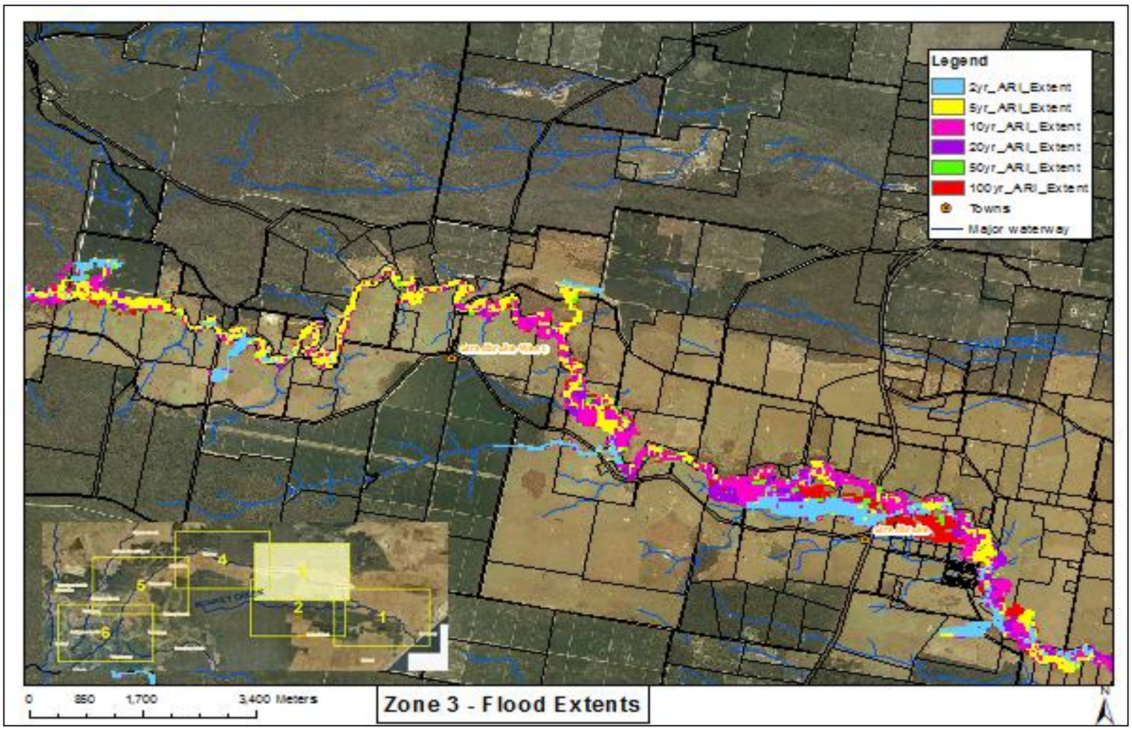


Figure 49 Zone 3 flood extents

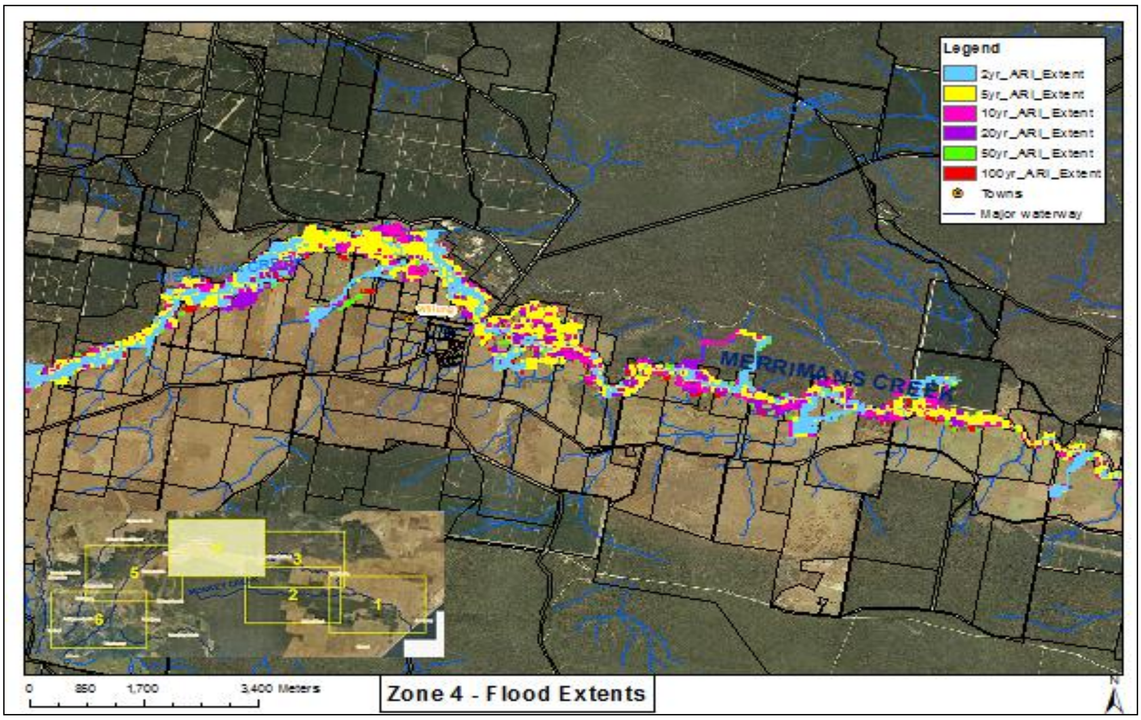


Figure 50 Zone 4 flood extents

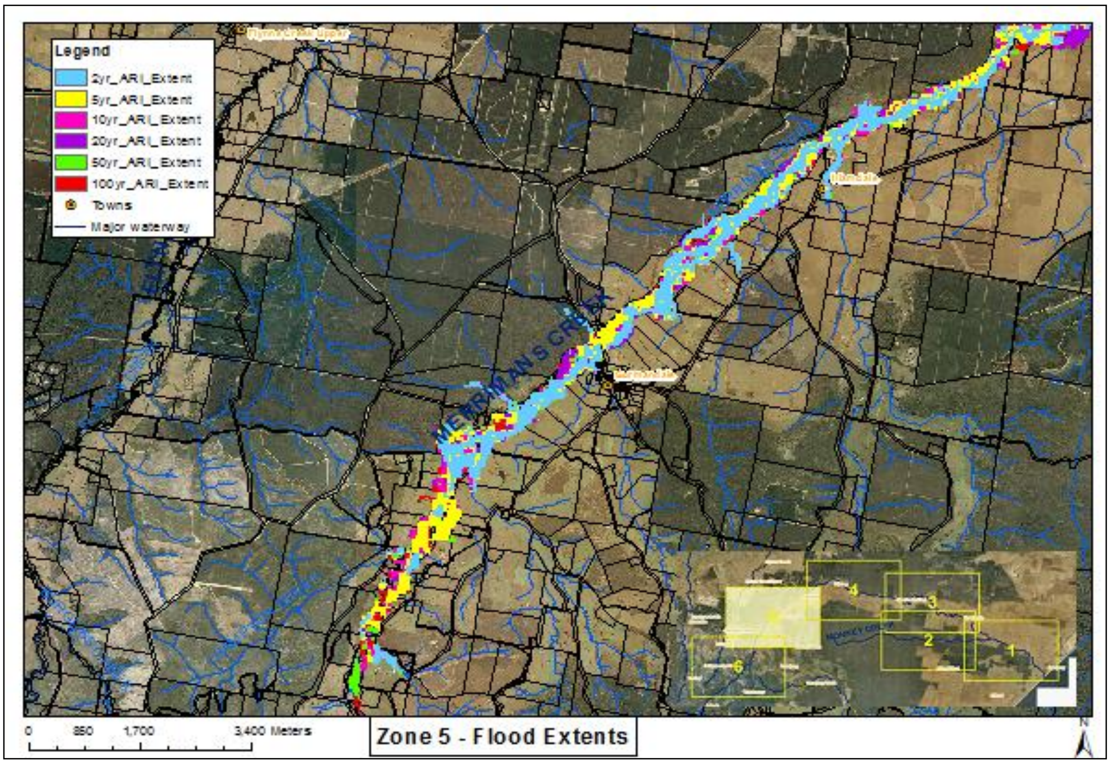


Figure 51 Zone 5 flood extents

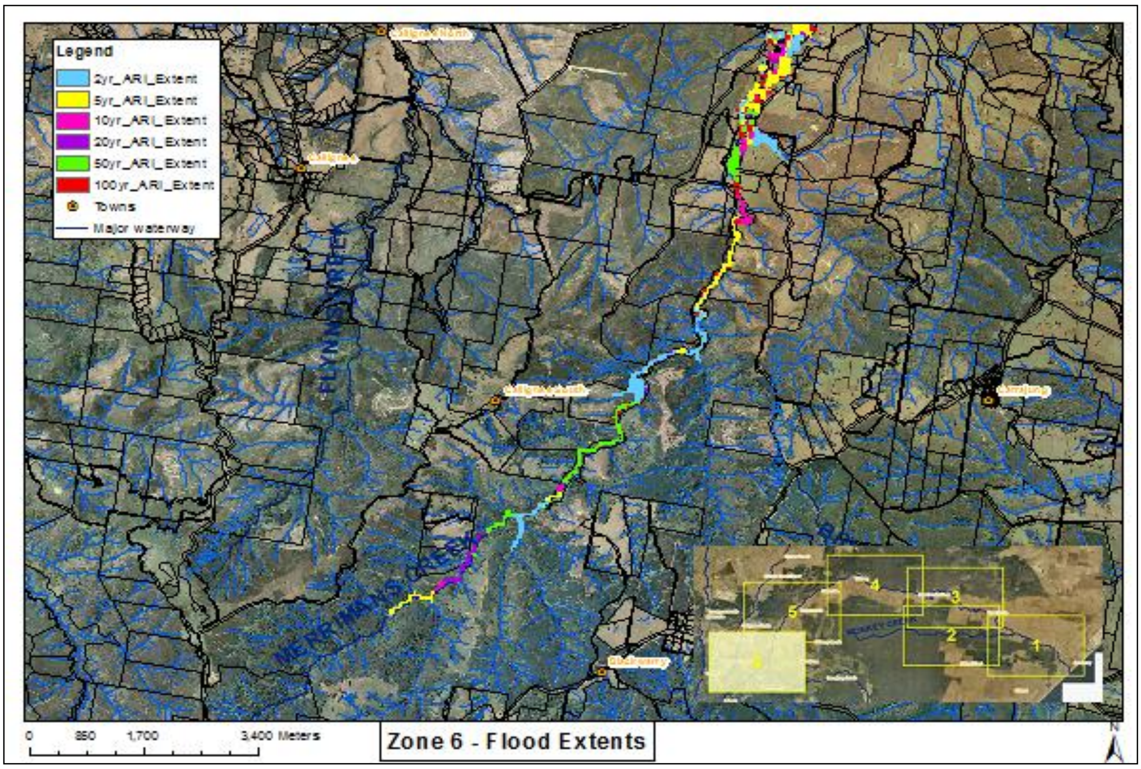
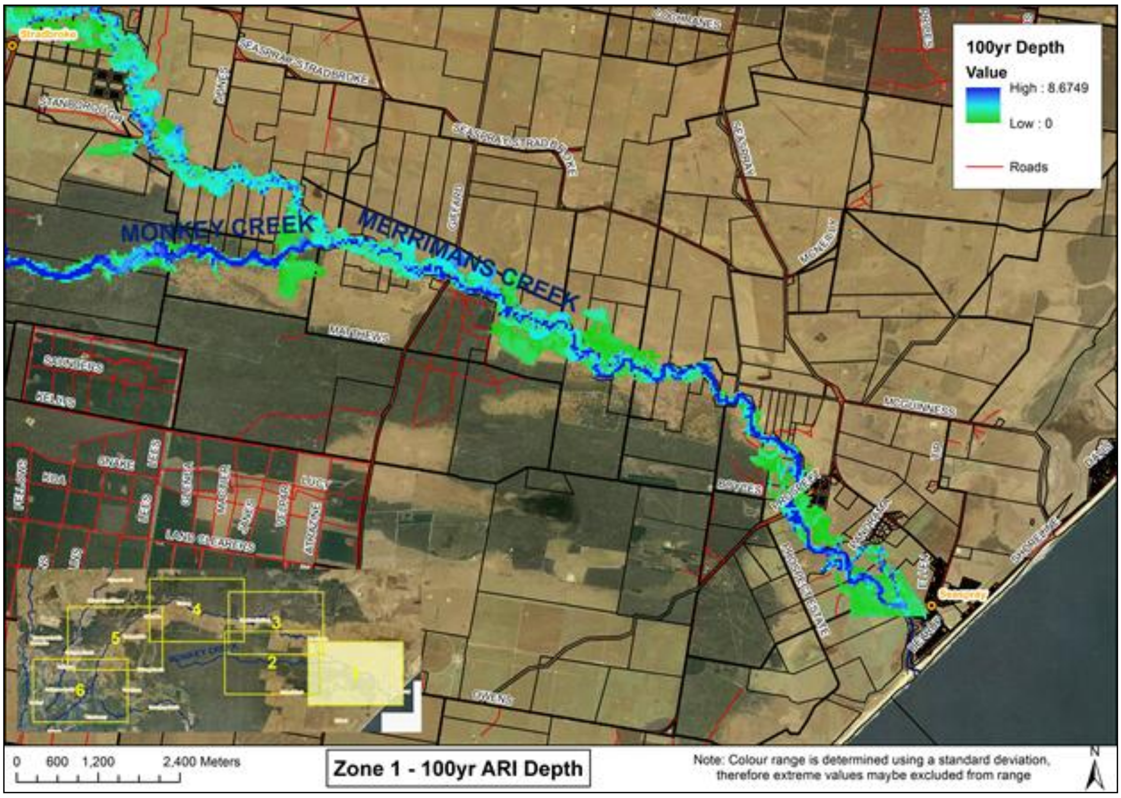
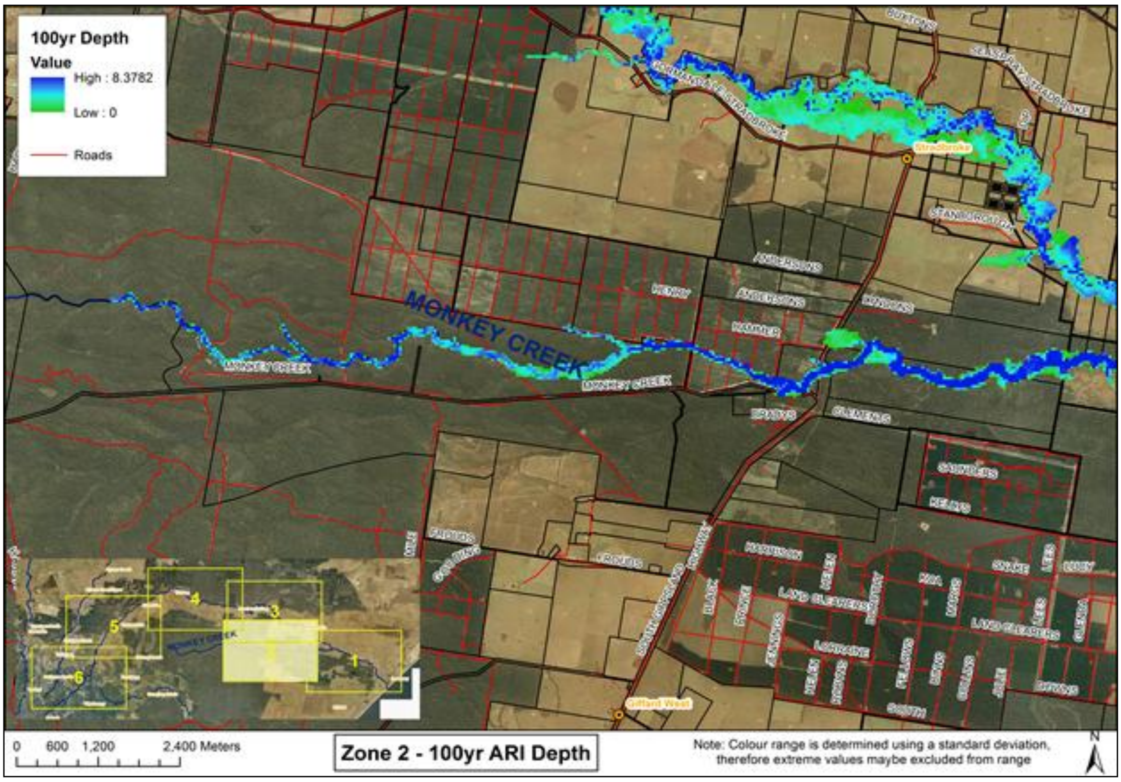


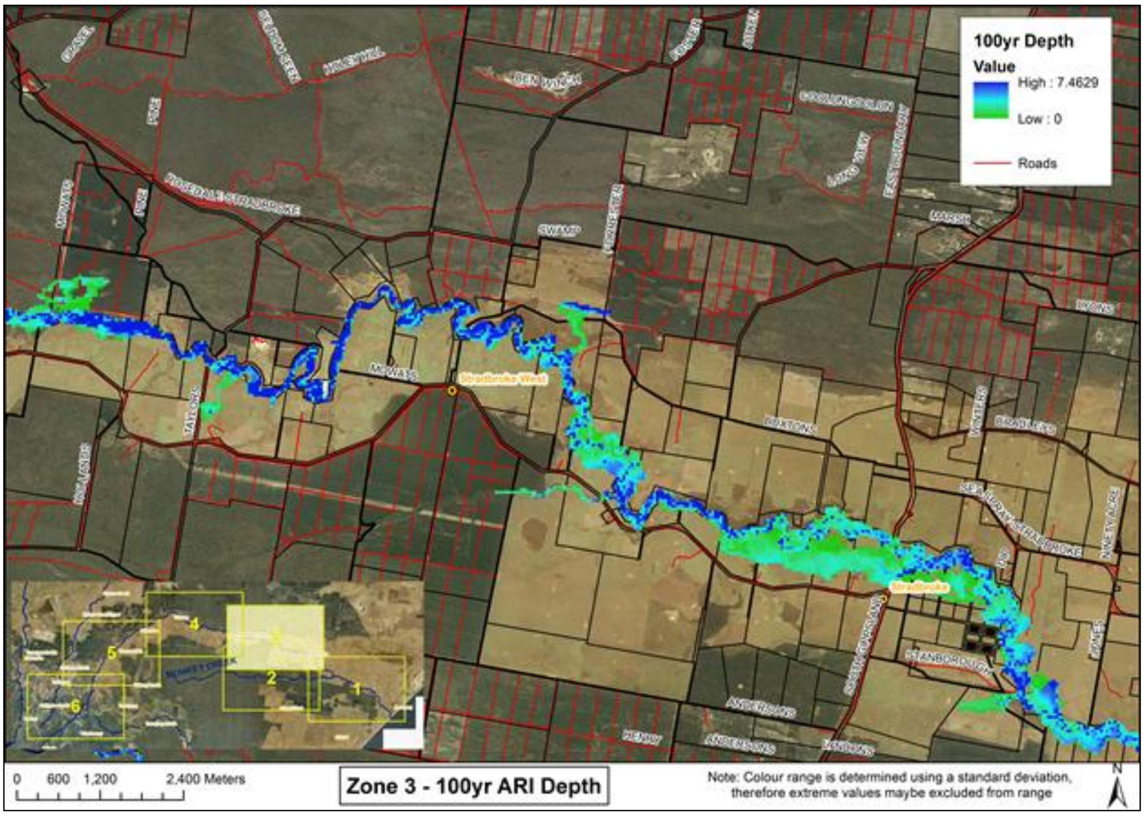
Figure 52 Zone 6 flood extents

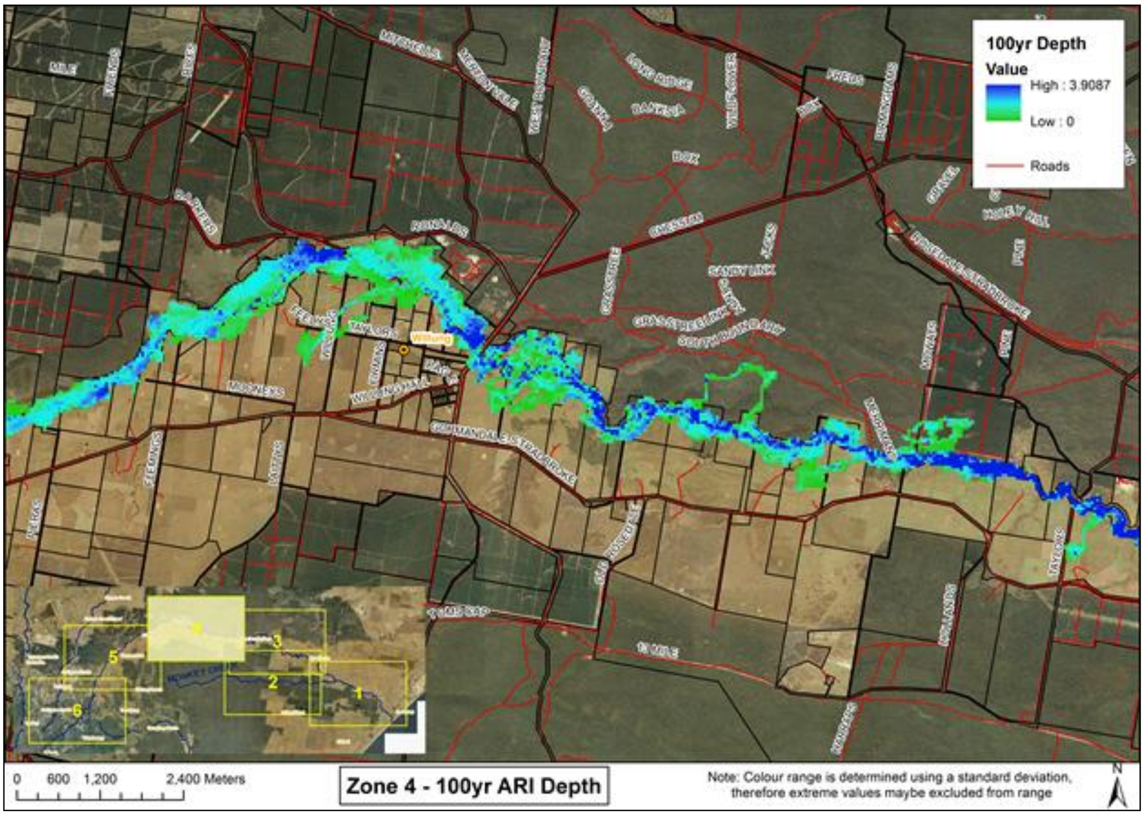
Appendix G: Flood depth maps

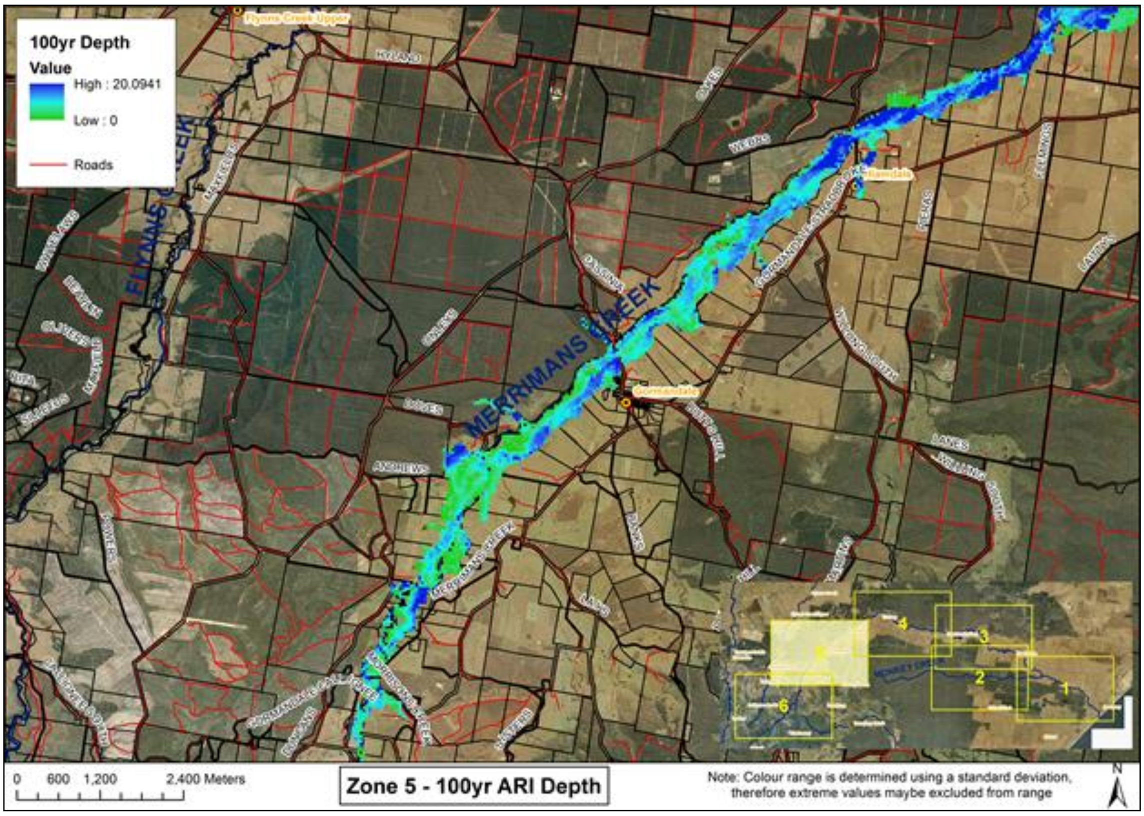
Appendix G.1 100yr Depth maps for Zones 1 to 6



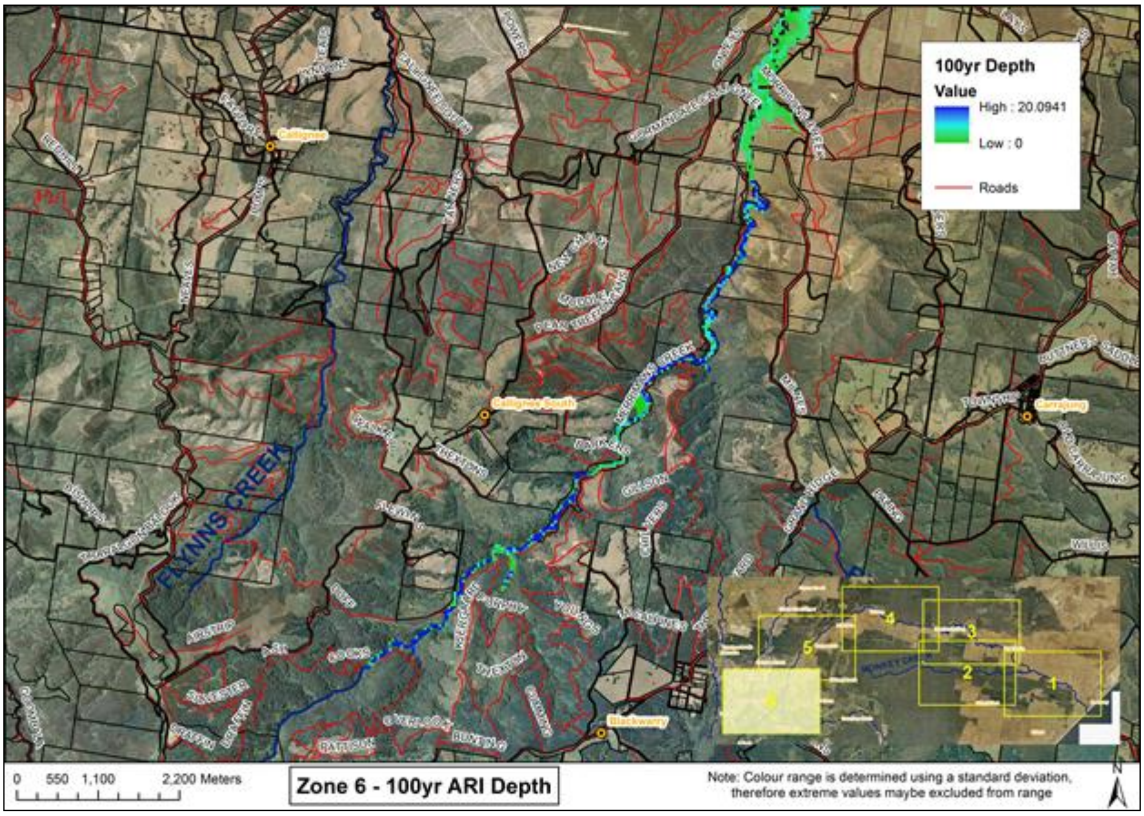



100yr Depth
Value
High : 7.4629
Low : 0
Roads
0 600 1,200 2,400 Meters
Zone 3 - 100yr ARI Depth
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N


100yr Depth
Value
High : 3.9087
Low : 0
Roads
0 600 1,200 2,400 Meters
Zone 4 - 100yr ARI Depth
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

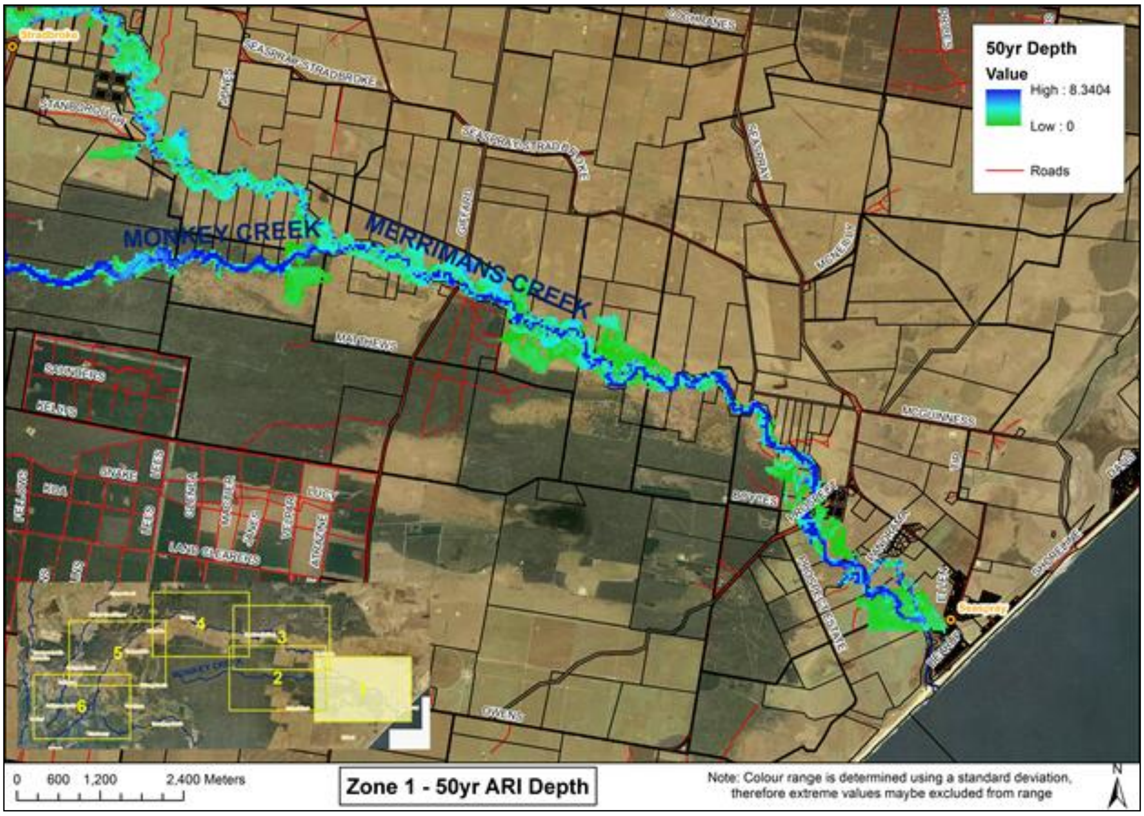


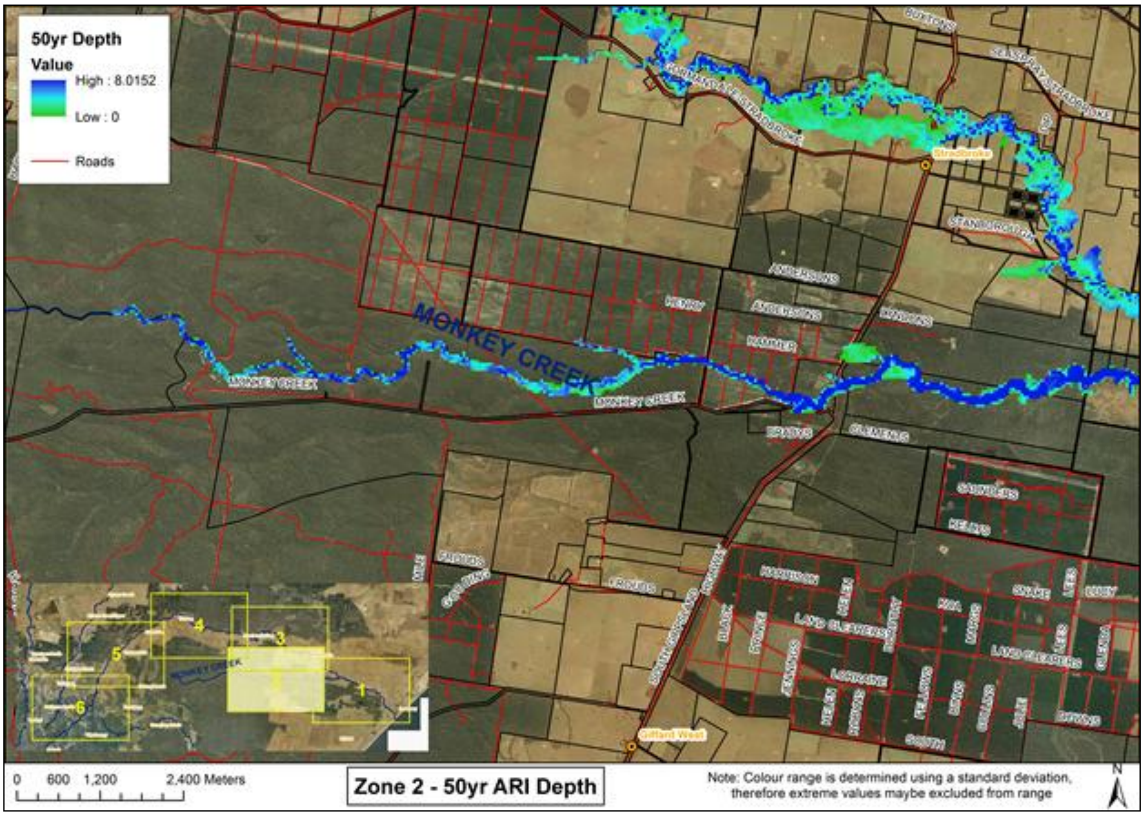
Zone 5 - 100yr ARI Depth

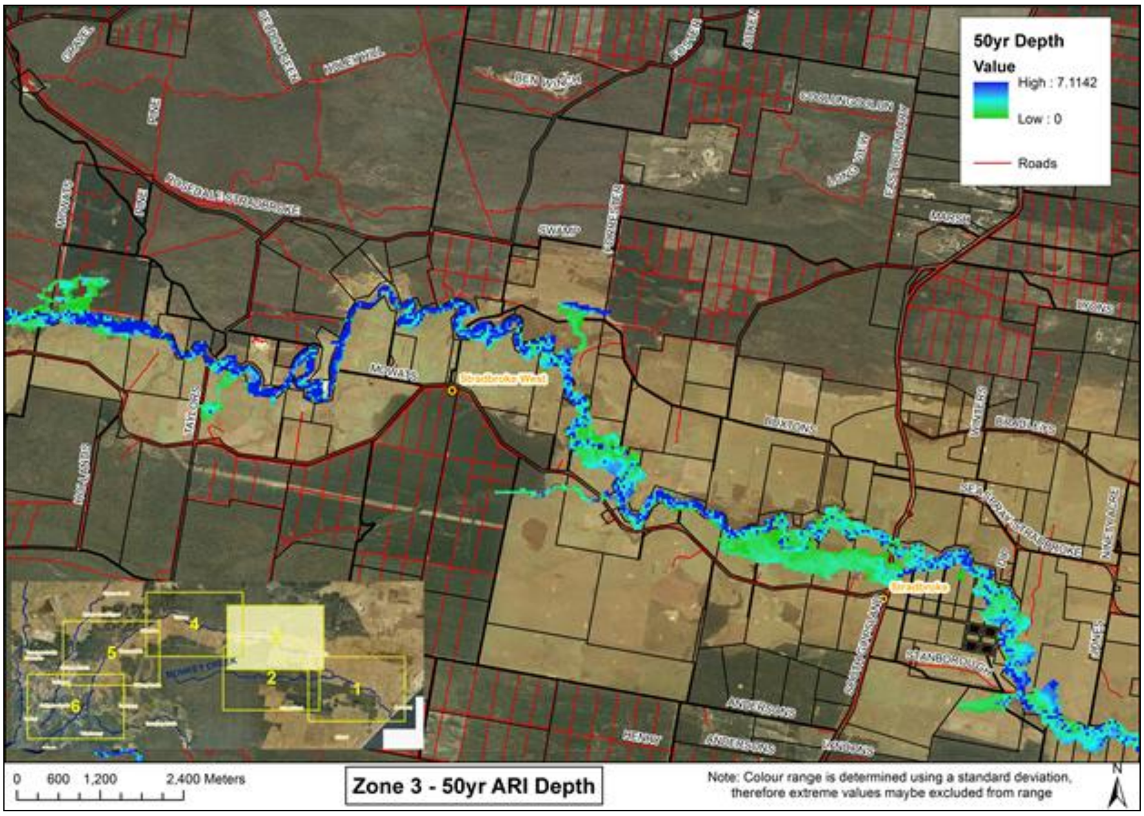


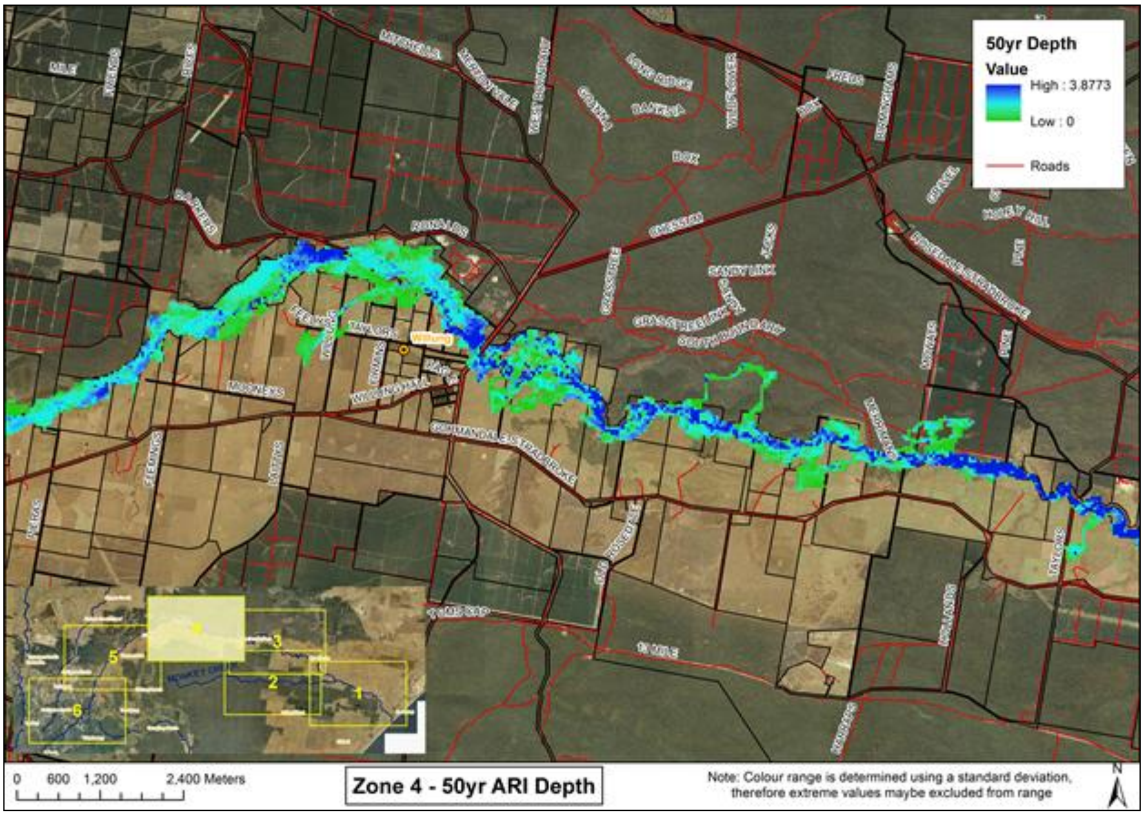
Zone 6 - 100yr ARI Depth

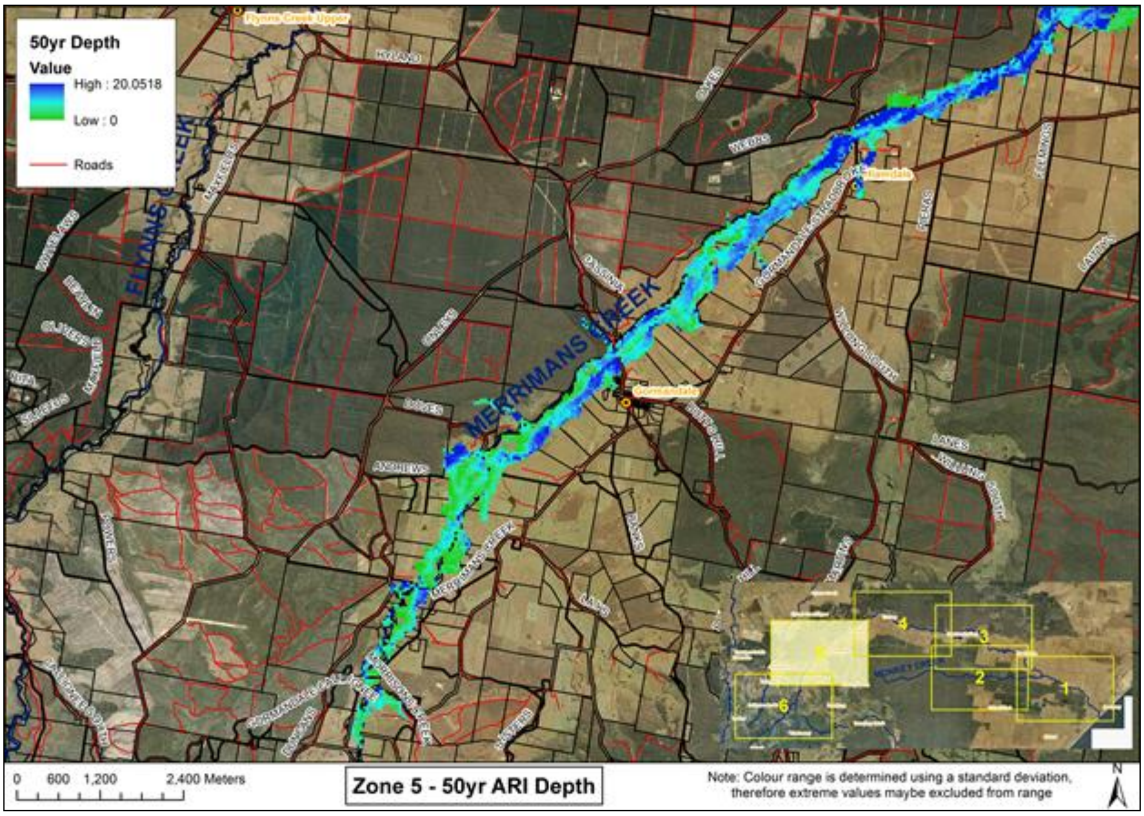
Appendix G.2 50yr Depth Maps for Zones 1 to 6

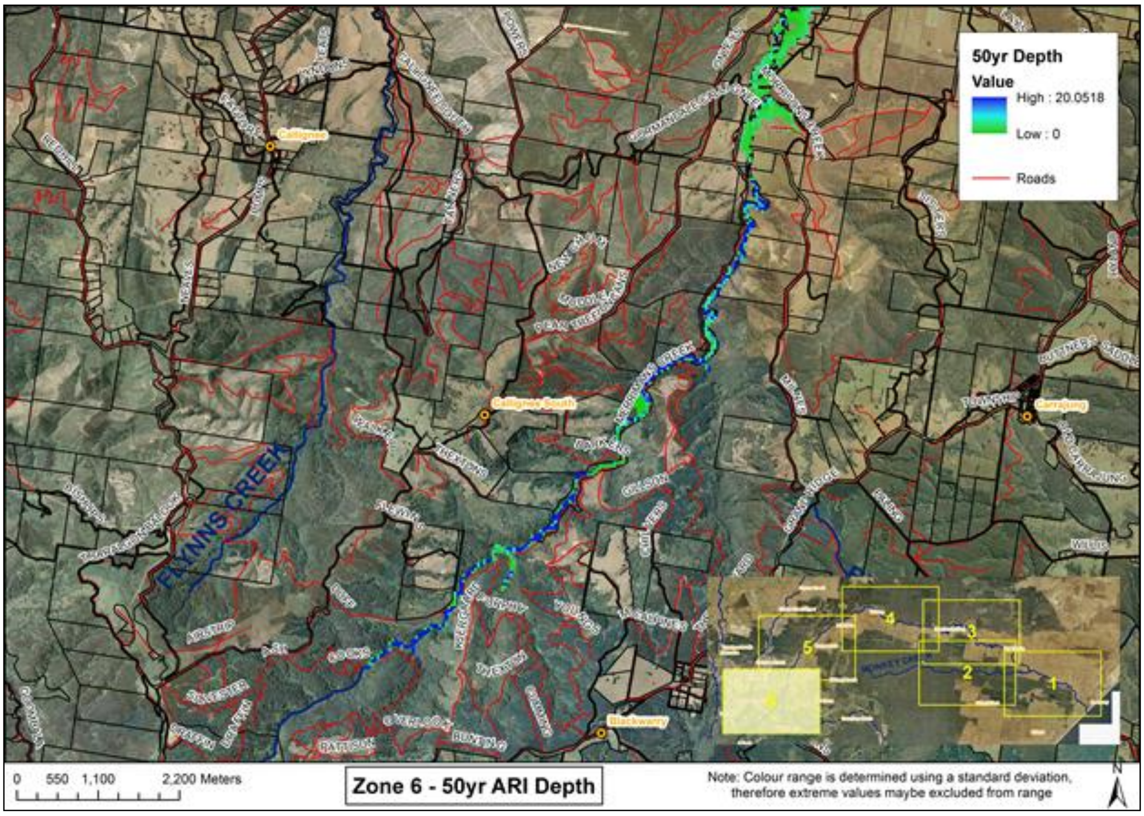




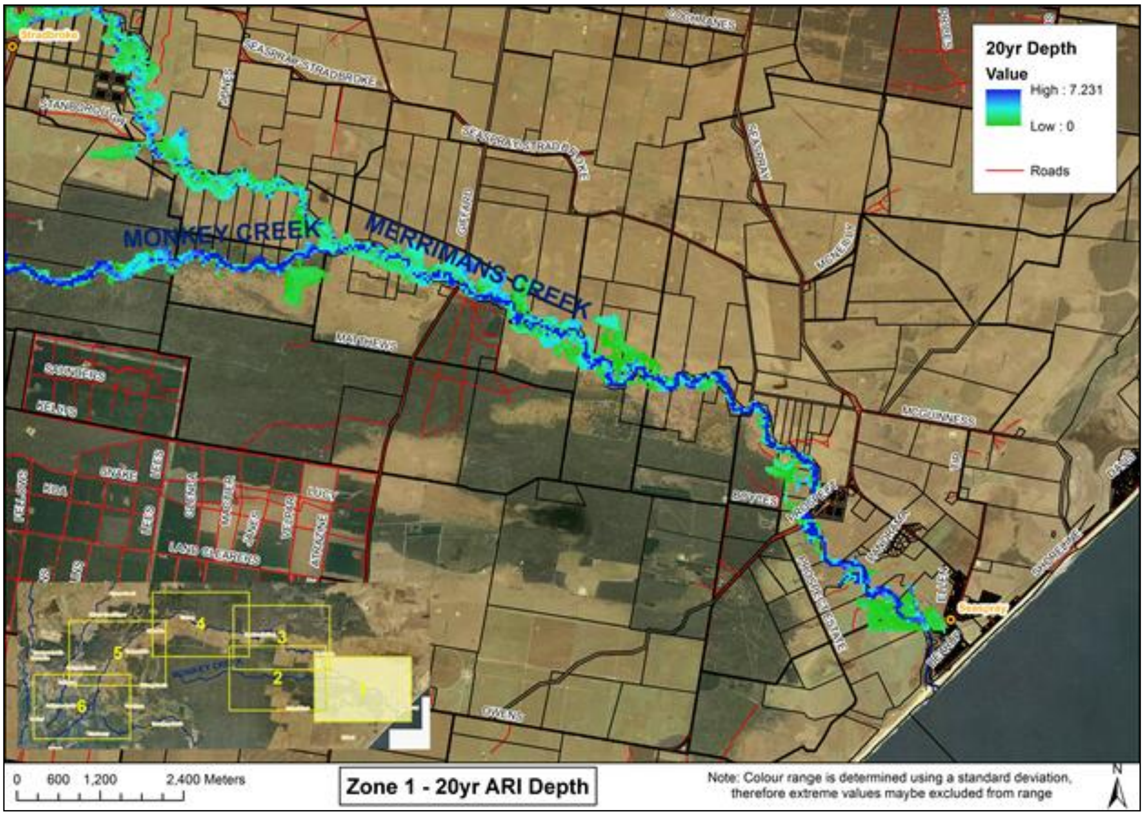

50yr Depth
Value
High : 7.1142
Low : 0
Roads
0 600 1,200 2,400 Meters
Zone 3 - 50yr ARI Depth
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

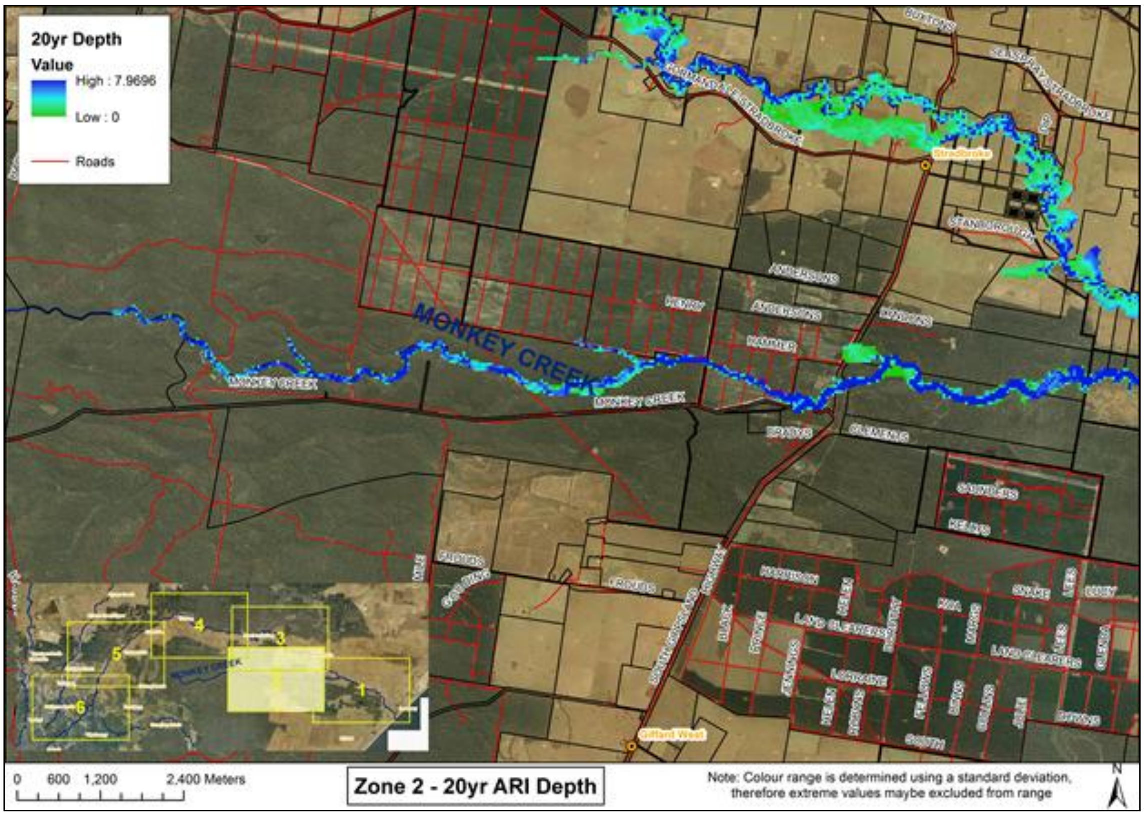

50yr Depth
Value
High : 3.8773
Low : 0
Roads
0 600 1,200 2,400 Meters
Zone 4 - 50yr ARI Depth
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

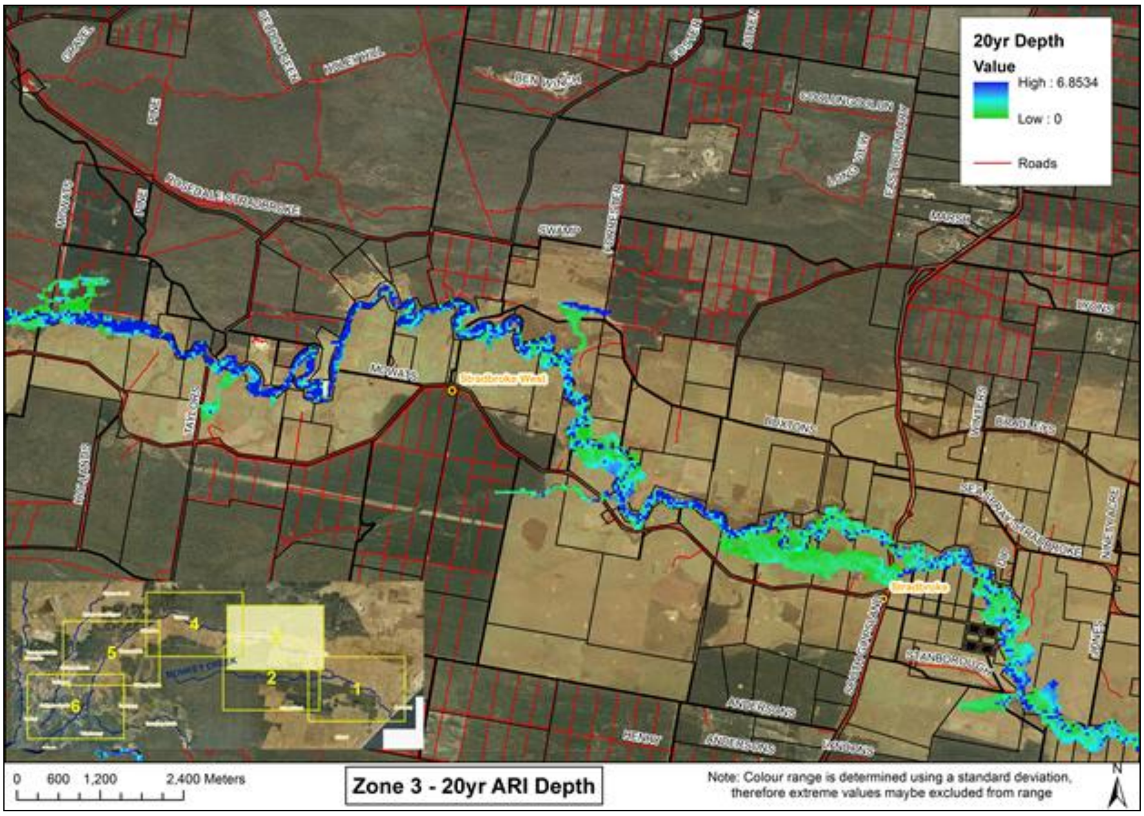

50yr Depth
Value
High : 20.0518
Low : 0
Roads
MERRIMANS CREEK
FLYNNS CREEK
0 600 1,200 2,400 Meters
Zone 5 - 50yr ARI Depth
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

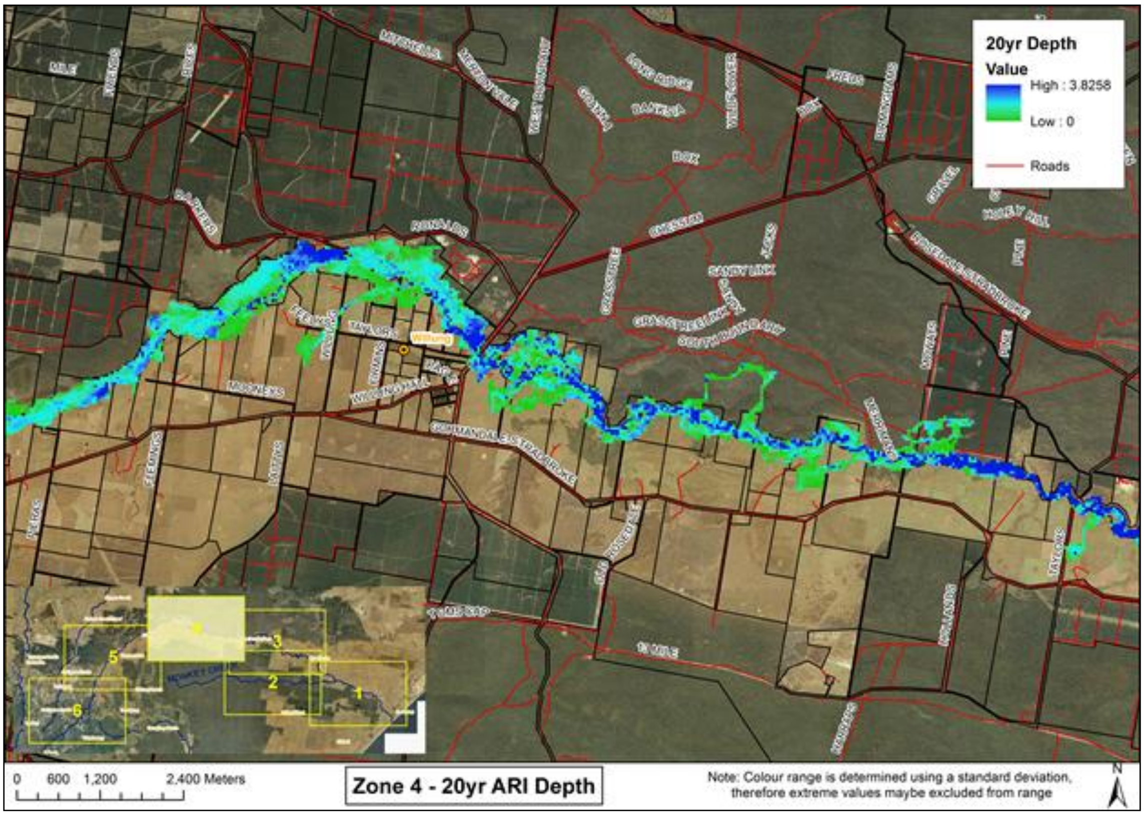

50yr Depth
Value
High : 20.0518
Low : 0
Roads
FLYNNS CREEK
0 550 1,100 2,200 Meters
Zone 6 - 50yr ARI Depth
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

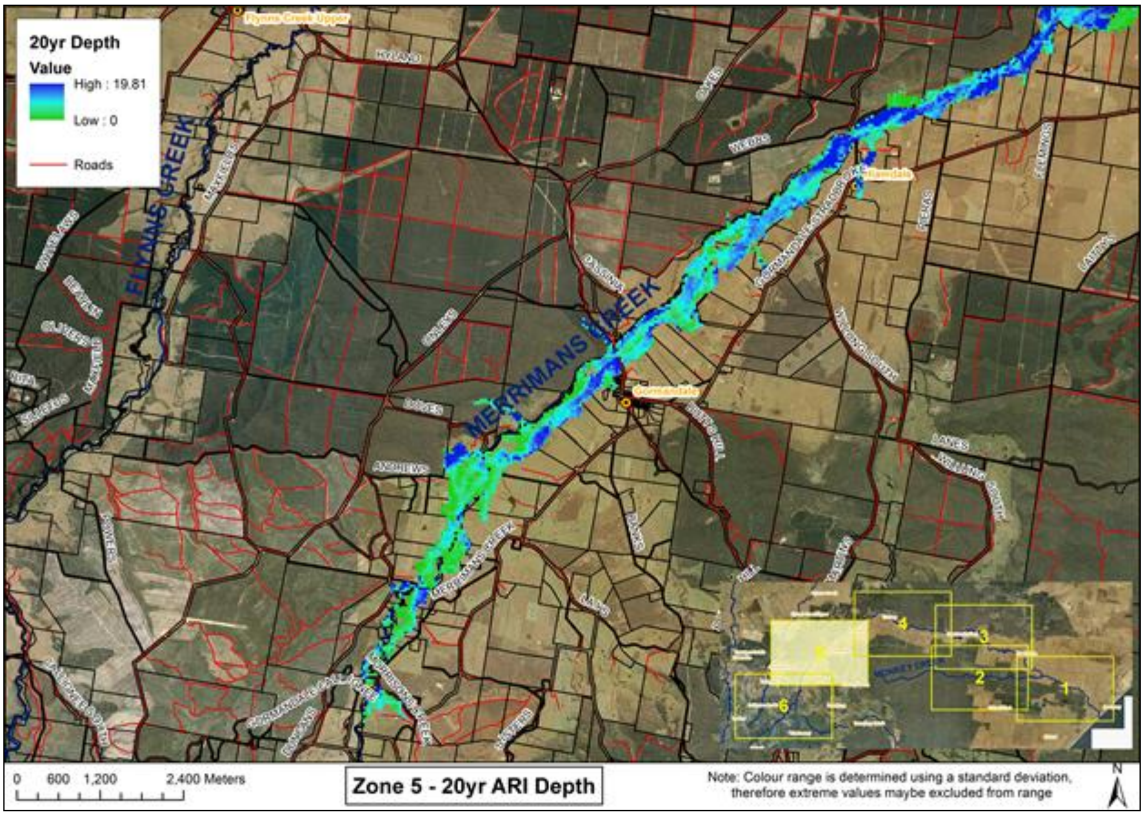
Appendix G.3 20yr Depth Maps for Zones 1 to 6

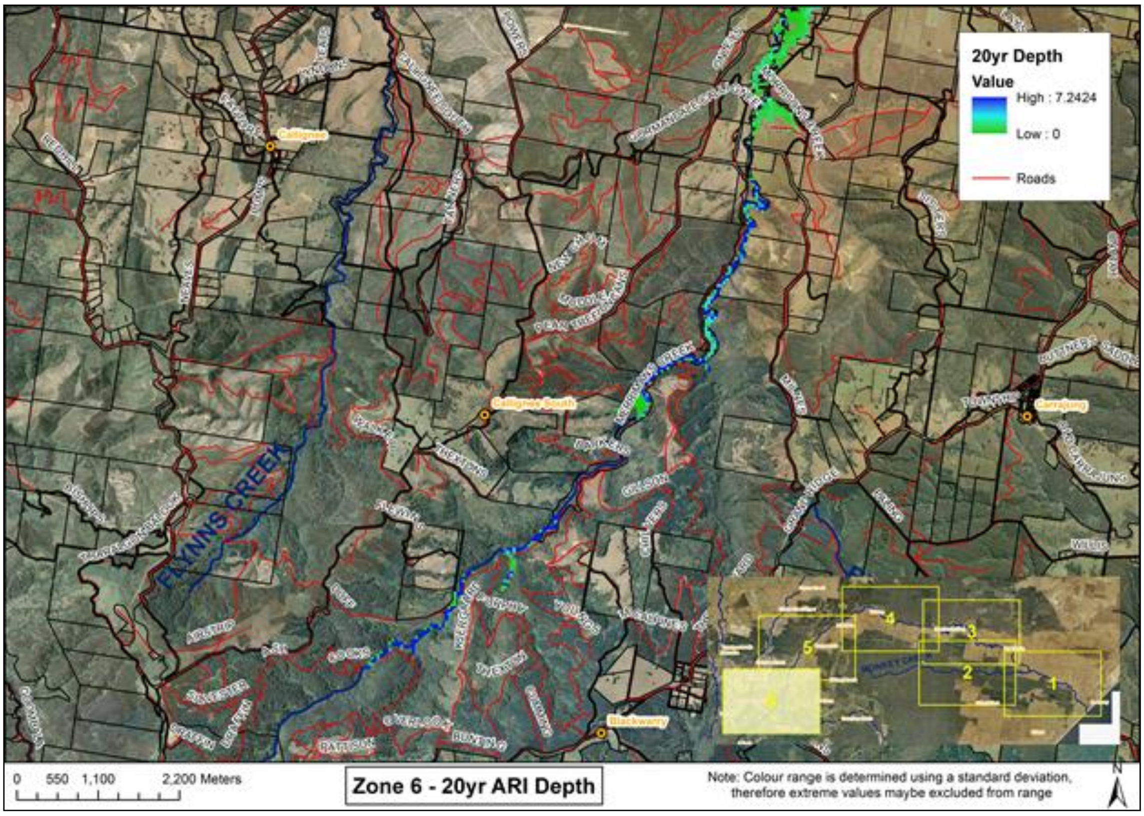




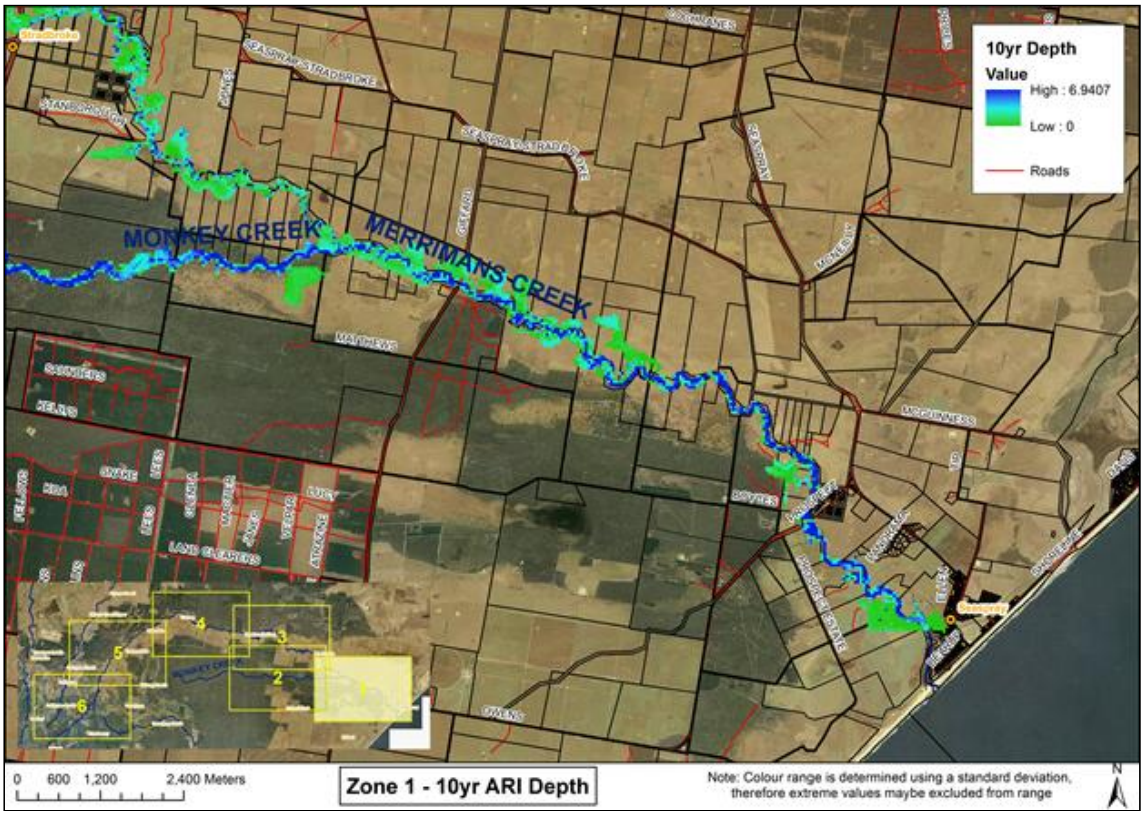

20yr Depth
Value
High : 6.8534
Low : 0
Roads
0 600 1,200 2,400 Meters
Zone 3 - 20yr ARI Depth
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

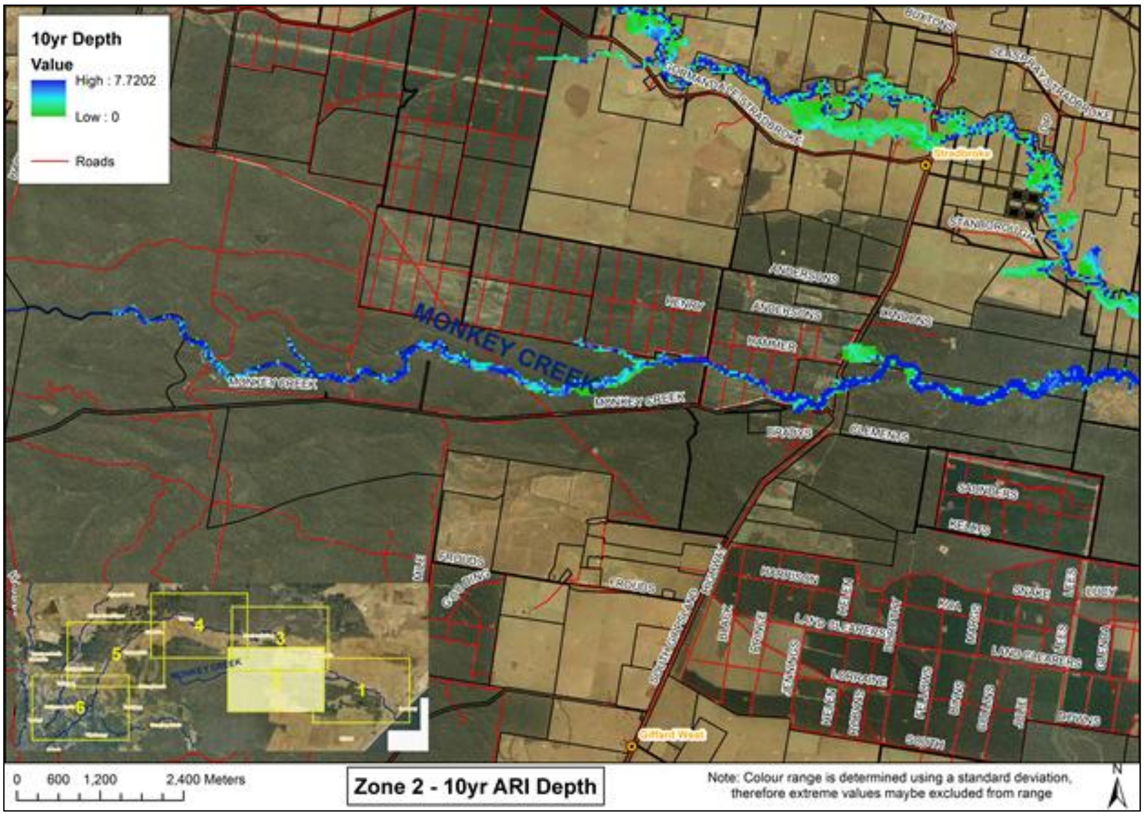

20yr Depth
Value
High : 3.8258
Low : 0
Roads
0 600 1,200 2,400 Meters
Zone 4 - 20yr ARI Depth
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

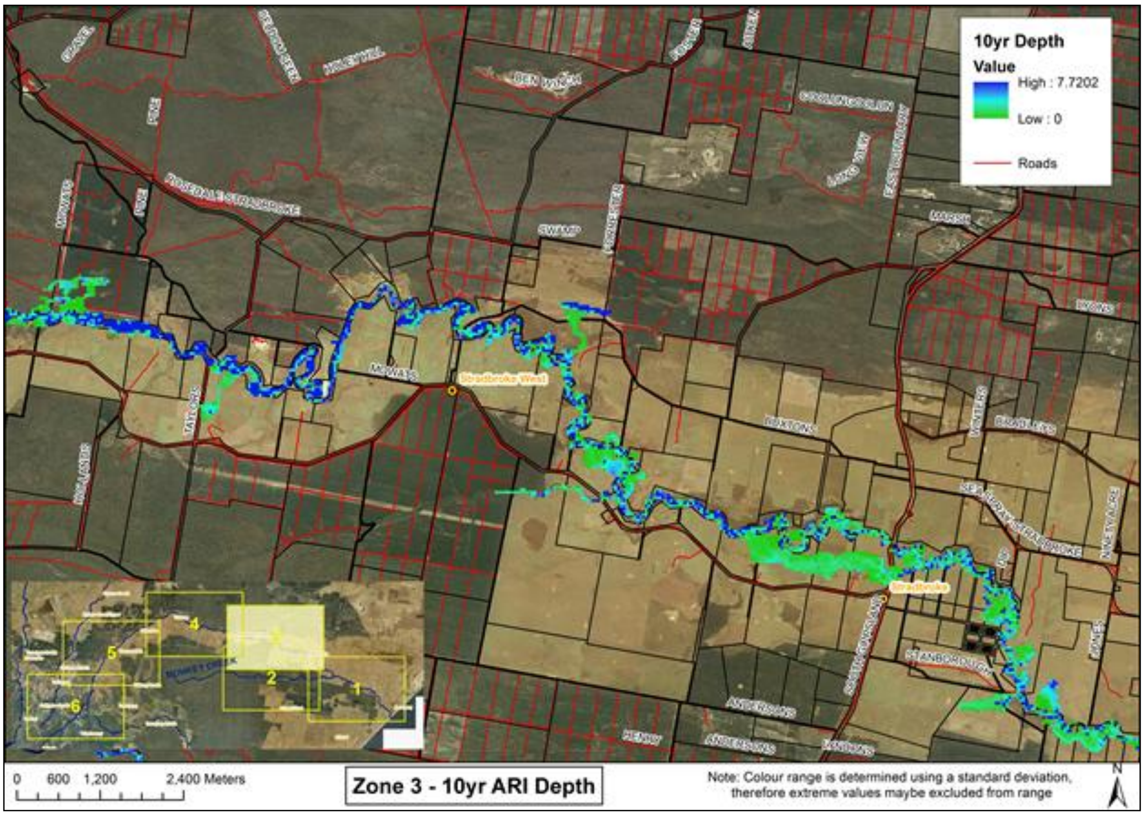

20yr Depth
Value
High : 19.81
Low : 0
Roads
FLYNNS CREEK
MERRIMANS CREEK
0 600 1,200 2,400 Meters
Zone 5 - 20yr ARI Depth
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range


20yr Depth
Value
High : 7.2424
Low : 0
Roads
FLYNNS CREEK
0 550 1,100 2,200 Meters
Zone 6 - 20yr ARI Depth
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range

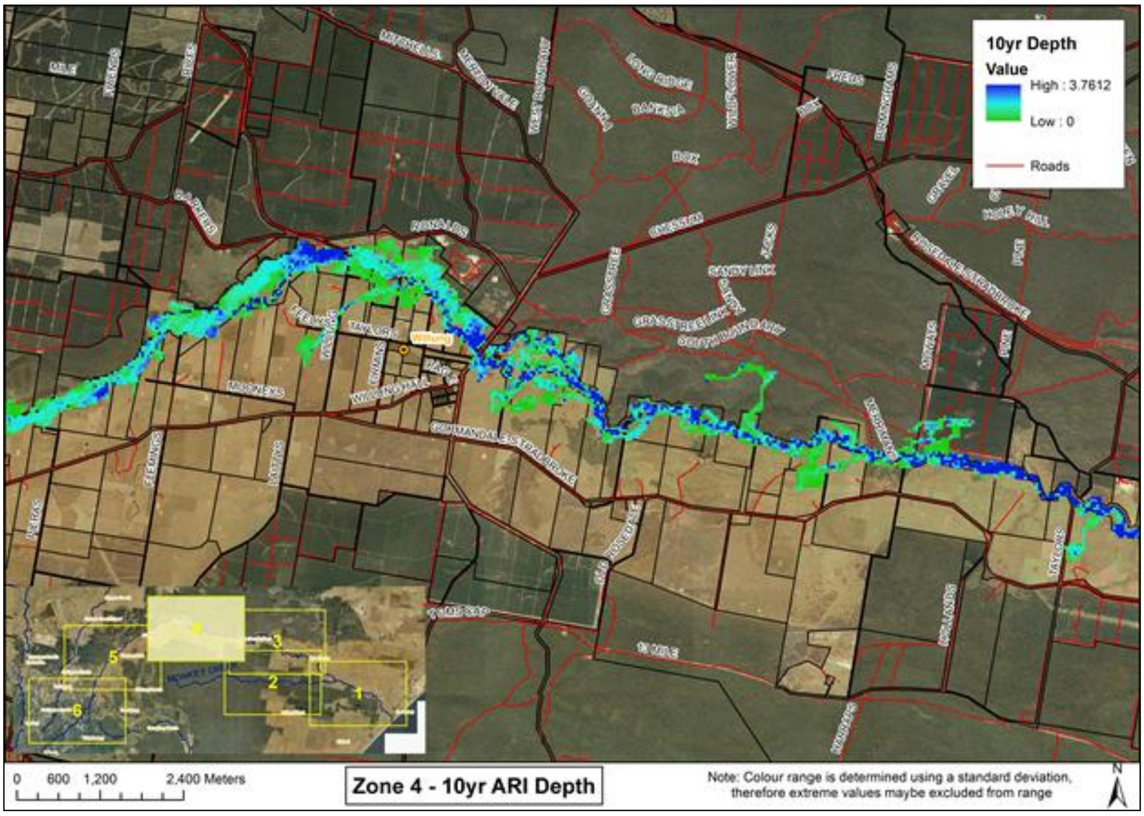
Appendix G.4 10yr Depth Maps for Zones 1 to 6



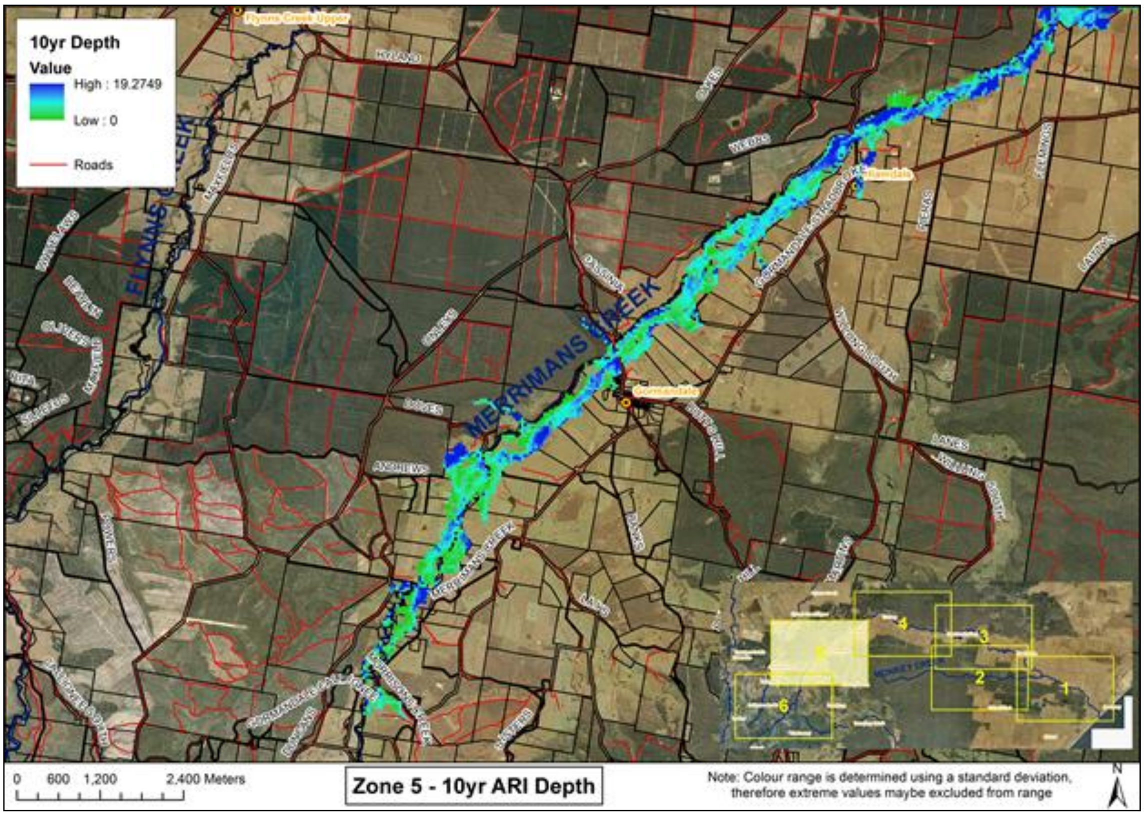


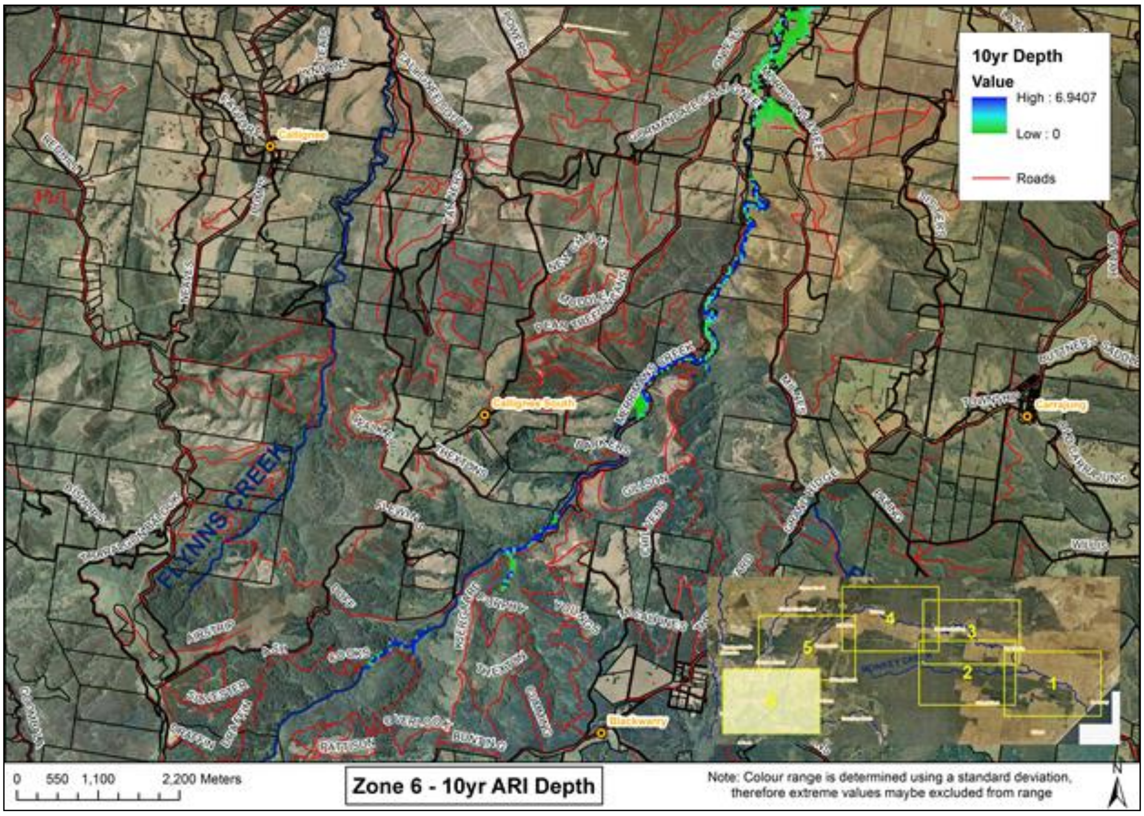


Zone 3 - 10yr ARI Depth

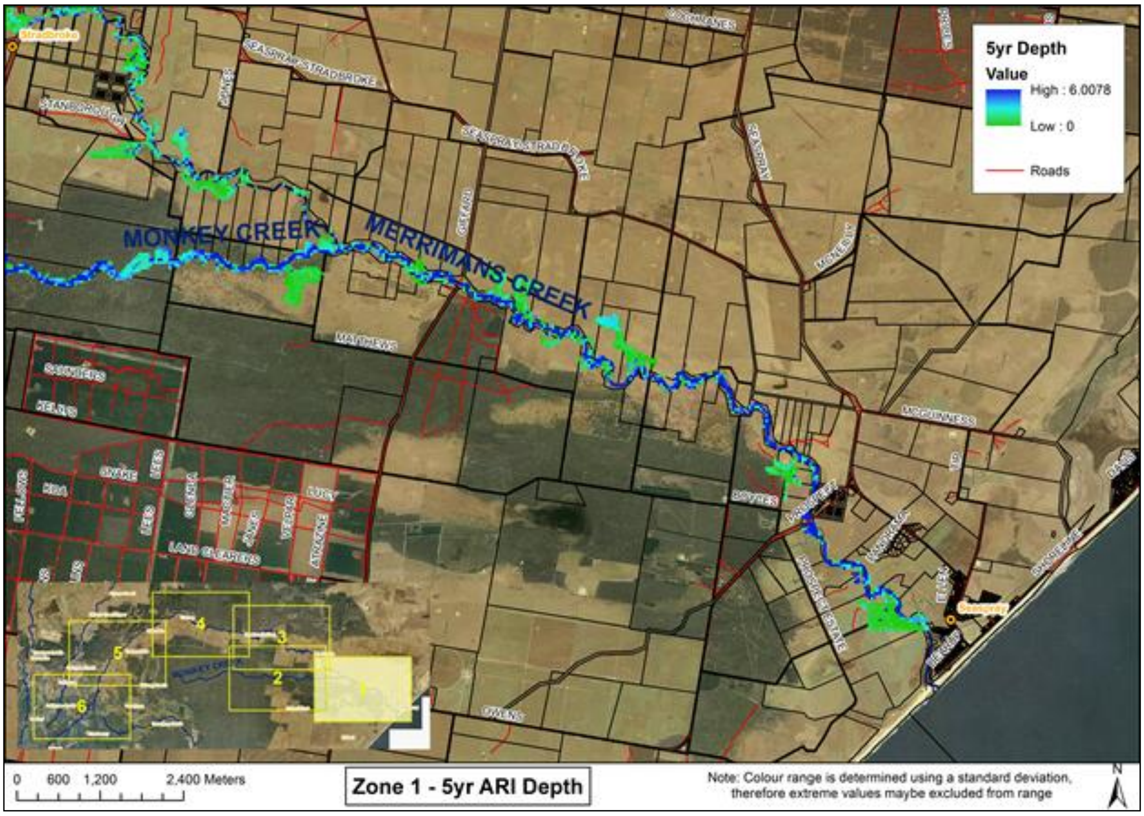


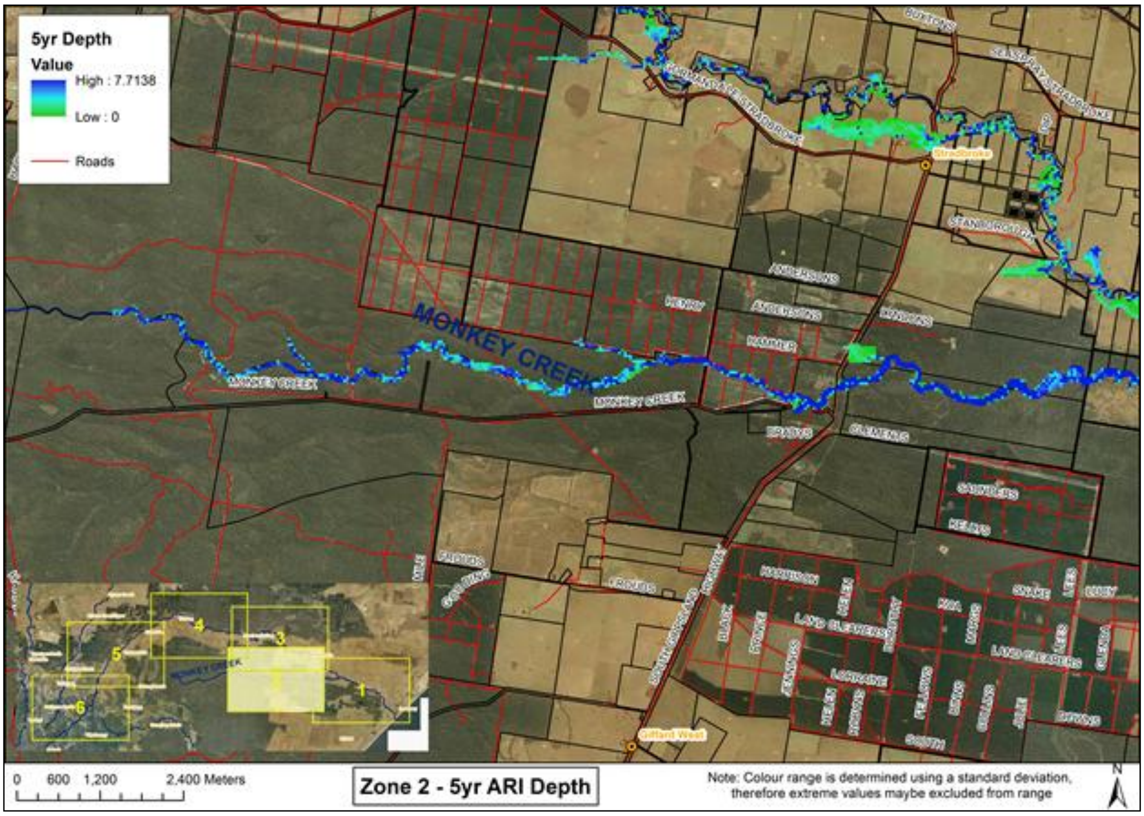
Zone 4 - 10yr ARI Depth

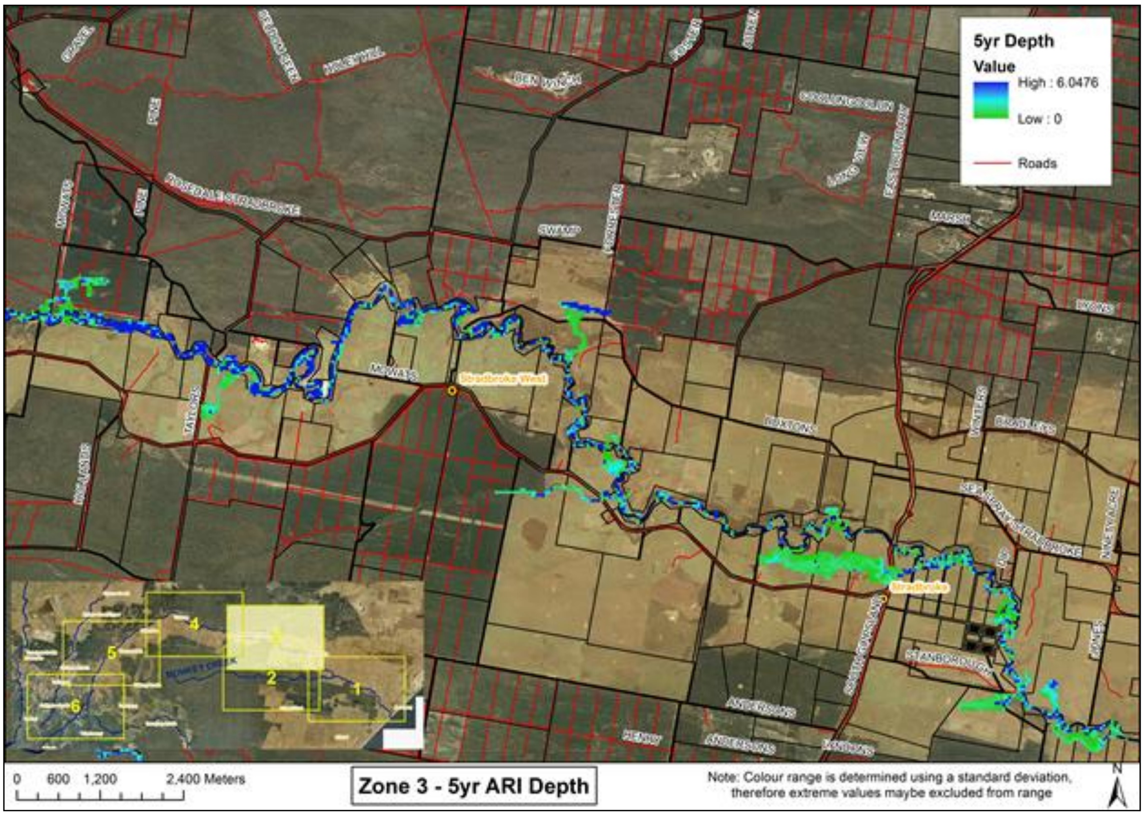

10yr Depth
Value
High : 19.2749
Low : 0
Roads
MERRIMANS CREEK
FLYNNS CREEK
0 600 1,200 2,400 Meters
Zone 5 - 10yr ARI Depth
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

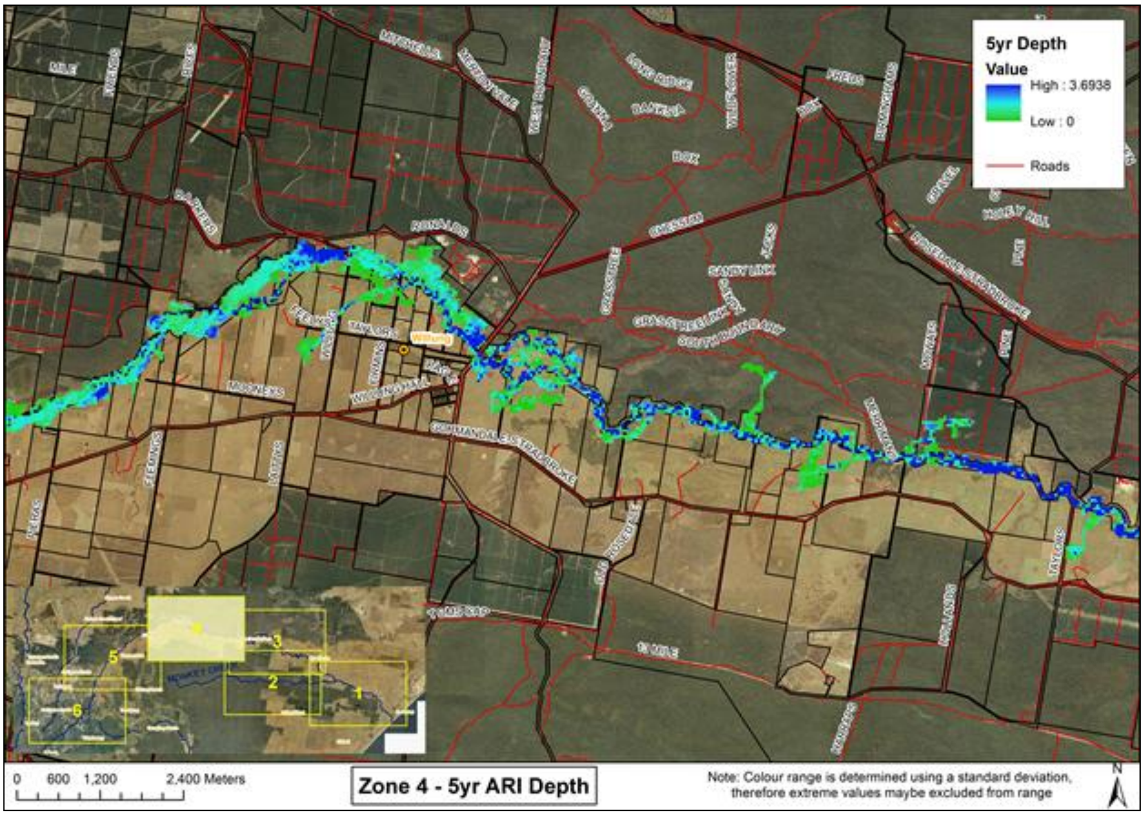

10yr Depth
Value
High : 6.9407
Low : 0
Roads
FLYNNS CREEK
0 550 1,100 2,200 Meters
Zone 6 - 10yr ARI Depth
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

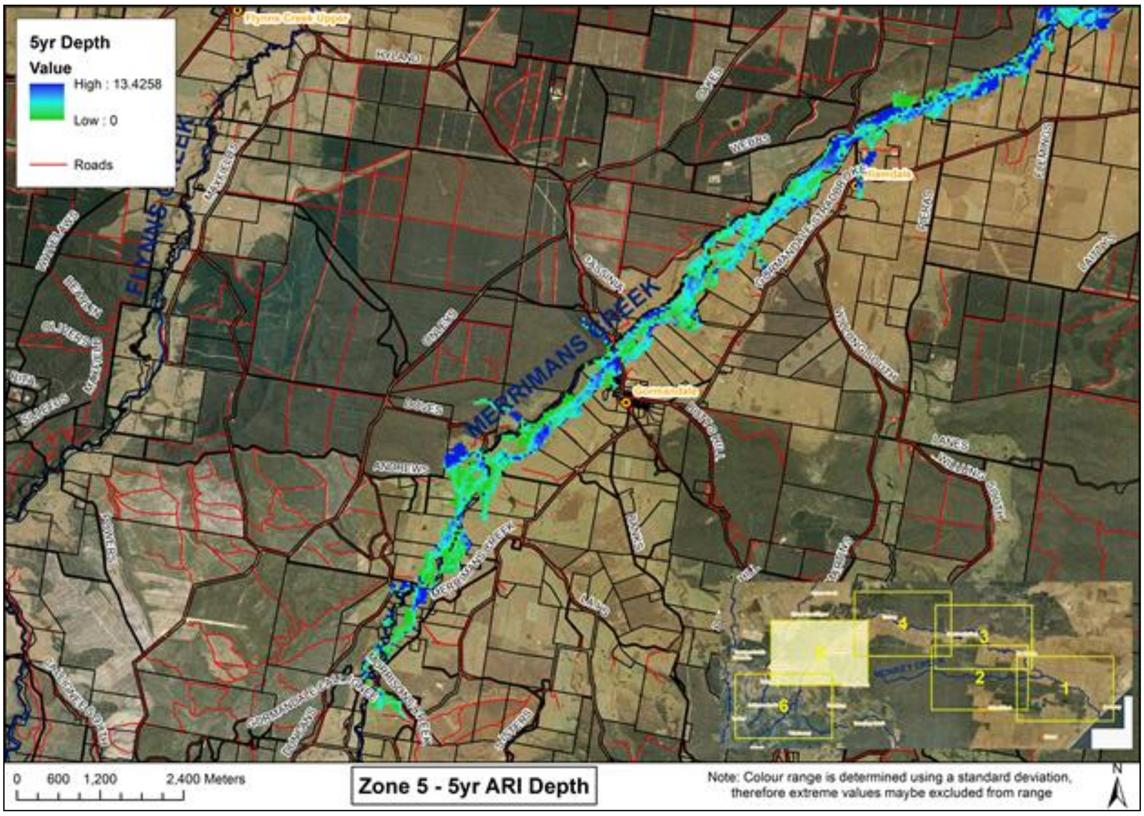
Appendix G.5 5yr Depth Maps for Zones 1 to 6



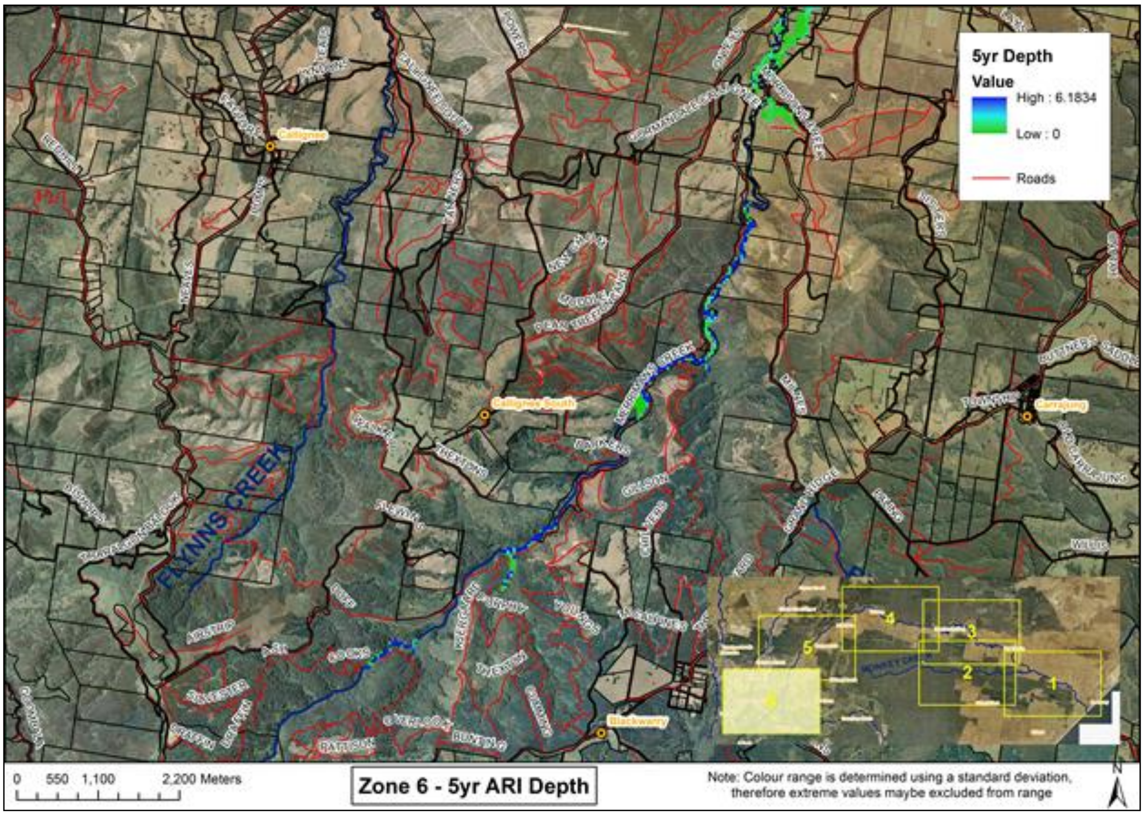



5yr Depth
Value
High : 6.0476
Low : 0
Roads
Stradbroke West
Stradbroke
0 600 1,200 2,400 Meters
Zone 3 - 5yr ARI Depth
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N


5yr Depth
Value
High : 3.6938
Low : 0
Roads
Willung
0 600 1,200 2,400 Meters
Zone 4 - 5yr ARI Depth
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

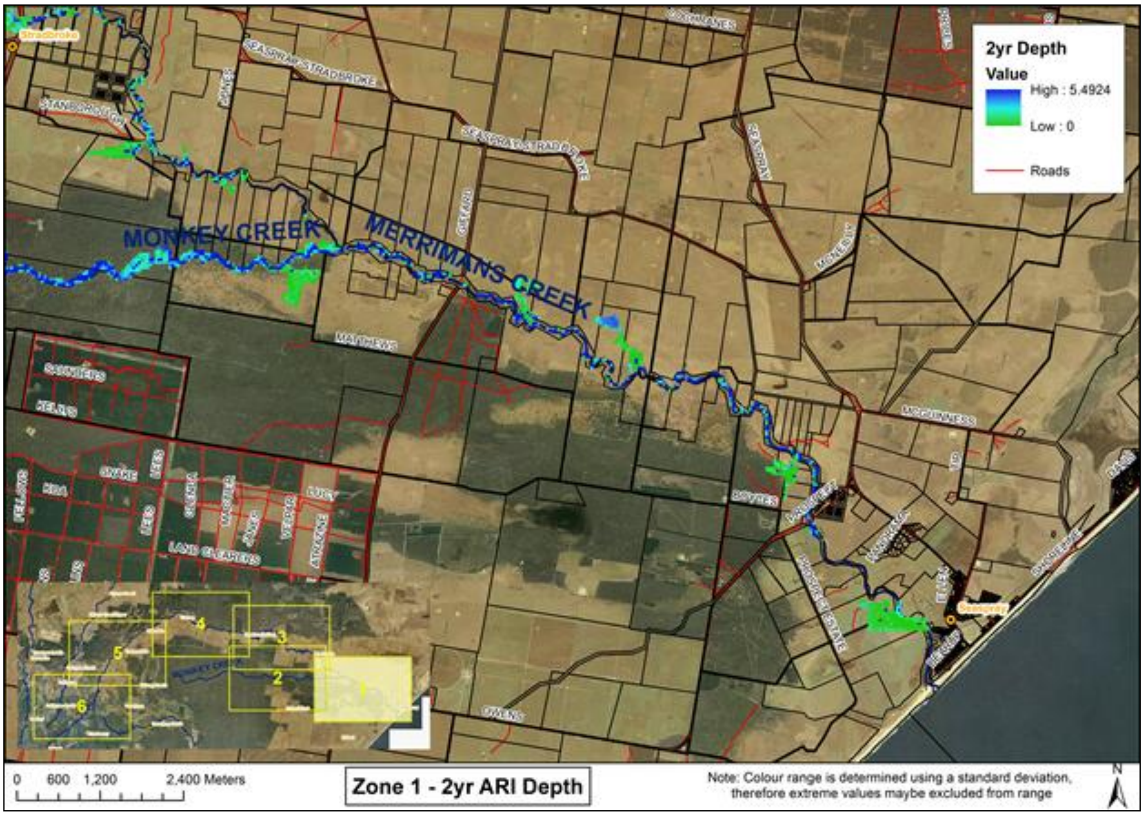


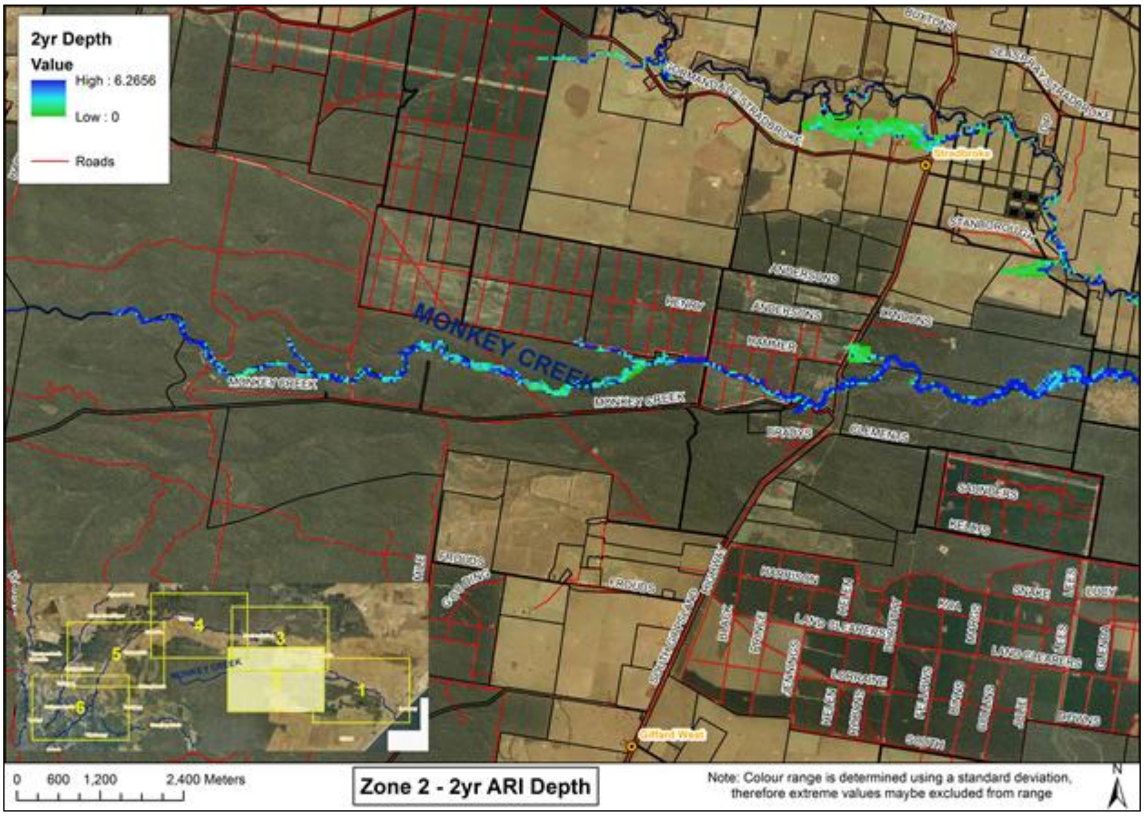
Zone 5 - 5yr ARI Depth

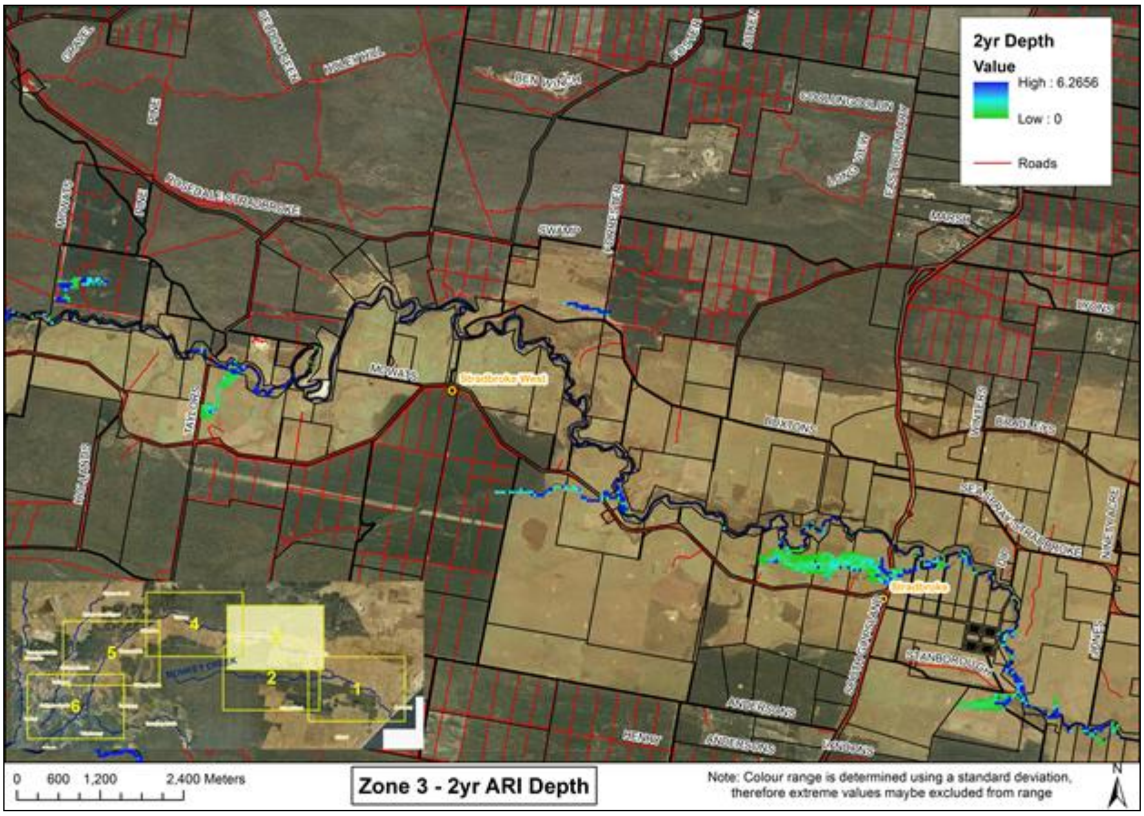


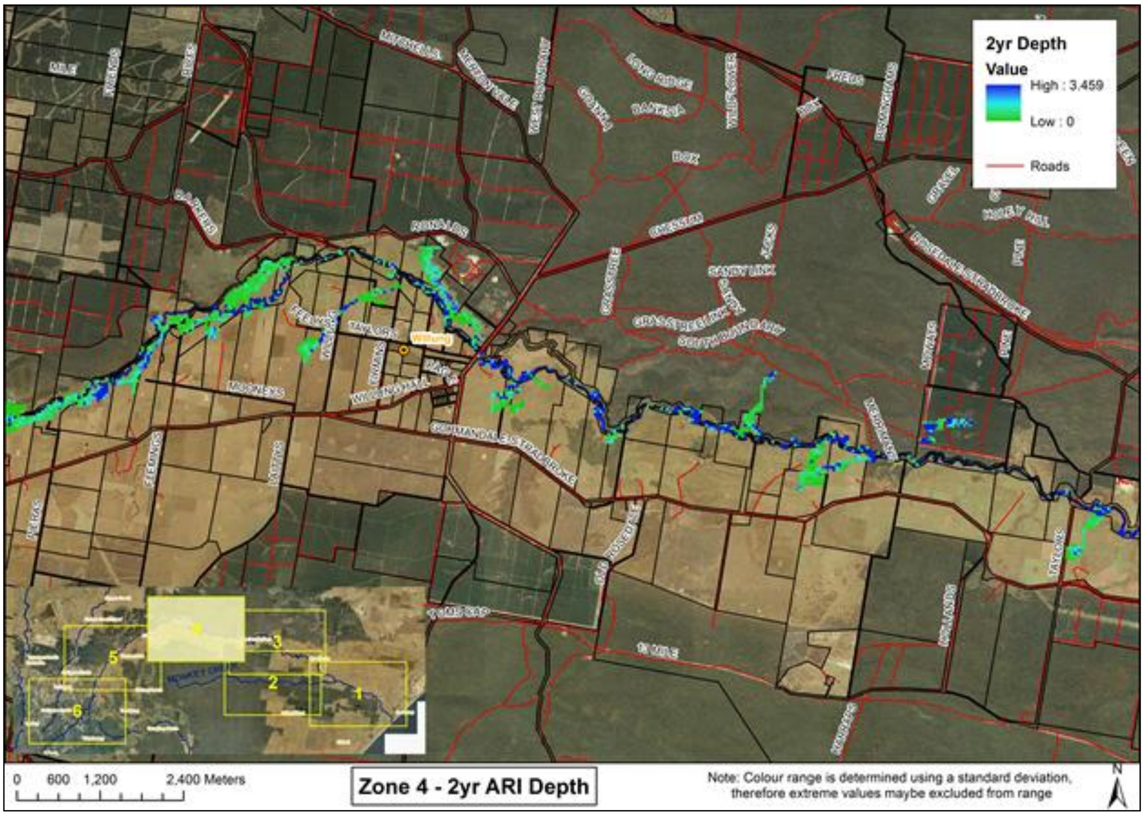
Zone 6 - 5yr ARI Depth

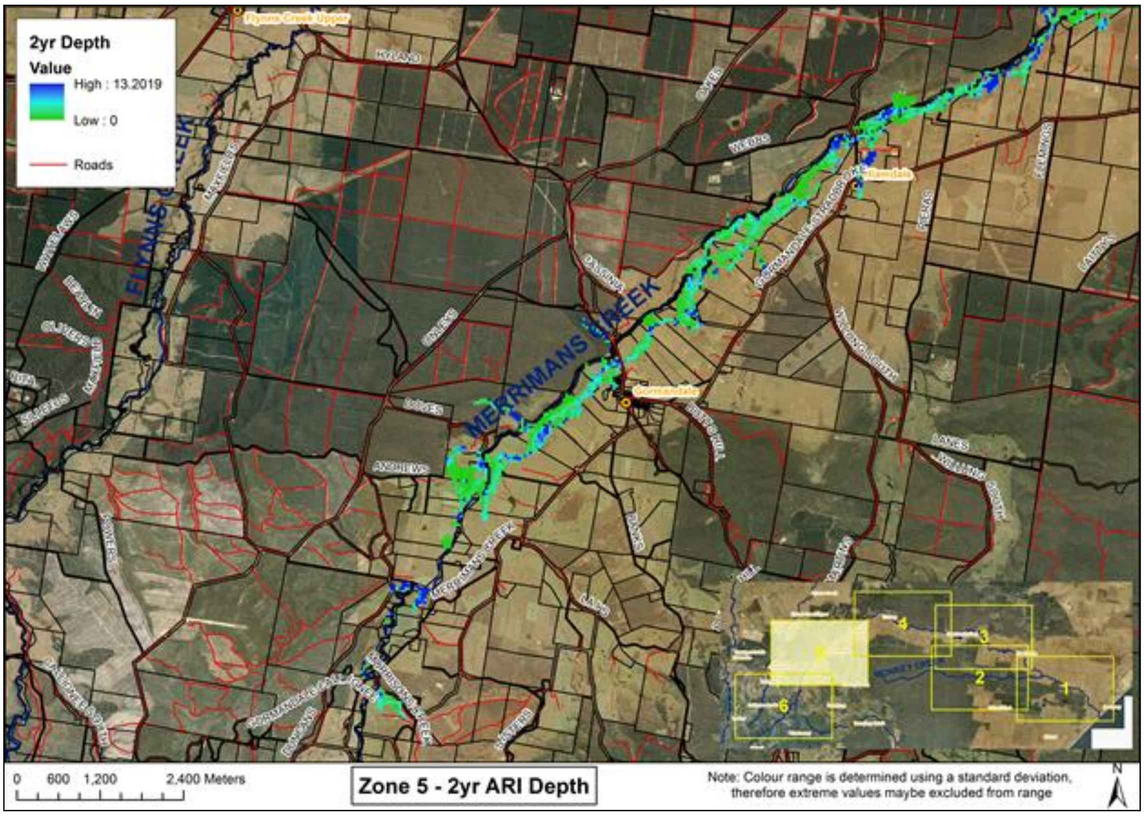
Appendix G.6 2yr Depth Maps for Zones 1 to 6

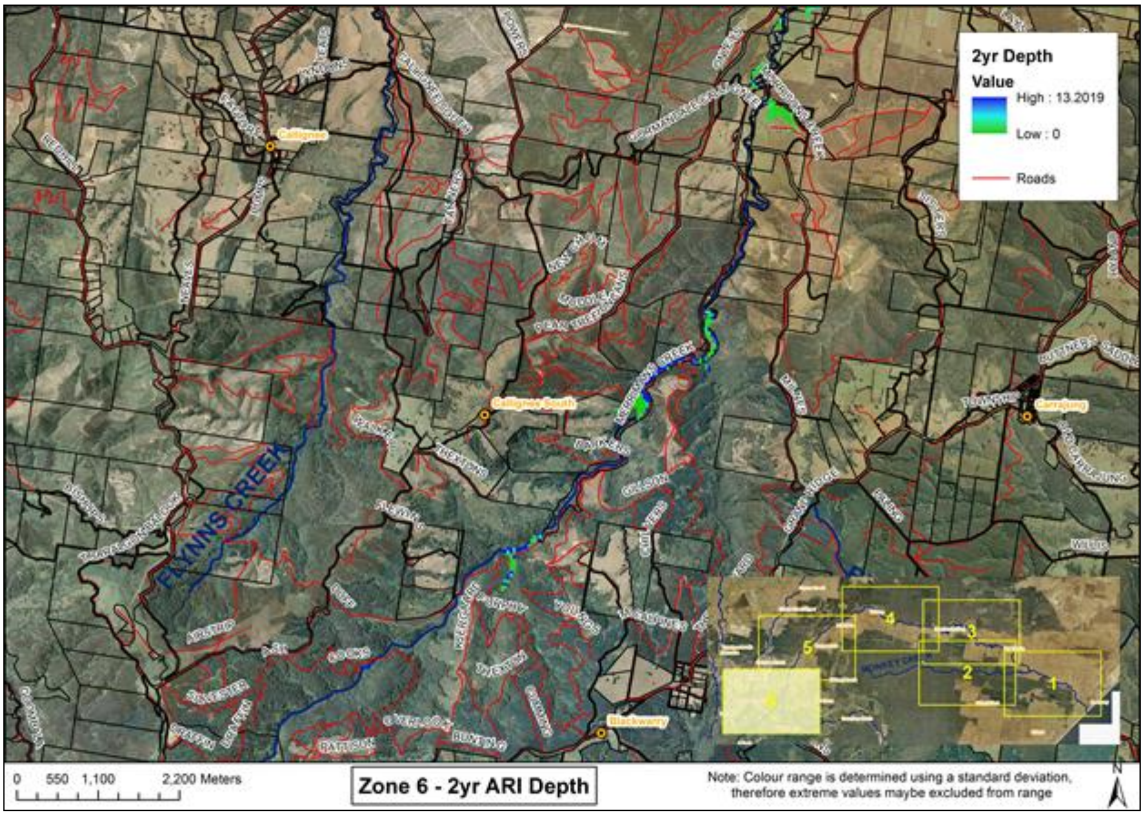





2yr Depth
Value
High : 6.2656
Low : 0
Roads
0 600 1,200 2,400 Meters
Zone 3 - 2yr ARI Depth
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

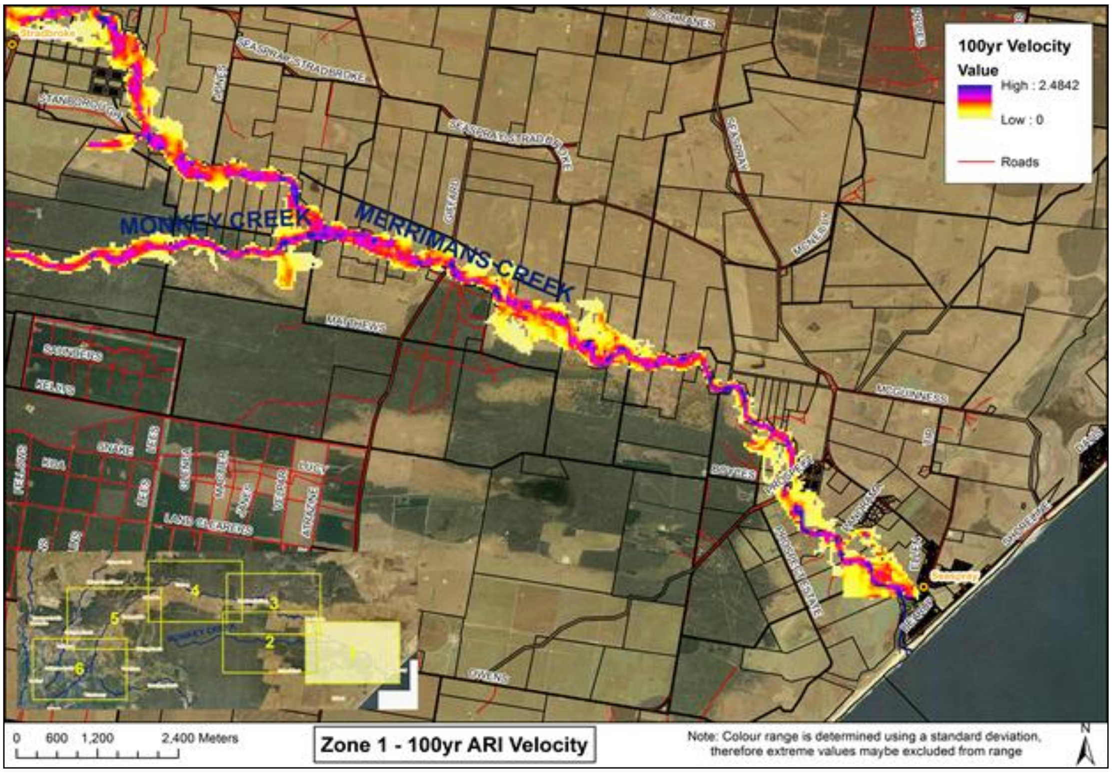

2yr Depth
Value
High : 3.459
Low : 0
Roads
0 600 1,200 2,400 Meters
Zone 4 - 2yr ARI Depth
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

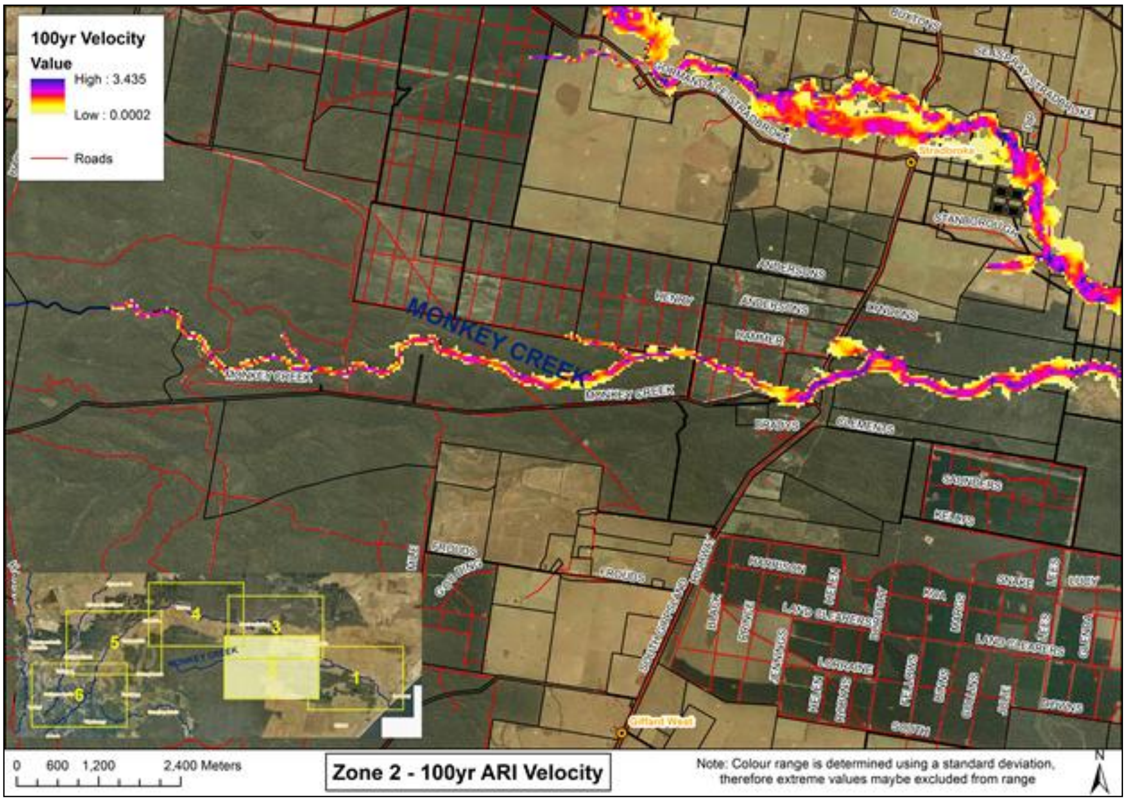

2yr Depth
Value
High : 13.2019
Low : 0
Roads
MERRIMANS CREEK
FLYNNS CREEK
0 600 1,200 2,400 Meters
Zone 5 - 2yr ARI Depth
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range

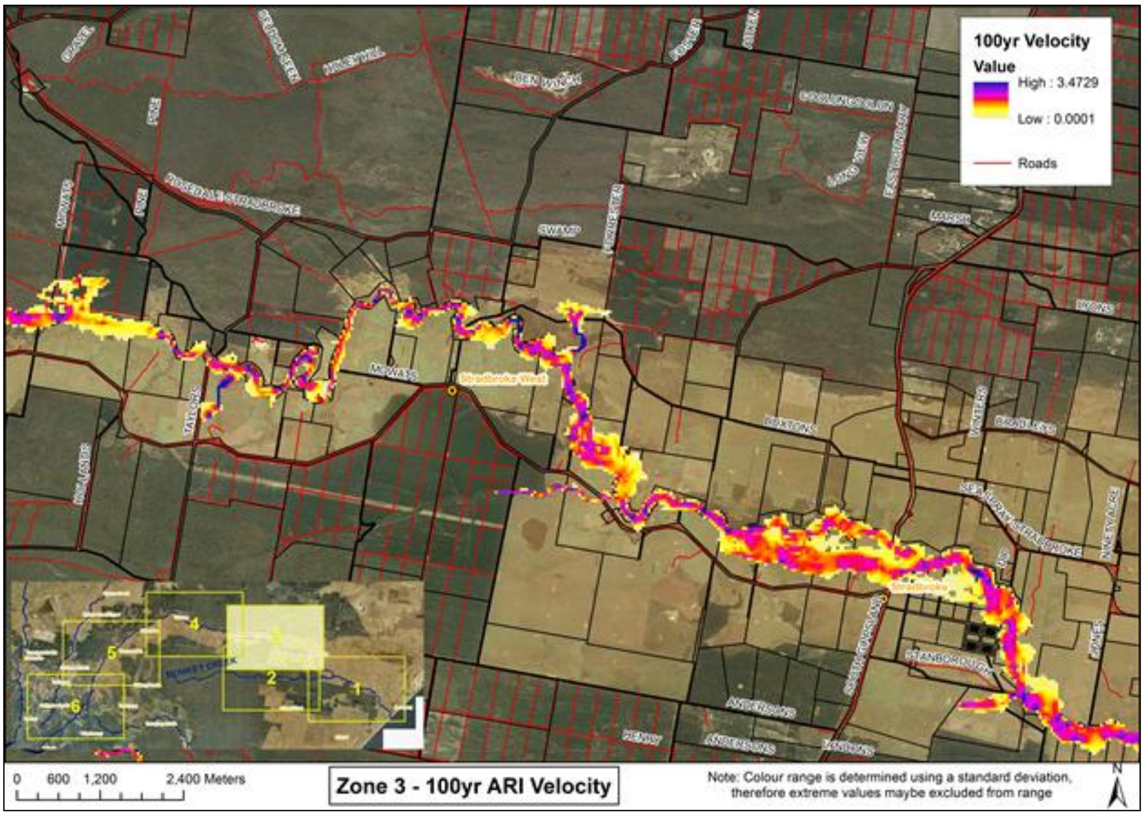

2yr Depth
Value
High : 13.2019
Low : 0
Roads
FLYNNS CREEK
0 550 1,100 2,200 Meters
Zone 6 - 2yr ARI Depth
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range

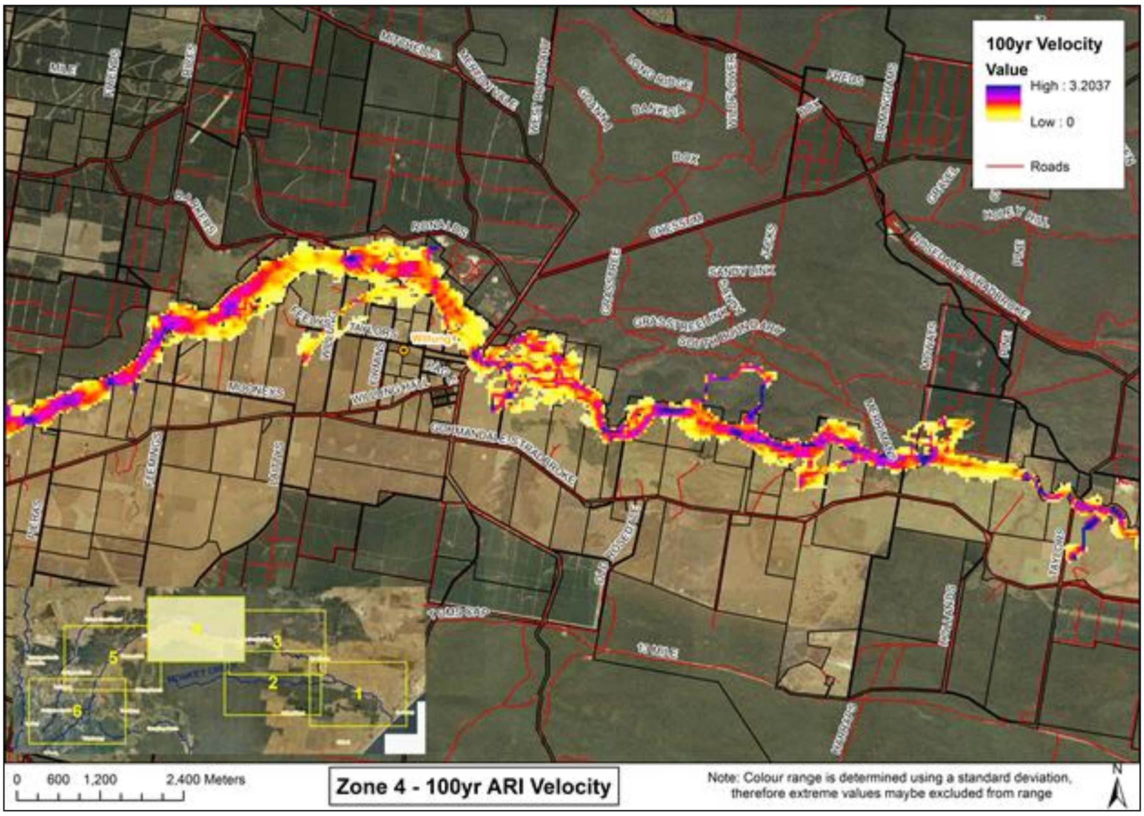
Appendix H: Flood flow velocity maps

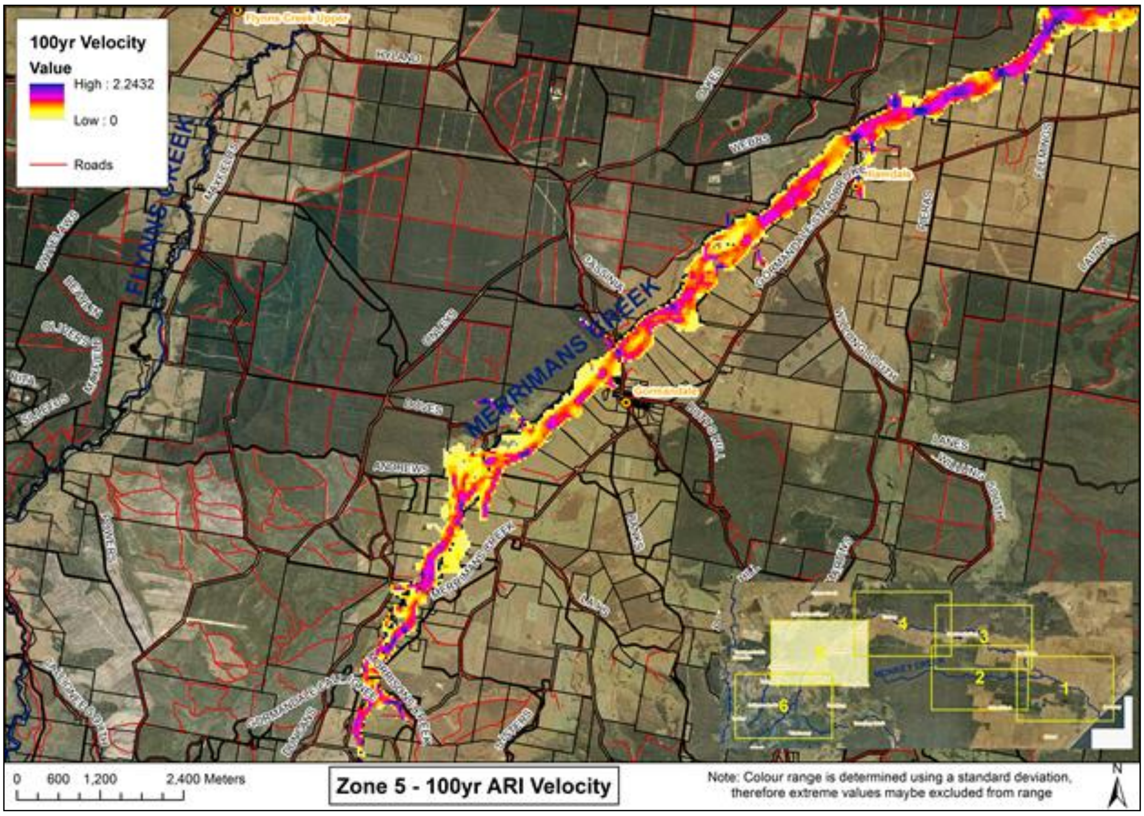
Appendix H.1 100yr Velocity Maps for Zones 1 to 6



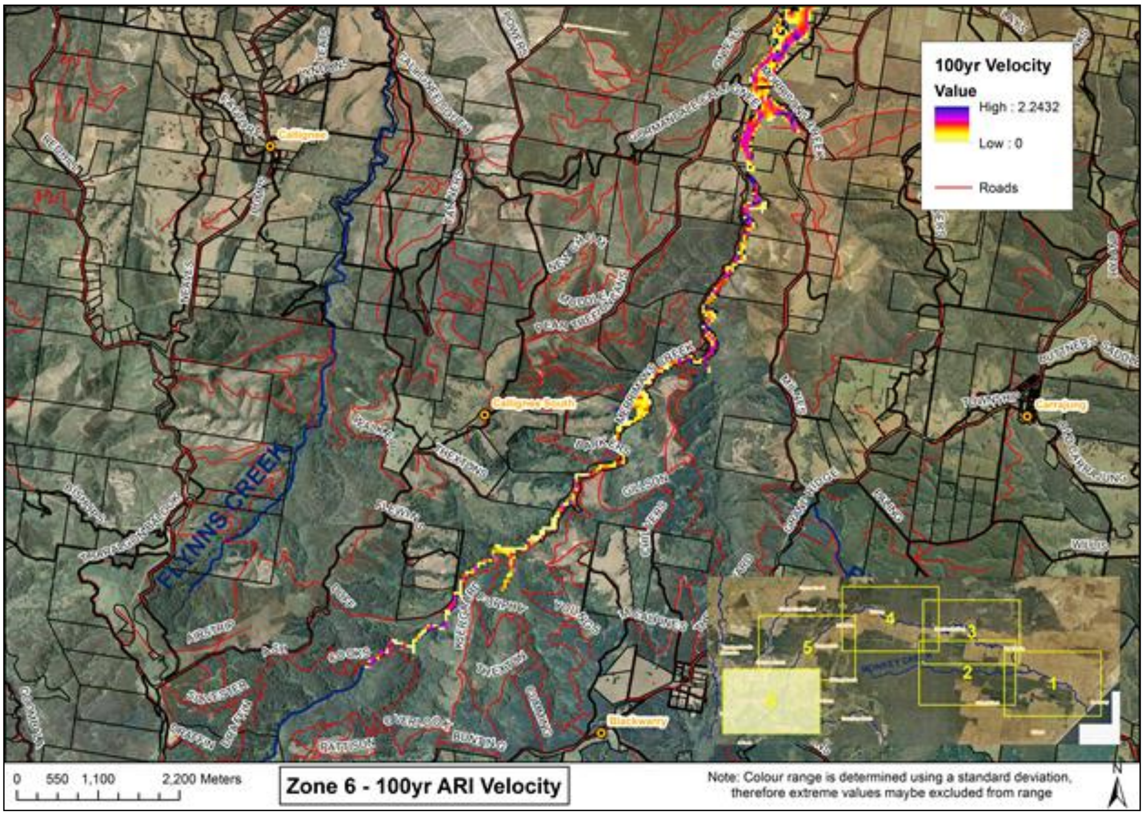



100yr Velocity
Value
High : 3.4729
Low : 0.0001
Roads
0 600 1,200 2,400 Meters
Zone 3 - 100yr ARI Velocity
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N


100yr Velocity
Value
High : 3.2037
Low : 0
Roads
0 600 1,200 2,400 Meters
Zone 4 - 100yr ARI Velocity
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

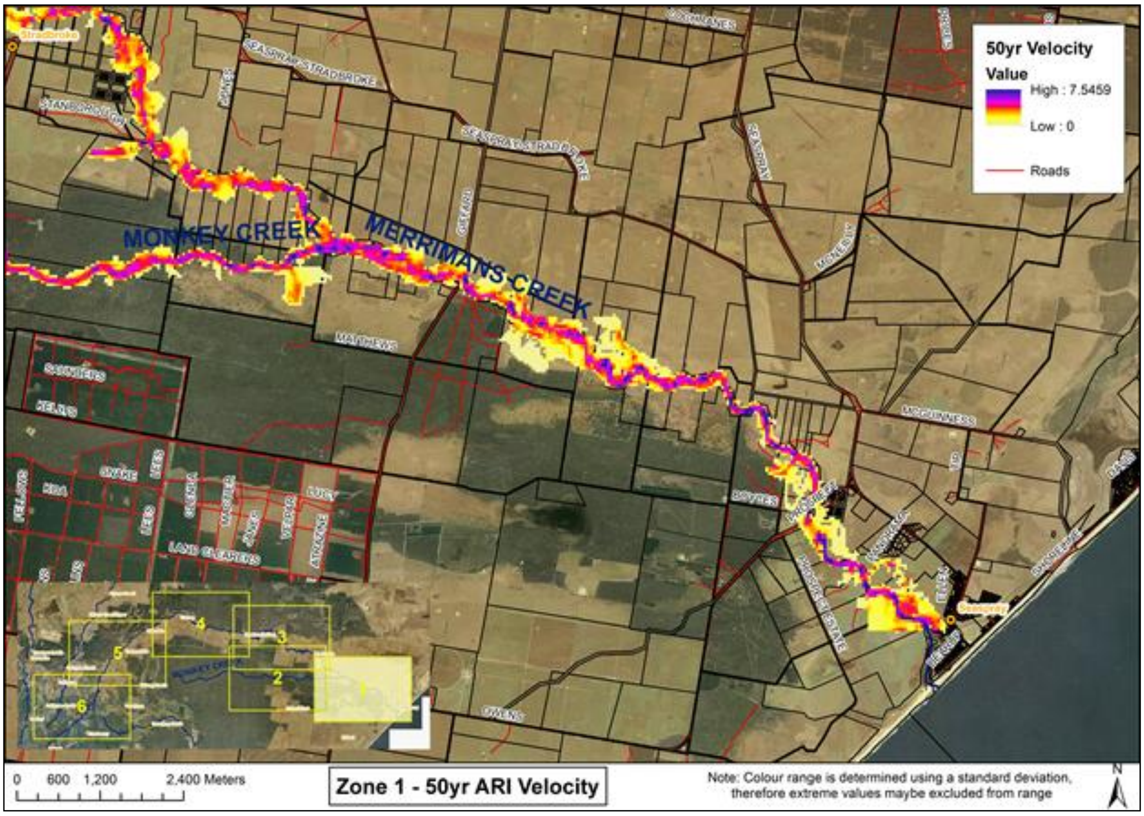


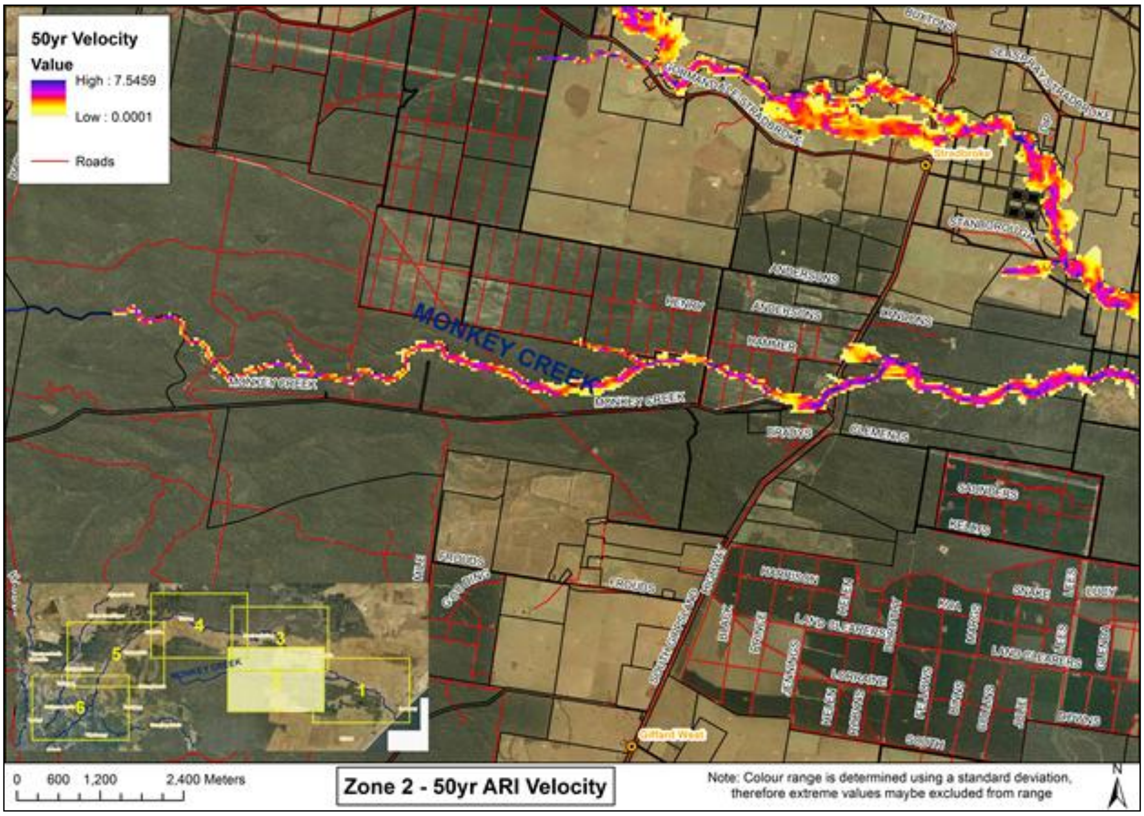
Zone 5 - 100yr ARI Velocity

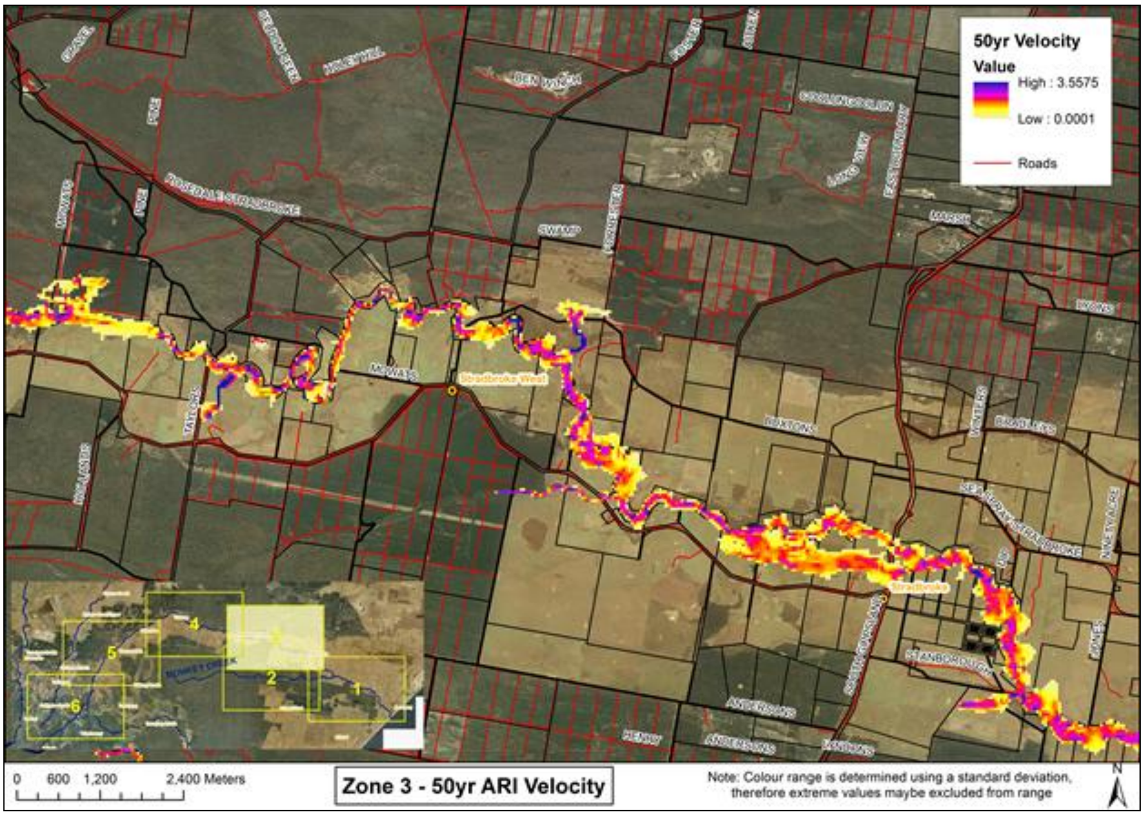


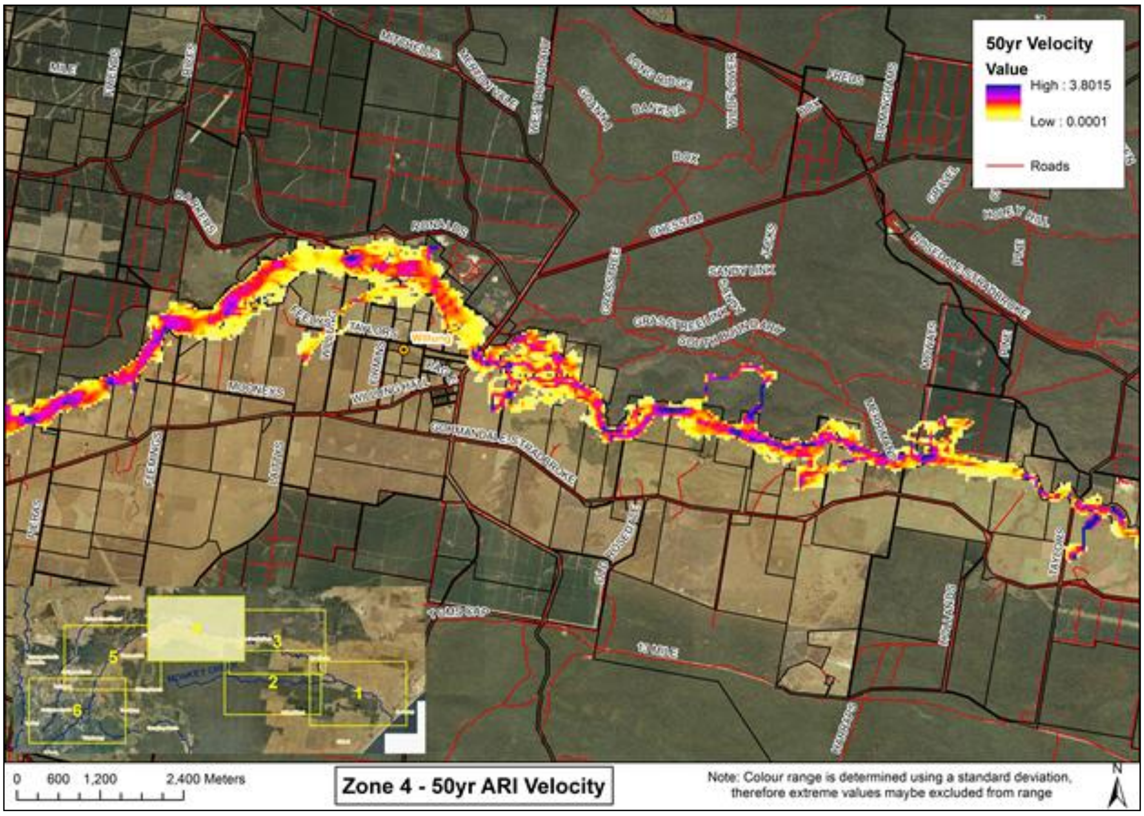
Zone 6 - 100yr ARI Velocity

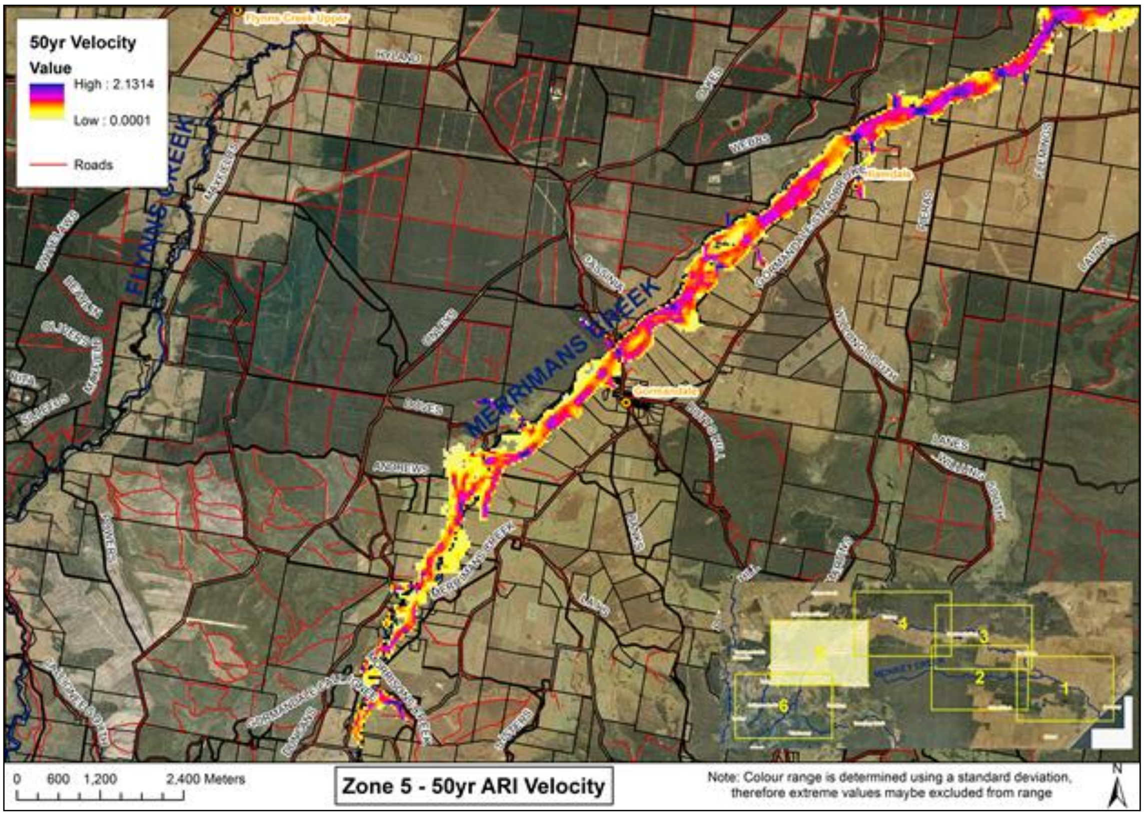
Appendix H.2 50yr Velocity Maps for Zones 1 to 6



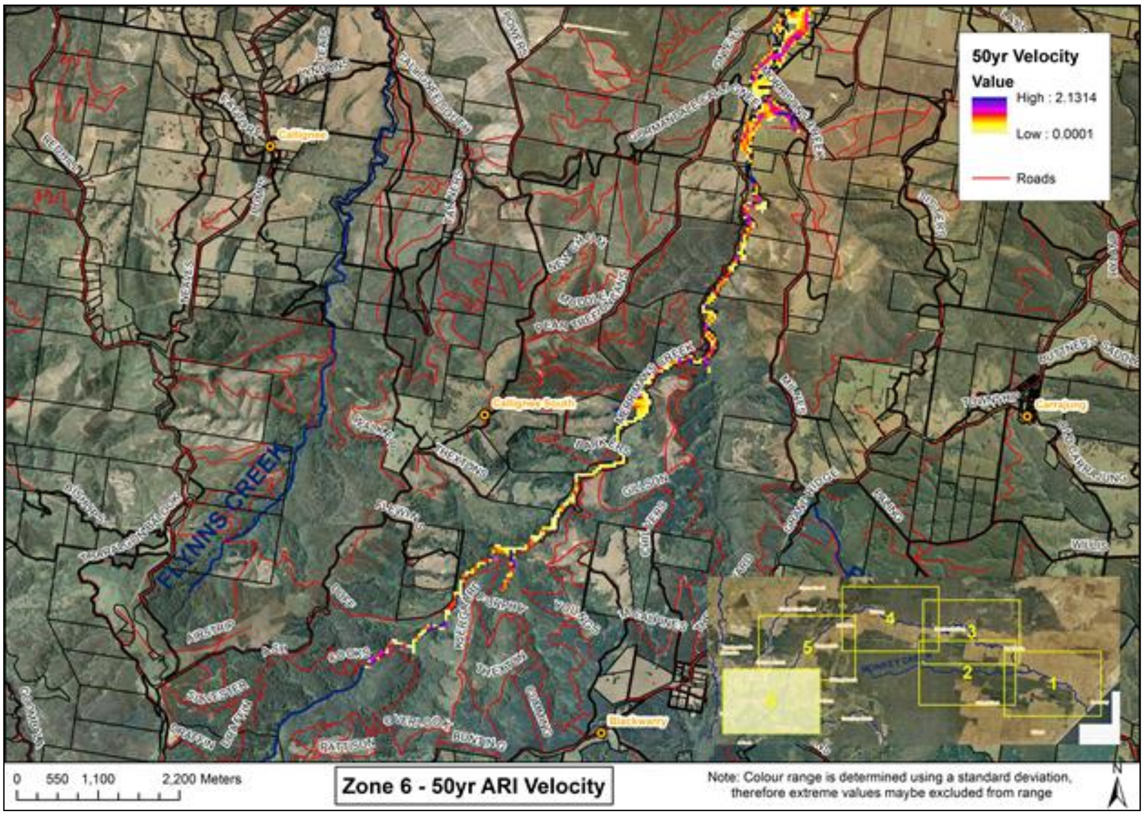



50yr Velocity
Value
High : 3.5575
Low : 0.0001
Roads
0 600 1,200 2,400 Meters
Zone 3 - 50yr ARI Velocity
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N


50yr Velocity
Value
High : 3.8015
Low : 0.0001
Roads
0 600 1,200 2,400 Meters
Zone 4 - 50yr ARI Velocity
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

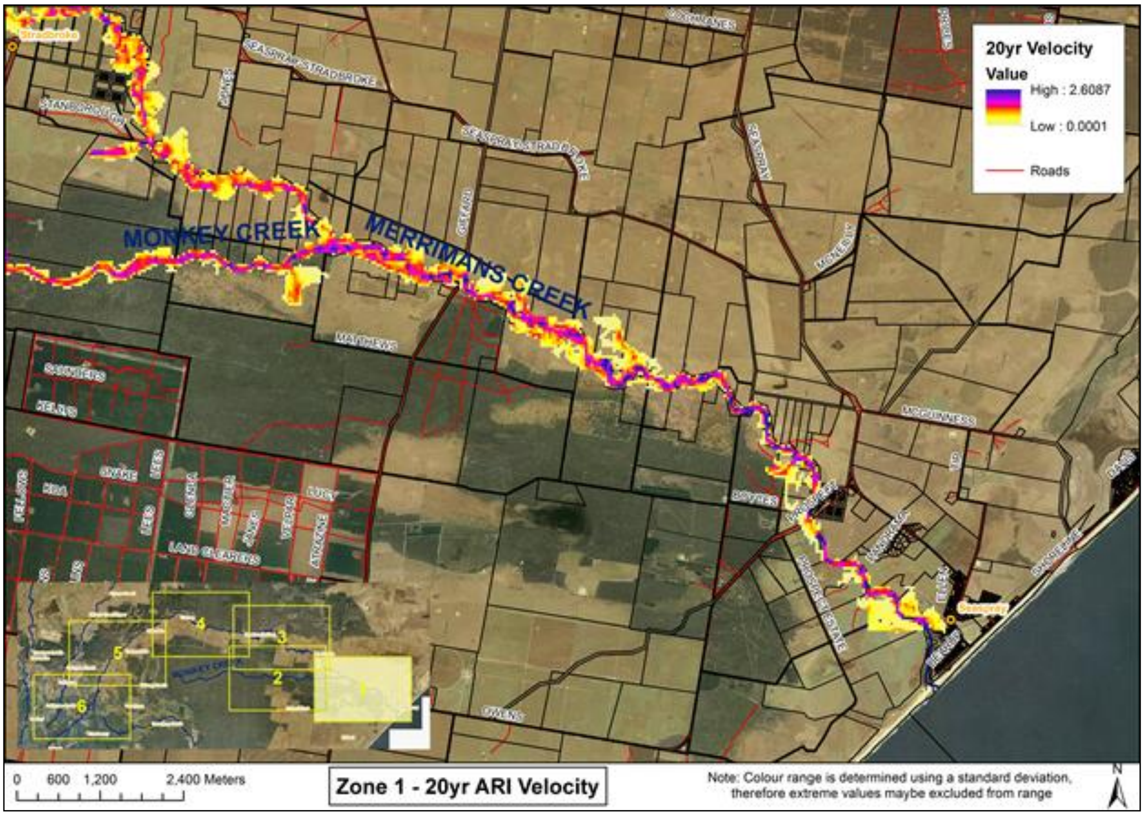


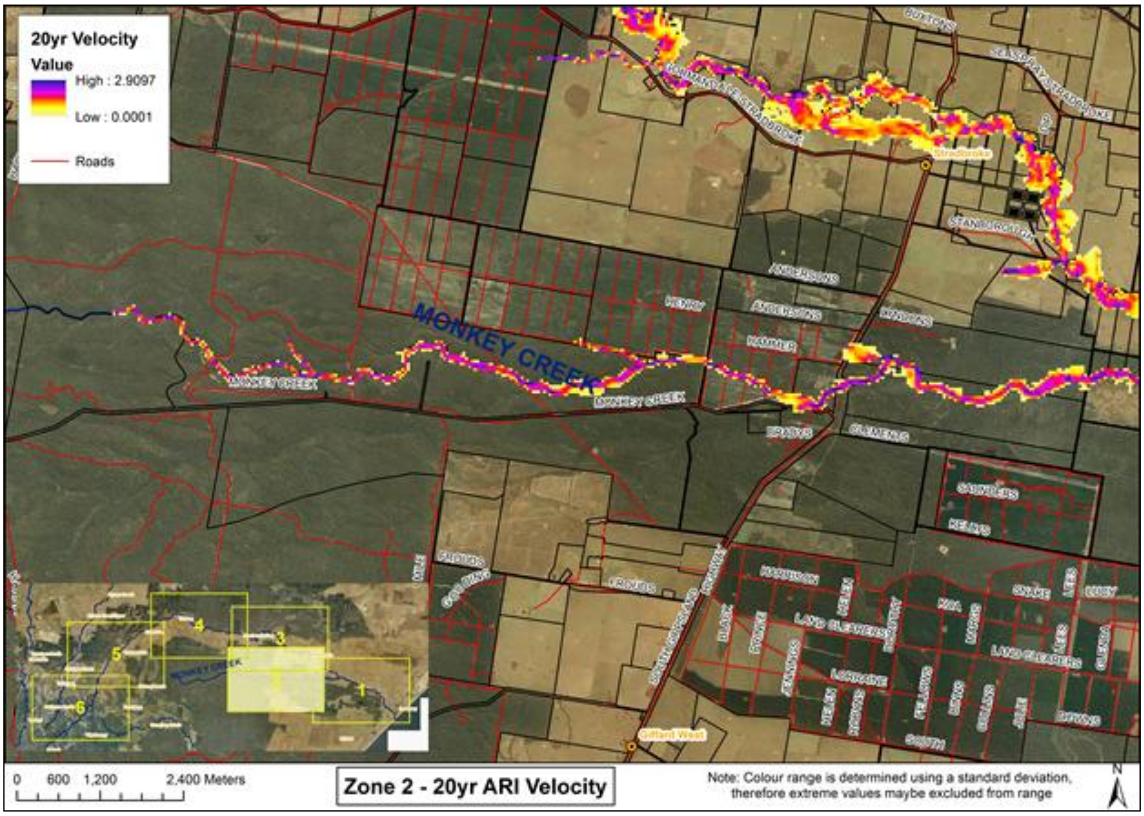
Zone 5 - 50yr ARI Velocity

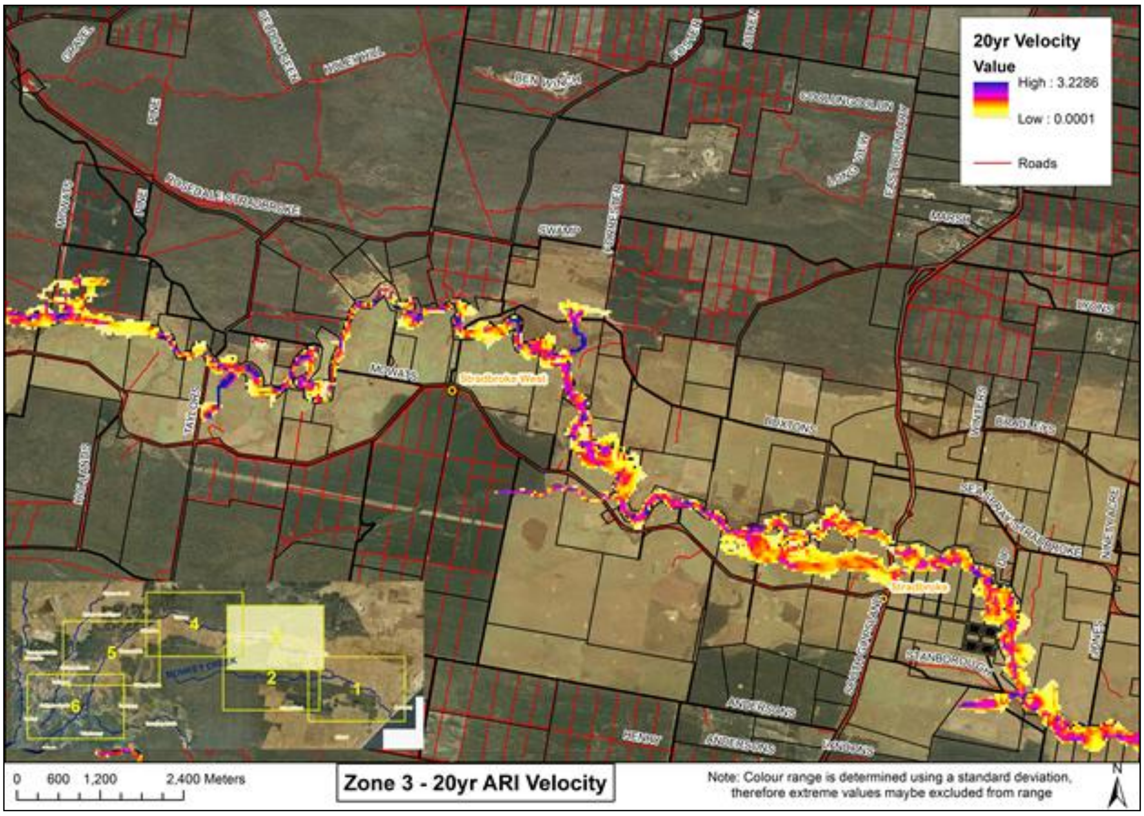


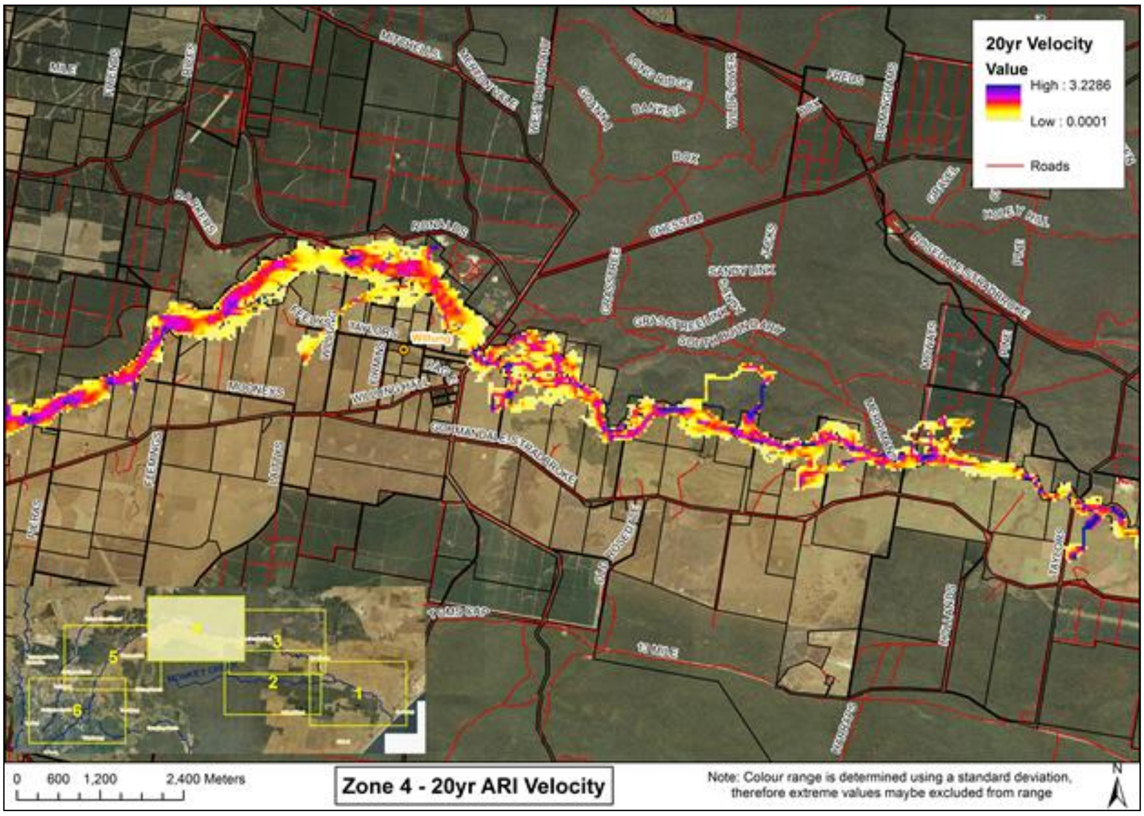
Zone 6 - 50yr ARI Velocity

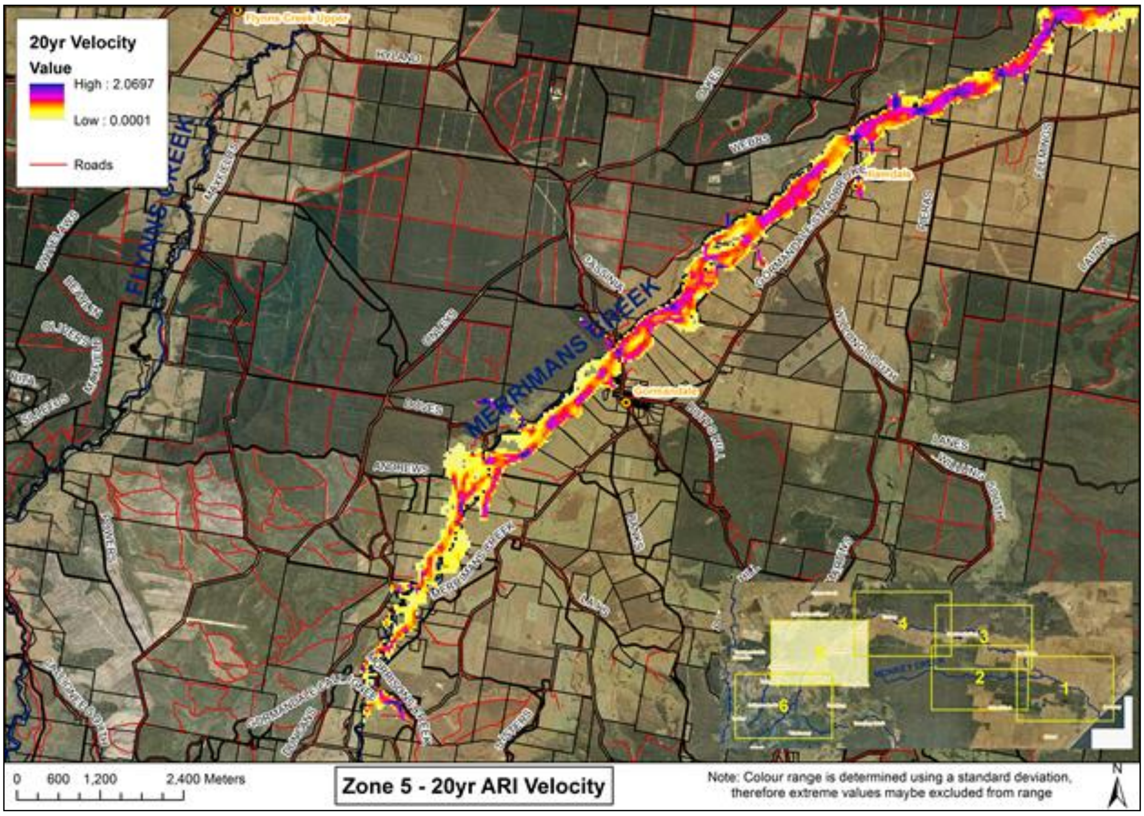
Appendix H.3 20yr Velocity Maps for Zones 1 to 6

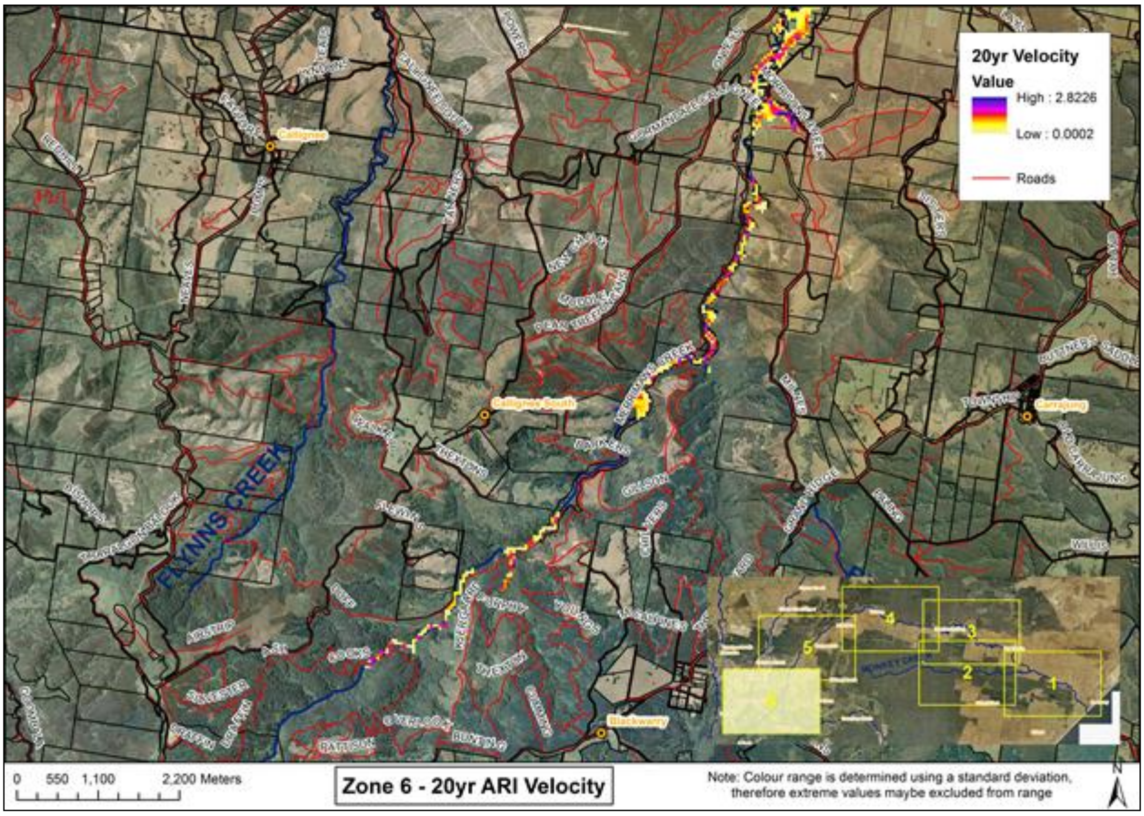




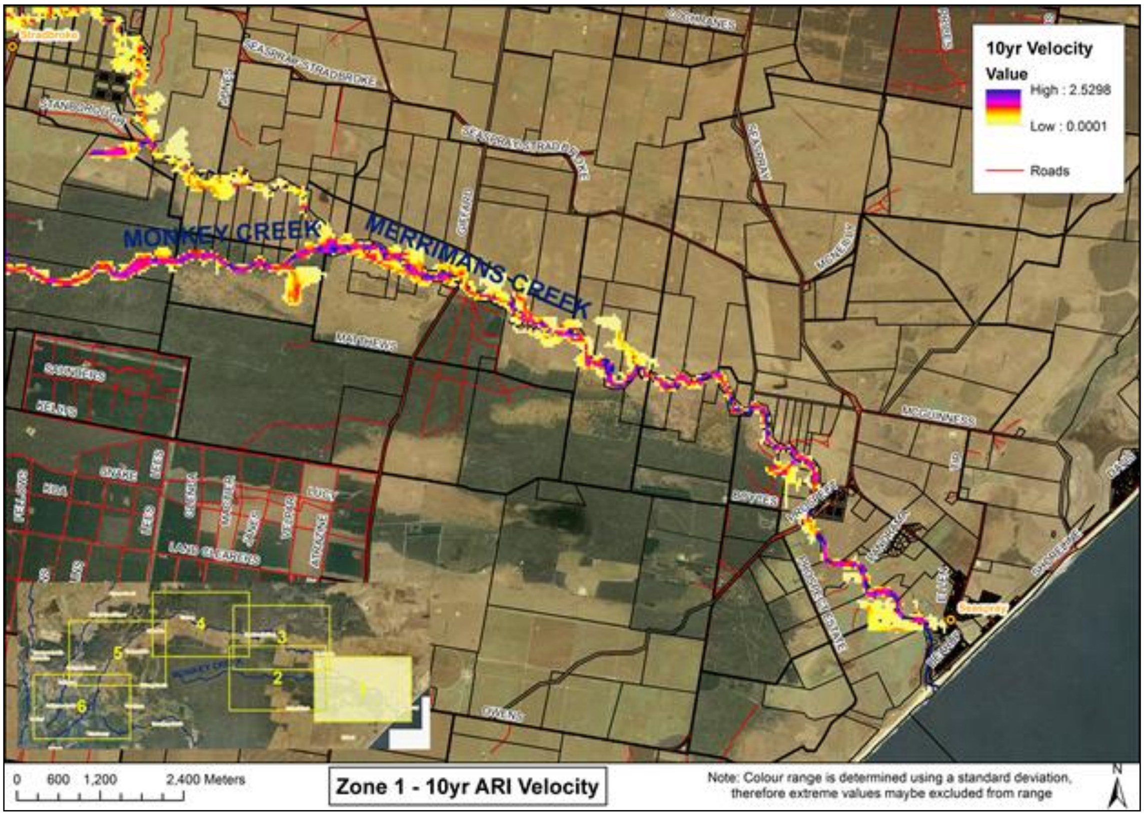

20yr Velocity
Value
High : 3.2286
Low : 0.0001
Roads
0 600 1,200 2,400 Meters
Zone 3 - 20yr ARI Velocity
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

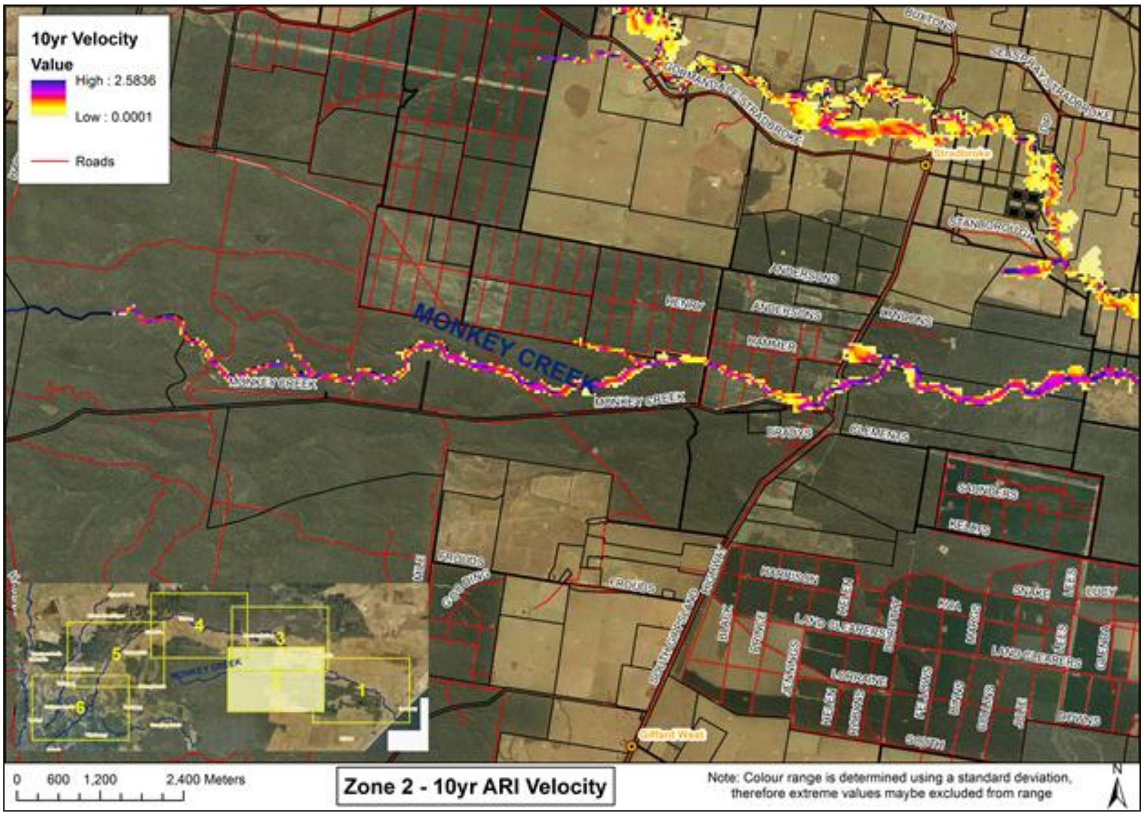

20yr Velocity
Value
High : 3.2286
Low : 0.0001
Roads
0 600 1,200 2,400 Meters
Zone 4 - 20yr ARI Velocity
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

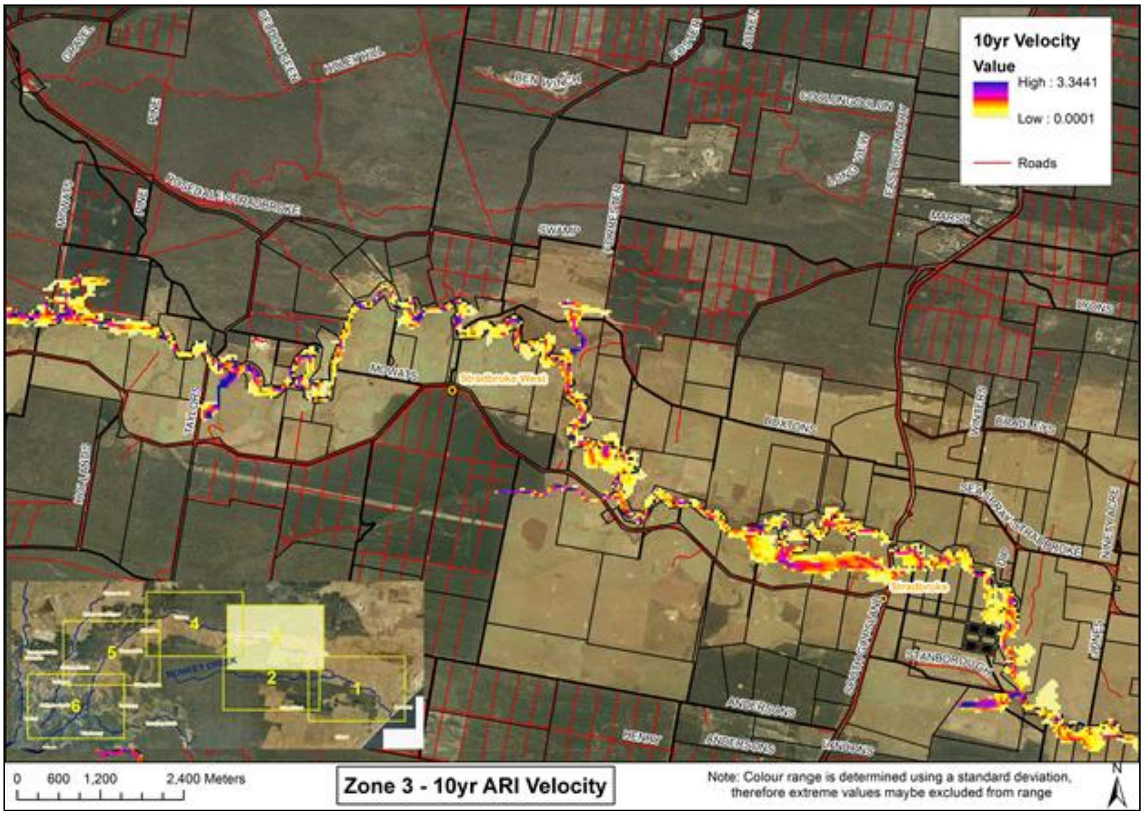

20yr Velocity
Value
High : 2.0697
Low : 0.0001
Roads
FLYNNS CREEK
MERRIMANS CREEK
0 600 1,200 2,400 Meters
Zone 5 - 20yr ARI Velocity
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

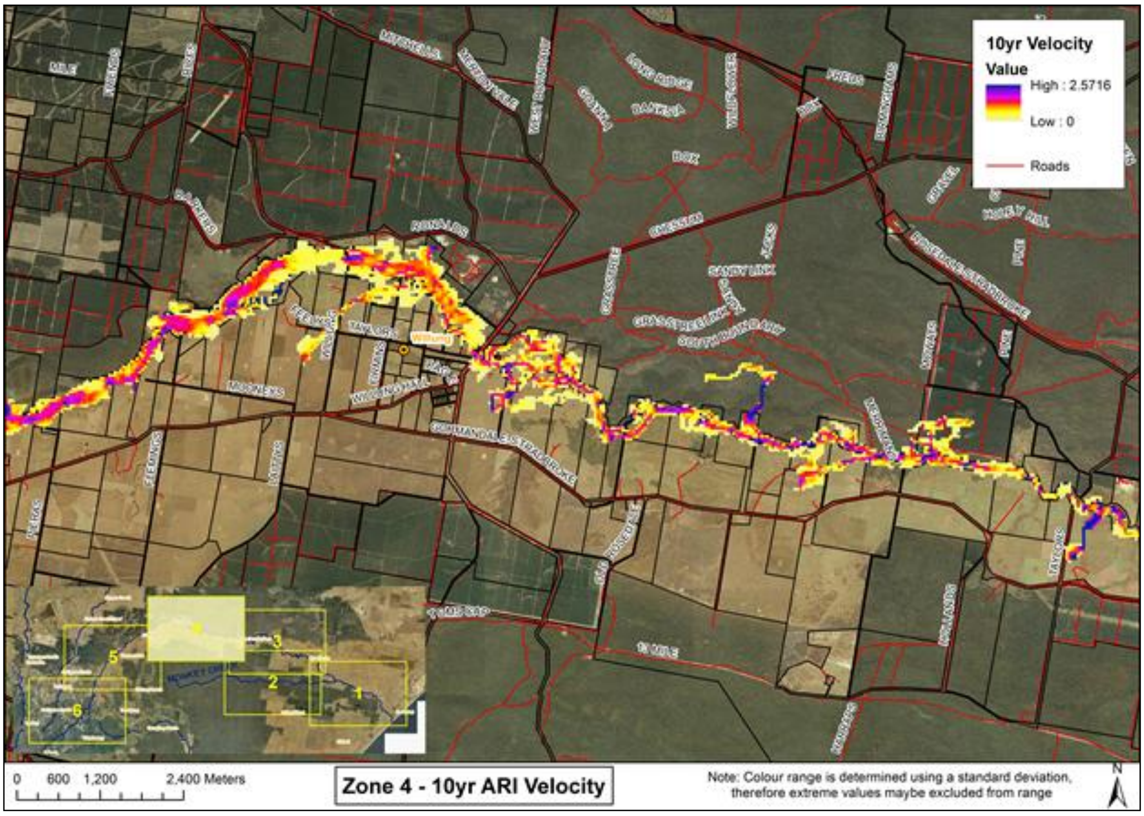

20yr Velocity
Value
High : 2.8226
Low : 0.0002
Roads
FLYNNS CREEK
0 550 1,100 2,200 Meters
Zone 6 - 20yr ARI Velocity
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

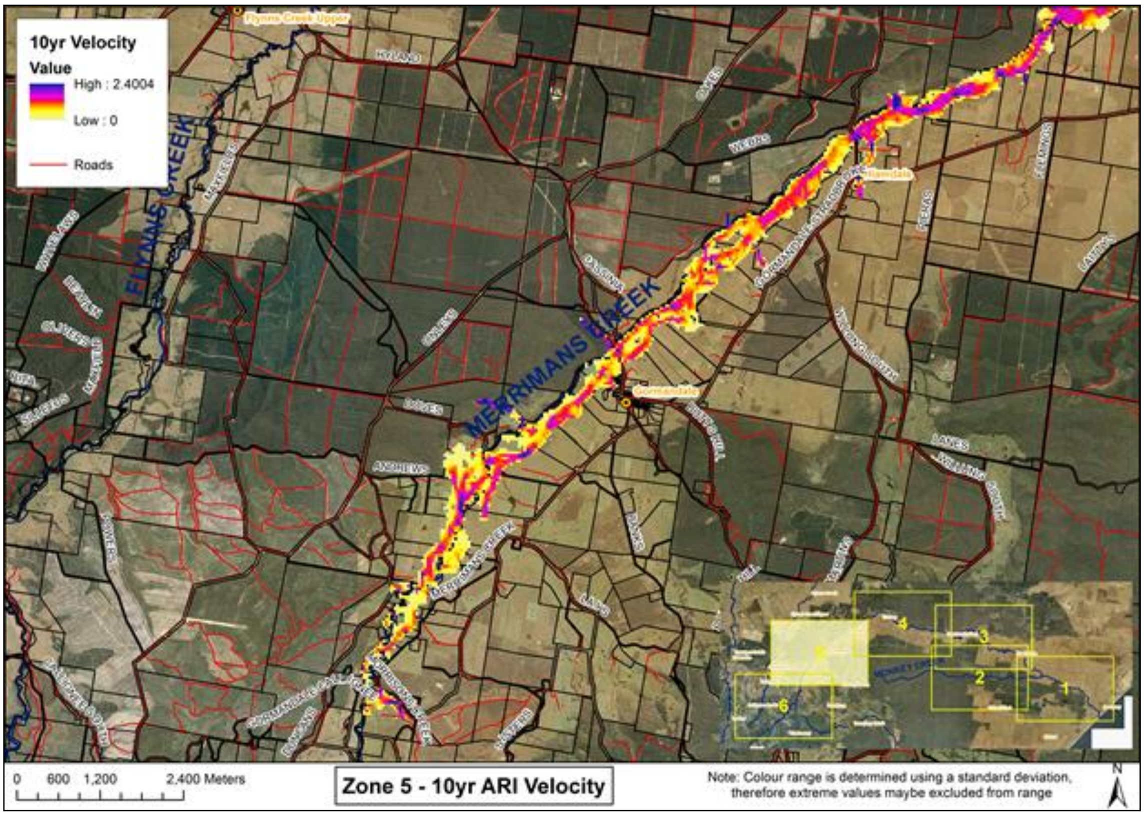
Appendix H.4 10yr Velocity Maps for Zones 1 to 6

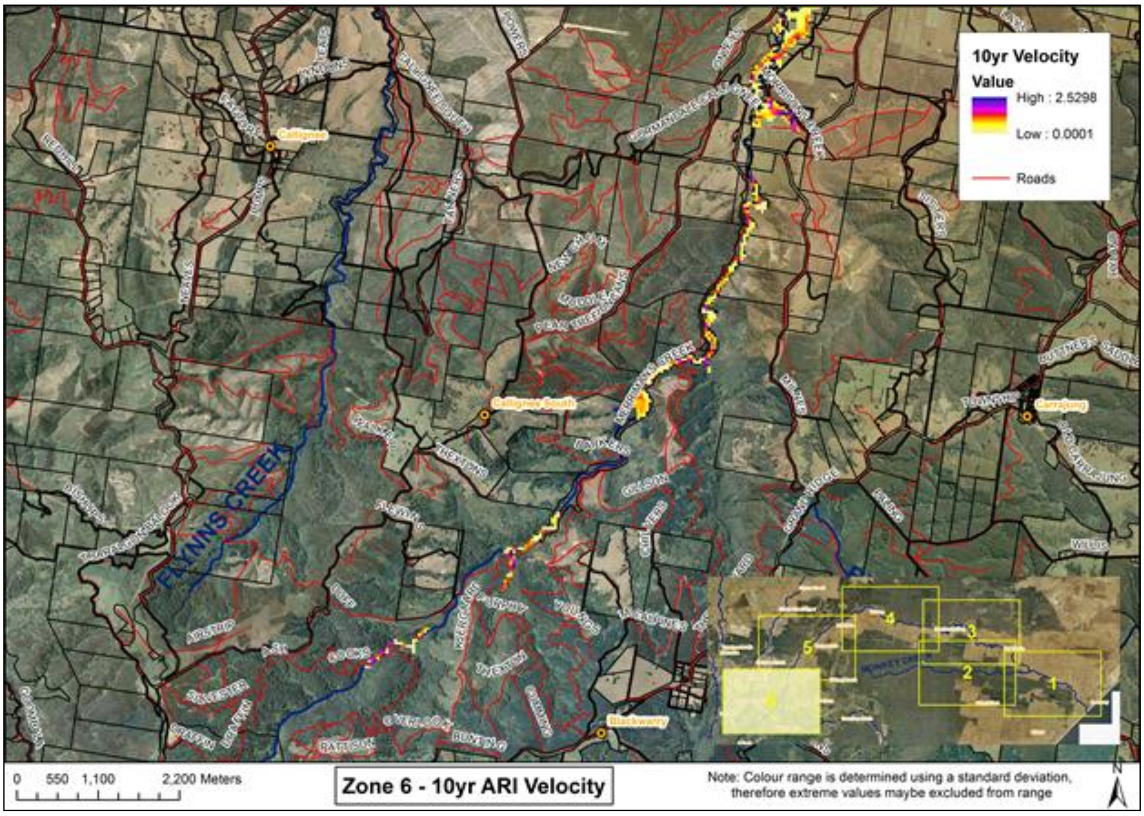




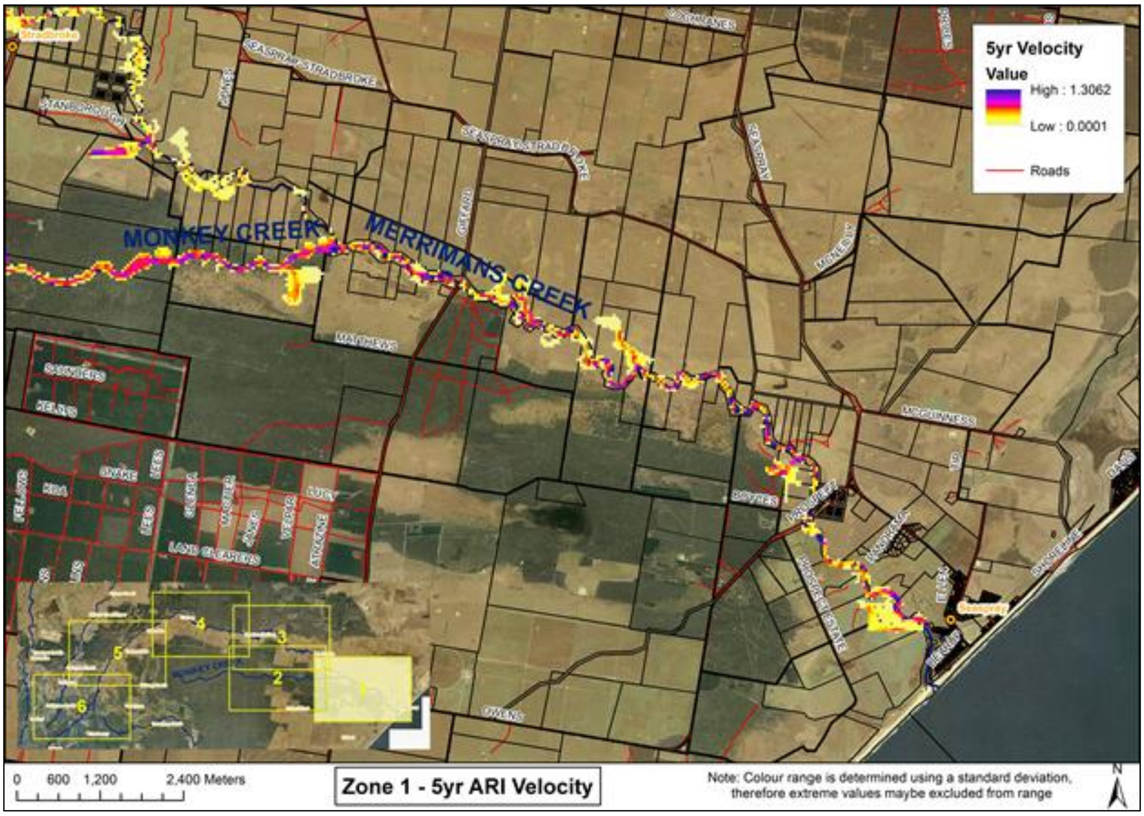

10yr Velocity
Value
High : 3.3441
Low : 0.0001
Roads
0 600 1,200 2,400 Meters
Zone 3 - 10yr ARI Velocity
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

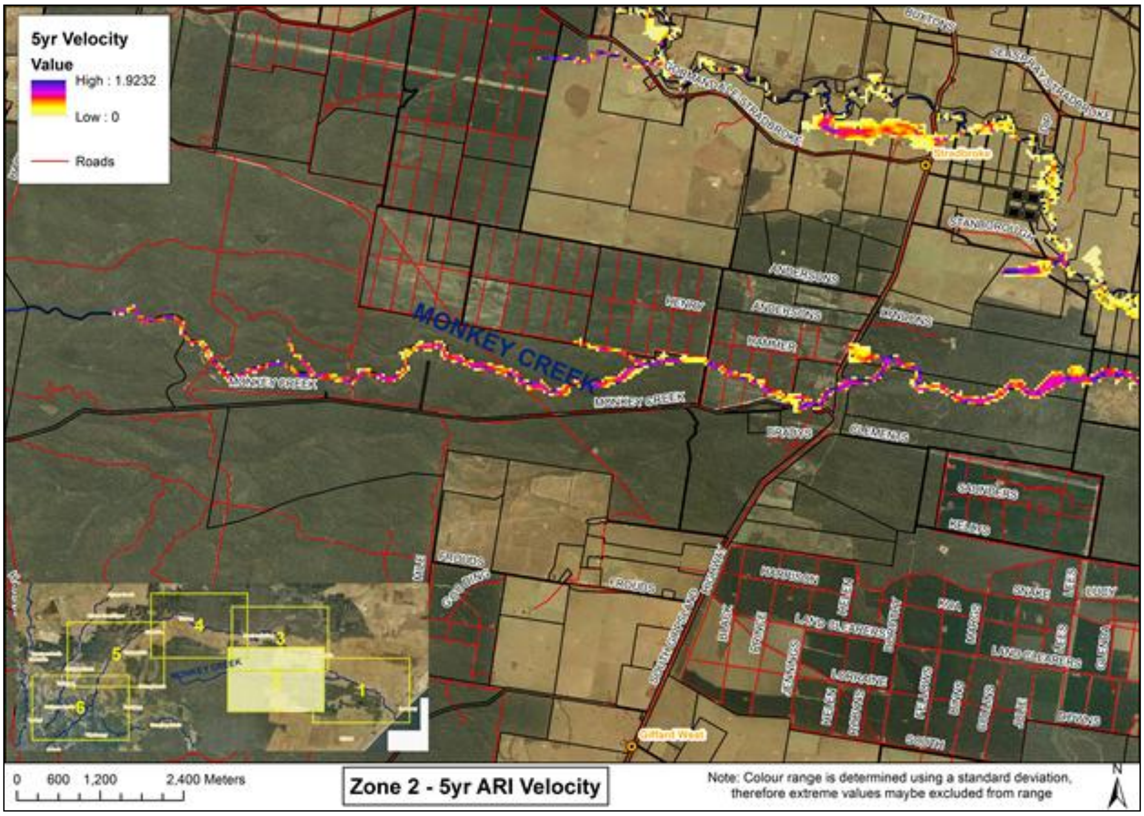

10yr Velocity
Value
High : 2.5716
Low : 0
Roads
0 600 1,200 2,400 Meters
Zone 4 - 10yr ARI Velocity
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

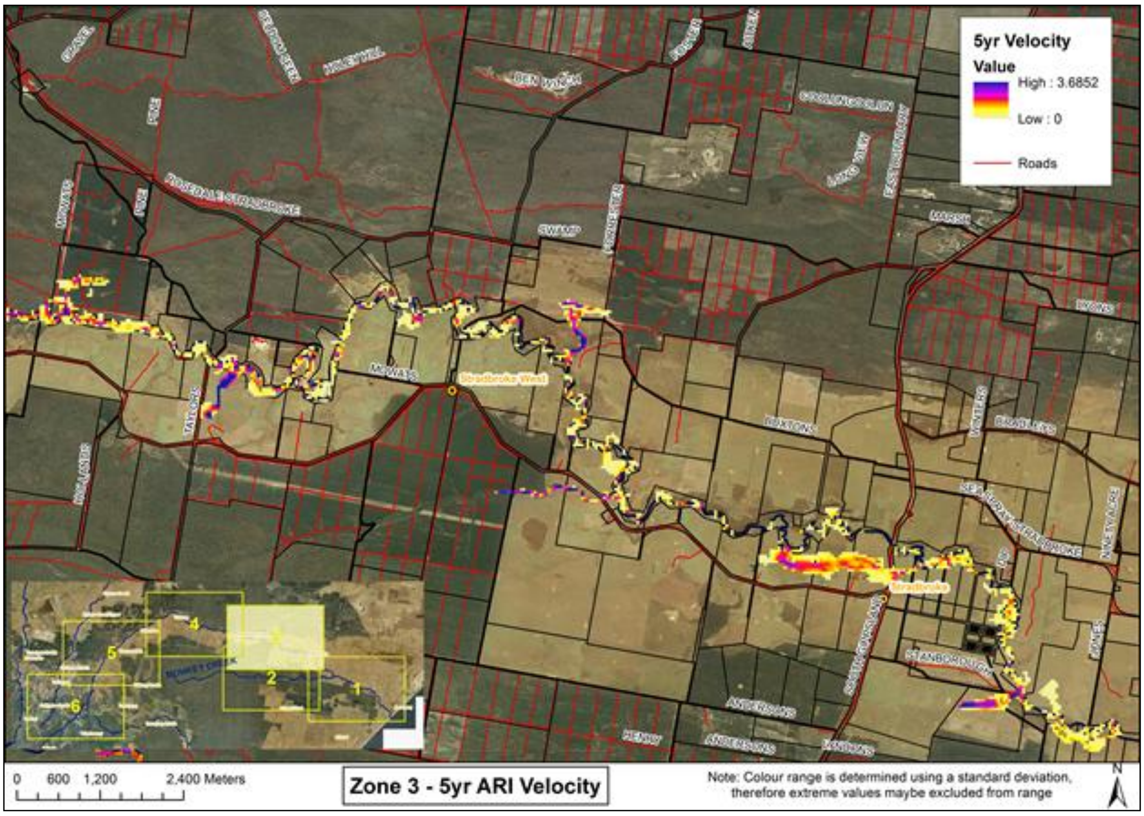

10yr Velocity
Value
High : 2.4004
Low : 0
Roads
MERRIMANS CREEK
FLYNNS CREEK
0 600 1,200 2,400 Meters
Zone 5 - 10yr ARI Velocity
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range


10yr Velocity
Value
High : 2.5298
Low : 0.0001
Roads
FLYNNS CREEK
0 550 1,100 2,200 Meters
Zone 6 - 10yr ARI Velocity
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range

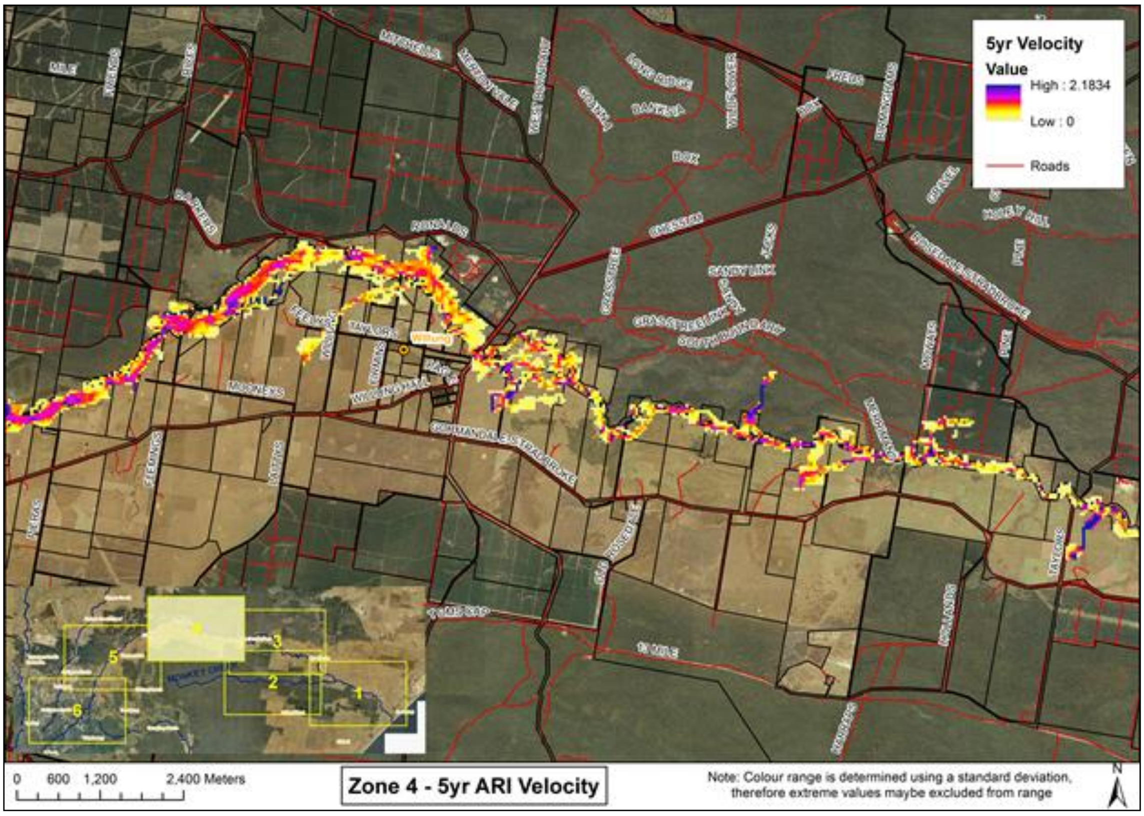
Appendix H.5 5yr Velocity Maps for Zones 1 to 6



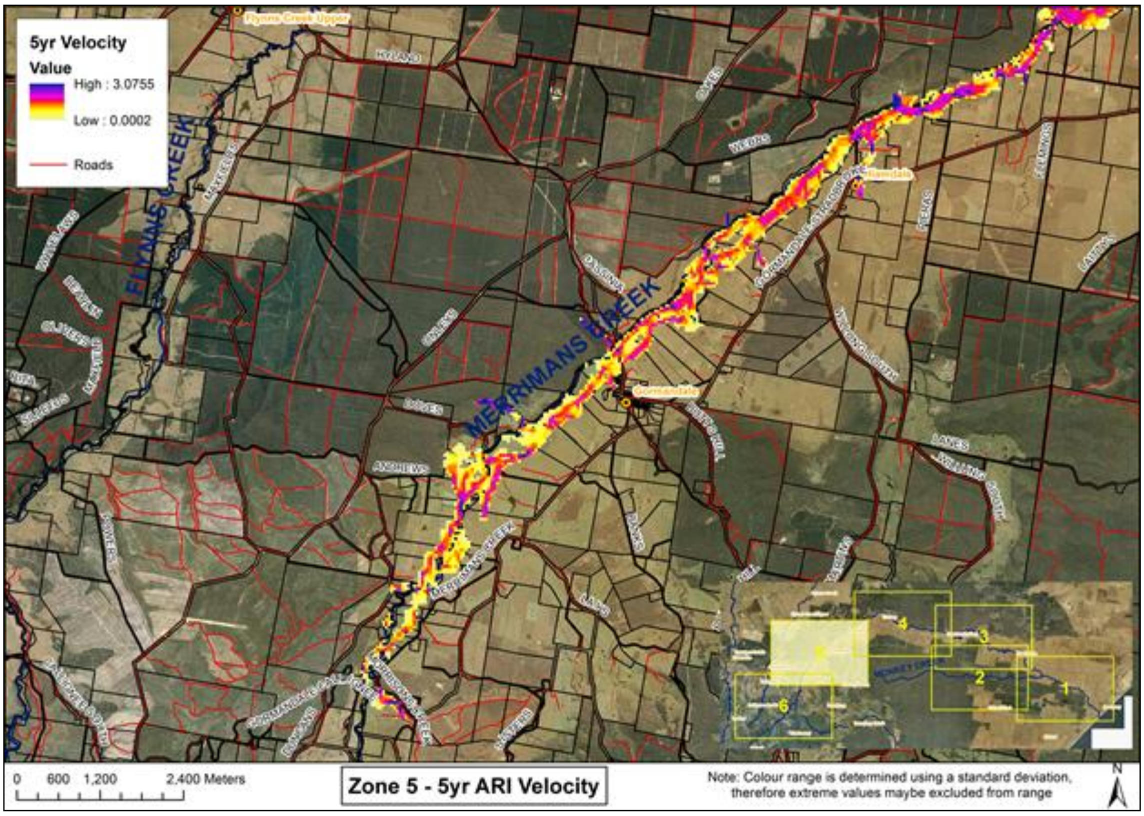


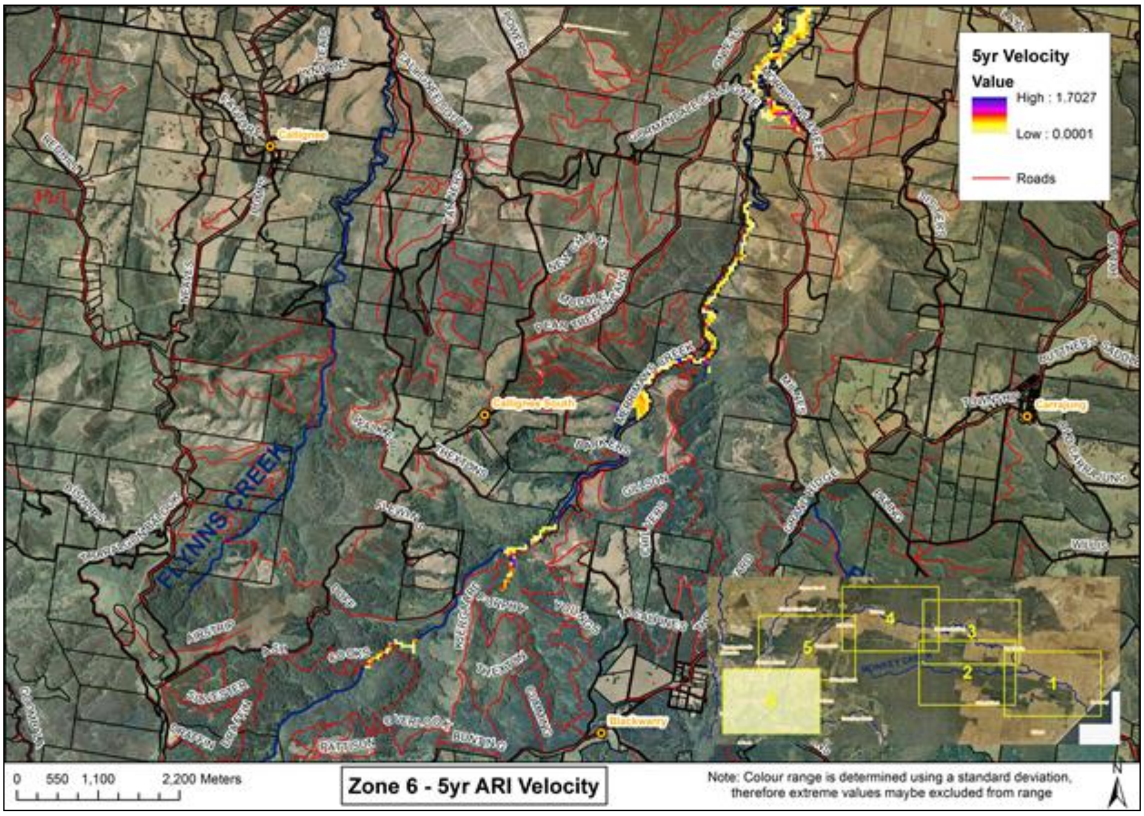


Zone 3 - 5yr ARI Velocity

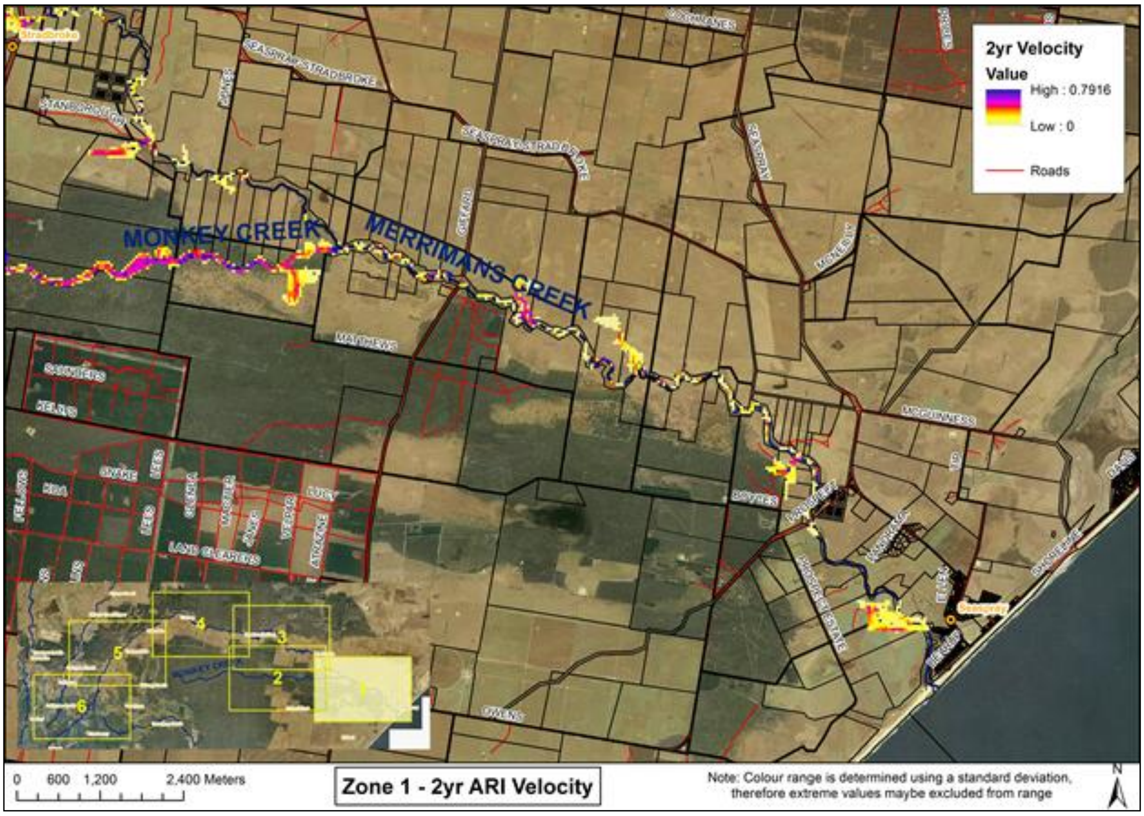


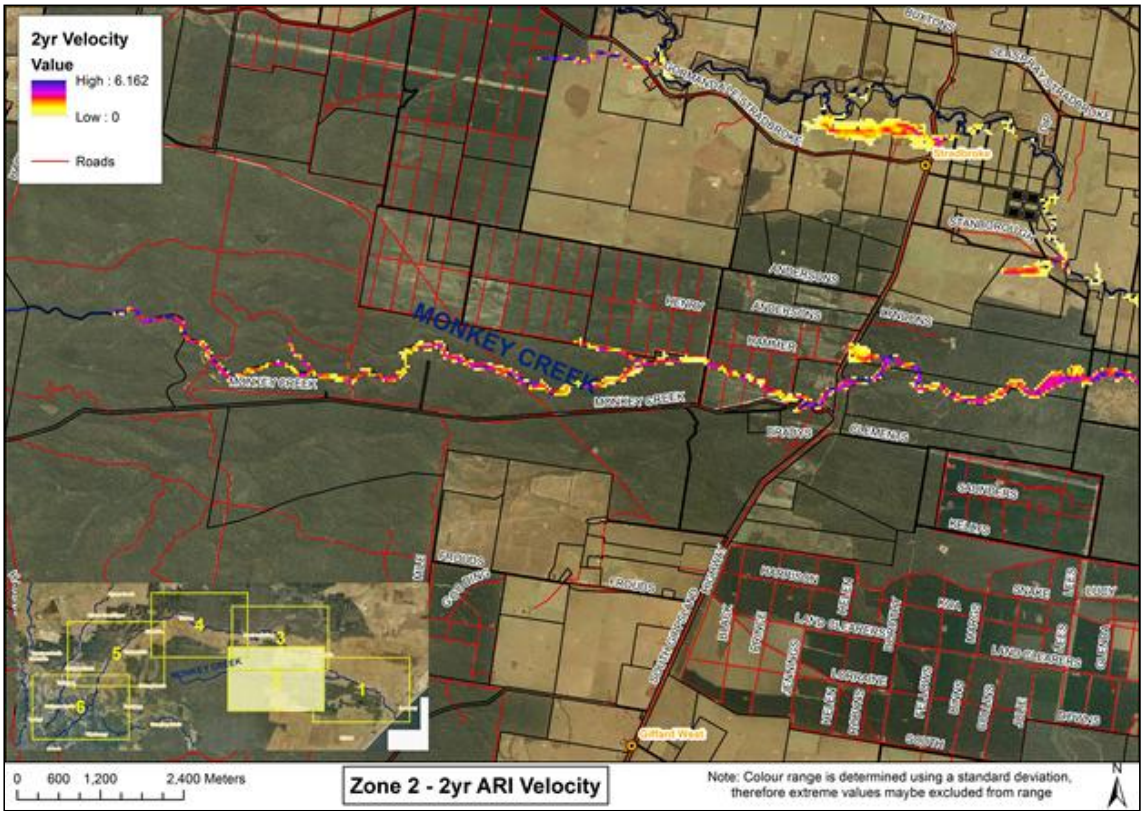
Zone 4 - 5yr ARI Velocity

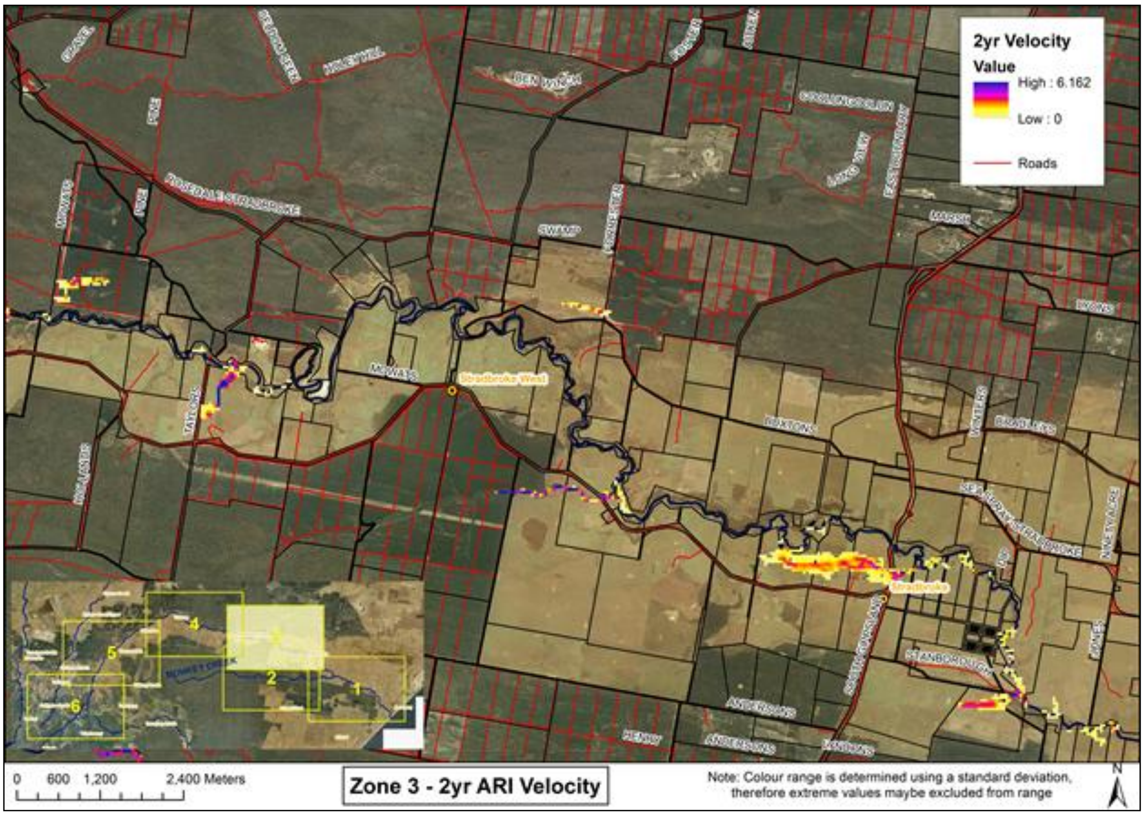

5yr Velocity
Value
High : 3.0755
Low : 0.0002
Roads
MERRIMANS CREEK
FLYNNS CREEK
0 600 1,200 2,400 Meters
Zone 5 - 5yr ARI Velocity
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range


5yr Velocity
Value
High : 1.7027
Low : 0.0001
Roads
FLYNNS CREEK
0 550 1,100 2,200 Meters
Zone 6 - 5yr ARI Velocity
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range

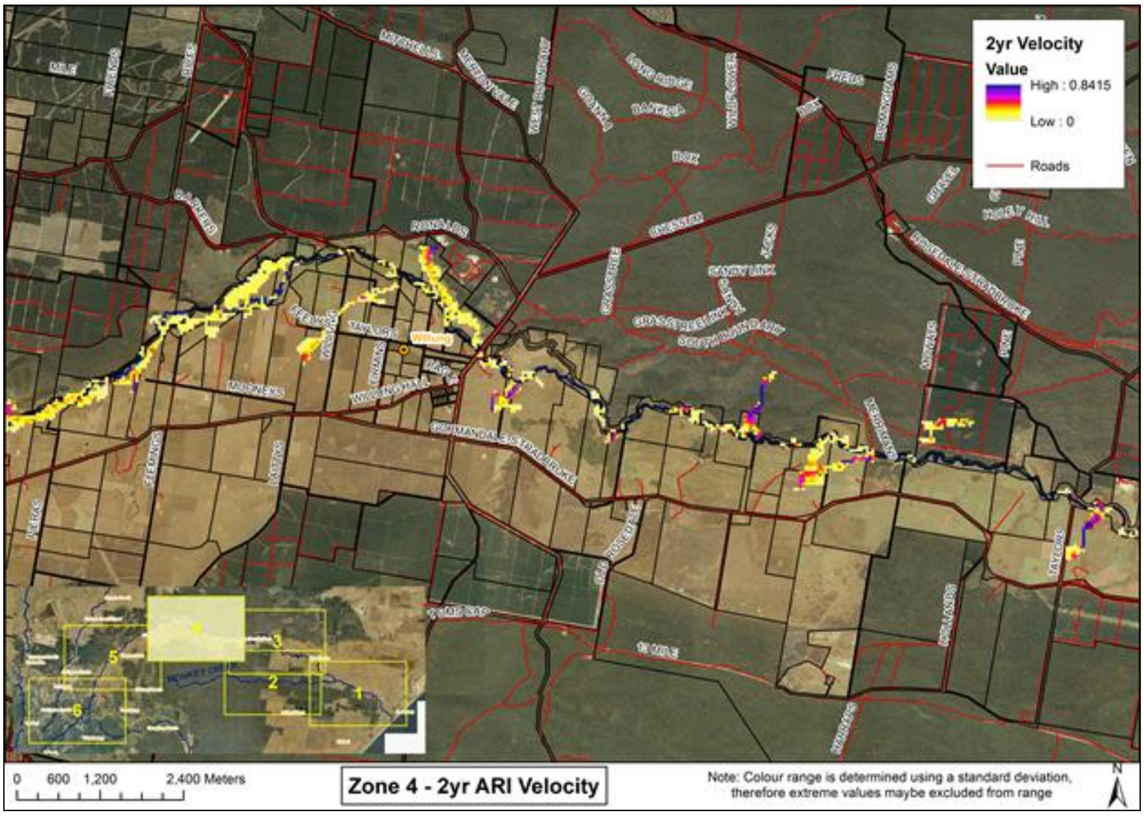
Appendix H.6 2yr Velocity Maps for Zones 1 to 6



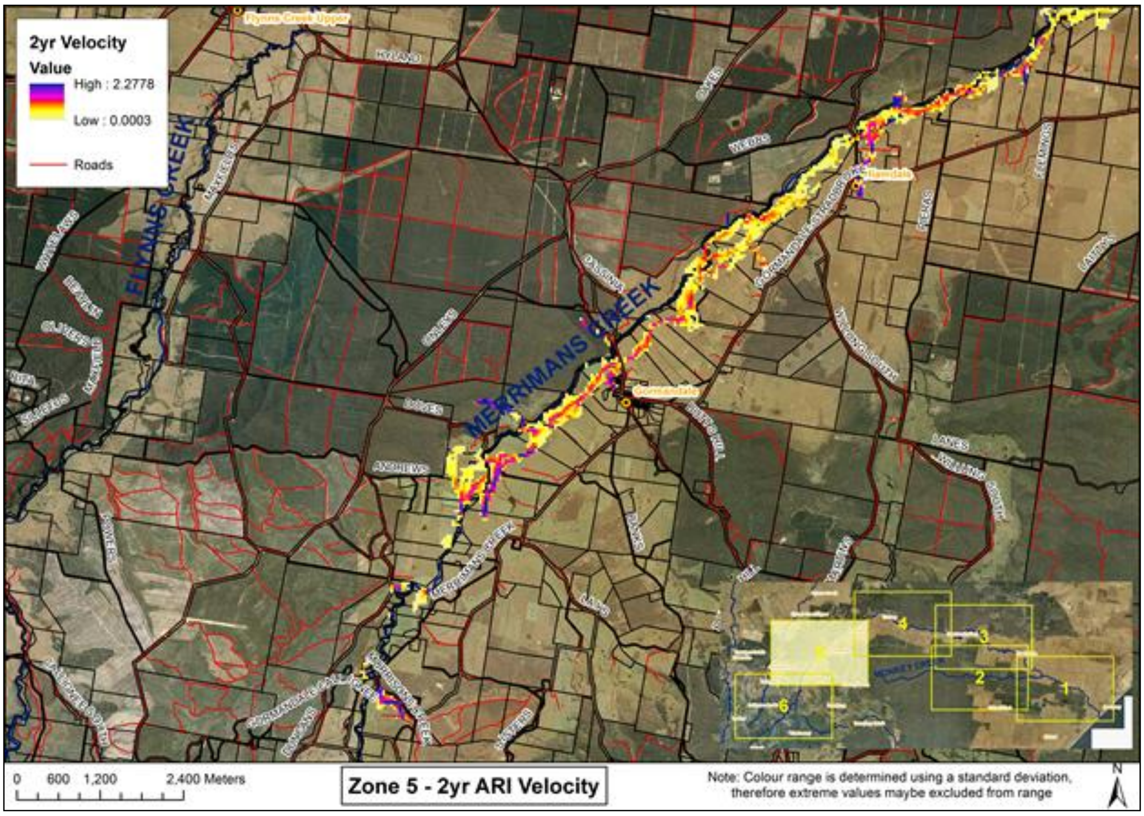


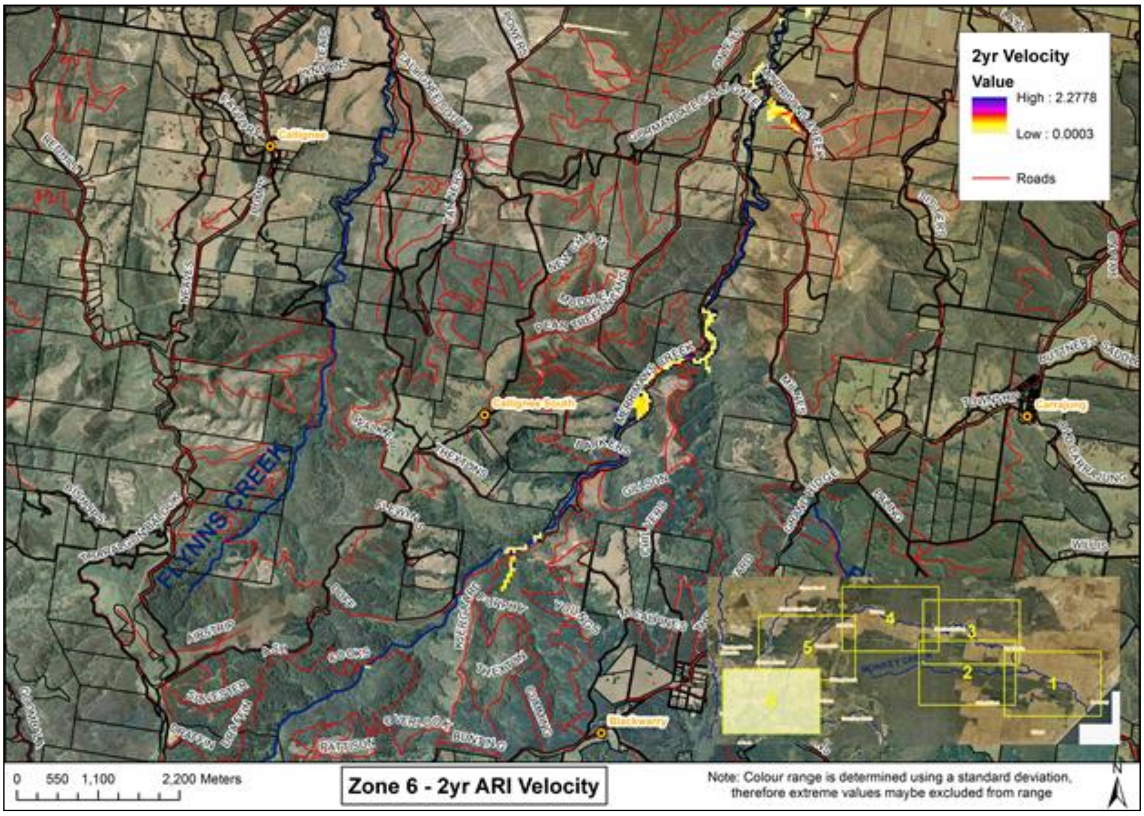


Zone 3 - 2yr ARI Velocity



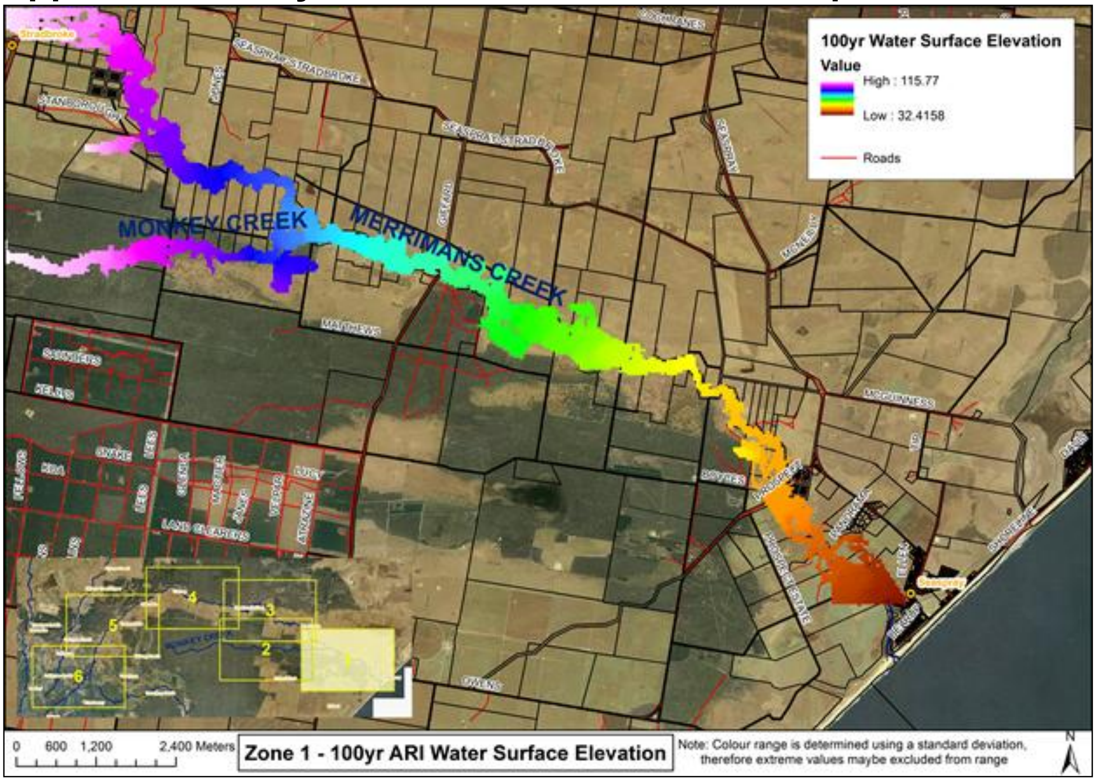
Zone 4 - 2yr ARI Velocity

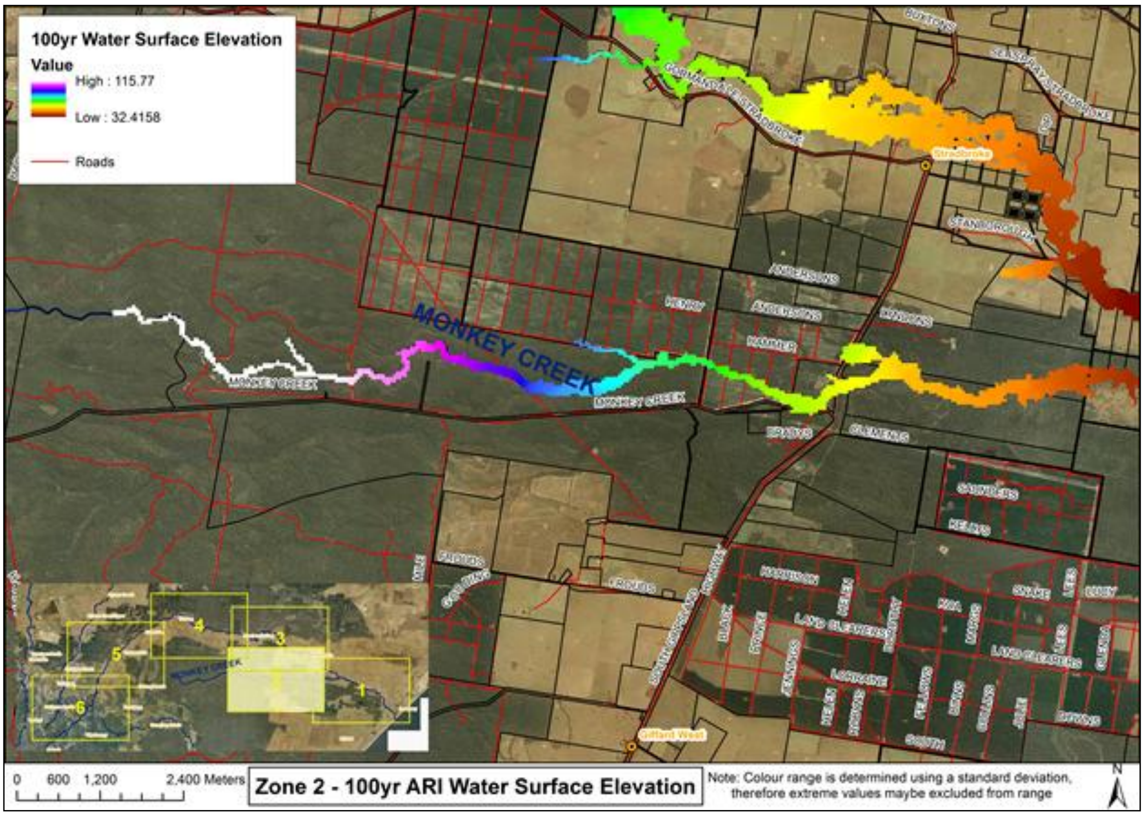

2yr Velocity
Value
High : 2.2778
Low : 0.0003
Roads
FLYNNS CREEK
MERRIMANS CREEK
0 600 1,200 2,400 Meters
Zone 5 - 2yr ARI Velocity
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

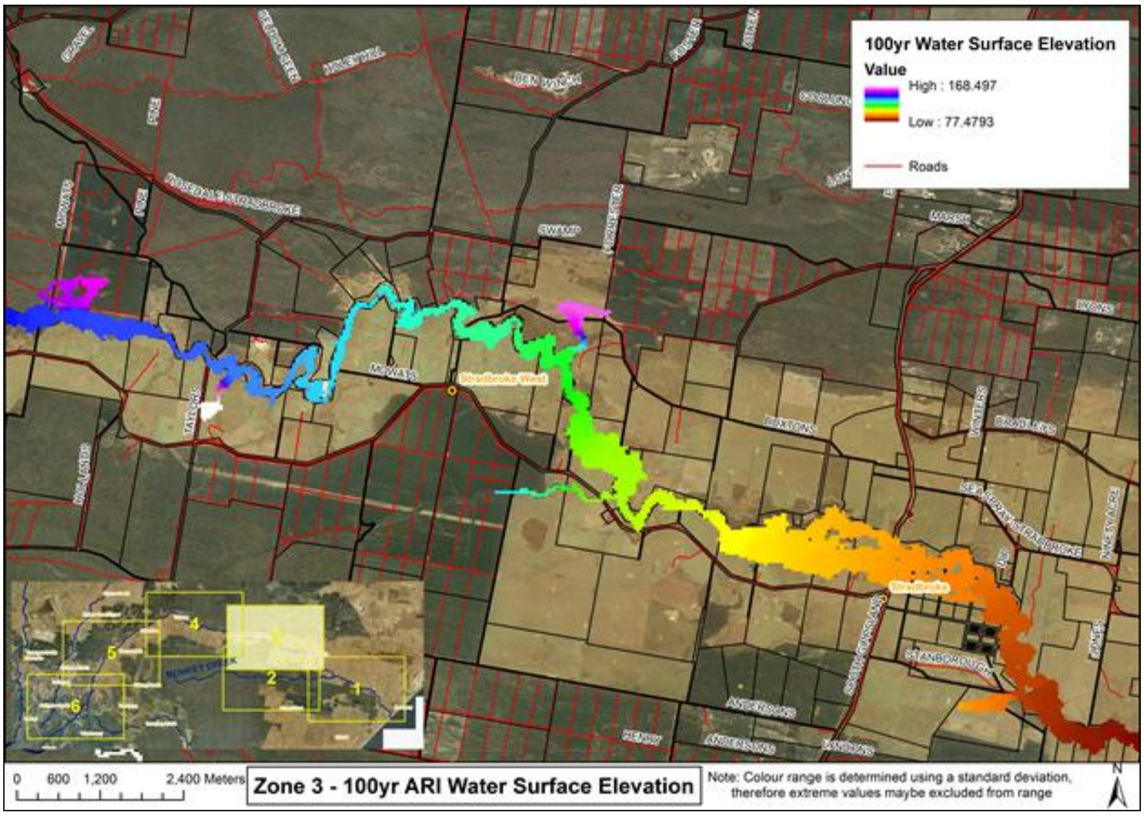

2yr Velocity
Value
High : 2.2778
Low : 0.0003
Roads
FLYNNS CREEK
0 550 1,100 2,200 Meters
Zone 6 - 2yr ARI Velocity
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

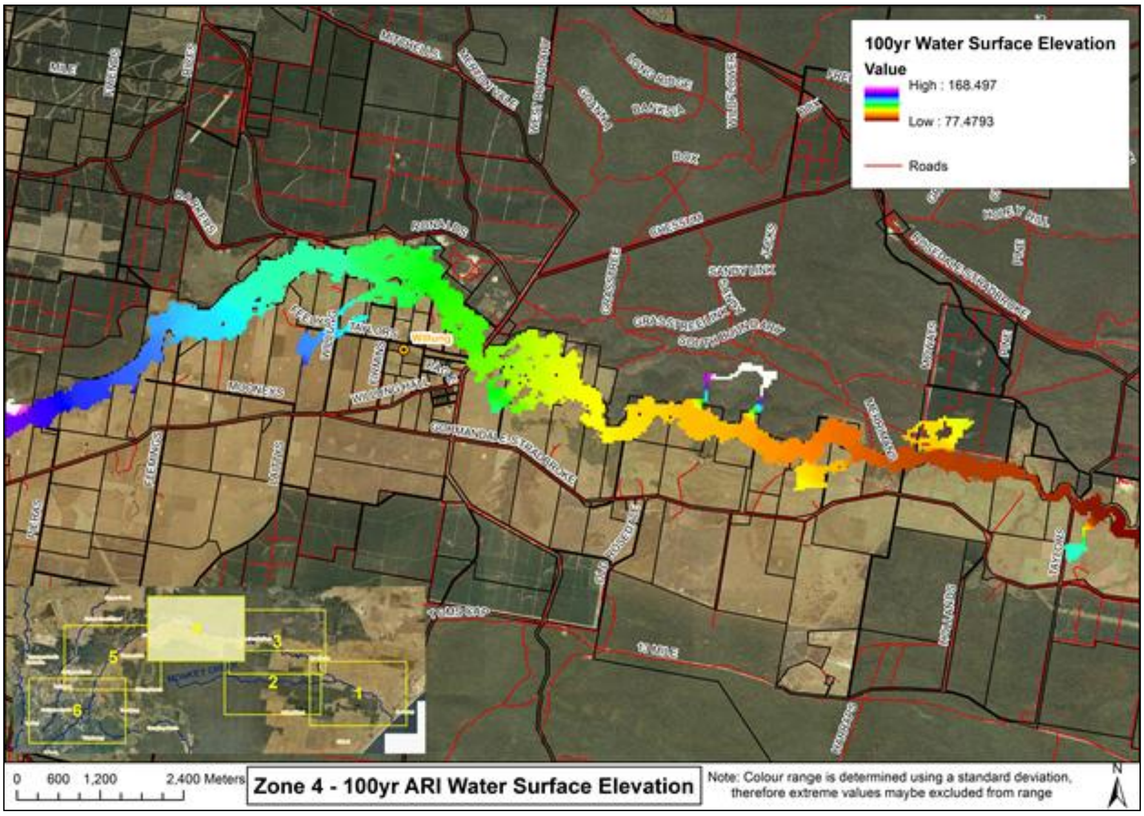
Appendix I: Flood level map

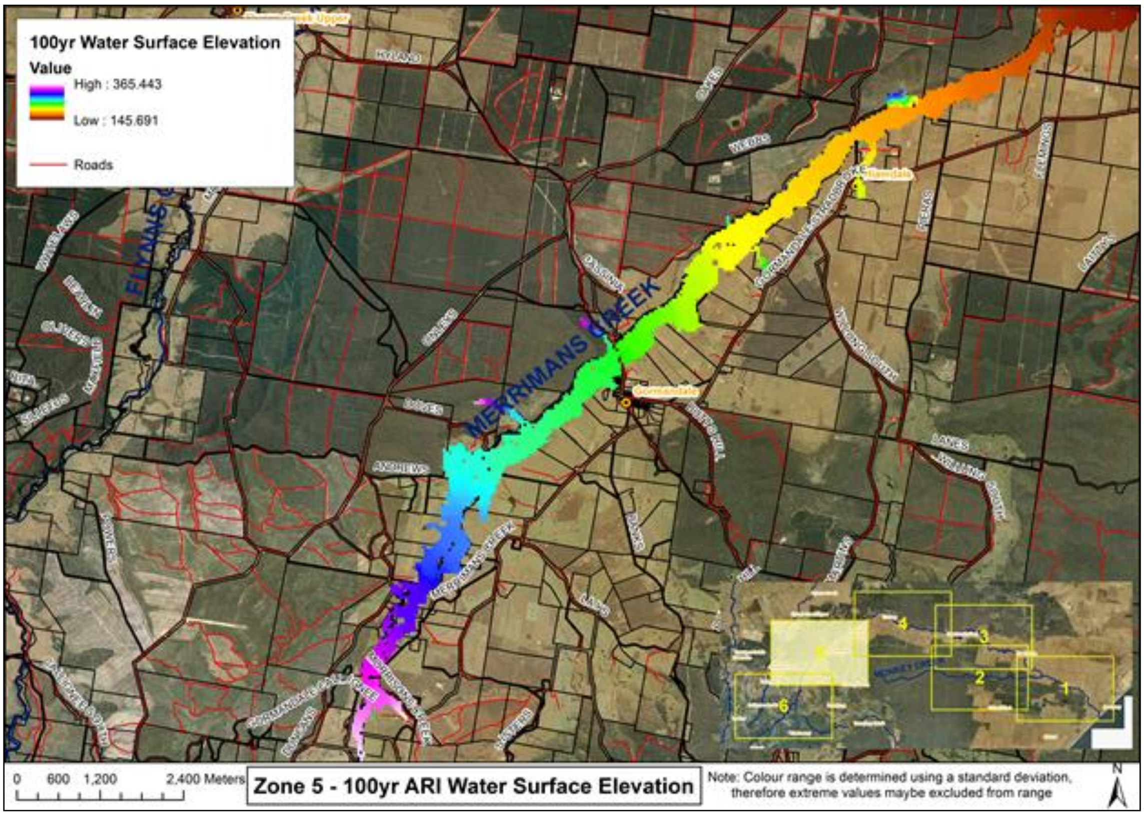
Appendix I.1 100yr Water Surface Elevation Maps for Zones 1 to 6

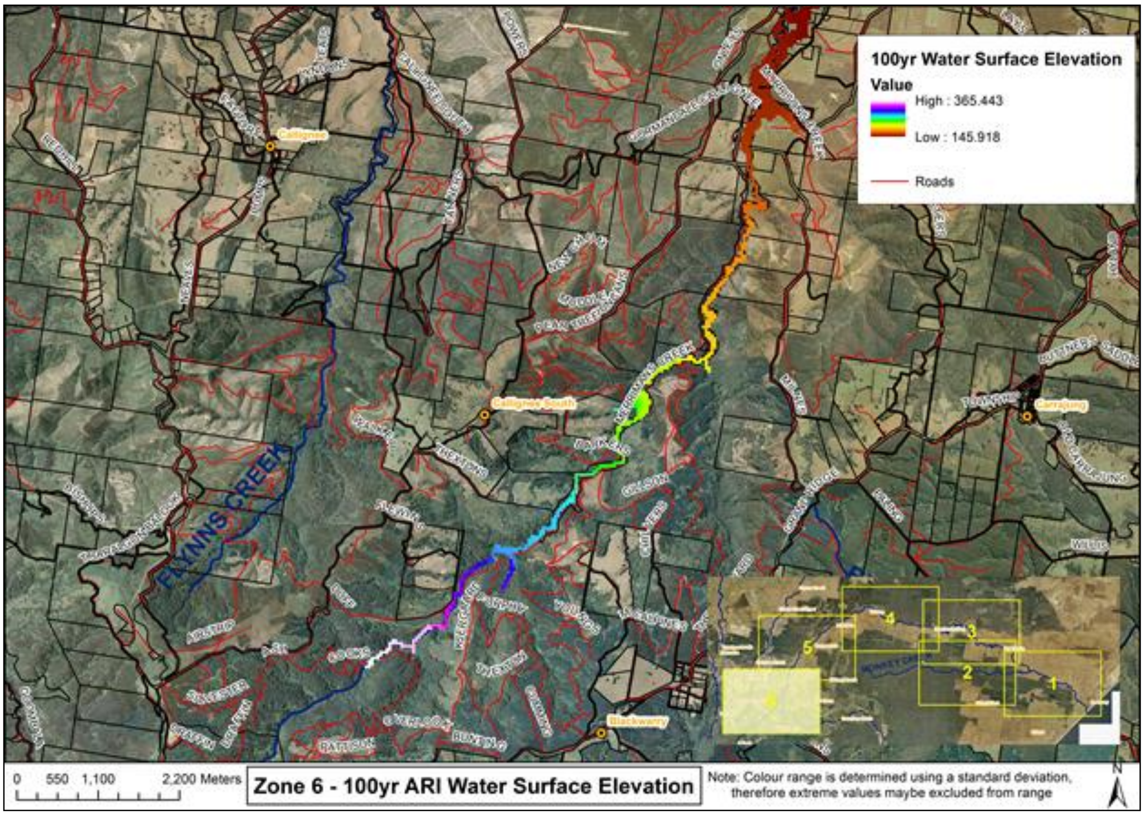




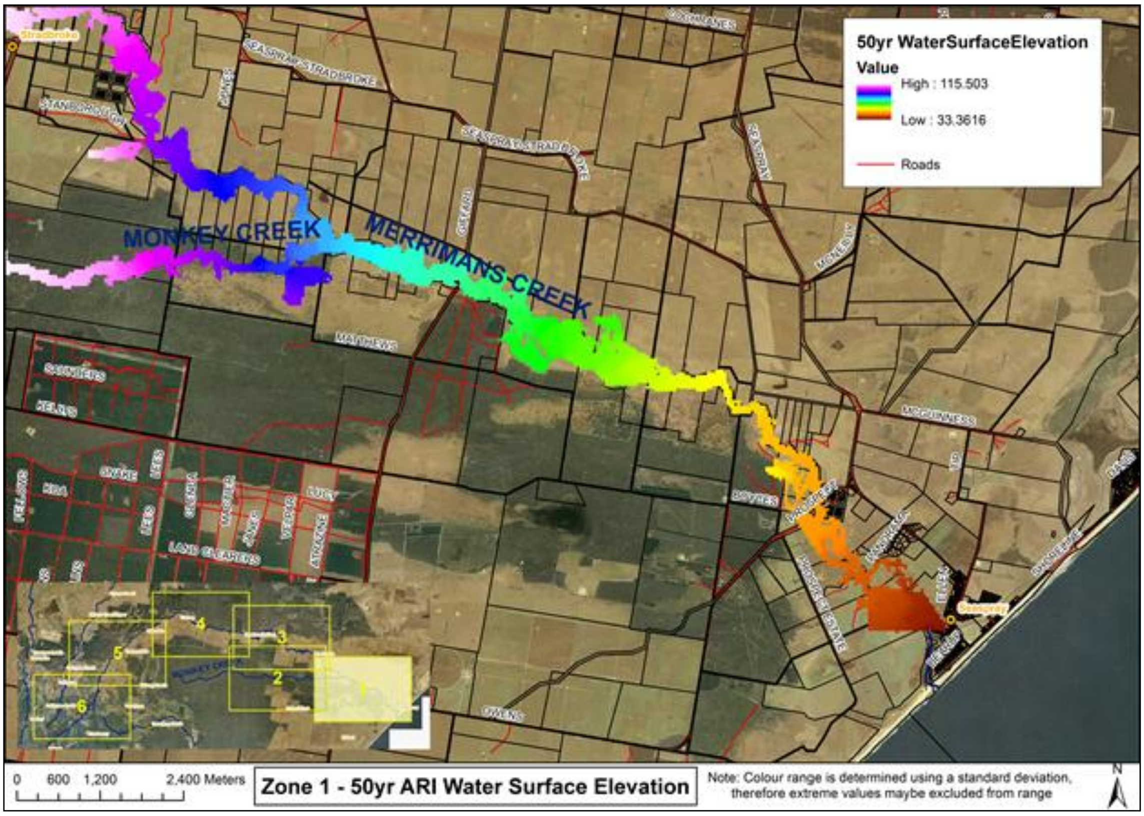

100yr Water Surface Elevation
Value
High : 168.497
Low : 77.4793
Roads
0 600 1,200 2,400 Meters
Zone 3 - 100yr ARI Water Surface Elevation
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

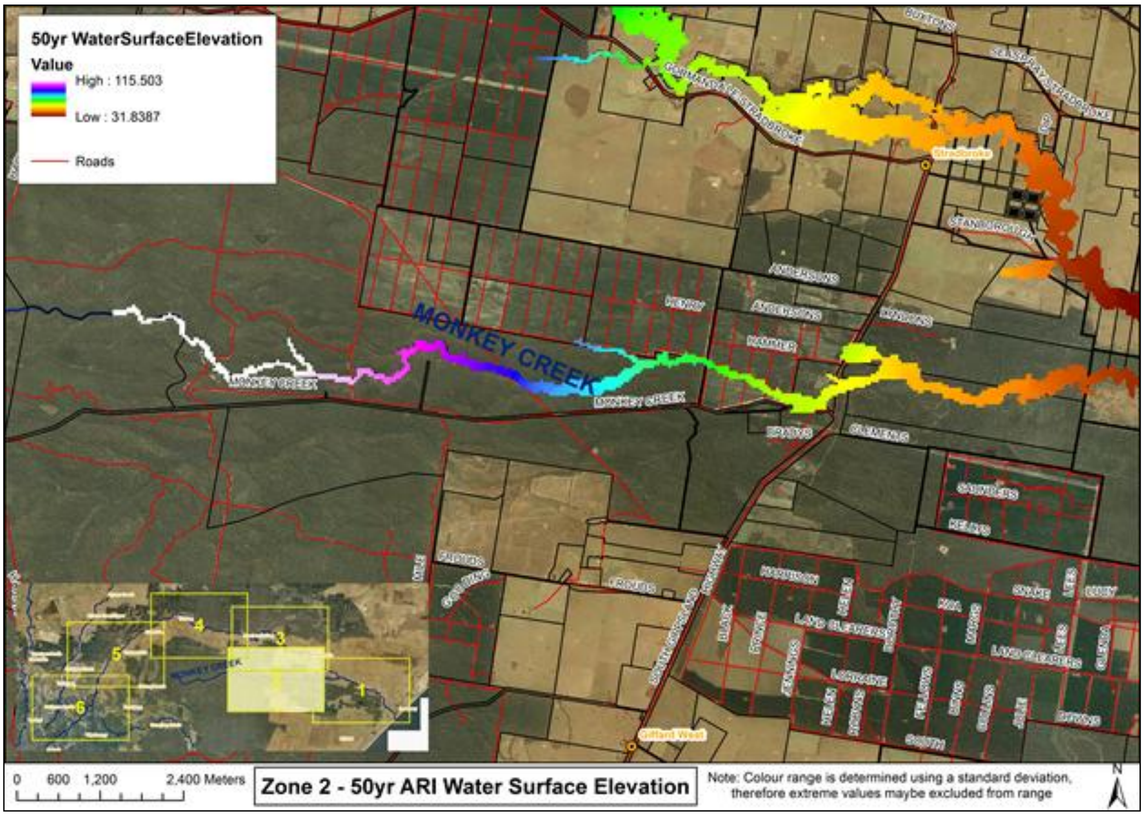

100yr Water Surface Elevation
Value
High : 168.497
Low : 77.4793
Roads
0 600 1,200 2,400 Meters
Zone 4 - 100yr ARI Water Surface Elevation
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

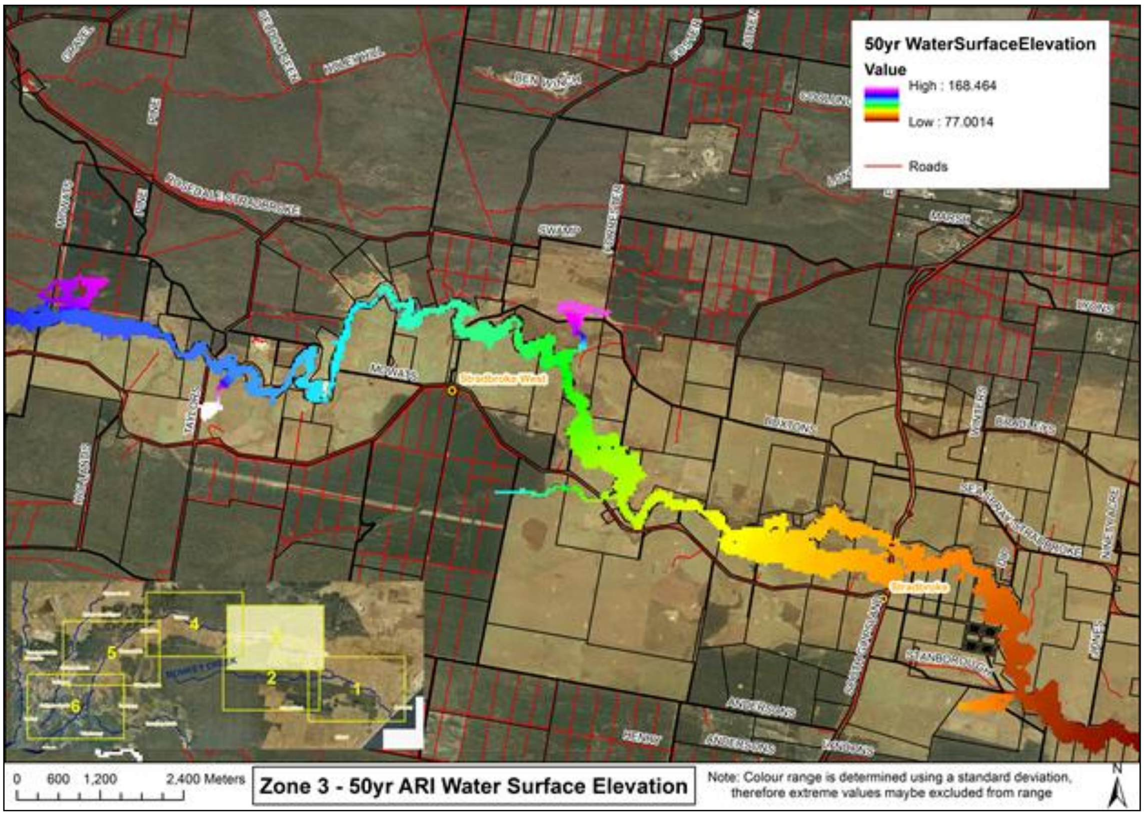

100yr Water Surface Elevation
Value
High : 365.443
Low : 145.691
Roads
MERRIMANS CREEK
FLYNNS CREEK
0 600 1,200 2,400 Meters
Zone 5 - 100yr ARI Water Surface Elevation
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range


100yr Water Surface Elevation
Value
High : 365.443
Low : 145.918
Roads
FLYNNS CREEK
0 550 1,100 2,200 Meters
Zone 6 - 100yr ARI Water Surface Elevation
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range

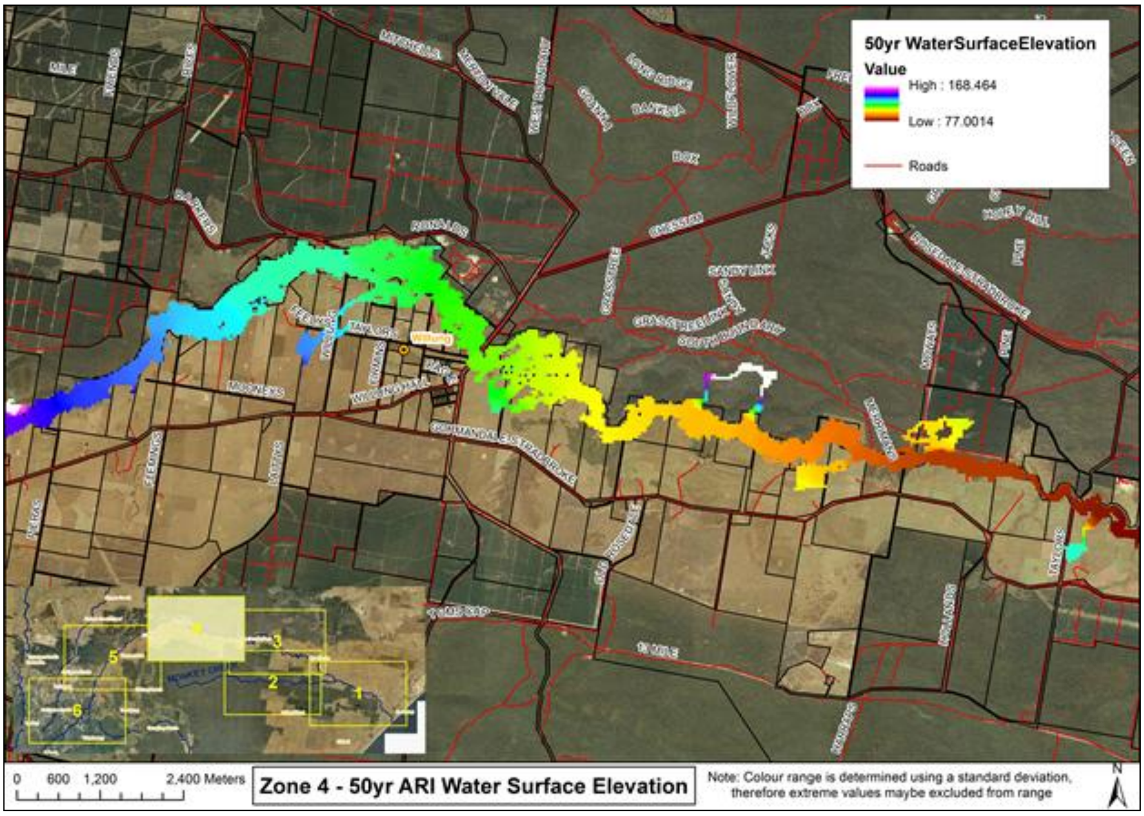
Appendix I.2 50yr Water Surface Elevation Maps for Zones 1 to 6



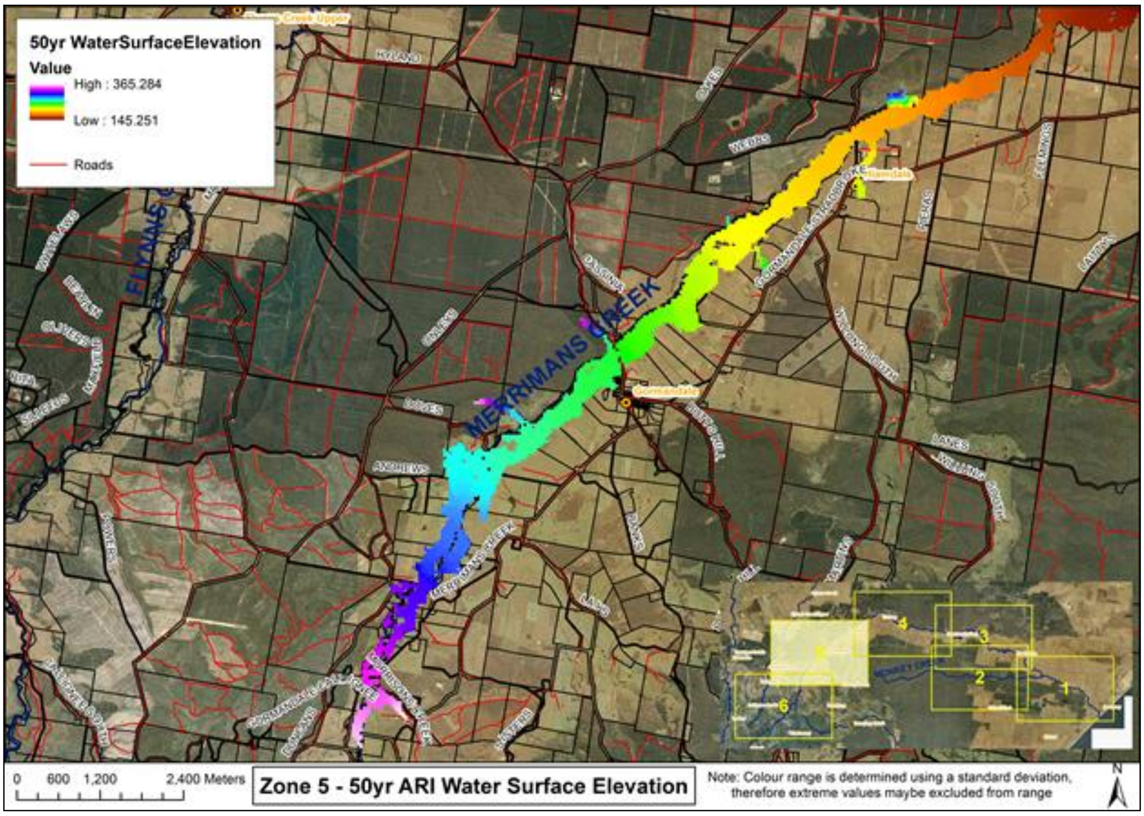


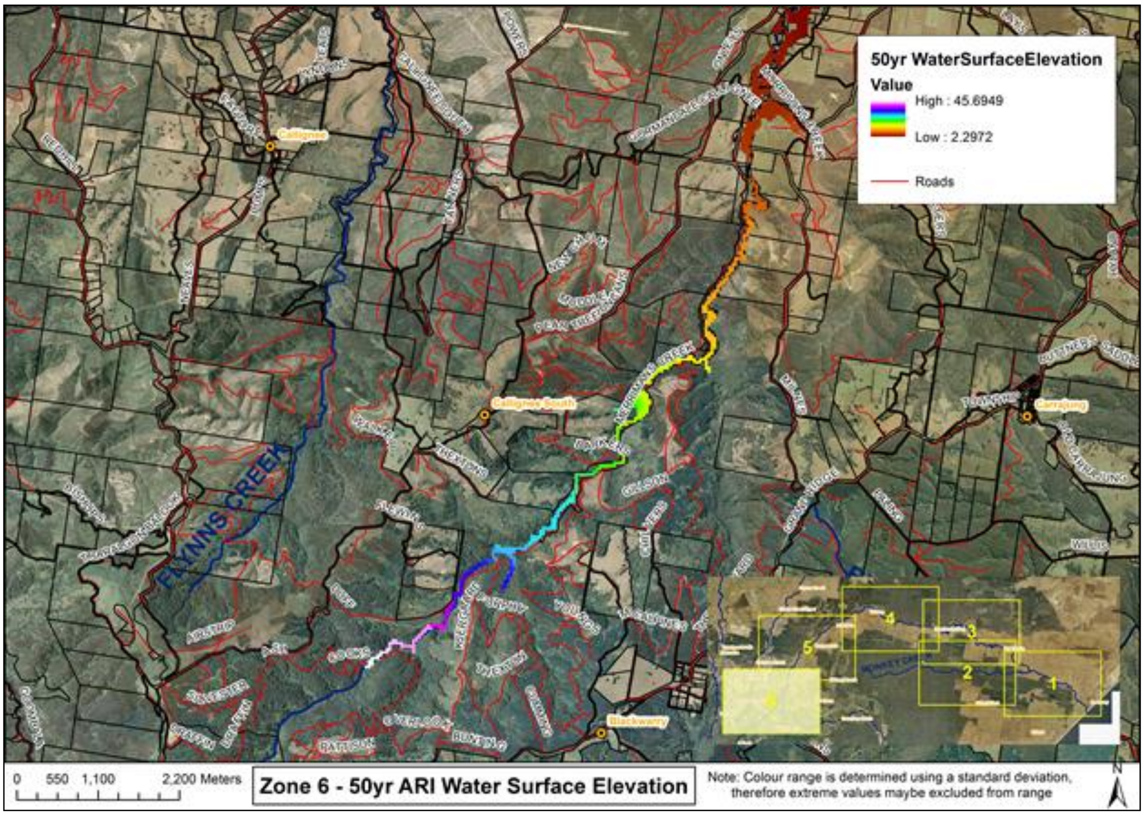


Zone 3 - 50yr ARI Water Surface Elevation

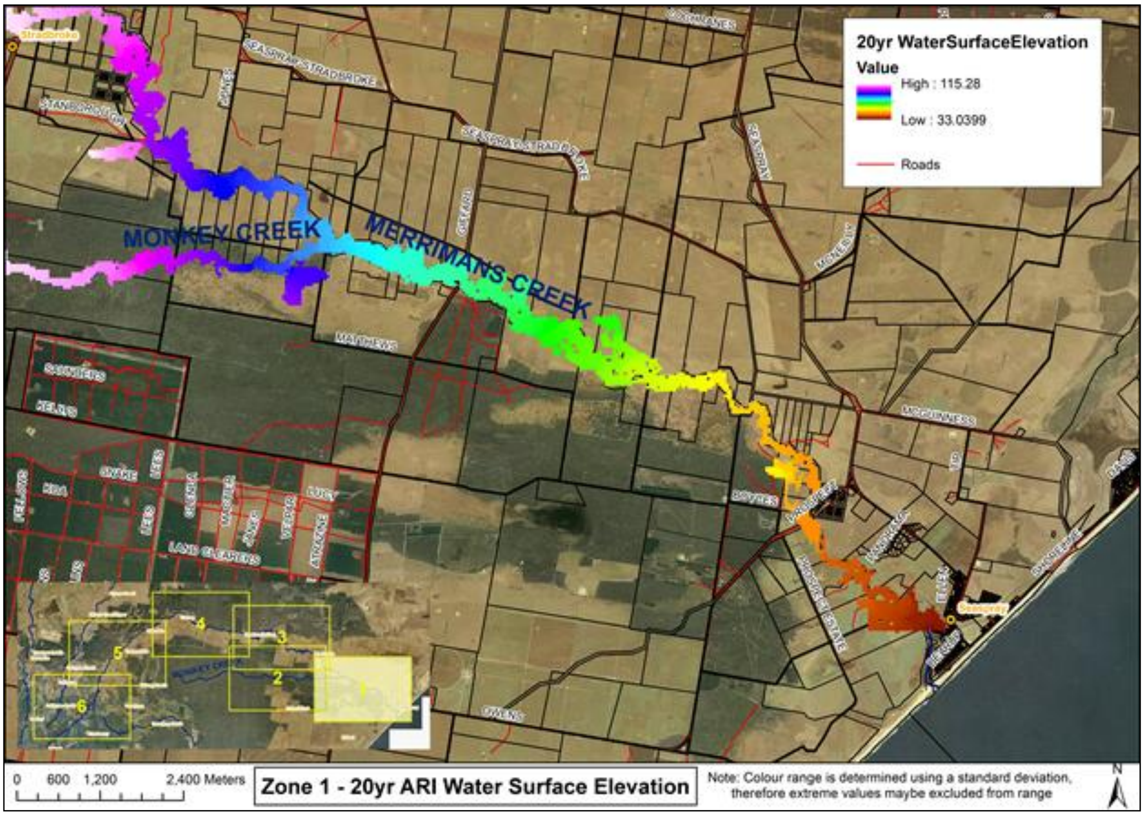


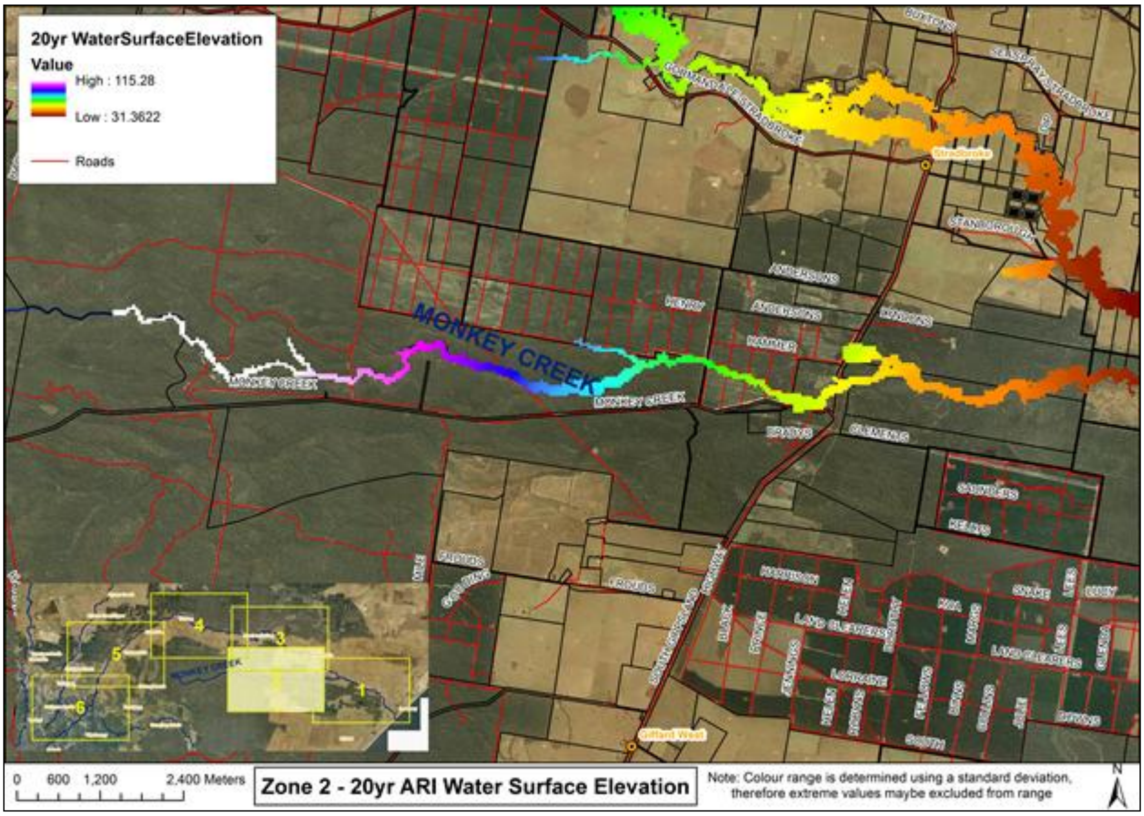
Zone 4 - 50yr ARI Water Surface Elevation

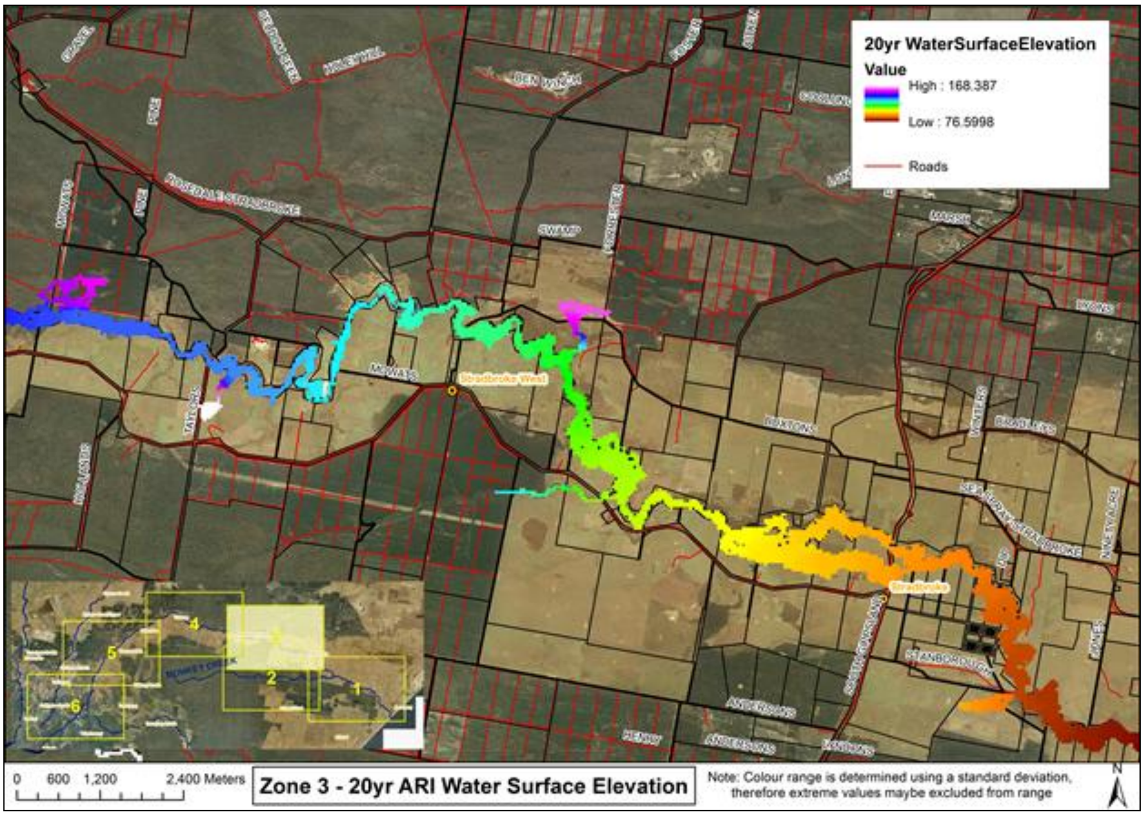

50yr WaterSurfaceElevation
Value
High : 365.284
Low : 145.251
Roads
MERRIMANS CREEK
FLYNNS CREEK
0 600 1,200 2,400 Meters
Zone 5 - 50yr ARI Water Surface Elevation
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

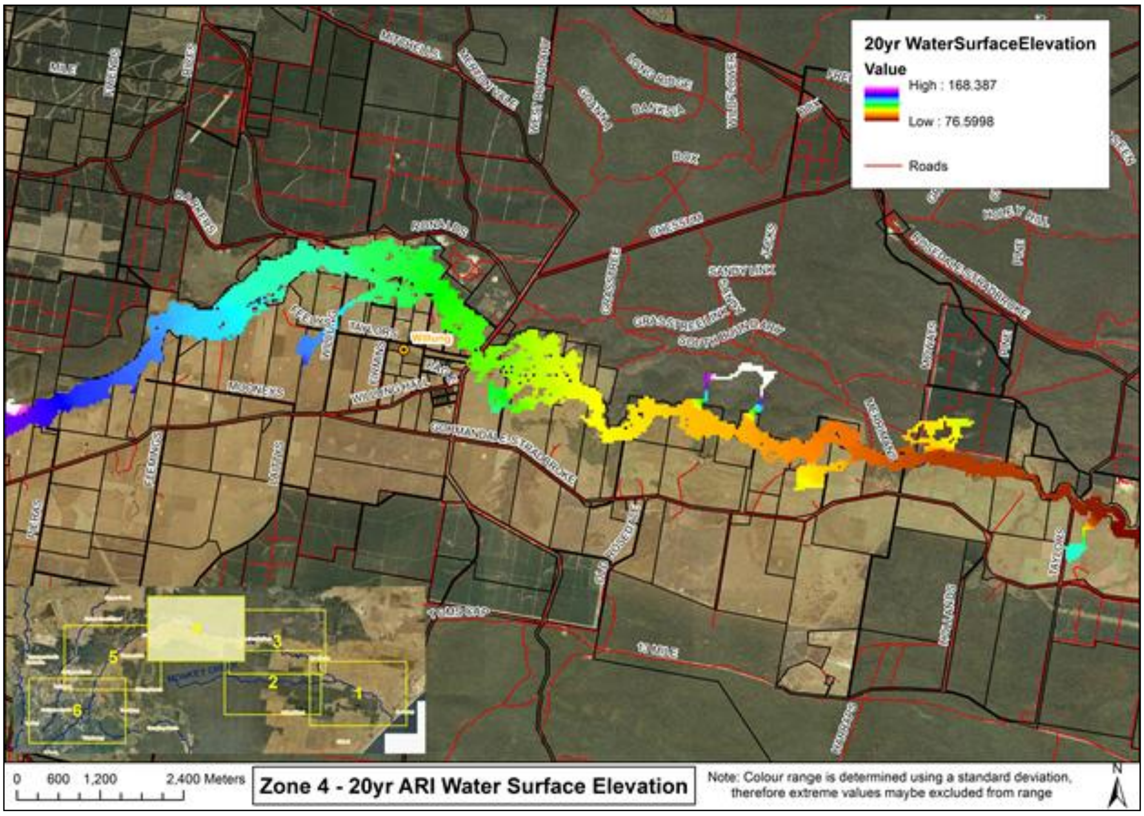

50yr WaterSurfaceElevation
Value
High : 45.6949
Low : 2.2972
Roads
FLYNNS CREEK
0 550 1,100 2,200 Meters
Zone 6 - 50yr ARI Water Surface Elevation
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

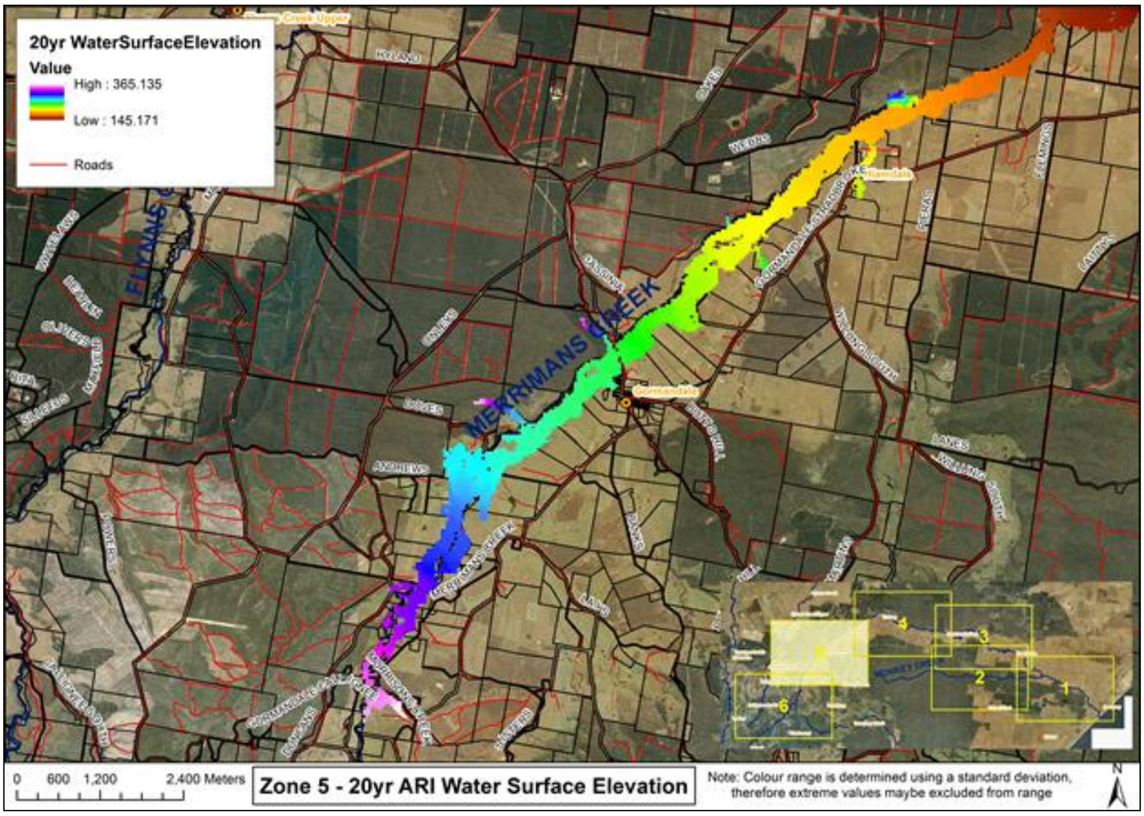
Appendix I.3 20yr Water Surface Elevation Maps for Zones 1 to 6



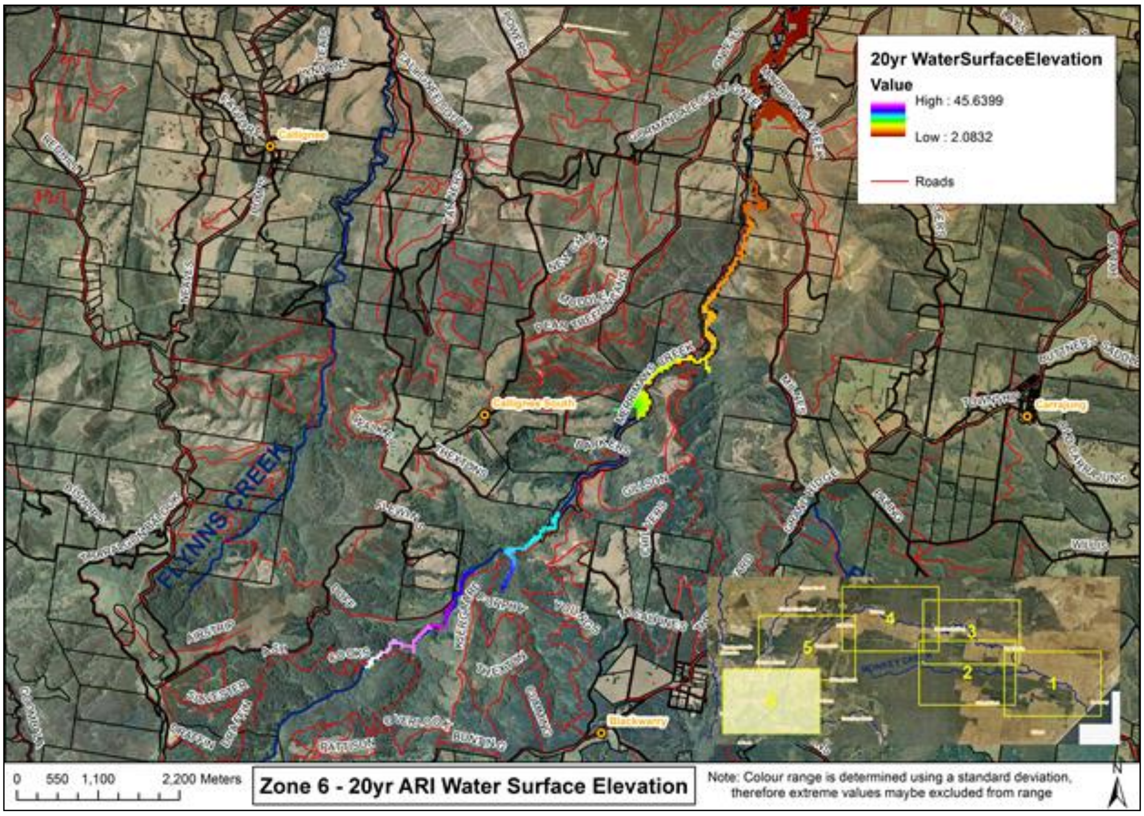



20yr WaterSurfaceElevation
Value
High : 168.387
Low : 76.5998
Roads
0 600 1,200 2,400 Meters
Zone 3 - 20yr ARI Water Surface Elevation
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N


20yr WaterSurfaceElevation
Value
High : 168.387
Low : 76.5998
Roads
0 600 1,200 2,400 Meters
Zone 4 - 20yr ARI Water Surface Elevation
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

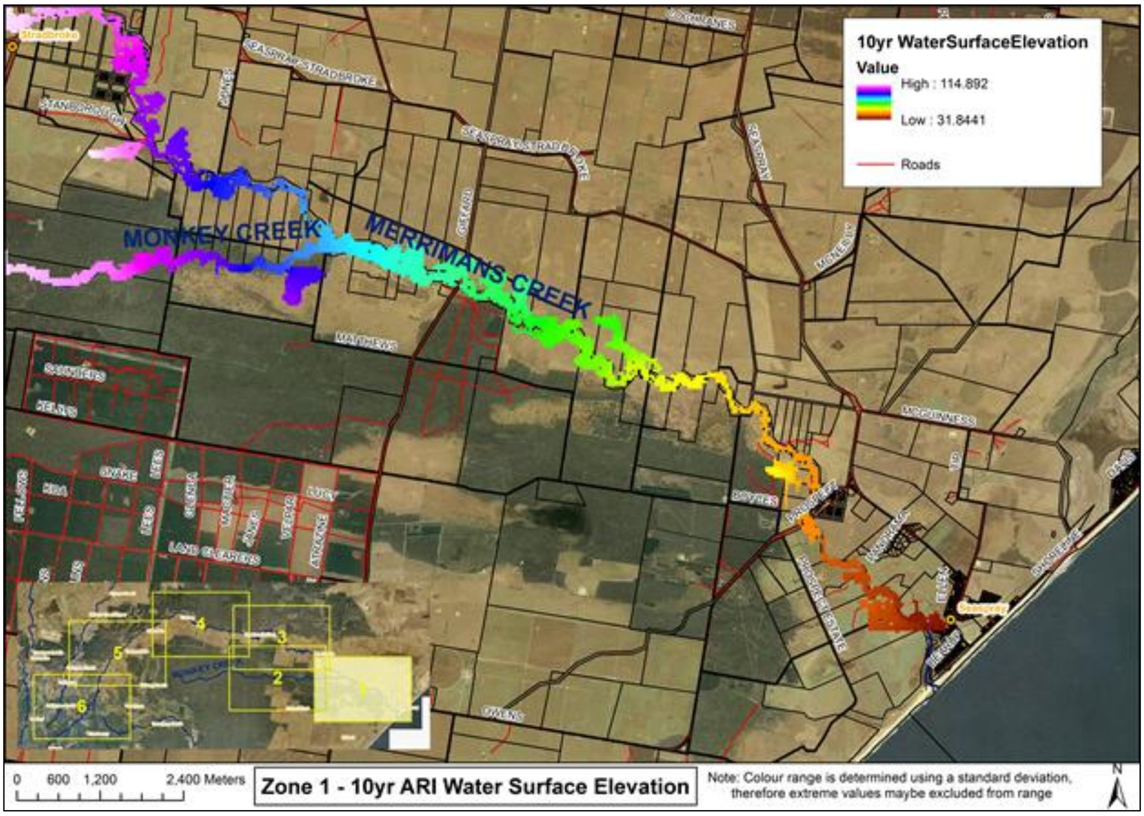


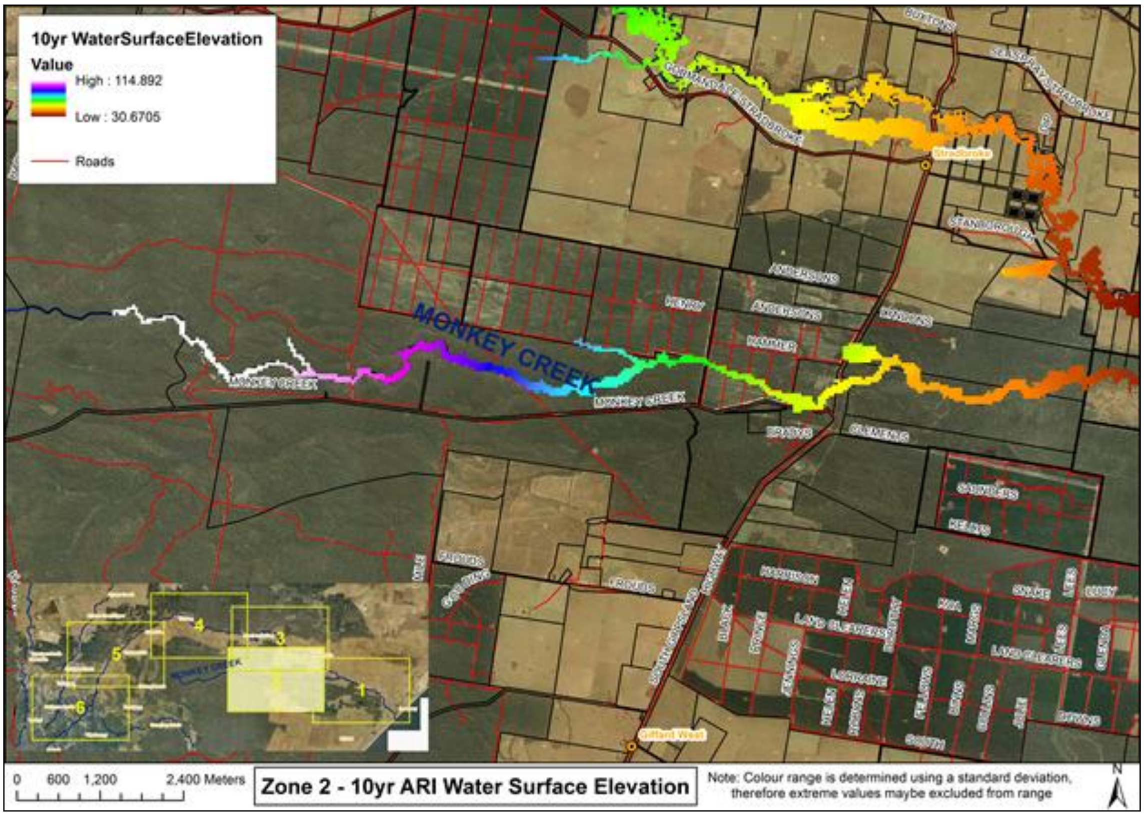
Zone 5 - 20yr ARI Water Surface Elevation

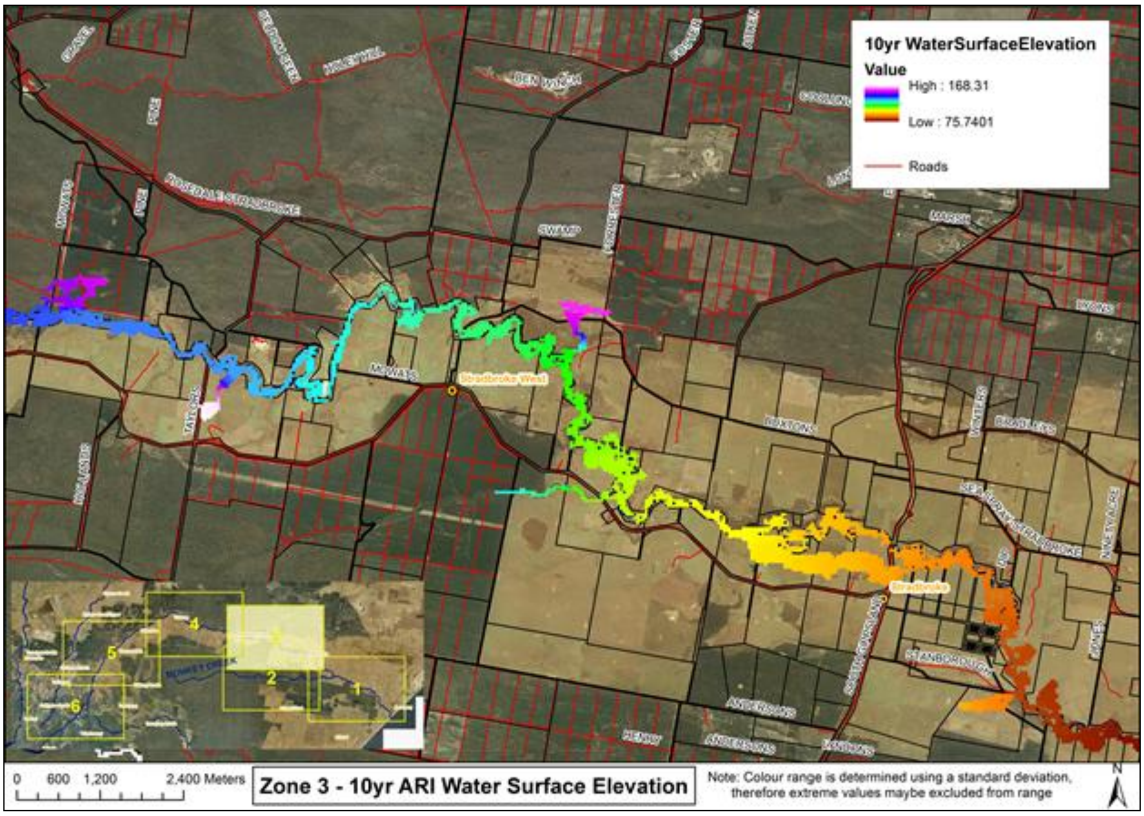


Zone 6 - 20yr ARI Water Surface Elevation

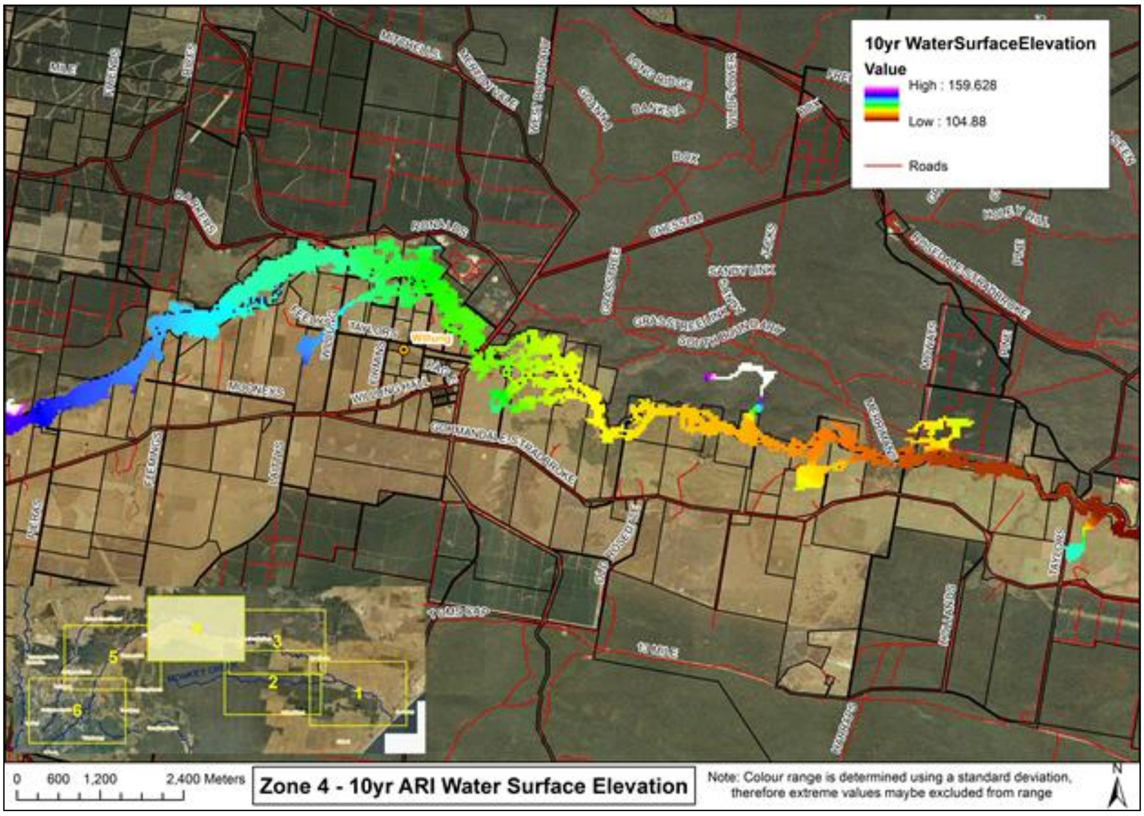
Appendix I.4 10yr Water Surface Elevation Maps



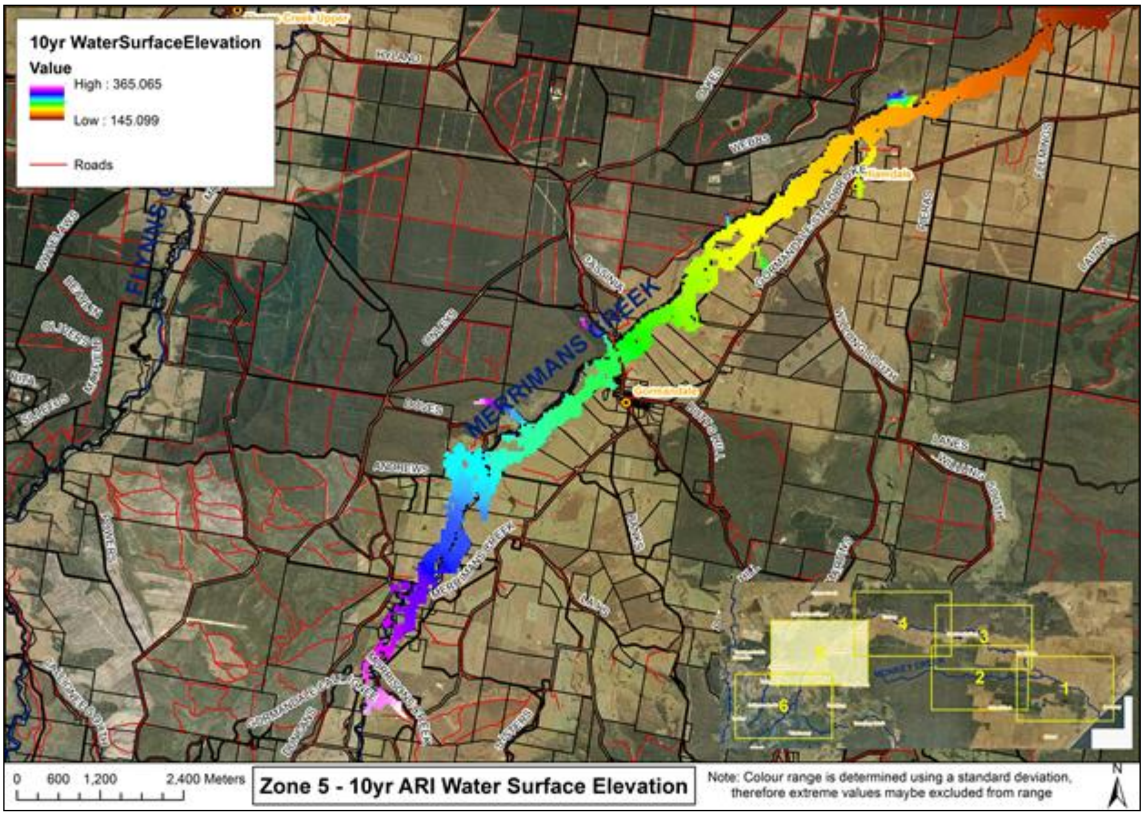




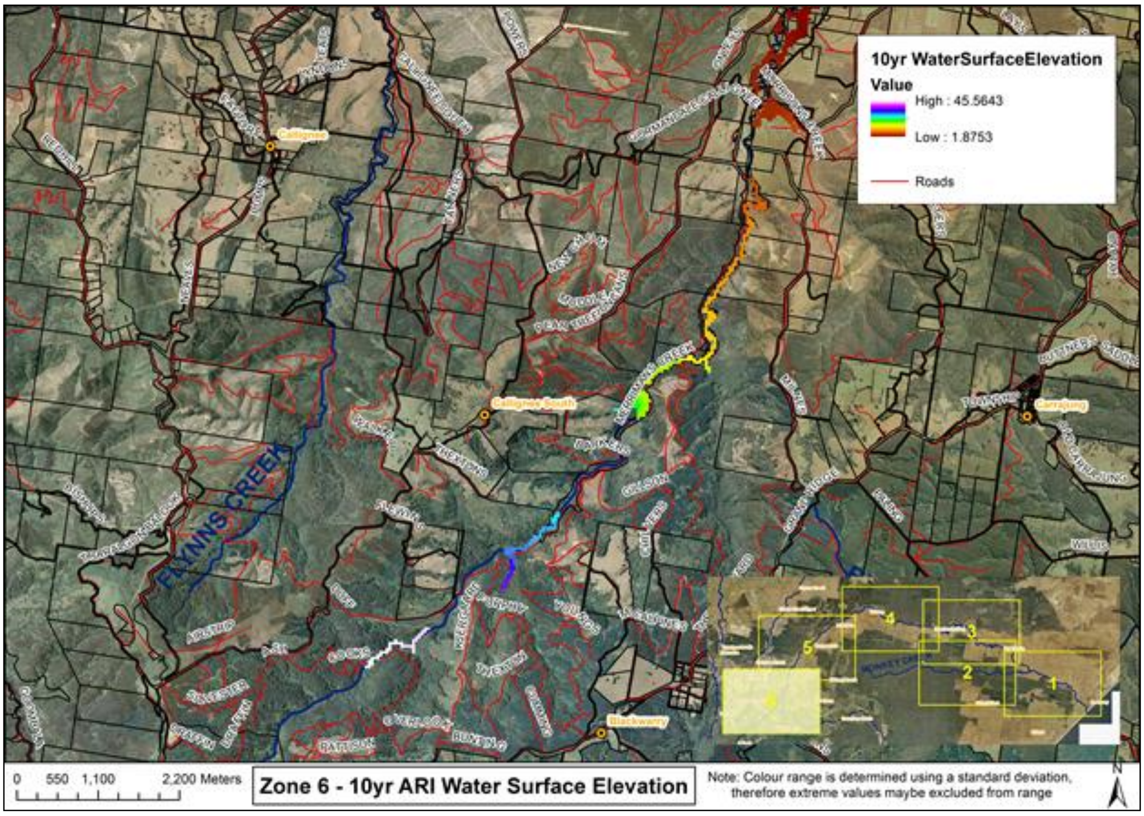
Zone 3 - 10yr ARI Water Surface Elevation



Zone 4 - 10yr ARI Water Surface Elevation

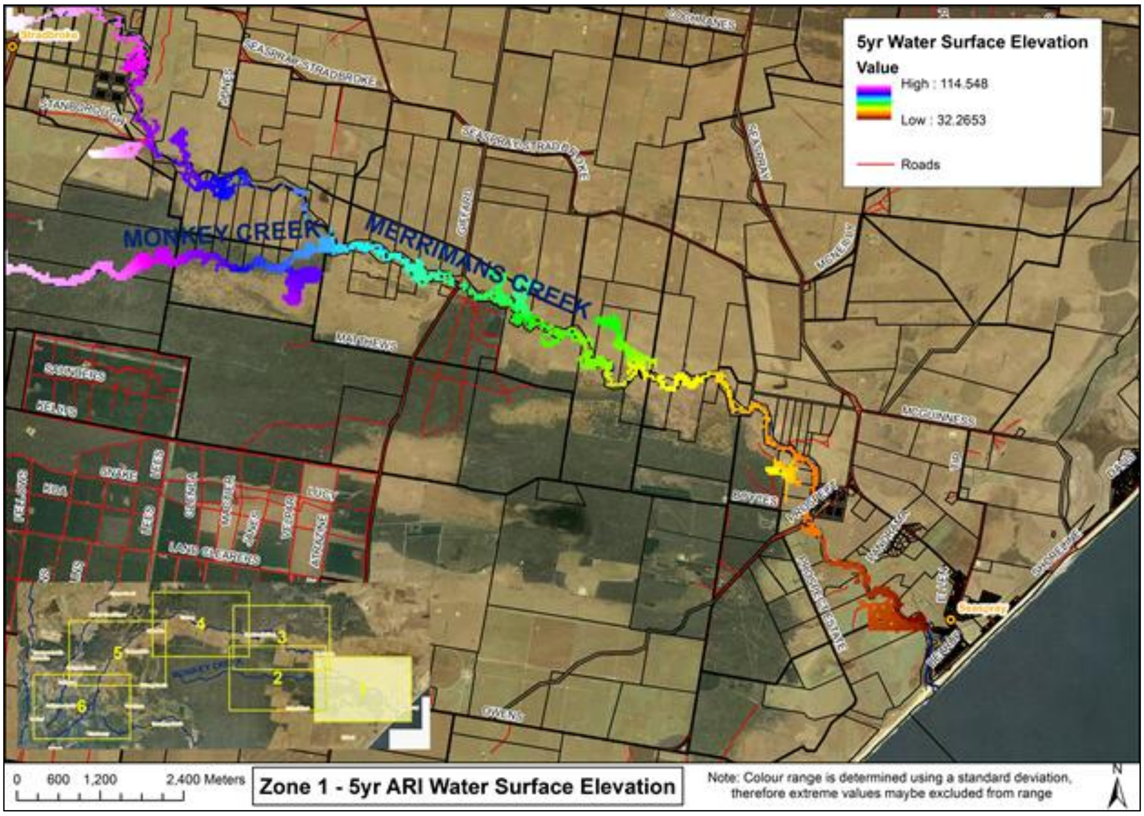


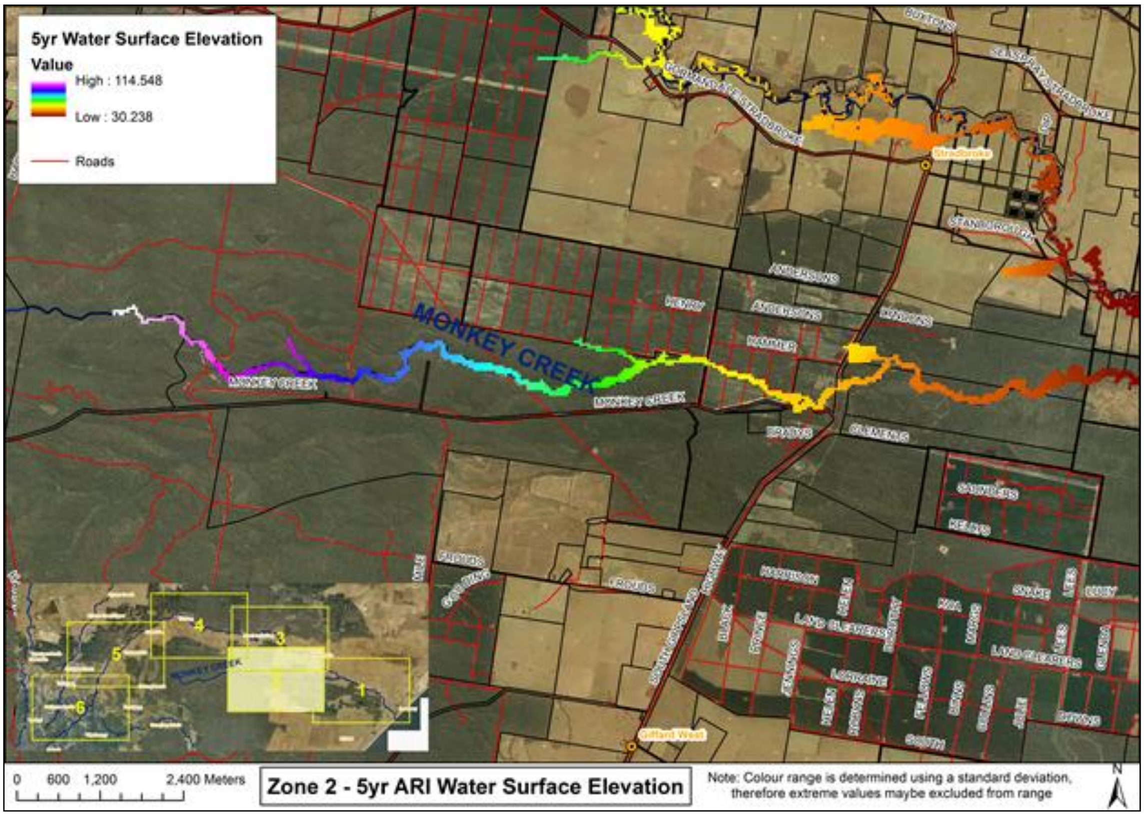
Zone 5 - 10yr ARI Water Surface Elevation

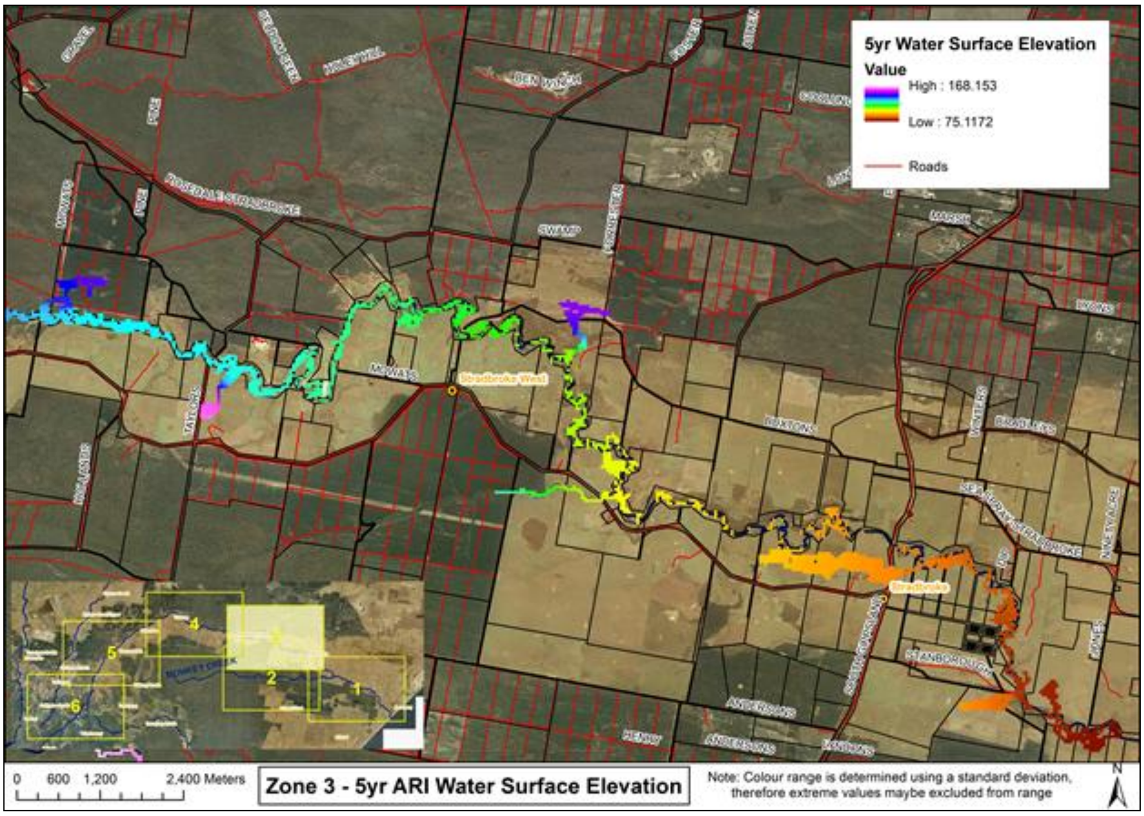


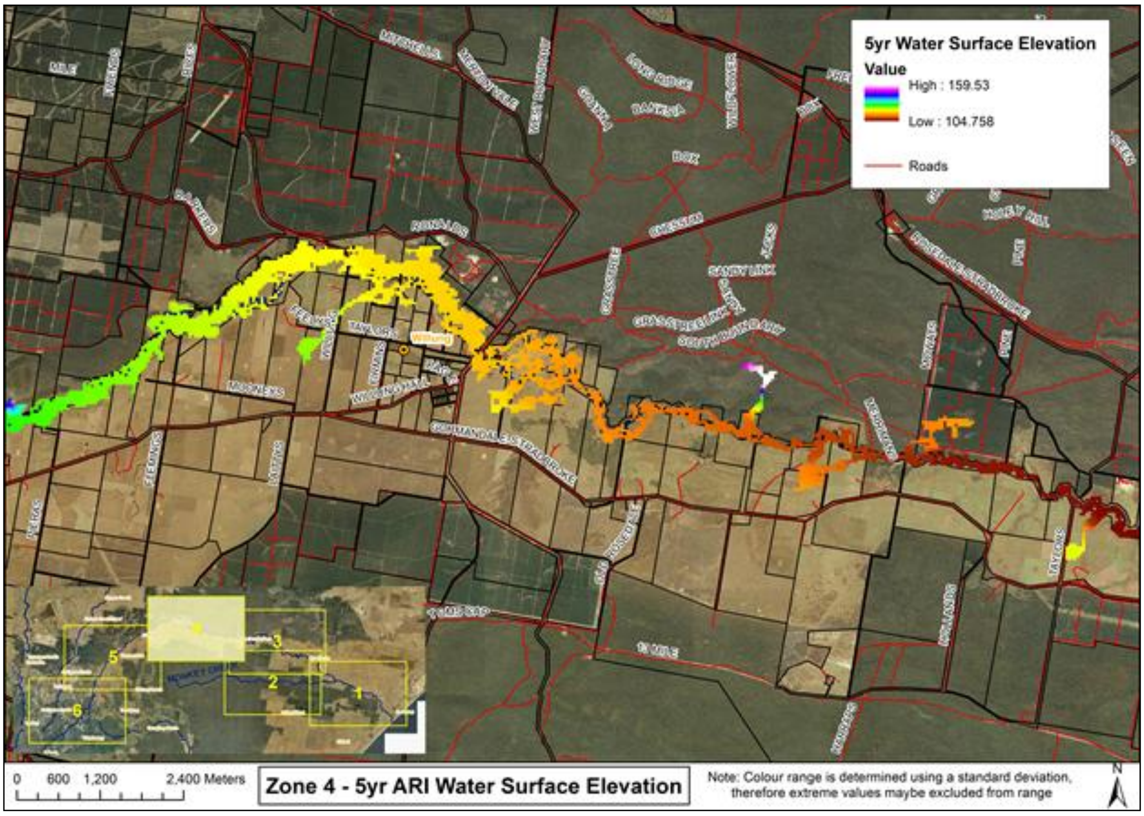
Zone 6 - 10yr ARI Water Surface Elevation

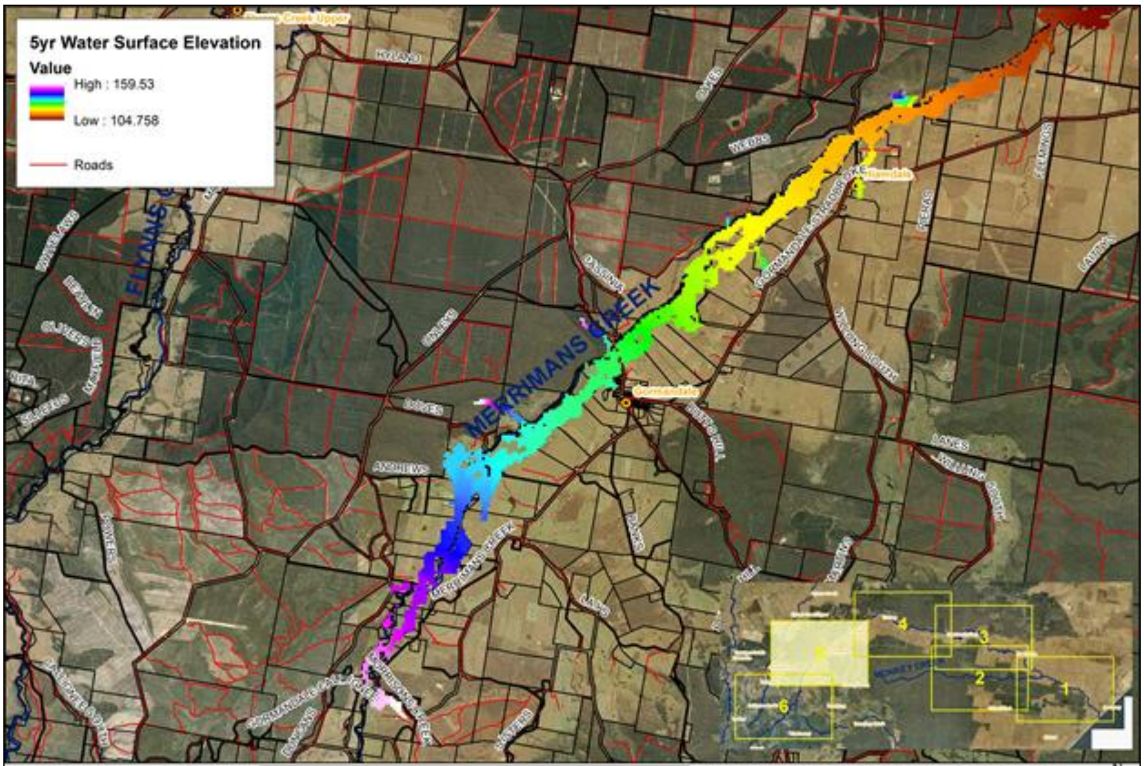
Appendix I.5 5yr Water Surface Elevation Maps for Zones 1 to 6



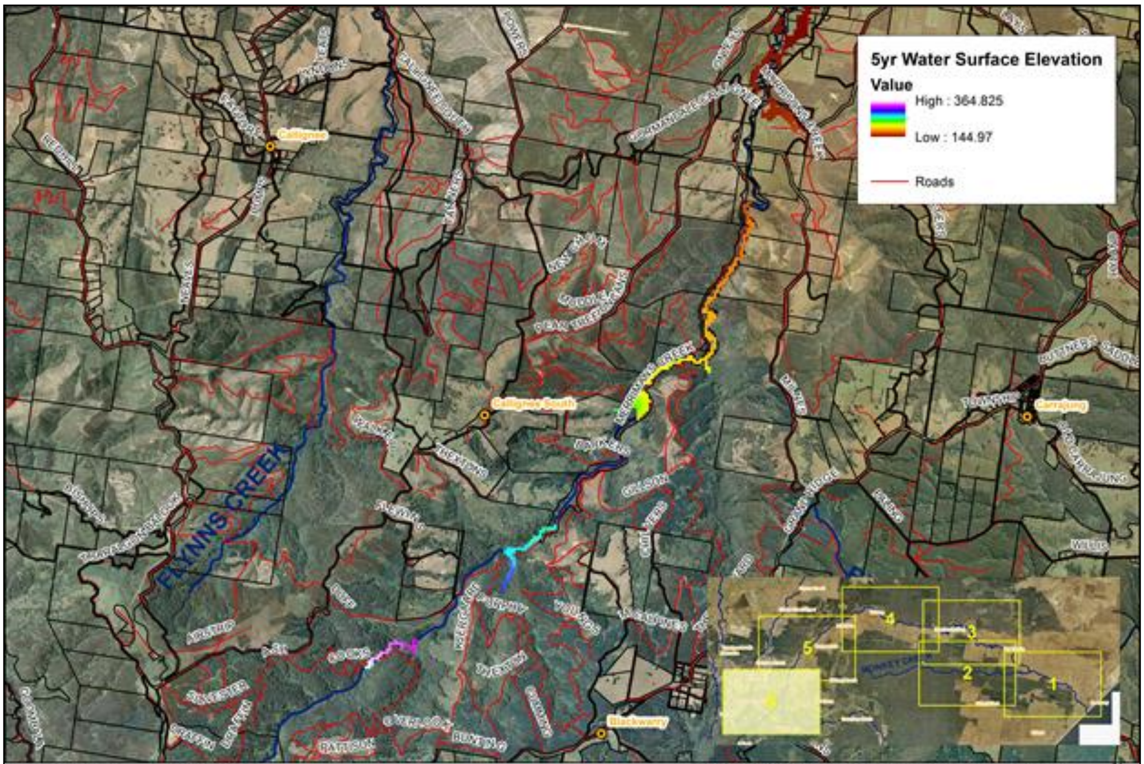



5yr Water Surface Elevation
Value
High : 168.153
Low : 75.1172
Roads
0 600 1,200 2,400 Meters
Zone 3 - 5yr ARI Water Surface Elevation
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N


5yr Water Surface Elevation
Value
High : 159.53
Low : 104.758
Roads
0 600 1,200 2,400 Meters
Zone 4 - 5yr ARI Water Surface Elevation
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N

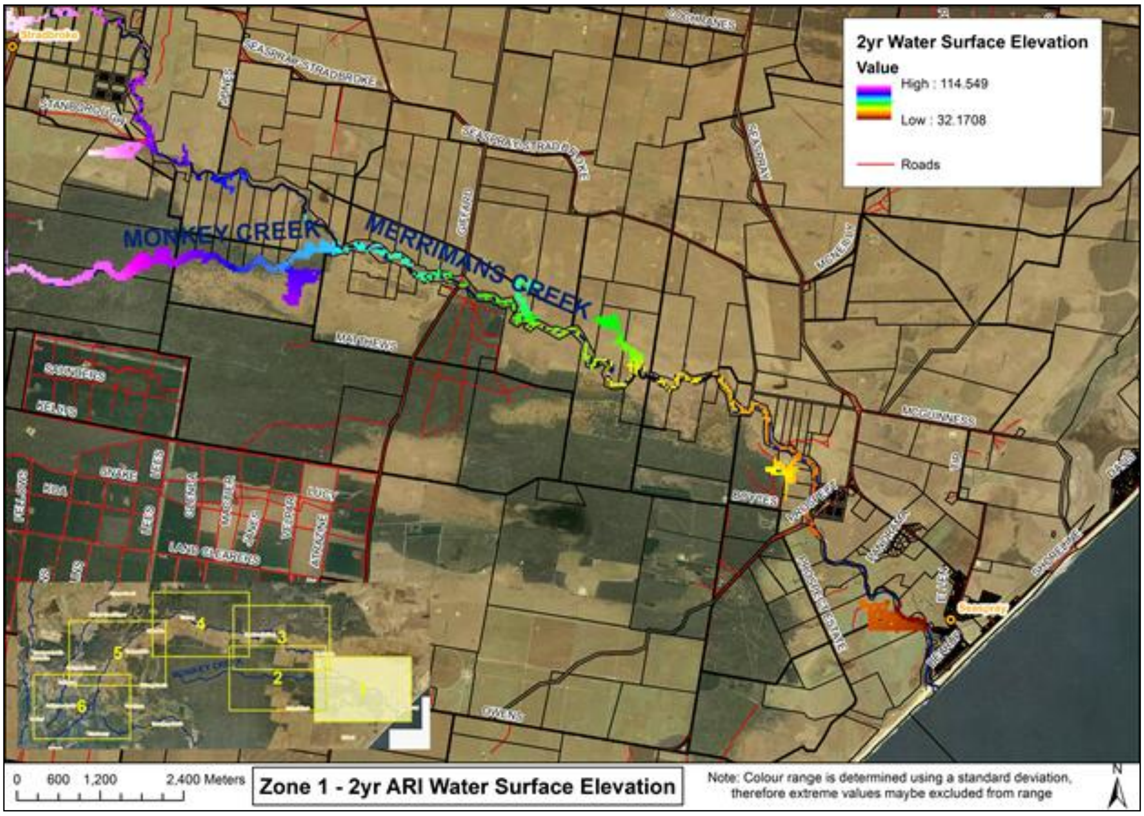


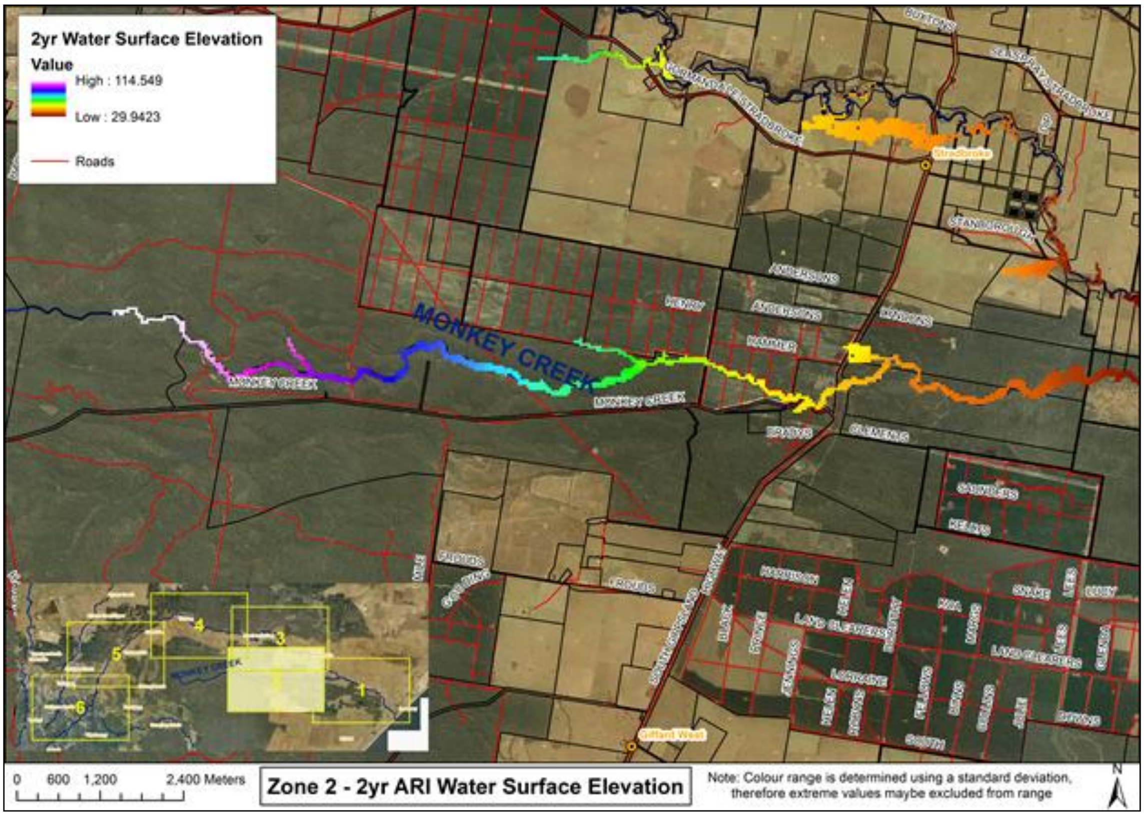
Zone 5 - 5yr ARI Water Surface Elevation

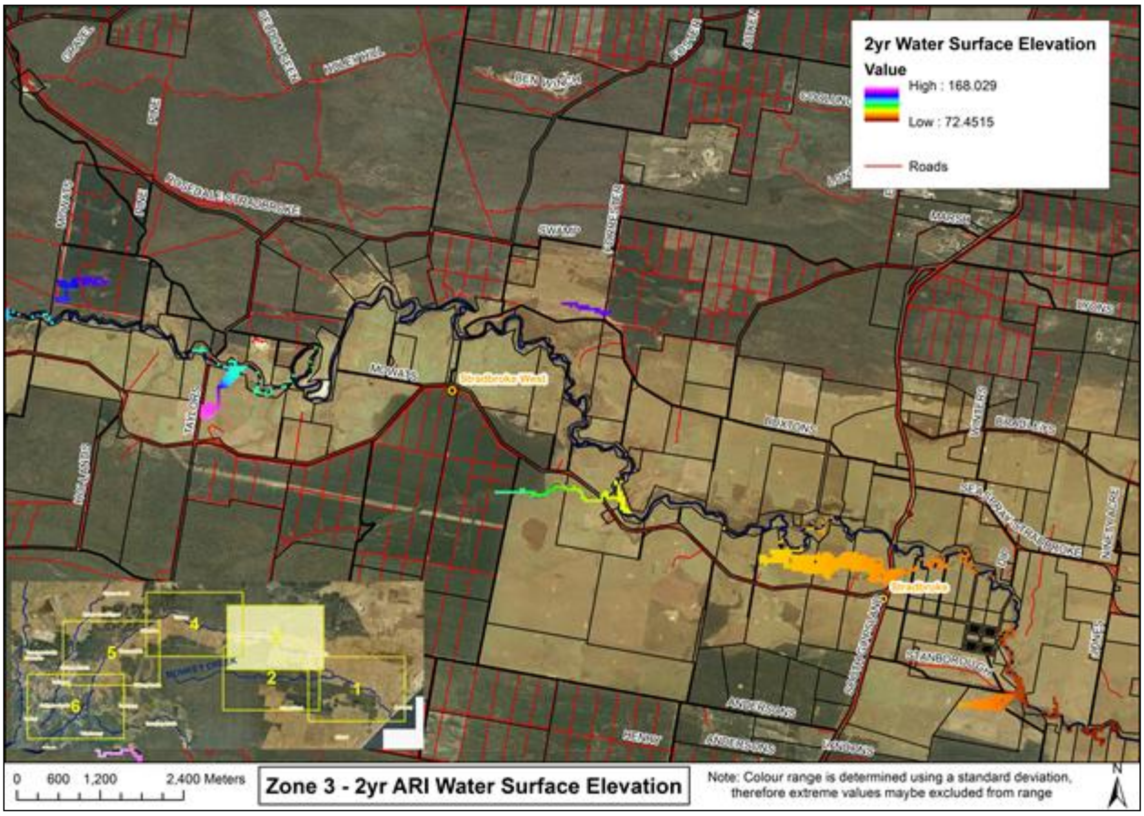


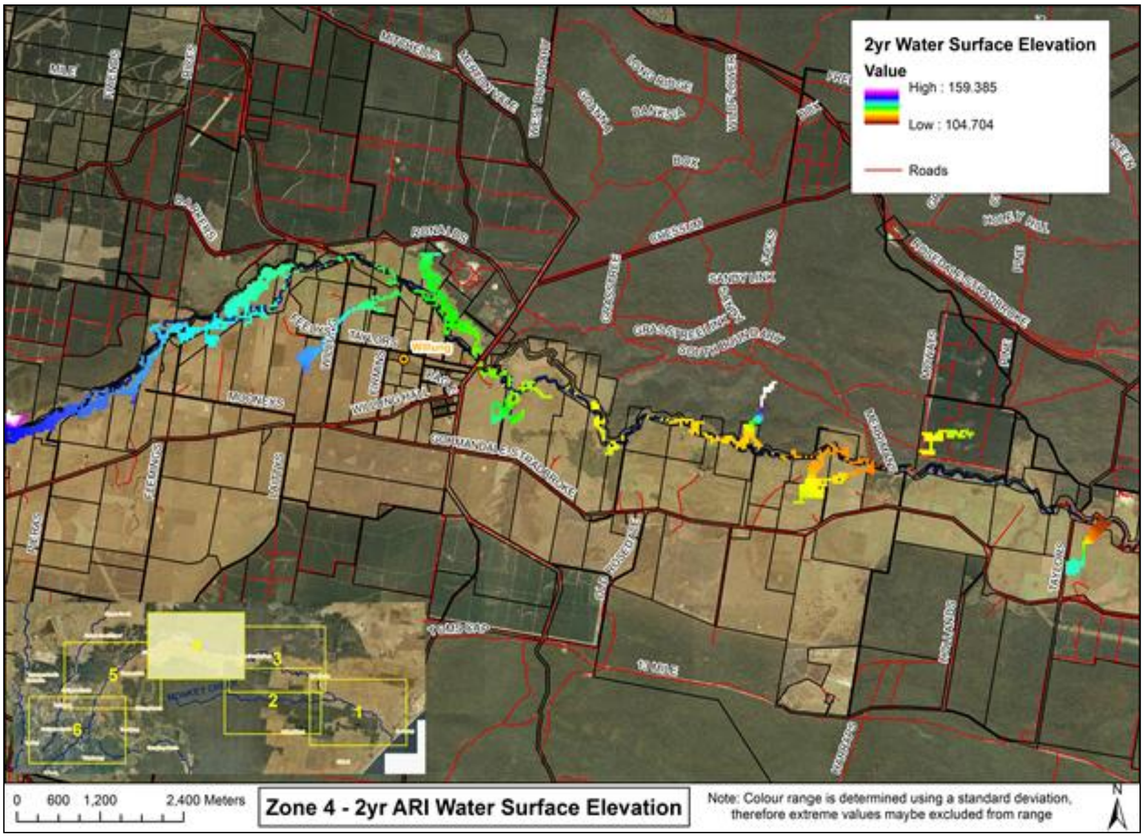
Zone 6 - 5yr ARI Water Surface Elevation

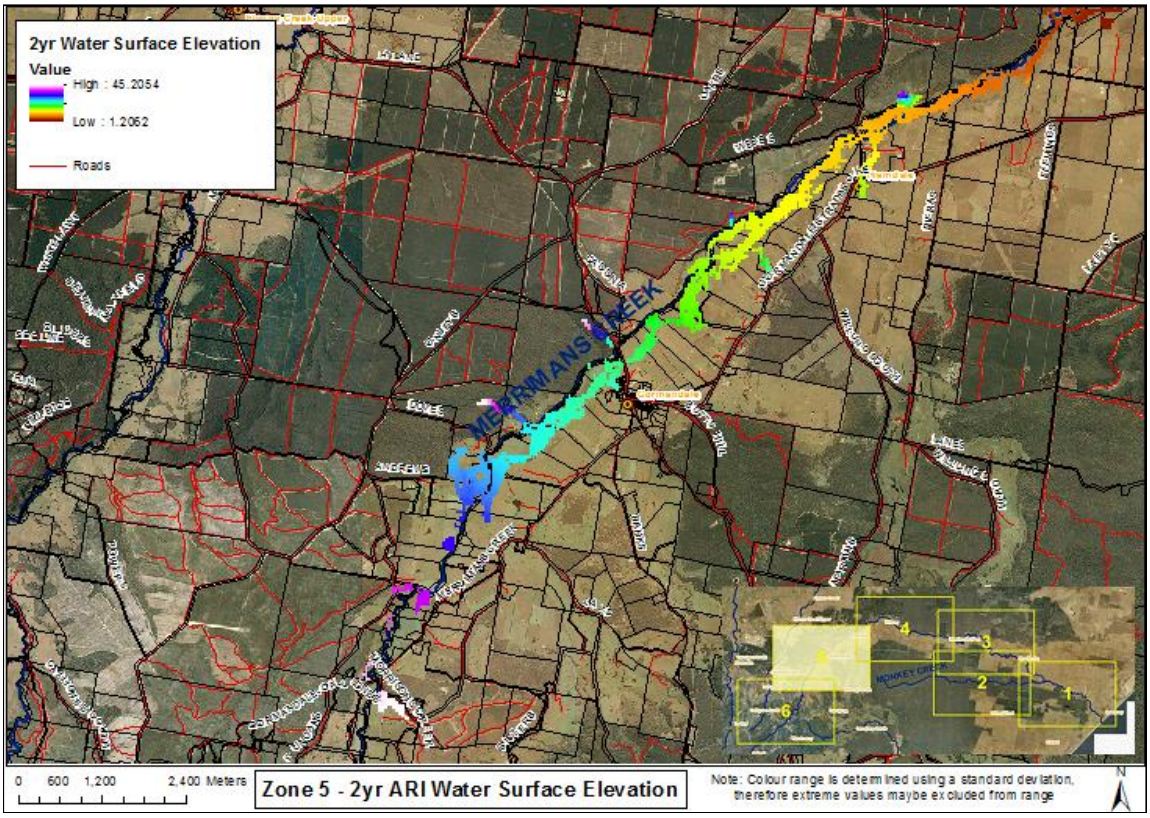
Appendix I.6 2yr Water Surface Elevation Maps for Zones 1 to 6



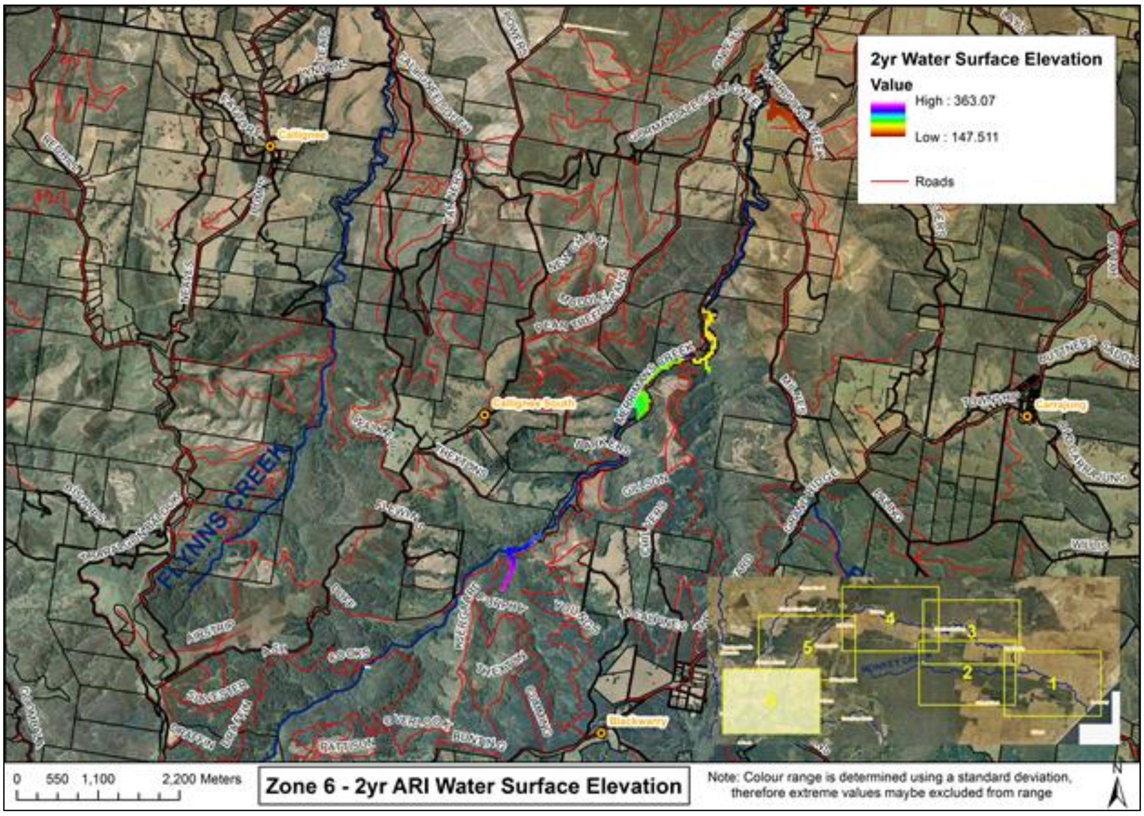



2yr Water Surface Elevation
Value
High : 168.029
Low : 72.4515
Roads
0 600 1,200 2,400 Meters
Zone 3 - 2yr ARI Water Surface Elevation
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N


2yr Water Surface Elevation
Value
High : 159.385
Low : 104.704
Roads
0 600 1,200 2,400 Meters
Zone 4 - 2yr ARI Water Surface Elevation
Note: Colour range is determined using a standard deviation, therefore extreme values maybe excluded from range
N



Zone 5 - 2yr ARI Water Surface Elevation



Zone 6 - 2yr ARI Water Surface Elevation