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Mackay Regional Council

Report for Goosepond/Vines Creek Flood Study

Final Report

February 2012

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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Abbreviations

AEP	Annual Exceedence Probability
ALS	Aerial Laser Survey
ARI	Average Recurrence Interval
DEM	Digital Elevation Model
GPND	Goosepond Creek
IFD	Intensity Frequency Duration
JC	Janes Creek
MRC	Mackay Regional Council
RCBC	Reinforced Concrete Box Culvert
RCP	Reinforced Concrete Pipe
U&N	Ullman and Nolan
VC	Vines Creek
Yr	Year

Executive Summary

GHD Pty Ltd (GHD) was commissioned by Mackay Regional Council (MRC) to prepare a Flood Study for Goosepond Creek, Janes Creek, Vines Creek and the Port Access Corridor in the North Mackay area. One of the primary reasons for doing this is to provide a degree of certainty to Council and developers with respect to future development requirements.

Importantly this report updates and supersedes the Gooseponds/Vines Creek Flood Study (GHD September 2009). The 2009 report has been updated in light of the results of the Pioneer River Flood Study (WRM, 2011) and the availability of new LiDAR survey (DERM, 2009). The flood levels predicted by the Pioneer River Flood Study in the vicinity of the Goosepond Creek/Pioneer River junction have been used to update the tailwater conditions previously adopted in the Goosepond Creek hydraulic model. The recently acquired ALS data has been used to update the topography of the model.

The city of North Mackay has been adversely affected by flooding in the Goosepond Creek catchment on several occasions in the last 50 years, with flash floods occurring in March 1963, November 2000 and February 2008. The February 2008 event is considered to be the most significant on record. An analysis of the 2008 event indicates:

- Rainfall intensities were the highest on record for the Goosepond Creek catchment;
- The maximum rainfall intensities experienced are considered to be exceptionally high. The probability of experiencing equal or greater rainfall intensities in any future year is less than 0.20% (1 in 500); and
- 886 properties were estimated to be adversely affected compared to 150 for the March 1963 event and 4 for the November 2000 event. The number of properties that were adversely affected by flooding from the Goosepond Creek catchment during the February 2008 event is equivalent to approximately 20% of all properties within Mackay that were adversely affected during the event.

A range of data has been collected for the project, including aerial photographs, ground and aerial survey, reports, historical rainfall records, stream gauge records, digital land use files and flood level survey. In addition, the study area was inspected and discussions were held with a range of people from MRC.

Hydrologic investigations (in this case the prediction of catchment rainfall runoff and creek flows) were undertaken using a hydrologic model (XP-RAFTS) of the catchment.

Flood level prediction was undertaken using the MIKEFLOOD hydraulic modelling package. The hydraulic model was calibrated to the February 2007 and 2008 flood events. Calibration data was considered to be reasonable for the February 2007 event and extensive for the February 2008 event, with Council's survey of flood levels a key data source. The hydraulic model is considered to reproduce flood levels to an acceptable level of accuracy. For the February 2007 event, 50% of flood levels are predicted to be within $\pm$200mm of recorded flood levels and 70% are within $\pm$300mm whilst for the February 2008 event 70% of predicted flood levels are within $\pm$200mm of recorded flood levels and 84% are within $\pm$300mm of recorded flood levels.

Calibration to the 2007 and 2008 flood events has allowed three design events to be simulated for existing catchment conditions in the hydraulic model, these being the 5 year, 50 year and 100 year

Average Recurrence Interval (ARI) events. The probability of these events being exceeded in any future year is approximately 20%, 2% and 1% respectively. Flood inundation maps indicating the maximum predicted flood levels and velocities for these events have been provided.

Results indicate that the 100 year ARI design flood event is generally 0.6 to 0.9m lower than the February 2008 event along Goosepond Creek, and is predicted to affect a number of properties on the Janes Creek, Goosepond Creek and Vines Creek floodplain. Affected properties have been identified on a flood inundation map.

The impact of potential future climate change on the 100 year ARI design event has been investigated by testing the sensitivity of the mathematical models to a 20% increase in rainfall intensity combined with a 0.8m sea level rise. This is consistent with the Department of Resources Management Increasing Queensland's resilience to inland flooding in a changing climate- Final Scientific Advisory Group Report (DERM,2010) and the Queensland Stage Planning Policy 3/11 (DERM, 2012). A set of flood inundation maps indicating the predicted change in existing flood levels has been provided. Results indicate that a 20% increase in rainfall intensity and 0.8m sea level rise will cause:

- Increases in flood levels of 100mm to 220mm along Janes Creek in Glenella;
- Increases in flood levels of 190mm to 570mm along Goosepond Creek in North Mackay; and
- Increases in flood levels of 350mm to 390mm in the Andergrove region.

In order to improve the water quality in Goosepond Creek, MRC has developed a riverine revegetation strategy that it plans to implement in several locations along the Goosepond Creek waterway. In order to test the impact of the revegetation strategy on the existing hydraulic regime of Goosepond Creek, the calibrated hydraulic model was run for the 100 year ARI design event with the revegetation strategy in place. A set of flood inundation maps indicating the predicted change in existing flood levels and velocities has been provided. Results indicate:

- Revegetation of banks and drainage easements in Goosepond Creek between Willetts Road and Evans Avenue results in an increase in flood levels of between 40mm to 90mm; and
- Revegetation of the banks of upstream of Willets Road to Glenella Road increases flood levels of between 70mm to 160mm.

The impact of potential future climate change (20% increase in rainfall intensity and 0.8m sea level rise) plus the proposed riverine revegetation strategy on the existing flood regime was also investigated. A set of inundation maps indicating the change in flood levels and velocities has been provided. Results indicate:

- Increases in flood levels of up to 340mm along Goosepond Creek in Glenella;
- Increases in flood levels of 320 to 370mm along Goosepond Creek in North Mackay; and
- Increases in flood levels approximately 370mm in the Andergrove Region.

The Goosepond Creek Tidal Reaches Masterplan proposes a number of changes to the existing condition of the Goosepond Creek waterway downstream of Evans Avenue (refer Figure E1). One change that has the potential to affect existing flood levels is the impact of mangrove regrowth in this area. In order to test the impact of the mangrove regrowth on the existing hydraulic regime of Goosepond Creek, the calibrated hydraulic model was run for the 100 year ARI design event with the mangrove re-growth in place. A set of flood inundation maps indicating the predicted change in existing

flood levels and velocities has been provided. Results indicate the Goosepond Creek Tidal Reaches Masterplan will:

- Increase flood levels by a maximum of approximately 90mm within the waterway reach located between 300m upstream and downstream of Evans Avenue, with a maximum reduction in flood velocity of 0.48m/s in this area; and
- Increase flood levels by a maximum of approximately 30mm within the waterway reach located between Willetts Road and Malcomson Street.

The hydraulic impacts of filling associated with development applications currently approved by Council, pending development applications, other potential development applications and flood mitigation scenarios have been assessed for the 100 year ARI design event. A set of flood inundation maps indicating the predicted change in existing flood levels and velocities has been provided. Results indicate:

- Glenella: Based on likely filling associated with areas which are currently zoned for urban development, the most significant impact just downstream of the Bruce Highway at Glenella. Filling on both sides of Janes Creek in this section is estimated to raise 100 year ARI levels in the area by 390 mm. Based on ground levels at lots on McLaren Drive, this increase in level would result in overtopping without flood mitigation;
- North Mackay: There is limited land remaining in the Goosepond Creek catchment which is zoned for urban development in the North Mackay and Mt Pleasant area. Hence, there is minimal impact on flood levels by developing the remaining land zoned for urban development. The impact is an increase of approximately 60mm; and
- Andergrove: Filling associated with development in the Vines Creek catchment has less of a hydraulic impact than Glenella with flood levels increasing by up to 80 mm.

The hydraulic impacts of filling associated with development applications currently approved by Council, pending development applications, and other potential development applications together with increased rainfall intensities and sea level due to potential future climate change will have the following impacts:

- Glenella: Based on likely filling associated with areas which are currently zoned for urban development, the most significant impact just downstream of the Bruce Highway at Glenella with predicted increases of up to 620mm;
- North Mackay: The impact is an increase in flood level of approximately 230mm to 360mm; and
- Andergrove: Flood levels in the Vines Creek catchment are predicted to increase by up to 420 mm.

To reduce flood levels along Goosepond Creek floodplain and within the Heaths Road industrial estate a mitigation option was tested which looked to convey flood flows from the north of Sugarshed Road to Fursden Creek. This mitigation option consisted of an upgrading the Sugarshed Road culverts and construction of a 50m base width trapezoidal channel. This option had the following flood benefits on Goosepond Creek:

- The drainage infrastructure will reduce existing conditions 100 year ARI design event peak flood levels by 0.04 to 0.16m along the Goosepond Creek floodplain downstream of Glenella Road; and
- The drainage infrastructure will reduce existing conditions 100 year ARI design event peak flood levels by 0.06m throughout Andergrove.

Based on the improvements achieved in flood levels by this mitigation channel it is recommended that an economic assessment be undertaken to assess the cost benefit of construction.

In light of the results of this study it is recommended that an Advisory Committee with stakeholder representatives propose 'acceptable' risk standards for the establishment of flood levels and future actions in the Goosepond and Janes Creek catchments. Members on the committee may include Councillors, Council Officers, Community representatives and those from relevant Government Agencies and Organisations.

It is further recommended that:

- Additional flood mitigation measures be investigated. These could include an assessment of the impact of road crossing upgrades, property resumptions and the construction of levees; and
- Council require development applications to assess both local and regional flooding impacts, with local flood studies to include consideration of a range of Pioneer River tailwater conditions.

1. Introduction

GHD Pty Ltd (GHD) were commissioned by Mackay Regional Council (MRC) to prepare a Flood Study for Janes Creek, Goosepond Creek, Vines Creek and the Port Access Corridor in the North Mackay area. Importantly this document updates and supersedes the previous GHD Report Gooseponds/Vines Creek Flood Study (GHD September 2009). This superseding is a result of updated tailwater conditions provided during the Pioneer River Flood Study update (WRM, 2011) and also the availability of new LiDAR survey (DERM, 2009). The location of the study area and the location of these flowpaths are provided in Figure 1.

As part of the study, a hydrologic model was developed for existing catchment conditions, and a 2D hydraulic model constructed for existing and developed catchment conditions. The hydraulic model was calibrated to the February 2007 and 2008 flood events and was verified using the November 2000 and flood event. The calibrated hydrologic and hydraulic models have been used to:

- Determine flood levels, velocities and the extent of flooding for existing catchment conditions for the 5, 50 and 100 year ARI flood events (for two storm durations only);
- Assess the hydraulic impact of increased rainfall intensities and tailwater conditions resulting from potential future climate change on the existing conditions 100 year ARI design event flood regime;
- Assess the hydraulic impact of Council's proposed re-vegetation strategy on the existing conditions 100 year ARI design event flood regime;
- Assess the combined hydraulic impact of Council's proposed re-vegetation strategy plus increased rainfall intensities/tailwater conditions resulting from potential future climate change on the existing conditions 100 year ARI design event flood regime;
- Assess the hydraulic impact of the Goosepond Creek Tidal Master Plan on the existing conditions 100 year ARI design event flood regime;
- Assess the potential hydraulic impacts impact that may be caused by filling associated with a number of proposed developments within the Goosepond Creek and Vines Creek catchments on the existing conditions 100 year ARI design event flood regime; and
- Assess the combined hydraulic impact of proposed developments and increased rainfall intensities/tailwater conditions on the existing conditions 100 year ARI design event flood regime.

2. Topography and Drainage

The Janes Creek, Goosepond Creek and Vines Creek catchments are located in North Mackay and discharge to the lower reaches of the Pioneer River (via the Bassett Basin) near its outlet to the Pacific Ocean. The extent of each catchment is shown in Figure 2.

2.1 Janes Creek and Goosepond Creek Catchment

Janes Creek originates in the hills and cane lands of Farleigh and Richmond approximately 10km north-west of the CBD of Mackay. The creek changes its name to Goosepond Creek downstream of the upper crossing of the Bruce Highway. The creek passes through the suburbs of Glenella, Mt Pleasant and North Mackay and eventually joins Vines Creek, which discharges into the Bassett Basin.

Table 1 details the catchment areas for Goosepond Creek.

Table 1 Goosepond Creek Catchment Areas

Location	Area (km^2)
Upper Bruce Highway Crossing	15.35
Hill End Road	16.22
Lower Bruce Highway Crossing	21.16
Evans Avenue	23.86

The main land uses in the catchment are currently agriculture, rural residential, residential and commercial. The agricultural land is predominantly grazing and sugar cane farming. A number of applications currently exist with Council to develop parts of the catchment.

The elevation in the headwaters of Janes Creek catchment reaches 80.0m AHD whilst the floodplain levels adjacent to the Goosepond Creek range from 4.0m AHD in the lower reaches to 15.0m AHD in the Glenella region.

2.2 Vines Creek Catchment

The Vines Creek waterway originates in the Beaconsfield area and travels through the suburb of Andergrove where it is joined by the Multi-modal corridor and then Goosepond Creek before discharging into the Bassett Basin.

The Vines Creek catchment is approximately 11km^2 in area and includes residential areas, commercial zones and large areas of cleared grazing paddocks.

The elevation at the top end of the catchment is approximately 15.0m AHD and drops to approximately 2.5m AHD in the lower reaches. The catchment is characterised by a large area of low-lying land around the 4.0m AHD level.

3. Data Collection and Review of Background Information

3.1 Topographic Information

Topographic information was obtained from the following sources:

- Council supplied point data, comprised of:
  - The Mackay and Whitsunday Mapping Project data (photogrammetry) which was created in 1991 and has a horizontal and vertical accuracy of approximately ±1.0m over the extent of this dataset.
  - Mackay Urban Mapping (photogrammetry) derived from 2004 imagery which has a horizontal & vertical accuracy of approximately ±0.5m
  - Survey from Stormwater and Drainage studies. This includes those for Gaylard Street, City Centre and Bakers Creek Stockroute Road (east). These points were surveyed during 2006 and 2007.
  - Department of Environment and Resource Management (DERM,2009) LiDAR capture provided at 1.0 x 1.0m resolution with a quoted vertical accuracy of ± 0.5m;
- Council supplied breakline data:
  - The major portion of breaklines was derived using photogrammetry and was generated from 2004 imagery. These have a quoted vertical and horizontal accuracy of 0.5m and generally cover the entire urban extent, excluding the region between town and Walkerston;
  - The City Centre and river has since been upgraded. The breaklines defined here were generated of 2004 imagery and have a vertical and horizontal accuracy of 0.3m;
- Survey of ground levels, roads and hydraulic structures by undertaken by MRC (refer Section 3.5);
- As-constructed design levels for a number of property developments including:
  - Andergrove Lakeside Village Development, Andergrove; and
  - Valetta Gardens Estate.

These topographic data sets were used to generate a digital elevation model (DEM) of the study area and formed the basis of the hydraulic model (refer Section 5.3).

3.2 Existing Land Use

Categorisation of the land use that currently exists in the catchment was defined using:

- Mackay Regional Council Zoning information (Mackay City Planning Scheme);
- Aerial photography (2004) supplied by Mackay Regional Council;
- Remnant vegetation mapping supplied by Mackay Regional Council; and
- Field inspections.
- Existing land use in the Goosepond and Vines Creek catchments is shown in Figure 3.

3.3 Future Development

In addition to the existing catchment conditions, hydraulic modelling has been undertaken to determine the impact of a number of proposed developments. This was undertaken by adjusting the digital terrain model and roughness coefficients in the hydraulic model to represent the proposed changes in ground surface (fill or excavation) and surface roughness. It is noted that development 'footprints' were stamped onto the digital terrain model at a nominal elevation that exceeded the existing conditions 100 year ARI design flood level. The location of each of the proposed developments assessed is provided in Appendix F.

3.4 Survey Data

For the purpose of the current study, additional ground survey of the flow paths in the Goosepond and Vine's Creek catchments was undertaken by Mackay Regional Council. This included survey of major hydraulic structures such as road culverts and bridge crossings.

Survey data was used to refine the representation of major waterways in the digital elevation model and to accurately represent structures in the hydraulic model.

The locations where ground survey was undertaken are provided in Figure 8.

3.5 Previous Studies

- The following studies have been reviewed:
- Report on Further Goosepond Creek Hydraulics (Ullman & Nolan, November, 1994);
- Local Government Disaster Mitigation Project for Department of Emergency Services – Mackay Technical Reports, Mitigation Options, Working Papers and Mapping (Hatch, December, 1999);
- Mackay Flash Flood 17 November 2000 (Bureau of Meteorology, 2001);
- Pioneer River Flood Study (Chaseling McGiffin Pty Ltd, November 2004);
- Forgan Bridge Replacement Flood Study (Department of Main Roads, 2007);
- Hydraulic Report, Bruce Highway over Goosepond/Janes Creeks, Mackay (MR, June, 2008);
- Report on Queensland Floods February 2008 (Bureau of Meteorology, 2008); and
- Pioneer River Flood Study (WARM Water and Environment, October, 2011).

4. Hydrologic Assessment

A hydrologic assessment of the Goosepond, Janes and Vines Creek catchments has been undertaken to generate runoff hydrographs throughout the catchment for existing catchment conditions. Hydrologic modelling was used to determine flow rates within the catchment for the November 2000, February 2007 and February 2008 historical events and the 5 year, 50 year and 100 year Average Recurrence Interval (ARI) design events. Hydrologic modelling was also undertaken to determine the impact of climate change induced rainfall intensity increases of 20%.

4.1 Model Description

Hydrologic modelling of the catchment was undertaken using the XP-RAFTS rainfall-runoff routing model. RAFTS is based on the RSWM model developed by the Snowy Mountains Engineering Corporation (SMEC). RAFTS is an industry standard rainfall-runoff routing analysis package capable of modelling changes in development for both rural and urban sub-catchments. Version 6.12 (XP-RAFTS 2000) of the RAFTS program was used for this investigation.

The RAFTS model layout is shown in Figure 4. The modelled catchment was divided into 80 individual sub-catchments. Sub-catchment boundaries were originally provided by MRC and were refined by GHD using the MRC aerial survey data. The catchment was sub-divided such that sub-catchments were generally of similar area.

4.2 Model Data

RAFTS estimates the runoff hydrograph from an individual sub-catchment based on rainfall intensities and temporal patterns, and the definition of a series of parameters that describe the sub-catchment characteristics. These parameters include the sub-catchment area, slope, roughness and fraction of impervious area.

Sub-catchment outflow hydrographs are routed downstream through the model via links. In RAFTS, links take the form of either lag links or routing links. Lag links delay the hydrograph by a user specified time interval representing the time it takes for the flow to travel downstream to the next node. Routing links perform Muskingum-type channel routing calculations and require channel cross sectional dimensions and the slope, roughness and the length of the channel.

4.3 Sub-Catchment Data

The sub-catchment division is shown in Figure 4. Sub-catchments are represented in the RAFTS model by nodes at the outlet of the sub-catchment. Junction nodes are used to combine hydrographs at the junction of two or more flow paths.

Sub-catchment areas were determined digitally using the MapInfo GIS software. Sub-catchment equal-area slopes were determined using the DEM generated from the aerial survey data provided by the MRC. Sub-catchment roughness was determined based on an area-weighted average of the roughness values shown in Table 2.

Table 2 Sub-Catchment Roughness Based on Land Use

Land Use Type	Pervious Area Roughness	Impervious Area Roughness
Remnant vegetation	0.1	-
Urban residential / road	0.025	0.015
Rural agriculture/ rural residential (all other land uses)	0.07	0.015

RAFTS splits each sub-catchment into a pervious area contribution and an impervious area contribution. The amount of impervious area in each sub-catchment of the model was calculated from the land use data discussed in Section 3.2 and fraction impervious values for each land use category specified by MRC Planning Scheme Zones (refer Table 3).

The total areas for each land use type within the catchment are also provided in Table 3. The amount of pervious and impervious area within each sub-catchment is provided in Table 4.

The slope of each sub-catchment is also provided in Table 4.

Table 3 Impervious Fractions for Planning Scheme Zones

Planning Scheme Zone	Fraction Impervious	Area (km^2)
Commercial Centre	1.00	0.00
Commercial	0.90	0.47
Mixed Use	0.90	3.73
Higher Density Residential	0.75	0.09
Urban Residential (including roads)	0.50	4.70
Village (including roads)	0.50	0.01
Rural	0.00	18.91
Urban Expansion (including roads)	0.50	0.44
Rural Residential	0.20	0.89
Special Activities (Tourism)	0.75	0.00
Industry (High Impact)	0.90	0.90
Industry (Low Impact)	0.90	0.09
Sport and Recreation	0.00 – 0.90	0.12
Public Purposes	0.75	1.53
Open Space	Dependent on Use	3.37

Table 4 RAFTS Sub-Catchment Areas, Fraction Impervious and Slope

Sub-Catchment	Total Area (km^2)	% Impervious (Existing Conditions)	Slope (%)
J1	1.40	0.00	2.94
J2	1.16	0.00	1.52
J3	1.69	10.00	1.36
J4	1.17	5.00	1.90
J5	1.34	4.00	1.65
J6	2.43	8.00	1.30
J7	1.74	7.00	3.10
J8	2.32	0.00	1.31
J9	2.11	0.00	1.44
J10	0.87	32.00	1.64
G1	1.16	5.50	1.10
G2	1.56	13.20	1.91
G3	0.53	38.80	2.93
G4	0.53	0.00	0.29
G5	0.38	32.00	4.63
G6	0.37	5.00	0.33
G7	0.19	71.00	4.93
G8	0.23	54.20	1.02
G9	0.62	59.80	1.04
G5	0.38	32.00	0.88
G7	0.19	71.00	2.43
G4	0.53	0.00%	4.53
G6	0.37	5.00	0.97
G8	0.23	54.20	1.62
G10	0.18	31.80	2.27
G11	0.26	43.70	3.35
G12	0.20	38.00	1.73

Sub-Catchment	Total Area (km^2)	% Impervious (Existing Conditions)	Slope (%)
G13	0.22	41.50	4.15
G14	0.11	37.00	3.62
G15	0.27	43.00	4.03
G16	0.34	45.30	0.50
G17	0.11	32.60	0.76
G18	0.06	43.70	1.11
G19	0.05	43.80	1.10
G20	0.19	27.20	1.91
G21	0.09	33.60	2.93
G22	0.33	49.00	0.29
G23	0.17	22.60	4.63
V1	0.18	19.00	1.18
V2	0.08	50.00	1.99
V3	0.08	34.50	0.72
V4	0.12	44.50	1.01
V5	0.11	50.00	1.55
V6	0.20	16.20	0.11
V7	0.12	49.00	1.80
V8	0.12	13.50	0.37
V9	0.15	0.00	0.50
V10	0.05	50.00	0.81
V11	0.10	5.00	0.45
V12	0.09	47.00	1.17
V13	0.12	50.00	0.71
V14	0.08	39.00	1.41
V15	0.04	46.00	1.58
V16	0.10	5.00	1.45
V17	0.13	5.00	0.34

Sub-Catchment	Total Area (km^2)	% Impervious (Existing Conditions)	Slope (%)
V18	0.13	50.00	1.22
V19	0.53	43.00	1.87
V20	0.10	46.00	0.73
V21	0.09	46.00	1.19
V22	0.08	13.00	1.77
V23	0.24	22.00	2.62
V24	0.18	11.40	1.78
V25	0.09	5.00	1.96
V26	0.45	30.00	2.26
V27	0.09	5.00	0.54
V28	0.17	46.00	0.78
V29	0.17	18.00	3.70
V30	0.12	29.00	2.07
V31	0.19	50.00	0.33
V32	0.31	13.00	1.55
V33	0.12	21.00	1.08
V34	0.46	50.00	0.65
V35	0.29	38.00	0.55
V36	0.35	28.00	0.34
V37	0.32	23.00	0.49
V38	3.23	0.00	0.01
V39	0.12	0.00	3.00
V40	0.32	3.00	1.03
V41	0.35	30.00	0.65
V42	0.52	8.00	0.84

Link Data / Channel Routing:

The XP-RAFTS channel routing link has been used to rout flows between catchment nodes according to the Muskingum-Cunge procedure. Physical parameters including channel shape, roughness and slope have been used to calculate hydrograph attenuation and lag. The channel shape was obtained from Council's ground survey (2008) and aerial survey (2004).

Historical Rainfall Data:

Historical rainfall data from the BoM's Mackay Post Office Gauge and the Goosepond Alert Station (located on the northern bank of Goosepond Creek, immediately downstream of Willetts Road) was obtained for the November 2000, February 2007 and February 2008 storm events. Rainfall data for the February 2008 storm was also obtained from Grant Paterson's private gauge located in Glenella.

The rainfall records at the Mackay Post Office date back to 1870. An analysis of the highest daily rainfall totals at this station indicate that the highest daily rainfall total for the February 2008 was 698mm and that this was the highest in the period of record. The highest daily rainfall total from the November 2000 event was 328mm and was the 7th highest on record, whilst the highest daily rainfall total from the February 2007 event was lower at 282mm.

An intensity-frequency-duration (IFD) analysis of the rainfall intensities recorded at the Goosepond Alert Station was undertaken for the November 2000, February 2007 and February 2008 storm events. The maximum total rainfall that fell in time periods corresponding to each of the standard design storm durations was determined for each of the historical events. These were then compared to the IFD design event curves for Mackay to determine the average recurrence interval of the rainfall intensity in these periods (refer Figure 5).

Table 5 provides a summary of the intensity-frequency-duration analysis of the November 2000, February 2007 and February 2008 storm events.

Table 5 indicates that for the February 2008 event, rainfall intensities for durations between 30 minutes and 24 hours significantly exceeded the 100 year ARI intensities. The ARI for intensities with durations between 1 and 12 hours is estimated to be greater than 500 years. This means that on average, the probability of the February 2008 event being exceeded in any future year is less than 1 in 500 (or approximately 0.2%). Based on this probability, in the next 50 years there is approximately a 10% chance of the Goosepond Creek catchment experiencing rainfall intensities as high as those that occurred during the February 2008 flood.

The probability estimate for the February 2008 is supported by the BoM who state *"By looking at the behaviour of observed rainfall intensities over the durations 1 to 12 hours, it is reasonable to assume that for ARIs below 24 hours, especially around 6 hours, will be considerably greater than 0.5% AEP (200 year ARI)"* (BoM, February 2008).

Table 5 Intensity-Frequency-Duration Analysis for Goosepond Alert Station

Duration	Average Recurrence Interval (years)		
	November 2000 Event	February 2007 Event	February 2008 Event
5 Mins	2 – 5 yr ARI	<1 yr ARI	2 – 5 yr ARI
10 Mins	5 – 10 yr ARI	<1 yr ARI	10 – 20 yr ARI
15 Mins	10 – 20 yr ARI	<1 yr ARI	20 – 50 yr ARI
30 Mins	20 – 50 yr ARI	<1 yr ARI	100 to 200 yr ARI
1 Hr	>100 yr ARI	<1 yr ARI	>500 yr ARI
2 Hrs	>100 yr ARI	1 yr ARI	>500 yr ARI
3 Hrs	>100 yr ARI	1 – 2 yr ARI	>500 yr ARI
6 Hrs	>100 yr ARI	1 - 2 yr ARI	>500 yr ARI
12 Hrs	20 – 50 yr ARI	2 – 5 yr ARI	>500 yr ARI
24 Hrs	10 – 20 yr ARI	5 – 10 yr ARI	200 - 500 yr ARI

Rainfall Distribution:

In order to simulate the distribution of rainfall across the catchment for the February 2008 storm event, the pluviograph from Grant Paterson's private gauge was applied to catchments J1 to J10 in the Glenella area whilst the pluviograph from the Goosepond Creek Alert Station was applied to the remainder of the catchment.

For the 2000 and 2007 events, the pluviograph from the Goosepond Creek Alert Station was used to simulate the applied rainfall.

The pluviographs for the 2000, 2007 and 2008 historical events are reproduced in Figure 6.

Design Event Rainfall Data:

Design storms were simulated for the 5, 50 and 100 year ARI flood events using standard design storm durations ranging from 10 minutes to 72 hours.

Design rainfall depths were determined using CRC-FORGE data for the Goosepond Creek catchment. The CRC-FORGE data was developed for Queensland by the Department of Natural Resources and Mines. The data is available in gridded form and can be extracted for any location in Queensland using the Rainfall Application software (Version 1.0). The data consists of rainfall totals for storms with durations of 1 day to 5 days (in 1 day increments) and ARIs ranging from 50 to 2,000 years.

It is noted that CRCFORGE is a statistical (regional) analysis method that provides estimates of rare rainfall events at individual stations. To account for the variability of rainfall across a catchment, aerial reduction factors are typically applied to these point estimates based on the aerial-reduction factors in ARR (1987). In this instance, given the relatively small size of the catchment, an aerial reduction factor of 1 has been applied.

Rainfall intensities for durations less than 24 hours are were derived using the following formula:

$$I_{\text{X Years ARI, n hrs Duration}}\ \text{(CRC-FORGE)} = \frac{I_{\text{X Years ARI, n hrs Duration}}\ \text{(IFD)}}{I_{\text{X Years ARI, 24 hrs Duration}}\ \text{(IFD)}} \times I_{\text{X Years ARI, 24 hrs Duration}}\ \text{(CRC-FORGE)}$$

Where:

n = storm duration (hrs);

$I_{\text{X Years ARI, n hrs Duration}}$ (IFD) = X year n hour rainfall intensity derived using ARR (1999);

$I_{\text{X Years ARI, 24 hrs Duration}}$ (IFD) = X year 24 hour rainfall intensity derived using ARR (1999);

$I_{\text{X Years ARI, 24 hrs Duration}}$ (FORGE) = $_{X}$ year 24 hour rainfall intensity from CRC-FORGE data set.

The applied rainfall depths for the design events for durations up to 24 hours are provided in Table 6 below.

Table 6 CRC-FORGE Rainfall Depth Estimates (mm)

Storm Duration (hrs)	5 Year ARI Rainfall Depth (mm)	50 Year ARI Rainfall Depth (mm)	100 Year ARI Rainfall Depth (mm)
0.25	40.71	63.25	73.95
0.5	59.61	92.80	108.50
1	84.28	131.40	153.70
3	134.30	217.70	254.60
6	178.80	297.20	347.50
12	238.40	406.50	475.30
18	287.40	496.20	580.10
24	327.40	570.50	667.00
48	451.70	787.00	915.10
72	524.60	914.10	1067.00

It is noted that the CRC-FORGE Rainfall depths were generally 15% higher than those obtained using the Australian Rainfall and Runoff IFD method and therefore represent a more conservative estimate of design rainfalls.

Design event temporal patterns were sourced from Volume 2 of Australian Rainfall and Runoff: A Guide to Flood Estimation (The Institution of Engineers, Australia, 1987).

Rainfall Loss Parameters:

Different rainfall losses were assumed for pervious and impervious areas in the catchment. The assumed rainfall loss parameters are summarised in Table 7 below.

Table 7 Rainfall Loss Parameters

Type of Surface	Initial Loss (mm)	Continuing Loss (mm/hr)
Impervious Area	1	0
Pervious Area – 5 year ARI	10	2.5
Pervious Area – 50 year ARI	5	2.5
Pervious Area – 100 year ARI	0	2.5

Storage Routing Coefficient (B):

The storage routing coefficient was set to 1.0 for all historical and design event simulations.

4.4 Model Validation

In the absence of any stream gauging data for the catchment, the model was validated against peak flowrates predicted by the Rational Method (The Institution of Engineers, Australia, 1999). The validity of the model was also tested by comparing the flow rates predicted by the hydrologic model to those reported in other recent flood studies (refer Section 4.7).

As part of the Rational Method, the Bransby-Williams formula was used to determine the time of concentration at each of the validation locations, with a minimum time of concentration of 15 minutes adopted. Runoff coefficients for the Rational Method calculations were obtained from Australian Rainfall and Runoff Volume 1 and were based on the fraction impervious value for the catchment. A summary of the parameters used in the Rational Method calculations is provided in Table 8

Validation of the RAFTS model was achieved by varying the sub-catchment storage coefficients utilised in the rainfall-runoff routing procedure.

A comparison of the RAFTS and Rational Method peak flow rates at key locations[1] is provided in Table 9 for existing catchment conditions. Table 9 indicates that there is good agreement between the RAFTS and Rational Method peak flow estimates at each of the validation locations.

[1] Rational Method calculations are most valid where catchment storages do not attenuate runoff. As such, Rational Method calculations were only undertaken in the upper reaches of catchments where there were no significant storage effects.

Table 8 Parameters Used in Rational Method Calculations

Parameter	Node				
	J1	J4	J8	V1	V34
Area (ha)	139.601	117.26	231	18.25	45.82
% Impervious	0%	5%	0%	19%	50%
Slope (%)	2.94	1.9	1.31	1.18	0.9
L (km)	2	2	2.5	0.4	0.65
$T_{c\ (min)}$	91.19	101.26	127.41	26.83	41.98
$I_{Tc,5}$	64.40	60.75	53.39	122.84	98.44
$I_{Tc,50}$	88.09	95.08	84.16	189.36	151.70
$I_{Tc,100}$	114.48	108.42	96.13	215.16	172.35
C_5	0.60	0.62	0.59	0.85	0.76
C_{50}	0.75	0.78	0.74	1.06	0.95
C_{100}	0.79	0.81	0.78	1.11	0.99
Q5	15.07	12.27	20.35	5.27	9.47
Q50	25.77	24.01	40.10	10.16	18.25
Q100	35.16	28.75	48.09	12.12	21.77

Where :

A = catchment area in hectares;

Tc = time of concentration in minutes (using the Bransby-Williams formula);

ITc,x = design rainfall intensity for the time of concentration in mm/hr for an X year ARI storm event;

E. = existing development; and

Cx = Runoff co-efficient for an x year ARI storm event.

Table 9 Rational Method Validation of Hydrologic Model

Node	Peak Flows (m^3/s)								
	5 year ARI			50 year ARI			100 year ARI		
	Rational Method	XP-RAFTS	% Diff.	Rational Method	XP-RAFTS	% Diff.	Rational Method	XP-RAFTS	% Diff.
J1	18.3	15.07	-18%	32.4	25.77	-20%	39.7	35.16	-11%
J4	12.8	12.27	-4%	22.7	24.01	+6%	27.6	28.75	+4%
J8	25.5	20.35	-20%	43.4	40.10	-8%	52.1	48.09	-8%
V1	7.2	5.27	-27%	11.6	10.16	-12%	13.5	12.12	-10%
V34	16.3	9.47	-42%	23.6	18.25	-23%	26.9	21.77	-19%

4.5 Model Results

4.5.1 Historical Events

The peak flow rates at key locations for the 2000, 2007 and 2008 historical events are provided in Table 10 below.

Table 10 Peak flow rates for Historical Storm Events

Location	RAFTS Node	Cumulative Catchment Area (km^2)	Nov 2000 (m^3/s)	Feb 2007 (m^3/s)	Feb 2008 (m^3/s)
Upper Bruce Hwy (GPND)	J9	15.35	354	88	603
Hill End Rd	JJ4	16.22	420	106	741
Hicks Rd (GPND)	G7	20.94	433	110	774
Lower Bruce Hwy (GPND)	G8	21.16	436	110	783
Willetts Rd (GPND)	G10	21.96	447	113	811
Malcomson St (GPND)	G15	23.02	460	115	844
Glenpark St (GPND)	G19	23.57	467	116	863
Evans Avenue	G21	23.86	468	116	866
Beaconsfield Rd 1 (VC)	VJ6	1.64	59	12	73
Beaconsfield Rd 2 (VC)	VJ3	1.42	26	8	54
Glenpark Underpass	V28	4.03	113	27	166
Harbour Rd	VJ9	6.36	571	145	1050

Notes:

GPND = Goosepond Creek; and

VC = Vines Creek.

4.5.2 Existing Catchment Conditions

The peak flow rates at key locations for the design flood events for existing catchment conditions are provided in Table 11 below. A summary of XP-RAFTS model results for design flood events is also provided in Appendix B.

Table 11 Peak flow rates for Existing Catchment Conditions

Location	RAFTS Node	Cumulative Catchment Area (km^2)	5 year ARI (m^3/s)	50 year ARI (m^3/s)	100 year ARI (m^3/s)
Upper Bruce Hwy (GPND)	J9	15.35	170	303	371
Hill End Rd	JJ4	16.22	203	362	443
Hicks Rd (GPND)	G7	20.94	209	374	458
Lower Bruce Hwy (GPND)	G8	21.16	210	376	460
Willetts Rd (GPND)	G10	21.96	215	385	472
Malcomson St (GPND)	G15	23.02	221	395	485
Glenpark St (GPND)	G19	23.57	224	401	491
Evans Avenue (GPND)	G21	23.86	224	401	492
Beaconsfield Rd 1 (VC)	VJ6	1.64	30	61	73
Beaconsfield Rd 2 (VC)	VJ3	1.42	13	23	29
Glenpark Underpass	V28	4.03	58	106	124
Harbour Rd	VJ9	6.36	278	499	614

Notes:

GPND = Goosepond Creek; and

4.5.3 VC = Vines Creek.

4.6 Comparison to Previous Studies

There are two recent flood studies of the Goosepond Creek Catchment:

- Further Goosepond Creek Hydraulic Report (Ullman and Nolan, November, 1994); and
- Hydraulic Report – Bruce Highway over Goosepond/Janes Creeks Mackay (DMR, June 2008).

Both studies provide results from separately developed RORB hydrologic models of the Goosepond Creek catchment.

4.6.1 Comparison of GHD and Ullman and Nolan Flow Rates

Table 12 provides a comparison of the existing conditions design event peak flowrates predicted by the XP-RAFTS model and the ultimate development conditions peak flowrates reported in the Further Goosepond Creek Hydraulic Report (Ullman and Nolan, November, 1994).

Table 12 Comparison of Hydrologic Model Results

Location & RAFTS Node	Peak Flow Rate (m3/s)						% Difference		
	Ullman and Nolan 1994 RORB Model			GHD 2008 XP-RAFTS Model					
	5 Year ARI	50 Year ARI	100 Year ARI	5 Year ARI	50 Year ARI	100 Year ARI	5 Year ARI	50 Year ARI	100 Year ARI
Upper Bruce Hwy Crossing (J9)	167	322	375	170	303	371	+2%	-6%	-1%
Hill End Road (JJ4)	192	375	436	203	362	443	+6%	-3%	+2%
Lower Bruce Hwy Crossing (G8)	197	385	449	210	376	460	+7%	-2%	+3%
Malcomson Street (G15)	203	398	463	220	395	485	+8%	-1%	+5%
Evans Avenue (G21)	207	405	472	224	401	492	+8%	-1%	+4%

Table 12 indicates that the 5, 50 and 100 year ARI design event peak flowrates predicted by GHD's XP-RAFTS model are up to 8% higher than those predicted by Ullman and Nolan's 1994 RORB model.

Differences in predicted flowrates are due to the following factors:

- Differences in the level of development within the catchment;
- CRC-FORGE rainfall intensities were applied in the GHD XP- RAFTS model, whilst IFD derived rainfall intensities were applied in the Ullman and Nolan RORB model;
- Minor differences in catchment delineation; and
- Minor differences in initial rainfall losses.

4.6.2 Comparison of GHD and DMR Flow Rates

Table 13 provides a comparison of the peak flowrates predicted by DMR's RORB model of the existing catchment and GHD's XP-RAFTS model.

Table 13 Peak Flood Discharges at Bruce Highway Bridge Crossings

Event	Goosepond Creek			Janes Creek		
	DMR	GHD	% Diff	DMR	GHD	% Diff
5 Yr ARI	188	210	+12%	149	170.2	+14%
50 Yr ARI	380	376	-1%	306	303	-1%
100 Yr ARI	450	460	+2%	365	371	+2%
2008	779	782	+0.5%	n/a	-	-

Table 13 indicates that the 5, 50 and 100 year ARI design event and the 2008 peak flowrates predicted by GHD's XP-RAFTS model are in very close agreement with those predicted by DMR.

4.6.3 Conclusion

The close agreement between the results obtained from GHD's XP-RAFTS model, the Ullman and Nolan's 1994 RORB model and the DMR RORB model indicate that GHD's hydrologic model provides a good estimate of design flowrates and is suitable for the purposes of this project.

4.7 Climate Change Impact Assessment

In order to assess the impact of climate change on flooding within the study area, Council requested that the hydrologic model be run with a 20% increase in rainfall intensity for the 100 year ARI 60 minute and 24 hour design events. This is consistent with the recommendations in the Department of Resources Management, Increasing Queensland's resilience to inland flooding in a changing climate- Final Scientific Advisory Group Report (DERM,2010). These increases in rainfall intensity generally resulted in 20% increase in runoff from local catchments.

The hydrographs from these scenarios were used as inputs in the hydraulic model to determine the impact of potential future climate change on existing conditions flood levels.

5. Hydraulic Model Setup and Calibration

5.1 Model Setup

Hydraulic modelling has been undertaken using a 1D-2D hydraulic modelling approach. This methodology has been selected so that the best features of both approaches can be realised. For example, the two-dimensional component of the hydraulic model has been used to more accurately simulate the two-dimensional flow patterns in the low-lying areas whilst the one-dimensional component has been used to more accurately simulate head loss across hydraulic structures such as bridge crossings and culverts. By combining 1D and 2D hydraulic modelling approaches, known and unknown flow paths are more accurately simulated with Council's aerial survey data used to its full capacity.

The extent of the 1D-2D hydraulic model is provided in Figure 7.

5.2 Software Description

Hydraulic modelling has been undertaken with the MIKE FLOOD software package. MIKE FLOOD is a hydraulic modelling package developed by DHI that integrates the one-dimensional MIKE11 and the two-dimensional MIKE21 models into a single, dynamically coupled hydraulic modelling system.

5.3 Bathymetric and Topographic Representation

The basis of the hydraulic model is a digital terrain model of the study area. The digital terrain model was generated by using the following bathymetric and topographic data:

- Council supplied photogrammetry data (refer Section 3.1);
- Council supplied LiDAR data;
- Council supplied spot heights;
- Council supplied breaklines;
- Council supplied waterway cross section survey; and
- As constructed design levels provided by developers.

The digital terrain model was generated with care taken to ensure that all hydraulically significant topographic features such as roads, levees, storages and waterways were represented as accurately as possible. The aerial survey data was also checked against ground survey where such data existed.

In developing the digital terrain model, a cell size of 5m x 5m was adopted to accurately represent the bathymetry and topography of the study area whilst limiting model run times to an acceptable length of time.

A plot of the digital terrain model is provided as Figure 7 whilst Figure 8 provides a summary of each of the data sources used to generate the digital terrain model.

5.4 Surface Roughness

The Manning's 'n' roughness coefficient has been used to represent the spatially varying 'roughness' across the hydraulic model extent. Initial estimates for the roughness coefficients were determined by field inspection and analysis of aerial photography. These values were then refined during calibration of the hydraulic model and confirmed through a second site visit.

Table 14 illustrates the basis for the assignment of roughness coefficients.

Table 14 Manning's 'n' Roughness Coefficients

Surface	Manning's Coefficients
Roadway	0.02
Urban	0.14
Channel	0.03
Trees	0.10 to 0.12
Sugar Cane	0.12 - 0.14
Grassland	0.04

Figure 9 illustrates the spatial distribution of Manning's 'n' roughness coefficients adopted in the calibrated hydraulic model.

5.5 Hydraulic Structures

There are a large number of hydraulic structures that have been included in the hydraulic model. The dimensions of each of the hydraulic structures and waterway crossings were obtained from Council survey. Table 15 provides a summary of the hydraulic structures included in the MIKEFLOOD model whilst the location of each of the structures is provided in Figure 10.

Table 15 Modelled Hydraulic Structures

Location	Details
NC Railway Bridge (GPND)	4x 1.0m diameter Circular Piers
NC Railway Bridge (GPND)	9 x 1500 x 650mm RCBC
Upper Bruce Hwy (GPND)	4x 0.6m Headstock and Pier
Glenella Rd (GPND)	4 x 3050 x 3050mm RCBC
Sugarshed Rd (GPND	3 x 1075mm RCP
Hicks Rd (GPND)	2 x 1200 x 450mm RCBC and 1 x 1200 x 900mm RCBC
Lower Bruce Hwy (GPND)	70 x 0.5m Circular Piers
Willetts Rd (GPND)	6 x 2500 x 2600mm RCBC
Malcomson St (GPND)	Pedestrian Bridge, 4x 0.4m Piers
Glenpark St (GPND)	6 x 0.5m Piers with 0.7m Headstock
Andergrove Access Easement (VC)	3 x 1050mm RCP
Beaconsfield Rd 1 (VC)	7 x 1200mm RCP
Beaconsfield Rd 2 (VC)	12 x 1200mm RCP
Railway Crossing 1 (VC)	8 x 1200mm RCP
Railway Crossing 2 (VC)	13 x 1250mm RCP
Bikepath 1 (GPND)	4 x 3000 x 2200mm RCBC
Bikepath 2 (GPND)	5 x 900mm RCP

Notes: GPND = Goosepond Creek, VC = Vines Creek, RCBC = Reinforced Concrete Box Culvert, RCP = Reinforced Concrete Pipe, NC = North Coast.

5.6 Boundary Conditions

The location of 2D model boundary conditions is provided in Figure 11.

5.6.1 Inflow Boundary Conditions

Boundary conditions in the MIKEFLOOD model consist of inflow hydrographs at the upstream extent of the model, local catchment "point source" inflows throughout the model and downstream tail-water conditions. Inflow hydrographs were generated using the hydrologic model (XP-RAFTS) of the catchment (refer Section 4). The peak inflows for each of the historical events are provided in Section 5.9.2 whilst peak inflows for existing condition design events are provided in Section 6.2. It is noted that in agreement with Council, the hydraulic model has only been run with flowrates derived for existing catchment conditions.

5.6.2 Downstream Boundary Conditions

The downstream boundary of the Goosepond Creek hydraulic model is located at the junction of the Goosepond Creek and the Pioneer River. It is noted that the Port Access Corridor (railway line) downstream of Goosepond and Vines Creek has been treated as a closed boundary.

Table 16 provides a summary of the tailwater conditions adopted in the hydraulic model. The development of these tailwater conditions is detailed as follows:

- For each historical event, dynamic tailwater conditions have been extracted from the Forgan Bridge Alert Station;
- Following completion of the Pioneer River Flood Study (WRM, 2011), Council requested that the 5 year ARI Pioneer River flood level (4.08 m AHD) predicted to occur at the junction of Goosepond Creek and the Pioneer River be adopted as the tailwater condition for Goosepond Creek when assessing 50 and 100 year ARI local flood events in Goosepond Creek.
- The Mean High Water Spring Tide in the Pioneer River has been adopted as the tailwater condition when assessing flooding during the 5 year ARI design event in Goosepond Creek. This level is consistent with tailwater levels observed during previous minor flooding of Goosepond Creek.

Table 16 Adopted Tailwater Conditions

Event	Tailwater level (m AHD)
November, 2000	Dynamic tide (peak level = 2.61 m AHD)
February, 2007	Dynamic tide (peak level = 4.06 m AHD)[a]
February, 2008	Dynamic tide (peak level = 4.06 m AHD)[a]
5 yr ARI	2.34 m AHD (Mean High Water Springs)
50 yr ARI	4.08 m AHD[b]
100 yr ARI	4.08 m AHD[b]
100 yr ARI (sensitivity analysis)	5.32 m AHD[c]

Note: a) For the 2007 and 2008 historical events, the tidal signal from the Forgan Bridge gauge was applied at the downstream boundary since a tidal signal was not available at the Goosepond Creek / Pioneer River junction. b) This level represents the 5 year ARI Pioneer River flood level at the junction of Goospond Creek and the Pioneer River. c) This level represents the 100 year ARI Pioneer River flood level at the junction of Goospond Creek and the Pioneer River

5.6.3 Sensitivity Analysis

The Further Goosepond Creek Hydraulics Report (Ullman and Nolan, 1994) adopted a downstream tailwater condition of 6.00m at Kingsford Court in their Goosepond Creek hydraulic model of the 100 year ARI design event. This level was based on previous physical model studies of the flooding in the Pioneer River and Basset Basin associated with a Pioneer River flowrate of 10,500m^3/s estimated as having an Average Recurrence Interval of 42 years.

In order to test the sensitivity of the existing conditions Goosepond Creek hydraulic model to downstream tailwater conditions, the 100 year ARI design event was also run with a tailwater level of 5.32 m AHD. This is equivalent to the 100 year ARI flood level predicted for this area in the Pioneer River Flood Study (WRM, 2011).

5.7 Initial Conditions

Initial conditions were applied in the hydraulic model(s). These typically consisted of a set of adopted 'starting' flood levels in low-lying areas, waterways and storages. At the downstream boundary of the model, initial flood level conditions were set to equal the relevant tailwater boundary condition. Initial flood levels in key storages were set at the 'normal' standing flood level and were determined in consultation with Council.

In some instances model 'hotstart' files were used to create a set of appropriate initial conditions for the hydraulic model(s).

5.8 Other Parameters

Values for eddy viscosity were applied according to industry standard practise. Constant values for eddy viscosity were determined using the following formula:

Eddy Viscosity = 0.02 x Cell Size in X direction x Cell Size in Y direction / time step.

In order to increase the likelihood of model stability and the accuracy of model results, model time steps were selected to keep Courant numbers below a value of three. This resulted in time steps ranging from 0.5-2.0 seconds.

5.9 Calibration and Verification

5.9.1 Calibration Event

The selection of calibration events is largely governed by the availability and quality of recorded rainfall and flood level information. The main source of rainfall and flood level information for Goosepond and Vines Creek was:

- Rainfall data recorded at the Goosepond Alert Station;

- Rainfall data recorded at Grant Paterson's private gauge located in Glenella;
- Recorded flood levels at the Goosepond Alert Station for the November 2000, February 2003 February 2007 and February 2008 flood events;
- Council survey of flood levels for the February 2007 flood event;
- Council survey of flood levels for the February 2008 flood event; and
- Aerial photographs of the February 2008 flood event.

In agreement with MRC, the February 2007 and 2008 events were selected for calibration of the hydraulic model. The model calibration was verified by simulating the November 2000 event.

5.9.2 Historical Event Inflow Hydrographs

Table 17 provides a summary of the peak discharges for the historical hydrographs applied at each of the point source inflow nodes in the MIKEFLOOD model. Hydrographs were obtained from the hydrologic model described in Section 4.

Table 17 Historical Catchment Peak Flows (m^3/s)

Location*	2000 (m^3/s)	2007 (m^3/s)	2008 (m^3/s)
PS1	196	50	342
PS2a	21	6	43
PS2b	21	6	43
PS3a	22	6	39
PS3b	22	6	39
PS4a	22	5	33
PS4b	22	5	33
PS5	24	6	42
PS6a	19	5	29
PS6b	19	5	29
PS7	25	7	41
PS8	18	4	21
PS9	20	5	31
PS10	25	6	34
PS11	17	4	20
PS12	12	2	12
PS13	25	5	27
PS14	8	2	12
PS15	17	4	22
PS16	12	3	15

Location*	2000 (m^3/s)	2007 (m^3/s)	2008 (m^3/s)
PS17	13	3	20
PS18a	23	5	27
PS18b	23	5	27
PS19	20	5	28
PS20	5	1	8
PS21	6	1	8
PS22	5	1	7
PS23	22	5	27
PS24	18	4	21
PS25a	25	7	42
PS25b	25	7	42
PS26	28	8	48
PS27	n/a	9	50

Notes:

1) Refer Figure 11 for the locations where hydrographs were applied in the hydraulic model.

2) At some locations point source inflow hydrographs were distributed across two or more adjacent hydraulic model cells (e.g. PS2a and PS2b) to avoid model instabilities generated by excessive flux.

5.9.3 Calibrated Flood Levels and Velocities

Calibration of the hydraulic model was achieved by refinement of the initial Manning's 'n' roughness coefficients that were determined from field inspection and analysis of aerial photography.

5.9.4 2007 Event

Figure 12 illustrates the extent of flooding and the level of calibration achieved for the February 2007 flood event. Peak flood velocities for the February 2007 flood event are also provided in Figure 13

Figure 12 indicates that 50% of the predicted flood levels are within ±200mm of recorded flood levels.

The predicted flood level at the Goosepond Alert Station gauge was 5.90m AHD. This compares reasonably well to the peak level of 6.15m AHD recorded by the BoM at this gauge.

5.9.5 2008 Event

Figure 14 illustrates the extent of flooding and the level of calibration achieved for the February 2008 flood event. Peak flood velocities for the February 2008 flood event are also provided in Figure 15.

Figure 14 indicates that 70% of the predicted flood levels are within ±200mm of recorded flood levels and 84% are within ±300mm of recorded flood levels.

The predicted flood level at the Goosepond Alert Station gauge was 7.91 m AHD. This compares well to the peak level of 7.70 m AHD recorded by the BoM at this gauge.

5.9.6 Verification

The calibrated hydraulic model was verified by simulating the November 2000 flood event.

Figure 16 illustrates the extent of flooding for the November 2000 flood event. Peak flood velocities for the November 2000 flood event are also provided in Figure 17.

Results indicate that the hydraulic model predicts a peak flood level of 6.64m AHD at the Goosepond Alert Station gauge. This compares well to the peak level of 6.70m AHD recorded by the BoM at this gauge. It is noted that a survey of flood levels was not undertaken by MRC following the November 2000 flood event so a more detailed comparison to additional historical flood levels is not possible.

5.9.7 Discussion

Differences between the predicted and recorded flood levels could be attributable to a number of factors. These include:

- A limited set of recorded flood levels;
- A lack of information regarding the time at which flood levels were recorded;
- A lack of flow gauges; and
- The accuracy of aerial survey:
  - The Mackay and Whitsunday Mapping Project data (photogrammetry) created in 1991 and has a horizontal and vertical accuracy of approximately $\pm$1.0m over the extent of this dataset;
  - Mackay Urban Mapping (photogrammetry) derived from 2004 imagery and has a horizontal & vertical accuracy of approximately $\pm$0.5m; and
  - The DERM 2009 LiDAR survey with a quoted accuracy of $\pm$0.5m.
- The hydraulic model has a grid cell size of 5m and the representation of bathymetry and topography is limited to this scale.

Based on the results of the calibration and verification simulations and considering the limitations listed above, it is concluded that:

- The hydraulic model has been calibrated to an acceptable level; and
- The hydraulic model is suitable for estimating flood levels for the 5, 50 and 100 year ARI design flood events.

6. Hydraulic Assessment of Existing Catchment Conditions

6.1 Introduction

This section summarises the hydraulic modelling undertaken for the 5, 50 and 100 year ARI design events for existing catchment condition flow rates. It is noted that the maximum flood levels and velocities referred to in this section represent the maximum flood levels and velocities from all of the storm durations run for each ARI design event (i.e. they represent an 'envelope of maxima').

Flood inundation maps of peak flood levels and velocities are provided in Appendix C.

6.2 Inflow Boundary Conditions

Table 18 provides a summary of peak flowrates for the design event inflow hydrographs applied in the calibrated hydraulic model. It is noted that the 24 hour event was found to be the critical event for the Goosepond Creek catchment whilst the 60 minute event was found to be the critical event for the Vines Creek catchment. As such (and in accordance with the study brief), hydraulic modelling has been undertaken for only these two storm durations.

Table 18 Existing Catchment Peak Flows

Location*	5 yr ARI 60 mins (m^3/s)	5 yr ARI 24 hours (m^3/s)	50 yr ARI 60 mins (m^3/s)	50 yr ARI 24 hours (m^3/s)	100 yr ARI 60 mins (m^3/s)	100 yr ARI 24 hours (m^3/s)
PS1	53	98	112	174	143	214
PS2	10	21	21	38	27	47
PS2a	5	11	11	19	13	23
PS2b	5	11	11	19	13	23
PS3	11	21	23	38	29	46
PS3a	5	11	11	19	15	23
PS3b	5	11	11	19	15	23
PS4	16	24	33	43	42	52
PS4a	8	12	16	22	21	26
PS4b	8	12	16	22	21	26
PS5	7	12	13	21	16	25
PS6	17	18	29	34	35	42
PS6a	9	9	15	17	18	21
PS6b	9	9	15	17	18	21
PS7	19	13	33	20	41	24
PS8	21	8	32	13	38	15

Location*	5 yr ARI 60 mins (m^3/s)	5 yr ARI 24 hours (m^3/s)	50 yr ARI 60 mins (m^3/s)	50 yr ARI 24 hours (m^3/s)	100 yr ARI 60 mins (m^3/s)	100 yr ARI 24 hours (m^3/s)
PS9	16	10	28	15	34	19
PS10	21	15	34	25	41	29
PS11	16	8	27	13	32	15
PS12	7	5	14	8	17	10
PS13	25	11	41	17	49	20
PS14	8	5	13	8	16	9
PS15	15	9	24	15	29	17
PS16	8	7	14	10	17	12
PS17	10	8	17	12	21	3
PS18	30	23	53	35	65	42
PS18a	15	11	27	18	33	21
PS18b	15	11	27	18	33	21
PS19	18	10	29	16	35	8
PS20	2	3	4	5	5	2
PS21	4	3	7	5	8	7
PS22	2	3	5	5	6	6
PS23	14	12	25	19	31	22
PS24	14	9	24	14	29	16
PS25	49	30	76	51	91	61
PS25a	25	15	38	25	45	30
PS25b	25	15	38	25	45	30
PS26	13	13	22	25	27	30
PS27	42	21	67	32	80	38
PS27a	21	10	33	16	40	19

Notes:

1) Refer Figure 11 for the locations where hydrographs were applied in the hydraulic model.

2) At some locations point source inflow hydrographs were distributed across two or more adjacent hydraulic model cells (e.g. PS2a and PS2b) to avoid model instabilities generated by excessive flux.

6.3 5 year ARI Design Event Results

Figures C1 and C5 illustrate the maximum predicted flood levels and velocities for the 5 year ARI design event for existing catchment conditions.

6.4 50 year ARI Design Event Results

Figures C2 and C6 illustrate the maximum predicted flood levels and velocities for the 50 year ARI design event for existing catchment conditions.

6.5 100 year ARI Design Event Results

Figures C3 and C4 illustrate the maximum predicted flood levels for the 100 year ARI design event for existing catchment conditions with tailwater levels of 4.08 (5 year ARI Pioneer River flood level) and 5.32m (100 year ARI Pioneer River flood level) respectively.

Figures C7 and C8 illustrate the maximum predicted flood velocities for the 100 year ARI design event for existing catchment conditions with tailwater levels of 4.08 and 5.32m respectively.

6.6 Summary of Peak Flood Levels Flood Timing at Road Crossings

A summary of predicted flood levels and flood timing for existing catchment conditions at key road crossings of Janes Creek, Goosepond Creek and Vines Creek are provided in Table 19 and Table 20 respectively. Results indicate that:

- All roads except the Bruce Highway and Glenpark Street will be overtopped during the 50 year and 100 year ARI design events; and
- All roads except Glenella (marginally) , Hicks Road, Malcolmson Street and Evans Avenue will be immune from flooding during the 5 year ARI design event.

Table 19 Predicted Peak Flood Levels at Road Crossings (m AHD)

Location	Road Level[e]	2000 year Event	2007 year Event	2008 year Event	5 year ARI	50 year ARI	100 year ARI[c]	100 year ARI[d]
U/S[a] Upper Bruce Hwy	13.22	13.02	11.55	13.84	12.17	12.80	13.15	13.15
D/S[b] Upper Bruce Hwy		12.36	11.46	13.19	11.84	12.29	12.45	12.45
U/S Glenella Rd	8.87	9.11	8.70	9.79	8.88	9.09	9.18	9.18
D/S Glenella Rd		8.92	8.51	9.71	8.68	8.91	9.02	9.02
U/S Hicks Rd	6.54	8.16	7.42	9.16	7.66	8.12	8.31	8.31
D/S Hicks Rd		7.99	7.27	9.03	7.51	7.96	8.17	8.17
U/S Lower Bruce Hwy	9.00	7.94	7.24	8.94	7.49	7.92	8.13	8.13
D/S Lower Bruce Hwy		7.91	7.25	8.94	7.49	7.92	8.12	8.12
U/S Willetts Rd	6.42	6.74	6.04	7.99	6.23	6.73	6.96	7.04
D/S Willetts Rd		6.66	5.94	7.90	6.14	6.63	6.87	6.95
U/S Malcomson St	5.46	6.02	5.52	7.07	5.65	6.04	6.25	6.41
D/S Malcomson St		5.82	5.15	6.90	5.30	5.85	6.08	6.29
U/S GlenPark St	6.72	5.56	5.02	6.51	5.11	5.62	5.83	6.11
D/S GlenPark St		5.50	4.97	6.45	5.07	5.56	5.77	6.05
U/S Evans Av	3.95	5.46	4.94	6.37	5.04	5.52	5.72	6.02
D/S Evans Av		5.44	4.92	6.35	5.02	5.50	5.70	6.00

Notes: a) U/S = Upstream, b) D/S = Downstream, c) Applied tailwater = 4.08m AHD, d) Applied tailwater = 5.32m AHD e) Road Level extracted from highest point of road normal to direction of flow

Table 20 Predicted Time to Peak at Road Crossings (hrs)

Location	2000 year Event	2007 year Event	2008 year Event	5 year ARI	50 year ARI	100 year ARI[b]	100 year ARI[c]
U/S Upper Bruce Hwy	4.25	24.50	6.25	4.50	4.00	3.75	3.75
U/S Glenella Rd	5.00	23.75	7.50	6.00	5.50	5.00	5.00
U/S Hicks Rd	5.75	22.5	7.50	7.50	6.50	6.00	6.00
U/S Lower Bruce Hwy	5.75	22.25	7.50	7.50	6.50	6.00	6.00
U/S Willetts Rd	6.25	22.00	7.50	7.50	6.50	6.00	6.00
US Malcomson St	6.25	22.50	7.50	7.75	6.75	6.50	6.00
U/S GlenPark St	6.50	23.00	7.75	8.00	7.00	6.75	6.50
U/S Evans Av	6.75	22.50	7.75	8.25	7.25	6.75	6.50
U/S Harbour Rd	9.25	23.75	11.00	10.00	9.00	8.50	2.50

Notes:

U/S = Upstream, b) Applied tailwater = 4.08m AHD. This level represents the 5 year ARI Pioneer River flood level at the junction of Goospond Creek and the Pioneer River. c) Applied tailwater = 5.32 m AHD. This level represents the 100 year ARI Pioneer River flood level at the junction of Goospond Creek and the Pioneer River.

Time to peak is only available from the model in 15 minute time increments. As such, the time to peak at some road crossings is identical when in reality there will be timing differences.

6.7 Comparison of Predicted Flood Levels to Existing Reports

A previous flood study of Janes Creek and Goosepond Creek was prepared by Ullman and Nolan Pty Ltd (U&N) for the Pioneer River Improvement Trust (PRIT) in 1994. The U&N study set reclamation limits and flood levels from the upper Bruce Highway crossing at Glenella to Evans Avenue in North Mackay. The Report from this study, Report on Further Goosepond Creek Hydraulics was used to set development levels for residential and commercial developments such as Oasis Waters, Edgewater Estate, Glenfields and Northpoint Retail.

Significant differences exist between the methodology and assumptions adopted in this current study (GHD, 2009) and those adopted by Ullman and Nolan. These are summarised in Table 21.

Table 21 Comparison of GHD and Ullman & Nolan Methodologies and Assumptions

Flood Study Parameter	GHD	Ullman & Nolan
Hydrologic model	XP-RAFTS	RORB
Hydraulic model type	The GHD model is a fully integrated dynamic 1D/2D flood model (MIKEFLOOD) with the full floodplain topography represented in three dimensions.	The U&N Study used a steady state 1D hydraulic model (HEC1) with a channel or "reclamation limit" to define the compounds of Goosepond Creek. This varied in width but was in the order of 170 m wide.
Hydraulic model extent	2D model of waterway and floodplain.	170 m wide reclamation channel, narrower sections around Malcomson Street area.
Calibration of hydraulic model	Calibration to two historical flood events and verification to one historical flood event.	No calibration or verification.
Hydraulic Roughness (Manning's n)	◗ Roadway = 0.02 ◗ Urban = 0.14 ◗ Channel = 0.03 ◗ Trees = 0.10 to 0.12 ◗ Sugar Cane = 0.14 ◗ Grassland = 0.04	◗ n = 0.027 downstream of Willetts Road; ◗ n = 0.040 channel & n =0.035 overbank upstream of Willetts Road.
Storm Durations	10 minutes to 72 hours	1 to 12 hours
Tail flood level (Bassett Basin)	◗ 2.34m AHD for 5 year ARI event; ◗ 4.08 AHD for 50 & 100 year ARI event. This level represents the 5 year ARI Pioneer River flood level at the junction of Goospond Creek and the Pioneer River. ◗ 5.32 m for 100 year ARI flood in Pioneer River. This level represents the 100 year ARI Pioneer River flood level at the junction of Goospond Creek and the Pioneer River.	◗ 6.0 m for 42 year ARI flood in Pioneer River; ◗ 6.5 m for 50 year ARI flood in Pioneer River.

A comparison of the existing flood levels predicted by GHD and U&N is provided in Table 22. Table 22 indicates that the differences in adopted methodology, topographic data sets and tailwater conditions result in different estimates for the 5, 50 and 100 year ARI flood profiles. However, given that GHD's MIKEFLOOD model is a calibrated fully dynamic 1D/2D hydraulic model with full floodplain representation, the model is considered to provide more accurate predictions of design event flood levels than the steady state 1D Ullman & Nolan hydraulic model.

Table 22. Comparison of GHD and Ullman & Nolan Flood Levels

Location	GHD 5 yr ARI Flood Level (mAHD)	GHD 50 yr ARI Flood Level (mAHD)	GHD 100 yr ARI Flood Level * (mAHD)	GHD 100 yr ARI Flood Level ** (mAHD)	U&N 5 yr ARI Flood Level (mAHD)	U&N 50 yr ARI Flood Level (mAHD)	U&N 100 yr ARI Flood Level (mAHD)	5yr ARI Difference (m)	50yr ARI Difference (m)	100yr ARI Difference * (m)	100yr ARI Difference ** (m)
Upper Bruce Highway Upstream	11.37	11.80	12.01	12.01	12.11	13.00	12.76	0.74	1.20	0.75	0.75
Upper Bruce Highway Downstream	11.28	11.64	11.80	11.80	11.45	11.89	12.02	0.17	0.25	0.22	0.22
Glenella Road Upstream	8.65	8.87	8.93	8.93	8.80	9.34	9.50	0.15	0.47	0.57	0.57
Hicks Road Downstream	6.97	7.33	7.51	7.52	7.40	8.02	8.19	0.43	0.69	0.68	0.67
Lower Bruce Highway Dowstream	6.92	7.27	7.44	7.45	7.24	7.77	7.91	0.32	0.50	0.47	0.46
Willets Road Downstream	5.58	5.97	6.15	6.53	6.34	7.08	7.19	0.76	1.11	1.04	0.66
Malcomson Street Downstream	4.42	4.79	5.00	6.34	6.10	6.73	6.45	1.68	1.94	1.45	0.11
Glenpark Street Downstream	4.30	4.62	4.78	6.29	6.05	6.61	6.23	1.75	1.99	1.45	-0.06

* Based on 5 year ARI Pioneer River tailwater (WRM,2011)

** Based on 100 year ARI Pioneer River tailwater (WRM,2011)

6.8 Climate Change Impact Assessment

In order to assess the impact of climate change, the existing conditions hydraulic model has be run for the 100 year ARI design event for the following scenarios:

- Existing Conditions with 20% increase in rainfall intensity; and
- Tailwater conditions increased by 0.70m from 4.08 to 4.78 m AHD to allow for potential future sea level rise. The 0.7m increase in tailwater represents levels extracted at the junction of Goosepond Creek and the Pioneer River from the Pioneer River 5 year ARI + Climate Change Design Event (WRM,2010)[2] based on discussion with Council.

These increases in rainfall intensity and the adopted tailwater conditions are consistent with the Department of Resources Management Increasing Queensland's Resilience to Inland Flooding in a Changing Climate - Final Scientific Advisory Group Report (DERM,2010) and the Queensland Stage Planning Policy 3/11 (DERM, 2012).

A series of maps illustrating the maximum predicted flood level and the expected increase in flood level (afflux) for each of these scenarios is provided in Figures C9 to C12. It is noted that afflux maps represent the increase in flood level above the existing conditions case with no increase in rainfall intensity and no new development.

Results indicate that a 20% increase in rainfall intensity and tailwater increase of 0.70m will cause:

- Increases in flood levels of 100mm to 220mm along Janes Creek in Glenella;
- Increases in flood levels of 190mm to 570mm along Goospond Creek in North Mackay; and
- Increases in flood levels of 350mm to 390mm in the Andergrove region.

[2] The Pioneer 5 year ARI Climate Change Design Event adopted an increase in tailwater of 0.8m at the mouth of the Pioneer River.

7. Hydraulic Assessment of MRC Riverine Revegetation Strategy

7.1 Revegetation Assessment

In order to improve the water quality in Goosepond Creek, MRC has developed a riverine revegetation strategy that it plans to implement in several locations along the Goosepond Creek waterway. The extent of the revegetation strategy is provided in Figure D1 in Appendix D.

In order to test the impact of the re-vegetation strategy on the existing hydraulic regime of Goosepond Creek, the calibrated hydraulic model was run for the 100 year ARI design event with the model roughness coefficient (Manning's 'n') increased in the revegetated areas (refer Figure D1).

The impact of the re-vegetation strategy on existing flood levels and velocities for the 100 year ARI design event is provided in Figures D3 to D4.

Model results indicate that the proposed re-vegetation strategy will:

- Increase flood levels by up to 0.07m upstream of the Bruce Highway crossing in Glenella with a minor change in flood velocities;
- Increase flood levels by approximately 0.16m and reduce flood velocities by a maximum of 1.02 m/s in the reach of Goosepond Creek located between Glenella Road and Hicks Road;
- Increase flood levels by 0.04 to 0.13m in the waterway and floodplain located between Hicks Road and Willetts Road;
- Increase flood levels by 0.04 to 0.09m in the waterway and floodplain located between Willetts Road and Malcomson Street; and
- Reduce flood levels by -0.03m in the Andergrove region (resulting from a change in the timing of peak flood flows along Goosepond Creek).

7.2 Climate Change Impact Assessment

In order to assess the hydraulic impact on the 100 year ARI design event existing conditions flood regime due to the combined effects of the revegetation strategy and potential future climate change, the hydraulic model has be run for the 100 year ARI design event with a 20% increase in rainfall intensity and 0.70m increase in tailwater conditions.

A series of maps illustrating the maximum predicted flood level and the expected increase in flood level (afflux) for each of these scenarios is provided in Figures D5 to D7. It is noted that afflux maps represent the increase in flood level above the existing conditions case with no increase in rainfall intensity, tailwater and no re-vegetation.

Model results indicate that the proposed re-vegetation strategy under the effects of potential future climate change will:

- Increase flood levels by up to 0.28m upstream of the Bruce Highway crossing in Glenella with reductions in flood velocities of up to 0.13;
- Increase flood levels by up to 0.34m and reduce flood velocities by a maximum of 1.02 m/s in the reach of Goosepond Creek located between Glenella Road and Hicks Road;
- Increase flood levels by 0.23 to 0.31m in the waterway and floodplain located between Hicks Road and Willetts Road;
- Increase flood levels by 0.31 to 0.37m in the waterway and floodplain located between Willetts Road and Malcomson Street; and
- Increase flood levels by approximately 0.37m in the Andergrove Region.

8. Hydraulic Assessment of Goosepond Creek Tidal Reaches Masterplan

The Goosepond Creek Tidal Reaches Masterplan (Chenoweth, 2004) proposes a number of changes to the existing condition of the Goosepond Creek waterway downstream of Evans Avenue (refer Figure E1). One change that has the potential to affect existing flood levels is the impact of mangrove regrowth in this area.

In order to test the impact of the mangrove regrowth on the existing hydraulic regime of Goosepond Creek, the calibrated hydraulic model was run for the 100 year ARI design event with the model roughness coefficient (Manning's 'n') increased in the re-growth areas as indicated in Figure E2.

The impact of the proposed mangrove re-growth on existing flood levels and velocities for the 100 year ARI design event is provided in Figures E3 to E5.

Model results indicate that the mangrove re-growth will:

- Increase flood levels by a maximum of approximately 90mm within the waterway reach located between 300m upstream and downstream of Evans Avenue, with a maximum reduction in peak flood velocity of 0.48m/s in this area; and
- Increase flood levels by a maximum of approximately 30mm within the waterway reach located between Willetts Road and Malcomson Street.

9. Hydraulic Assessment of Development Scenarios

9.1 Introduction

The potential hydraulic impacts of a number of proposed developments within the Goosepond Creek and the Andergrove catchments were investigated for the 100 year ARI design event. It is noted that in agreement with MRC, the hydraulic assessment of development scenarios has been undertaken using existing conditions hydrology.

In order to represent each of the proposed developments, the digital elevation model used in the 2D MIKEFLOOD hydraulic model was modified by adjusting DEM nodal elevations within the development footprints.

Key features for each of the development scenarios assessed are provided in Figures F1 to F2 in Appendix F.

The potential hydraulic impacts of the proposed developments was assessed by comparing pre and post development flood levels and velocities.

It is noted that the hydraulic models used in this analysis were:

- Based on the Existing Conditions calibrated hydraulic model(s); and
- Run with Existing Conditions catchment hydrology (which was based on 2006 Planning Scheme Zones).

Flood inundation maps of peak flood levels, velocities and afflux are provided in Appendix G.

9.2 Development Scenario 1

Development Scenario 1 consists of testing the impact of fill within the development footprints illustrated in Figure F1. Scenario 1 represents an estimate of the fill footprint associated with pending or currently approved development applications.

The 100 year ARI peak flood levels and velocities for this scenario are presented in Figures G1 and G2 respectively. The change in peak flood levels due to this proposed development scenario is presented in Figure G3.

Results indicate that this fill scenario will:

- Increase the existing conditions 100 year ARI design event peak flood levels by up to 0.39m in the reach of Janes Creek located immediately downstream of the Bruce Highway Crossing and adjacent to Cinnamon Drive;
- Increase the existing conditions 100 year ARI design event peak flood levels by 0.06m along Goosepond Creek; and
- Increase the existing conditions 100 year ARI design event peak flood levels by up to 0.08m in the Andergrove region.

9.3 Development Scenario 2

Development Scenario 2 consists of no additional fill (i.e. existing catchment conditions) together with the following flood mitigation drainage infrastructure (refer Figure F1):

- 8/1800 x 1500 RCBC's under Sugarshed Road discharging into:
- A 50m wide drainage channel (15m base width 1:6 side slopes).

The purpose of this infrastructure is to reduce flood levels along Goosepond Creek floodplain and within the Heaths Road industrial estate by conveying flood flows from the north of Sugarshed Road to Fursden Creek.

The 100 year ARI peak flood levels and velocities for Scenario 2 are presented in Figures G4 and G5 respectively while the change in peak flood levels is presented in Figure G6.

Results for the 100 year ARI design event indicate that:

- The proposed drainage infrastructure conveys approximately 132m^3/s of flow;
- The drainage infrastructure will reduce existing conditions 100 year ARI design event peak flood levels by 0.04 to 0.16m along the Goosepond Creek floodplain downstream of Glenella Road; and
- The drainage infrastructure will reduce existing conditions 100 year ARI design event peak flood levels by 0.06m throughout Andergrove.

9.4 Climate Change Impact Assessment

In order to assess the combined hydraulic impact on the 100 year ARI design event existing conditions flood regime due to the proposed developments within the Goosepond Creek and Vines Creek catchments and increased rainfall intensities/tailwater levels resulting from potential future climate change, the hydraulic model has be run for the 100 year ARI design event for the following scenarios:

- Development Scenario 1 with 20% increase in rainfall intensity and 0.70m increase in tailwater conditions;
- Development Scenario 2 with 20% increase in rainfall intensity and 0.70m increase in tailwater conditions;

A series of maps illustrating the maximum predicted flood level and the expected increase in flood level (afflux) for each of these scenarios is provided in Figures G7 to G12. It is noted that afflux maps represent the increase in flood level above the existing conditions case with no increase in rainfall intensity, tailwater and no new development.

Table 23 provides a summary of results for the climate change impact assessment.

Table 23 Maximum Increase in 100yr ARI Design Event Flood Levels due to the Cumulative Impact of Future Development and Climate Change

Location	Development Scenario 1	Development Scenario 2
North Coast Railway to Upper Bruce Hwy to	600mm	250mm
Upper Bruce Hwy to Glenella Rd	620mm	220mm
Glenella Rd to Evans Avenue	340mm	200mm
Andergrove Region	420mm	320mm
Upstream of Harbour Road	480mm	450mm

10. Discussion

10.1 2008 Event

- Based on an analysis of recorded rainfall intensity data, the February 2008 flood event has been estimated to have an average recurrence interval of at least 500 years. This means that on average, the probability of the rainfall intensities experienced during the February 2008 event being exceeded in any future year is less than 1 in 500 (or approximately 0.2%). Based on this probability, in the next 50 years there is approximately a 10% chance of the Goosepond and Vines Creek catchments experiencing rainfall intensities as high as those that occurred during the February 2008 flood.
- A comparison of the February 2008 and 100 year ARI flood profiles is provided as Figure 18. Figure 18 indicates that the flood levels experienced during the 2008 event are significantly higher (up to 1.50m) than those predicted for the existing conditions 100 year ARI design event.
- The flood levels experienced during the February 2008 event may have been exacerbated by developments within the Goosepond and Vines Creek floodplain with surface levels at elevations greater than the predicted 100 year ARI design event flood surface. For example, it is likely that the levee constructed at the back of the Valetta Gardens estate may have worsened flooding in the estate by preventing the escape of floodwaters originating in Goosepond Creek..

10.2 100 year ARI Design Event

- Flood levels at locations upstream of the confluence of Goosepond and Vines Creek are governed by the magnitude of flows in Goosepond Creek, flood levels at locations downstream this confluence are more controlled by flood levels in the Pioneer River (based on a 100 year level of 5.32m AHD, (WRM, 2011).
- The flood levels predicted for the existing conditions 100 year ARI design event are generally 0.6-0.9m lower than those experienced in Goosepond Creek during the 2008 flood event.
- A comparison of the 100 year ARI design event flood surface (with tailwater level = 4.08m AHD) to the MRC's 2004 aerial photo indicates that a number of properties that contain dwellings will be affected by the 100 year ARI design flood. Figure 19 illustrates the location of these flood affected dwellings. Properties with dwellings that lay within the 100 year ARI design flood extent include:
  - Properties along the Blue Gum Drive;
  - Properties along Bradman Drive, Davey Street, Tallon Street Border Street and Glenella Richmond Road;
  - Property immediately south of the Upper Bruce Highway adjacent to Cinnamon Drive ;
  - Properties to the north and south of the Wheeler Drive;
  - Some inundation on the property immediately south of the Hill End Rd, Frank Cowley Driver and Francy Drive Glenella.
  - Properties within the Heaths Road Industial Estate and Valetta Gardens;
  - Properties along Windmill Crossing adjacent to Highway Plaze and along Fairrmeadow Drive;
  - Properties north of Goosponds Creek along Daniel/Burgess Streets, Valley Street, Hicks Street and Meadow Street;

- Properties along Evans Avenue and Hamilton Street East;
- Properties in the vicinity of the Evans Avenue and Glenpark Street Junction; and
- Properties along Bedford Road.

10.3 Establishment of Design Flood Levels

- In establishing a set of 100 year ARI design event flood levels in the Goosepond and Vines Creek catchments, it is recommended that Council consider flood levels resulting from both local and regional flood events and select the maximum set of flood levels from the two data sets. The flood levels predicted in this study (GHD, 2012) represent local flood levels only and should only be considered in this context. Regional flood levels should be obtained from a separate regional flood study of the Pioneer River catchment.
- Local flooding in the Goosepond and Vines Creek waterways are affected by flood conditions in the Pioneer River. In this study, the local 100 year ARI design event was assessed with tailwater levels equivalent to 4.08m AHD[3] and 5.32 m AHD[4]. In terms of determining a set of local 100 year ARI design event flood levels for planning purposes, it is recommended that MRC consider the local 100 year ARI design event flood surface from this study for the case where the tailwater level was set to 4.08m AHD. This is because the 5.32 m AHD tailwater level is not considered to be representative of the conditions generally experienced during local flooding. Regional flood levels should be obtained from a separate regional flood study of the Pioneer River catchment.
- It is recommended that the local 100 year ARI design event flood surface (with coincident 5 year ARI Pioneer River flood level of 4.08 m AHD) and the February 2008 flood surface be included in Council's GIS system (MIMAPS). It is also recommended that these layers be considered together with flood surfaces derived from separate regional flood studies of the Pioneer River.

10.4 Flood Mitigation

- Given the rarity of the February 2008 flood, it is not considered to be economically viable to provide flood inundation measures that would protect the 886 properties affected by the 2008 event from a future event of similar magnitude. This is supported by the State Planning Policy 1/03 – Mitigating the Adverse Impacts of Flood, Bushfire and Landslide (A3.2), which nominates the Queensland Governments position that generally, the appropriate flood event for determining a natural hazard management area (flood) is the 100 year ARI flood.
- While Development Scenario 2 resulted in reductions in flood level of up to 0.16m downstream no cost estimations have been undertaken on the likely magnitude of the capital works. It is recommended that an economic viability study to assess the cost benefit of constructing a mitigation channel of this size;
- In order to improve the level of flood immunity throughout the Goosepond and Vines Creek catchment, it is recommended that a number of flood mitigation options be considered to minimise the impact of flooding during a 100 year ARI design flood event. These include:
  - Upgrade of existing waterway crossings with significant blockages to flow;

[3] Equivalent to 5 year ARI Peak Flood Level in Pioneer River, Pioneer River Flood Study (WRM, 2011).

[4] Equivalent to 100 year ARI Peak Flood Level in Pioneer River, Pioneer River Flood Study (WRM, 2011).

- Property Resumptions;
- Construction of levees; and
- The aforementioned mitigation channel (Development Scenario 2).

11. Conclusions

Hydrologic and hydraulic models have been developed for Janes Creek, Goosepond Creek and Vines Creek for existing and developed catchment conditions. These models have been updated from the GHD September 2009 Gooseponds/Vines Creek Report following the provision of recent tailwater estimates for the Pioneer River (WRM, 2011) and more accurate aerial survey data (DERM,2009). Importantly this report (GHD, February 2012) updates and supersedes the previous flood study (GHD, September 2009).

The hydraulic model was calibrated to the February 2007 and 2008 flood events and was verified using the November 2000 flood event. The hydrologic and hydraulic models have successfully been used to:

- Determine flood levels, velocities and the extent of flooding for existing catchment conditions for the 5, 50 and 100 year ARI flood events (for two storm durations only);
- Assess the impact of increased rainfall intensities resulting from climate change on the existing conditions flood regime for the 100 year ARI design event;
- Assess the impact of Council's proposed re-vegetation strategy on the existing conditions 100 year ARI design event flood regime;
- Assess the combined hydraulic impact of Council's proposed re-vegetation strategy, increased rainfall intensities and tailwater resulting from potential future climate change;
- Assess the hydraulic impact of the Goosepond Creek Tidal Master Plan on the existing conditions 100 year ARI design event flood regime;
- Assess the potential hydraulic impacts impact that may be caused by filling associated with a number of proposed developments within the Goosepond Creek and Vines Creek catchments;
- Assess the impact of potential flood mitigation options; and
- Assess the combined hydraulic impact on the 100 year ARI design event existing conditions flood regime due to the proposed developments within the Goosepond Creek and Vines Creek catchments and increased rainfall intensities resulting from potential future climate change.

Results from the hydrologic and hydraulic assessment indicate:

- Based on an analysis of recorded rainfall intensity data, the February 2008 flood event has been estimated to have an average recurrence interval of at least 500 years. This means that on average, the probability of the rainfall intensities experienced during the February 2008 event being exceeded in any future year is less than 1 in 500 (or approximately 0.2%).
- The 100 year ARI design flood event is generally 0.6 to 0.9m lower than the February 2008 event along Goosepond Creek and is predicted to affect a number of identified properties on the Janes Creek, Goosepond Creek and Vines Creek floodplain.
- A 20% increase in rainfall intensity and a 0.7m sea level rise for the 100 year ARI design event will cause:
  - Increases in flood levels of 100mm to 220mm along Janes Creek in Glenella;
  - Increases in flood levels of 190mm to 570mm along Goospond Creek in North Mackay; and

- Increases in flood levels of 350mm to 390mm in the Andergrove region.

- The Goosepond Creek Riverine Revegetation Strategy will:
  - Increase flood levels by up to 0.07m upstream of the Bruce Highway crossing in Glenella with a minor change in flood velocities;
  - Increase flood levels by approximately 0.16m and reduce flood velocities by a maximum of 1.02 m/s in the reach of Goosepond Creek located between Glenella Road and Hicks Road;
  - Increase flood levels by 0.04 to 0.13m in the waterway and floodplain located between Hicks Road and Willetts Road;
  - Increase flood levels by 0.04 to 0.09m in the waterway and floodplain located between Willetts Road and Malcomson Street; and
  - Reduce flood levels by -0.03m in Andergrove region (resulting from a change in the timing of peak flood flows along Goosepond Creek).
- The Goosepond Creek Riverine Revegetation Strategy will under the effects of potential future climate change will:
  - Increase flood levels by up to 0.28m upstream of the Bruce Highway crossing in Glenella with reductions in flood velocities of up to 0.13;
  - Increase flood levels by approximately 0.34m and reduce flood velocities by a maximum of 1.02 m/s in the reach of Goosepond Creek located between Glenella Road and Hicks Road;
  - Increase flood levels by 0.23 to 0.31m in the waterway and floodplain located between Hicks Road and Willetts Road;
  - Increase flood levels by 0.32 to 0.37m in the waterway and floodplain located between Willetts Road and Malcomson Street; and
  - Increase flood levels by approximately 0.37m in the Andergrove Region.
- Mangrove regrowth due to Goosepond Creek Tidal Reaches Masterplan will:
  - Increase flood levels by a maximum of approximately 90mm within the waterway reach located between 300m upstream and downstream of Evans Avenue, with a maximum reduction in peak flood velocity of 0.48m/s in this area; and
  - Increase flood levels by a maximum of approximately 30mm within the waterway reach located between Willetts Road and Malcomson Street.
- The hydraulic impacts of filling associated with development applications currently approved by Council, pending development applications, and other potential development applications will have the following impacts:
  - Glenella: Based on likely filling associated with areas which are currently zoned for urban development, the most significant impact just downstream of the Bruce Highway at Glenella. Filling on both sides of Janes Creek in this section is estimated to raise 100 year ARI levels in the area of 390 mm. The lowest lots in this area are on McLaren Drive at 11.15 m AHD. The 100 year ARI level is 10.95 which is 200mm lower. Therefore, the lots would be overtopped by with development on either side of Janes Creek just downstream of the Bruce Highway without flood mitigation;
  - North Mackay: There is limited land remaining in the Goosepond Creek catchment which is zoned for urban development in the North Mackay and Mt Pleasant area. Hence, there is minimal impact

on flood levels by developing the remaining land zoned for urban development. The impact is an increase of approximately 60mm; and

  - Andergrove: Filling associated with development in the Vines Creek catchment has less of a hydraulic impact than Glenella with flood levels increasing by up to 80 mm.

- The hydraulic impacts of filling associated with development applications currently approved by Council, pending development applications, and other potential development applications together with increased rainfall intensities and sea level due to climate change will have the following impacts:
  - Glenella: Based on likely filling associated with areas which are currently zoned for urban development, the most significant impact just downstream of the Bruce Highway at Glenella with predicted increases of up to 620mm;
  - North Mackay: The impact is an increase in flood level of approximately 230mm to 360mm; and
  - Andergrove: Flood levels in the Vines Creek catchment are predicted to increase by up to 420 mm.
- The construction of a 50m base width mitigation channel and upgrade of the Sugarshed Road culverts has the potential to:
  - Reduce existing conditions 100 year ARI design event peak flood levels by 0.04 to 0.16m along the Goosepond Creek floodplain downstream of Glenella Road; and
  - Reduce existing conditions 100 year ARI design event peak flood levels by 0.06m throughout Andergrove.

In light of the results of this study, it is recommended that:

- For the local 100 year ARI design event, Council refer to flood levels from the 100 year ARI existing conditions design flood event for the case for the case where the tailwater level in the Bassett Basin is 4.08 AHD;
- In developing a set of 100 year ARI flood levels for future planning purposes, Council consider regional flood levels resulting from regional flood events in the Pioneer River catchment;
- In developing a set of 100 year ARI flood levels for future planning purposes, Council consider the impact of climate change, the impact of waterway revegetation, the impact of mangrove regrowth and the impact of existing, pending and potential development applications;
- An Advisory Committee with stakeholder representatives propose 'acceptable' risk standards for the establishment of flood levels and future actions in the Goosepond and Janes Creek catchments. Members on the committee may include Councillors, Council Officers, Community representatives and those from relevant Government Agencies and Organisations;
- An economic assessment be undertaken on the viability of constructing a 50m base width mitigation channel linking Goosepond Creek to Fursden Creek which results in reductions in peak flood level of up to 0.16m in Goosepond Creek;
- Additional flood mitigation measures be investigated. These measures could include road crossing upgrades, property resumptions and the construction of levees.
- Council require development applications to assess both local and regional flooding impacts, with local flood studies to include consideration of a range of Pioneer River tailwater conditions.

12. References

Australian Rainfall and Runoff: A Guide to Flood Estimation (The Institution of Engineers, Australia, 1987).

Forgan Bridge Replacement Flood Study (Department of Main Roads, 2007);

Goosepond Creek Tidal Reaches Masterplan (Chenoweth, January, 2004);

Hydraulic Report, Bruce Highway over Goospond/Janes Creeks, Mackay (DMR, June, 2008);

Increasing Queensland's resilience to inland flooding in a changing climate: Final Scientific Advisory Group (SAG) Report – Derivation of a rainfall intensity figure to inform and effective interim policy approach to managing inland flood risks in a changing climate (DERM, 2010).

Local Government Disaster Mitigation Project for Department of Emergency Services – Mackay Technical Reports, Mitigation Options, Working Papers and Mapping (Hatch, December, 1999);

Pioneer River Flood Study (Chaseling McGiffin Pty Ltd, November 2004);

Pioneer River Flood Study (WRM Water and Environment, October, 2011)

Report on Further Goosepond Creek Hydraulics (Ullman & Nolan, November, 1994).

Report on Queensland Floods (February, 2008).

State Planning Policy 3/11 Coastal Protection (Department of Environment and Resources Management, 2012)

Appendix A

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Figure 16 **2000 Event Maximum Flood Levels**

Figure 17 **2000 Event Maximum Velocity Map**

Figure 18 **100 year ARI Design Event and 2008 Flood Profile**

Figure 19 **Properties Affected by 100 year ARI Design Event**

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Road
- Railway
- Waterway

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Goose Ponds\Vines Creek Flood Study

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Revision	A
Date	13 Dec 2011

Study Area

Figure 1

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1:30,000 @A3

0 750 1,500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Road
- Railway
- Waterway

Catchment

- Janes Creek Catchment
- Vines Creek Catchment
- Goose Ponds Creek Catchment

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Catchment Plan

Figure 2

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1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Road
- Railway
- Commercial
- Industrial - Light/Medium
- Rural
- Rural Residential
- Special Facilities
- Sport and Recreation
- Urban

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Existing Land Use

Figure 3

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Data source: MRC - Imagery (2004); DERM - DCDB (2011), Roads (2011), Locality(2009).

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1:30,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- RAFTS Subcatchment Node
- Road
- Railway
- RAFTS Routing Link
- RAFTS Subcatchment

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RAFTS Model Layout

Figure 4

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Data source: DERM - Roads(2011), Rail(2011); Mackay Regional Council - Aerial Imagery(2004); GHD - Rafts Model Results(2009).

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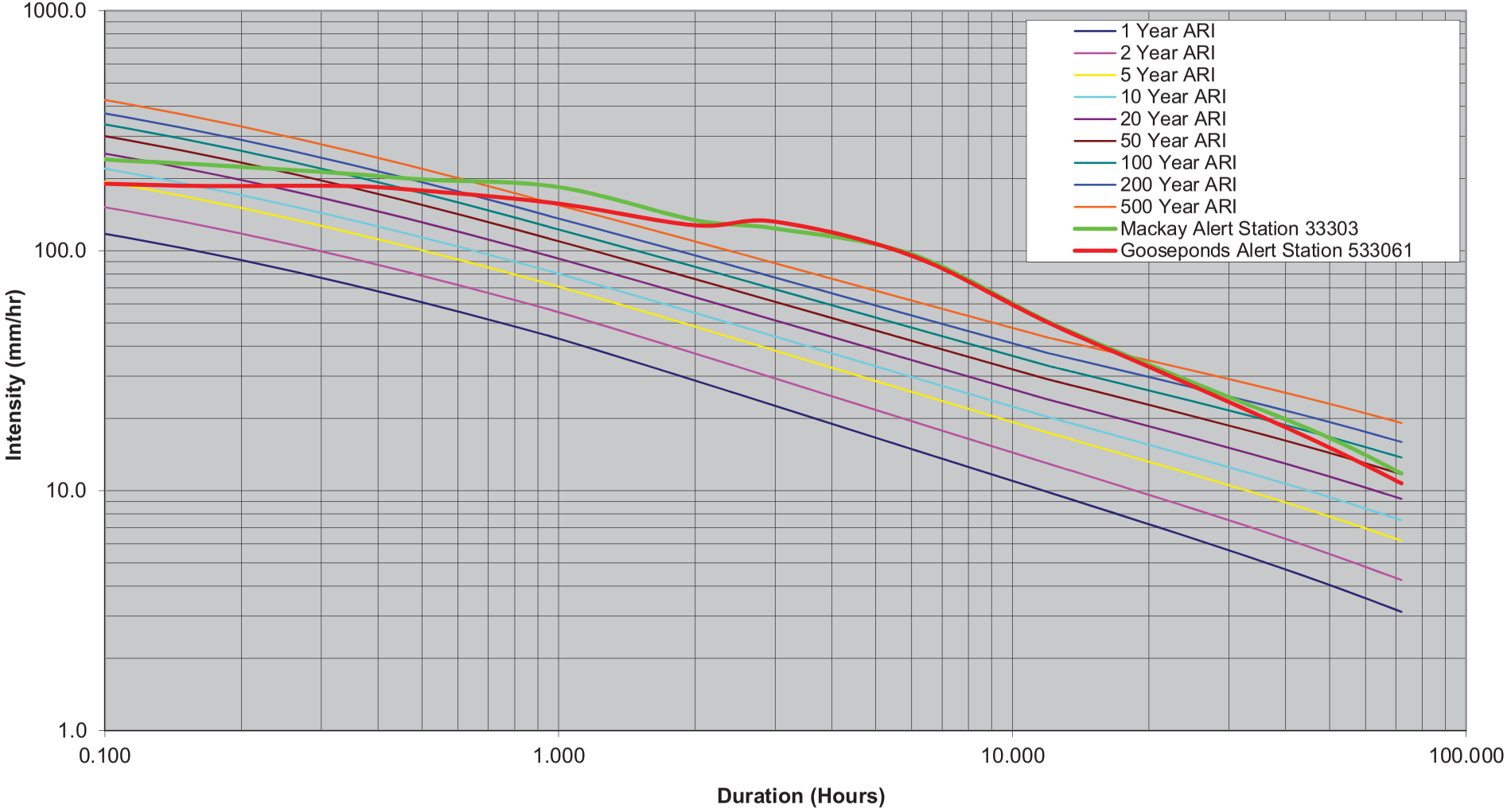
Figure 5. IFD Analysis for Mackay & Goosepond Creek Alert Stations



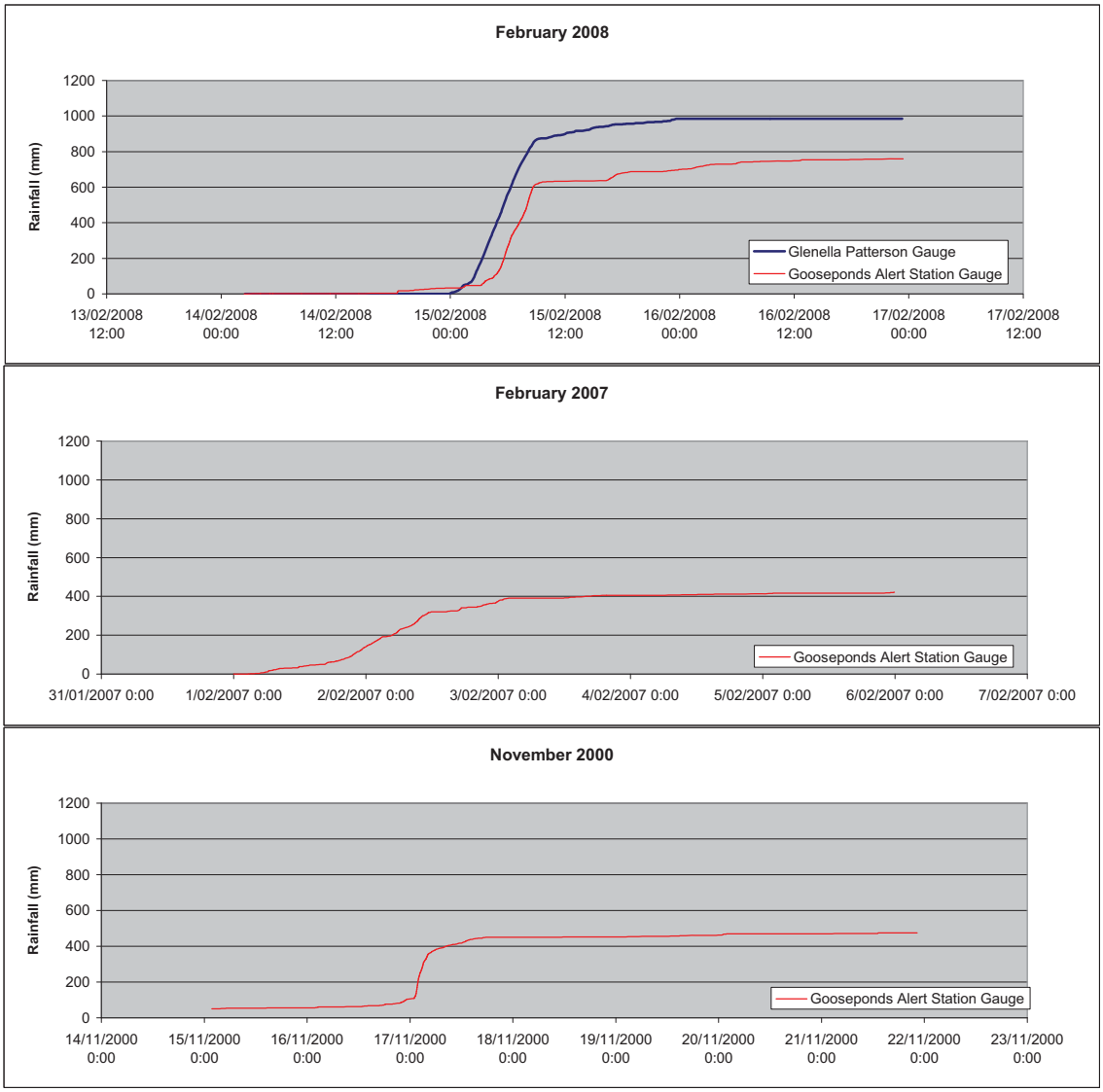
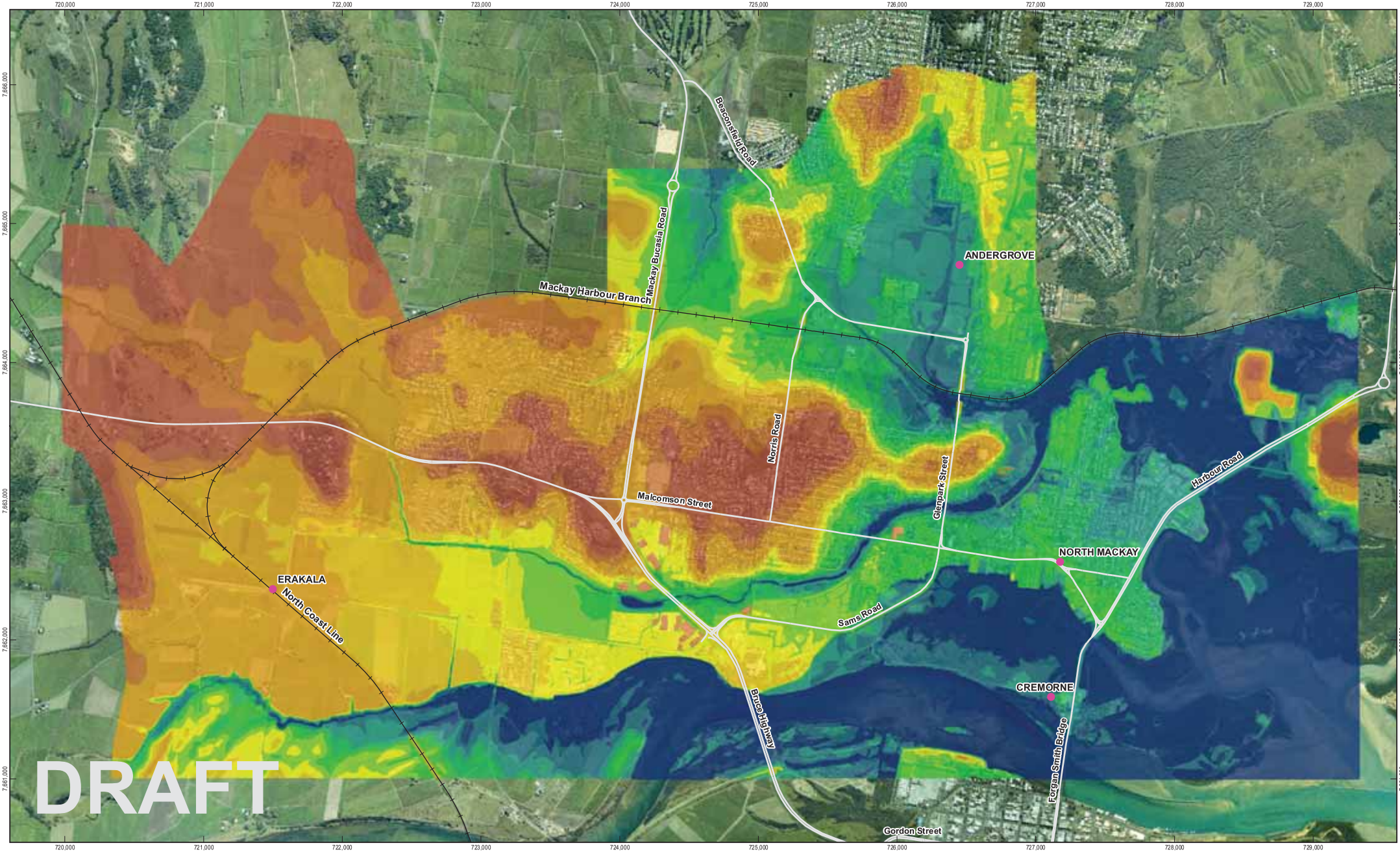


Figure 6. Historical Temporal Patterns



1:25,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Road
- Railway

Ground Elevation (mAHD)

-4.67 - 3 | 3.01 - 4 | 4.01 - 5 | 5.01 - 6 | 6.01 - 7 | 7.01 - 8 | 8.01 - 9 | 9.01 - 10 | 10.01 - 15 | 15.01 - 20 | >20

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Revision A
Date 01 Dec 2011

2D Model
Digital Elevation Model

Figure 7

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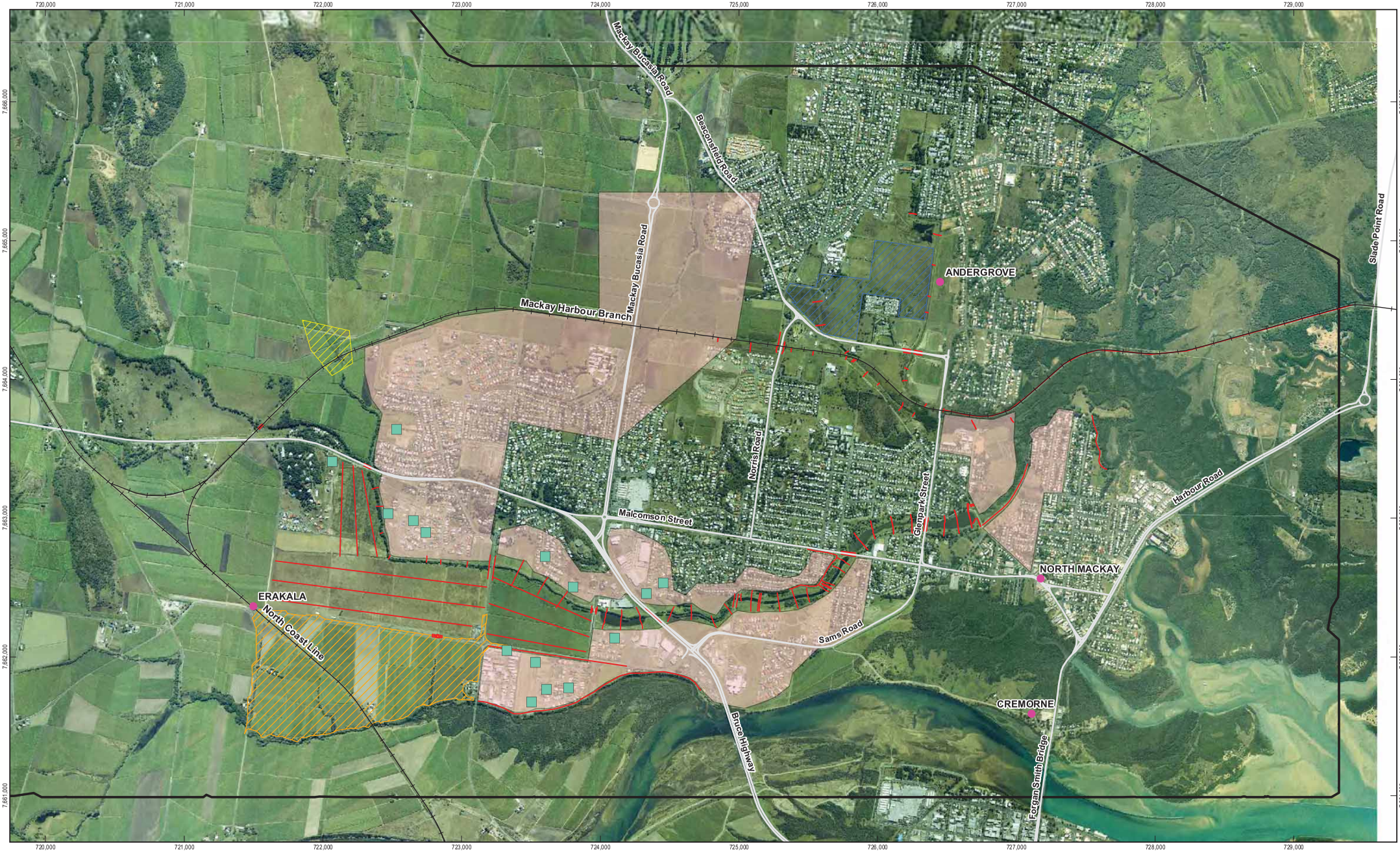

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- As Built Drawings
- Road
- Railway
- MRC Ground Survey
- Glenella Estate Digital Survey
- Andergrove Lakes Digital Survey
- Larkins Road Digital Survey
- DERM LiDar Data (2009)
- MRC Photogrammetry Extent 1991 and 2004 Datasets (exceedes study area bounds)

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2D Model
Digital Elevation Model - Data Sources

Figure 8

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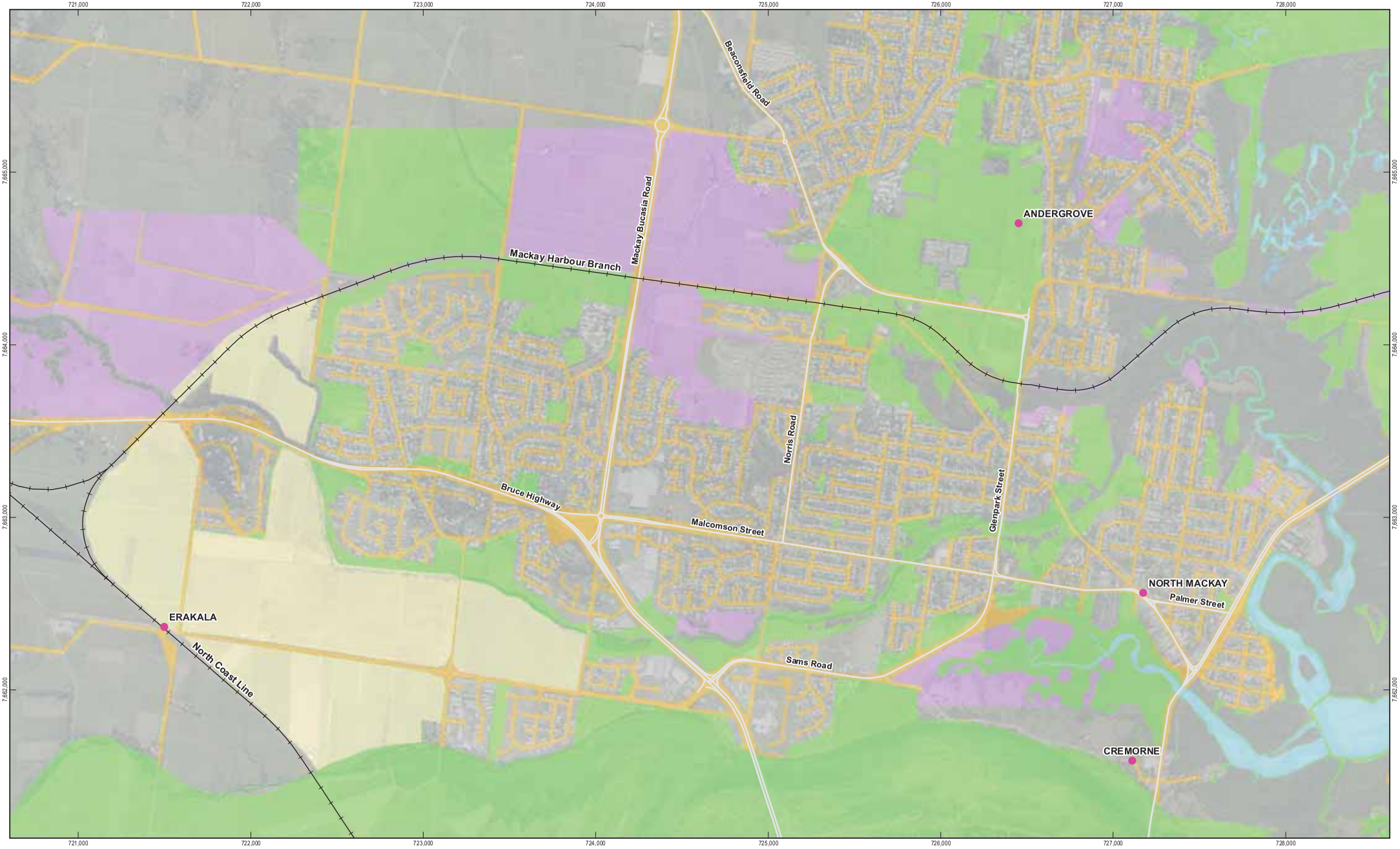

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Railway
- Road

Bed Resistance (Manning's n Coefficient)

0.02 - 0.02	0.04 - 0.05	0.12 - 0.14
0.02 - 0.03	0.05 - 0.06	0.14 - 0.2
0.03 - 0.04	0.06 - 0.12	

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2D Model Roughness Map

Figure 9

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1:23,194 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Hydraulic Structure
- Road
- Railway

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2D Model
Hydraulic Structures

Figure 10

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Data source: GHD - Hydraulic Structures (2009); MRC - Imagery (2004); DERM - Roads (2011), Locality(2009).

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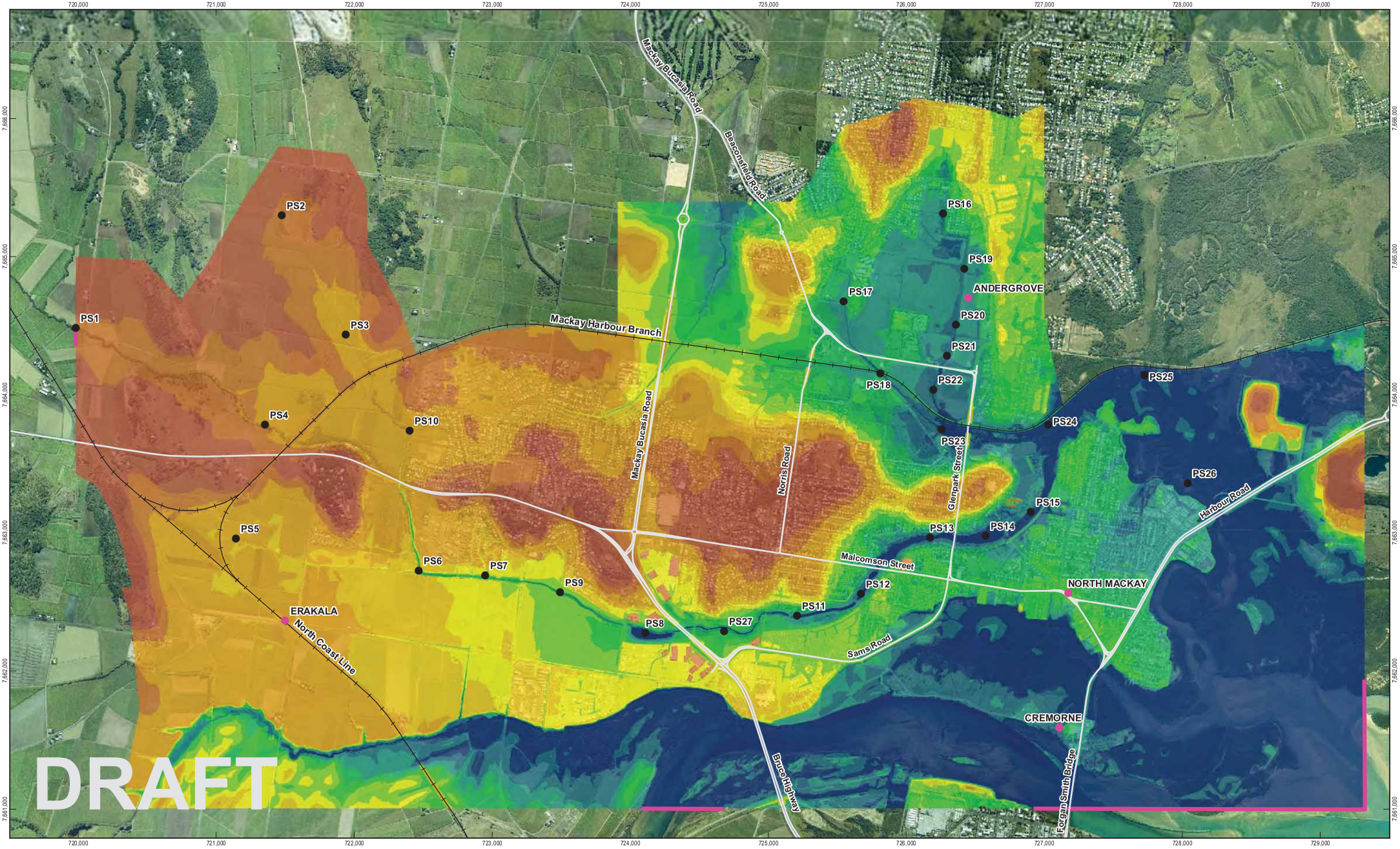

1:25,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Point Source Inflow
- Open Boundary
- Road
- Railway

Ground Elevation (mAHD)

-4.67 - 3 | 3.01 - 4 | 4.01 - 5 | 5.01 - 6 | 6.01 - 7 | 7.01 - 8 | 8.01 - 9 | 9.01 - 10 | 10.01 - 15 | 15.01 - 20 | >20

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Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number	41-24514
Revision	A
Date	01 Dec 2011

Location of 2D Model Boundary Conditions

Figure 11

G:\41\24514\GIS\Maps\Deliverables\41124514_011_rev_a.mxd

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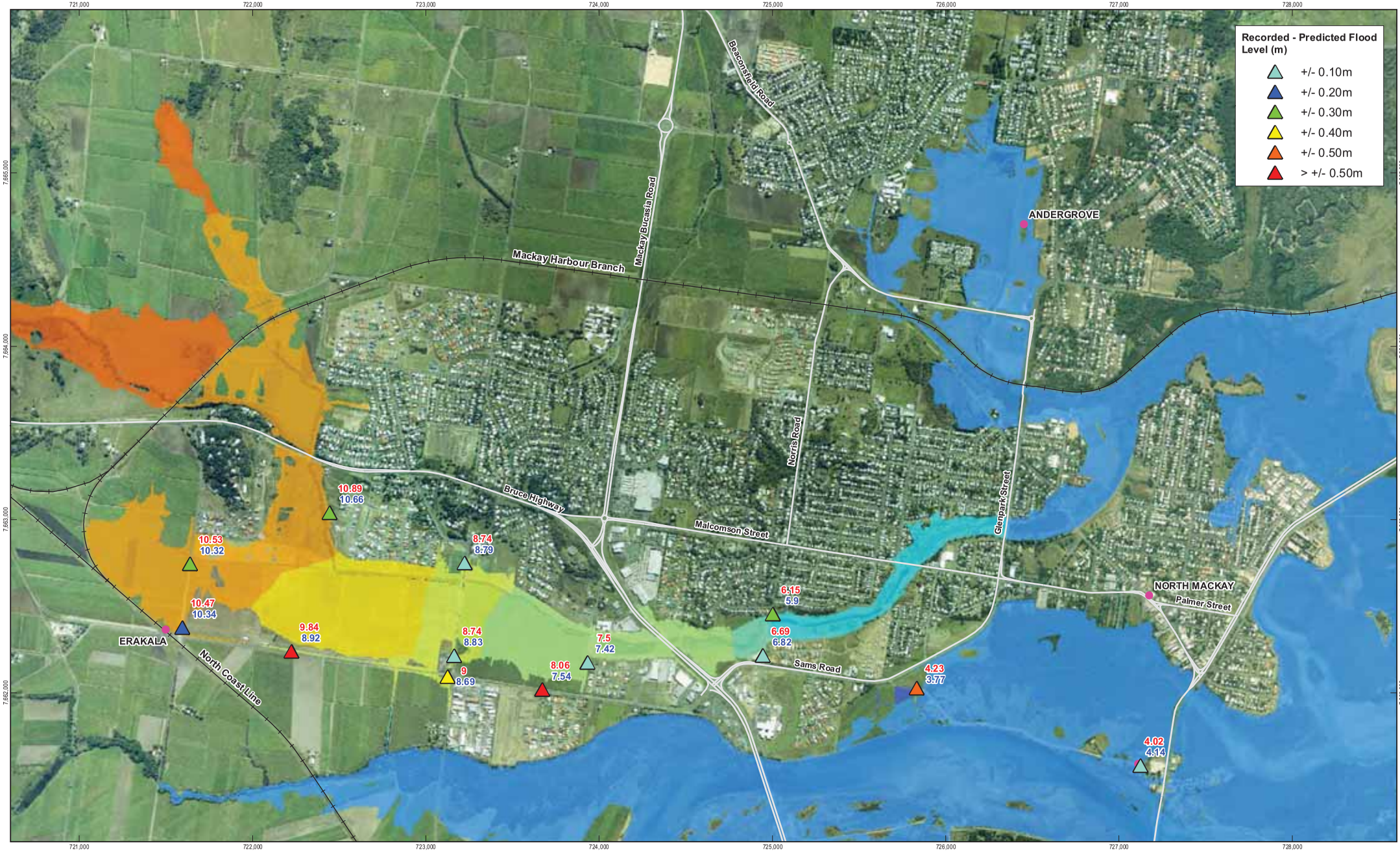

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Road
- Railway

Maximum Flood Level (mAHD)

2 - 3 | 3 - 4 | 4 - 5 | 5 - 6 | 6 - 7 | 7 - 8 | 8 - 9 | 9 - 10 | 11 - 15 | 16 - 20 | 21 - 25

9.99 Surveyed Flood Level
9.99 Predicted Flood Level

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Goose Ponds\Vines Creek Flood Study

Job Number 41-24514
Revision A
Date 06 Dec 2011

2007 Event Maximum Flood Level

Figure 12

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1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Velocity (m/s)

< 0.5 | 0.5 - 1 | 1 - 1.5 | 1.5 - 2 | 2.0 - 2.5 | > 2.5

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Goose Ponds\Vines Creek Flood Study

Job Number 41-24514
Revision A
Date 01 Dec 2011

2007 Event Maximum Velocity

Figure 13

G:\41\24514\GIS\Maps\Deliverables\41245l4_013_rev_a.mxd

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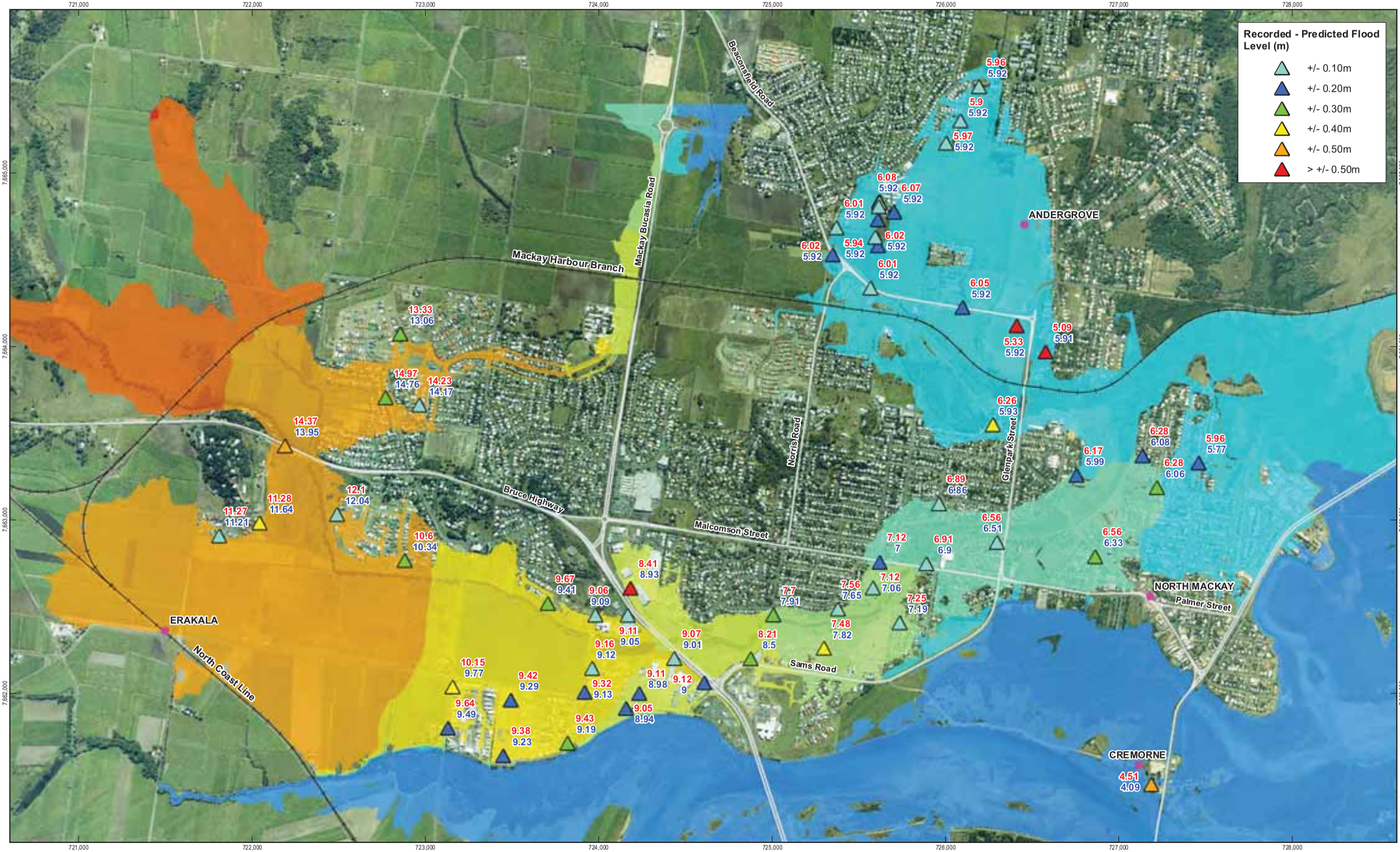

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Road
- Railway

Maximum Flood Level (m AHD)

2 - 3 | 3 - 4 | 4 - 5 | 5 - 6 | 6 - 7 | 7 - 8 | 8 - 9 | 9 - 10 | 11 - 15 | 16 - 20 | 21 - 25

9.99 Surveyed Flood Level
9.99 Predicted Flood Level

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Goose Ponds\Vines Creek Flood Study

Job Number 41-24514
Revision A
Date 06 Dec 2011

2008 Event Maximum Flood Level

Figure 14

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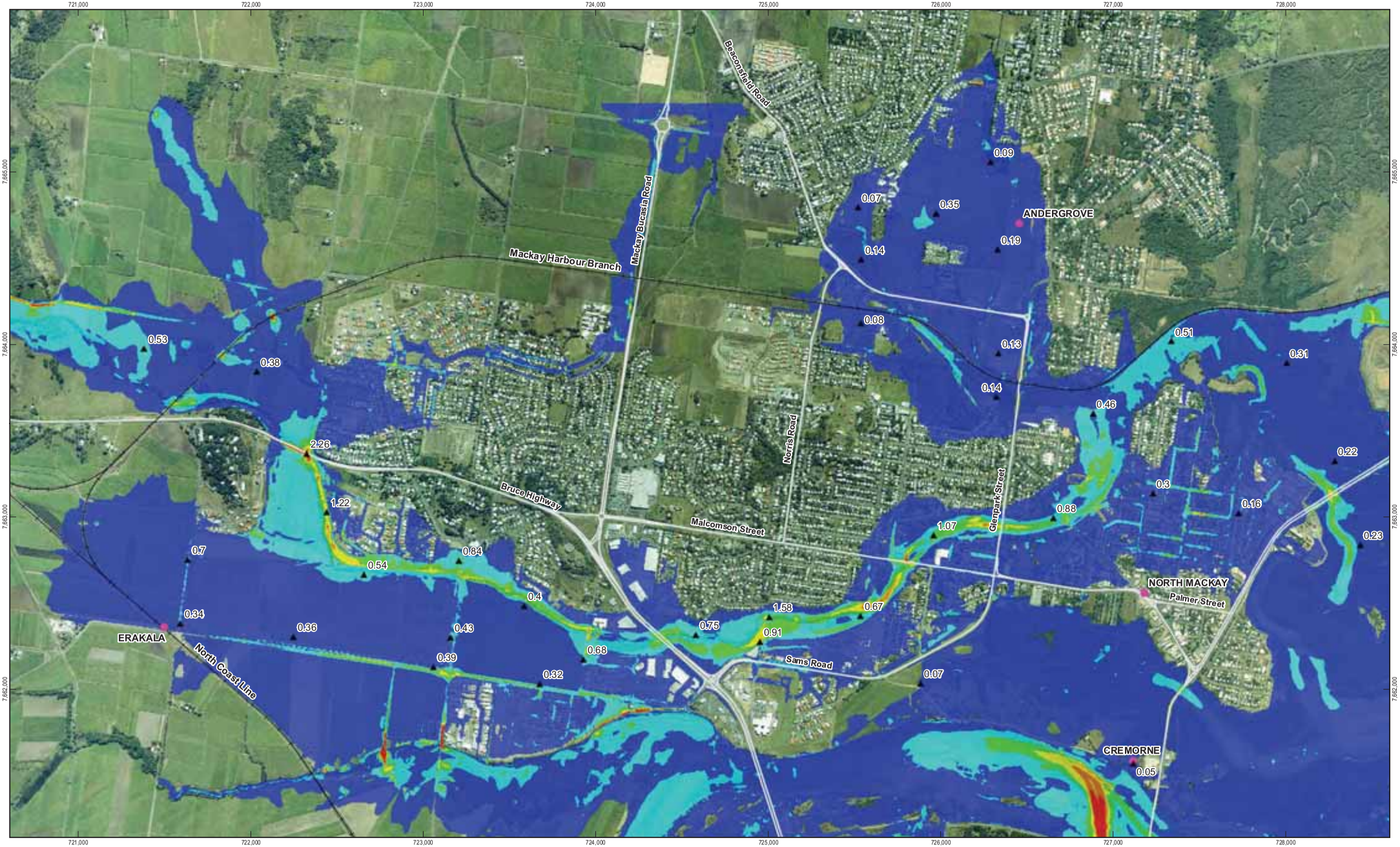

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Velocity (m/s)

< 0.5 | 0.5 - 1 | 1 - 1.5 | 1.5 - 2 | 2.0 - 2.5 | > 2.5

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Goose Ponds\Vines Creek Flood Study

Job Number 41-24514
Revision A
Date 01 Dec 2011

2008 Event Maximum Velocity

Figure 15

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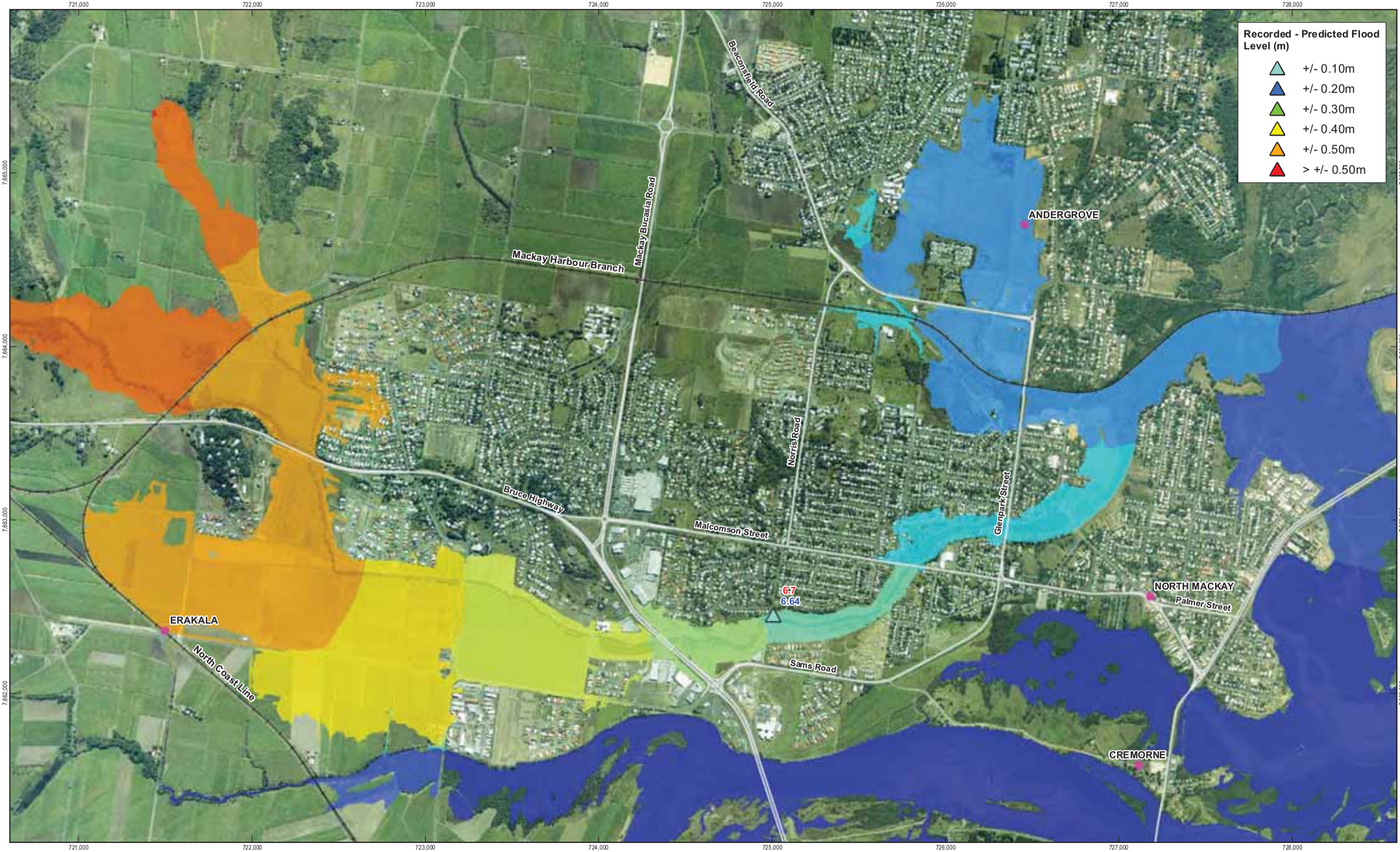

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Railway
- Road

Maximum Flood Level (mAHD)

2 - 3 | 3 - 4 | 4 - 5 | 5 - 6 | 6 - 7 | 7 - 8 | 8 - 9 | 9 - 10 | 11 - 15 | 16 - 20 | 21 - 25

9.99 Surveyed Flood Level
9.99 Predicted Flood Level

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Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number 41-24514
Revision A
Date 06 Dec 2011

2000 Event Maximum Flood Level

Figure 16

G:\41\24514\GIS\Maps\Deliverables\41245l4_016_rev_a.mxd

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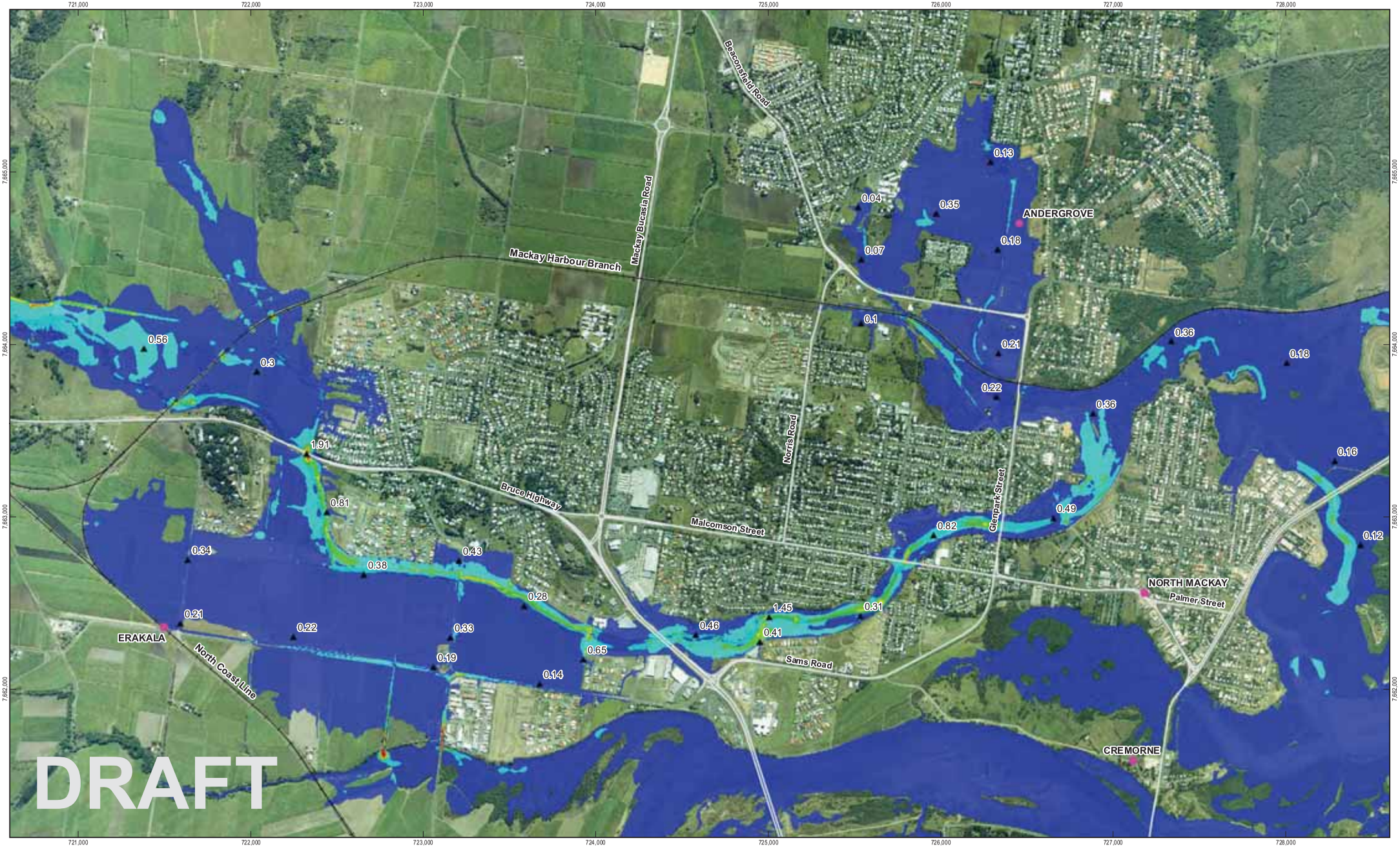

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Velocity (m/s)

< 0.5 | 0.5 - 1 | 1 - 1.5 | 1.5 - 2 | 2.0 - 2.5 | > 2.5

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Goose Ponds\Vines Creek Flood Study

Job Number 41-24514
Revision A
Date 01 Dec 2011

2000 Event Maximum Velocity

Figure 17

G:\41\24514\GIS\Maps\Deliverables\4124514_017_rev_a.mxd

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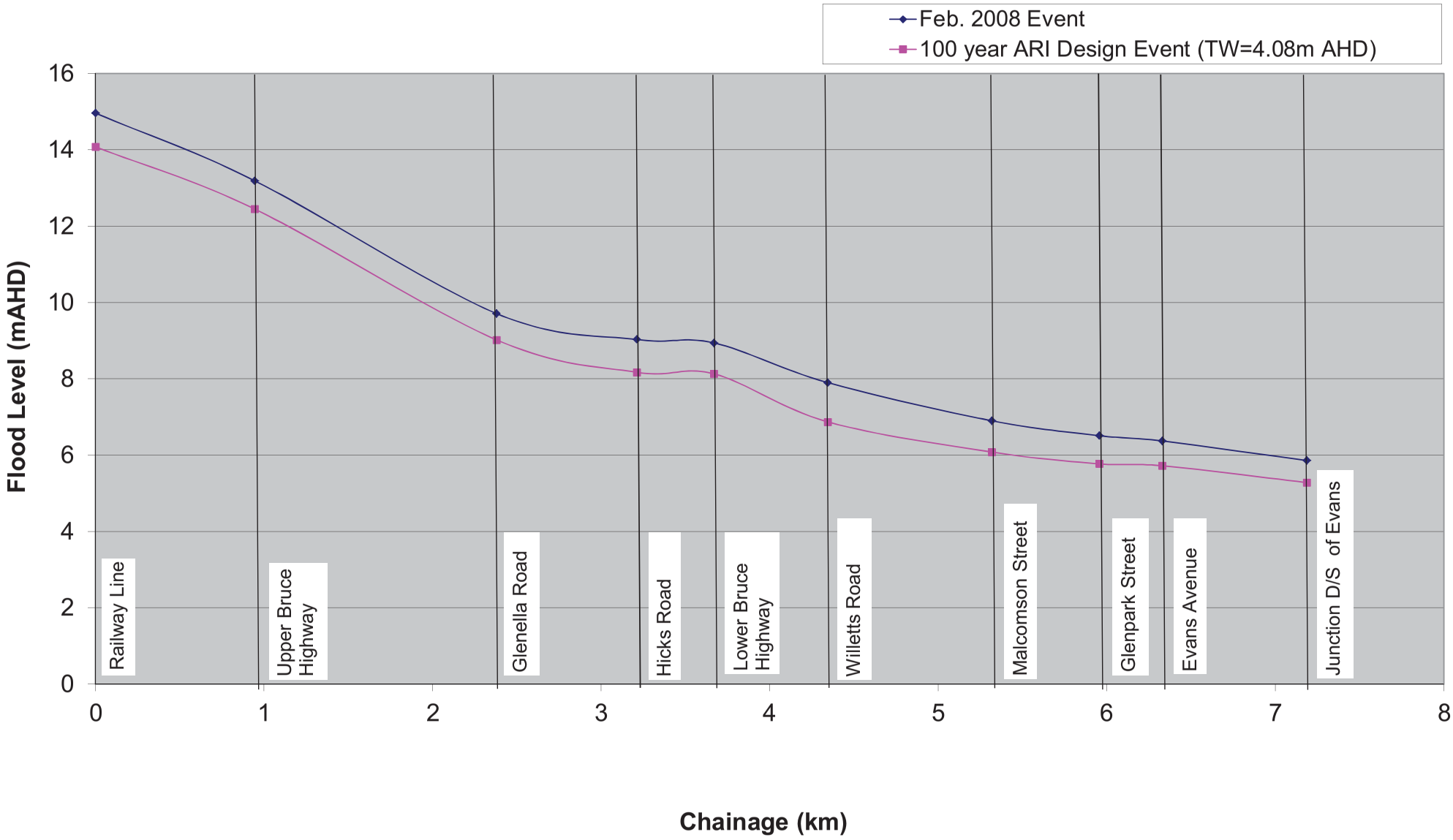
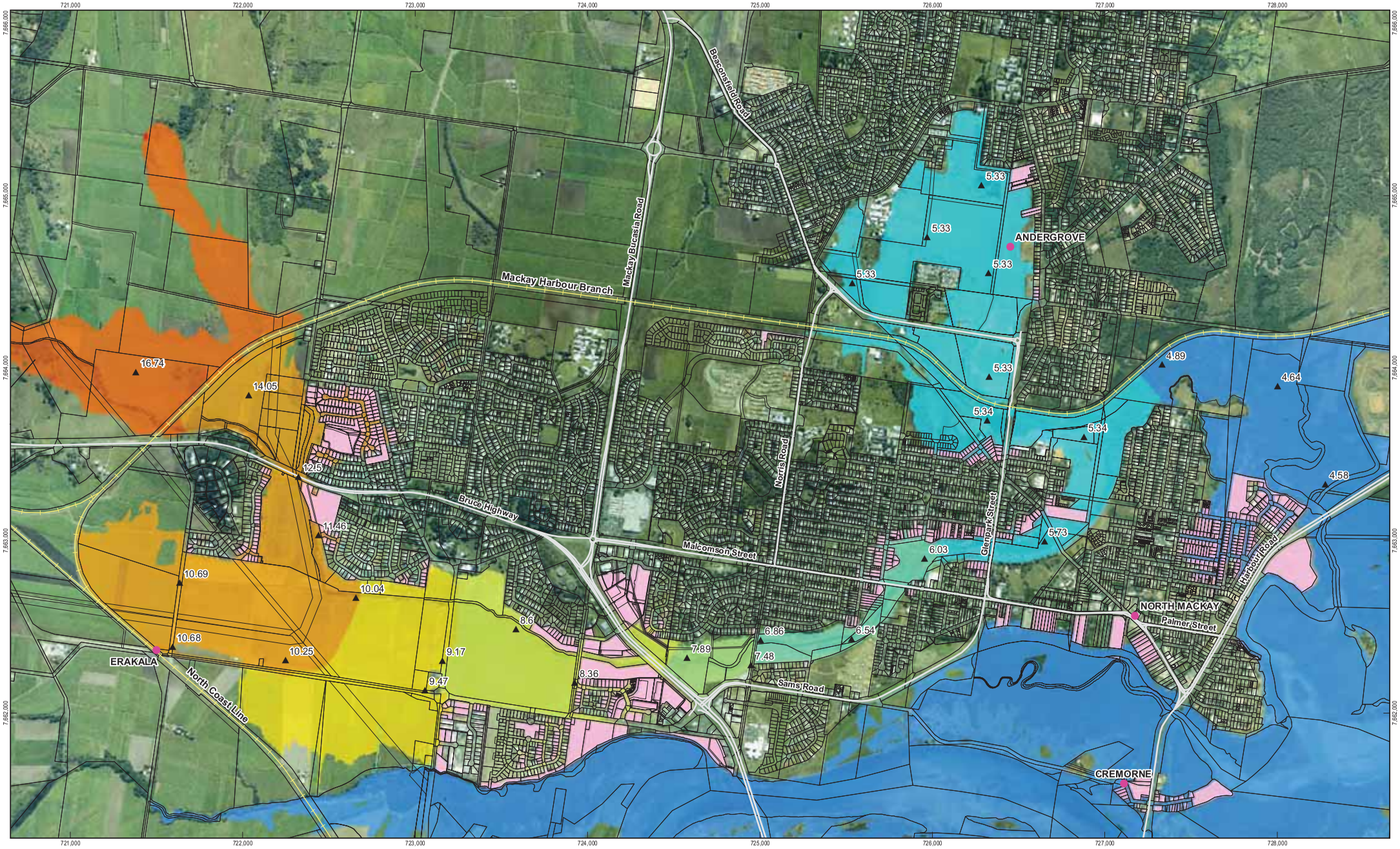
Figure 18. 100 year ARI Design Event and 2008 Flood Profile





1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway
- Cadastre
- Affected Property

Maximum Flood Level (mAHD)

2 - 3, 3 - 4, 4 - 5, 5 - 6, 6 - 7, 7 - 8, 8 - 9, 9 - 10, 11 - 15, 16 - 20, 21 - 25

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Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number 41-24514
Revision A
Date 03 Feb 2012

Properties affected by 100 year ARI Design Event

Figure 19

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Data source: GHD - Hydraulic Structures (2009); MRC - Imagery (2004); DERM - Cadastre(2011), Roads (2011), Locality(2009).

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Appendix B

Rafts Model Results

Maximum Values for Nodes

Node Name	Peak Inflow (M^3/S)	Time to Peak (minutes)	Critical Stm Dur (minutes)
V2	4.0	25.0	60.0
V1	7.2	25.0	60.0
V3	7.8	30.0	60.0
V4	10.5	34.0	60.0
V5	4.8	25.0	60.0
V8	1.5	25.0	60.0
V6	7.0	36.0	60.0
V7	4.8	25.0	60.0
VJ1	10.3	25.0	60.0
V9	1.1	61.0	60.0
V10	1.9	23.0	60.0
VJ2	10.5	45.0	60.0
V11	1.1	60.0	60.0
V12	3.2	25.0	60.0
VJ3	12.7	47.0	60.0
V25	1.6	50.0	60.0
V27	0.8	60.0	60.0
VJ4	14.7	60.0	60.0
V18	4.8	25.0	60.0
V19	22.1	25.0	60.0
V23	25.3	30.0	60.0
V20	3.2	25.0	60.0
V21	3.3	25.0	60.0
V13	4.5	25.0	60.0
V14	6.4	28.0	60.0
V15	1.7	25.0	60.0
VJ5	7.9	30.0	60.0
V17	0.7	60.0	60.0
V16	9.2	40.0	60.0
V22	14.0	43.0	60.0
VJ6	36.1	35.0	60.0
V24	38.5	36.0	60.0
V26	46.3	41.0	60.0
VJ7	57.8	45.0	60.0
V28	60.0	47.0	60.0
V29	62.8	52.0	60.0
G1	6.5	25.0	60.0
J1	11.4	61.0	60.0
J2	7.5	61.0	60.0
J3	14.3	25.0	60.0
JJ1	27.5	60.0	60.0
J4	6.9	60.0	60.0
J6	17.0	25.0	60.0
J5	8.7	60.0	60.0
JJ2	52.7	85.0	60.0
J7	15.9	60.0	60.0
J8	25.5	74.0	60.0
J10	21.2	25.0	60.0
JJ3	31.5	78.0	60.0
J9	94.2	111.0	60.0
G2	108.0	119.0	60.0
G3	18.8	25.0	60.0
G4	1.4	61.0	60.0
JJ4	109.5	129.0	60.0
G5	109.5	135.0	60.0
G6	110.6	135.0	60.0
G7	110.6	141.0	60.0
G8	110.6	146.0	60.0
G9	110.8	148.0	60.0
G10	111.0	152.0	60.0
G11	111.0	154.0	60.0
G13	111.0	157.0	60.0
G12	111.1	160.0	60.0

G14	111.1	164.0	60.0
G15	111.1	168.0	60.0
G16	111.0	171.0	60.0
G17	111.0	173.0	60.0
G18	111.0	173.0	60.0
G19	111.0	178.0	60.0
G21	110.9	181.0	60.0
G20	111.2	181.0	60.0
G22	11.8	25.0	60.0
G23	111.5	184.0	60.0
V30	134.8	68.0	60.0
V31	6.8	25.0	60.0
V32	8.9	40.0	60.0
V33	2.2	25.0	60.0
VJ8	139.3	70.0	60.0
V34	16.3	25.0	60.0
V35	19.6	40.0	60.0
V36	6.8	25.0	60.0
V37	15.7	88.0	60.0
VJ9	149.5	84.0	60.0
V39	150.7	84.0	60.0
V38	0.3	61.0	60.0
V40	1.8	125.0	60.0
V41	7.5	25.0	60.0
VJ10	154.2	85.0	60.0
V42	154.3	109.0	60.0
oneerRvr	154.3	109.0	60.0
node1	154.3	109.0	60.0

Maximum Values for Basins

Basin Name	Peak Inflow (M^3/S)	Critical Stm Dur (minutes)	Peak Outflow (M^3/S)	Critical Stm Dur (minutes)	Peak Water Level (M)
node1	154.3	60.0	59.2	60.0	10481.80

Maximum Values for Nodes

Node Name	Peak Inflow (M^3/S)	Time to Peak (minutes)	Critical Stm Dur (minutes)
V2	1.7	100.0	1440.0
V1	5.1	120.0	1440.0
V3	6.6	120.0	1440.0
V4	9.0	120.0	1440.0
V5	2.2	100.0	1440.0
V8	1.7	120.0	1440.0
V6	4.9	130.0	1440.0
V7	2.4	120.0	1440.0
VJ1	9.9	250.0	1440.0
V9	1.9	150.0	1440.0
V10	1.0	120.0	1440.0
VJ2	11.3	250.0	1440.0
V11	1.6	130.0	1440.0
V12	1.8	120.0	1440.0
VJ3	13.0	120.0	1440.0
V25	1.7	120.0	1440.0
V27	1.2	130.0	1440.0
VJ4	15.2	140.0	1440.0
V18	2.5	120.0	1440.0
V19	12.9	120.0	1440.0
V23	17.7	120.0	1440.0
V20	1.7	120.0	1440.0
V21	1.9	120.0	1440.0
V13	2.3	120.0	1440.0
V14	3.9	120.0	1440.0
V15	0.8	100.0	1440.0
VJ5	4.6	110.0	1440.0
V17	1.3	180.0	1440.0
V16	7.6	120.0	1440.0
V22	12.5	120.0	1440.0
VJ6	30.1	120.0	1440.0
V24	33.2	120.0	1440.0
V26	41.3	120.0	1440.0
VJ7	55.4	120.0	1440.0
V28	57.7	120.0	1440.0
V29	60.5	130.0	1440.0
G1	11.6	190.0	1440.0
J1	18.3	140.0	1440.0
J2	13.3	170.0	1440.0
J3	17.1	180.0	1440.0
JJ1	47.8	160.0	1440.0
J4	12.8	170.0	1440.0
J6	22.7	190.0	1440.0
J5	15.2	170.0	1440.0
JJ2	97.9	180.0	1440.0
J7	24.4	130.0	1440.0
J8	43.1	170.0	1440.0
J10	15.3	120.0	1440.0
JJ3	51.7	170.0	1440.0
J9	170.2	200.0	1440.0
G2	196.2	200.0	1440.0
G3	10.6	120.0	1440.0
G4	3.7	290.0	1440.0
JJ4	202.6	210.0	1440.0
G5	204.8	220.0	1440.0
G6	207.6	220.0	1440.0
G7	208.7	220.0	1440.0
G8	209.9	230.0	1440.0
G9	213.7	230.0	1440.0
G10	214.9	230.0	1440.0
G11	216.4	230.0	1440.0
G13	217.5	230.0	1440.0
G12	218.9	240.0	1440.0

G14	219.6	240.0	1440.0
G15	220.5	240.0	1440.0
G16	222.2	240.0	1440.0
G17	222.8	240.0	1440.0
G18	223.0	250.0	1440.0
G19	223.5	250.0	1440.0
G21	223.9	250.0	1440.0
G20	225.2	250.0	1440.0
G22	6.3	120.0	1440.0
G23	227.8	250.0	1440.0
V30	256.8	260.0	1440.0
V31	3.4	120.0	1440.0
V32	6.7	140.0	1440.0
V33	2.1	120.0	1440.0
VJ8	261.0	260.0	1440.0
V34	8.3	120.0	1440.0
V35	12.3	120.0	1440.0
V36	3.5	120.0	1440.0
V37	17.3	160.0	1440.0
VJ9	271.2	270.0	1440.0
V39	271.9	270.0	1440.0
V38	2.6	1450.0	1440.0
V40	3.9	200.0	1440.0
V41	4.7	120.0	1440.0
VJ10	277.8	270.0	1440.0
V42	279.0	290.0	1440.0
oneerRvr	279.0	290.0	1440.0
node1	279.0	290.0	1440.0

Maximum Values for Basins

Basin Name	Peak Inflow (M^3/S)	Critical Stm Dur (minutes)	Peak Outflow (M^3/S)	Critical Stm Dur (minutes)	Peak Water Level (M)
node1	278.9	1440.0	102.7	1440.0	31487.10

Maximum Values for Nodes

Node Name	Peak Inflow (M^3/S)	Time to Peak (minutes)	Critical Stm Dur (minutes)
V2	6.5	25.0	60.0
V1	12.3	25.0	60.0
V3	13.7	29.0	60.0
V4	18.7	32.0	60.0
V5	8.0	25.0	60.0
V8	2.5	25.0	60.0
V6	11.8	36.0	60.0
V7	7.8	25.0	60.0
VJ1	16.9	35.0	60.0
V9	2.4	61.0	60.0
V10	3.0	25.0	60.0
VJ2	18.8	44.0	60.0
V11	2.3	56.0	60.0
V12	5.1	25.0	60.0
VJ3	23.6	45.0	60.0
V25	3.1	45.0	60.0
V27	1.6	60.0	60.0
VJ4	27.2	56.0	60.0
V18	7.8	25.0	60.0
V19	36.9	25.0	60.0
V23	44.6	29.0	60.0
V20	4.9	25.0	60.0
V21	5.3	25.0	60.0
V13	7.2	25.0	60.0
V14	11.0	28.0	60.0
V15	2.9	25.0	60.0
VJ5	13.3	30.0	60.0
V17	1.5	60.0	60.0
V16	16.5	36.0	60.0
V22	25.4	40.0	60.0
VJ6	65.7	30.0	60.0
V24	70.3	35.0	60.0
V26	85.8	36.0	60.0
VJ7	107.2	41.0	60.0
V28	112.0	44.0	60.0
V29	117.1	46.0	60.0
G1	12.7	60.0	60.0
J1	23.9	61.0	60.0
J2	15.8	61.0	60.0
J3	24.1	25.0	60.0
JJ1	58.3	60.0	60.0
J4	14.7	60.0	60.0
J6	28.6	25.0	60.0
J5	18.5	60.0	60.0
JJ2	111.5	77.0	60.0
J7	32.9	60.0	60.0
J8	53.5	73.0	60.0
J10	34.1	25.0	60.0
JJ3	64.6	60.0	60.0
J9	197.6	96.0	60.0
G2	226.3	101.0	60.0
G3	31.9	25.0	60.0
G4	2.8	61.0	60.0
JJ4	229.5	109.0	60.0
G5	229.6	113.0	60.0
G6	231.9	113.0	60.0
G7	231.8	118.0	60.0
G8	231.8	123.0	60.0
G9	232.4	124.0	60.0
G10	232.8	126.0	60.0
G11	232.8	128.0	60.0
G13	232.7	131.0	60.0
G12	232.9	133.0	60.0

G14	232.8	136.0	60.0
G15	232.8	139.0	60.0
G16	232.8	141.0	60.0
G17	232.8	143.0	60.0
G18	232.8	143.0	60.0
G19	232.6	146.0	60.0
G21	232.6	149.0	60.0
G20	233.3	149.0	60.0
G22	18.3	25.0	60.0
G23	233.7	151.0	60.0
V30	263.2	59.0	60.0
V31	10.4	25.0	60.0
V32	14.4	40.0	60.0
V33	3.7	25.0	60.0
VJ8	274.0	60.0	60.0
V34	24.8	25.0	60.0
V35	31.0	40.0	60.0
V36	10.3	25.0	60.0
V37	31.6	63.0	60.0
VJ9	302.5	70.0	60.0
V39	305.2	70.0	60.0
V38	0.7	61.0	60.0
V40	3.7	110.0	60.0
V41	11.7	25.0	60.0
VJ10	310.0	70.0	60.0
V42	309.8	91.0	60.0
oneerRvr	309.8	91.0	60.0
node1	309.8	91.0	60.0

Maximum Values for Basins

Basin Name	Peak Inflow (M^3/S)	Critical Stm Dur (minutes)	Peak Outflow (M^3/S)	Critical Stm Dur (minutes)	Peak Water Level (M)
node1	309.8	60.0	88.8	60.0	23562.60

Maximum Values for Nodes

Node Name	Peak Inflow (M^3/S)	Time to Peak (minutes)	Critical Stm Dur (minutes)
V2	2.6	100.0	1440.0
V1	8.0	120.0	1440.0
V3	10.2	120.0	1440.0
V4	14.0	120.0	1440.0
V5	3.4	100.0	1440.0
V8	3.0	120.0	1440.0
V6	8.3	130.0	1440.0
V7	3.7	120.0	1440.0
VJ1	17.1	230.0	1440.0
V9	3.3	130.0	1440.0
V10	1.6	120.0	1440.0
VJ2	19.6	230.0	1440.0
V11	2.8	120.0	1440.0
V12	2.7	120.0	1440.0
VJ3	22.8	120.0	1440.0
V25	2.7	120.0	1440.0
V27	2.2	120.0	1440.0
VJ4	26.5	130.0	1440.0
V18	3.8	120.0	1440.0
V19	19.9	120.0	1440.0
V23	27.2	120.0	1440.0
V20	2.8	120.0	1440.0
V21	2.9	120.0	1440.0
V13	3.5	120.0	1440.0
V14	6.0	120.0	1440.0
V15	1.2	100.0	1440.0
VJ5	7.2	110.0	1440.0
V17	2.4	150.0	1440.0
V16	12.2	120.0	1440.0
V22	20.0	120.0	1440.0
VJ6	47.2	120.0	1440.0
V24	52.1	120.0	1440.0
V26	65.1	120.0	1440.0
VJ7	90.4	120.0	1440.0
V28	94.3	120.0	1440.0
V29	98.0	130.0	1440.0
G1	20.7	170.0	1440.0
J1	32.4	130.0	1440.0
J2	23.6	140.0	1440.0
J3	30.3	150.0	1440.0
JJ1	85.1	150.0	1440.0
J4	22.7	150.0	1440.0
J6	40.9	170.0	1440.0
J5	27.0	150.0	1440.0
JJ2	174.0	160.0	1440.0
J7	43.4	120.0	1440.0
J8	75.9	140.0	1440.0
J10	24.8	120.0	1440.0
JJ3	92.7	150.0	1440.0
J9	303.2	170.0	1440.0
G2	350.8	180.0	1440.0
G3	16.2	120.0	1440.0
G4	6.8	250.0	1440.0
JJ4	362.3	180.0	1440.0
G5	366.7	190.0	1440.0
G6	371.7	190.0	1440.0
G7	374.0	190.0	1440.0
G8	375.5	200.0	1440.0
G9	382.5	200.0	1440.0
G10	384.8	200.0	1440.0
G11	387.5	200.0	1440.0
G13	389.7	200.0	1440.0
G12	391.9	200.0	1440.0

G14	392.8	200.0	1440.0
G15	394.7	210.0	1440.0
G16	398.6	210.0	1440.0
G17	399.8	210.0	1440.0
G18	400.4	210.0	1440.0
G19	400.7	210.0	1440.0
G21	401.1	210.0	1440.0
G20	403.5	210.0	1440.0
G22	9.8	120.0	1440.0
G23	409.3	220.0	1440.0
V30	461.6	220.0	1440.0
V31	5.5	120.0	1440.0
V32	11.7	120.0	1440.0
V33	3.4	120.0	1440.0
VJ8	469.4	230.0	1440.0
V34	13.3	120.0	1440.0
V35	20.6	120.0	1440.0
V36	6.2	120.0	1440.0
V37	30.3	130.0	1440.0
VJ9	487.2	240.0	1440.0
V39	488.5	240.0	1440.0
V38	5.2	1390.0	1440.0
V40	6.7	1210.0	1440.0
V41	8.4	120.0	1440.0
VJ10	499.1	240.0	1440.0
V42	502.8	250.0	1440.0
oneerRvr	502.8	250.0	1440.0
node1	502.8	250.0	1440.0

Maximum Values for Basins

Basin Name	Peak Inflow (M^3/S)	Critical Stm Dur (minutes)	Peak Outflow (M^3/S)	Critical Stm Dur (minutes)	Peak Water Level (M)
node1	502.8	1440.0	141.5	1440.0	59818.10

Maximum Values for Nodes

Node Name	Peak Inflow (M^3/S)	Time to Peak (minutes)	Critical Stm Dur (minutes)
V18	9.3	25.0	60.0
V19	45.1	25.0	60.0
V23	54.7	29.0	60.0
V20	5.8	25.0	60.0
V21	6.3	25.0	60.0
V13	8.7	25.0	60.0
V14	13.2	28.0	60.0
V15	3.4	25.0	60.0
VJ5	16.1	29.0	60.0
V17	1.9	60.0	60.0
V16	20.2	36.0	60.0
V22	31.1	39.0	60.0
VJ6	80.8	30.0	60.0
V24	86.4	32.0	60.0
V26	106.3	35.0	60.0
V2	7.7	25.0	60.0
V1	14.9	25.0	60.0
V3	16.9	29.0	60.0
V4	23.0	31.0	60.0
V5	9.6	25.0	60.0
V8	3.1	25.0	60.0
V6	14.1	36.0	60.0
V7	9.3	25.0	60.0
VJ1	20.3	35.0	60.0
V9	3.0	61.0	60.0
V10	3.6	25.0	60.0
VJ2	22.8	43.0	60.0
V11	2.9	55.0	60.0
V12	6.1	25.0	60.0
VJ3	28.8	45.0	60.0
V25	3.8	44.0	60.0
V27	2.1	60.0	60.0
VJ4	33.3	54.0	60.0
VJ7	132.1	40.0	60.0
V28	137.9	42.0	60.0
V29	144.5	45.0	60.0
G1	16.2	60.0	60.0
J1	30.4	61.0	60.0
J2	20.5	61.0	60.0
J3	29.3	25.0	60.0
JJ1	74.6	60.0	60.0
J4	19.0	60.0	60.0
J6	35.0	25.0	60.0
J5	23.5	60.0	60.0
JJ2	142.6	76.0	60.0
J7	42.2	60.0	60.0
J8	68.5	68.0	60.0
J10	40.9	25.0	60.0
JJ3	83.8	60.0	60.0
J9	252.8	91.0	60.0
G2	290.4	95.0	60.0
G3	39.0	25.0	60.0
G4	3.6	61.0	60.0
JJ4	294.7	102.0	60.0
G5	294.8	105.0	60.0
G6	297.8	105.0	60.0
G7	297.7	110.0	60.0
G8	297.7	115.0	60.0
G9	298.5	116.0	60.0
G10	299.0	118.0	60.0
G11	299.1	119.0	60.0
G13	299.0	122.0	60.0
G12	299.3	123.0	60.0

G14	299.3	126.0	60.0
G15	299.3	129.0	60.0
G16	299.3	131.0	60.0
G17	299.3	132.0	60.0
G18	299.3	132.0	60.0
G19	299.1	135.0	60.0
G21	299.0	137.0	60.0
G20	300.0	137.0	60.0
G22	21.8	25.0	60.0
G23	300.6	139.0	60.0
V30	329.9	55.0	60.0
V31	12.3	25.0	60.0
V32	17.4	40.0	60.0
V33	4.5	25.0	60.0
VJ8	343.5	56.0	60.0
V34	29.4	25.0	60.0
V35	37.1	40.0	60.0
V36	12.2	25.0	60.0
V37	39.1	61.0	60.0
VJ9	378.5	69.0	60.0
V39	381.8	69.0	60.0
V38	0.9	61.0	60.0
V40	4.7	60.0	60.0
V41	13.9	25.0	60.0
VJ10	387.5	69.0	60.0
V42	388.2	86.0	60.0
oneerRvr	388.2	86.0	60.0
node1	388.2	86.0	60.0

Maximum Values for Basins

Basin Name	Peak Inflow (M^3/S)	Critical Stm Dur (minutes)	Peak Outflow (M^3/S)	Critical Stm Dur (minutes)	Peak Water Level (M)
node1	388.2	60.0	100.3	60.0	30015.20

Maximum Values for Nodes

Node Name	Peak Inflow (M^3/S)	Time to Peak (minutes)	Critical Stm Dur (minutes)
V18	4.5	120.0	1440.0
V19	23.3	120.0	1440.0
V23	31.9	120.0	1440.0
V20	3.3	120.0	1440.0
V21	3.4	120.0	1440.0
V13	4.1	120.0	1440.0
V14	7.0	120.0	1440.0
V15	1.4	100.0	1440.0
VJ5	8.4	110.0	1440.0
V17	2.9	150.0	1440.0
V16	14.5	120.0	1440.0
V22	23.8	120.0	1440.0
VJ6	55.7	120.0	1440.0
V24	61.6	120.0	1440.0
V26	77.0	120.0	1440.0
V2	3.1	100.0	1440.0
V1	9.4	120.0	1440.0
V3	12.0	120.0	1440.0
V4	16.5	120.0	1440.0
V5	4.0	100.0	1440.0
V8	3.6	120.0	1440.0
V6	9.9	130.0	1440.0
V7	4.3	120.0	1440.0
VJ1	20.3	220.0	1440.0
V9	4.1	130.0	1440.0
V10	1.8	120.0	1440.0
VJ2	23.4	220.0	1440.0
V11	3.3	120.0	1440.0
V12	3.2	120.0	1440.0
VJ3	27.9	120.0	1440.0
V25	3.1	120.0	1440.0
V27	2.6	120.0	1440.0
VJ4	32.4	130.0	1440.0
VJ7	108.0	120.0	1440.0
V28	112.7	120.0	1440.0
V29	116.6	130.0	1440.0
G1	25.4	150.0	1440.0
J1	39.7	130.0	1440.0
J2	28.8	140.0	1440.0
J3	37.2	150.0	1440.0
JJ1	104.9	130.0	1440.0
J4	27.6	150.0	1440.0
J6	49.9	170.0	1440.0
J5	33.2	130.0	1440.0
JJ2	213.7	150.0	1440.0
J7	52.1	120.0	1440.0
J8	93.8	140.0	1440.0
J10	29.4	120.0	1440.0
JJ3	113.2	150.0	1440.0
J9	371.1	160.0	1440.0
G2	430.0	170.0	1440.0
G3	19.0	120.0	1440.0
G4	8.4	240.0	1440.0
JJ4	443.4	170.0	1440.0
G5	449.5	180.0	1440.0
G6	455.7	180.0	1440.0
G7	458.2	180.0	1440.0
G8	460.4	190.0	1440.0
G9	469.0	190.0	1440.0
G10	471.9	190.0	1440.0
G11	475.7	190.0	1440.0
G13	478.7	190.0	1440.0
G12	481.2	190.0	1440.0

G14	481.6	200.0	1440.0
G15	484.5	200.0	1440.0
G16	489.0	200.0	1440.0
G17	490.5	200.0	1440.0
G18	491.2	200.0	1440.0
G19	491.2	200.0	1440.0
G21	491.5	200.0	1440.0
G20	494.6	200.0	1440.0
G22	11.6	120.0	1440.0
G23	501.3	210.0	1440.0
V30	565.3	210.0	1440.0
V31	6.5	120.0	1440.0
V32	14.1	120.0	1440.0
V33	4.1	120.0	1440.0
VJ8	574.7	210.0	1440.0
V34	15.8	120.0	1440.0
V35	24.5	120.0	1440.0
V36	7.6	120.0	1440.0
V37	37.0	130.0	1440.0
VJ9	599.1	220.0	1440.0
V39	600.7	220.0	1440.0
V38	6.6	1440.0	1440.0
V40	8.5	1190.0	1440.0
V41	10.2	120.0	1440.0
VJ10	613.7	220.0	1440.0
V42	618.0	230.0	1440.0
oneerRvr	618.0	230.0	1440.0
node1	618.0	230.0	1440.0

Maximum Values for Basins

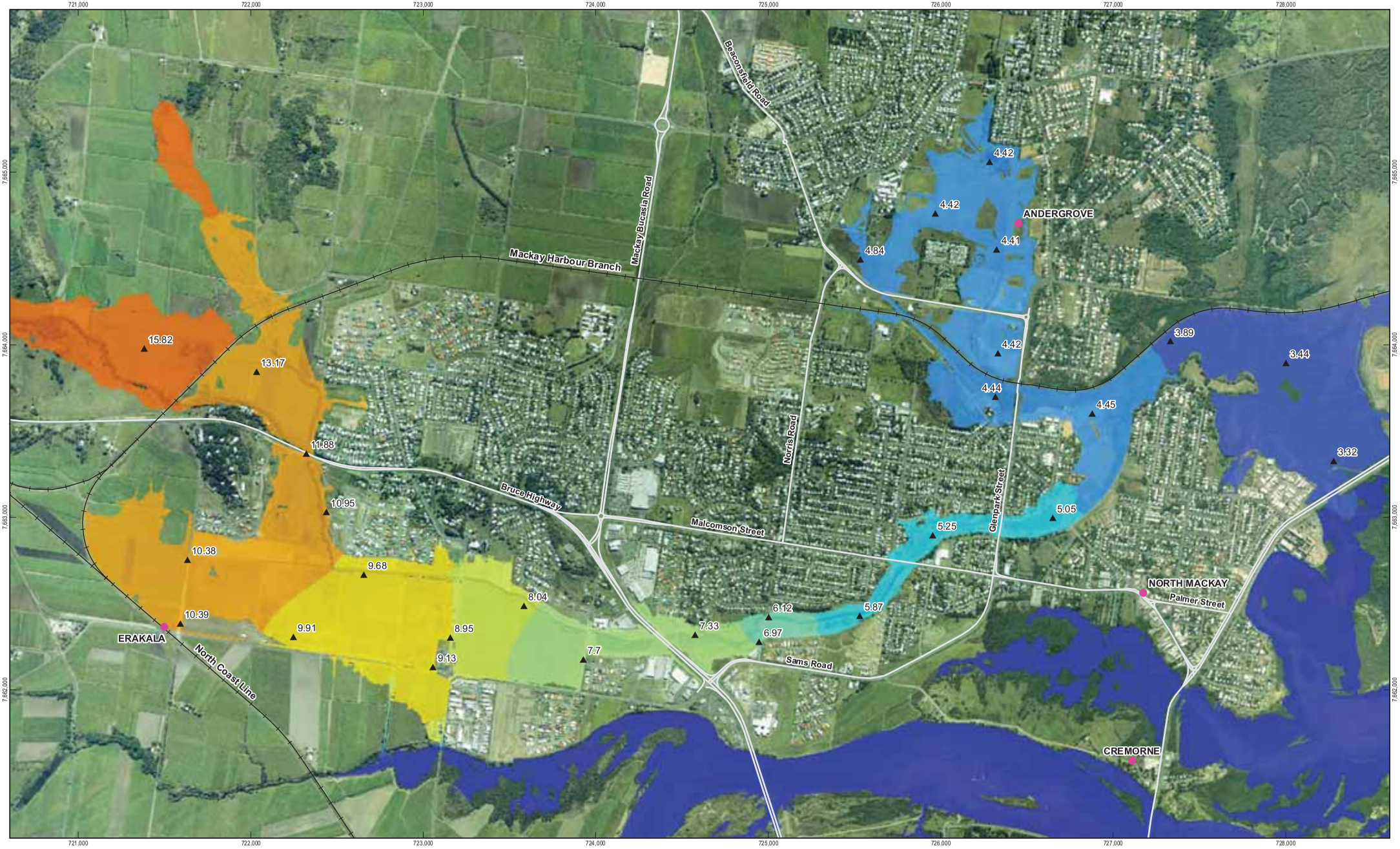
Basin Name	Peak Inflow (M^3/S)	Critical Stm Dur (minutes)	Peak Outflow (M^3/S)	Critical Stm Dur (minutes)	Peak Water Level (M)
node1	618.0	1440.0	161.9	1440.0	78271.60

Appendix C

Existing Catchment Conditions Flood Inundation Maps

Appendix C - Figure Summary	
Figure	**Title**
Figure C1	5yr ARI Maximum Flood Levels (tailwater = 2.34m AHD)
Figure C2	50yr ARI Maximum Flood Levels (tailwater = 4.08m AHD)
Figure C3	100yr ARI Maximum Flood Levels (tailwater = 4.08m AHD)
Figure C4	100yr ARI Maximum Flood Levels (tailwater = 5.32m AHD)
Figure C5	5yr ARI Maximum Flood Velocities (tailwater = 2.34m AHD)
Figure C6	50yr ARI Maximum Flood Velocities (tailwater = 4.08m AHD)
Figure C7	100yr ARI Maximum Flood Velocities (tailwater = 4.08m AHD)
Figure C8	100yr ARI Maximum Flood Velocities (tailwater = 5.32m AHD)
Figure C9	100yr ARI Maximum Flood Levels – Future Climate (20% Increase in Rainfall Intensity, tailwater = 4.78m AHD)

Figure C10	100yr ARI Maximum Flood Velocities – Future Climate (20% Increase in Rainfall Intensity, tailwater = 4.78m AHD)
Figure C11	100yr ARI Afflux Map – Impact of Future Climate (20% Increase in Rainfall Intensity, tailwater = 4.78m AHD)



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0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Maximum Flood Level (mAHD)

2 - 3 | 3 - 4 | 4 - 5 | 5 - 6 | 6 - 7 | 7 - 8 | 8 - 9 | 9 - 10 | 11 - 15 | 16 - 20 | 21 - 25

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Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number 41-24514
Revision A
Date 01 Dec 2011

5 year ARI Maximum Flood Level (tailwater = 2.34m AHD)

Figure C1

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Data source: GHD - Model Results (2011); MRC - Imagery (2004); DERM - Roads (2011), Locality(2009).

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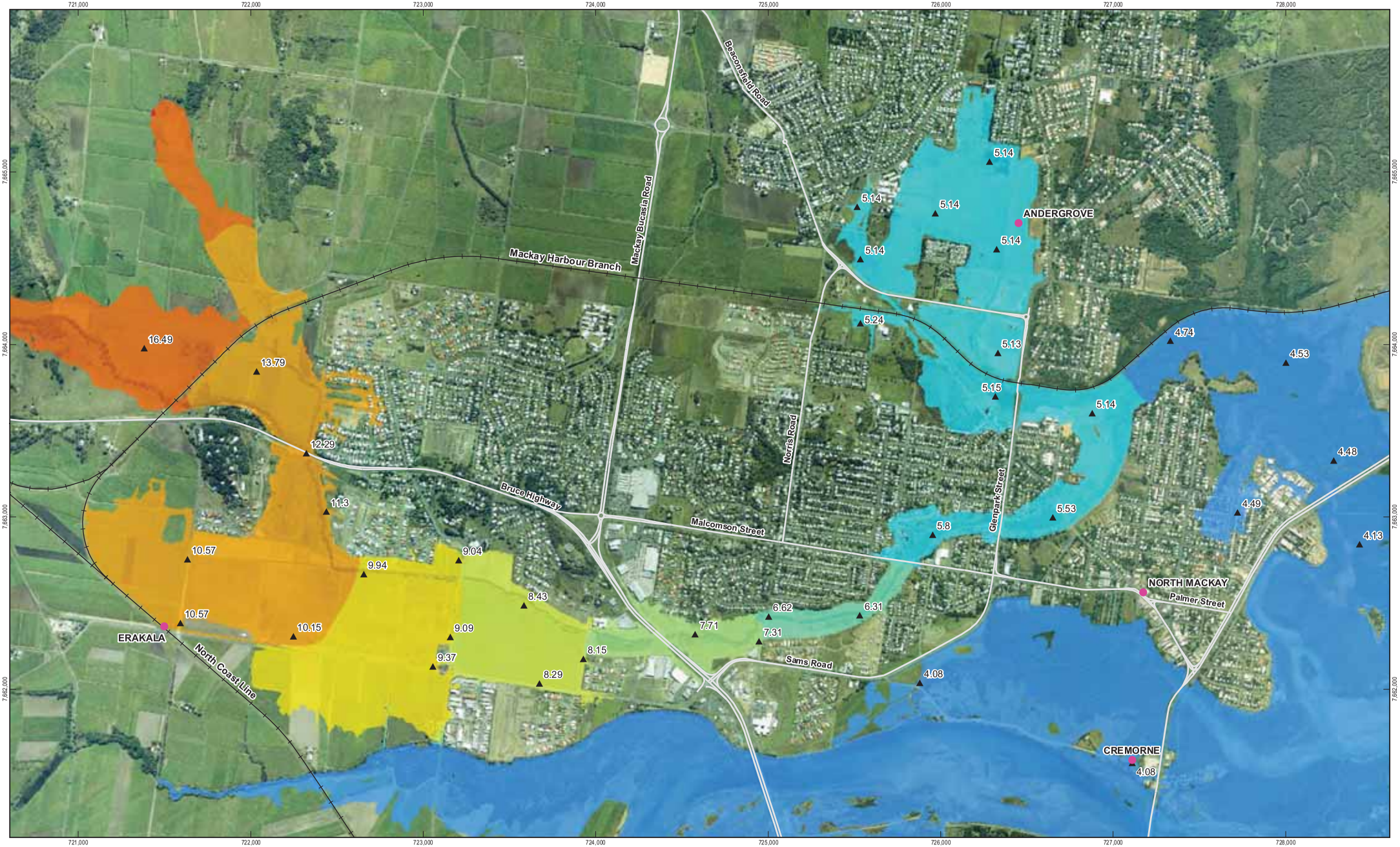

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0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Maximum Flood Level (mAHD)

2 - 3 | 3 - 4 | 4 - 5 | 5 - 6 | 6 - 7 | 7 - 8 | 8 - 9 | 9 - 10 | 11 - 15 | 16 - 20 | 21 - 25

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CLIENTS | PEOPLE | PERFORMANCE

Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number	41-24514
Revision	A
Date	30 Nov 2011

50 year ARI Maximum Flood Level (tailwater = 4.08m AHD)

Figure C2

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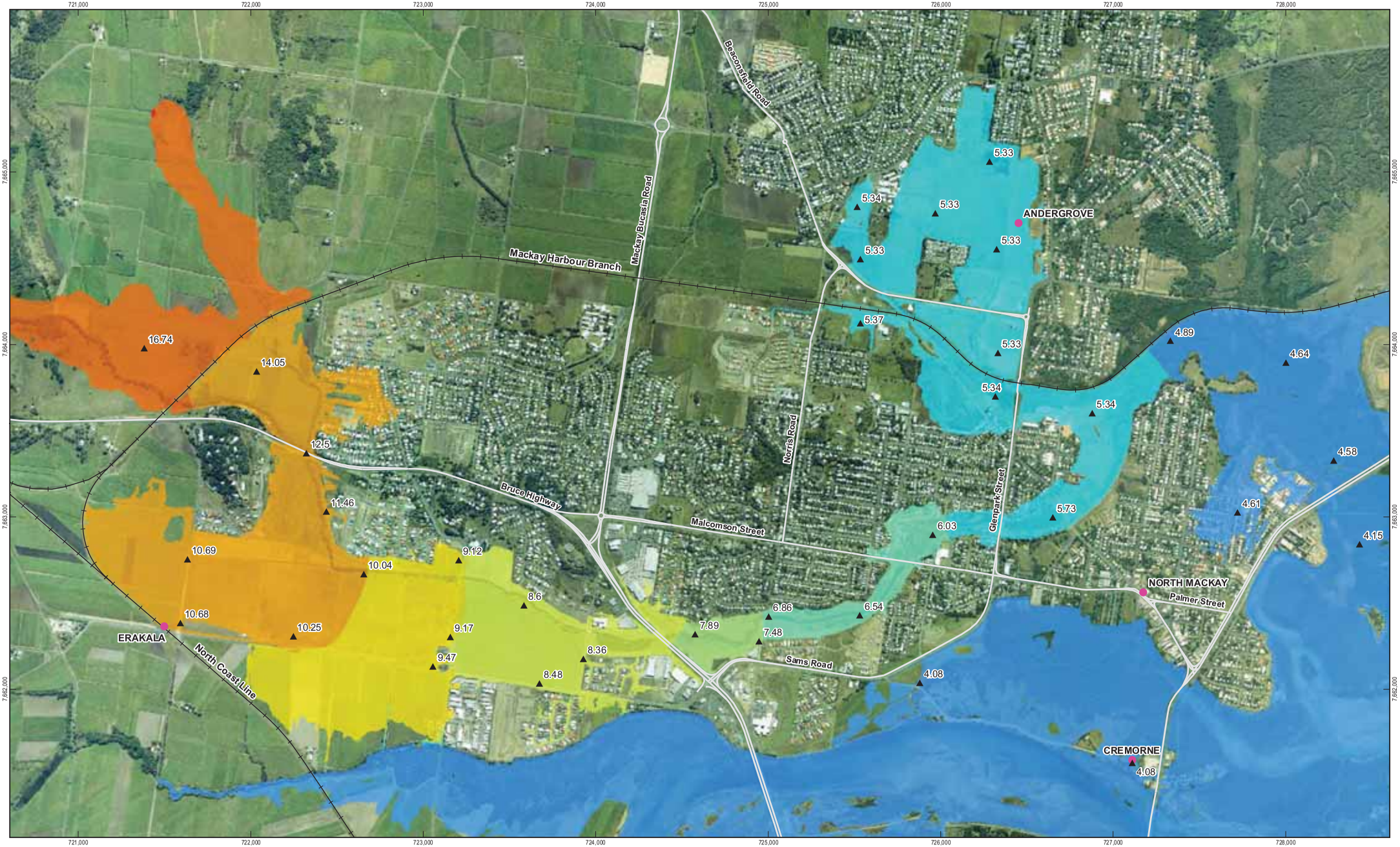

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0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Maximum Flood Level (mAHD)

2 - 3 | 3 - 4 | 4 - 5 | 5 - 6 | 6 - 7 | 7 - 8 | 8 - 9 | 9 - 10 | 11 - 15 | 16 - 20 | 21 - 25

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CLIENTS | PEOPLE | PERFORMANCE

Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number	41-24514
Revision	A
Date	30 Nov 2011

100 year ARI Maximum Flood Level (tailwater = 4.08m AHD)

Figure C3

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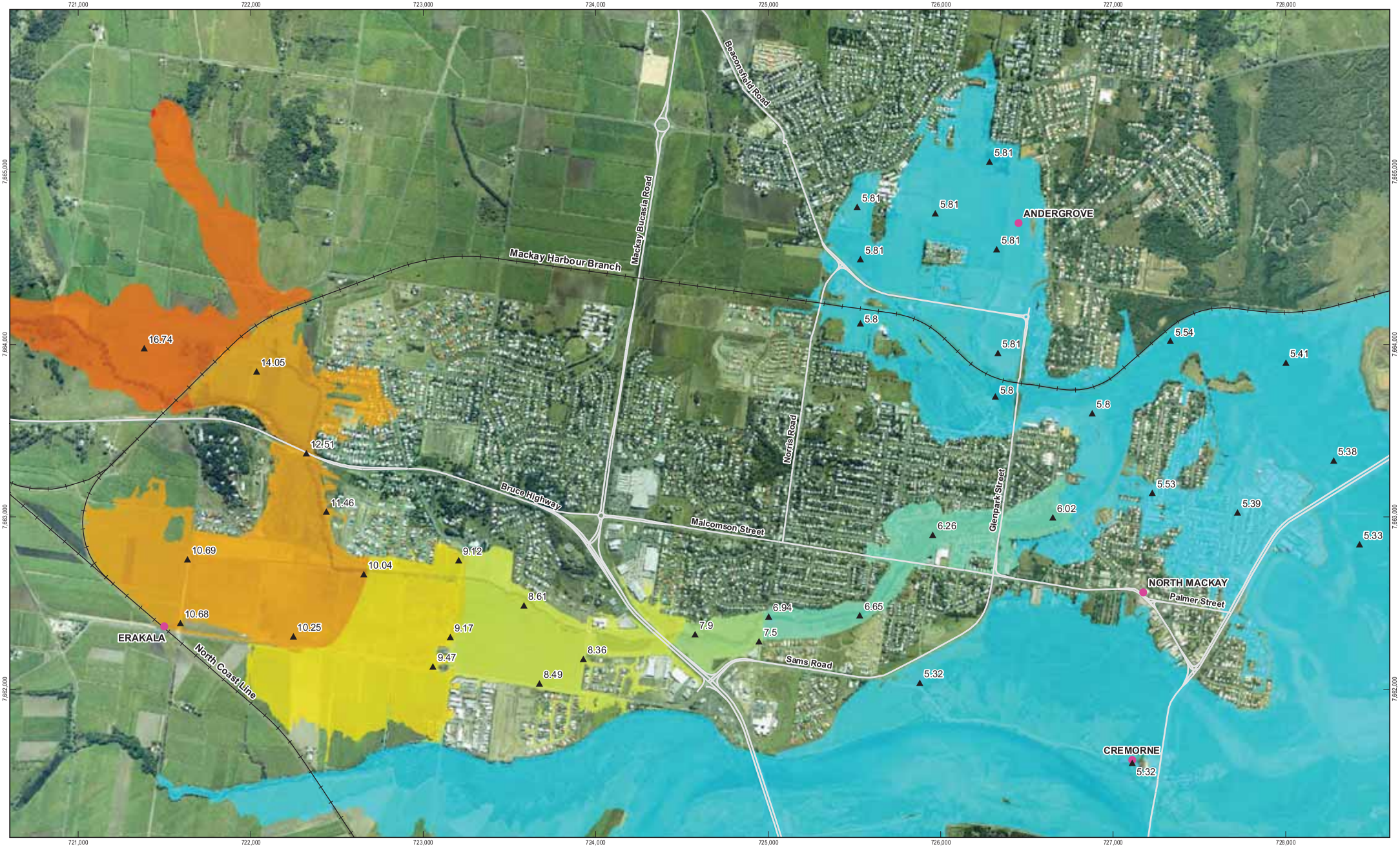

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Maximum Flood Level (mAHD)

2 - 3 | 3 - 4 | 4 - 5 | 5 - 6 | 6 - 7 | 7 - 8 | 8 - 9 | 9 - 10 | 10 - 15 | 15 - 20 | 20 - 25

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Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number	41-24514
Revision	A
Date	30 Nov 2011

100 year ARI Maximum Flood Level (tailwater = 5.32m AHD)

Figure C4

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Data source: Data Custodian, Data Set Name/Title, Version/Date.

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1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Velocity (m/s)

<0.5 | 0.5 - 1 | 1 - 1.5 | 1.5 - 2 | 2.0 - 2.5 | >2.5

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CLIENTS | PEOPLE | PERFORMANCE

Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number 41-24514
Revision A
Date 30 Nov 2011

5 year ARI Maximum Flood Velocity (tailwater = 2.34m AHD)

Figure C5

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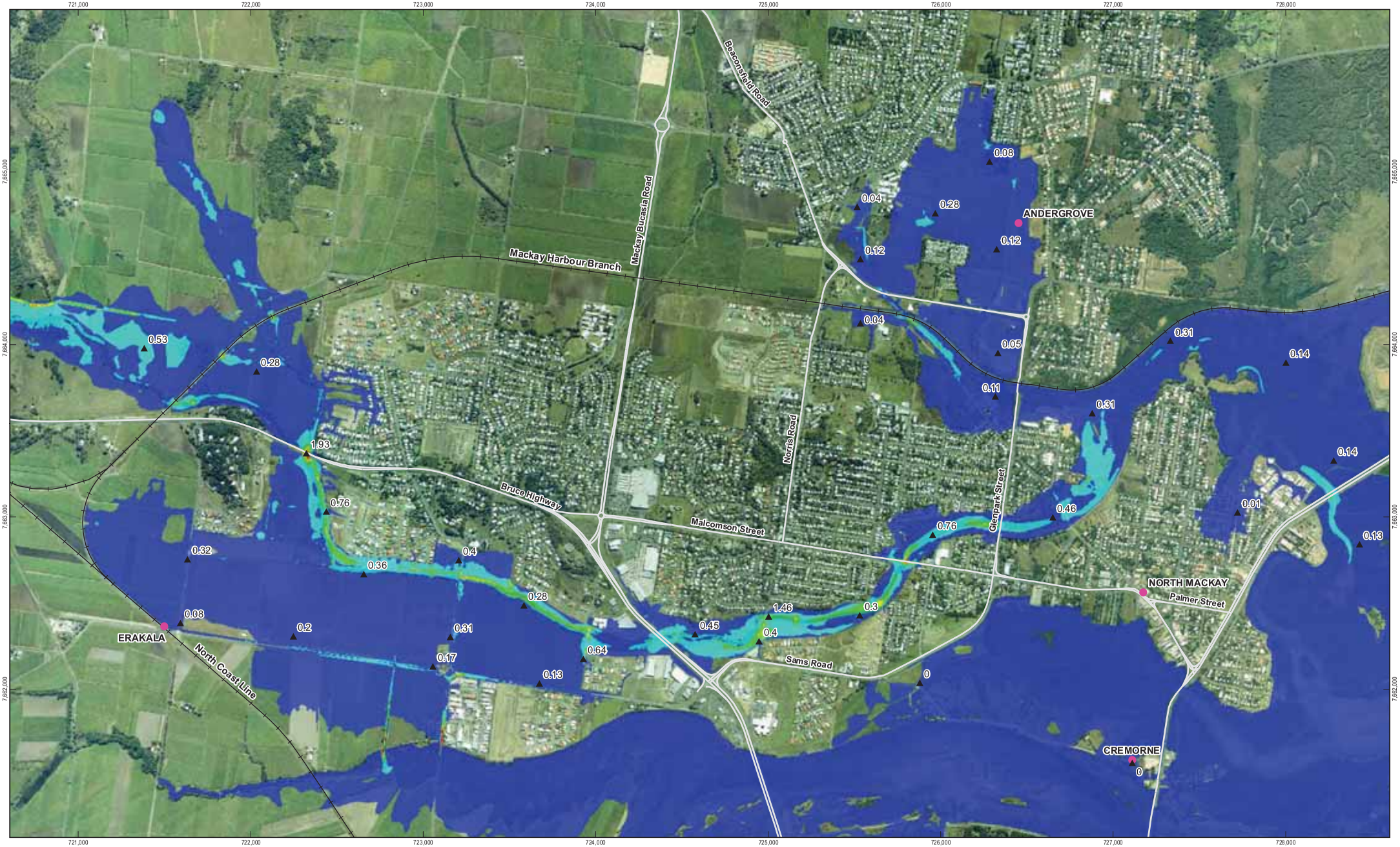

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Velocity (m/s)

<0.5 | 0.5 - 1 | 1 - 1.5 | 1.5 - 2 | 2.0 - 2.5 | >2.5

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CLIENTS | PEOPLE | PERFORMANCE

Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number 41-24514
Revision A
Date 30 Nov 2011

50 year ARI Maximum Flood Velocity (tailwater = 4.08m AHD)

Figure C6

G:\41\24514\GIS\Maps\Deliverables\41245l4_025_rev_a.mxd

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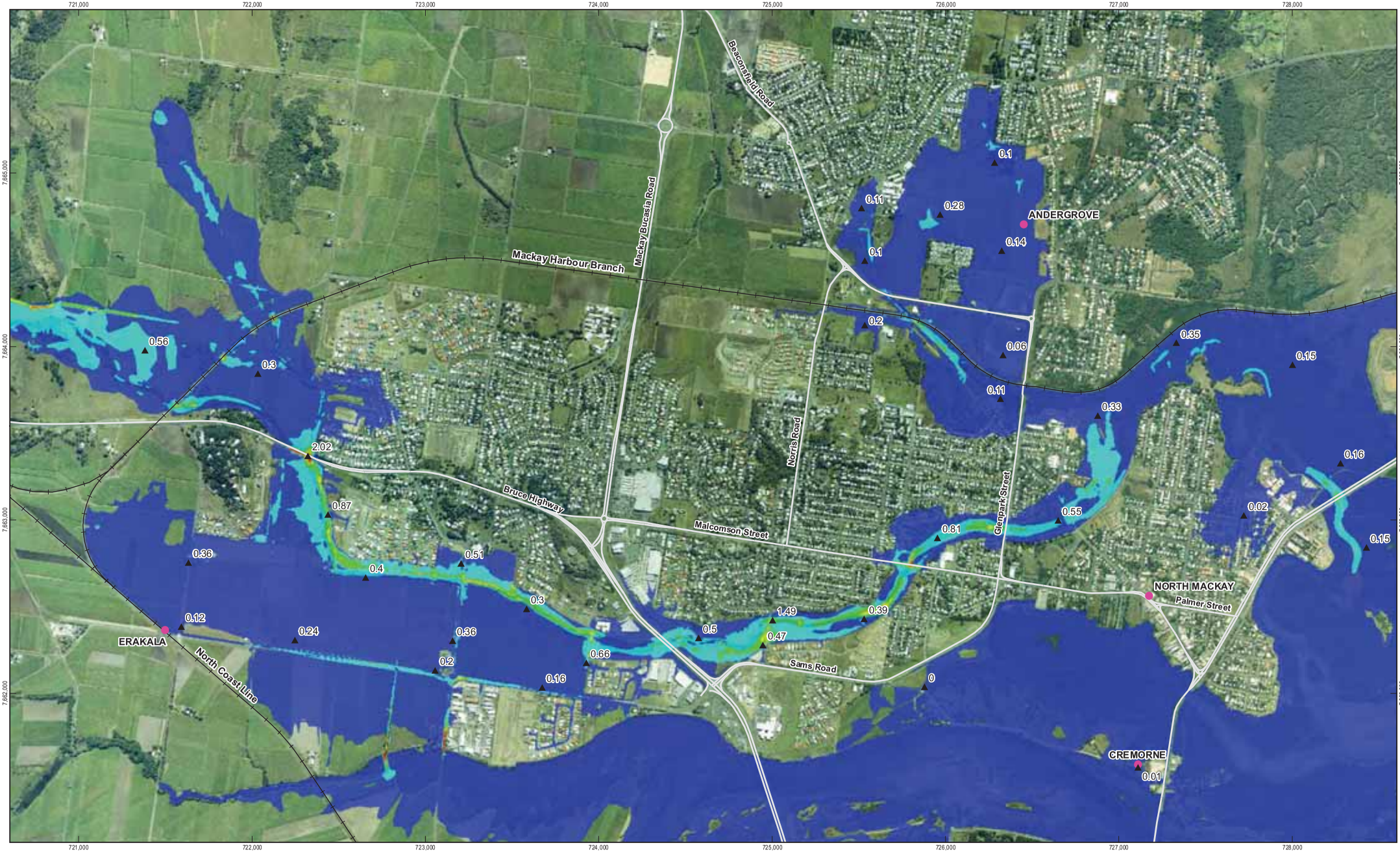

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0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Velocity (m/s)

< 0.5 | 0.5 - 1 | 1 - 1.5 | 1.5 - 2 | 2.0 - 2.5 | > 2.5

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Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number 41-24514
Revision A
Date 30 Nov 2011

100 year ARI Maximum Flood Velocity (tailwater = 4.08m AHD)

Figure C7

G:\41\24514\GIS\Maps\Deliverables\41245l4_026_rev_a.mxd

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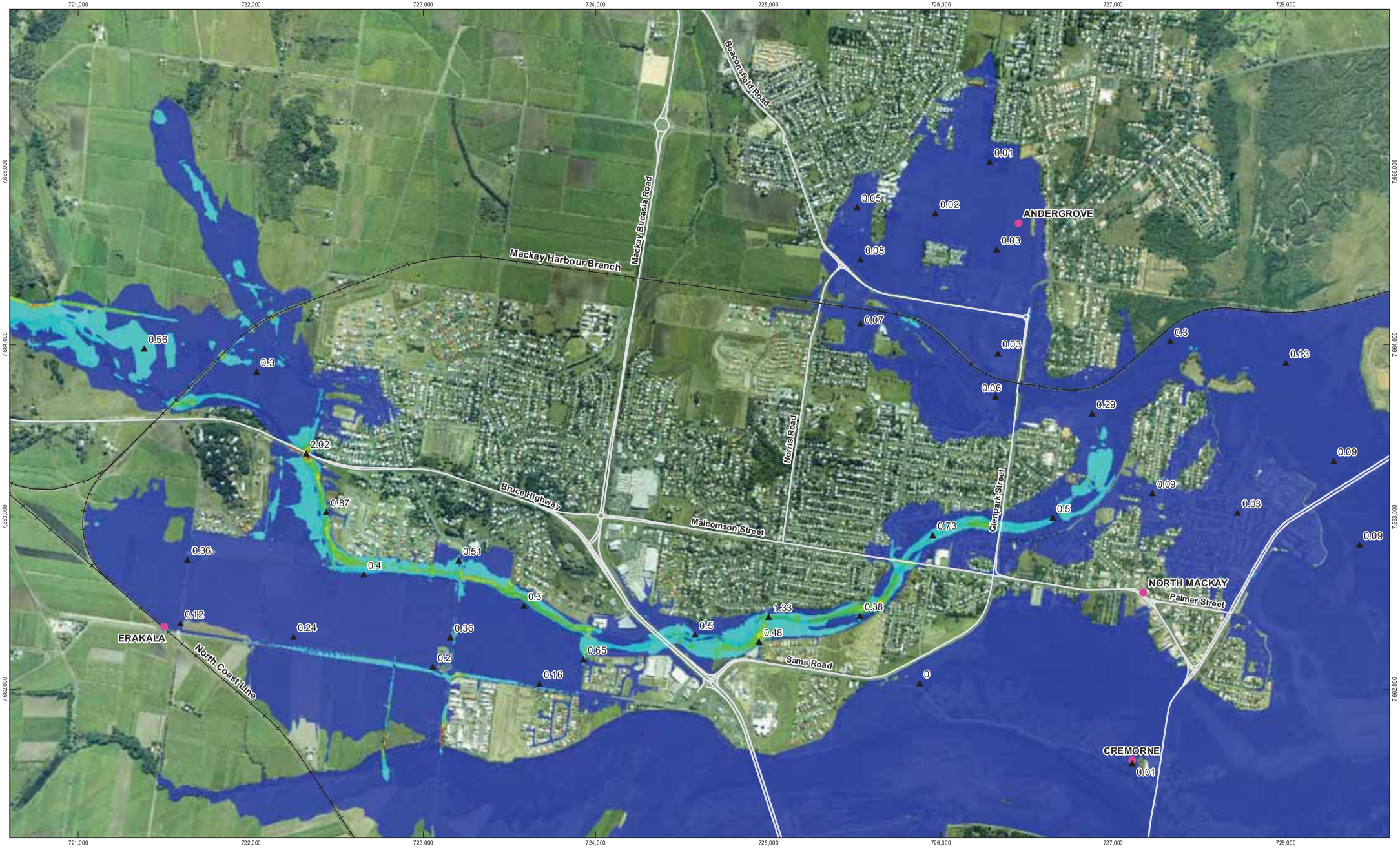

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Velocity (m/s)

<0.5 | 0.5 - 1 | 1 - 1.5 | 1.5 - 2 | 2.0 - 2.5 | >2.5

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Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number 41-24514
Revision A
Date 30 Nov 2011

100 year ARI Maximum Flood Velocity (tailwater = 5.32m AHD)

Figure C8

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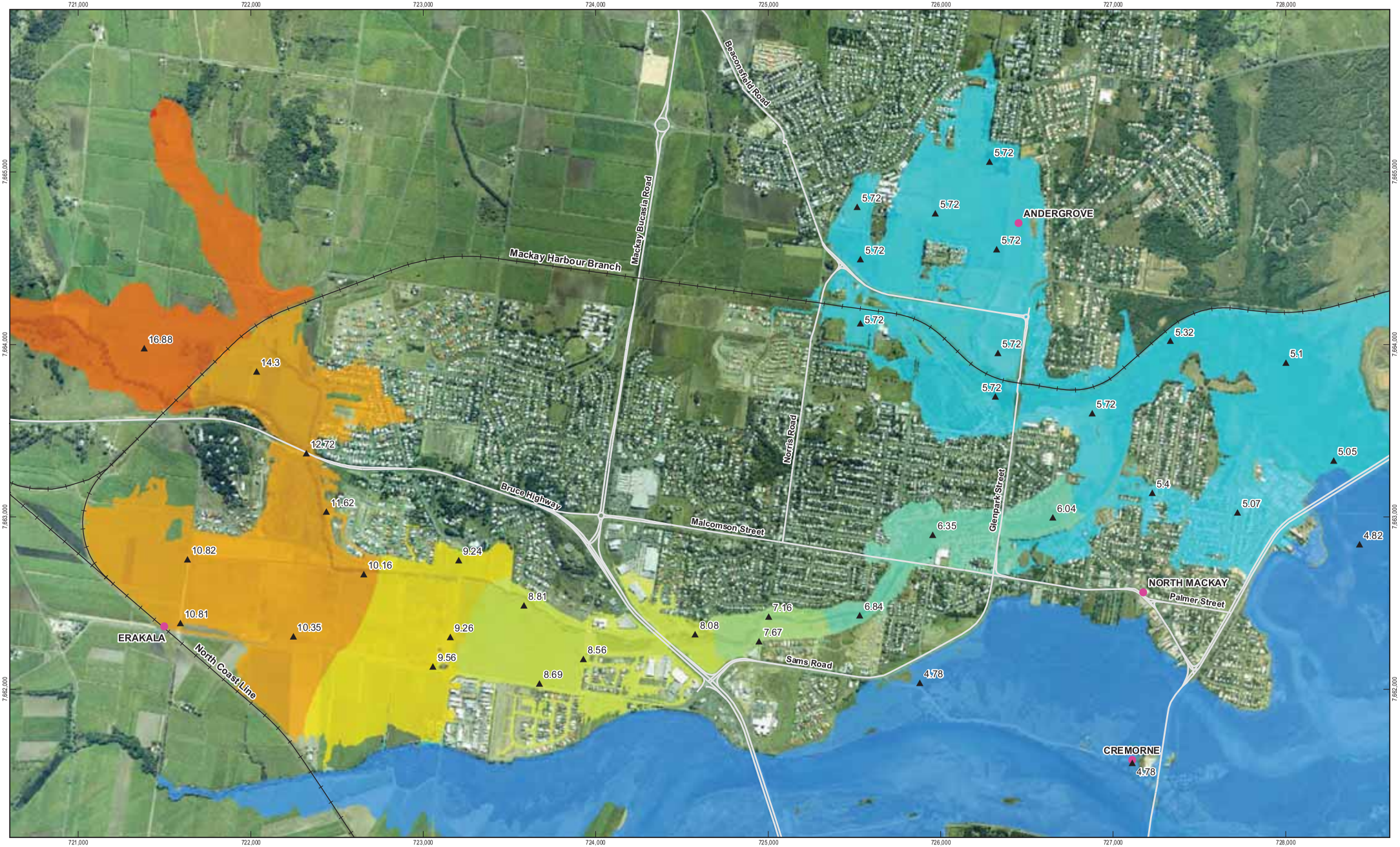

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0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Maximum Flood Level (mAHD)

2 - 3 | 3 - 4 | 4 - 5 | 5 - 6 | 6 - 7 | 7 - 8 | 8 - 9 | 9 - 10 | 11 - 15 | 16 - 20 | 21 - 25

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Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number	41-24514
Revision	A
Date	30 Nov 2011

100 year ARI Maximum Flood Level Future Climate

Figure C9

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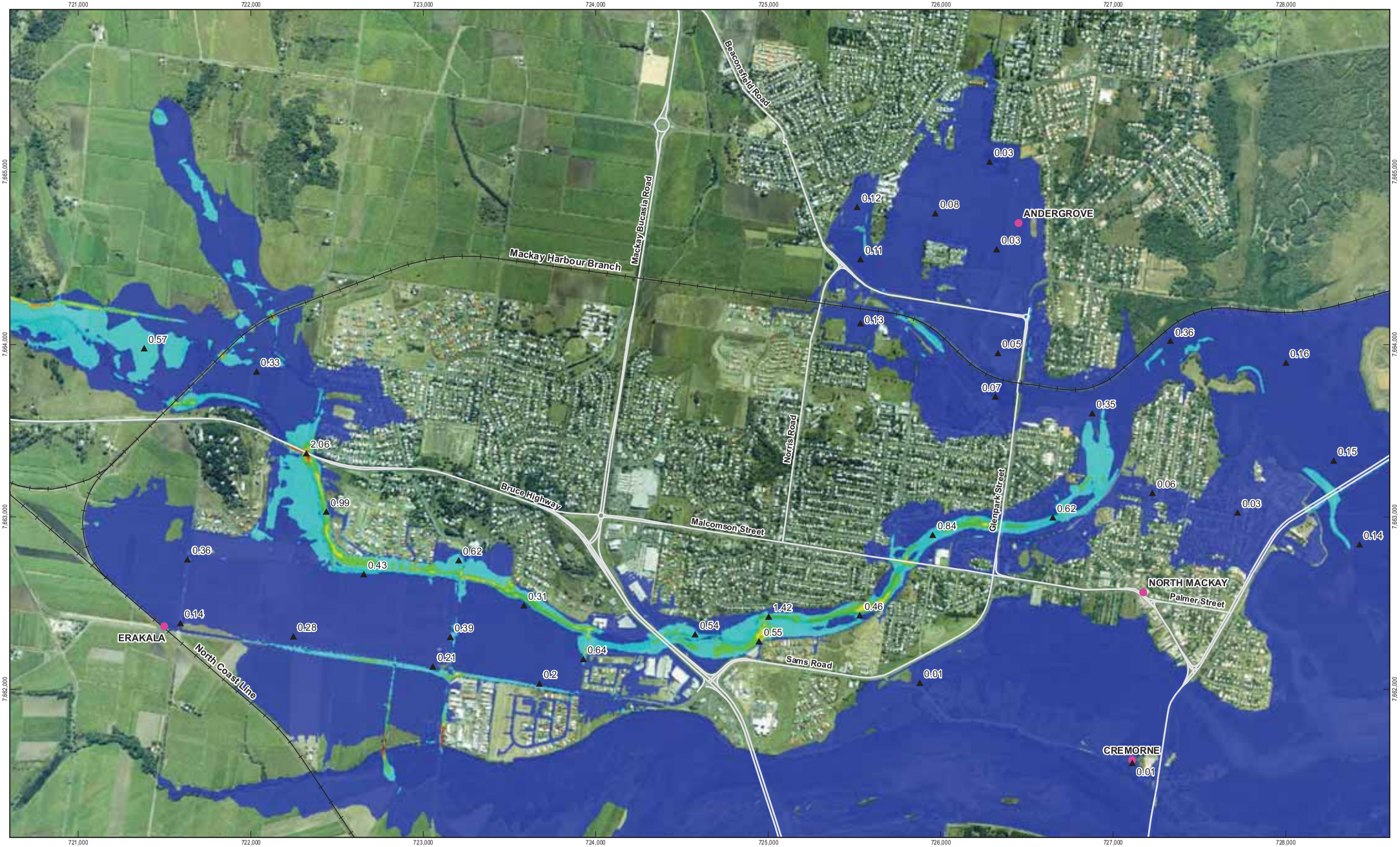

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Velocity (m/s)

< 0.5 | 0.5 - 1 | 1 - 1.5 | 1.5 - 2 | 2.0 - 2.5 | > 2.5

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Goose Ponds\Vines Creek Flood Study

Job Number 41-24514
Revision A
Date 30 Nov 2011

100 year ARI Maximum Flood Velocity Future Climate

Figure C10

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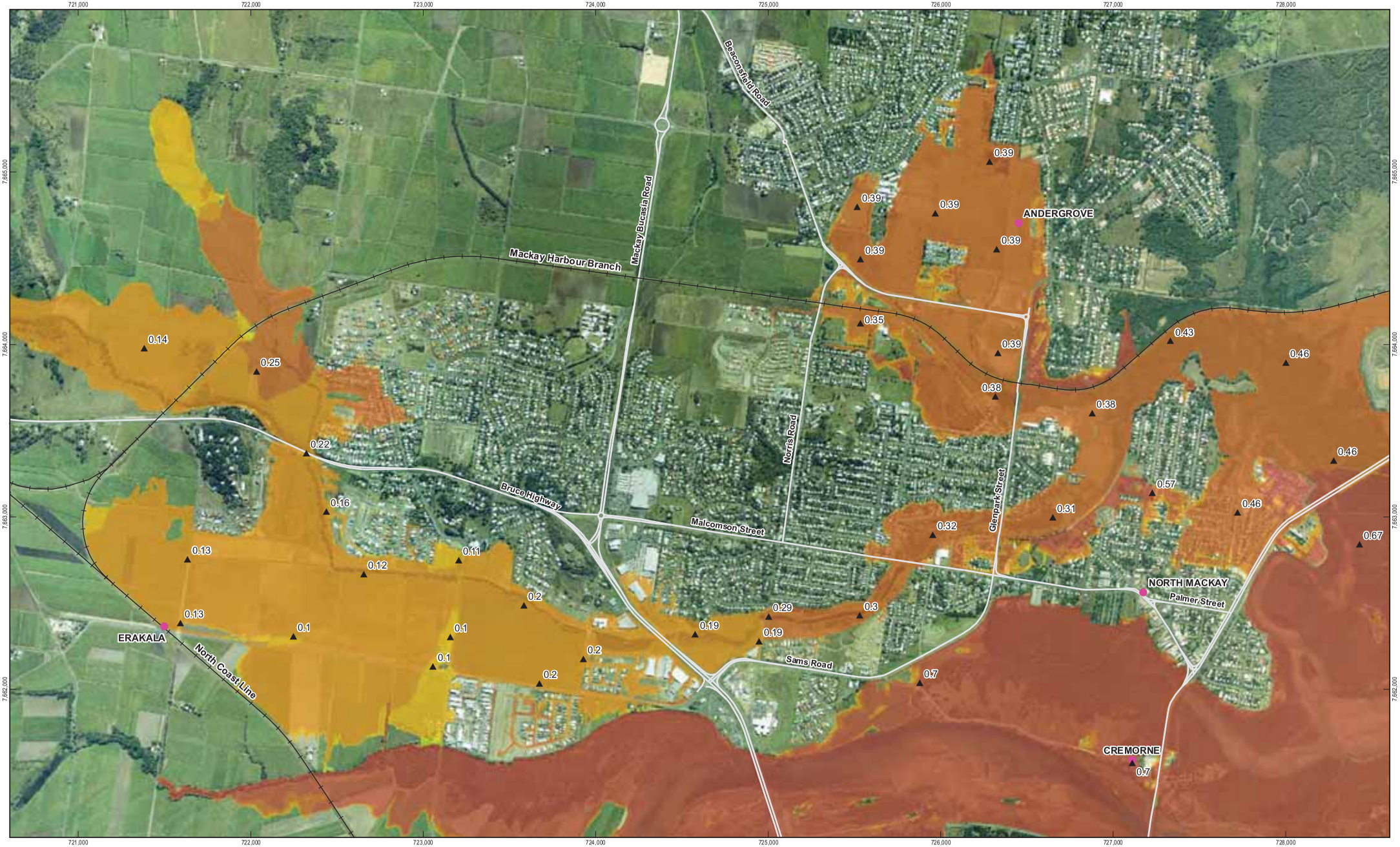

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Afflux (m)

< 0.500 | -0.500 - -0.250 | -0.250 - -0.100 | -0.100 - -0.050 | -0.050 - -0.025 | -0.025 - 0.000 | 0.000 - 0.025 | 0.025 - 0.050 | 0.050 - 0.100 | 0.100 - 0.250 | 0.250 - 0.500 | > 0.500

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Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number 41-24514
Revision A
Date 30 Nov 2011

100 year ARI Afflux Map
Impact of Future Climate

Figure C11

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Appendix D

Impact of Revegetation Strategy - Flood Inundation Maps

Appendix D - Figure Summary	
Figure	**Title**
Figure D1	Revegetation Strategy
Figure D2	100yr ARI Maximum Flood Levels – Revegetation Strategy
Figure D3	100yr ARI Afflux Map - Revegetation Strategy
Figure D4	100yr ARI Change in Velocity - Revegetation Strategy
Figure D5	100yr ARI Maximum Flood Levels – Revegetation Strategy + Future Climate (20% Increase in Rainfall Intensity, tailwater = 4.78m AHD)
Figure D6	100yr ARI Afflux Map - Revegetation Strategy + Future Climate (20% Increase in Rainfall Intensity, tailwater = 4.78m AHD)
Figure D7	100yr ARI Change in Velocity - Revegetation Strategy + Future Climate (20% Increase in Rainfall Intensity, tailwater = 4.78m AHD)

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Road
- Railway

Manning's n Value

- 0.07
- 0.12

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Goose Ponds\Vines Creek Flood Study

Job Number	41-24514
Revision	A
Date	30 Nov 2011

Revegetation Strategy

Figure D1

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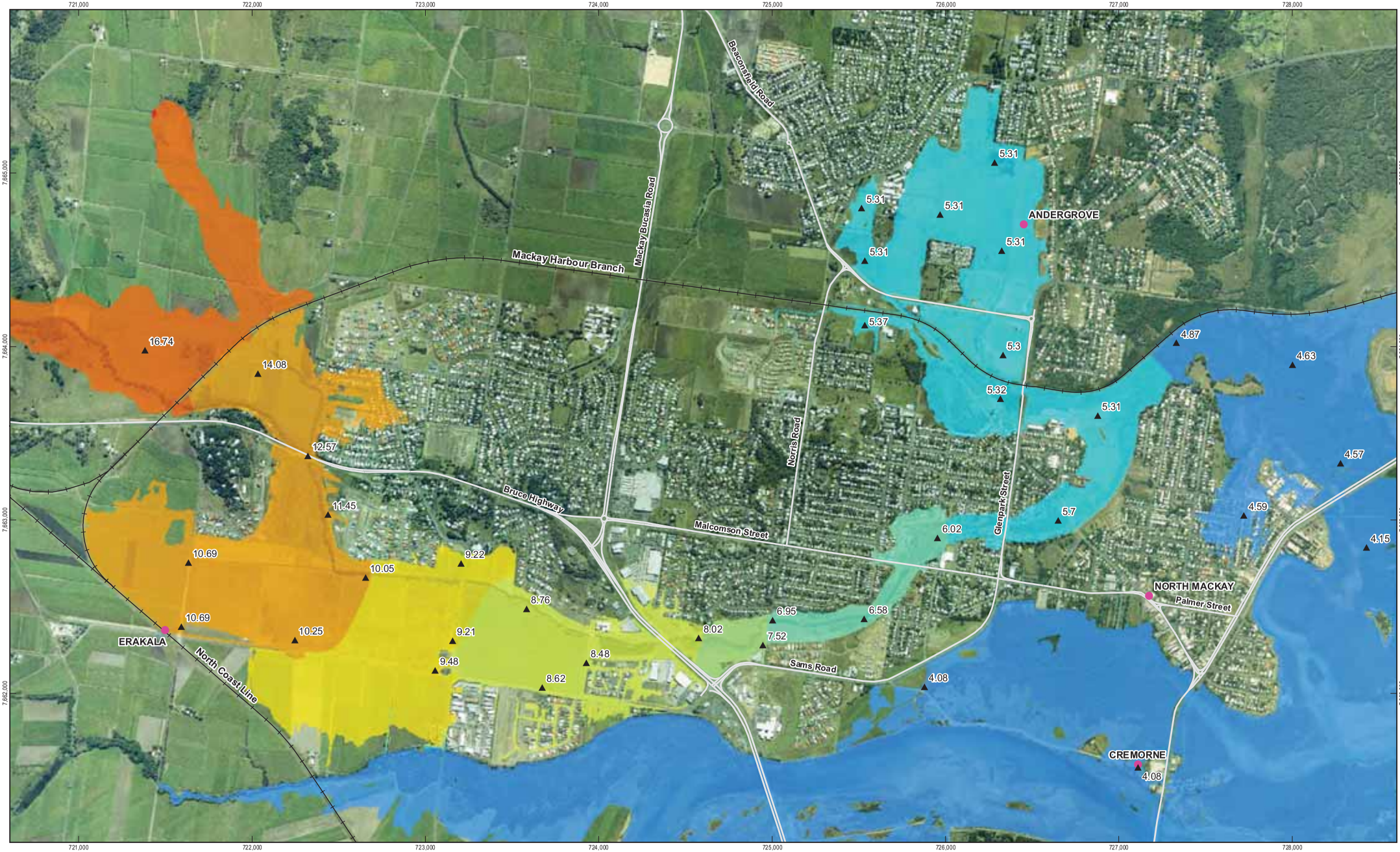

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0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Maximum Flood Level (m AHD)

2 - 3 | 3 - 4 | 4 - 5 | 5 - 6 | 6 - 7 | 7 - 8 | 8 - 9 | 9 - 10 | 11 - 15 | 16 - 20 | 21 - 25

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Goose Ponds\Vines Creek Flood Study

Job Number	41-24514
Revision	A
Date	30 Nov 2011

100 year ARI Maximum Flood Level Revegetation Strategy

Figure D2

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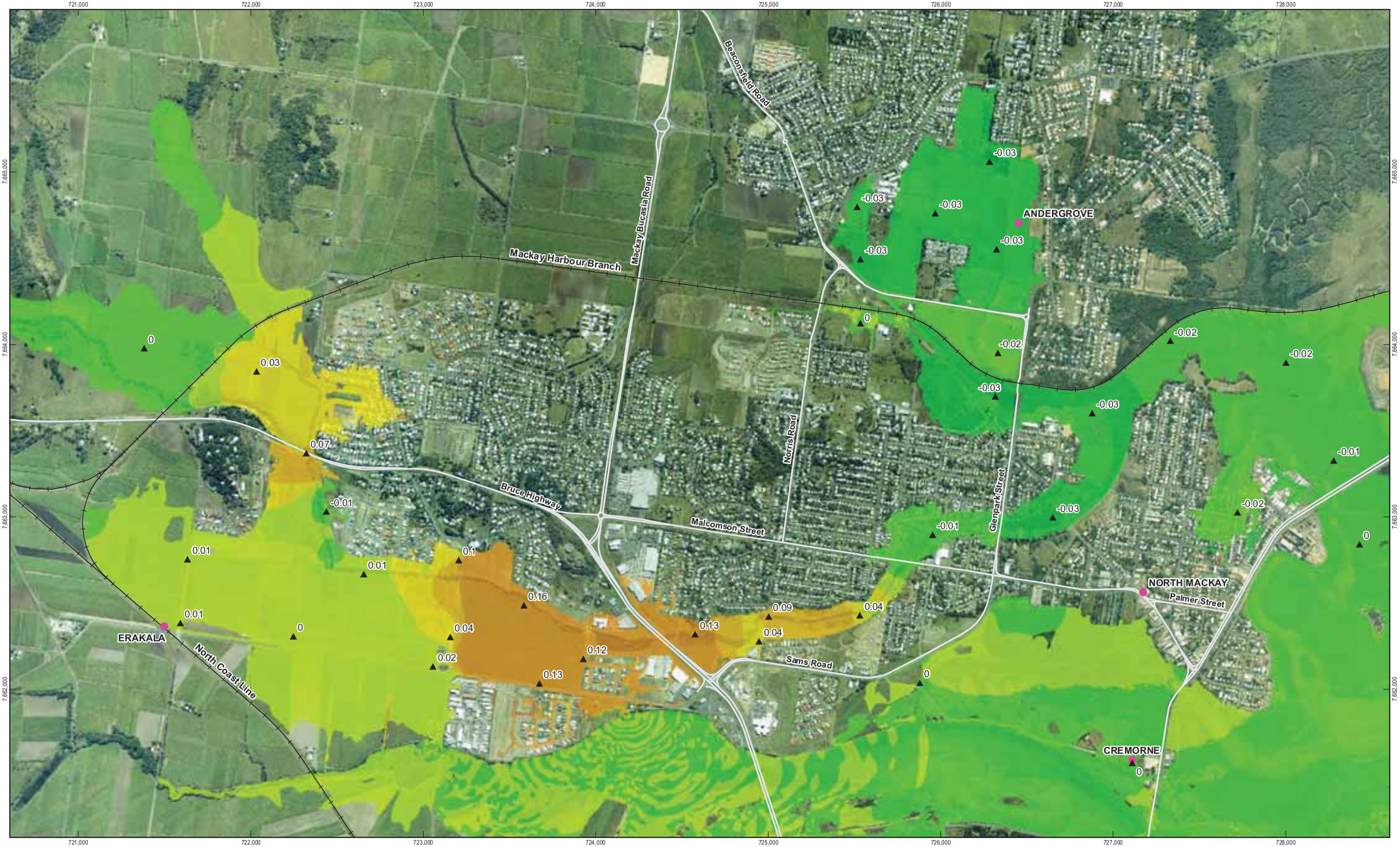

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Afflux (m)

< 0.500 | -0.500 - -0.250 | -0.250 - -0.100 | -0.100 - -0.050 | -0.050 - -0.025 | -0.025 - 0.000 | 0.000 - 0.025 | 0.025 - 0.050 | 0.050 - 0.100 | 0.100 - 0.250 | 0.250 - 0.500 | > 0.500

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Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number 41-24514
Revision A
Date 30 Nov 2011

100 year ARI Afflux Revegetation Strategy

Figure D3

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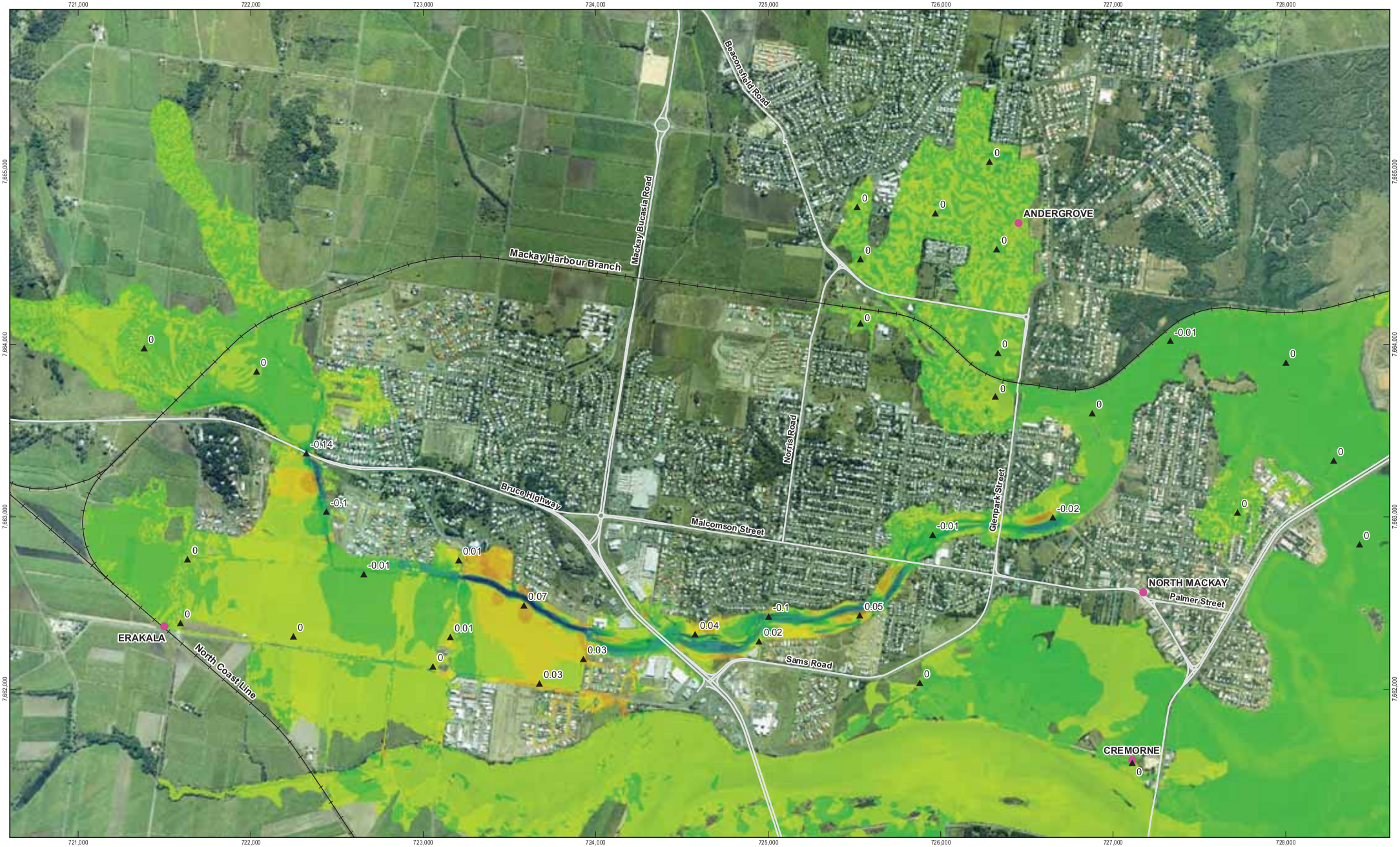

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Velocity (m/s)

-1.263 - -0.5 | -0.499 - -0.25 | -0.249 - -0.1 | -0.099 - -0.05 | -0.049 - -0.025 | -0.024 - 0 | 0.001 - 0.025 | 0.026 - 0.05 | 0.051 - 0.1 | 0.101 - 0.25 | 0.251 - 0.5 | 0.501 - 1

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Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number 41-24514
Revision A
Date 30 Nov 2011

100 year ARI Change in Velocity Revegetation Strategy

Figure D4

G:\41\24514\GIS\Maps\Deliverables\41245l4_033_rev_a.mxd

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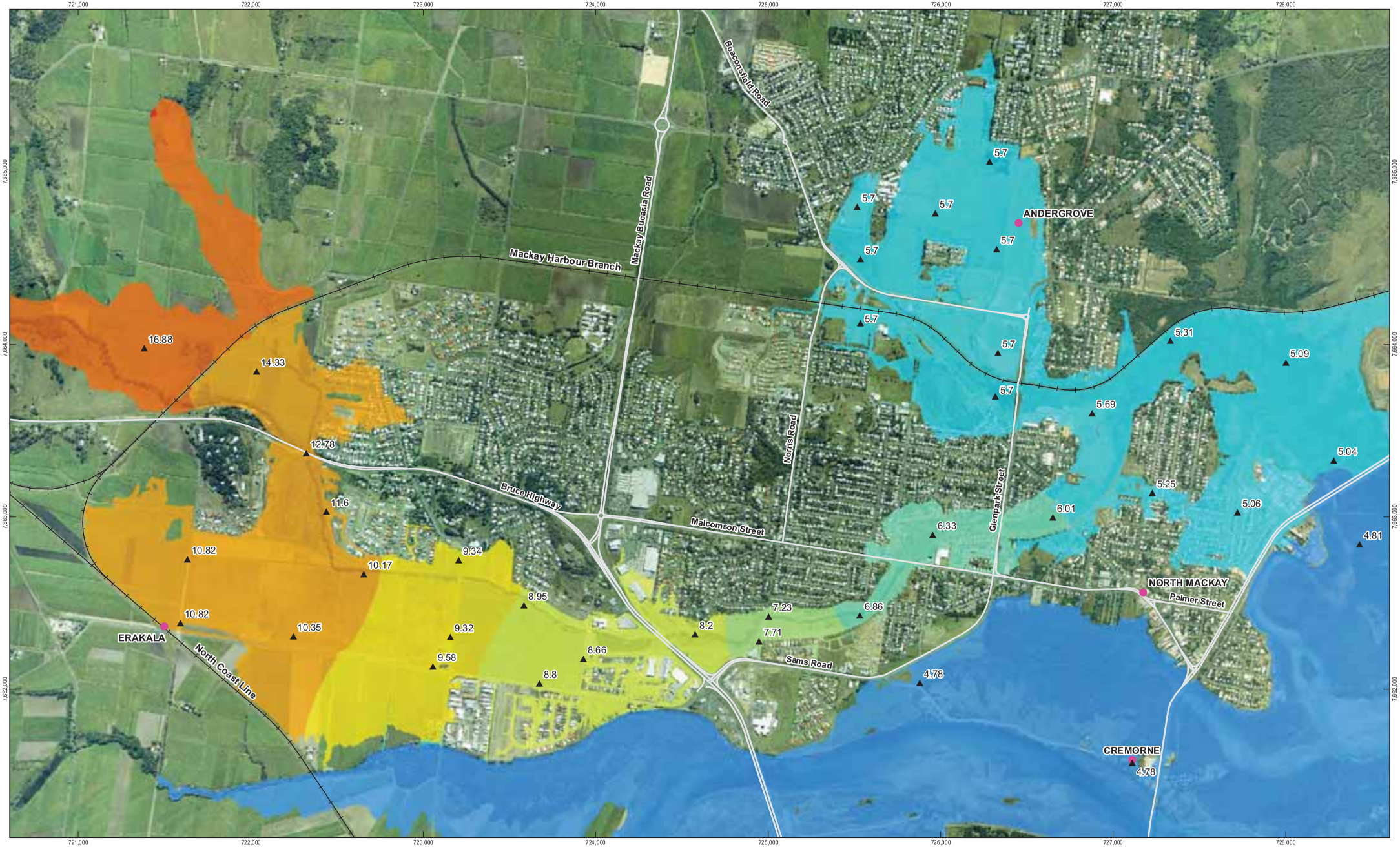

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Maximum Flood Level (mAHD)

2 - 3 | 3 - 4 | 4 - 5 | 5 - 6 | 6 - 7 | 7 - 8 | 8 - 9 | 9 - 10 | 11 - 15 | 16 - 20 | 21 - 25

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Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number	41-24514
Revision	A
Date	30 Nov 2011

100 year ARI Maximum Flood Level Revegetation Strategy and Future Climate

Figure D5

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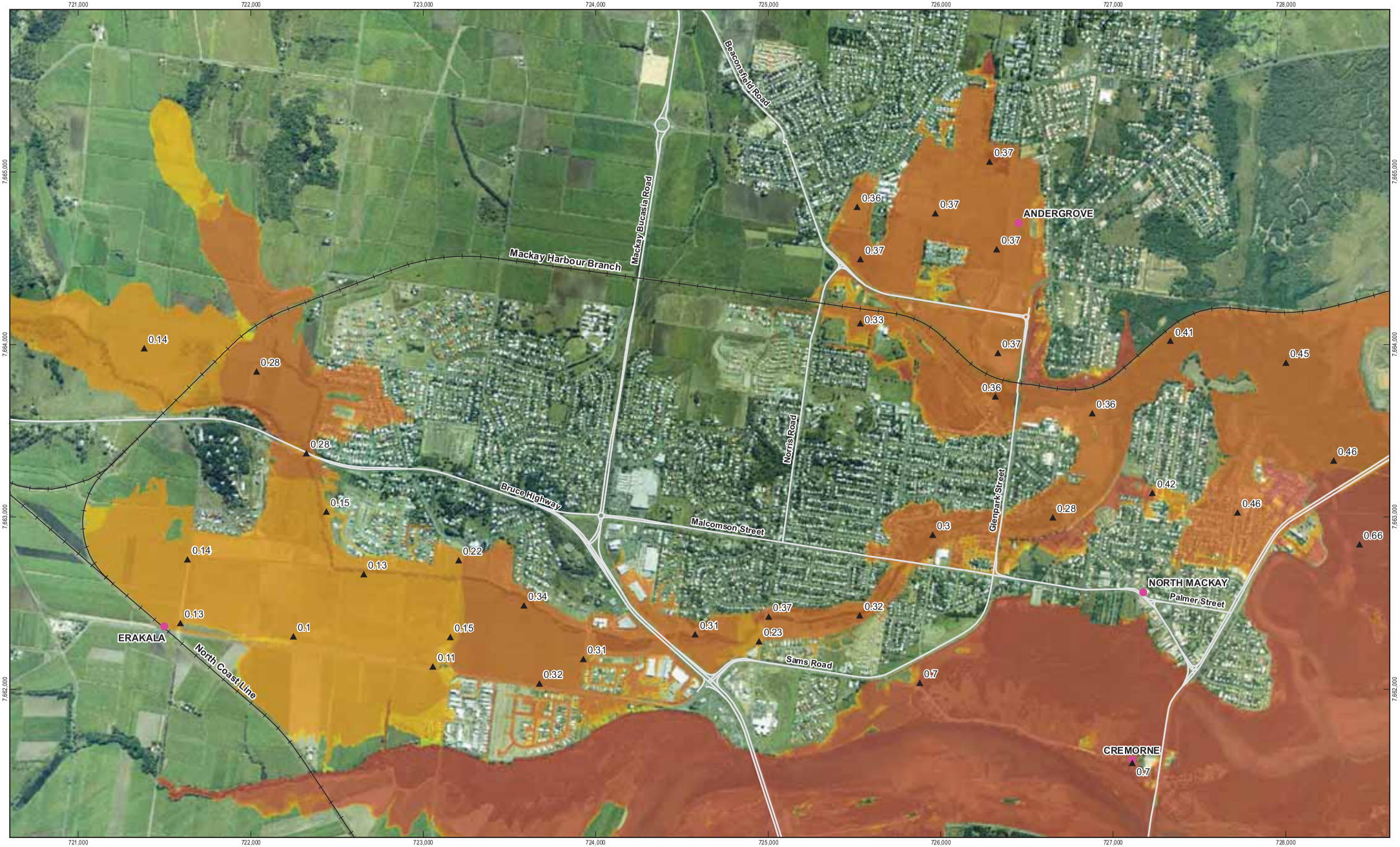

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Afflux (m)

< 0.500 | -0.500 - -0.250 | -0.250 - -0.100 | -0.100 - -0.050 | -0.050 - -0.025 | -0.025 - 0.000 | 0.000 - 0.025 | 0.025 - 0.050 | 0.050 - 0.100 | 0.100 - 0.250 | 0.250 - 0.500 | > 0.500

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Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number 41-24514
Revision A
Date 30 Nov 2011

100 year Afflux Map - Revegetation Strategy and Future Climate

Figure D6

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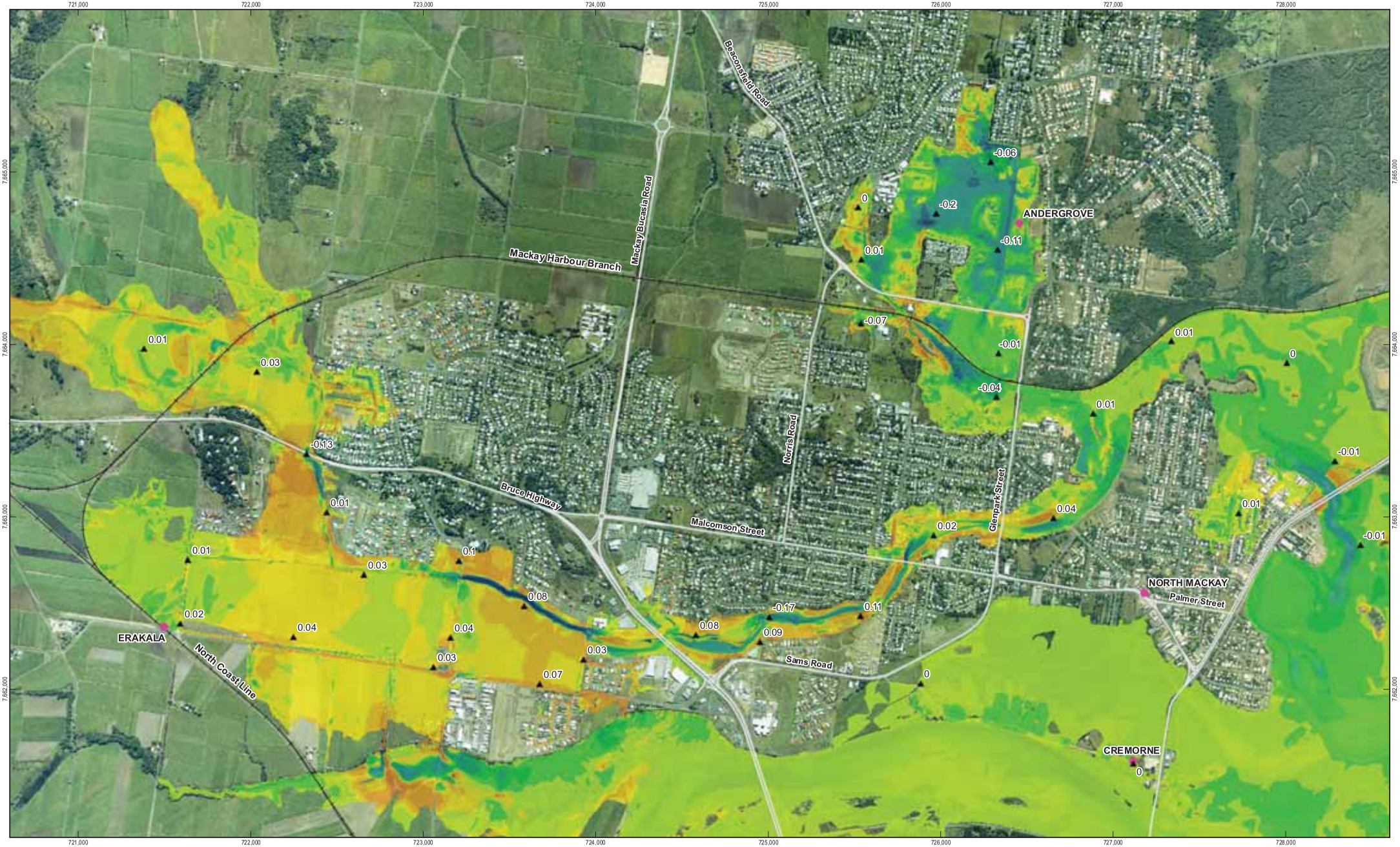

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Velocity (m/s)

< 0.500	-0.500 - -0.250	-0.250 - -0.100	-0.100 - -0.050	-0.050 - -0.025	-0.025 - 0.000	0.000 - 0.025	0.025 - 0.050	0.050 - 0.100	0.100 - 0.250	0.250 - 0.500	> 0.500

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Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number	41-24514
Revision	A
Date	30 Nov 2011

100 year ARI Change in Velocity
Revegetation Strategy and Future Climate Figure D7

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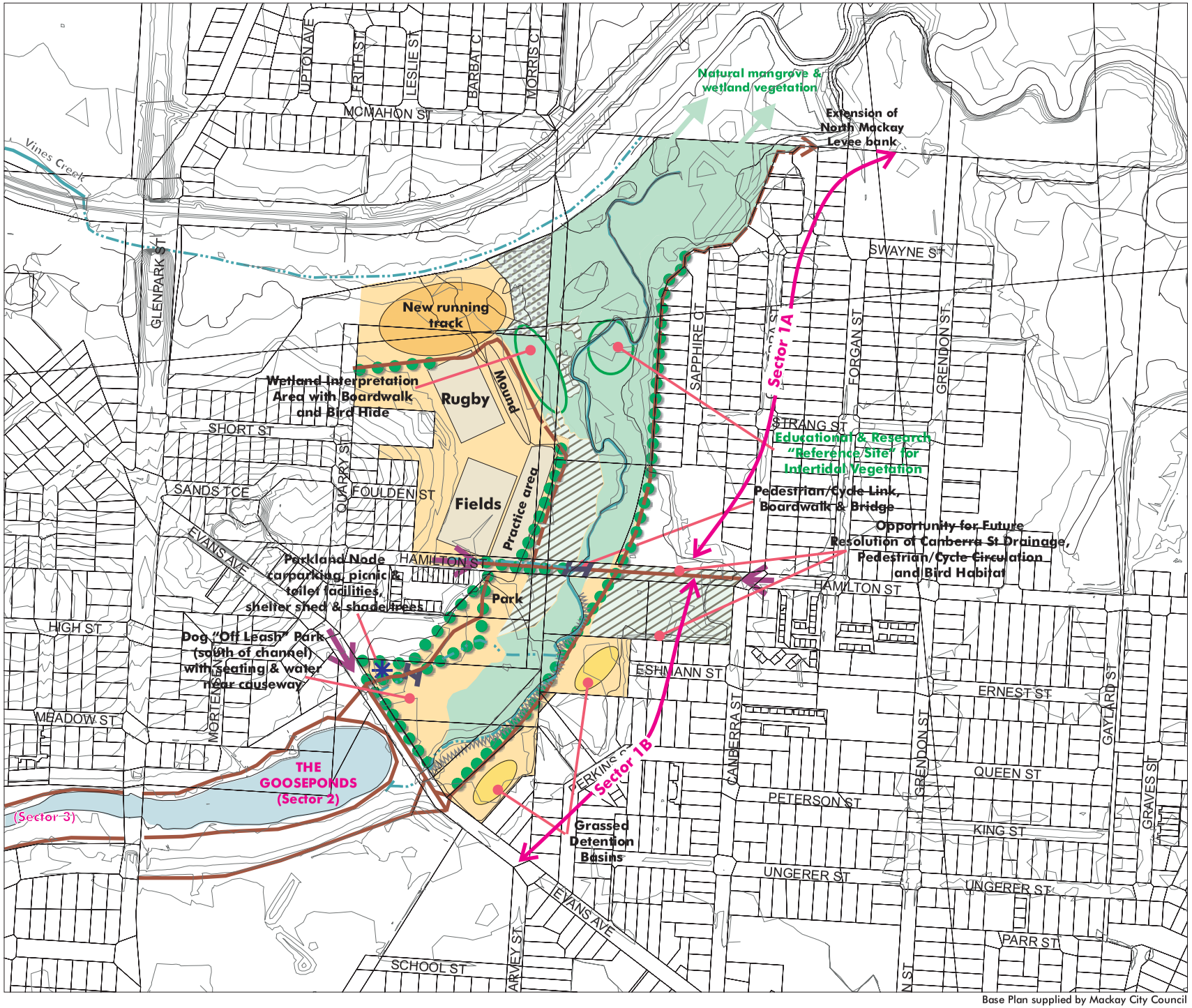
Appendix E

Impact of Goosepond Creek Tidal Reaches Masterplan - Flood Inundation Maps

Appendix E - Figure Summary	
Figure	**Title**
Figure E1	Goosepond Creek Tidal Reaches Masterplan
Figure E2	Manning's Grid - Goosepond Creek Tidal Reaches Masterplan
Figure E3	100yr ARI Maximum Flood Levels – Goosepond Creek Tidal Reaches Masterplan
Figure E4	100yr ARI Afflux Map - Goosepond Creek Tidal Reaches Masterplan
Figure E5	100yr ARI Change in Velocity - Goosepond Creek Tidal Reaches Masterplan



Base Plan supplied by Mackay City Council

LEGEND

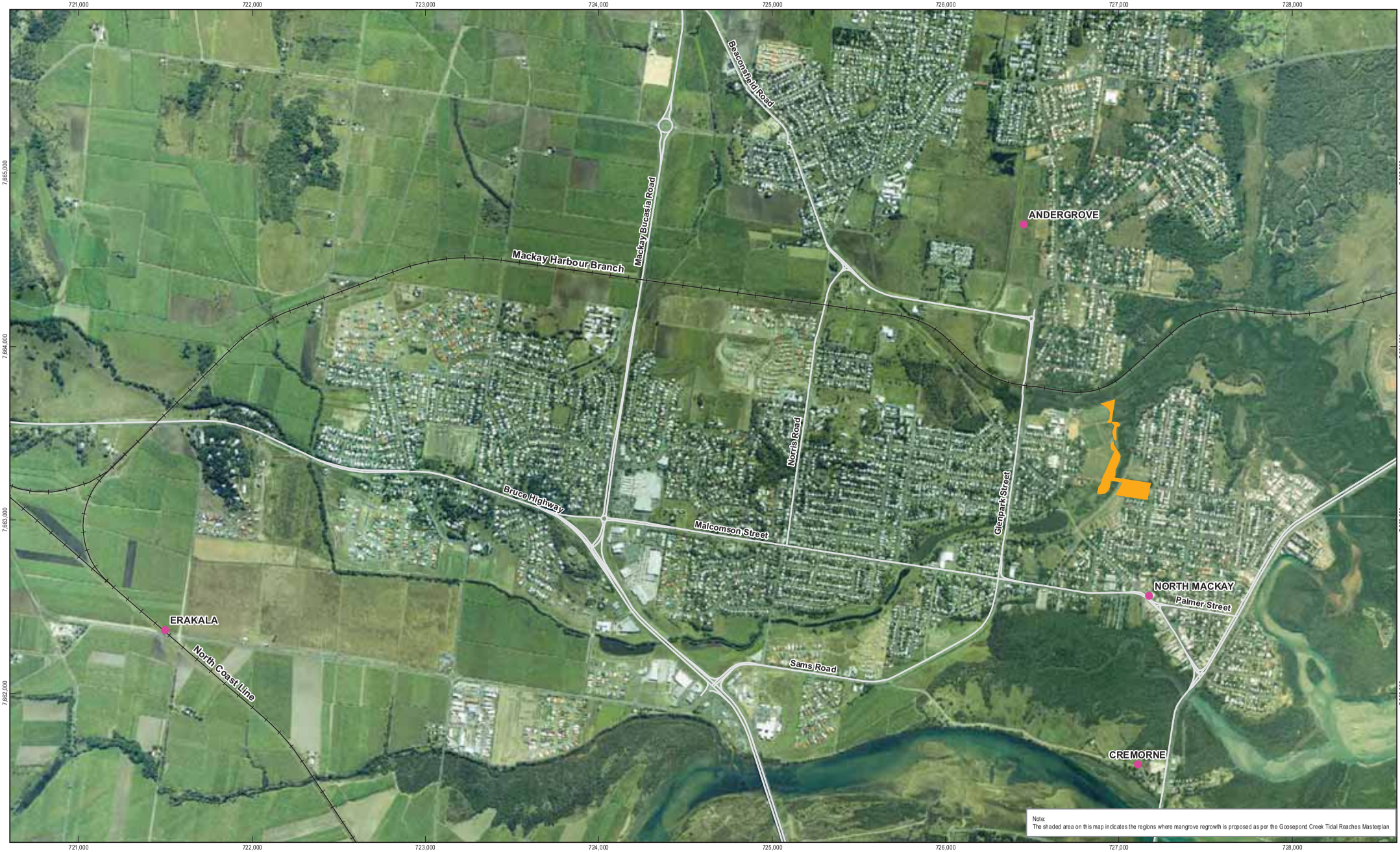
- Sector 1A: Vines Creek to Hamilton St
- Sector 1B: Hamilton St to Evans Ave
- Areas Managed in Natural Condition
- DPI Permit Area with Existing Mangroves (part disturbed)
- Areas Rehabilitated and Managed for Ecological Values
- Areas Managed as Parkland, Sporting Fields, Detention Basin etc.
- Natural Creek Channels
- Drain Lines & Trained Creek Channel
- Sealed Path / Boardwalk
- Decomposed Granite Paths
- Main Park Access Points
- Shade Tree Planting
- Managed Edge Between Levee Bank Mown Grass, Sedge Ponds & Saline Creek Areas (See Detail)

Gooseponds Creek
Tidal Masterplan

FIGURE 7
MASTERPLAN

1:5000
02868 Dwn. AC/AS 24/10/03

CHENOWETH
ENVIRONMENTAL PLANNING & LANDSCAPE ARCHITECTURE
Level 20, 344 Queen Street
BRISBANE, 4000 Australia
Telephone: +61 (07) 3831 8582
Facsimile: +61 (07) 3831 8587
E-mail: mail@chenoweth.com.au



1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Road
- Railway

Manning's n Value

- 0.12

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Goose Ponds\Vines Creek Flood Study

Job Number	41-24514
Revision	A
Date	30 Nov 2011

Manning's Grid - Goosepond Creek Tidal Reaches Masterplan

Figure E2

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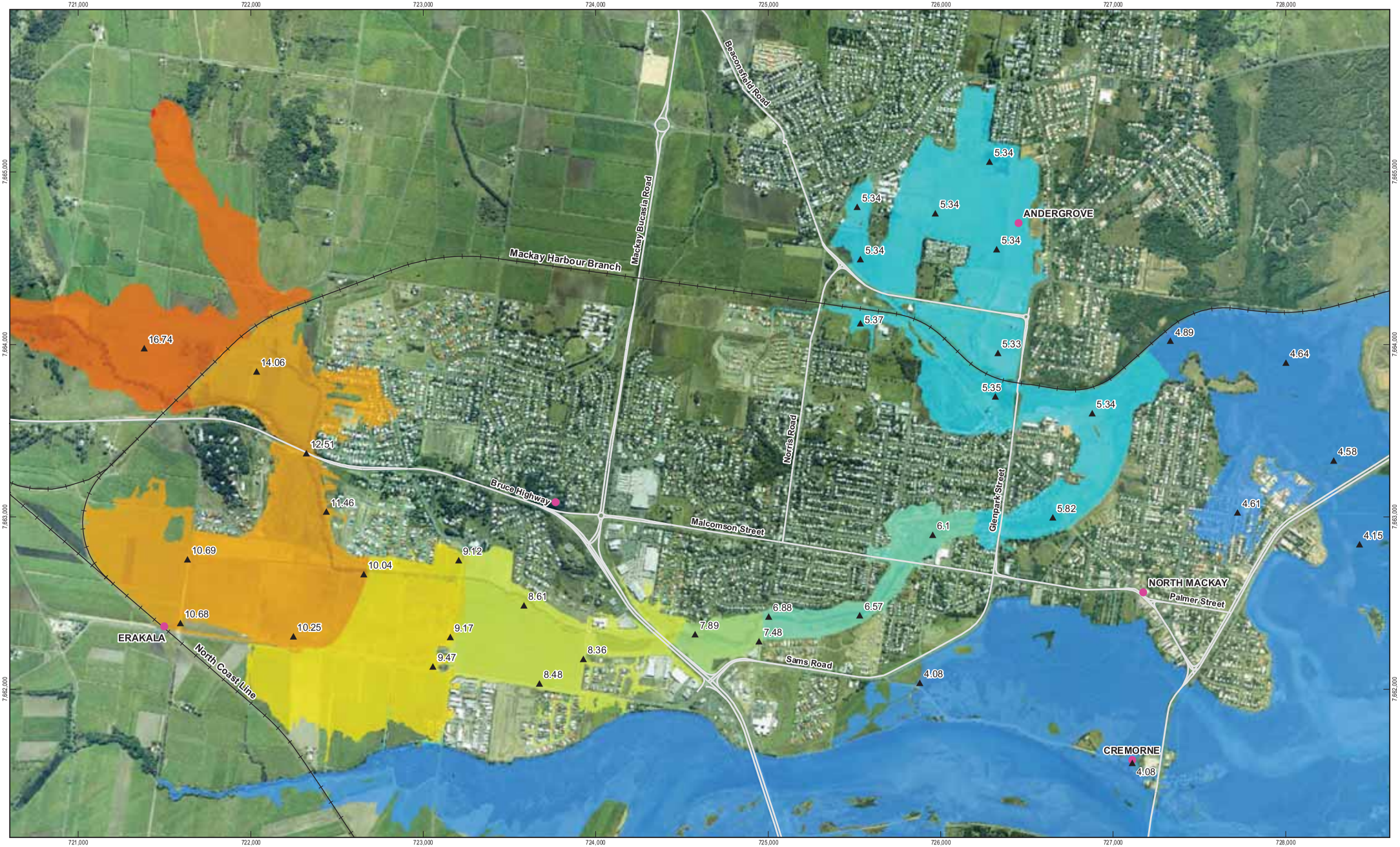

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Maximum Flood Level (mAHD)

2 - 3 | 3 - 4 | 4 - 5 | 5 - 6 | 6 - 7 | 7 - 8 | 8 - 9 | 9 - 10 | 11 - 15 | 16 - 20 | 21 - 25

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Goose Ponds\Vines Creek Flood Study

Job Number	41-24514
Revision	A
Date	30 Nov 2011

100 year ARI Max Flood Level
Goosepond Creek Tidal Reaches Masterplan

Figure E3

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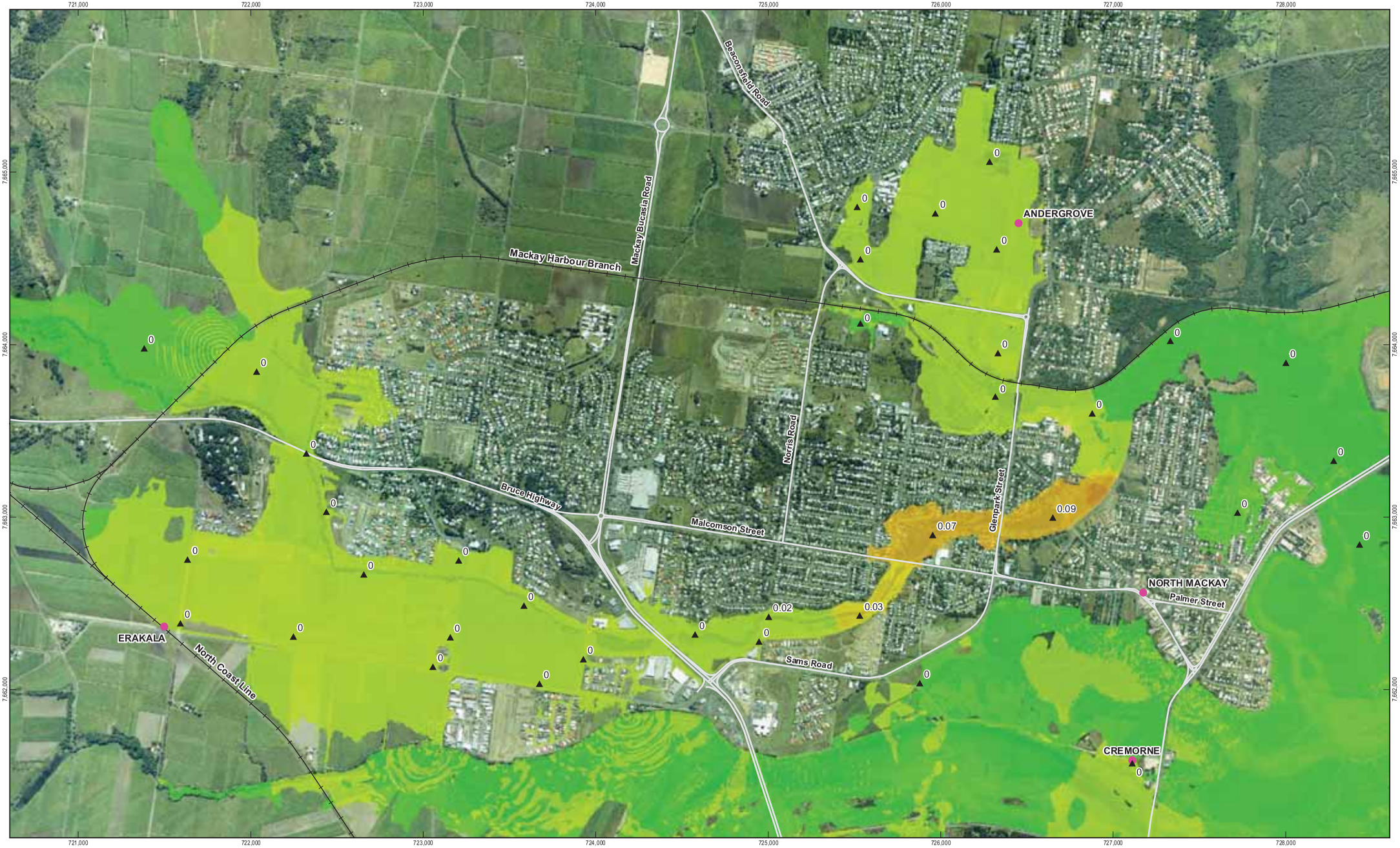

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0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Afflux (m)

< 0.500	-0.500 - -0.250	-0.250 - -0.100	-0.100 - -0.050	-0.050 - -0.025	-0.025 - 0.000	0.000 - 0.025	0.025 - 0.050	0.050 - 0.100	0.100 - 0.250	0.250 - 0.500	> 0.500

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Goose Ponds\Vines Creek Flood Study

Job Number 41-24514
Revision A
Date 02 Feb 2012

100 year Afflux Map - Goosepond Creek Tidal Reaches Masterplan

Figure E4

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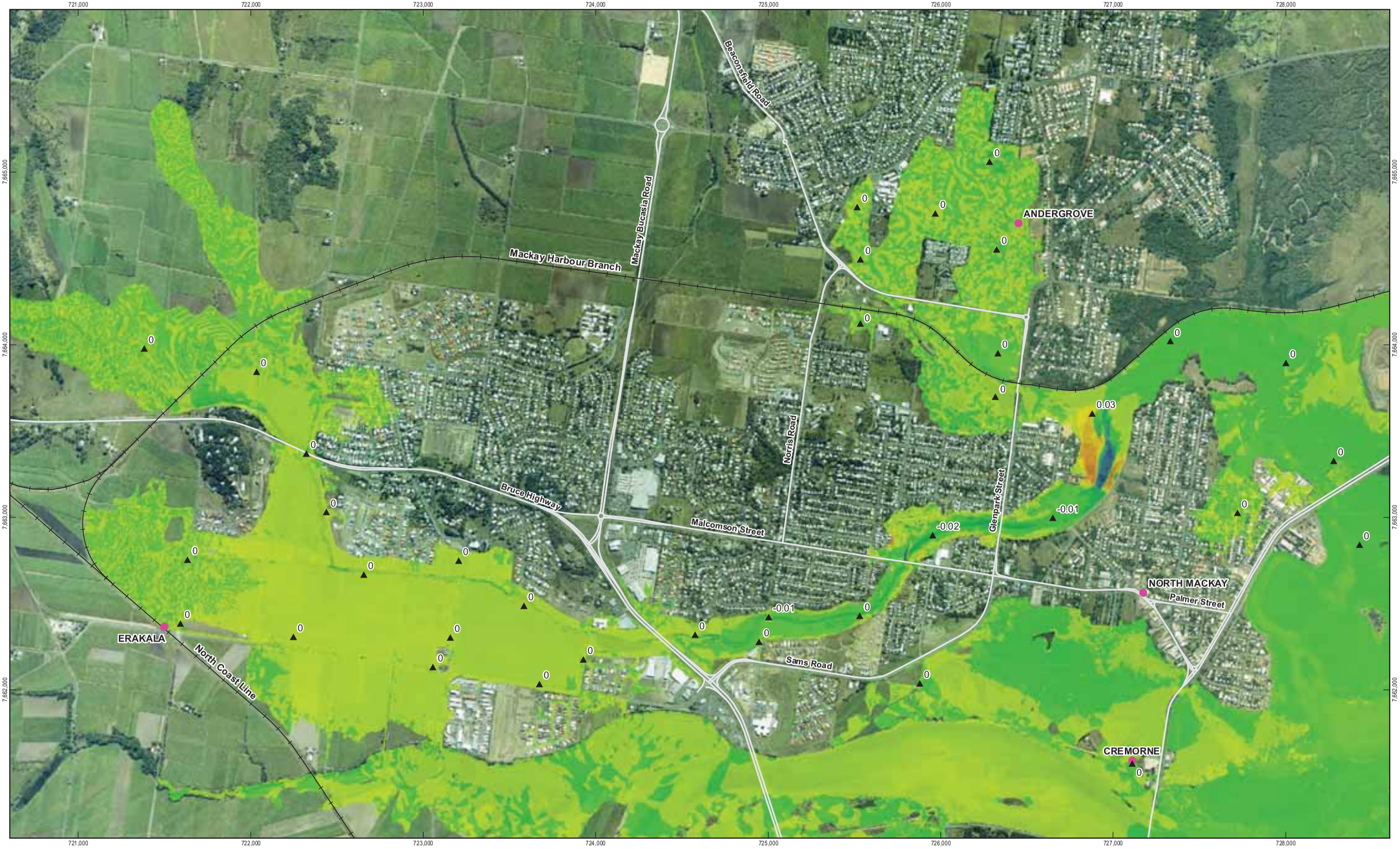

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway

Velocity (m/s)

< 0.500 | -0.500 - -0.250 | -0.250 - -0.100 | -0.100 - -0.050 | -0.050 - -0.025 | -0.025 - 0.000 | 0.000 - 0.025 | 0.025 - 0.050 | 0.050 - 0.100 | 0.100 - 0.250 | 0.250 - 0.500 | > 0.500

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Job Number	41-24514
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100 year ARI Change in Velocity
Goosepond Creek Tidal Reaches Masterplan

Figure E5

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Appendix F

Development Scenarios

Appendix F - Figure Summary	
Figure	**Title**
Figure F1	Development Scenario 1
Figure F2	Development Scenario 2

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Road
- Railway
- Proposed Fill Area

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Development Scenario 1

Figure F1

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1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Culvert
- Locality
- Railway
- Road
- Channel

CLIENTS | PEOPLE | PERFORMANCE

Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

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Revision	A
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Development Scenario 2

Figure F2

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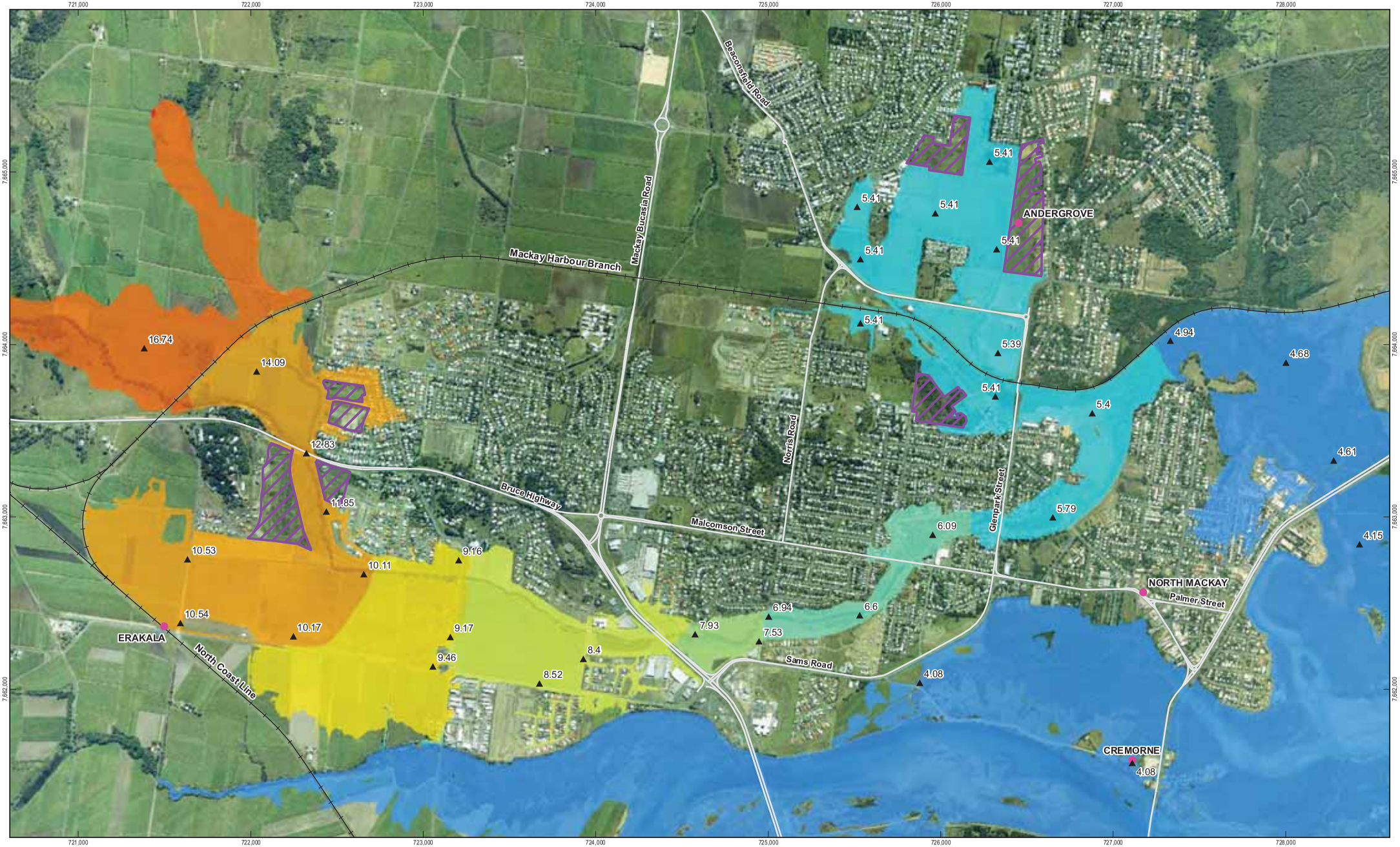
Appendix G

Impact of Development Scenarios - Flood Inundation Maps

Appendix G - Figure Summary	
Figure	**Title**
Figure G1	100yr ARI Maximum Flood Levels – Development Scenario 1
Figure G2	100yr ARI Maximum Flood Velocities - Development Scenario 1
Figure G3	100yr ARI Afflux Map - Development Scenario 1
Figure G4	100yr ARI Maximum Flood Levels - Development Scenario 2
Figure G5	100yr ARI Maximum Flood Velocities - Development Scenario 2
Figure G6	100yr ARI Afflux Map - Development Scenario 2
Figure G7	100yr ARI Maximum Flood Levels – Development Scenario 1 + Future Climate (20% Increase in Rainfall Intensity, tailwater = 4.78m AHD)
Figure G8	100yr ARI Maximum Flood Velocities– Development Scenario 1 + Future Climate (20% Increase in Rainfall Intensity, tailwater = 4.78m AHD)

Figure G9	100yr ARI Afflux Map – Development Scenario 1 + Future Climate (20% Increase in Rainfall Intensity, tailwater = 4.78m AHD)
Figure G10	100yr ARI Maximum Flood Levels – Development Scenario 2 + Future Climate (20% Increase in Rainfall Intensity, tailwater = 4.78m AHD)
Figure G11	100yr ARI Maximum Flood Velocities– Development Scenario 2 + Future Climate (20% Increase in Rainfall Intensity, tailwater = 4.78m AHD)
Figure G12	100yr ARI Afflux Map – Development Scenario 2 + Future Climate (20% Increase in Rainfall Intensity, tailwater = 4.78m AHD)



1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway
- Proposed Fill Area

Maximum Flood Level (mAHD)

2 - 3 | 3 - 4 | 4 - 5 | 5 - 6 | 6 - 7 | 7 - 8 | 8 - 9 | 9 - 10 | 11 - 15 | 16 - 20 | 21 - 25

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Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number 41-24514
Revision A
Date 06 Feb 2012

100 year ARI Maximum Flood Level Development Scenario 1

Figure G1

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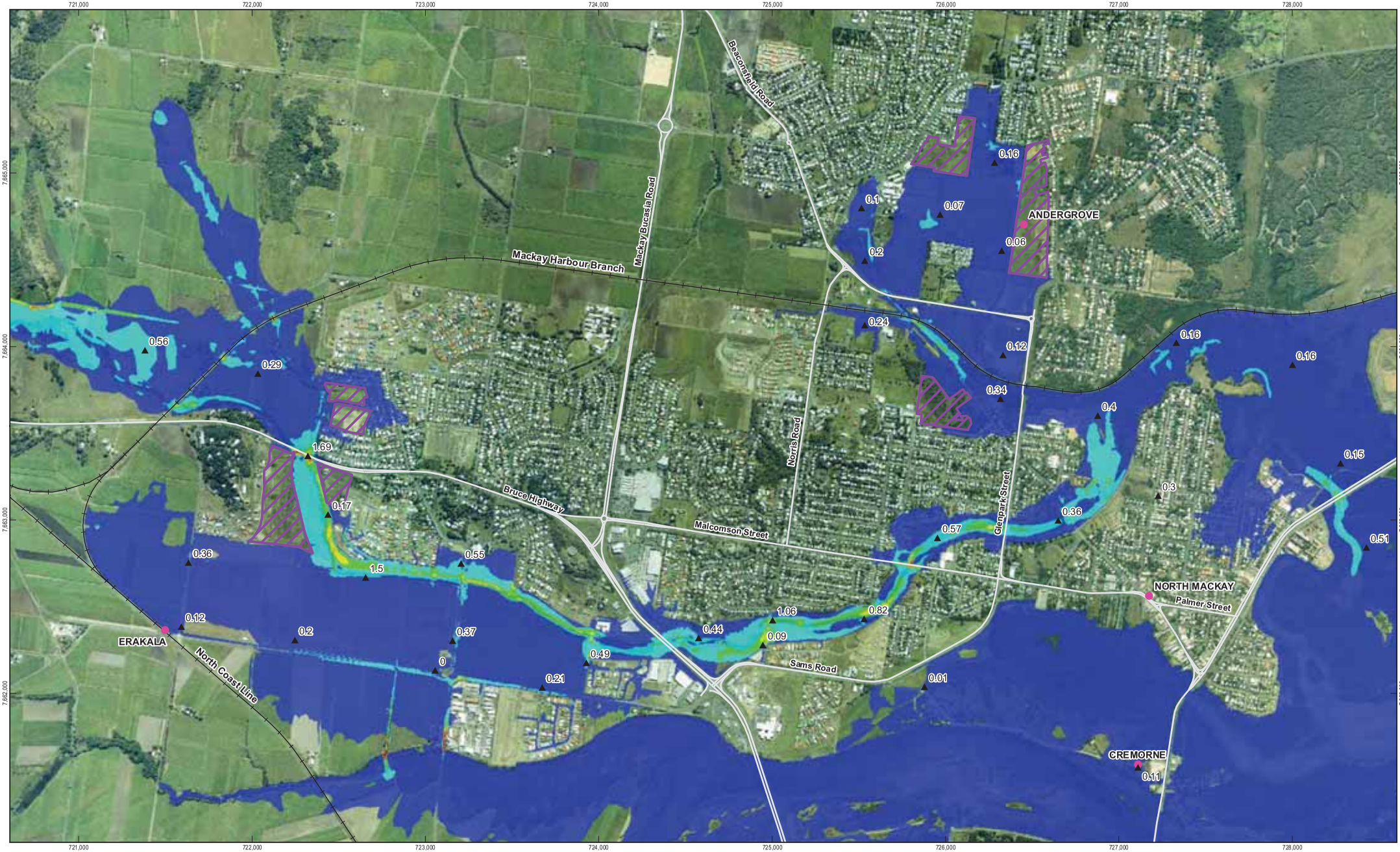

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway
- Proposed Fill Area

Velocity (m/s)

< 0.5 | 0.5 - 1 | 1 - 1.5 | 1.5 - 2 | 2.0 - 2.5 | > 2.5

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Job Number 41-24514
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100 year ARI Maximum Flood Velocity Development Scenario 1

Figure G2

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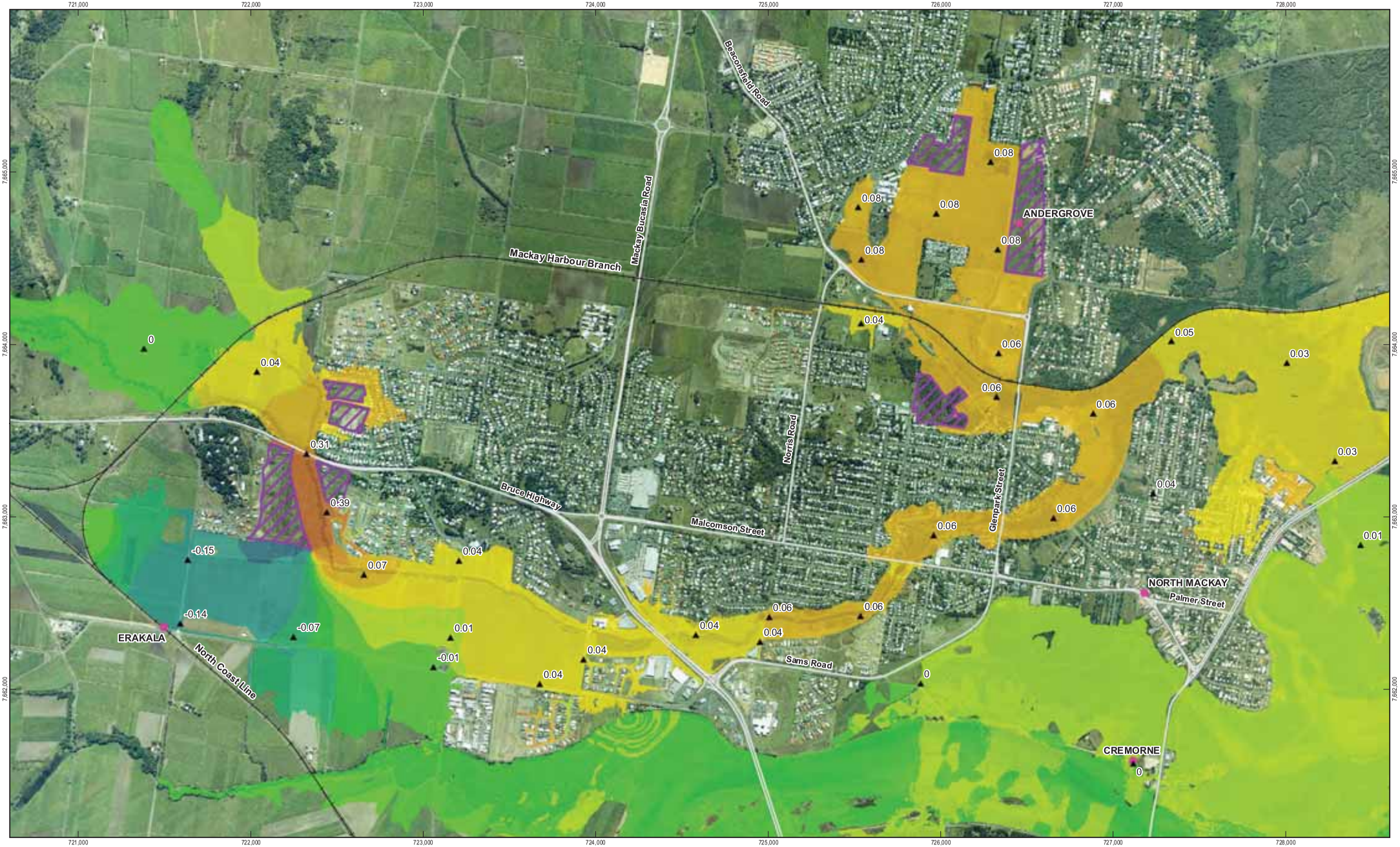

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway
- Proposed Fill Area

Afflux (m)

< 0.500	-0.500 - -0.250	-0.250 - -0.100	-0.100 - -0.050	-0.050 - -0.025	-0.025 - 0.000	0.000 - 0.025	0.025 - 0.050	0.050 - 0.100	0.100- 0.250	0.250 - 0.500	> 0.500

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Job Number 41-24514
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100 year ARI Afflux Development Scenario 1

Figure G3

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Data source: Data Custodian, Data Set Name/Title, Version/Date.

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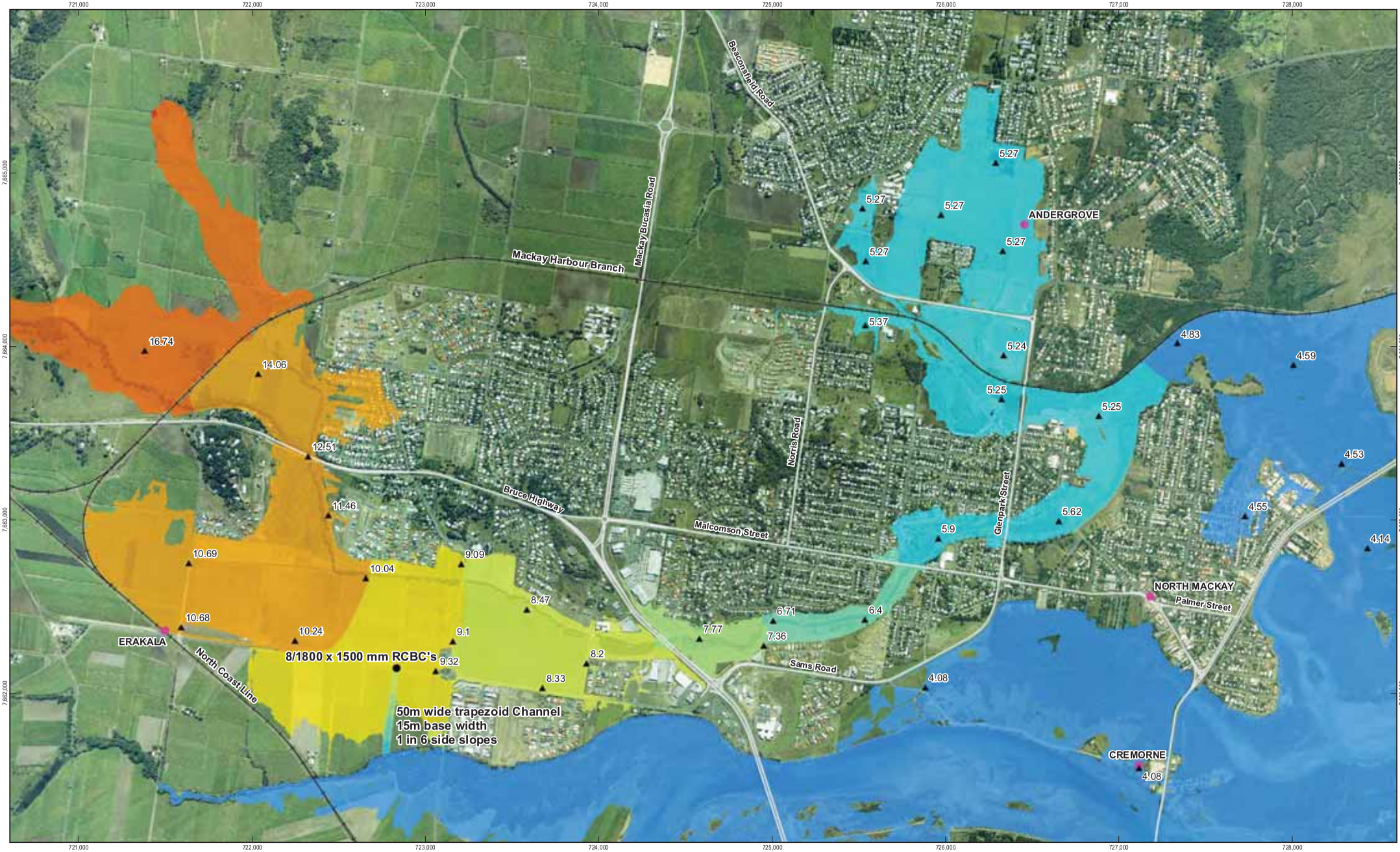

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Culvert
- Inspection Point
- Road
- Railway

Maximum Flood Level (mAHD)

2 - 3 | 3 - 4 | 4 - 5 | 5 - 6 | 6 - 7 | 7 - 8 | 8 - 9 | 9 - 10 | 11 - 15 | 16 - 20 | 21 - 25

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Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number 41-24514
Revision A
Date 01 Dec 2011

100 year ARI Maximum Flood Level Development Scenario 2

Figure G4

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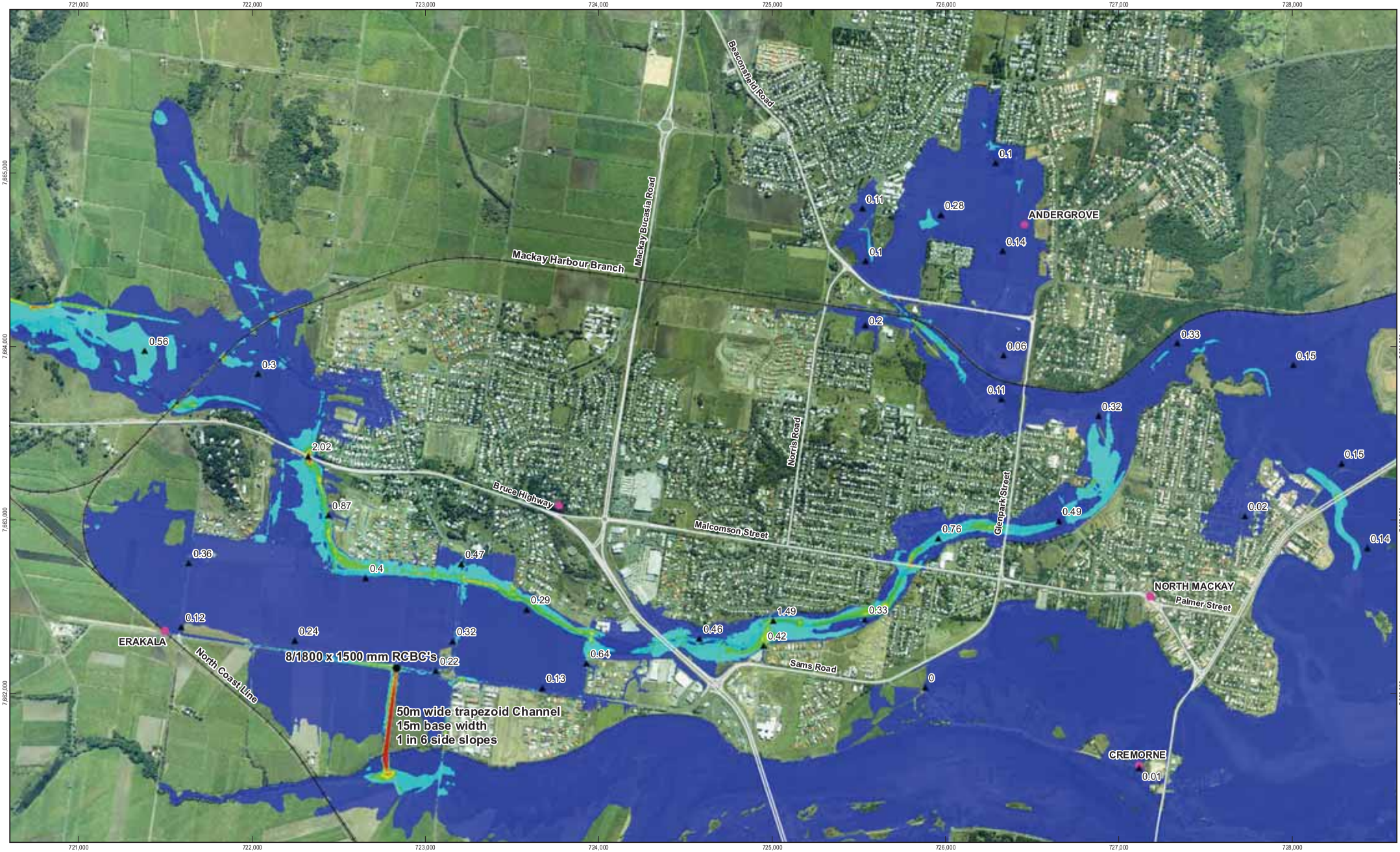

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Culvert
- Inspection Point
- Road
- Railway

Velocity (m/s)

< 0.5 | 0.5 - 1 | 1 - 1.5 | 1.5 - 2 | 2.0 - 2.5 | > 2.5

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100 year ARI Maximum Flood Velocity Development Scenario 2

Figure G5

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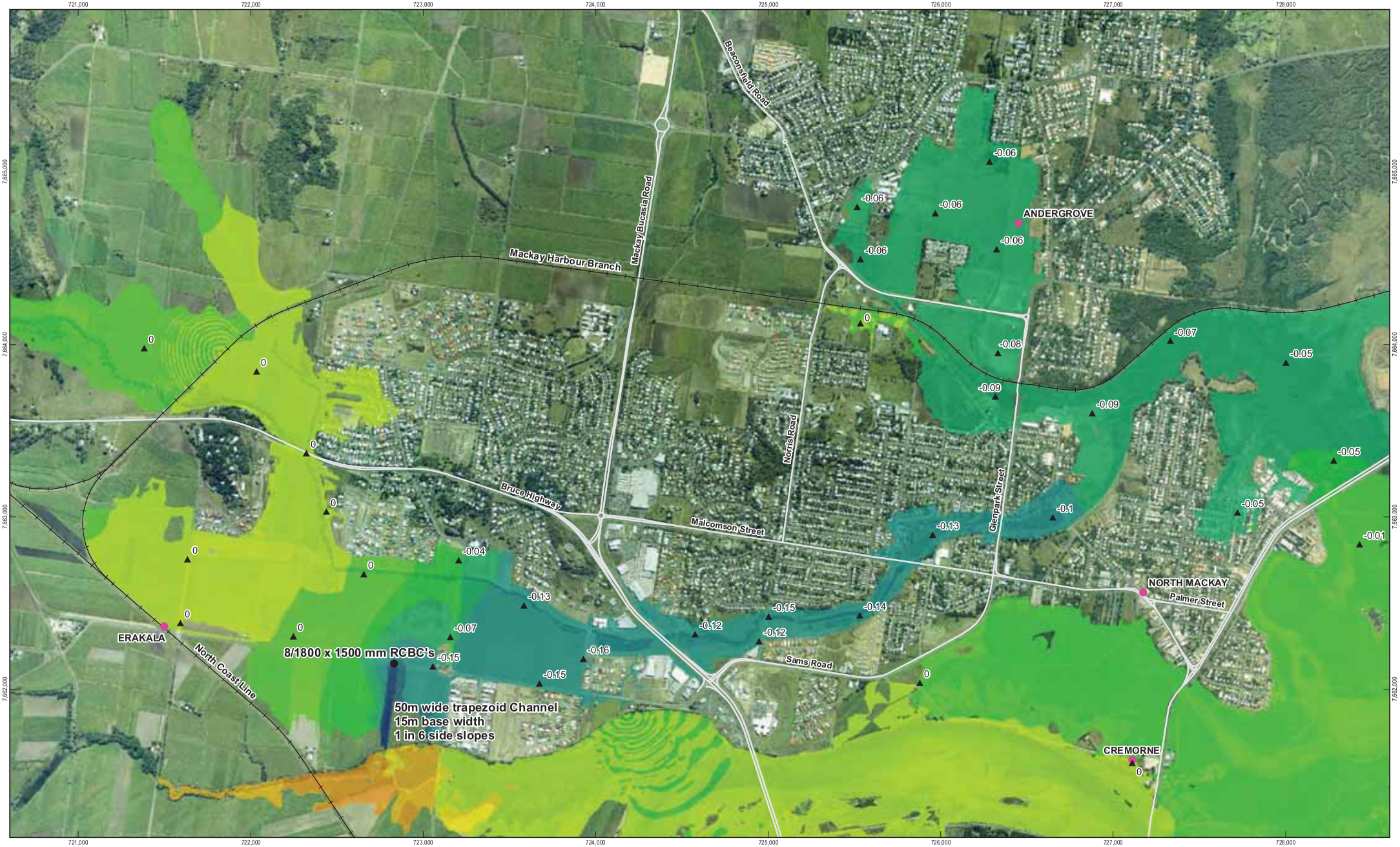

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Culvert
- Inspection Point
- Road
- Railway

Afflux (m)

< 0.500 | -0.500 - -0.250 | -0.250 - -0.100 | -0.100 - -0.050 | -0.050 - -0.025 | -0.025 - 0.000 | 0.000 - 0.025 | 0.025 - 0.050 | 0.050 - 0.100 | 0.100 - 0.250 | 0.250 - 0.500 | > 0.500

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Job Number	41-24514
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100 year ARI Afflux Map Development Scenario 2

Figure G6

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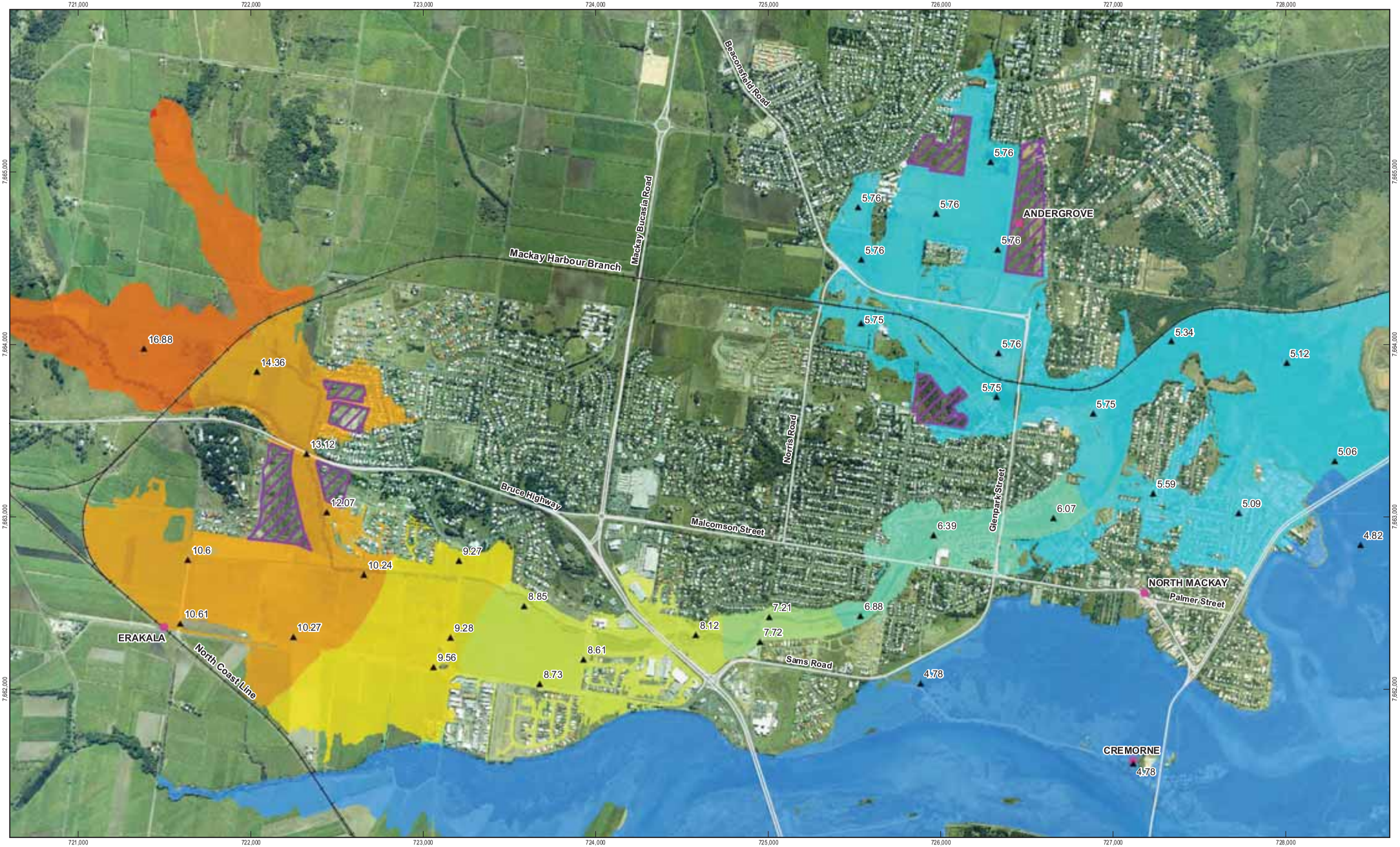

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway
- Proposed Fill Area

Maximum Flood Level (mAHD)

2 - 3 | 3 - 4 | 4 - 5 | 5 - 6 | 6 - 7 | 7 - 8 | 8 - 9 | 9 - 10 | 11 - 15 | 16 - 20 | 21 - 25

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Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number	41-24514
Revision	A
Date	02 Feb 2012

100 year ARI Maximum Flood Level Development Scenario 1 + Future Climate

Figure G7

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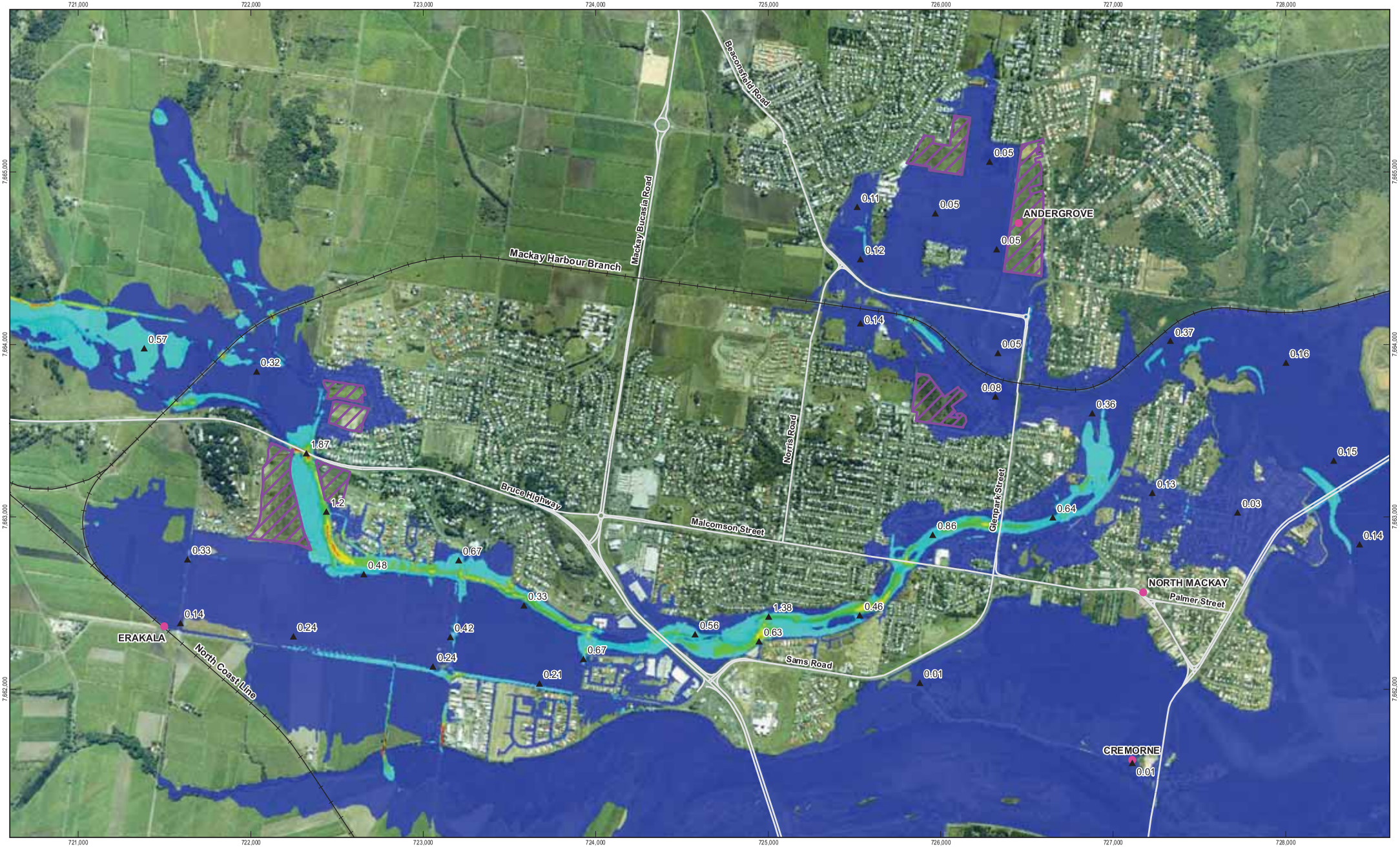

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway
- Proposed Fill Area

Velocity (m/s)

<0.5 | 0.5 - 1 | 1 - 1.5 | 1.5 - 2 | 2.0 - 2.5 | >2.5

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Goose Ponds\Vines Creek Flood Study

Job Number	41-24514
Revision	A
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100 year ARI Maximum Flood Velocity Development Scenario 1 + Future Climate

Figure G8

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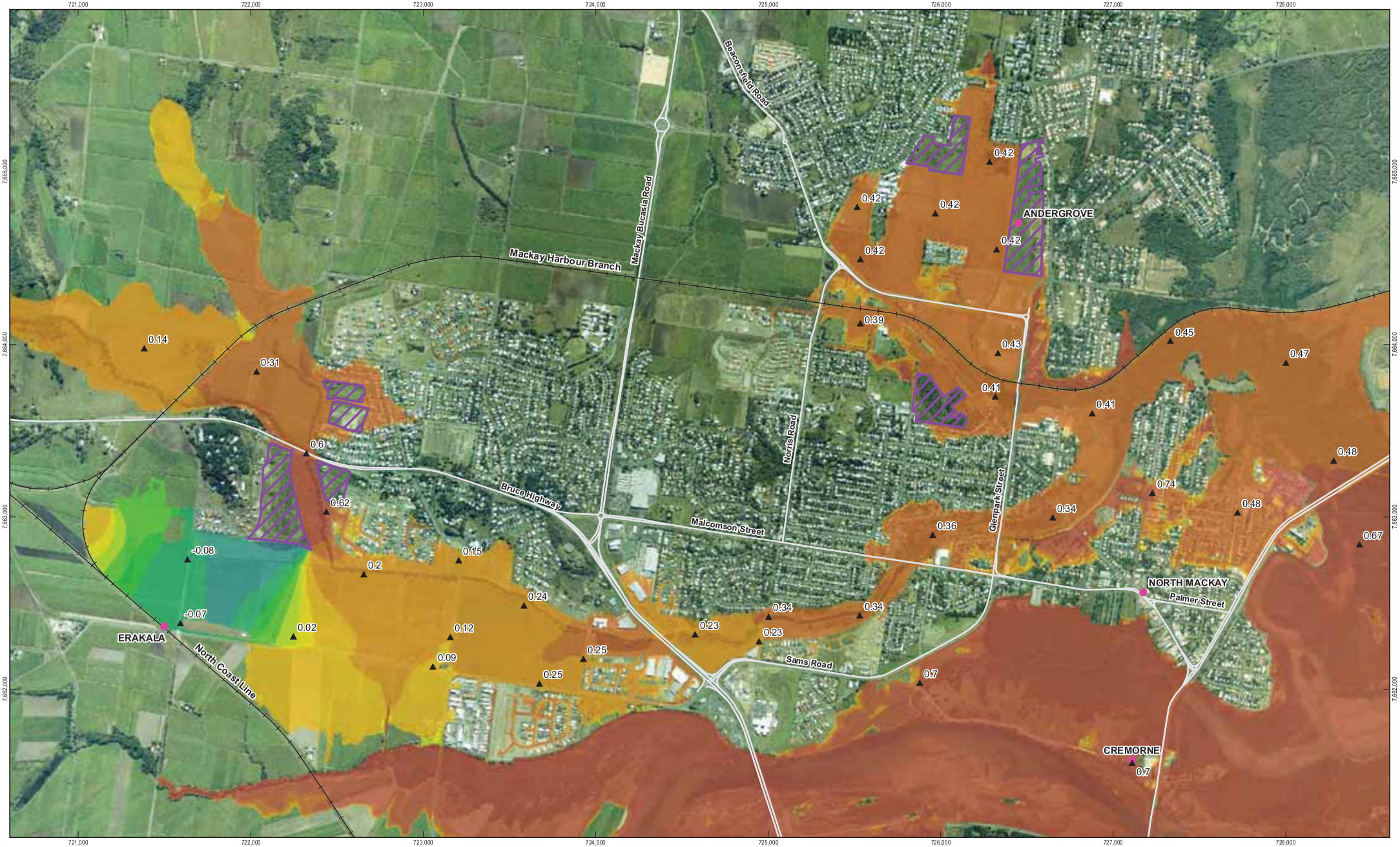

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Inspection Point
- Road
- Railway
- Proposed Fill Area

Afflux (m)

< 0.500	-0.500 - -0.250	-0.250 - -0.100	-0.100 - -0.050	-0.050 - -0.025	-0.025 - 0.000	0.000 - 0.025	0.025 - 0.050	0.050 - 0.100	0.100 - 0.250	0.250 - 0.500	> 0.500

CLIENTS | PEOPLE | PERFORMANCE

Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number	41-24514
Revision	A
Date	02 Feb 2012

100 year ARI Afflux Map
Development Scenario 1 + Future Climate

Figure G9

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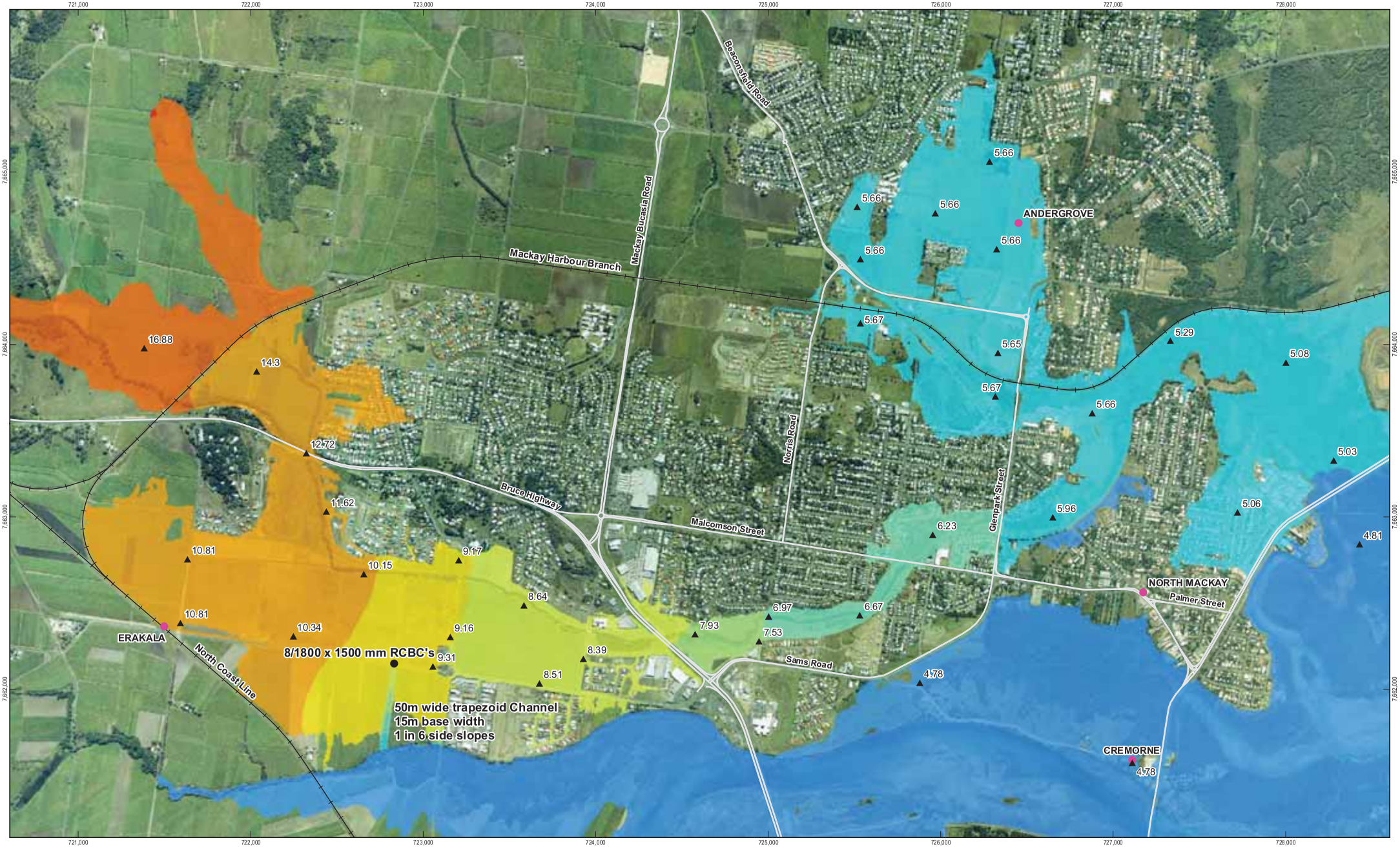

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Culvert
- Inspection Point
- Road
- Railway

Maximum Flood Level (mAHD)

2 - 3 | 3 - 4 | 4 - 5 | 5 - 6 | 6 - 7 | 7 - 8 | 8 - 9 | 9 - 10 | 11 - 15 | 16 - 20 | 21 - 25

CLIENTS | PEOPLE | PERFORMANCE

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Goose Ponds\Vines Creek Flood Study

Job Number	41-24514
Revision	A
Date	01 Dec 2011

100 year ARI Maximum Flood Level Development Scenario 2 + Future Climate

Figure G10

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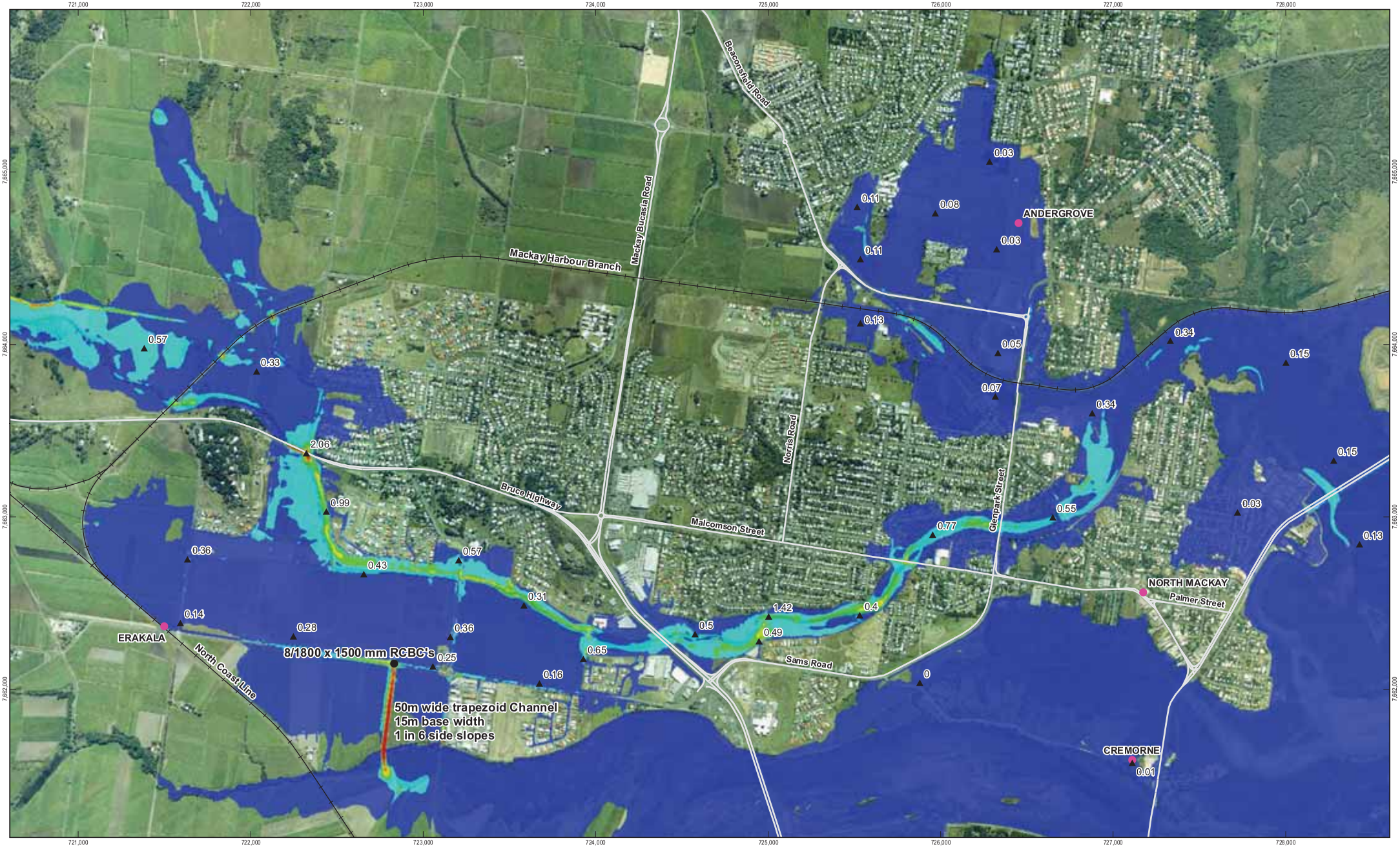

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Culvert
- Inspection Point
- Road
- Railway

Velocity (m/s)

< 0.5 | 0.5 - 1 | 1 - 1.5 | 1.5 - 2 | 2.0 - 2.5 | > 2.5

CLIENTS | PEOPLE | PERFORMANCE

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Goose Ponds\Vines Creek Flood Study

Job Number	41-24514
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100 year ARI Maximum Flood Velocity Development Scenario 2 + Future Climate

Figure G11

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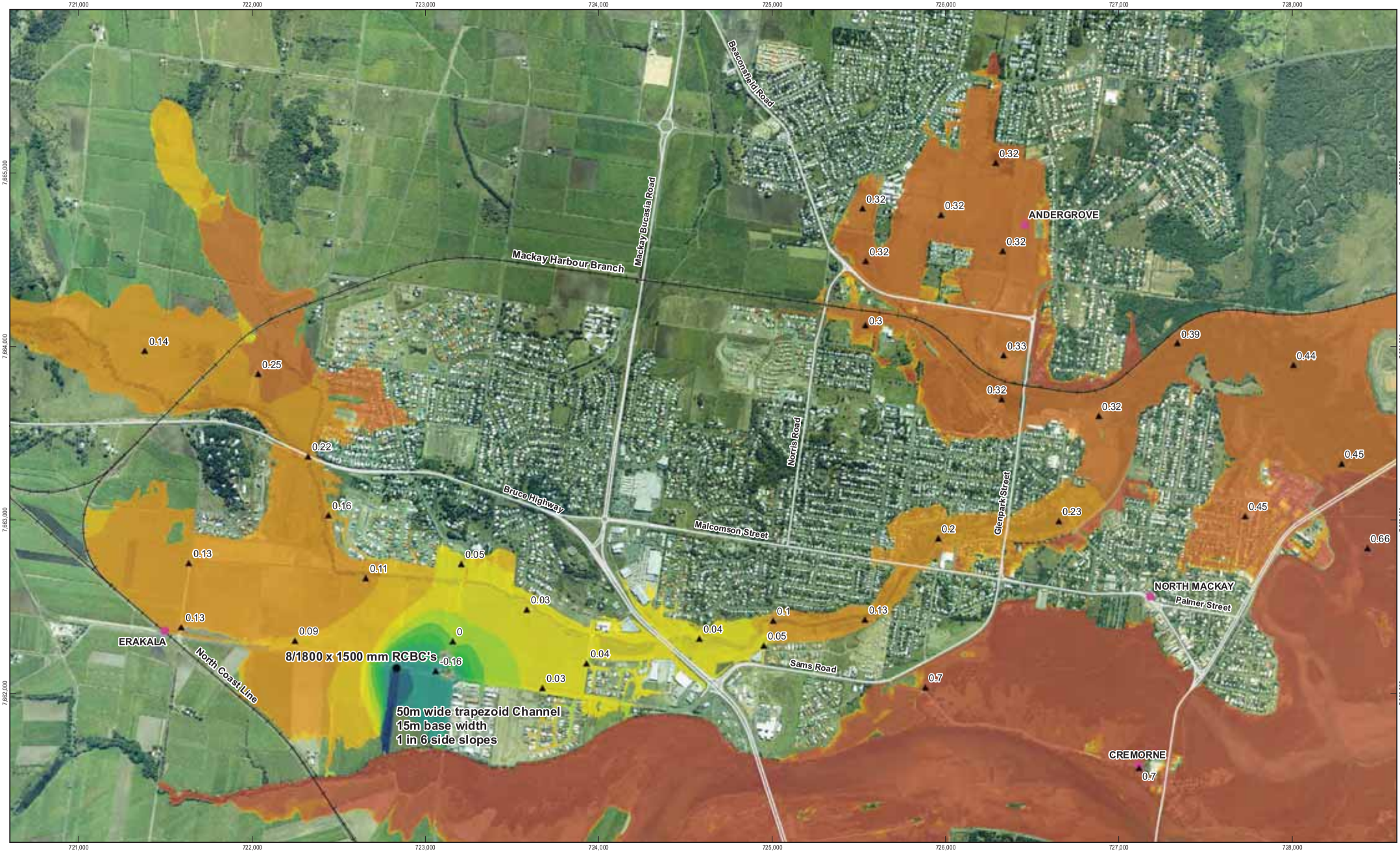

1:20,000 @A3

0 500 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Culvert
- Inspection Point
- Road
- Railway

Afflux (m)

<0.500 | -0.500 - -0.250 | -0.250 - -0.100 | -0.100 - -0.050 | -0.050 - -0.025 | -0.025 - 0.000 | 0.000 - 0.025 | 0.025 - 0.050 | 0.050 - 0.100 | 0.100 - 0.250 | 0.250 - 0.500 | >0.500

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Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number	41-24514
Revision	A
Date	01 Dec 2011

100 year ARI Afflux Map
Development Scenario 2 + Future Climate

Figure G12

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Data source: GHD - Hydraulic Structures (2009); MRC - Imagery (2004); DERM - Cadastre(2011), Roads (2011), Locality(2009).

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Appendix G

Tables of Flood Levels, Depths and Velocities

1:10,000 @A3

0 250 500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Reporting Station
- Road
- Railway

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Mackay Regional Council
Goose Ponds\Vines Creek Flood Study

Job Number 41-24514
Revision A
Date 22 Feb 2012

Reporting Station Locations
Sheet 1 of 4

Figure H 1

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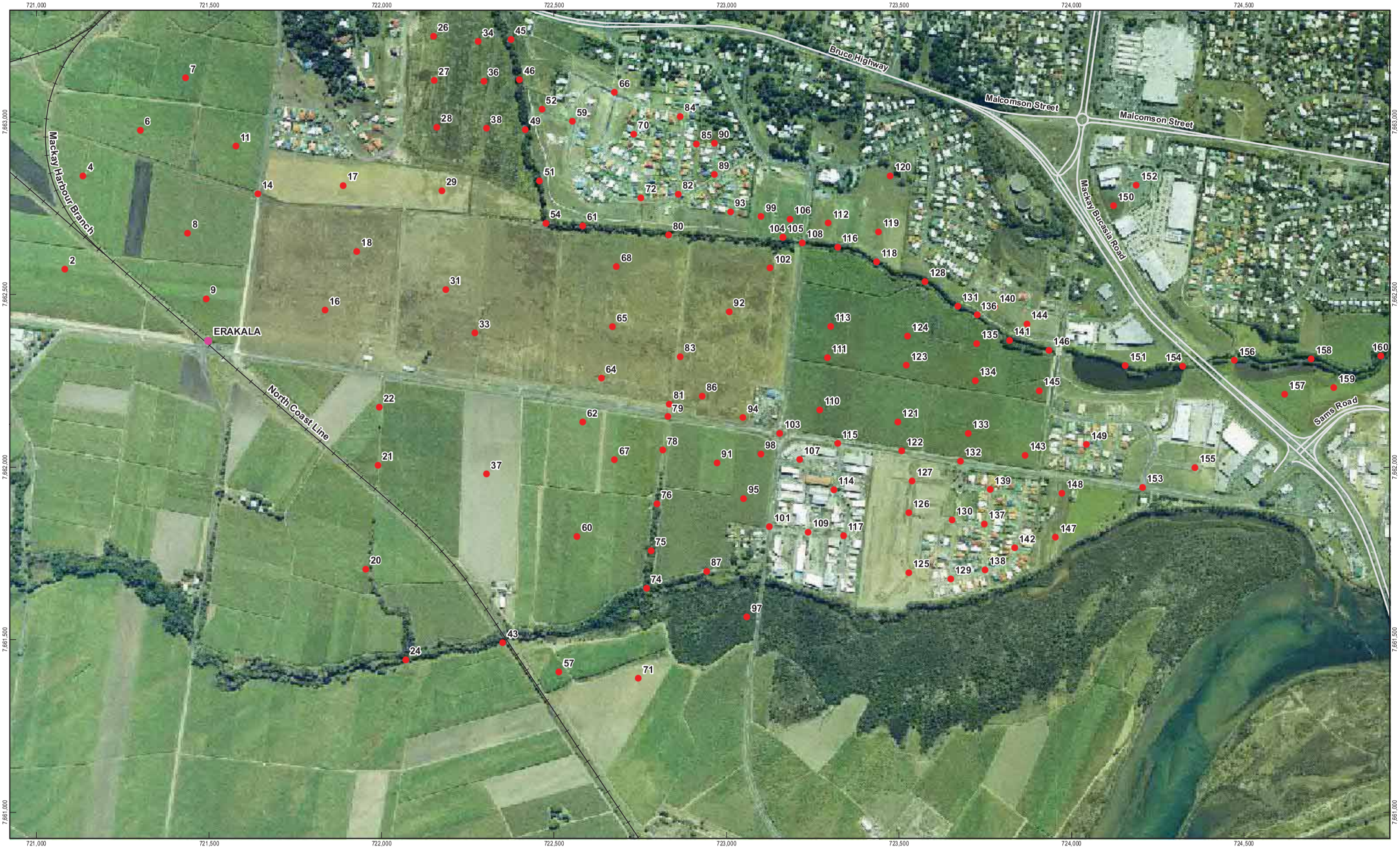

1:10,000 @A3

0 250 500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Reporting Station
- Road
- Railway

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Job Number 41-24514
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Date 22 Feb 2012

Reporting Station Locations
Sheet 2 of 4

Figure H 2

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Data source: GHD - Model Results (2011); MRC - Imagery (2004); DERM - Roads (2011), Locality(2009).

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1:10,000 @A3

0 250 500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Reporting Station
- Road
- Railway

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Date 22 Feb 2012

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Sheet 3 of 4

Figure H 3

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1:10,000 @A3

0 250 500

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Locality
- Reporting Station
- Road
- Railway

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Reporting Station Locations
Sheet 4 of 4

Figure H 4

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Data source: GHD - Model Results (2011); MRC - Imagery (2004); DERM - Roads (2011), Locality(2009).

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Appendix H - Tabulated Water Levels, Velocity and Depths

No.	X (MGA55)	Y(MGA55)	Ground Elevation (mAHD)	2008 Historic Event WL	2008 Historic Event V	2008 Historic Event D	5 Year Design EventWL	5 Year Design Event V	5 Year Design Event D	50 Year Design Event WL	50 Year Design Event V	50 Year Design Event D	100 Year Design Event WL*	100 Year Design Event V*	100 Year Design Event D*	100 Year Design Event WL**	100 Year Design Event V**	100 Year Design Event D**	Future Climate Design Event WL***	Future Climate Design Event V***	Future Climate Design Event D***
1	720607	7664156	15.82	19.23	0.80	3.41	18.25	0.54	2.43	18.62	0.65	2.80	18.79	0.70	2.97	18.79	0.70	2.97	18.94	0.75	3.12
2	721083	7662574	9.98	10.73	0.09	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3	721133	7664009	14.00	17.34	0.55	3.34	16.32	0.45	2.32	16.67	0.54	2.67	16.88	0.56	2.88	16.88	0.56	2.88	17.04	0.57	3.04
4	721136	7662845	9.82	11.23	0.11	1.41	10.53	0.09	0.71	10.66	0.11	0.84	10.73	0.26	0.91	10.73	0.26	0.91	10.85	0.32	1.03
5	721209	7663820	15.35	17.25	0.41	1.90	16.16	0.39	0.81	16.57	0.43	1.22	16.81	0.43	1.46	16.81	0.43	1.45	16.95	0.44	1.60
6	721301	7662977	10.18	11.22	0.10	1.04	10.46	0.09	0.28	10.61	0.12	0.43	10.71	0.14	0.53	10.71	0.14	0.53	10.84	0.15	0.66
7	721433	7663128	9.97	11.22	0.03	1.25	10.45	0.04	0.48	10.60	0.06	0.63	10.71	0.03	0.74	10.71	0.03	0.74	10.83	0.08	0.86
8	721438	7662679	10.06	11.20	0.11	1.14	10.40	0.09	0.34	10.58	0.12	0.52	10.69	0.13	0.63	10.69	0.13	0.63	10.82	0.14	0.76
9	721492	7662488	10.17	11.19	0.13	1.02	10.39	0.03	0.22	10.58	0.05	0.41	10.69	0.06	0.52	10.69	0.06	0.52	10.82	0.06	0.65
10	721534	7663670	14.95	16.96	0.85	2.01	15.63	0.35	0.68	16.32	0.60	1.37	16.56	0.69	1.61	16.56	0.69	1.61	16.69	0.73	1.74
11	721578	7662930	11.00	11.21	0.05	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	721609	7665038	16.08	17.90	0.62	1.82	17.26	0.50	1.18	17.49	0.55	1.41	17.58	0.57	1.50	17.58	0.57	1.50	17.67	0.59	1.59
13	721631	7663576	22.44	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	721642	7662792	10.58	11.20	0.35	0.62	0.00	0.00	0.00	0.00	0.00	0.00	10.69	0.03	0.11	10.69	0.03	0.11	10.82	0.08	0.24
15	721660	7663650	14.10	15.44	1.01	1.34	14.40	0.34	0.30	14.83	0.72	0.73	14.99	0.84	0.89	14.99	0.84	0.89	15.10	0.90	1.00
16	721835	7662455	10.10	11.13	0.18	1.03	10.23	0.07	0.13	10.51	0.08	0.41	10.63	0.13	0.53	10.63	0.12	0.53	10.76	0.11	0.66
17	721889	7662817	9.94	11.22	0.26	1.28	10.29	0.07	0.35	10.56	0.08	0.62	10.68	0.08	0.74	10.69	0.09	0.75	10.82	0.13	0.88
18	721929	7662625	9.95	11.17	0.21	1.22	10.24	0.07	0.29	10.52	0.12	0.57	10.65	0.13	0.70	10.65	0.13	0.70	10.77	0.15	0.82
19	721936	7663824	12.94	14.95	0.37	2.01	13.27	0.27	0.33	13.84	0.30	0.90	14.09	0.30	1.15	14.10	0.31	1.16	14.34	0.34	1.40
20	721955	7661704	10.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	721990	7662006	10.15	10.61	0.09	0.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	721994	7662174	9.66	10.65	0.17	0.99	0.00	0.00	0.00	0.00	0.00	0.00	9.97	0.05	0.31	9.97	0.04	0.31	10.13	0.04	0.47
23	721998	7664354	12.63	16.54	0.39	3.91	14.07	0.31	1.44	14.68	0.38	2.05	15.06	0.39	2.43	15.05	0.39	2.42	15.41	0.42	2.78
24	722070	7661442	3.00	4.15	0.43	1.15	0.00	0.00	0.00	4.10	0.01	1.10	4.11	0.01	1.11	5.32	0.00	2.32	4.79	0.00	1.79
25	722134	7664069	11.84	14.96	0.47	3.12	13.18	0.31	1.34	13.82	0.38	1.98	14.08	0.40	2.24	14.09	0.40	2.25	14.34	0.40	2.50
26	722150	7663249	11.39	12.71	0.61	1.32	0.00	0.00	0.00	11.79	0.21	0.40	11.98	0.32	0.59	11.98	0.33	0.59	12.18	0.43	0.79
27	722153	7663121	10.50	12.31	0.77	1.81	11.13	0.34	0.63	11.50	0.47	1.00	11.67	0.53	1.17	11.67	0.53	1.17	11.84	0.61	1.34
28	722161	7662985	10.39	11.81	0.55	1.42	10.75	0.07	0.36	11.07	0.24	0.68	11.23	0.31	0.84	11.23	0.31	0.84	11.38	0.38	0.99
29	722175	7662801	10.11	11.33	0.55	1.22	10.43	0.24	0.32	10.68	0.35	0.57	10.80	0.40	0.69	10.81	0.40	0.70	10.93	0.44	0.82
30	722176	7663755	11.06	14.82	0.39	3.76	13.04	0.21	1.98	13.72	0.23	2.66	13.97	0.26	2.91	13.98	0.26	2.92	14.22	0.30	3.16
31	722186	7662515	9.53	10.96	0.38	1.43	10.02	0.17	0.49	10.32	0.23	0.79	10.44	0.26	0.91	10.44	0.26	0.91	10.57	0.29	1.04
32	722268	7663524	11.55	14.65	0.67	3.10	12.93	0.31	1.38	13.62	0.39	2.07	13.86	0.45	2.31	13.87	0.45	2.32	14.10	0.51	2.55
33	722271	7662389	9.28	10.78	0.37	1.50	9.92	0.14	0.64	10.19	0.23	0.91	10.29	0.26	1.01	10.29	0.26	1.01	10.40	0.29	1.12
34	722281	7663234	10.77	12.72	0.74	1.95	11.44	0.30	0.67	11.84	0.44	1.07	12.03	0.51	1.26	12.03	0.51	1.26	12.23	0.58	1.46
35	722284	7663958	11.62	14.86	0.20	3.24	13.06	0.07	1.44	13.74	0.10	2.12	13.99	0.12	2.37	14.00	0.12	2.38	14.25	0.14	2.63
36	722296	7663119	10.47	12.38	0.72	1.91	11.20	0.31	0.73	11.57	0.44	1.10	11.74	0.50	1.27	11.74	0.50	1.27	11.91	0.56	1.44
37	722304	7661980	9.59	10.49	0.22	0.90	0.00	0.00	0.00	9.77	0.07	0.18	9.91	0.10	0.32	9.91	0.10	0.32	10.05	0.13	0.46
38	722305	7662982	10.20	11.88	0.69	1.68	10.83	0.31	0.63	11.15	0.43	0.95	11.30	0.49	1.10	11.31	0.49	1.11	11.46	0.55	1.26
39	722319	7663691	11.64	14.77	0.41	3.13	13.00	0.28	1.36	13.69	0.30	2.05	13.94	0.30	2.30	13.94	0.30	2.30	14.19	0.33	2.55
40	722329	7663339	9.14	13.11	2.49	3.97	11.80	1.76	2.65	12.21	2.25	3.07	12.40	2.36	3.26	12.41	2.37	3.27	12.61	2.44	3.47
41	722337	7663411	10.33	14.21	1.70	3.88	12.63	1.29	2.30	13.30	1.41	2.97	13.53	1.44	3.20	13.54	1.44	3.21	13.75	1.49	3.42
42	722347	7663769	9.96	14.79	0.31	4.83	13.02	0.31	3.06	13.70	0.28	3.74	13.95	0.27	3.99	13.96	0.27	4.00	14.20	0.26	4.24
43	722352	7661491	3.28	4.23	0.53	0.95	0.00	0.00	0.00	4.10	0.01	0.82	4.11	0.01	0.83	5.32	0.00	2.04	4.79	0.01	1.51
44	722370	7663582	9.73	14.71	0.47	4.98	12.96	0.47	3.23	13.65	0.52	3.92	13.89	0.54	4.16	13.90	0.54	4.17	14.14	0.55	4.41
45	722375	7663240	7.33	12.74	1.46	5.41	11.47	1.13	4.14	11.87	1.28	4.54	12.05	1.36	4.72	12.05	1.36	4.72	12.24	1.44	4.91
46	722400	7663123	6.96	12.41	1.28	5.45	11.23	0.95	4.27	11.60	1.08	4.64	11.77	1.15	4.81	11.77	1.15	4.81	11.95	1.23	4.99
47	722406	7663717	10.09	14.77	0.42	4.68	13.00	0.47	2.91	13.69	0.52	3.60	13.94	0.53	3.85	13.95	0.53	3.86	14.19	0.56	4.10
48	722412	7663411	14.03	14.53	0.11	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
49	722418	7662978	9.35	11.89	1.15	2.54	10.85	0.72	1.50	11.17	0.83	1.82	11.32	0.89	1.97	11.32	0.89	1.97	11.47	0.95	2.12
50	722451	7663687	14.53	14.76	0.22	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
51	722459	7662830	5.98	11.25	1.36	5.27	10.33	1.01	4.35	10.60	1.16	4.62	10.73	1.23	4.75	10.73	1.24	4.75	10.86	1.30	4.88
52	722464	7663037	10.93	12.05	0.18	1.12	0.00	0.00	0.00	11.31	0.03	0.38	11.47	0.04	0.54	11.47	0.04	0.54	11.63	0.05	0.70
53	722476	7663834	13.13	14.77	0.17	1.64	0.00	0.00	0.00	13.69	0.12	0.56	13.94	0.10	0.81	13.95	0.12	0.82	14.19	0.20	1.06
54	722476	7662707	7.52	10.95	0.72	3.43	10.01	0.47	2.49	10.30	0.56	2.78	10.42	0.59	2.90	10.43	0.59	2.91	10.55	0.63	3.03
55	722480	7663497	13.28	14.74	0.28	1.46	0.00	0.00	0.00	13.68	0.06	0.40	13.92	0.13	0.64	13.93	0.12	0.65	14.16	0.30	0.88
56	722511	7663376	14.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
57	722514	7661407	3.33	4.23	0.44	0.90	0.00	0.00	0.00	4.10	0.03	0.77	4.11	0.03	0.78	5.32	0.02	1.99	4.79	0.03	1.46
58	722534	7663466	13.51	14.75	0.06	1.24	0.00	0.00	0.00	13.68	0.03	0.17	13.92	0.09	0.41	13.93	0.06	0.42	14.16	0.03	0.65
59	722553	7663003	11.37	12.00	0.19	0.63	0.00	0.00	0.00	0.00	0.00	0.00	11.47	0.00	0.10	11.47	0.00	0.10	11.62	0.03	0.25
60	722567	7661799	9.48	10.25	0.20	0.77	0.00	0.00	0.00	9.59	0.05	0.11	9.70	0.08	0.22	9.70	0.08	0.22	9.84	0.11	0.36

WL = Water Level (mAHD)
D = Flood Depth (m)
V = Flood Velocity

*TW of 4.08mAHD (Equivlant to 5 Year ARI Pioneer River)

**TW of 5.32mAHD (Equivlant to 100 Year ARI Pioneer RIver)

***100 Year ARI, TW of 4.78m + 20% Rainfall Intensity

Appendix H - Tabulated Water Levels, Velocity and Depths

No.	X (MGA55)	Y(MGA55)	Ground Elevation (mAHD)	2008 Historic Event WL	2008 Historic Event V	2008 Historic Event D	5 Year Design EventWL	5 Year Design Event V	5 Year Design Event D	50 Year Design Event WL	50 Year Design Event V	50 Year Design Event D	100 Year Design Event WL*	100 Year Design Event V*	100 Year Design Event D*	100 Year Design Event WL**	100 Year Design Event V**	100 Year Design Event D**	Future Climate Design Event WL***	Future Climate Design Event V***	Future Climate Design Event D***
61	722583	7662700	5.37	10.70	0.95	5.33	9.79	0.83	4.42	10.06	0.90	4.69	10.18	0.93	4.81	10.18	0.93	4.81	10.30	0.97	4.93
62	722583	7662131	9.10	10.32	0.31	1.22	0.00	0.00	0.00	9.64	0.17	0.54	9.75	0.20	0.65	9.75	0.20	0.65	9.89	0.23	0.79
63	722610	7663908	14.14	14.76	0.12	0.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
64	722636	7662258	9.16	10.34	0.33	1.18	9.53	0.15	0.37	9.72	0.22	0.56	9.81	0.24	0.65	9.81	0.24	0.65	9.93	0.26	0.77
65	722669	7662407	9.05	10.38	0.38	1.33	9.54	0.20	0.49	9.76	0.26	0.71	9.86	0.28	0.81	9.86	0.28	0.81	9.97	0.31	0.92
66	722675	7663086	10.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
67	722676	7662022	9.08	10.20	0.30	1.12	0.00	0.00	0.00	9.54	0.14	0.46	9.65	0.17	0.57	9.65	0.17	0.57	9.78	0.21	0.70
68	722682	7662582	8.98	10.47	0.44	1.49	9.59	0.22	0.61	9.84	0.30	0.86	9.94	0.33	0.96	9.95	0.33	0.97	10.06	0.36	1.08
69	722723	7663675	13.42	14.76	0.18	1.34	0.00	0.00	0.00	13.68	0.02	0.26	13.93	0.04	0.51	13.94	0.05	0.52	14.18	0.20	0.76
70	722732	7662966	10.21	10.46	0.03	0.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
71	722745	7661388	3.43	4.22	0.17	0.79	0.00	0.00	0.00	4.10	0.02	0.67	4.11	0.02	0.68	5.32	0.13	1.89	4.79	0.21	1.36
72	722753	7662781	10.08	10.41	0.84	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
73	722758	7663533	13.76	14.76	0.08	1.00	0.00	0.00	0.00	0.00	0.00	0.00	13.93	0.00	0.17	13.94	0.00	0.18	14.18	0.02	0.42
74	722769	7661649	4.11	4.74	5.57	0.63	4.19	0.86	0.08	4.36	2.84	0.25	4.41	3.61	0.30	5.32	1.10	1.21	4.78	3.11	0.67
75	722781	7661758	4.19	9.24	1.99	5.05	6.72	0.78	2.53	7.60	1.68	3.41	7.92	1.92	3.73	7.93	1.92	3.74	8.30	2.06	4.11
76	722798	7661894	5.30	9.89	1.25	4.59	7.27	0.99	1.97	8.44	1.36	3.14	8.81	1.40	3.51	8.81	1.40	3.51	9.17	1.42	3.87
77	722809	7663694	14.09	14.76	0.03	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.18	0.01	0.09
78	722815	7662049	8.19	10.06	0.52	1.87	8.84	0.42	0.65	9.38	0.46	1.19	9.50	0.48	1.31	9.50	0.48	1.31	9.63	0.46	1.44
79	722830	7662147	7.40	10.07	0.43	2.67	9.11	0.42	1.71	9.45	0.44	2.05	9.56	0.42	2.16	9.56	0.42	2.16	9.67	0.42	2.27
80	722832	7662673	7.95	10.31	0.48	2.36	9.42	0.30	1.47	9.66	0.34	1.71	9.77	0.36	1.82	9.77	0.36	1.82	9.88	0.38	1.93
81	722834	7662183	7.94	10.12	0.40	2.18	9.25	0.63	1.31	9.48	0.61	1.54	9.59	0.66	1.65	9.59	0.66	1.65	9.71	0.64	1.77
82	722860	7662791	10.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
83	722867	7662320	8.74	10.13	0.33	1.39	9.27	0.16	0.53	9.50	0.22	0.76	9.60	0.24	0.86	9.60	0.24	0.86	9.72	0.25	0.98
84	722867	7663016	9.92	10.35	0.23	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
85	722914	7662937	9.85	10.23	0.04	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
86	722929	7662206	8.88	10.04	0.32	1.16	9.21	0.12	0.33	9.43	0.15	0.55	9.53	0.18	0.65	9.54	0.18	0.66	9.65	0.21	0.77
87	722943	7661699	8.58	8.59	0.21	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
88	722949	7663681	13.75	14.17	0.51	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
89	722965	7662848	9.77	10.22	0.25	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
90	722965	7662939	9.78	10.23	0.17	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
91	722973	7662013	8.76	9.90	0.29	1.14	9.10	0.07	0.34	9.34	0.13	0.58	9.43	0.16	0.67	9.43	0.16	0.67	9.53	0.19	0.77
92	723009	7662450	8.63	10.00	0.38	1.37	9.15	0.19	0.52	9.37	0.24	0.74	9.47	0.27	0.84	9.47	0.27	0.84	9.58	0.30	0.95
93	723012	7662740	9.49	10.09	0.30	0.60	0.00	0.00	0.00	0.00	0.00	0.00	9.57	0.02	0.08	9.57	0.02	0.08	9.67	0.06	0.18
94	723048	7662144	8.87	9.92	0.30	1.05	9.13	0.14	0.26	9.37	0.17	0.50	9.47	0.19	0.60	9.47	0.19	0.60	9.57	0.22	0.70
95	723050	7661909	8.83	9.77	0.27	0.94	9.07	0.06	0.24	9.27	0.12	0.44	9.35	0.15	0.52	9.35	0.15	0.52	9.43	0.18	0.60
96	723054	7663626	14.01	14.15	0.42	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
97	723059	7661566	2.74	4.19	0.51	1.45	0.00	0.00	0.00	4.09	0.14	1.35	4.10	0.17	1.36	5.32	0.08	2.58	4.79	0.09	2.05
98	723100	7662038	8.64	9.80	0.34	1.16	9.07	0.11	0.43	9.29	0.19	0.65	9.37	0.23	0.73	9.37	0.23	0.73	9.46	0.26	0.82
99	723101	7662726	8.95	9.88	1.02	0.93	9.12	0.32	0.17	9.30	0.49	0.35	9.38	0.57	0.43	9.38	0.57	0.43	9.47	0.66	0.52
100	723110	7663739	13.15	13.20	0.31	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
101	723125	7661828	8.69	9.61	1.33	0.92	8.85	1.22	0.16	9.06	1.32	0.37	9.15	1.31	0.46	9.15	1.31	0.46	9.25	1.35	0.56
102	723127	7662577	7.75	9.88	0.38	2.13	9.03	0.20	1.28	9.23	0.27	1.48	9.32	0.30	1.57	9.32	0.30	1.57	9.43	0.32	1.68
103	723155	7662098	8.68	9.70	1.06	1.02	0.00	0.00	0.00	9.17	0.08	0.49	9.22	0.20	0.54	9.22	0.20	0.54	9.29	0.37	0.61
104	723163	7662666	6.10	9.84	0.74	3.74	8.97	0.61	2.87	9.18	0.69	3.08	9.26	0.72	3.16	9.26	0.72	3.16	9.37	0.74	3.27
105	723163	7662666	6.10	9.84	0.74	3.74	8.97	0.61	2.87	9.18	0.69	3.08	9.26	0.72	3.16	9.26	0.72	3.16	9.37	0.74	3.27
106	723185	7662719	8.97	9.79	0.95	0.82	0.00	0.00	0.00	9.14	0.55	0.17	9.21	0.68	0.24	9.21	0.68	0.24	9.31	0.78	0.34
107	723211	7662023	9.09	9.76	0.16	0.67	0.00	0.00	0.00	9.27	0.00	0.18	9.34	0.00	0.25	9.35	0.04	0.26	9.43	0.01	0.34
108	723220	7662651	5.40	9.80	1.51	4.40	8.71	1.55	3.31	8.94	1.56	3.54	9.08	1.61	3.68	9.07	1.57	3.67	9.19	1.56	3.79
109	723237	7661812	9.32	9.64	0.01	0.32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
110	723271	7662166	8.18	9.57	0.33	1.39	8.33	0.12	0.15	8.58	0.17	0.40	8.73	0.19	0.55	8.73	0.19	0.55	8.92	0.22	0.74
111	723293	7662317	7.99	9.58	0.31	1.59	8.30	0.20	0.31	8.59	0.23	0.60	8.74	0.24	0.75	8.75	0.24	0.76	8.94	0.26	0.95
112	723296	7662708	8.34	9.69	0.85	1.35	8.54	0.41	0.20	8.79	0.63	0.45	8.92	0.69	0.58	8.92	0.69	0.58	9.08	0.73	0.74
113	723302	7662408	7.99	9.60	0.32	1.61	8.31	0.19	0.32	8.63	0.24	0.64	8.78	0.27	0.79	8.78	0.27	0.79	8.96	0.28	0.97
114	723311	7661935	9.09	9.51	0.23	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
115	723322	7662069	8.28	9.51	1.28	1.23	8.34	0.37	0.06	8.51	0.79	0.23	8.67	0.93	0.39	8.67	0.93	0.39	8.86	1.06	0.58
116	723322	7662638	6.15	9.66	1.64	3.51	8.44	1.86	2.29	8.73	1.87	2.58	8.87	1.88	2.72	8.87	1.88	2.72	9.04	1.89	2.89
117	723339	7661802	9.27	9.51	0.09	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
118	723436	7662595	4.91	9.60	1.27	4.69	8.26	1.44	3.35	8.61	1.47	3.70	8.77	1.47	3.86	8.77	1.47	3.86	8.96	1.47	4.05
119	723441	7662682	8.00	9.66	0.52	1.66	8.35	0.29	0.35	8.68	0.37	0.68	8.83	0.40	0.83	8.83	0.40	0.83	9.01	0.43	1.01
120	723475	7662845	8.93	9.68	0.05	0.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.03	0.02	0.10

WL = Water Level (mAHD)
D = Flood Depth (m)
V = Flood Velocity

*TW of 4.08mAHD (Equivlant to 5 Year ARI Pioneer River)

**TW of 5.32mAHD (Equivlant to 100 Year ARI Pioneer RIver)

***100 Year ARI, TW of 4.78m + 20% Rainfall Intensity

Appendix H - Tabulated Water Levels, Velocity and Depths

No.	X (MGA55)	Y(MGA55)	Ground Elevation (mAHD)	2008 Historic Event WL	2008 Historic Event V	2008 Historic Event D	5 Year Design EventWL	5 Year Design Event V	5 Year Design Event D	50 Year Design Event WL	50 Year Design Event V	50 Year Design Event D	100 Year Design Event WL*	100 Year Design Event V*	100 Year Design Event D*	100 Year Design Event WL**	100 Year Design Event V**	100 Year Design Event D**	Future Climate Design Event WL***	Future Climate Design Event V***	Future Climate Design Event D***
121	723497	7662131	7.73	9.41	0.30	1.68	7.98	0.12	0.25	8.39	0.17	0.66	8.57	0.19	0.84	8.58	0.19	0.85	8.78	0.21	1.05
122	723509	7662047	8.20	9.39	1.14	1.19	0.00	0.00	0.00	8.38	0.52	0.18	8.56	0.65	0.36	8.57	0.65	0.37	8.77	0.76	0.57
123	723522	7662295	7.43	9.43	0.33	2.00	8.01	0.16	0.58	8.41	0.21	0.98	8.59	0.23	1.16	8.59	0.23	1.16	8.79	0.24	1.36
124	723525	7662380	7.38	9.45	0.36	2.07	8.04	0.20	0.66	8.43	0.25	1.05	8.61	0.26	1.23	8.61	0.26	1.23	8.81	0.28	1.43
125	723528	7661694	8.11	9.23	0.52	1.12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.44	0.06	0.33
126	723529	7661868	7.95	9.24	0.14	1.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.44	0.08	0.49
127	723539	7661960	8.34	9.25	0.29	0.91	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.44	0.00	0.10
128	723576	7662538	4.64	9.48	1.44	4.84	8.09	1.35	3.45	8.47	1.45	3.83	8.64	1.50	4.00	8.64	1.50	4.00	8.84	1.50	4.20
129	723650	7661676	8.05	9.22	0.37	1.17	0.00	0.00	0.00	0.00	0.00	0.00	8.15	0.01	0.10	8.16	0.01	0.11	8.44	0.08	0.39
130	723654	7661847	8.31	9.23	0.60	0.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.44	0.05	0.13
131	723671	7662467	4.37	9.40	1.17	5.03	7.98	1.13	3.61	8.38	1.18	4.01	8.56	1.20	4.19	8.57	1.20	4.20	8.77	1.20	4.40
132	723678	7662018	8.18	9.29	1.00	1.11	0.00	0.00	0.00	8.28	0.32	0.10	8.48	0.45	0.30	8.48	0.45	0.30	8.68	0.56	0.50
133	723701	7662098	7.36	9.29	0.30	1.93	7.84	0.11	0.48	8.27	0.16	0.91	8.47	0.18	1.11	8.48	0.18	1.12	8.68	0.21	1.32
134	723721	7662251	7.00	9.30	0.38	2.30	7.85	0.21	0.85	8.28	0.25	1.28	8.47	0.27	1.47	8.48	0.27	1.48	8.68	0.29	1.68
135	723726	7662358	6.92	9.33	0.39	2.41	7.90	0.24	0.98	8.31	0.28	1.39	8.50	0.29	1.58	8.50	0.29	1.58	8.70	0.31	1.78
136	723727	7662442	4.21	9.37	1.15	5.16	7.94	1.12	3.73	8.34	1.20	4.13	8.53	1.22	4.32	8.53	1.22	4.32	8.73	1.23	4.52
137	723748	7661836	8.22	9.22	1.15	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.43	0.52	0.21
138	723749	7661703	7.99	9.21	0.28	1.22	0.00	0.00	0.00	0.00	0.00	0.00	8.16	0.06	0.17	8.17	0.06	0.18	8.43	0.12	0.44
139	723765	7661935	8.20	9.22	0.59	1.02	0.00	0.00	0.00	0.00	0.00	0.00	8.22	0.25	0.02	8.22	0.25	0.02	8.43	0.35	0.23
140	723778	7662464	9.12	9.34	0.13	0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
141	723821	7662367	4.93	9.26	0.62	4.33	7.82	0.56	2.89	8.24	0.60	3.31	8.44	0.61	3.51	8.44	0.61	3.51	8.64	0.63	3.71
142	723835	7661767	8.16	9.16	0.35	1.00	0.00	0.00	0.00	0.00	0.00	0.00	8.28	0.11	0.12	8.28	0.11	0.12	8.43	0.16	0.27
143	723866	7662035	7.62	9.19	0.25	1.57	7.74	0.04	0.12	8.20	0.08	0.58	8.41	0.09	0.79	8.42	0.09	0.80	8.61	0.11	0.99
144	723871	7662415	7.36	9.21	0.20	1.85	7.77	0.02	0.41	8.19	0.08	0.83	8.39	0.09	1.03	8.39	0.09	1.03	8.59	0.10	1.23
145	723907	7662222	6.78	9.14	0.53	2.36	7.68	0.33	0.90	8.12	0.42	1.34	8.33	0.45	1.55	8.34	0.45	1.56	8.53	0.48	1.75
146	723935	7662339	4.90	9.14	1.31	4.24	7.64	1.37	2.74	8.08	1.43	3.18	8.28	1.35	3.38	8.29	1.30	3.39	8.49	1.33	3.59
147	723955	7661797	8.73	8.99	0.53	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
148	723973	7661924	8.18	9.05	0.50	0.87	0.00	0.00	0.00	0.00	0.00	0.00	8.41	0.01	0.23	8.42	0.02	0.24	8.60	0.09	0.42
149	724044	7662066	8.43	9.07	0.08	0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.55	0.00	0.12
150	724122	7662757	8.34	8.93	0.08	0.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
151	724157	7662294	4.33	9.05	0.46	4.72	7.53	0.12	3.20	7.98	0.20	3.65	8.18	0.24	3.85	8.19	0.24	3.86	8.40	0.28	4.07
152	724189	7662817	8.79	8.93	0.01	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
153	724206	7661941	8.38	8.95	0.74	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.54	0.13	0.16
154	724323	7662293	4.33	8.98	0.76	4.65	7.50	0.76	3.17	7.94	0.57	3.61	8.14	0.68	3.81	8.15	0.62	3.82	8.34	0.67	4.01
155	724358	7661999	8.30	8.97	0.12	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.51	0.01	0.21
156	724473	7662310	5.53	8.80	0.77	3.27	7.39	0.45	1.86	7.80	0.57	2.27	7.99	0.62	2.46	8.00	0.62	2.47	8.19	0.66	2.66
157	724618	7662212	5.97	8.67	0.99	2.70	7.31	0.46	1.34	7.70	0.63	1.73	7.87	0.70	1.90	7.88	0.70	1.91	8.06	0.77	2.09
158	724695	7662314	1.87	8.60	0.48	6.73	7.26	0.53	5.39	7.64	0.62	5.77	7.81	0.65	5.94	7.82	0.65	5.95	8.00	0.68	6.13
159	724761	7662231	6.46	8.54	1.30	2.08	7.19	0.61	0.73	7.57	0.85	1.11	7.74	0.95	1.28	7.75	0.94	1.29	7.93	1.03	1.47
160	724898	7662322	4.33	8.25	0.83	3.92	6.95	0.64	2.62	7.28	0.76	2.95	7.45	0.80	3.12	7.47	0.79	3.14	7.64	0.83	3.31
161	724937	7662159	8.01	8.10	0.90	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
162	724960	7662423	4.33	8.01	1.26	3.68	6.35	1.23	2.02	6.80	1.24	2.47	7.02	1.24	2.69	7.08	1.11	2.75	7.28	1.18	2.95
163	725003	7662226	7.75	8.11	0.42	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
164	725162	7662382	4.65	7.85	1.15	3.20	6.04	1.23	1.39	6.55	1.08	1.90	6.79	1.01	2.14	6.88	0.83	2.23	7.09	0.91	2.44
165	725236	7662113	7.86	7.92	0.32	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
166	725275	7662253	6.88	7.82	0.42	0.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.06	0.02	0.18
167	725348	7662531	9.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
168	725413	7662418	4.60	7.65	0.41	3.05	5.94	0.20	1.34	6.41	0.23	1.81	6.65	0.25	2.05	6.75	0.25	2.15	6.95	0.27	2.35
169	725432	7664458	5.71	5.92	0.31	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.80	0.11	0.09	0.00	0.00	0.00
170	725466	7664556	5.18	5.92	0.08	0.74	0.00	0.00	0.00	0.00	0.00	0.00	5.33	0.01	0.15	5.81	0.09	0.63	5.72	0.06	0.54
171	725490	7664270	5.57	5.92	0.16	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.80	0.06	0.23	5.72	0.05	0.15
172	725494	7662256	7.38	7.69	0.08	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
173	725513	7664054	5.44	5.92	0.08	0.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.80	0.04	0.36	5.72	0.02	0.28
174	725526	7664684	5.05	5.92	0.53	0.87	0.00	0.00	0.00	5.14	0.15	0.09	5.34	0.43	0.29	5.81	0.32	0.76	5.72	0.55	0.67
175	725552	7664881	5.13	5.92	0.03	0.79	0.00	0.00	0.00	0.00	0.00	0.00	5.34	0.03	0.21	5.81	0.03	0.68	5.72	0.02	0.59
176	725555	7664779	4.87	5.92	0.12	1.05	5.00	0.02	0.13	5.14	0.17	0.27	5.34	0.15	0.47	5.81	0.10	0.94	5.72	0.16	0.85
177	725564	7664503	4.06	5.92	0.33	1.86	4.84	0.41	0.78	5.14	0.51	1.08	5.33	0.55	1.27	5.81	0.13	1.75	5.72	0.41	1.66
178	725565	7662563	5.47	7.06	0.39	1.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
179	725588	7662772	6.28	7.00	0.26	0.72	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.36	0.00	0.08	6.47	0.01	0.19
180	725606	7661954	3.45	0.00	0.00	0.00	0.00	0.00	0.00	4.08	0.00	0.63	4.08	0.00	0.63	5.32	0.00	1.87	4.78	0.00	1.33

WL = Water Level (mAHD)
D = Flood Depth (m)
V = Flood Velocity

*TW of 4.08mAHD (Equivlant to 5 Year ARI Pioneer River)

**TW of 5.32mAHD (Equivlant to 100 Year ARI Pioneer RIver)

***100 Year ARI, TW of 4.78m + 20% Rainfall Intensity

Appendix H - Tabulated Water Levels, Velocity and Depths

No.	X (MGA55)	Y(MGA55)	Ground Elevation (mAHD)	2008 Historic Event WL	2008 Historic Event V	2008 Historic Event D	5 Year Design EventWL	5 Year Design Event V	5 Year Design Event D	50 Year Design Event WL	50 Year Design Event V	50 Year Design Event D	100 Year Design Event WL*	100 Year Design Event V*	100 Year Design Event D*	100 Year Design Event WL**	100 Year Design Event V**	100 Year Design Event D**	Future Climate Design Event WL***	Future Climate Design Event V***	Future Climate Design Event D***
181	725667	7665097	5.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
182	725671	7662555	0.50	7.11	1.53	6.61	5.73	0.80	5.23	6.09	1.09	5.59	6.29	1.18	5.79	6.44	1.12	5.94	6.56	1.25	6.06
183	725673	7664418	4.62	5.92	0.18	1.30	4.83	0.15	0.21	5.14	0.27	0.52	5.33	0.27	0.71	5.81	0.07	1.19	5.72	0.18	1.10
184	725708	7662265	6.85	7.20	0.17	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
185	725732	7662962	5.66	6.87	0.61	1.21	0.00	0.00	0.00	5.81	0.02	0.15	6.04	0.07	0.38	6.27	0.15	0.61	6.36	0.22	0.70
186	725735	7662515	6.59	7.13	0.23	0.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
187	725786	7662726	2.96	7.03	1.39	4.07	5.64	1.24	2.68	6.01	1.22	3.05	6.22	1.28	3.26	6.39	1.02	3.43	6.50	1.14	3.54
188	725792	7664166	3.00	5.93	0.29	2.93	4.94	0.21	1.94	5.27	0.34	2.27	5.41	0.37	2.41	5.80	0.30	2.80	5.72	0.39	2.72
189	725799	7662247	6.92	7.02	0.27	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
190	725815	7662497	6.93	7.13	0.20	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
191	725849	7664835	4.64	5.92	0.31	1.28	0.00	0.00	0.00	5.14	0.04	0.50	5.33	0.29	0.69	5.81	0.02	1.17	5.72	0.07	1.08
192	725864	7664949	4.75	5.92	0.10	1.17	0.00	0.00	0.00	5.14	0.01	0.39	5.33	0.01	0.58	5.81	0.02	1.06	5.72	0.03	0.97
193	725870	7665240	5.56	5.92	0.05	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.81	0.00	0.25	5.72	0.00	0.16
194	725878	7662316	4.50	5.48	0.73	0.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
195	725906	7662463	6.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
196	725943	7662711	6.15	6.76	0.49	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
197	725957	7664535	6.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
198	725969	7664355	5.59	5.92	0.06	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.81	0.02	0.22	5.72	0.01	0.13
199	725989	7663731	4.15	5.93	0.05	1.78	4.44	0.02	0.29	5.15	0.04	1.00	5.34	0.04	1.19	5.80	0.04	1.65	5.72	0.04	1.57
200	725989	7663924	4.81	5.93	0.31	1.12	0.00	0.00	0.00	5.15	0.06	0.34	5.34	0.11	0.53	5.80	0.20	0.99	5.72	0.36	0.91
201	725994	7662960	3.39	6.80	0.58	3.41	5.24	0.23	1.85	5.78	0.35	2.39	6.01	0.39	2.62	6.24	0.38	2.85	6.32	0.43	2.93
202	726008	7665210	5.55	5.92	0.02	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.81	0.02	0.26	5.72	0.01	0.17
203	726030	7662362	3.58	5.48	0.09	1.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
204	726069	7662472	6.55	6.63	0.38	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
205	726083	7664519	5.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
206	726097	7662691	6.23	6.68	0.30	0.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
207	726123	7664943	4.03	5.92	0.13	1.89	4.42	0.11	0.39	5.14	0.21	1.11	5.33	0.23	1.30	5.81	0.02	1.78	5.72	0.05	1.69
208	726148	7664735	4.15	5.92	0.13	1.77	4.42	0.07	0.27	5.14	0.15	0.99	5.33	0.19	1.18	5.81	0.02	1.66	5.72	0.03	1.57
209	726161	7662786	6.04	6.65	0.33	0.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.19	0.19	0.15	6.25	0.22	0.21
210	726161	7665472	4.98	5.92	0.01	0.94	0.00	0.00	0.00	5.14	0.00	0.16	5.33	0.04	0.35	5.81	0.01	0.83	5.72	0.02	0.74
211	726170	7662882	6.03	6.68	0.92	0.65	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.19	0.35	0.16	6.25	0.46	0.22
212	726200	7664355	4.13	5.92	0.19	1.79	4.41	0.11	0.28	5.14	0.23	1.01	5.33	0.23	1.20	5.81	0.01	1.68	5.72	0.02	1.59
213	726207	7664011	3.63	5.92	0.17	2.29	4.42	0.18	0.79	5.13	0.05	1.50	5.33	0.06	1.70	5.81	0.03	2.18	5.72	0.04	2.09
214	726238	7662970	2.46	6.58	1.72	4.12	5.15	1.14	2.69	5.66	1.36	3.20	5.87	1.46	3.41	6.14	1.25	3.68	6.19	1.45	3.73
215	726243	7665358	4.44	5.92	0.05	1.48	4.56	0.01	0.12	5.14	0.05	0.70	5.33	0.05	0.89	5.81	0.05	1.37	5.72	0.09	1.28
216	726255	7665608	4.39	5.92	0.09	1.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.81	0.01	1.42	5.72	0.01	1.33
217	726256	7664199	3.05	5.92	0.40	2.87	4.41	0.38	1.36	5.14	0.28	2.09	5.33	0.31	2.28	5.81	0.05	2.76	5.72	0.20	2.67
218	726282	7664504	3.92	5.92	0.13	2.00	4.41	0.07	0.49	5.14	0.08	1.22	5.33	0.09	1.41	5.81	0.03	1.89	5.72	0.03	1.80
219	726322	7665221	5.66	5.85	0.21	0.19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
220	726323	7665060	3.30	5.92	0.07	2.62	4.42	0.03	1.12	5.14	0.05	1.84	5.33	0.07	2.03	5.81	0.01	2.51	5.72	0.03	2.42
221	726323	7662965	1.53	6.45	1.73	4.92	5.10	0.90	3.57	5.59	1.15	4.06	5.80	1.25	4.27	6.09	1.07	4.56	6.11	1.28	4.58
222	726324	7662767	6.02	6.51	0.53	0.49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.12	0.03	0.10	6.17	0.06	0.15
223	726329	7664903	4.03	5.92	0.24	1.89	4.42	0.17	0.39	5.14	0.22	1.11	5.33	0.23	1.30	5.81	0.05	1.78	5.72	0.09	1.69
224	726331	7663901	3.37	5.92	0.15	2.55	4.42	0.08	1.05	5.13	0.08	1.76	5.33	0.09	1.96	5.81	0.04	2.44	5.72	0.06	2.35
225	726336	7663663	2.58	5.93	0.06	3.35	4.44	0.07	1.86	5.15	0.05	2.57	5.34	0.06	2.76	5.80	0.06	3.22	5.72	0.08	3.14
226	726358	7664693	4.02	5.92	0.23	1.90	4.41	0.15	0.39	5.14	0.16	1.12	5.33	0.18	1.31	5.81	0.03	1.79	5.72	0.06	1.70
227	726396	7664265	4.18	5.92	0.07	1.74	4.41	0.02	0.23	5.14	0.04	0.96	5.33	0.06	1.15	5.81	0.03	1.63	5.72	0.04	1.54
228	726408	7664035	3.93	5.92	0.09	1.99	4.42	0.08	0.49	5.13	0.06	1.20	5.33	0.06	1.40	5.81	0.02	1.88	5.72	0.02	1.79
229	726428	7663033	5.45	6.35	0.13	0.90	0.00	0.00	0.00	5.52	0.01	0.07	5.72	0.03	0.27	6.01	0.05	0.56	6.03	0.06	0.58
230	726457	7663764	3.11	5.93	0.45	2.82	4.44	0.29	1.33	5.15	0.26	2.04	5.34	0.28	2.23	5.80	0.26	2.69	5.72	0.27	2.61
231	726503	7664151	5.41	5.92	1.63	0.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.81	1.14	0.40	5.72	1.25	0.31
232	726553	7663920	4.86	5.91	0.13	1.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.80	0.04	0.94	5.71	0.12	0.85
233	726556	7663072	4.92	6.35	0.05	1.43	5.05	0.01	0.13	5.52	0.03	0.60	5.72	0.04	0.80	6.01	0.04	1.09	6.03	0.04	1.11
234	726576	7663821	5.02	5.91	0.11	0.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.79	0.05	0.77	5.71	0.06	0.69
235	726604	7664414	5.52	5.92	0.01	0.40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.81	0.00	0.29	5.72	0.01	0.20
236	726610	7662784	5.35	6.34	0.08	0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.55	0.02	0.20	5.41	0.00	0.06
237	726659	7663126	4.55	6.34	0.85	1.79	5.00	0.73	0.45	5.49	0.68	0.94	5.69	0.69	1.14	6.00	0.51	1.45	6.01	0.58	1.46
238	726688	7663024	2.35	6.36	0.88	4.01	5.04	0.36	2.69	5.52	0.50	3.17	5.72	0.58	3.37	6.02	0.54	3.67	6.04	0.65	3.69
239	726709	7663580	4.07	5.94	0.23	1.87	4.45	0.09	0.38	5.15	0.17	1.08	5.35	0.21	1.28	5.80	0.09	1.73	5.73	0.10	1.66
240	726715	7663688	3.16	5.94	0.20	2.78	4.44	0.17	1.28	5.15	0.13	1.99	5.34	0.14	2.18	5.80	0.11	2.64	5.72	0.13	2.56

WL = Water Level (mAHD)
D = Flood Depth (m)
V = Flood Velocity

*TW of 4.08mAHD (Equivlant to 5 Year ARI Pioneer River)

**TW of 5.32mAHD (Equivlant to 100 Year ARI Pioneer RIver)

***100 Year ARI, TW of 4.78m + 20% Rainfall Intensity

Appendix H - Tabulated Water Levels, Velocity and Depths

No.	X (MGA55)	Y(MGA55)	Ground Elevation (mAHD)	2008 Historic Event WL	2008 Historic Event V	2008 Historic Event D	5 Year Design EventWL	5 Year Design Event V	5 Year Design Event D	50 Year Design Event WL	50 Year Design Event V	50 Year Design Event D	100 Year Design Event WL*	100 Year Design Event V*	100 Year Design Event D*	100 Year Design Event WL**	100 Year Design Event V**	100 Year Design Event D**	Future Climate Design Event WL***	Future Climate Design Event V***	Future Climate Design Event D***
241	726731	7662991	4.05	6.30	1.56	2.25	4.99	1.23	0.94	5.48	0.85	1.43	5.68	0.88	1.63	5.99	0.75	1.94	6.00	0.88	1.95
242	726784	7662904	4.64	6.33	0.30	1.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.55	0.02	0.91	5.41	0.03	0.77
243	726864	7662830	5.73	6.33	0.15	0.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
244	726868	7663360	3.86	5.98	0.96	2.12	4.57	0.64	0.71	5.20	0.64	1.34	5.39	0.68	1.53	5.82	0.53	1.96	5.76	0.66	1.90
245	726919	7662787	6.02	6.33	0.07	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
246	726977	7663215	1.97	6.07	0.71	4.10	4.79	0.52	2.82	5.29	0.53	3.32	5.47	0.56	3.50	5.86	0.44	3.89	5.82	0.53	3.85
247	726997	7663099	3.28	6.12	0.42	2.84	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.53	0.04	2.25	5.40	0.03	2.12
248	727093	7663959	2.89	5.79	0.15	2.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.74	0.01	2.85	5.68	0.01	2.79
249	727128	7662811	6.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
250	727142	7662918	5.76	5.96	0.32	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
251	727173	7663074	5.03	6.07	0.35	1.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.53	0.05	0.50	5.40	0.05	0.37
252	727202	7663200	5.64	6.07	0.72	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
253	727242	7663417	6.46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
254	727322	7663184	5.56	5.85	1.45	0.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
255	727329	7663964	1.73	5.43	0.54	3.70	3.90	0.29	2.17	4.75	0.33	3.02	4.91	0.36	3.18	5.55	0.32	3.82	5.33	0.38	3.60
256	727349	7663408	5.47	5.78	0.68	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
257	727374	7662770	4.10	5.25	0.53	1.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.39	0.01	1.29	5.07	0.02	0.97
258	727393	7662844	4.50	5.21	0.29	0.71	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.39	0.01	0.89	5.07	0.02	0.57
259	727394	7663645	5.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
260	727406	7662930	5.04	5.20	1.27	0.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.39	0.05	0.35	0.00	0.00	0.00
261	727417	7663036	5.00	5.38	0.96	0.38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.39	0.12	0.39	5.13	0.50	0.13
262	727438	7663162	5.49	5.62	1.20	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
263	727469	7663379	5.18	5.77	0.52	0.59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.46	0.01	0.28	0.00	0.00	0.00
264	727651	7662892	4.11	5.12	0.31	1.01	0.00	0.00	0.00	4.49	0.04	0.38	4.61	0.04	0.50	5.39	0.03	1.28	5.07	0.02	0.96
265	727663	7662997	4.04	5.12	0.54	1.08	0.00	0.00	0.00	4.49	0.04	0.45	4.61	0.06	0.57	5.39	0.04	1.35	5.07	0.05	1.03
266	727692	7663125	3.80	5.08	0.79	1.28	0.00	0.00	0.00	4.49	0.07	0.69	4.61	0.09	0.81	5.39	0.07	1.59	5.07	0.09	1.27
267	727752	7663112	4.06	5.09	0.43	1.03	0.00	0.00	0.00	4.49	0.07	0.43	4.61	0.07	0.55	5.39	0.05	1.33	5.07	0.06	1.01
268	727830	7662891	4.47	5.10	0.16	0.63	0.00	0.00	0.00	0.00	0.00	0.00	4.60	0.01	0.13	5.38	0.05	0.91	5.07	0.04	0.60
269	727945	7663038	4.70	5.07	0.34	0.37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.38	0.10	0.68	5.06	0.12	0.36
270	728077	7663929	0.86	5.09	0.39	4.23	3.42	0.22	2.56	4.52	0.14	3.66	4.64	0.16	3.78	5.40	0.12	4.54	5.10	0.16	4.24
271	728132	7663265	0.61	4.95	1.04	4.34	3.25	0.73	2.64	4.43	0.72	3.82	4.53	0.79	3.92	5.38	0.32	4.77	5.03	0.62	4.42
272	729127	7663981	2.42	5.09	0.35	2.67	3.40	0.14	0.98	4.52	0.01	2.10	4.64	0.01	2.22	5.40	0.01	2.98	5.09	0.01	2.67

WL = Water Level (mAHD)
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*TW of 4.08mAHD (Equivlant to 5 Year ARI Pioneer River)

**TW of 5.32mAHD (Equivlant to 100 Year ARI Pioneer RIver)

***100 Year ARI, TW of 4.78m + 20% Rainfall Intensity

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