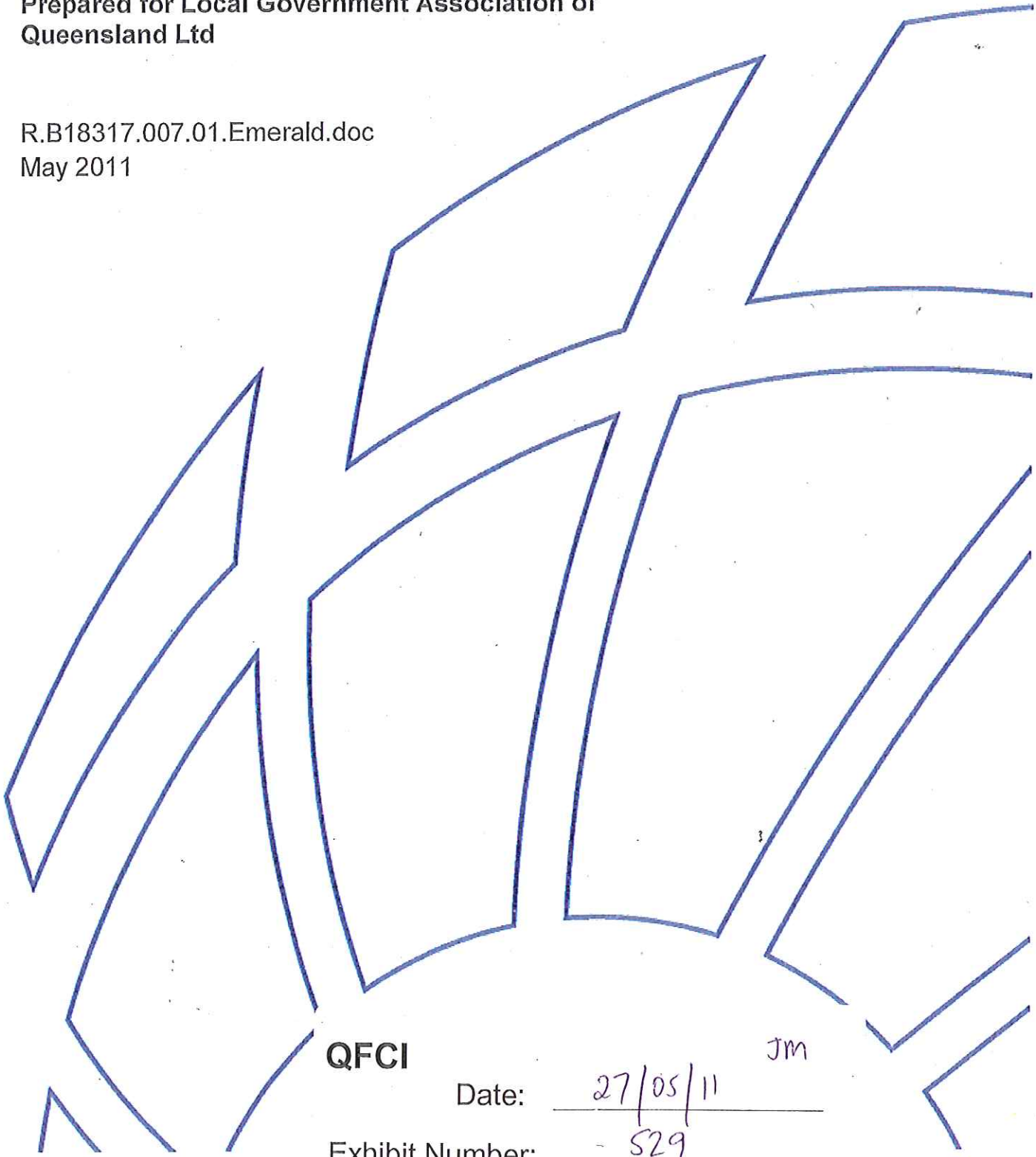


Queensland Floods Commission of Inquiry

**Technical Report on the December 2010
January 2011 Flooding within Emerald**

Prepared for Local Government Association of
Queensland Ltd

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May 2011



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Date:

27/05/11

Exhibit Number:

- 529

**Queensland Floods Commission of
Inquiry**

**Technical Report on the December
2010 - January 2011 Flooding within
the Emerald**

**Prepared for Local Government
Association of Queensland Ltd**

May 2011

Prepared For: Local Government Association of Queensland Limited

Prepared By: BMT WBM Pty Ltd (Member of the BMT group of companies)

Offices
*Brisbane
Denver
Mackay
Melbourne
Newcastle
Perth
Sydney
Vancouver*

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APPENDIX A: CURRICULUM VITAE OF NEIL IAN COLLINS **A-1**

APPENDIX B: EMERGENCY PLANNING RESPONSE SUMMARY **B-1**

GLOSSARY

ARI	Average Recurrence Interval is the measure of the rarity of the event; it is the estimate of the interval of time between events. For a 100 year ARI event, there is a 1% chance that this event can occur in any given year. However it should be noted that planning for a 1 in 100 ARI event does not guarantee immunity for the next 100 years.
Catchment	The catchment at a particular point is the area of land that drains to that point.
Design flood	The hypothetical flood used for planning and floodplain management investigations. It is defined by the probability of its occurrence and represents a flood which has a particular chance of happening in any year.
Flood mitigation	Measures implemented to reduce the risk of flooding
Headwater	The most upstream sections of a river system typically located in steep upland areas
Hydrograph	A graph showing how a river or creek's discharge changes with time.
Inundation	the rising of a body of water and its overflowing onto normally dry land
Levee	a raised embankment typically used to impede the flow of floodwater
Runoff	The amount of rainfall from a catchment that actually ends up as flowing water in the river or creek.
Stream gauge	A site along a stream where measurements of water surface elevation and or volumetric discharge (flow) are made.
Tributary	A stream, creek or river which flows into a main stream, creek, river or lake.
Velocity	The speed at which the flood waters are moving. Typically, modelled velocities in a river or creek are quoted as the depth and width averaged velocity, i.e. the average velocity across the whole river or creek section.

1 INTRODUCTION

1.1 Purpose of the Report

BMT WBM Pty Ltd was commissioned by LGAQ on behalf of Central Highlands Regional Council (CHRC), to provide expert advice in relation to flooding which took place across the area in December 2010 and January 2011. This technical report provides information on:

- The nature and cause of the flood along with its associated impacts;
- Previous flood studies and floodplain management planning carried out in Councils administrative area; and
- Flood warning and the emergency management response.

The report focuses on the larger town of Emerald but gives consideration to other townships within the CHRC administrative area. It considers the flooding in December 2010 to January 2011 and has been specifically prepared to assist the Queensland Floods Commission of Inquiry.

The Report has been prepared by Neil Collins, Principal Hydraulic Engineer with BMT WBM Pty Ltd, a firm of specialist water and environmental professionals. Neil specialises in water, in particular, flooding and stormwater management. A copy of Neil's CV is included as Appendix A to this Report. Neil has been assisted by senior BMT WBM staff, including Flood Group Manager, Jo Tinnion. Bill Wilkinson of Central Highlands Regional Council provided a significant amount of detailed technical information that this report has drawn upon.

In preparing this report, key BMT WBM staff have drawn upon a range of technical sources and have previously visited the area.

1.2 Structure of the Report

The report is structured into the following remaining sections:

- Section 2 provides background information on the affected towns, including historical floods and gives details of rainfall events leading up to the flood event;
- Section 3 presents an analysis of the rainfall and resulting flood events;
- Section 4 summarises flood mitigation measures implemented within the Region;
- Section 5 summaries previous flood investigations and floodplain management planning within the Shire area;
- Section 6 summaries flood warnings; and
- Section 7 provides a summary of findings.

2 BACKGROUND

2.1 Study Area

CHRC covers an area of 54,000 square kilometres and includes the larger townships of Emerald, Capella, Tieri, Sapphire, Rubyvale, Blackwater, Duaringa, Springsure and Rolleston. CHRC area has a total population of around 30,000 people and is located in the Fitzroy region of Queensland. The principal economic activities are agriculture and mining. Emerald is the largest town with around 14,000 inhabitants and it is the administrative capital of the Region. An open cut coal mine known as the Ensham Mine lies approximately 40km east of Emerald. There are plans to expand the mine through a combination of open cast and underground mining techniques. This is known as the Ensham Central Project.

Two main roads cross through Emerald. The Capricorn Highway runs east-west and connects Emerald to Rockhampton. The Gregory Highway runs north-south linking Emerald to Capella in the north and Springsure and Rolleston in the south. The Capricorn Highway is one of only two road crossings of the Nogoa River (via the Vince Lester Bridge) in Emerald, the other being the John Gay Bridge providing local road access between the east and west areas of Emerald.

The Rockhampton to Winton Branch of Queensland Rails' line passes through Emerald crossing the Nogoa River to the south of, and immediately adjacent to the Vince Lester Bridge.

2.2 Catchment and Creek Description

The Central Highlands area is located within the Fitzroy River basin which drains through Rockhampton and out into the Coral Sea. The Nogoa River flows through Emerald in an approximately south west to north east direction after which it flows in an easterly direction becoming the Mackenzie River and then the Fitzroy River. Fairbairn Dam was constructed on the Nogoa River approximately 18km upstream of Emerald in 1972 for the purposes of water supply to the Emerald area. Behind it, the dam has created one of the largest lakes in Queensland, Lake Maraboon. The dam is owned and operated by Sunwater and has a capacity at full supply level of over 1,300,000 ML.

Key tributary catchments include the Retreat and Theresa Creeks which drain the north west part of the Council area, the River Comet which drains the central portion of Council area and the Dawson River and its associated creeks which drain the eastern portion of the Council area.

In the south of the district the Carnarvon National Park lies on the Great Dividing Range with the Nogoa catchment to the north and the upper Warrego catchment (part of the Murray/Darling system) to the south.

The Council area, larger townships and main rivers are shown in Figure 2-1. Figure 2-2 is a similar figure but focuses on Emerald and the surrounding area and Figure 2-3 focuses on the town of Emerald itself.

2.3 Historic Flooding

Emerald is located in the floodplain of the Nogoa River and as such has been subject to major¹ flood events throughout its history.

The previous largest flood on record at Emerald occurred in November 1950 when the river gauge recorded a flood level of 15.7m. This flood occurred before the construction of Fairbairn Dam.

The most significant flood to occur after the dam was completed in 1972 was in January 2008.

This was caused when a low pressure system, the remnants of Tropical Cyclone Helen, tracked inland from the north and brought heavy rain to the headwaters of the Nogoa River. River levels on the Nogoa were the highest on record for gauges at Craigmore, Fairbairn Dam and Duckponds. The peak flood levels recorded at the Emerald gauge was 15.36m, at the time the second highest on record being exceeded only by the 1950 flood event.

Elsewhere in the CHRC area, Rubyvale experienced a number of significant flood events between 2001 and 2004 with the largest being in 2004 when approximately 40 houses were affected.

2.4 Antecedent Conditions

In 2010 Queensland experienced substantial rainfall including the wettest December on record. This was in large part due to the influence of a strong La Niña event. Previous strong La Niña events such as those of 1974 and 1955 were associated with widespread and severe flooding.

The lead up to the flooding experienced across the CHRC area saw heavy rain falling within the Fitzroy River Basin (which the Nogoa is part of) during November 2010. Rainfall on the 16 and 17 November produced river level rises and minor to moderate flooding in the Gemfields Creek systems. Further rain fell towards the end of the month. The November rainfall served to wet the catchment soils and fill Lake Maraboon behind Fairbairn Dam.

¹ The Bureau of Meteorology classify any flood with a recorded water level at the Emerald Gauge of 15m or more as a 'major' flood.

3 JANUARY 2011 FLOOD ANALYSES

Two distinct rainfall events led to flooding in the CHRC area in December 2010 and early January 2011. There were also localised flood events in early January 2011 such as the flash flooding at Bluff on 2 January 2011. The following sections detail the gauged data recorded during the events and then highlight the key material impacts of the flooding.

3.1 Rainfall

Figure 3-1 plots the December daily rainfall totals for selected gauges in the Nogoia catchment to the south of Emerald. The locations of the selected rain gauges (along with selected river gauges) are shown in Figure 3-2. It can be seen that there are two distinct significant rainfall events; one on 3 December 2010 and one on 27 December 2010².

The gauged records in Figure 3-1 are coloured based on approximate location with red shading indicating gauges located within 70km from Emerald and green shading indicating those gauges located in the far south west of the Nogoia catchment in the Carnarvon Range. It can be seen that the rain event of the 3 December fell largely in the area to the south of Emerald whereas the 27 December event fell principally on the elevated areas in the Carnarvon Range. This second event registered the highest daily rainfall totals on record for the 5 gauges shown in green (Birraban, Carnarvon, Yandaburra, Wharton Creek and Spring Creek) indicating the extreme nature of the rainfall.

The highest daily total was 273.6mm at the Carnarvon Gauge. The majority of this reportedly fell in a 12 hour period beginning on the afternoon of the 26 December. For comparison the mean monthly rainfall for December at Carnarvon is 103mm.

3.2 Flooding

The two distinct rainfall events (3 and 27 December 2010) caused two flood events across the CHRC area.

Rainfall recorded on the 3 December affected the Gemfields area (Retreat Creek) first, during the night. The Retreat and Theresa Creeks, and lower Nogoia and Comet Rivers all suffered major floods. Further east the Mackenzie and Dawson Rivers suffered moderate flooding.

The rainfall recorded on the 27 December saw the heaviest falls in the south of the district and consequently the upland creeks in these areas received high volumes of runoff. The Nogoia River in particular was impacted by this rainfall event and its upland headwaters began to respond through rising floodwaters during the early hours of the 27 December.

River levels were recorded at a number of locations from the ALERT system of gauges put in place by Council in conjunction with BoM. Figure 3-2 plots the locations of some key river level gauges

² Note that reported rainfall totals are for the preceding 24 hours up to 9am on the reported day. Therefore the rain may have fallen (after 9 a.m.) on the previous day to that reported.

which are commented on in the text below. Raymond River gauge on the Nogoia near Nandowrie was overtopped during the event and ceased to operate.

Recorded water levels in Emerald for the period from 1 December 2010 to 31 January 2011 (Figure 3-3a) clearly show the two distinct flood events with the latter event being of greater magnitude in Emerald. Also plotted in Figure 3-3 are other hydrographs for recorded water levels where the attenuating effect of Fairbairn Dam can clearly be seen when comparing the hydrograph upstream at Craigmore Alert (3-3b) to the recorded levels at Fairbairn Dam itself (3-3c) and the response at Emerald gauge downstream. The 'peaky' nature of the rivers response exhibited at Craigmore is smoothed at the Fairbairn Dam gauge due to the attenuating effect of the dam and whilst the two main peaks can be seen downstream of the dam the other smaller peaks have generally be absorbed into the attenuated response.

The second event peaked in Emerald in the early hours of 31 December 2010 at a gauge height of 16.05m. This is the highest on record, exceeding the previous record of 15.7m observed in 1950. The first smaller peak occurred on 6 December at 5pm when the peak level reached 10.95m at the Emerald gauge.

The response of the catchments to the north west of Emerald can be seen from the recorded levels at the Gregory Highway gauge on Theresa Creek (3-3d). Here the larger peak was the one caused by the rain event on the 3 December with peak levels reaching 10.37m in the early hours of the 4 December. The creek response to the rainfall event of the 27 December can still be seen but as this event had the heaviest falls on land in the upper Nogoia catchment to the south the peak is not as pronounced on Theresa Creek.

The response of the Nogoia River downstream of Emerald can be seen in the gauged water levels plot for the Duckponds gauge (3-3e) located near Ensham Mine approximately 12km upstream from the confluence with the River Comet. The Nogoia at this location has received the flows from the key tributaries of the Retreat and Theresa Creeks although any peaky response from those creeks has been absorbed into the main river hydrograph due to the attenuation effects of the floodplain. The two flood peaks are clearly distinguishable however with the second peak being larger than the first by 1.45m. The first peak occurred at 14:30 on 5 December at 13.58m and the second was at 00:30 on 1 January 2011 at 15.03m.

3.3 Flood Impacts

For the purpose of this report flood impacts have been described as event 1 and event 2 based on the causative rainfall information.

Event 1

The first flood event triggered by rainfall on 3 December 2010 led to sections of the Capricorn Highway west of Duaringa being closed and the River Theresa cutting the Gregory highway north of Emerald. The main township at risk was Sapphire. By 6 December 2010 many of the main highways in the Central Highlands area were inaccessible due to flood water inundation. Rolleston was isolated for a number of days following the event. One family was rescued by SES boat due to flooding in Comet.

Event 2

The second rainfall event on the night of the 26/27 December caused significant flooding on the Nogoa River as well as other creek systems across the CHRC area.

By 30 December 2010 three evacuation centres were established in Emerald. The railway crossing of the Nogoa River had closed at approximately 8am that morning.

On 31 December 2010 the Nogoa River peaked in Emerald at 16.05m. Fairbairn Dam peaked at 5.65m over the spillway and all roads in and out of the Central Highlands region were closed.

In Emerald approximately 1,000 houses suffered internal inundation at various levels. A total of 3,000 properties had water within their property boundaries and all industrial areas suffered either partial or full water inundation. The Coles supermarket was flooded and there was approximately 100mm depth of water inside the Woolworths supermarket. Queensland Health also made the decision to evacuate the hospital in Emerald.

In total approximately 80% of buildings in Emerald were inundated in some way and over 1200 people were evacuated. The inundation left a number of 'dry islands' on raised ground within Emerald which were temporarily isolated due to surrounding floodwater. The largest of these in the centre of Emerald contained approximately 7000 people at the time of the peak flood. This area was isolated for between one and two days before water levels dropped.

The Vince Lester Bridge was reopened on 3 January 2011 and by the 7 January the Capricorn Highway between Emerald and Dingo was open as well as the road from Emerald north to Capella and beyond.

Outside Emerald Township five residences in Rolleston, one house in Springsure and Arcadia Valley School were also inundated. Furthermore the water treatment plant at Rolleston was inundated affecting the supply of potable water. A secondary water supply system set up by Council was initiated and restored supply with minimal delay.

Ensham Mine

Ensham Mine is located east of Emerald on the Nogoa River. A system of levees is in place to prevent flooding of the mine as occurred in 2008. There is some concern that the levees may be increasing water levels upstream in the proximity of Emerald. Approximate ground levels near Ensham Mine in the floodplain are 160m AHD. Levels at Emerald are typically around 10m to 20m above this indicating that any backwater influence from the levees are unlikely to impact upon Emerald.

4 PREVIOUS INVESTIGATIONS

Investigations undertaken in the region to date largely relate to previous flood events, in particular that of 2008. This section summarises both the investigations and the key improvements that have come from them.

4.1 Flood Studies

Central and Western Queensland Floods January 2008 – Draft

A report was produced by the Bureau of Meteorology (BoM) on the meteorology and hydrology of the January 2008 floods which affected the region. The report presents recorded rainfall and river flow/level data for the event and summarises the various warnings that were issued by BoM. It does not discuss the impact of the floods or make any recommendations.

Flood Warning System – Post Flood Maintenance Jan 2008

A service report by Greenspan Technology Pty Ltd (Greenspan) on behalf of Emerald Shire Council (now amalgamated into CHRC) into the flood warning gauges followed the January 2008 flooding. It was noted that a number of gauges failed during the flood and the purpose of the site visits was to investigate the reasons behind this. Site visits by Greenspan and BoM were undertaken and it was concluded that a key reason for gauge failure was the automated communication mechanism. Many relied on the mobile phone GSM network which went down at the time of flooding. It was suggested that an independent radio link such as that used by the BoM ALERT system could be used to avoid this problem.

In February 2008 a proposal was provided by Greenspan to Emerald Shire Council to upgrade the flood warning system to an ALERT system³.

Flood Inundation Mapping – Post 2008

The CHRC Community Recovery Program identified flood inundation mapping to be a key task following the 2008 flooding. Areas were identified as 'critical' to map due to 'population size and perceived hazard'. These areas were:

- Selma Road – Fairbairn Dam to Emerald
- Emerald Township
- Nogoia Floodplain - Lower Retreat Ck and Theresa Ck to Nogoia / Comet confluence
- Sapphire township – Graves Hill to approx 1km downstream of bridge over Retreat Ck at Sapphire

Work included detailed investigation of flood levels recorded/observed within Emerald in the January 2008 event.

³ This system was implemented and was operational by July 2010.

Developing Solutions to Flooding in Policeman's Creek, Rubyvale, June 2005

Land prone to flooding from the 1 in 100 year rainfall event was identified and mapped from Policeman's Knob to 600m downstream from the Clermont-Rubyvale crossing. A workshop was arranged with key stakeholders to:

- review previous flood study findings and collected data;
- listen to the experiences of local residents in Rubyvale;
- promote understanding of the problem;
- identify knowledge gaps; and
- develop some solutions to mitigate future flood impacts.

CHRC Flood Audit and Gap Analysis (Proposed)

A proposed study with invitations to tender was issued on 14 December 2010. Following this Council intends to undertake additional studies to address gaps in its knowledge of flood risk.

4.2 Flood Improvements

Following the major flood event of 2008 Council has implemented a number of improvements based on the experiences of that event.

The two principal improvements were:

1. Installation of a flood warning ALERT system in association with BOM which was up and running by 2010. Council staff received training in the operation of the associated Environmon software in August 2010.
2. Improvements to emergency evacuation planning in Emerald. The basis for this came from observations of flood behaviour in 2008 and the extent of inundation.

4.2.1 Flood Warning 'ALERT' Network

A key recommendation arising from the January 2008 flood event was that the flood warning instrumentation and telecommunication to the instrumentation be improved⁴. A proposal was submitted to Council in February 2008 (then Emerald Shire Council) by Greenspan to upgrade and expand the existing rain and river gauges to allow for real-time radio network flood warning service (the ALERT system).

A joint project between CHRC and BOM led to the installation of a number of rain gauges across the district as well as a weather radar located near Emerald. The rain gauges use VHF radio to communicate information in real-time. The radar is well situated to monitor rain bearing weather systems that may affect the catchments and valleys of Lake Maraboon, the Nogoia River and Theresa Creek systems. The ALERT system became operational in July 2010 and has a total of 38 gauging

⁴ Letter from Bill Wilkinson, Department of Natural Resources and Water, August 2008.

stations across the Nogoia, Comet and Mackenzie catchments (22 rain gauges and 16 rain/river combination gauges).

Following implementation of the ALERT Network Council has since sought to improve the spatial resolution of the gauging network. In November 2010 it received confirmation from the Natural Disaster Resilience Funding Program (NDR2) that funding had been secured for additional river and rain ALERT gauges in the Upper Comet catchment. This includes an additional two gauges in the Rolleston area enabling improved forecasting for townships such as Rolleston along the Comet River.

4.2.2 Emergency Planning

A significant amount of effort was undertaken by Council to map the extent and depths of flooding for the event of 2008. This allowed emergency planning and in particular the siting of Emergency Evacuation Centres to be reviewed. The 2008 flood event saw seven evacuation zones established in Emerald. In 2010 the number was reduced as based on observed flood extents in 2008 the higher number was not needed and simplification of the system was sought to aid communication to the public.

4.2.3 Other Improvements

Other improvements implemented following the January 2008 flooding were:

- Local drainage within Emerald was improved through maintenance of the local watercourses. Specifically, a co-ordinated burn off of the LN1 drain within Emerald was undertaken in a coordinated effort by Council and Sunwater in August 2010. Furthermore the Local Disaster Coordinator requested that Sunwater undertake maintenance to remove any obstructions to flow. Emphasis was placed on the LN1 drain within Emerald and maintenance was undertaken following both events in December 2010.
- An emergency services map was prepared by the LDMG for the Gemfields area. Community consultation was undertaken on this in August and November 2010.
- Council and State acted to remove old spoil heaps which were partially blocking Policemans Creek downstream of Rubyvale.

5 FLOOD WARNINGS

The majority of flood warnings were issued by the LDMG with the advice of BOM. The BOM website will have also detailed the key warnings. ABC Radio was on site to facilitate the issue of warnings. Warnings were put on the Council website and also distributed for display in key businesses thought to be visited by local residents.

On Selma Road immediately downstream of Fairbairn Dam an additional warning arrangement between Sunwater and local residents is in place as part of the dams Emergency Action Plan (EAP). If water over the spillway is above 1.5m then local residents are advised that evacuation may be required.

Table 5-1 presents the flood warnings issued along with issuer and method.

Table 5-1 Flood Warnings Summary

Date/Time	Warning Summary	Issuing Authority	Method of Issue
26/12/2010	Briefing note by LDMG following rainfall over previous 24h. Dam at 1.87m over spillway and not expected to go above 2m. Further rainfall predicted	LDMG	Website and posters in town
27/12/2010 Early am	Local residents advise LDMG of rising floodwaters in upper Nogoia catchment	NA	NA
27/12/2010 Early am	LDMG notify residents in areas at risk	LDMG	Telephone
27/12/2010 11:00	BOM advise that Emerald is facing a minor flood level of just under 3.5m over the spillway in next 72h. Levels expected to peak in Emerald at 14m if no further rain.	LDMG/BOM	Website and posters in town
28/12/2010 12:58	BOM predict flood levels in Emerald will reach those of 2008	LDMG/BOM	Website and posters in town
29/12/2010 7:30	Advice to residents that Vince Lester Bridge will close at 14:00. Nogoia River water level expected to peak at midday on Fri 31 December at 300mm above 2008 level	LDMG/BOM	Website and posters in town
30/12/2010 6:30	Expected peak at bridge is 16.2m on Friday at 0.8m above 2008 level.	LDMG/BOM	Website and posters in town
30/12/2010 18:00	Expected peak at 16m around midnight, 0.6m above 2008 peak. Levels are expected to peak in northern Emerald at 6am on 31 December.	LDMG/BOM	Website and posters in town
31/12/2010	Nogoia peaked at 16m at 23:30 on 30 December	LDMG/BOM	Website and posters in town

In addition to the warnings provided in Table 5-1, the LDMG also issued warnings and updates via SMS Texts. This was the first occasion the LDMG had attempted this and in the post flood feedback anecdotal reports suggest it was well received by the public.

Table 5-2 lists the SMS warnings provided.

Table 5-2 SMS Alerts Issued by LDMG

Date / Time	Message Content
28/12/2010 12:58	WARNING: Emerald area residents. Flooding to reach 2008 levels & close Vince Lester Bridge late Wed. afternoon. Evacuation notices to effected residents will follow. Mayor P Maguire
28/12/2010 17:56	Flood info from CHRC – Situation continually monitored – Vince Lester Bridge expected to close Wed PM-Emerald evacuation centres open – Town Hall today & Ag College Wed. Mayor Peter Maguire
29/12/2010 09:14	Vince Lester Bridge closed by 2pm today. Flood equal to 2008 by Thursday. Expected to go higher by Friday. Evacuations will be necessary. Contact CHRC. Mayor Peter Maguire.
29/12/2010 10:02	Flood info from CHRC – Flood at Emerald same level as 2008 at 2am Thurs – Latest estimate flood peak Fri am – up to 0.5metres higher than 2008. Mayor Peter Maguire
30/12/2010 07:07	Urgent flood info for all Emerald residents from CHRC. Please make emergency preparations. Expected peak at bridge 16.2m which is 0.8m above 2008 level
30/12/2010 10:01	Advice from CHRC, residents wishing to get vehicles to high ground proceed to SES complex, Emerald Downs Hill, Capella Road. Bus will transport back. Mayor Peter Maguire
03/01/2011 07:31	CHRC Advice: Relevant info on insurance & cleanup supplies available on Council website or at Council office. Go to www.chcr.qld.gov.au or ph:1300242686. Mayor Peter Maguire

5.1.1 Flood Warning Maps

Using information obtained from the post 2008 flood analysis Council prepared maps of estimated inundation extent in Emerald. The first such map was issued on 27 December (through the Council website and distributed to areas likely to be inundated). A second, updated map was prepared and distributed on the final flood warning on the 30 December.

6 SUMMARY OF FINDINGS

In summary, our investigation has found the following:

- CHRC saw the largest floods on record across much of its Region during December 2010 and January 2011. In particular, the Nogoa River floods which peaked in Emerald on 31 December 2010 caused significant property inundation.
- In general two separate flood events can be described. The first was caused primarily by heavy rain in the west of the CHRC area on the 2/3 December impacting on levels in Retreat and Theresa Creeks. The second was caused by extremely heavy rain in the south and south western parts of the district which primarily affected the Nogoa River. This second event led to the flooding in Emerald.
- Fairbairn Dam is located approximately 18km upstream from Emerald. Due to heavy rain in both November and December 2010 this was full before the floodwater passed through it in late December 2010.
- Flooding in Emerald was the largest on record peaking at a gauge height of 16.05m. This compares to the previous record in 1950 of 15.70m. Approximately 80% of the town was inundated with more than 1000 homes flooded.
- Flooding was experienced at Rolleston, Comet, the Gemfields area and at Bluff.
- Ensham Mine, 40km east of Emerald was not flooded like it was in 2008. A system of levees is in place to keep floodwaters from entering the open cut mine. The levees are unlikely to hydraulically impact on Emerald which is at an elevation of approximately 10m to 20m above the floodplain near the mine.
- Councils flood warning system was updated following the major floods of January 2008. The update was to an ALERT system which provides real time information through reliable communications networks. The system allowed for monitoring of rainfall and river levels in the upper catchments and for forecasts to be issued on a daily basis.
- Positioning of evacuation centres in Emerald was updated using knowledge gained from the 2008 event.

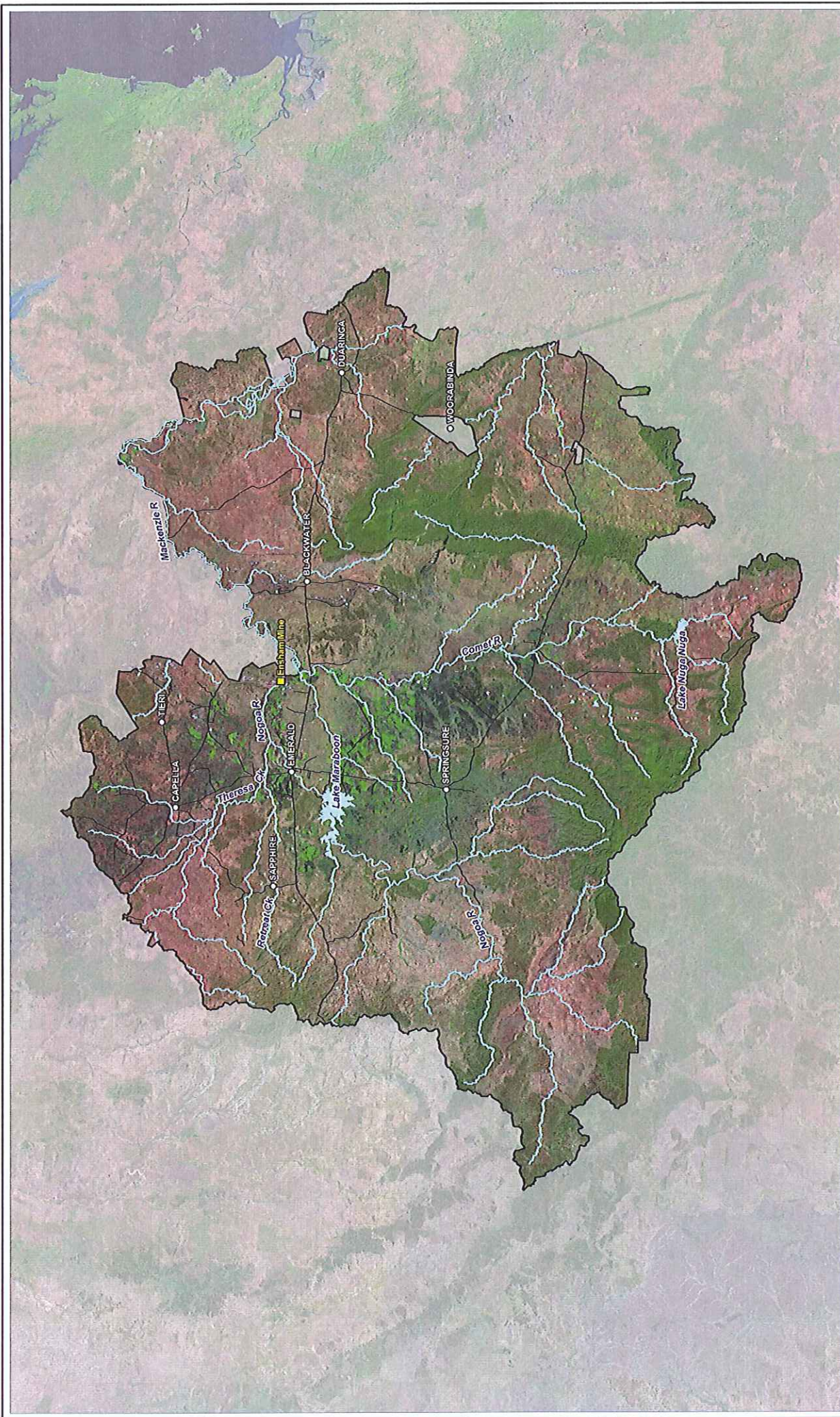
7 REFERENCES








Bureau of Meteorology, 2010, Monthly Weather Review, Queensland November 2010.

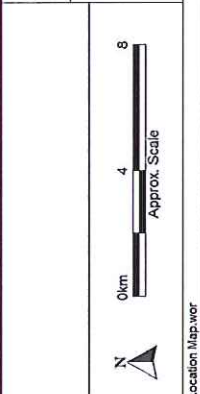
Bureau of Meteorology, 2010, Monthly Weather Review, Queensland December 2010

Rockhampton District Disaster Management Group Debrief Plan. Central Highland and Rockhampton Flood Event, December 2010 to January 2011.

8 FIGURES



<p>Figure: 2-1</p> <p>Rev: A</p>  <p>www.bmtwbm.com.au</p>	<p>Title: Locality Map Central Highlands Regional Council</p> <p>BMT WBM endeavours to ensure that the information provided in this map is accurate, but does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.</p> <p>Filepath: \\B:\18317_1_BRH\DRG\FID_025_110509_Central Highlands Regional Council Locality.wer</p>	<p>LEGEND</p> <ul style="list-style-type: none">  Central Highlands Regional Council Boundary  Lake, Reservoir  Major Watercourse  Main Road  Ensham Mine <p>0km 25 50 Approx. Scale</p> <p>N</p> 
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Title: Emerald Locality Map

BMT WBM endeavours to ensure that the information provided in this document is accurate at the time of publication. BMT WBM does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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LEGEND

-  Major Watercourse
-  Main Road
-  Railway

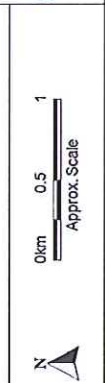




Figure: 2-3

Title: Emerald Map

Rev: A



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- LEGEND**
- Major Watercourse
 - Railway
 - Cadastro



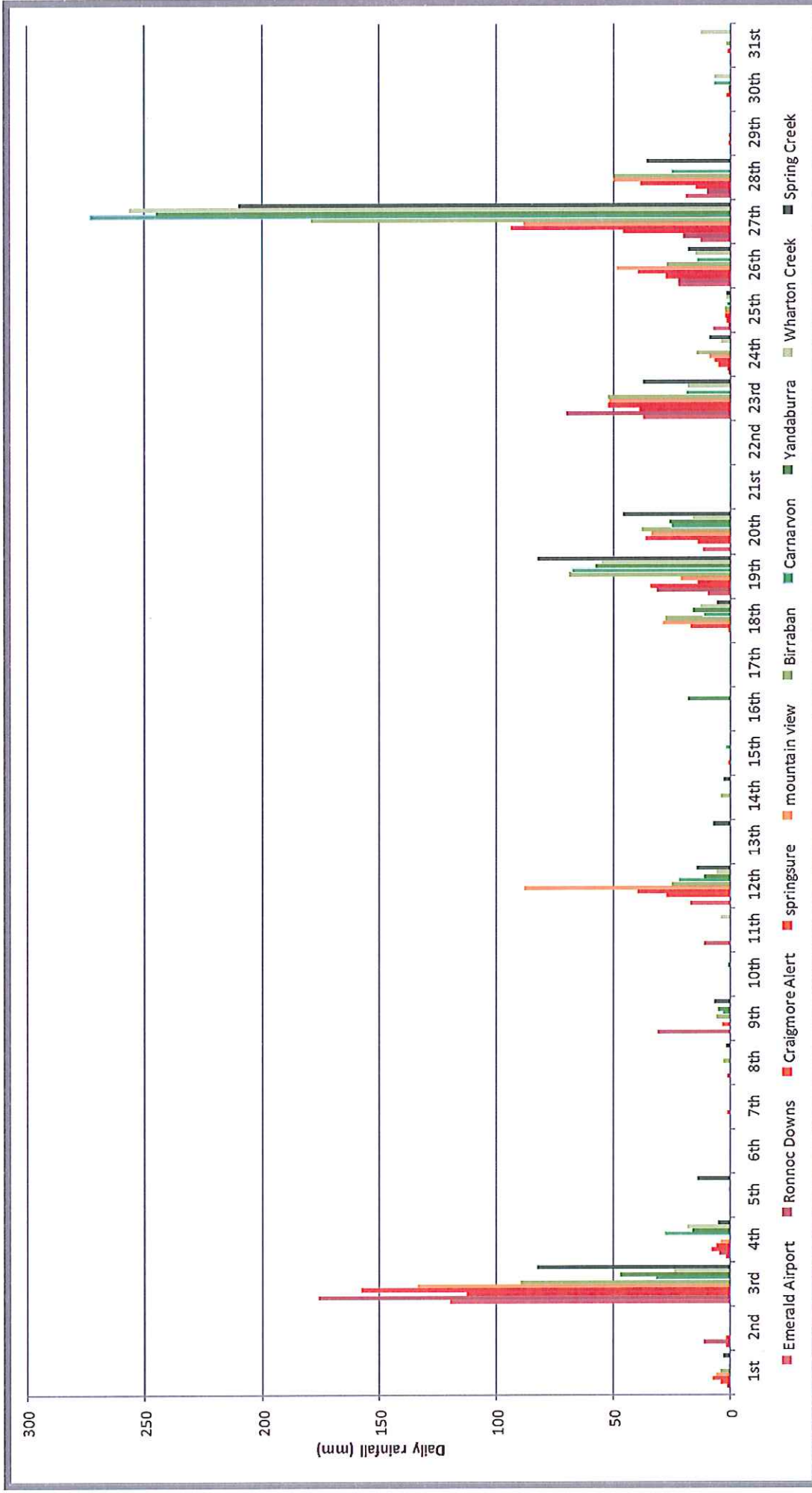


Figure: 3-1
Rev: A

Title: December 2010 Rainfall Plots

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Filepath: I:\B18317_L_BRH\DRG\FID_027_110518_Emerald_Plots.wor

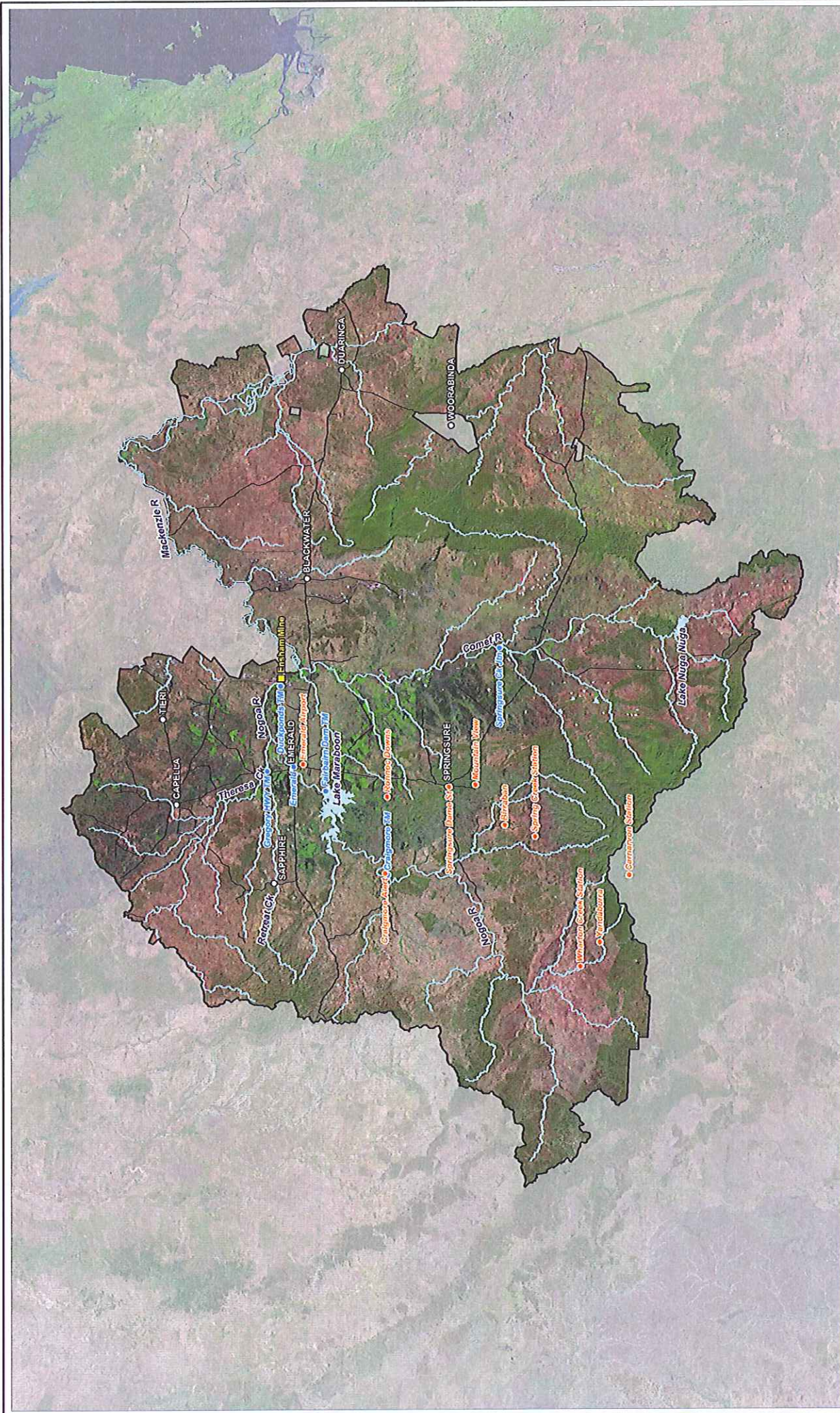


Figure: 3-2
Rev: A



Title: Gauging Network
Central Highlands Regional Council

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- LEGEND**
- Rainfall Gauge
 - River Gauge
 - Emerald Dam
 - Central Highlands Regional Council Boundary
 - Lake, Reservoir
 - Major Watercourse
 - Main Road



Nogoa River @ Emerald

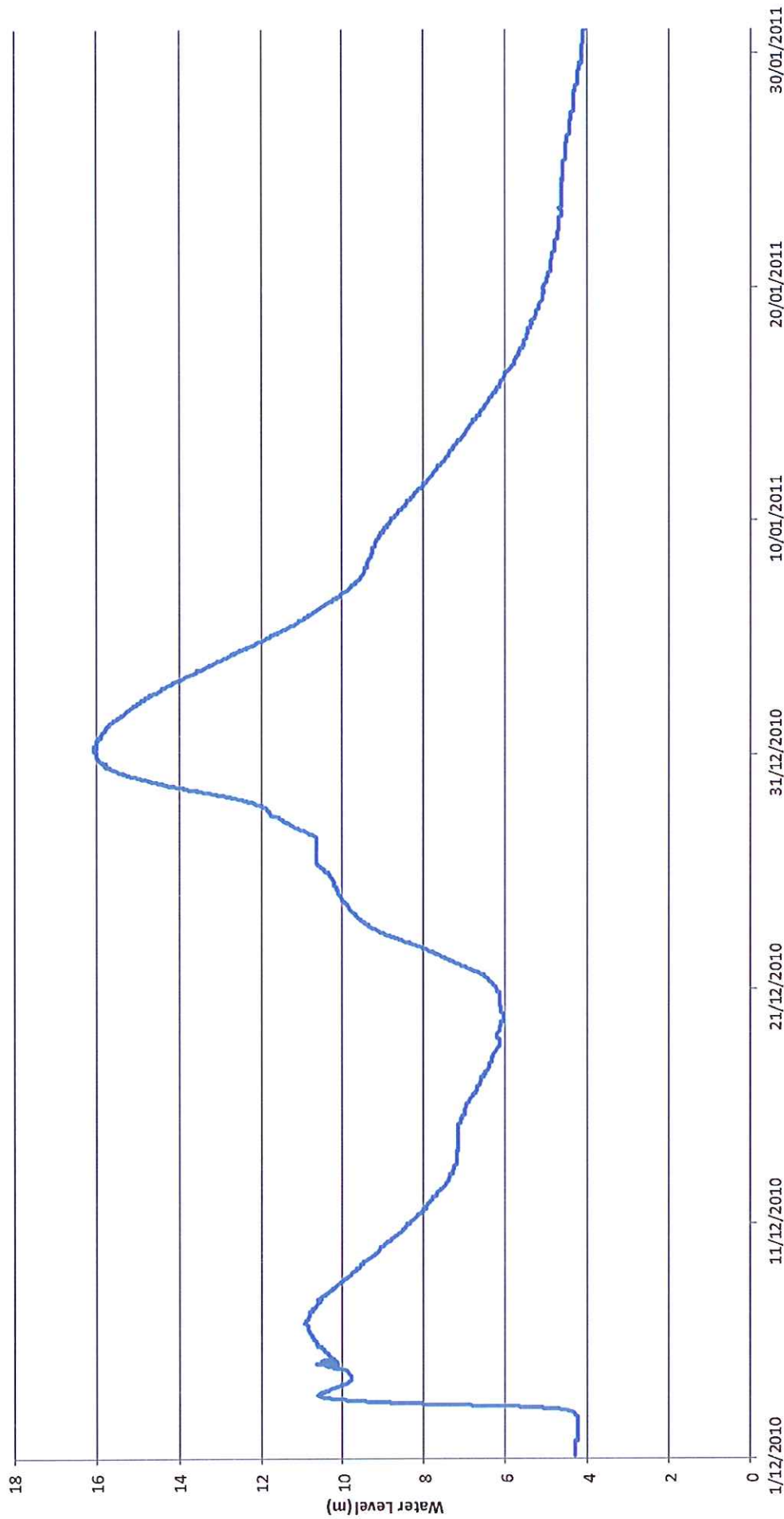


Figure: 3-3a
Rev: A

Title: **Nogoa River at Emerald Alert**

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Nogoa River at Craigmore Alert

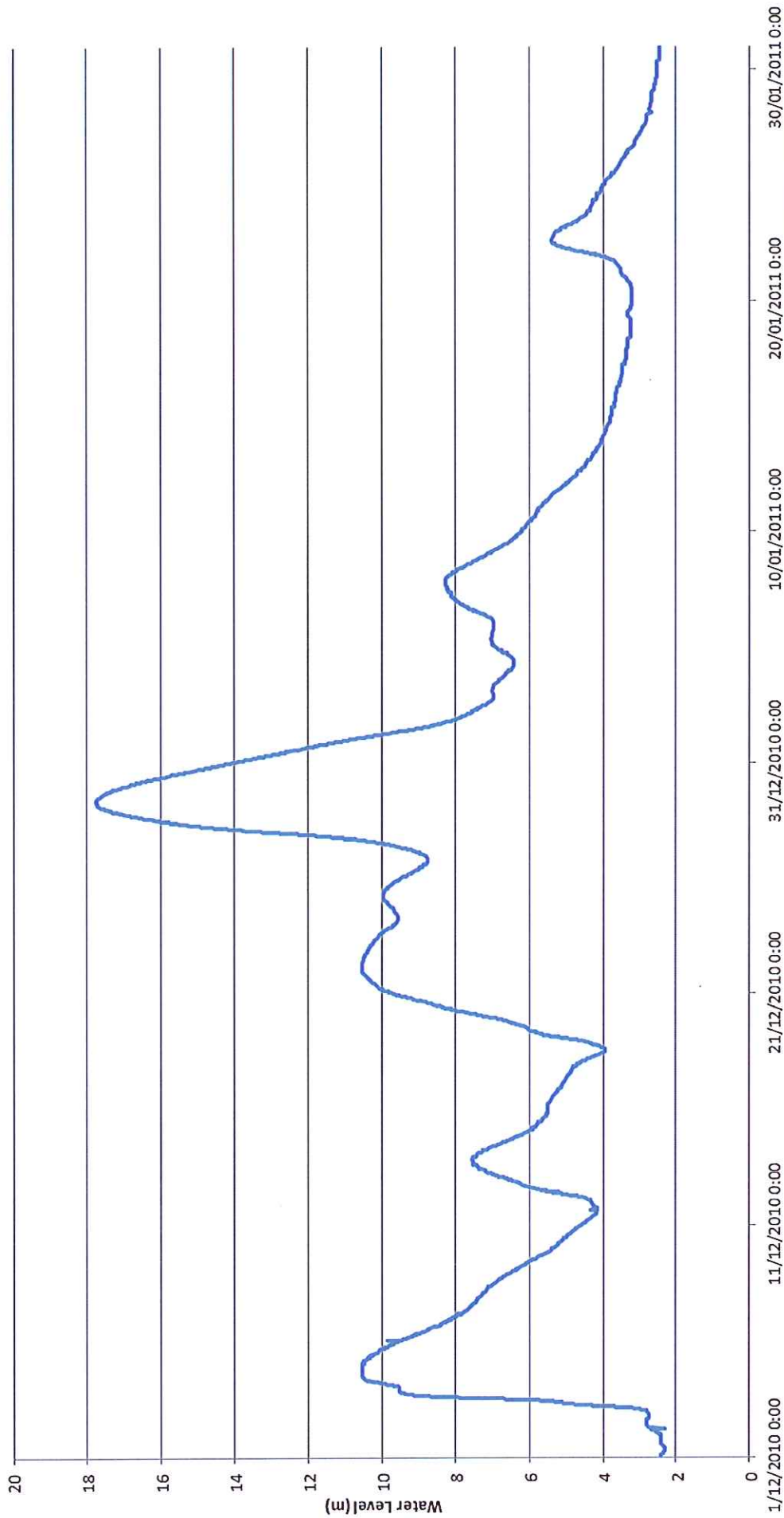


Figure: **3-3b**
Rev: **A**

Title: **Nogoa River at Craigmore Alert**

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Filepath: I:\B18317_BRH\DRG\FLD_027_110518_Emerald_Pics.wor

Fairbairn Dam Alert

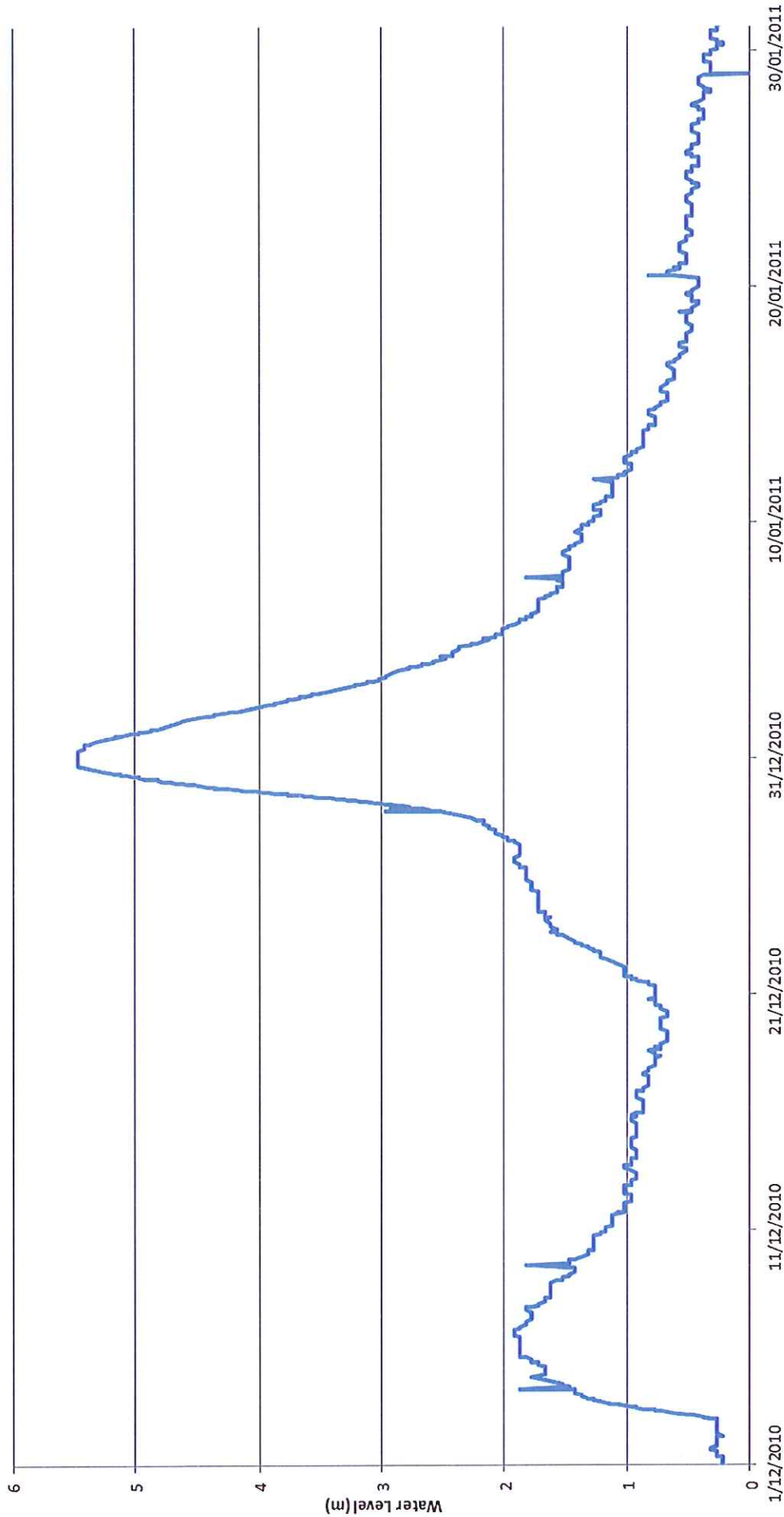


Figure: **3-3c**
Rev: **A**

Title: **Fairbairn Dam**

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Theresa Creek @ Gregory Highway Alert

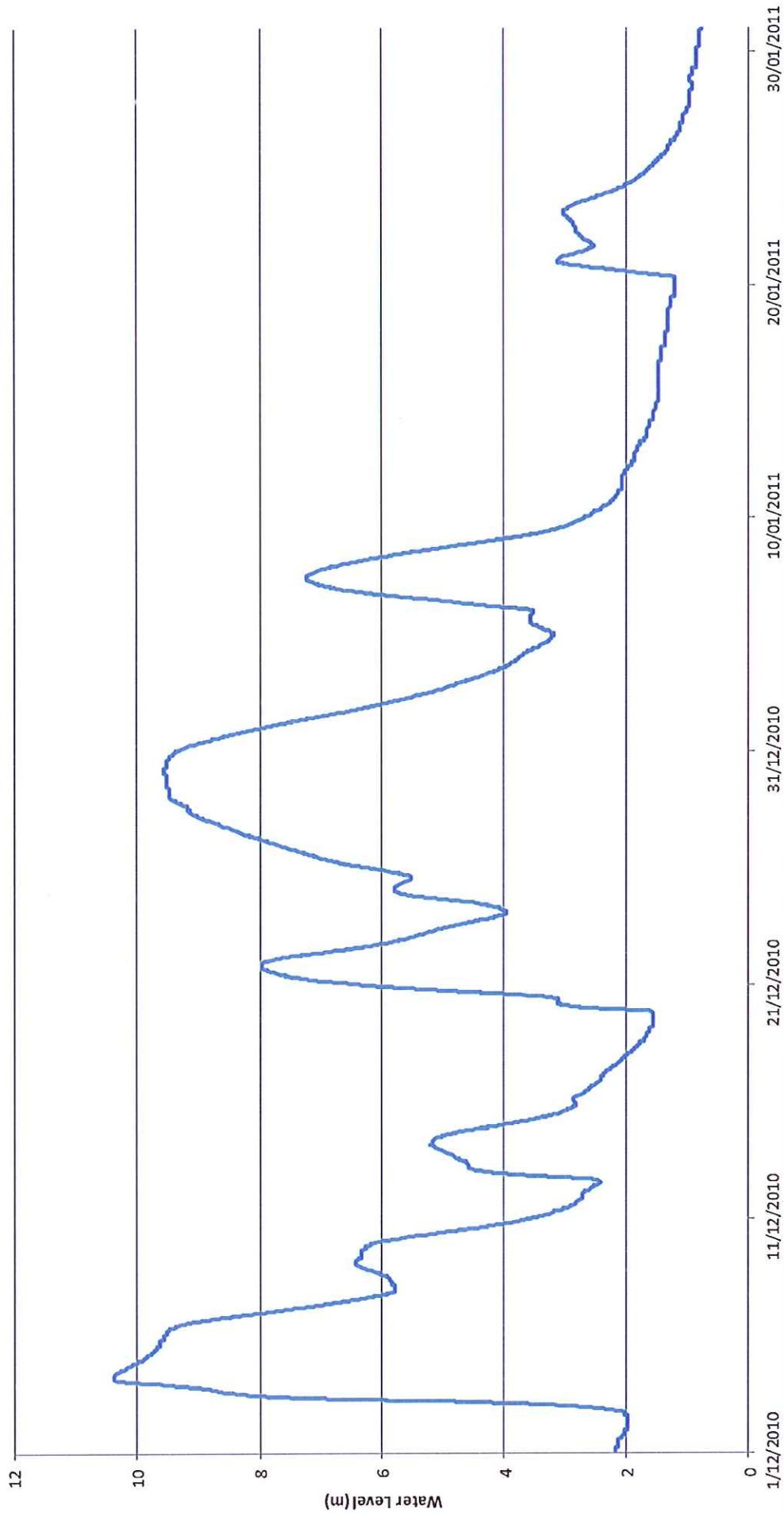


Figure: 3-3d
Rev: A



Title: Theresa Creek at Gregory Highway

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Filepath: I:\B18317_BRH\DRG\FLD_027_110518_Emerald_Pics.wor

Nogoa River @ Duckponds Alert



Figure: **3-3e**
Rev: **A**

Title: **Nogoa River at Duckponds Alert**

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APPENDIX A: CURRICULUM VITAE OF NEIL IAN COLLINS

Neil Ian Collins

Position	Principal Hydraulic Engineer – Expert Services
Years of Experience	31
Professional Affiliations	PIANC NPER-3 RPEQ
Qualifications	Master of Science Engineering, University of Queensland Bachelor of Engineering (Civil) University of Queensland
Recent Employment Profile	2010 to Present BMT WBM Pty Ltd – <i>Principal Hydraulic Engineer - Expert Services</i> 2007 to 2010 Gilbert & Sutherland Pty Ltd – <i>Principal Hydraulic and Water Resources Engineer</i> 2004 to 2007 Cardno Lawson Treloar – <i>Director, Queensland Manager</i> 1993 to 2004 Lawson Treloar - <i>Director</i>

Career Overview

Neil is BMT WBM's Principal Hydraulic Engineer; part of the Expert Services team, based in our Brisbane office. He has 31 years experience and is an acknowledged expert in the P+E, Land Court and Supreme Court of Queensland in flooding, water quality and coastal processes. He was also the independent hydraulic expert to the Queensland Government for the North Bank project. Neil has worked on major infrastructure projects as an Hydraulic Specialist including Sydney Third Runway, Sydney Harbour Tunnel, Gateway Bridge and Arterial and several coal ports in Queensland and in Indonesia, power stations in Queensland and Thailand, hydro-electric schemes in PNG and port dredging management at Cairns, Townsville, Weipa and Mackay.

Areas of Expertise

Hydraulics, Hydrology and Water Resources

Provision of Expert Witness Services in Flooding, Stormwater, Quality Control and Coastal Engineering

Summary of Major Projects

- Lauderdale Quay, Hobart – Coastal Hydraulics, Water Sediment Quality for IIS on a Major Marina Residential Reclamation Project.
- Brisbane Airport - International Terminal Drainage Design.
- Sydney Harbour Tunnel - Hydraulics Engineer for Immersed Tube Tow and Placement.
- Sydney Third Runway - Hydraulic Model Testing, Sea Wall Design and Environmental Management.
- Gateway Arterial - South East Freeway to Lytton Road - Civil and Hydraulic Design Manager.
- Gateway Bridge - Hydraulics and Approaches Services Relocations.
- Trade Coast Central - Flooding Review for BCC.
- Oak Flats to Yallah RTA Freeway Hydraulics.
- Kedron Brook Flood Impacts due to Airtrain.
- Tully and Murray River Floodplains Hydraulic Analysis and Modelling, for Drainage Scheme Design includes Large MIKE11 Modelling, with over 40 Bridges and 200 Channels.
- Expert Review - Mossman Daintree Road, Saltwater Creek Crossing: Independent Review of the Hydraulic Design of two Large Bridges.
- Hydraulic Design of Rock Armouring Works for the Barron River Bend at Cairns Airport.
- Eastern Corridor Study - Hydraulics and Hydrology investigation for Department of Transport.
- Relief Drainage Scheme Design for Albion Windsor Area Brisbane (Capital cost \$2 million).
- Tarong Power Station - Design of Earthfill Dam (max. 23m height), Ash trench, Stormwater Diversion Channels.

Professional History

BMT WBM Pty Ltd

Principal Hydraulic Engineer providing expert witness services in flooding, stormwater, quality control and coastal engineering.

Gilbert & Sutherland Pty Ltd

Wet 'n' Wild, Sunshine Coast – site and soil assessments, input to and review of AGE groundwater assessment, conceptual stormwater quality assessment, hydraulic and flooding assessments including yield, medli modelling for onsite and input to S&B water balance, contamination investigation.

- Stockland, Twin Waters – Flooding Assessment
- Mackay Boat Harbour – Wave Investigation
- Bourton Road, Alkira – Flooding and Stormwater Management Plan
- The Glades, Robina – Water Quality Compliance and Inspection Report

Expert Services:

2007: Truloff Pty Ltd -v- Gold Coast City Council
2008: Jimboomba Turf Co Pty Ltd -v- Logan City Council
2008: Lechaim -v- Gold Coast City Council
2008: Sunnygold International Pty Ltd -v- Brisbane City Council
2008: Bon Accord -v- Brisbane City Council
2008: Blue Eagle -v- Beaudesert Shire Council
2008: Brian Paddison -v- Redland Bay Shire Council
2008: Monarch Nominees -v- Brisbane City Council
2008: Kunda Park Pty Ltd -v- Maroochy Shire Council
2008: Owl Projects & Hyder -v- Gold Coast City Council
2008: Port Pacific Estates Pty Ltd -v- Cairns Regional Council
2008: Joanne Shepherd & Ors -v- Brisbane City Council
2009: Lenthalls Dam, Hervey Bay
2009: Testarossa -v- Brisbane City Council
2009: Heritage Properties & Ausbuild -v- Redland City Council
2009: Samantha Skippen -v- Miriam Vale Shire Council
2009: Anthony Wan Pty Ltd -v- Brisbane City Council
2010: Over 25 appeals in progress this year

Professional History (cont)

Cardno Lawson Treloar

Sovereign Waters, Wellington Point - flooding, tidal exchange and water quality management.

EMP Water Quality Management Plan preparation and site stormwater management, including hydrodynamic, advection/ dispersion and catchment pollutant yield modelling for:

- Emerald Lakes Project, Carrara
 - Glenwood Estate, Mudgeeraba
 - 'The Glades' (Greg Norman Design Course), at Robina
 - Sovereign Waters, Wellington Point
 - Pacific Palisades, Gavin
 - Freshwater Valley Estate, Cairns
 - Carrara Golf Course Re-development, Carrara
 - The Broadwater Development, Mudgeeraba
 - Over a Dozen Major Residential Development Projects.
-
- Full Two-dimensional (MIKE 21) Floodplain Modelling for Cairns Airport Inundation, Nerang River Floodplain and Martins Creek, Maroochydore.
 - Noosa River System Flood Study: Includes full G.I.S. Interfacing, Colour Inundation Plan Production and MIKE11 Modelling.
 - Detention Basin Design for Development Consulting, Calamvale, Brisbane: Hydrologic and Hydraulic Design using RAFTS.
 - Hydraulic and Water Quality Design, Lucinda Drive Main Drain, Port of Brisbane, including Catchment Pollutant Runoff Management.
 - Moreton Bay College Flood Investigation: MIKE11 Analysis of Flooding, Including Culvert and Channel Diversion Options.
 - Input on EIS Report on Water Quality for Freshwater Valley Development, including EMP.
 - Townsville Port Road and Rail Access Study - Hydraulics.
 - Freshwater Creek Flooding, for Main Roads, included Bridge and Culvert Sizing and Positioning of Channel Training Works. (RORB/RUBICON).
 - Mountain Creek Flooding Investigation Examination of 1992 Floods using detailed Hydrologic/Hydraulic Modelling and Design of Mitigation Works.

Expert Services:

- 2004: T.M. Burke Appeal
- 2004: East Point Mackay
- 2004: Dore Appeal
- 2004: 900 Hamilton Road, McDowall
- 2004: Milton Tennis Centre
- 2005: P&E Appeal Mount Samonsvale
- 2005: BCC & George Pasucci
- 2005: P&E Appeal 48 Comley Street Sunnybank
- 2005: P&E Appeal 398 Wondall Road, Tingalpa
- 2005: Cabbage Tree Creek Appeal
- 2006: 35 Suscatand Street, Rocklea Appeal
- 2006: Leong - v- Redland Shire Council Appeal
- 2006: Barry Hilson & Bach Pty Ltd - v- GCCC Appeal
- 2006: 57 Longhill Road Appeal
- 2006: 699 Bargara Road Appeal
- 2006: Chevellum Road Appeal
- 2006: 10 Karridawn Street, Nudgee Appeal
- 2006: Australian Hardboards Limited Appeal
- 2006: Dell Road and Hawkin Drive, St Lucia Appeal
- 2006: 106 Munro Street, Auchenflower Appeal
- 2006: 10 Adsett Road, P&E Appeal
- 2006: Saunders Creek Appeal
- 2006: 64, 70 & 74 Washington Avenue, Tingalpa

Professional History (cont)

Lawson Treloar

- Coastal Data Gathering and Analysis for Projects in Bali, Lombok and Malaysia.
- Pandorah Gas Project, Gulf of Papua. Neil was Responsible for Project Management of all Coastal and Oceanographic Aspects of this Project, including Preparation of the Relevant Components of EIS. This included Extreme Climate, Wind/Wave and Current Modelling.

Chevron PNG to Cape York Gas Pipeline Project, Gulf of Papua

Neil Carried out Project Management for all Coastal/Oceanographic Components of this Project, including:

- Wind/Wave Modelling
- Extremal Climate
- Bed Current Prediction
- Kumul Platform Berthing
- Endeavor Passage Landfall
- Wave, Current and Wind Data Gathering.
- Tidal Lagoon, Breakwater/Groynes, Water Quality and Quantity Management at Pecatu Indah Resort, Lombok.
- Marina and Reclamation, S-W Bali, (Putri Nyale) including Coastal Investigations and Hydraulic Design of Breakwaters and Revetments.
- Sediment Sampling and Monitoring Program for the Albatross Bay Dumpsite, Weipa, for Dept. of Transport. Job Manager for this Investigation which includes Monitoring of Movement of Material Following Dumping, and its Impact on Water Quality and Benthic Communities.
- Wellington Point Canal Estate - Coastal Hydraulic Investigation of Proposed Marina and Dredged Channel.
- Weipa, Embley Inlet Environmental Monitoring: Review and Planning for Long Term Monitoring and Assessment of Water Quality (for Comalco).
- Full 2D flooding assessments for Dept of Main Roads using MIKE 21 on Yarrabah, Cairns and Warrego Highway at Marburg.
- Current Profiling, Warrego River (1994).
- Sovereign Waters, Wellington Point - Flooding, Tidal Exchange and Water Quality Management.
- Responsible for all Flood and Water Quality aspects for several Gold Coast Projects, including Emerald Lakes, Nifsan's Glenwood and Broadlakes, including Lake, Wetland and EMP Design.
- Stream Diversion, including Sloping Drop Structure, Hydraulic Design, at 'Coops' Development, Brisbane (1993).
- Northumbria Lakes Estate, Flooding, Drainage, Gross Pollutant Trap and Trash Rack Modelling and Design (1994).
- Barron River Delta Prawn Farm I.A.S., including Flooding and Water Quality Monitoring and Modelling, using MIKE11 (1995).
- Hydraulic Manager for Cairns Airport Master Drainage Study, 1995, including Complex Hydrodynamic Flow and Catchment Management Analysis.

Expert Services:

- 1993: for Mulgrave Shire Council; Land Resumption Compensation Case in Land Court. (Flooding)
- 1993: for Mulgrave Shire Council; Development Appeal (Kamerunga Villas) in Planning and Environmental Court. (Flooding)
- 1994: for Pullenvale Residents Action Group, on Rezoning Appeal. (Flooding and Water Quality)
- 1994: for Development Consulting, on Rezoning Appeal for a Development with a Large Detention Basin at Calamvale. (Flooding and Drainage)
- 1994: for an Earthworks Contractor Regarding a Disputed Claim Over Levee Bank Construction at Mungindi. (Flooding)
- 1995: for a Developer on Bohle River Works. (Flooding and Water Quality)
- 1995: for Residents on Flooding, Murrumba Downs. (Flooding)
- 1995: for Residents on Flooding, Dayboro. (Flooding)

Connell Wagner

- Current Profiling, Warrego River (1994).
- Sovereign Waters, Wellington Point - Flooding, Tidal Exchange and Water Quality Management.
- Responsible for all Flood and Water Quality Aspects for several Gold Coast Projects, including Emerald Lakes, Nifsan's Glenwood and Broadlakes, including Lake, Wetland and EMP Design.
- Stream Diversion, including Sloping Drop Structure, Hydraulic Design, at 'Coops' Development, Brisbane (1993).
- Northumbria Lakes Estate, Flooding, Drainage, Gross Pollutant Trap and Trash Rack Modelling and Design (1994).
- Barron River Delta Prawn Farm I.A.S., including Flooding and Water Quality Monitoring and Modelling, using MIKE11 (1995).
- Hydraulic Manager for Cairns Airport Master Drainage Study, 1995, including Complex Hydrodynamic Flow and Catchment Management Analysis.
- Tarong Power Station. Design of earthfill dam (max. 23m height), Ash trench, Stormwater Diversion Channels.
- Callide B Power Station. Evaporation Ponds Simulation; Hydraulic Design and Stormwater Bypass Channel. Design of (25m) Ash Dam.
- Hay Point Multi-User Coal Export Facility. Design of Dams, Stormwater Drainage, Water Supply and General Civil.
- Townsville Container Terminal. Design of Stormwater Drainage and General Civil.
- Abbot Point Coal Terminal. Design of an Offshore Causeway.
- Subdivisional Design and Supervision, on over a dozen Projects.
- Bulk Sugar Terminal - Brisbane. Feasibility Studies, including Flooding.
- Gladstone Power Station. Ash Handling including Piping.
- Stanwell Power Station. Design Check on General Civil.
- Patrick Container Terminal - Port of Brisbane. Flooding and General Civil.

Expert Services:

- 1993: for Mulgrave Shire Council; Land Resumption Compensation Case in Land Court. (Flooding)
- 1993: for Mulgrave Shire Council; Development Appeal (Kamerunga Villas) in Planning and Environmental Court. (Flooding)
- 1994: for Pullenvale Residents Action Group, on Rezoning Appeal. (Flooding and Water Quality)
- 1994: for Development Consulting, on Rezoning Appeal for a Development with a Large Detention Basin at Calamvale. (Flooding and Drainage)
- 1994: for an Earthworks Contractor Regarding a Disputed Claim Over Levee Bank Construction at Mungindi. (Flooding)
- 1995: for a Developer on Bohle River Works. (Flooding and Water Quality)
- 1995: for Residents on Flooding, Murrumba Downs. (Flooding)
- 1995: for Residents on Flooding, Dayboro. (Flooding)
- Expert Services for Phillips Fox; Caboolture Shopping Centre Extension Appeal in Planning and Environment Court. (Flooding)
- Expert Services for Mulgrave Shire Council; Land Resumption Compensation Case in Land Court. (Flooding)
- Expert Services for Mulgrave Shire Council; Development Appeal (Kamerunga Villas) in Planning and Environmental Court. (Flooding).

Papers/Publications

May 2007 QELA Conference Presentation – The Approval and Appeal Process in QLD and NSW, Experts view on soil and water issues.

Nov 2004 Publication - 'Application of Australian Runoff Quality Draft Chapter 6 – A model approach', Water Sensitive Urban Design Conference, 2004, Adelaide.

Jul 2004 'Integrated High Order Water Quality and Hydrodynamic Analysis', 8th National Conference on Hydraulics in Water Engineering, July 2004.

Nov 2002 Publication - 'Hervey Bay Storm Surge', 30th PIANC Congress, Sydney 2002.

Nov 2001 'The Use of Runoff Event Monitoring in Validating Sediment Control Measures', 9th Annual Conference, International Erosion Control Association, Nov 2001.

Nov 2001 'Specialist 2D Modelling in Floodplains with Steep Hydraulic Gradients', 6th Conference on Hydraulics in Civil Engineering, Nov 2001.

Mar 2001 'Planning Implications of New Technology in Floodplains', RAPI Conference, Gold Coast, 2001.

Nov 1999 'Best Management Practices for Water Quality Control', and 'Zero Flooding Impact Assessments; the need for full two dimensional analysis', 8th International Conf. on Urban Stormwater Drainage, 1999.

Jul 1999 'Desktop Ship Simulation for a new Port Facility in The Gulf of Papua', Coasts and Port '99.

Mar 1997 'Implications of the Nifsan -v- G.C.C.C. ruling on floodplain hydraulics', Qld Envir. Law Assoc., 1997.

Jul 1994 'What the Community Needs to Know – Approaches to Community Construction for Water Engineering Projects', I.E. Aust., Queensland Division, 1994.

Nov 1993 'Hydraulic Assessment of Floodplain Development: Case Studies', The Institute of Municipal Engineering, Goondiwindi, 1993.

Jul 1993 'Long Term Environmental Planning – Weipa Port Dredging', 11th Australasian Conf on Coastal and Ocean Engineering. Townsville, 1993.

Mar 1993 'Integrated Hydrologic and Hydraulic Modelling', WATERCOMP '93. The Second Australasian Conference on Technical Computing.

Mar 1992 'Russell and Mulgrave River Catchment Management', Invited Guest speaker for Queensland River Trusts Conference, Cairns, 1992.

Nov 1990 'Recent Studies of Port Dredging and Offshore Spoil Dumps', Third Australasian Port and Harbour Conference 1990, IE Aust.

Aug 1990 'Barron River Airport Bend Study - An Exercise in Joint Numerical and Physical Modelling', Conf. on Hyd. in Civil Eng., 1990, IE Aust.

May 1989 'Comparison and Evaluation of Current Dynamic Flow Models', WATERCOMP '89. The First Australasian Conference on Technical Computing in the Water Industry, Melbourne, 1989.

May 1989 Publication - Dynamic Flow Modelling : Comparison and Evaluation of Current Models - final Report', ACADS International publication No. U-249, May 1989.

May 1988 'Comparison of Dynamic Flow Models', ACADS 2D Modelling of Flood Plains, Melbourne, 1988.

Jun 1985 'ACADS Project on Comparison of Unsteady Flow Models', ACADS workshop, Brisbane 1985.

APPENDIX B: EMERGENCY PLANNING RESPONSE SUMMARY

Key features in the emergency planning response are provided below. The features are documented by flood event. This is not an exhaustive account but is intended to summarise the decision making process.

Event 1

Following the rainfall of the 2-3 December 2010 which fell heaviest in areas to the west of the Gemfields area the Gemfield SES group leader notified the SES Local Controller and the Local Disaster Coordinator around 2am. The notification was regarding rapidly rising floodwaters in the Sapphire area. A Local Disaster Management Group meeting was called and landowners on properties immediately downstream from Sapphire to Emerald were telephoned between 3:30am and 5:30am. Other landholders likely to be affected further downstream were then telephoned. The LDMG also met that afternoon and again on 4 December and the decision made was not to proceed to full activation of the group.

On 10 December 2010 the Councils CEO set out a message to all managers to be proactive in preparing for the floods. A number of measures were then taken by Council to help prepare towns such as Emerald for the event of future flooding;

- Sandbags were stockpiled for communities at Rolleston, Gemfields and Emerald;
- The LDMG assisted in the placing of sandbags by strategically ensuring that known vulnerable areas, particularly those affected by flooding in 2008 were supplied
- Checks and servicing were undertaken on flood forecasting gauges (both rainfall and river gauges)
- Residents of Selma Road (immediately downstream of Fairbairn Dam) were advised by the Local Disaster Coordinator as to what water level over the dam spillway would begin to inundate their property.
- Council established a car park on top of Emerald Downs Hill approximately 5km to the north of Emerald. Residents were encouraged to take their vehicles there and then have free transport back into Emerald
- The Coordination Centre in Emerald (Council Board Room) was set up on 24 December 2010 in anticipation for a likely flood event;

Event 2

Following the rainfall on the night of the 26/27 December 2010 the LDMG met in the early morning of the 27th and the Group was activated at 12pm later that day with the DDMG notified. The group consequently met on a daily basis up to the 5 January when the group was deactivated.

Key activities of the group included media alerts, teleconferences with BOM and Sunwater and issuing of flood warning updates via various means including use of SMS texts.

The group helped establish evacuation centres at:

- Emerald Agricultural College
- St Patrick's School
- Emerald Town Hall
- Harvest Life Church

Details of these centres were provided to the public along with a location map which also showed areas of expected floodwater inundation.

Emerald Hospital was assessed on the basis of the latest available flood level predictions and it was determined that water was unlikely to enter the hospital⁵.

The LDMG Chair established a mini coordination centre in Springsure to assist with managing response and resupply in the southern areas including Rolleston.

Once the LDMG was deactivated on the 5 January 2011 the Recovery Team took over and will run for 6 months to ensure recovery occurs as quickly and efficiently as possible.

⁵ The decision was later made by Queensland Health to evacuate the hospital



BMT WBM Brisbane
Level 8, 200 Creek Street Brisbane 4000
PO Box 203 Spring Hill QLD 4004
Tel +61 7 3831 6744 Fax +61 7 3832 3627
Email bmtwbm@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Denver
14 Inverness Drive East, #B132
Englewood Denver Colorado 80112 USA
Tel +1 303 792 9814 Fax +1 303 792 9742
Email denver@bmtwbm.com
Web www.bmtwbm.com.au

BMT WBM Mackay
Suite 1, 138 Wood Street Mackay 4740
PO Box 4447 Mackay QLD 4740
Tel +61 7 4953 5144 Fax +61 7 4953 5132
Email mackay@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Melbourne
Level 5, 99 King Street Melbourne 3000
PO Box 604 Collins Street West VIC 8007
Tel +61 3 8620 6100 Fax +61 3 8620 6105
Email melbourne@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Newcastle
126 Belford Street Broadmeadow 2292
PO Box 266 Broadmeadow NSW 2292
Tel +61 2 4940 8882 Fax +61 2 4940 8887
Email newcastle@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Perth
Suite 3, 1161 Hay Street West Perth 6005
Tel +61 8 9328 2029 Fax +61 8 9484 7588
Email perth@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Sydney
Level 1, 256-258 Norton Street Leichhardt 2040
PO Box 194 Leichhardt NSW 2040
Tel +61 2 9713 4836 Fax +61 2 9713 4890
Email sydney@bmtwbm.com.au
Web www.bmtwbm.com.au

BMT WBM Vancouver
401 611 Alexander Street Vancouver
British Columbia V6A 1E1 Canada
Tel +1 604 683 5777 Fax +1 604 608 3232
Email vancouver@bmtwbm.com
Web www.bmtwbm.com.au