QFCI

Date: 29/09/11 JM

Exhibit Number: 672

QUEENSLAND TO WIT

I, **ROBERT ARNOLD AYRE**, of c/- SunWater Limited (**SunWater**), Level 10, 179 Turbot Street, Brisbane in the State of Queensland do solemnly and sincerely declare, as follows:

I make this statement in response to the Requirement issued by the Commission of Inquiry on 2 September 2011.

Explanation of the type of advice provided by SunWater, or studies or assessments performed by SunWater for government bodies, companies or private individuals regarding levee banks built for flood mitigation

1. SunWater has been engaged by the Nogoa River Flood Plain Board (**Board**) to undertake the numerical hydraulic modelling of development applications on the flood plain, including levee banks built for flood mitigation, as part of the Board's assessment of development applications for proposed developments on the Nogoa river flood plain. Some of that work involves consideration of levee banks for flood mitigation.

2. I have been involved in that work for the Board on behalf of SunWater. I know from my experience in working on the matter that the process adopted by the Board for assessing a development application is as follows:

   a. The developer (**applicant**) submits an application to the Board which includes details of the proposed works. The applicant can seek either a permit to construct or an exemption from obtaining a permit under the Local Law.

   b. The Board engages SunWater (formerly DNR) to undertake the numerical hydraulic modelling of the development application using the Nogoa River Flood Plan Numerical Model (hydraulic impact assessment).

   c. SunWater report the findings of the hydraulic impact assessment to the Board's 'Engineer'. This role was originally [redacted] Director of Engineering Services, Emerald Shire Council.

   d. The Board's Engineer then prepares a report for the Board based upon the hydraulic impacts assessment and makes a recommendation to the Board as to the approval or non-approval of the proposed works.

3. SunWater's modelling is based upon the Nogoa River Flood Plain Numerical Model which is described in paragraphs 22 to 37 below.

4. SunWater can provide hydrologic and hydraulic modelling as well as civil design services for applicants to assist in preparing the necessary documentation to facilitate the approval process. However, as SunWater act

on behalf of the Nogoa River Flood Plain Board in the assessment process, SunWater has refrained from offering such services to prospective applicants. The exception being Ensham Resources after the Nogoa River Flood Plain Board indicated that the Board could not prepare the Engineer's report as part of the process.

5. Other than the services provided in the Nogoa river region, I am aware that SunWater has been involved in the design of levees in other irrigation areas in Queensland, including:

   a. Codenwarra Levee – Weemah Section, Emerald Irrigation Area, Nogoa, Mackenzie Water Supply Scheme;

   b. Retreat Creek Levee/Drain – Selma Section, Emerald Irrigation Area, Nogoa, Mackenzie Water Supply Scheme; and

   c. Theodore Levee – Theodore Section, Dawson Valley Water Supply Scheme.

6. SunWater was responsible for the hydraulic and civil design and construction supervision of these structures.

7. SunWater has previously bid for design projects such as the Charleville levee project on behalf of local authorities in the past; however, SunWater has not been successful in those bids.

8. SunWater regularly designs levees or above ground channels as part of the irrigation area design services offered through SunWater's Ayr office.

An overview of any involvement of the State of Queensland in the provision of that advice of the performance of the assessment of those studies.

9. I have set out below my understanding (based on my work with the Board) as to the background to the establishment of the Nogoa river flood plain planning process (in relation to which SunWater provides numerical hydraulic modelling services) as well as DNR's and SunWater's involvement in the development and implementation of this process.

(a) Establishment of the Steering Committee and Board

10. In 1994 the Nogoa River Flood Plain Steering Committee **(Nogoa River Steering Committee)** was established following community concerns about development on the Nogoa River flood plain, including the potential adverse impact of this development on existing landholder's use of their land.

11. On 12 December 1993, a public meeting was held in relation to these issues. This meeting was attended by representatives of Emerald Shire Council, Broadsound Shire Council, Peak Downs Shire Council, Department of Natural Resources (DNR); and Nogoa landholders. Subsequently, the Nogoa River

Steering Committee was formed in February 1994 for the purposes of managing and controlling development on the flood plain.

12. The Nogoa River Steering Committee was comprised of representatives from landholders (graziers and irrigators), mining companies; local governments; and DNR (now DERM). The Nogoa River Steering Committee's Charter stated that it would:

    - Consider and approve any proposed conceptual plans of the study area for modelling;
    - Develop guidelines against which the impact of existing and proposed works on natural runoff over the study area could be measured and compared;
    - Determine future development scenarios to be modelled; and
    - Consider and endorse modifications to existing and proposed developments.

13. The Board was established under the *Local Government* Act on 19 September 1996 (Gazettal Notice S96/0251V06) to manage development on the Nogoa River Flood Plain in accordance with the laws and policies which arose out of the Steering Committee's investigations into development on the flood plain.

14. The Nogoa River Steering Committee commissioned a scoping study to assess the survey, hydrologic and hydraulic modelling requirements of Nogoa Rive flood plain. This scoping study was undertaken by consultants (Connell Wagner Pty Ltd in association with Lawson and Treloar Pty Ltd) and was completed in August 1994.

15. In January 1995, a public meeting of the Nogoa River Steering Committee was held to outline its progress and seek endorsement from the community to proceed to a detailed study.

16. On 16 February 1995, DNR was appointed to develop a numerical model of the flood plain and prepare a Flood Plain Management Plan. The Nogoa River Flood Plain Management Plan was based on the desired process outlined in the Best Practice Principles and Guidelines for Flood Plain Management in Australia (SCARM Report No 73, 2000). However, because of the nature of the proposed development activities, including the significant time pressures upon these developments, some components of the recommended process were not fully addressed in the interim plan. For example, the interim plan did not include a Flood Emergency Management System and nor was an economic appraisal carried out as part of the determination of the Designated Design Flood Event.

17. The DNR modelling and Interim Flood Plain Management Plan was presented at a public meeting in May 1997. This interim report was adopted as a planning instrument by the Board.

(b) Planning instruments

18. The Board's primary responsibility is to manage and control development and use of works on the Nogoa River Flood Plain. The Board carries out its functions in accordance with the following instruments:

- Nogoa River Flood Plain Board – Local Law (Levee Banks) (**Local Law**);
- Nogoa River Flood Plain Board – Interim Flood Plain Management Plan (Superseded by Nogoa River Flood Plain Board Local Law Policy No 1 – Levee Banks, dated 27 April 1998) (**Flood Management Plan**); and
- Nogoa River Flood Plain Numerical Model.

19. The Local Law, made under the Local Government Act, enables the Board to control development applications for the construction, maintenance and use of works that comprise of levees, above ground channels, above ground storage structures and other structures (as noted in Section 3.3.1 of the Interim Flood Plain Management Plan, on the Nogoa River flood plain, as well as prescribing a process for its management and control of the development process.

20. The Flood Management Plan is the policy document for the Board. It details the basis on which decisions are made by the Board in relation to the development and use of the Nogoa River flood plain. The plan includes:

- Management principles and objectives, and
- Specific interim criteria and measures for allowable development.

21. The Nogoa River Flood Plain Numerical Model is the tool by which the hydraulic impacts of any development proposal on the flood plain are quantified for the Board to assist the decision making process. It is based on a designated design flood event (discussed in paragraphs 22 to 37 below),

NOGOA RIVER FLOOD PLAIN NUMERICAL MODEL

22. The Designated Design Flood Event included within the Nogoa River Interim Flood Plain Management Plan is based on the following parameters:

a. Event duration; and

b. Event magnitude.

23. The Designated Design Flood Event, coupled with a representation of the topography of the flood plain and river system, forms the basis of the Nogoa River Flood Plain Numerical Model.

Event Duration

24. The event duration selected for the designated design flood event was based data/observations of contributing catchments for a number of historical flood events. These catchments range in size, and include:

    - Nogoa River at Fairbairn Dam, 16,320 km^2
    - Retreat Creek at Main Road, 8,415 km^2
    - Comet River at Comet, 16,395 km^2
    - and a residual catchment area over the flood plain of 4,065 km^2.

25. As a consequence size of the contributing catchment, a long duration event (168 hours) was adopted, which maximises the flood volume within the flood plain. The 168 hour duration flood event was the longest duration available from the design flood hydrology of the study area. Methodologies described in Australian Rainfall and Runoff, (IEAust, 1987) were used to derive the design flood event.

Event Magnitude

26. The event magnitude of the designated flood event was based upon the representativeness of the typical flood immunity for a large percentage of existing works on the flood plain. The February 1978 flood event on which the numerical model was principally calibrated appears to form the basis on which many rural enterprises have established bank heights and pump station levels. This event was nominally assigned an Annual Exceedence Probability (AEP) of 1 in 25 for the overall flood plain.

27. An AEP of 1 in 20 was adopted as the magnitude of the Designated Design Flood as it is consistent with the level of immunity adopted for rural enterprises on other flood plains in Queensland and it was consistent with current flood plain literature relating rural environments and the best practice principles and guidelines.

28. It should also be noted that in the derivation of the Designated Design Flood Event, Fairbairn Dam was assumed full at the onset of the event. This is a conservative assumption, meaning that the subsequent outflow from Fairbairn Dam is likely to be larger than the AEP neutral derived estimate.

Adopted Topographic Base

29. The topographic base adopted by the Board upon which impacts of proposed developments are assessed is derived from the aerial photography and ground survey undertaken in October 1994. This survey information was combined and used to develop a digital elevation model (DEM) of the study area. Cross-

sections were then extracted from the DEM and used to construct a numerical hydraulic model of the flood plain.

30. It was decided by the Steering Committee that only those works constructed on the flood plain or with approval (to construct specific works on the flood plain) prior to October 1994 would be considered eligible for inclusion in the topographic base.

31. This decision was made with consideration to the timing of the Gazettal of the Emerald Shire Council Local Law (Levee Banks) and the availability of the topographical information on which the numerical model was based.

32. Determination of those works to be incorporated into the topographic base entailed a detailed assessment of how well those works, both individually and cumulatively satisfied the general management principles and objectives outlined in the Interim Flood Plain Management Plan.

33. This topographic base was then used as the benchmark against which development applications were tested. A development application model, that included modified cross-sections within the vicinity of the proposed development, was established as part of the assessment process. Comparisons of the changes in flood levels and flow distribution were made between the benchmark model and the development application model to assess compliance with the criteria contained within the Interim Flood Plain Management.

34. The Adopted Topographic Base Case was identified as Case057 in the Interim Flood Plain Management Plan in 1997. Figures 3 and 3a in the Interim Flood Plain Management Plan provide a summary of those developments included in the Adopted Topographic Base Case. The Adopted Topographic Base was revised in May 2000 in response to some minor amendments that affected a limited number of cross-sections within the modelled area. The Revised Adopted Topographic Base Case was referred to as Case086.

35. The Numerical Hydraulic Model was developed using the RUBICON Hydro-dynamic modelling package (Haskoning BV). This model was implemented on a HP Workstation under a UNIX operating environment. In September 2007 the modelling platform was converted from RUBICON into MIKE 11 (DHI) which is a PC based application.

Approved Development Topographic Base

36. A second topographic base was developed in September 2007 which is referred to as the Approved Development model and known as Case086AD. This model included all of the development applications that had been granted approval from the Board so as to monitor development 'creep' in accordance with the criteria outlined in the Interim Flood Plain Management Plan.

37. The Approved Development Model includes the following approved works:

- Millar Farms Ring Tanks (February 1998)
- Ensham Resources Levees and Haul Road (February 1998)
- Parker Development Supply Channel and Developments (April and December 1999)
- McIntosh –Lurline Levees (September 2000)
- Rileys Crossing Bridge (March 2001)
- Braylands Ring Tank and Supply Channel (September 2001)
- Morawitz Levee (August 2002)
- Burnetts – Colorada Levees (January 2003)
- Wilsons – Currimundi Levees (January 2003)
- Burnetts – Wyuna Levees (January 2003)
- Ensham Mine Haul Road Berm (April 2003)
- Citricorp Pty Ltd – Proposed Storage (August 2006)

38. In addition to these approved developments there are several 'exempt' works which were located on the fringe of the designated flood plain or were classed as Exempt Works under Section 3.3.2 of the Interim Flood Plain Management Plan.

39. The only new applications that have been considered since the advent of the Approved Development model are:

- Ensham Resources Pty Ltd – Proposed Levee Bank Extension (February 2008 and June 2008)
- Ensham Resources Pty Ltd – Existing Levee Rehabilitation (July 2008)
- PrimeAg Australia Ltd – Proposed Levee Banks (August 2008)

Two specific examples of the advice provided or studies performed by SunWater with respect to levee systems

(a) Ensham Mine Proposed Levee Extension

40. SunWater reported to the Nogoa River Flood Plain Board in February 2008 in respect to an application by Ensham Resources to extend the original approved levees on its Ensham Mine Project. (Reference document #610167).

41. This application was submitted in December 2007, however during the period of assessment, the flood plain experienced its largest flood since February 1978. The January 2008 flood event caused failures in both the northern and southern levees of the Ensham Mine Project, rendering the extension application redundant. The Nogoa River Flood Plain Board therefore did not consider the findings of the hydraulic assessment provided by SunWater and did not make a decision regarding the extension application.

(b) Ensham Mine Levee Rehabilitation

42. The approval process for the rehabilitation of the original Ensham Mine Levees which failed during the course of the January 2008 flood event was not performed in accordance with process outlined in Policy No 1. Central Highlands Regional Council indicated that they did not have an 'Engineer' to make a recommendation and therefore could not comply with the policy.

43. Failure of the Nogoa River Flood Plain Board to comply with the proposed progression notices and notices to decide allowed the Co-ordinator General to issue step in notices. These step in notices empowered the Co-ordinator General to:

- Cause a report to be prepared in lieu of the 'Director of Engineer Services' report; and
- Rely upon the report when determining the Ensham applications under Section 11 of the Local Law No 1.

44. The Department of Infrastructure Planning approached SunWater to undertake the review and prepare the report in this instance. (Reference Document #698914).

(c) PrimeAg Australia Levee Application

45. SunWater processed an application from PrimeAg Australia for the re-instatement of levees on the 'Braylands' property on behalf of the Nogoa River Flood Plain Board in August 2008. (Reference document #709296).

46. The approval of the PrimeAg Australia levees was challenged by local landholders and this case was subject to an appeal process under the Local Government Act 1993 – Section 942. [redacted] (DERM) heard the appeal and made a ruling in February 2009, which disallowed the appeal and ruled in favour of the original approval. (Reference document #1420-001.pdf).

(d) Ensham Central Project – Raising of Original Downstream Levees

47. Ensham Resources engaged SunWater directly to review a report prepared by KBR in September 2009 which underpinned the application by Ensham Resources and the Department of Environment and Resource Management (DERM) of the upgrade of the original levee sections to meet the new imposed

conditions. The KBR report is referenced as BEW801-W-REP-007 Rev 1, dated 10 August 2009. (Reference document #856921).

Technical/scientific advice needed before constructing levees

48. I consider that the appropriate technical/scientific advice required before the construction or alteration of a levee built for flood mitigation are set out in the in the Best Practice Principles and Guidelines for Flood Plain Management in Australia (SCARM Report No 73, 2000) Specifically, Sections 3.7 and B.1, and 3.10 and B2.1 describe considerations relating to control measures within flood plain management plans and the effect of levees.

49. The design and construction of structures on the flood plain should be to a standard that is commensurate with the risk of failure of the structure. Proposed developments must comply with the relevant local authority Strategic Plan, and By-Laws of the constituent Local Government. A Design Report, including plans and specifications must be prepared by suitably qualified individuals or companies. All works on the flood plain must be constructed and maintained in accordance with the approved Design Report to the satisfaction of the local authority.

AND I MAKE this solemn declaration conscientiously believing the same to be true and by virtue of the provisions of the *Oaths Act 1867.*

Sworn and Declared at Brisbane)

this 13 day of September 2011 in)

the presence of:)

[redacted] .....

Signature of the declarant

[redacted]

~~Justice of the Peace~~/ Solicitor/

~~Commissioner for Declarations~~

[redacted]

B:1440719_1 NMW

Final Report

Nogoa River Flood Plain Sensitivity Analysis

Date: May 2010

Ref: P-AEXP-0901-AB-01-03

File: 10-001204

SunWater

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Final Report

Nogoa River Flood Plain Sensitivity Analysis

Date: May 2010
Ref: P-AEXP-0901-AB-01-03
File: 10-001204

Prepared for:
Juris Ace Pty Ltd

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Permission to use or quote information from this report in studies external to the Corporation must first be obtained from the Chief Executive, SunWater.

EXECUTIVE SUMMARY

In February 2010, SunWater was commissioned by [redacted] of Juris Ace Pty Ltd to undertake a hydraulic assessment of the sensitivity of the numerical hydraulic modelling used to by the Nogoa River Flood Plan Board to underpin the approval process. The assessment was to determine if peak flood levels were influenced by changes in the Ensham Mine levees. The impacts were to be assessed at the property of [redacted] The property is identified as Lot 63 Crown Plan DSN801593, County of Denison, Parish of Moodewarra.

The sensitivity analysis was to be used to determine if changes to the Ensham Mine levee system configuration (location and height) impact on the upstream reaches of the Nogoa River Flood Plain, and the analysis also provides an assessment of the level of immunity afforded by the SunWater structure known as the "Codenwarra Levee Bank".

The numerical hydraulic model MIKE-11 (DHI, 2005) was used to undertake the hydraulic modelling of several flood scenarios and development conditions. The flood events investigated include:

- January 2008 Historical Flood Event
- 1 in 20 Year Annual Exceedence Probability Design Flood Event (Also known as the Designated Design Flood Event)
- 1 in 50 Year AEP DFE
- 1 in 100 Year AEP DFE

The main model used during the assessment was the "Case 086 Adopted Topographic Base Model", originally developed in 2007 by SunWater and updated in 2008 to simulate the Nogoa Mackenzie flood of January 2008. This model is referred to as *Case 086* in this report.

As part of the sensitivity investigation, modifications were required to the *Case 086* model. The modifications were made to ensure the flow and flood height at Duckponds Gauging station was 3,000 m^3/s and 155.2 m AHD respectively. This level was the recorded peak flood level during the event.

The sensitivity testing indicates that with the incorporation of the Northern and Southern Levees flood levels are raised by up to 72mm at the Codenwarra Levee for the January 2008 flood event. The corresponding increases for the design events are as follows:

- Q20 increases of up to 98 mm
- Q50 increase of up to 75 mm
- Q100 increases of up to 45 mm

The modifications indicate that the MIKE-11 model is sensitive to changes in roughness coefficients and that both peak flood levels and flood flows are impacted by such changes.

The absolute levels derived from the Sensitivity Base Case are less that the peak flood levels predicted under the original Base Case simulation. For example, comparisons of the peak flood level at Bridge Flats under the original Base Case calibration for the Q20 event was EL 164.43 m compared with the Sensitivity Case peak level of EL 164.36 m. These results indicate that the Sensitivity Base Case produces absolute flood levels that are lower than the corresponding Adopted Topographical Base Case for the range of design floods investigated. Similar values were noted for the inclusion of only the Northern Levee.

In all cases examined, the peak flood levels were significantly less than the Codenwarra Levee crest level indicating that the levee provides substantial protection against the design flood event scenarios considered.

A further investigation was conducted to determine the effect of the Parker Development Supply Channel upon the peak flood levels in the vicinity of the Codenwarra Levee. This investigation involved the removal of the Parker Supply Channel which effectively blocks three flood runners on the southern Nogoa River Flood Plain (branches BNO_R00008, BNO_R00010 and BNO_R00012).

TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 BACKGROUND 1
1.2 SCOPE OF WORKS 2
2.0 HYDRAULIC ANALYSIS 7
2.1 CODENWARRA LEVEE BANK DETAILS 7
2.2 HYDRAULIC MODEL MODIFICATIONS 7
2.2.1 Historical Case Modifications 7
2.2.2 Cross-Section Modifications 8
2.3 MODELLING RUNS 9
2.4 HYDRAULIC MODEL RESULTS 10
2.4.1 Historical Flood Scenario 10
2.4.2 Q20 Flood Scenario 15
2.4.3 Q50 Flood Scenario 20
2.4.3 Q100 Flood Scenario 23
2.5 PARKER DEVELOPMENT SUPPLY CHANNEL 27
2.5.1 Q20 Flood Scenario 27
3.0 SUMMARY 28
4.0 REFERENCES 30

LIST OF APPENDICES

APPENDIX A – Peak Water Height Graphics

LIST OF FIGURES

Figure 1: #A3-500083 RSC, inc location inset 4
Figure 2: Drawing #222263 (Codenwarra general location) 5
Figure 3: Drawing #58437B (Codenwarra details) 6

LIST OF TABLES

Table 2.1 Comparison of Roughness Coefficients 8

Table 2.2: Peak River Heights and Flows for Sensitivity Base Case Development – January 2008 Flood Event 10

Table 2.3: Peak River Heights and Flows for Northern Levee Development - January 2008 Flood Event 12

Table 2.4: Peak River Heights and Flows for Northern and Southern Levee Development - January 2008 Flood Event 13

Table 2.5: Peak River Heights and Flows for Sensitivity Base Case Development -Q20 Flood Event 15

Table 2.6: Peak River Heights and Flows for Northern Levee Development -Q20 Flood Event 16

Table 2.7: Peak River Heights and Flows for Northern and Southern Levee Development - Q20 Flood Event 18

Table 2.8: Peak River Heights and Flows for Base Case Development -Q50 Flood Event 20

Table 2.9: Peak River Heights and Flows for Northern Levee Development -Q50 Flood Event 21

Table 2.10: Peak River Heights and Flows for Northern and Southern Levee Development - Q50 Flood Event 22

Table 2.11: Peak River Heights and Flows for Base Case Development - Q100 Flood Event 23

Table 2.12: Peak River Heights and Flows for Northern Levee Development - Q100 Flood Event 24

Table 2.13: Peak River Heights and Flows for Northern and Southern Levee Development - Q100 Flood Event 25

1.0 INTRODUCTION

1.1 BACKGROUND

The Nogoa River Flood Plain Boar d approved the original constr uction of levees for Ensham Mine as part of the Interim Flood Plain Mana gement Plan in May 1997 (DNR, 1997) . A further approval in was sought and obtai ned by Ensham Resources Pty Ltd in March 1998 (DNR, 1998) for the modification of the location of the levees and inclusion of a low level haul road crossing.

Another application was lodged by Ensham Res ources Pty Ltd involving th e Haul Road Safety Berm in April 2004 (SunW ater, 2007) and this was also approved by the Nogoa River Flood Board after satisfactory hydraulic assessments were undertaken.

Ensham Resources Pty Ltd subm itted a further application in Novem ber 2007 which involv ed the extension of levees around the northern and southern m ine works. This application was assessed but not approved due to the flood event of January 2008, (KBR 2008 and SunW ater 2008a). As a consequence of th e impacts of the flood in the N ogoa-Mackenzie River in January 2008 and associated breaching of the Ensham Mi ne levees, the Queensland State Governm ent redefined the required flood immuni ty protection of Ensham Mine from a 1 in 100 year Annual Exceedence Probability (AEP) event to a 1 in 1,000 year AEP event, necessitating th e construction of larger levees (both in extent and height).

The modified levees were re-assessed by the Nogoa River Flood Plain Board and approval was provided by the Board through the Coordina tor-Generals Departm ent in June/July 2008 (SunWater, 2008b) for the rehabilitation and re-instatement of the existing levees.

Ensham Resources Pty Ltd then subsequently applied to the Board as part of the Ensham Central Project – Raising of Original Downstream Levees in September 2009 (KBR, 2009a and 2009b) to increase the height of the existing levees to provide the sam e level of protection to the entire mine site.

The decision to approve the modified levees was the subject of an appeal in February 2010.

1.2 SCOPE OF WORKS

In February 2010, SunWater was commissioned by [redacted] of Juris Ace Pty Ltd to undertake a hydraulic assessment of the sensitivity of the numerical hydraulic modelling used to by the Nogoa River Flood Plan Board to underpin the approval process. The assessment was to determine if increases in peak flood levels were due to the changes in Ensham Mine levees at the property of Mr Les Fluerty. The property is identified as Lot 63 Crown Plan DSN801593, County of Denison, Parish of Moodewarra.

The sensitivity analysis was to be used to determine if changes to the Ensham Mine levee system configuration (location and height) impact on the upstream reaches of the Nogoa River Flood Plain, and the analysis also provides an assessment of the level of immunity afforded by the SunWater structure known as the "Codenwarra Levee Bank".

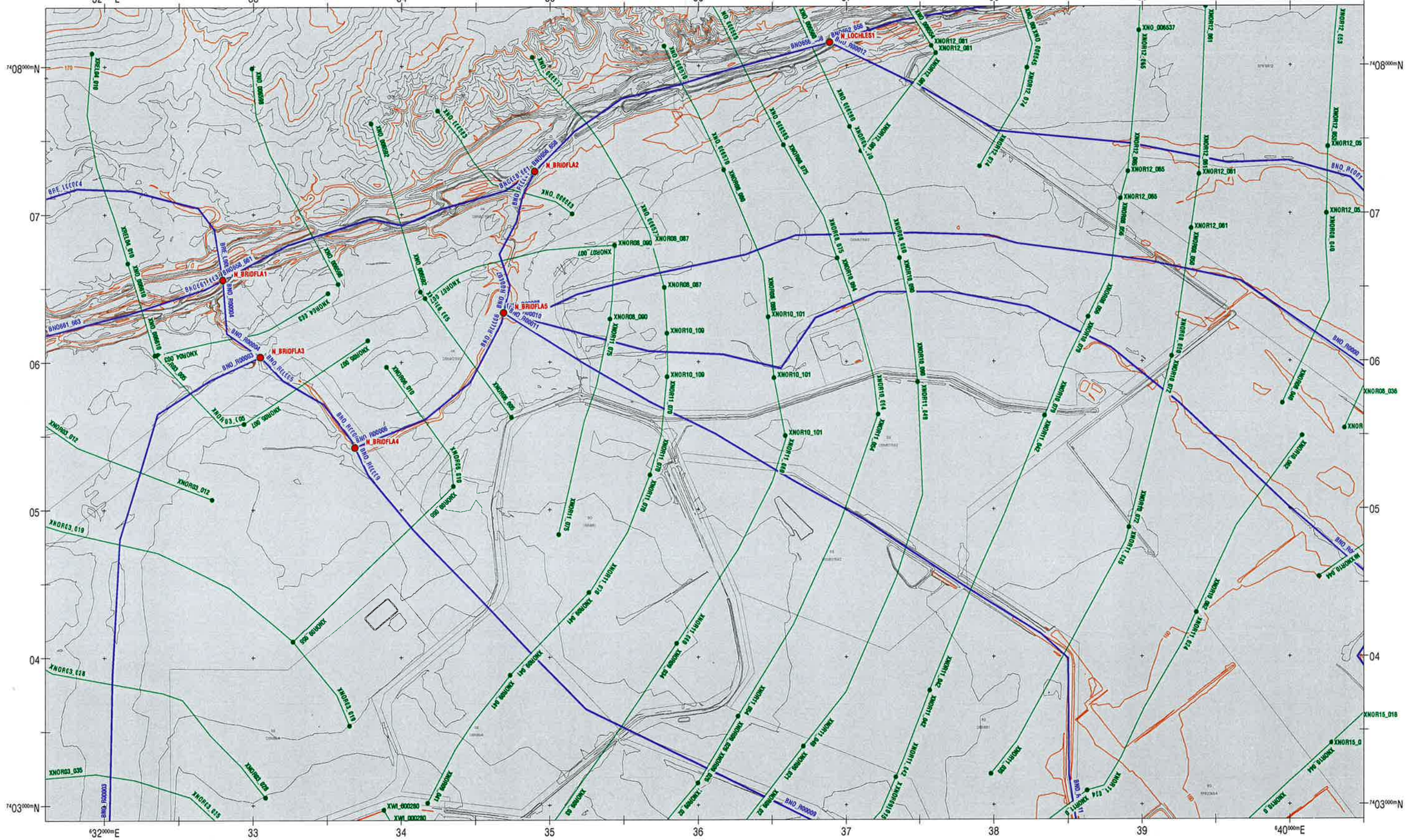
The Codenwarra Levee protects several properties approximately 20km north east of Emerald, near the intersections of Foley and Lochlees Roads (see Figures 1 and 2). Codenwarra Levee was designed and constructed by QWRC in response to the February 1978 flood event, and it was designed to eliminate flood plain flow that effectively flowed from the Nogoa River across the flood plain and into Winton Creek.

This report describes the results of a hydraulic assessment of the proposed works, specifying the "Codenwarra Levee Bank" (Figure 3) and surrounding area in particular.

The numerical hydraulic model MIKE-11 (DHI, 2005) was used to undertake the hydraulic modelling of several flood scenarios and development conditions. The flood events investigated include:

- January 2008 Historical Flood Event
- 1 in 20 Year Annual Exceedence Probability Design Flood Event (Also known as the Designated Design Flood Event)
- 1 in 50 Year AEP DFE
- 1 in 100 Year AEP DFE

The investigation of the impact of the Parker Development Supply Channel involved the removal of the supply channel. The supply channel effectively blocked three flood runners on the southern flood plain of the Nogoa River (model branches BNO_R00008, BNO_R00010 and BNO_R00012). In the Adopted Topographic Base Case (NRW 19997 Figure 3A) the original Parker Development Supply had to be modified to incorporate larger openings (siphons) with dimensions of 30m, 150m and 200m which enabled flow through two of the blocked branches (BNO_R00008 and BNO_R00012). The removal of these restrictions and the re-connection of branch BNO_R00010, highlights the impact of this infrastructure.



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Produced at the Resource Sciences Centre of the Department of Natural Resources by the Spatial Information and Mapping Group.

Legend:

- Cross Section
- Branch
- DCDB (Blocks > 1.0ha, Supplied by Dept. of Lands)
- Node

KILOMETRES

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RESOURCE SCIENCES CENTRE

NATURAL RESOURCES

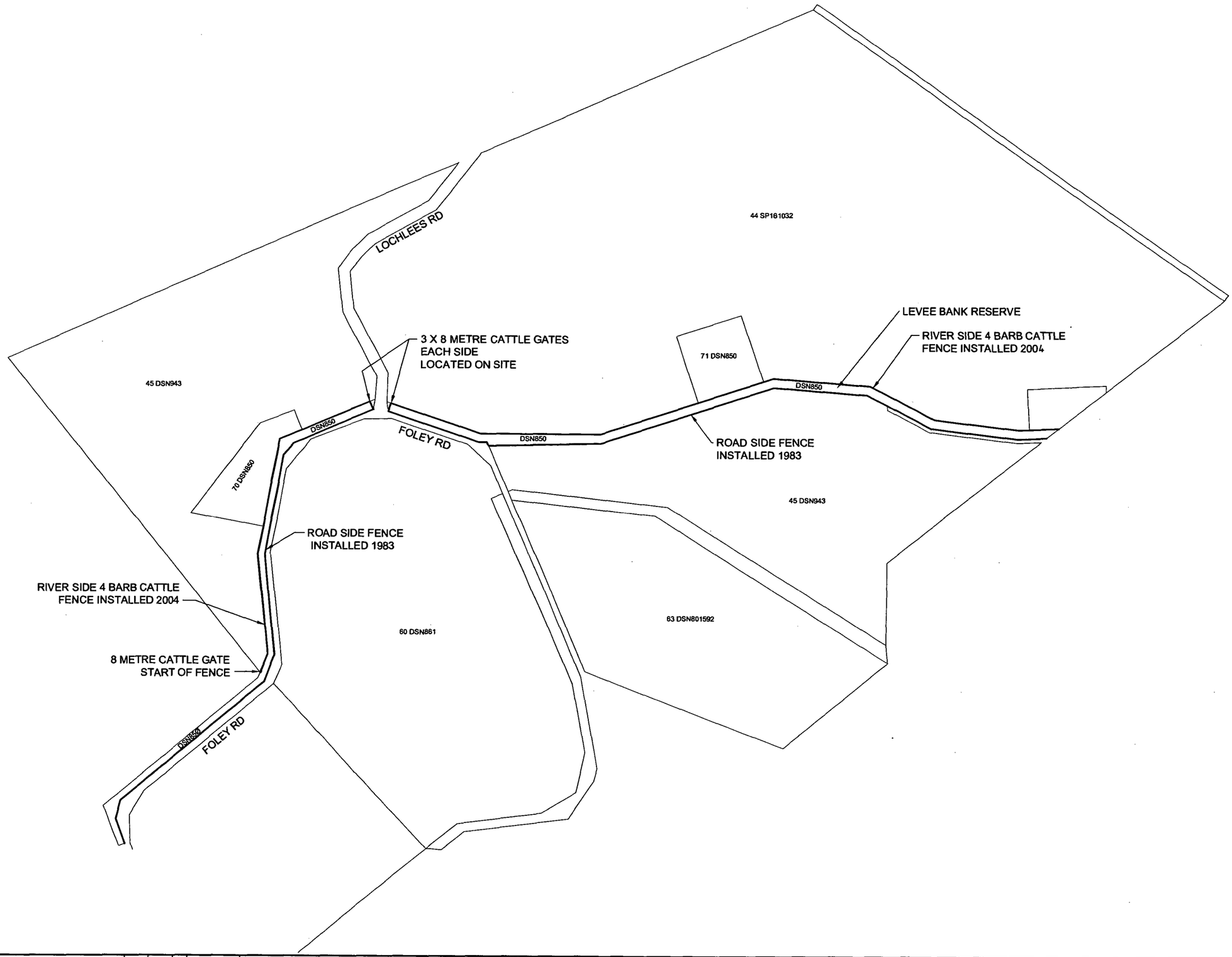
QUEENSLAND GOVERNMENT

Nogoa Flood Plain Study
Calibration Model

Schematic and Cross Sections
Sheet 21 of 42

05/01/96

A3-500083 RSC



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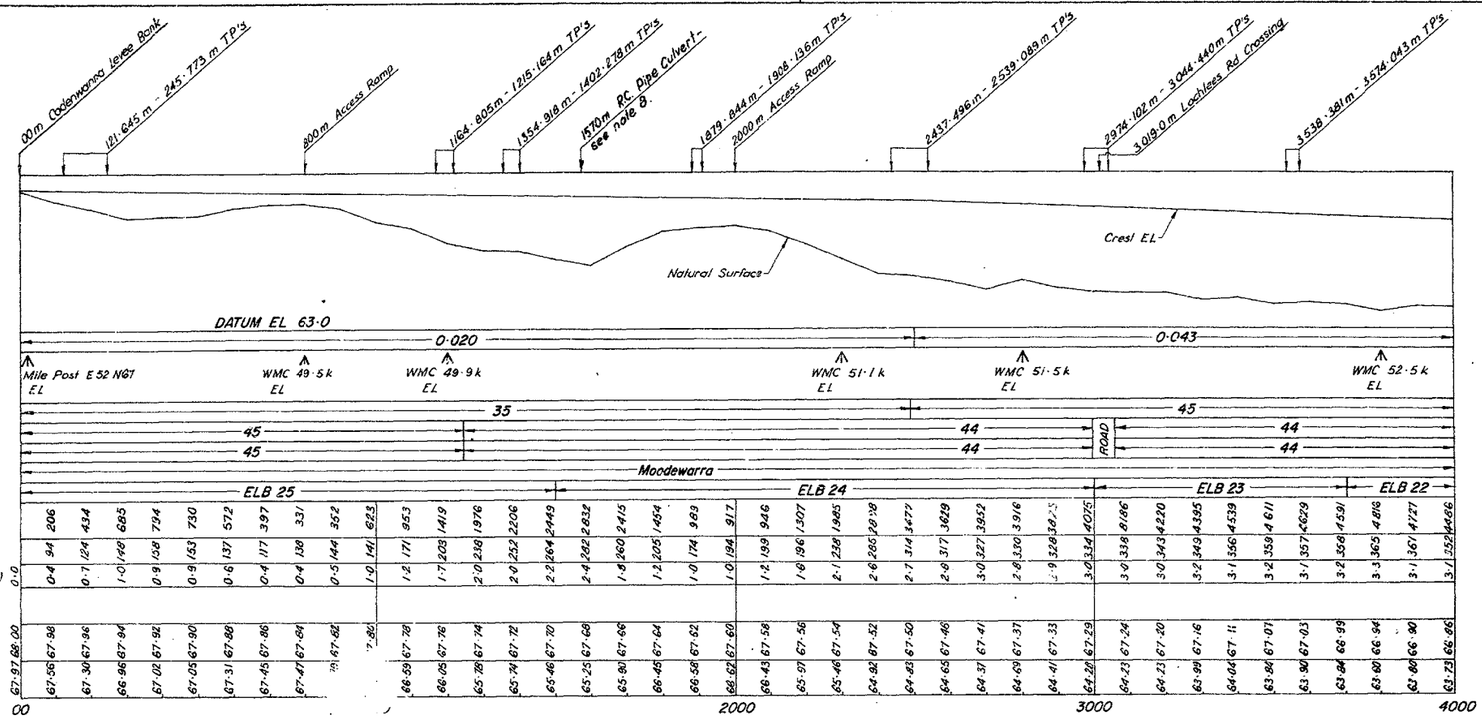
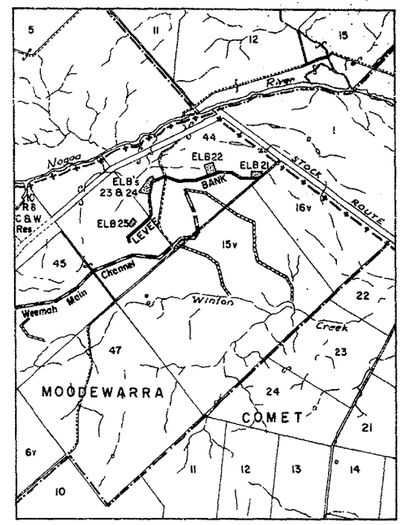
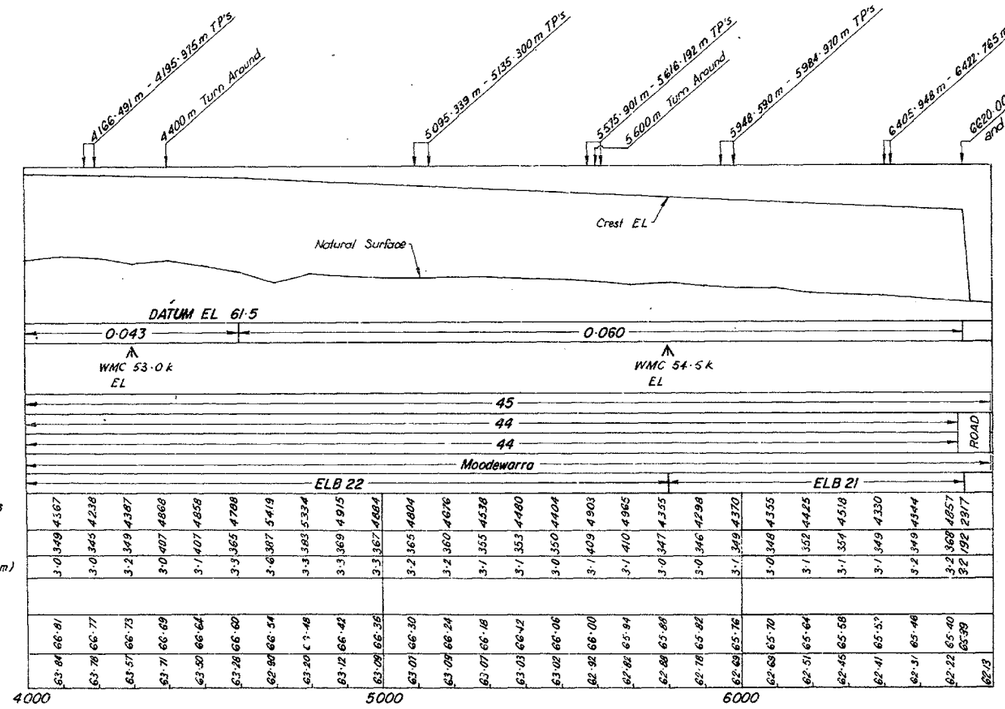
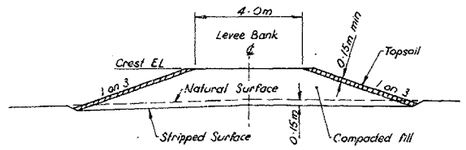




LOCALITY PLAN





TYPE SECTION
Not to Scale

NOTES

1. Add 100 m to all elevations to bring to State Datum
2. All curves are 100 m radius at bank centreline
3. All distances are measured around curves
4. Solid quantities have been used throughout
5. Tolerances
   - Centreline alignment ..... ± 0·5 m
   - Crest EL ..... - 0·0 m, + 0·1 m
   - Crest width ..... - 0·0 m, + 0·3 m
   - Bank slope 1 on s ..... s + 0·2, - 0·0
6. Bench Marks will be established by the Commission and their elevations and locations supplied to the successful tenderer
7. Reference Plans
   - Cross Sections ..... A1-56972 (E1580) to A1-56976 (E1584) and A2-58439 (E1614)
   - Access and Turn Around Details K1-58438 (E1613)
   - Clay Borrow Areas Locality Plan A2-58072 (E1615)
8. RC Culvert details as follows :- 1570m RC. Pipe, 600mm dia., 19·52m lg., Invert EL 164·80 (fitted with suitable Reflux Valve)
9. Earthwork quantities :- Total volume of Fill ..... 224 931 m³ Total volume of stripping ..... 19 687 m³

Revision					Drawing Schedule	Survey Books		
23·9·80	B	Pipe at 1570m added	B.E.M.					
25·8·80	A	Length of levee bank reduced.	B.E.M.			F 142	L 376	
Date		Remarks	Ckd	Psd		Field	Level	

Horizontal: 75 0 100 200 300 400 500 600 700 800 metres
Longitudinal Section
Vertical: 1 0 1 2 3 4 5 6 7 8 9 10 metres
Locality Plan: 1000 0 2000 4000 6000 8000 10000 metres

Design [redacted]	Drafting Dr B.E.M.
Prej	
Ckd	Ckd B.P.
Supv	Supv
Submitted [redacted]	

District Engineer

Recommended [redacted]
Senior Engineer

Approved [redacted]
Chief Irrigation Engineer

QUEENSLAND WATER RESOURCES COMMISSION
EMERALD IRRIGATION AREA
CODENWARRA LEVEE BANK
LONGITUDINAL SECTION 00m TO 6 620m

21·1·80	A1-58437	A	B	
21·1·80	E 1612			

DWG 58437B.tif

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2.0 HYDRAULIC ANALYSIS

The assessment was undertaken using the MIKE11 numerical hydraulic model, and was based upon a modified version of the "Case 086 Adopted Topographic Base Model". Four flood scenarios were considered during the process, including:

- January 2008 flood
- Q20 Design Flood Event
- Q50 DFE
- and Q100 DFE

The design flood events are consistent with those utilised in the Interim Flood Plain Management Plan, (DNR, 1997).

2.1 CODENWARRA LEVEE BANK DETAILS

The "Codenwarra Levee Bank" is a compacted earth fill levee located approximately 20 km north-east of Emerald, near the intersection of Foley and Lochlees Roads. It is 6,620m long; with its highest point being at chainage 0m, at 168.00 m AHD, and its lowest is at chainage 6,620m, at 165.39 m AHD. The levee is designed to protect several nearby properties that form part of the Weemah Irrigation Area from floods that emanate from the Nogoa River. The intent of the levee was to deflect flows away from the flood plain but not necessarily prevent flooding of the properties. The properties could still be flooded by backwatering effects. The levee was therefore effectively designed to reduce the impacts of the relatively high velocities observed in this area of the flood plain during the February 1978 flood event.

2.2 HYDRAULIC MODEL MODIFICATIONS

2.2.1 Historical Case Modifications

The main model used during the assessment was the "Case 086 Adopted Topographic Base Model", originally developed in 2007 by SunWater and updated in 2008 to simulate the Nogoa Mackenzie flood of January 2008. This model is referred to as *Case 086* in this report.

As part of the sensitivity investiga tion, modifications were required to the *Case 086* model. The modifications were m ade to ensure the flow and flood height at Duckponds Gauging station (Located between grid point 60,400 on the NOGOA_MACKENZIE branch, and grid point 4,700 on BNO_R22-23-24-25 branch), was 3,000 m ^{3}/s and 155.2 m AHD respectively. T his level was the recorded peak flood level during the event.

This was achieved by m odifying the m odel's boundary file and Hydro-Dynam ic (HD) parameters file until the required values were obtained. In the HD parameters file, the Manning's *n* value for the bed resistance was m odified by a constant proportion ensuring the resultant value was not less than 0.035. In the boundary file, the upstr eam inflows were m odified by a constant percentage. The adopted reduction in Manning's *n* is about 17%.

The increase in relative roughness between the m ain stream and the fl ood plain for the original Base Case and the Sensitivity Base Case is illustrated in the Table 2.1.

Table 2.1 Comparison of Roughness Coefficients

Feature	Base Case	Sensitivity Base Case
Main Stream	0.070	0.060
Flood Plain	0.046	0.039
Main Stream to Flood Plain Roughness	1.522	1.538

Following verif ication that thes e model adju stments had produced the required values, the modified files were marked as the "*Case086 Sensitivity*" version.

2.2.2 Cross-Section Modifications

No cross-sections changes were required as pa rt of the sensitivity testing. However, ne w network configuration files were required to ensure the differe ntiation between the o riginal calibration model parameters and the revised sensitivity model parameters.

2.3 MODELLING RUNS

A total of 12 modelling runs were undertaken – one for each flood scenario (January 2008 Historical Event, and the Design Flood Events : Q20, Q50 and Q100) for each of the three development cases:

- Base Case
- Northern Levee
- Northern and Southern Levee

The time-step for the modelling runs was reduced to 15 seconds (as opposed to the previously utilised time-step of 30 seconds).

Note that it was originally intended to also do an analysis of the Q1000 scenario, but the flow estimates for this event were not provided by Ensham Resources Pty. Ltd. and so as to avoid any confusion by deriving an independent estimate of the 1 in 1,000 year AEP this event was not modelled.

2.4 HYDRAULIC MODEL RESULTS

2.4.1 Historical Flood Scenario

The historical flood scenario using the recorded January 2008 flood flows was used as a baseline to compare other development scenario results. The sensitivity analysis was conducted by modifying the roughness coefficients to ensure the peak flood level at the Duckponds gauge was maintained, but ensuring an associated peak flow of approximately 3,000 m^3/s.

Table 2.2: Peak River Heights and Flows for Sensitivity Base Case Development – January 2008 Flood Event

Levee Chainage	Flood Height	Flow	Levee Chainage	Flood Height	Flow
(m)	(m AHD)	(m^3/s)	(m)	(m AHD)	(m^3/s)
0	164.585 0.	0	3400	165.070 3.	0
100	164.709 0.	0	3500	165.070 3.	0
200	164.852 0.	0	3600	165.070 3.	0
300	164.852 0.	0	3700	165.070 3.	0
400 16	4.842	0.0	3800	164.355	439.9
500 16	4.839	0.0	3900	164.318	439.6
600 16	4.833	0.0	4000	164.302	439.5
700 16	4.827	0.0	4100	164.283	439.3
800 16	4.821	0.0	4200	164.269	439.2
900 16	4.816	0.0	4300	164.255	439.1
1000 16	4.810	0.0	4400	164.255	439.1
1100 16	4.804	0.0	4500	164.255	439.1
1200 16	4.804	0.0	4600	164.255	439.1
1300 16	5.518	3.0	4700	164.243	439.2
1400 16	5.518	3.0	4800	164.229	439.0
1500 16	5.518	3.0	4900	164.217	438.9
1600 16	5.518	3.0	5000	164.204	438.9
1700 16	5.518	3.0	5100	164.107	438.4
1800 16	5.518	3.0	5200	164.088	438.4
1900 16	5.518	3.0	5300	164.074	438.3
2000 16	5.518	3.0	5400	164.049	438.3
2100 16	5.119	1573.3	5500	164.011	438.3
2200 16	5.070	1573.3	5600	163.985	438.3

Levee Chainage	Flood Height	Flow	Levee Chainage	Flood Height	Flow
2300 16	5.069	1453.0	5700	163.956	438.3
2400 16	5.068	1336.2	5800	163.918	438.3
2500 16	5.068	1324.2	5900	163.824	438.3
2600 16	5.068	1315.6	6000	163.805	438.3
2700 16	5.066	1186.8	6100	163.771	438.3
2800 16	5.070	3.0	6200	163.733	438.3
2900 16	5.070	5.1	6300	163.701	438.3
3000 16	5.070	3.0	6400	163.667	438.3
3100 16	5.070	3.0	6500	163.635	438.3
3200 16	5.070	3.0	6600	163.635	438.3
3300 16	5.070	3.0	6620	163.635	438.3
Duckponds GS	155.087	3,017.9			

As can be seen from t he results shown in Table 2.1, the flow at the Duckponds GS was maintained at around 3,000 m^3/s, with a corresponding level of 155.09m AHD.

This compares with the original January 2008 model calibration resu lt that was reported in the SunWater Report en titled, " *Nogoa River Flood Plain Ensham Mine Flood Modelling* " dated June 2008. The Duckponds GS m odelled level in this case was 155.11m AHD so the resultant level is within 0.02m.

Table 2.3: Peak River Heights and Flows for Northern Levee Development - January 2008 Flood Event

Levee Chainage	Flood Height	Flow	Levee Chainage	Flood Height	Flow
(m)	(m AHD)	(m^3/s)	(m)	(m AHD)	(m^3/s)
0	164.585 0.	0	3400	165.117 3.	0
100	164.709 0.	0	3500	165.117 3.	0
200	164.852 0.	0	3600	165.117 3.	0
300	164.852 0.	0	3700	165.117 3.	0
400 16	4.842	0.0	3800	164.418	460.2
500 16	4.839	0.0	3900	164.382	459.9
600 16	4.833	0.0	4000	164.367	459.8
700 16	4.827	0.0	4100	164.348	459.6
800 16	4.821	0.0	4200	164.335	459.5
900 16	4.816	0.0	4300	164.321	459.4
1000 16	4.810	0.0	4400	164.321	459.4
1100 16	4.804	0.0	4500	164.321	459.4
1200 16	4.804	0.0	4600	164.321	459.4
1300 16	5.550	3.0	4700	164.310	459.4
1400 16	5.550	3.0	4800	164.296	459.3
1500 16	5.550	3.0	4900	164.284	459.3
1600 16	5.550	3.0	5000	164.272	459.2
1700 16	5.550	3.0	5100	164.177	458.8
1800 16	5.550	3.0	5200	164.159	458.7
1900 16	5.550	3.0	5300	164.146	458.6
2000 16	5.550	3.0	5400	164.121	458.6
2100 16	5.164	1583.3	5500	164.082	458.6
2200 16	5.117	1583.3	5600	164.056	458.6
2300 16	5.116	1458.4	5700	164.027	458.6
2400 16	5.115	1337.0	5800	163.989	458.6
2500 16	5.115	1324.5	5900	163.893	458.6
2600 16	5.115	1315.6	6000	163.874	458.6
2700 16	5.114	1181.7	6100	163.839	458.6
2800 16	5.117	3.0	6200	163.801	458.6
2900 16	5.117	5.1	6300	163.768	458.6
3000 16	5.117	3.0	6400	163.734	458.6
3100 16	5.117	3.0	6500	163.701	458.6
3200 16	5.117	3.0	6600	163.701	458.6
3300 16	5.117	3.0	6620	163.701	458.6
Duckponds GS	155.063	3,041.2			

The introduction of the Northern Levee results in some changes to the flow distribution and peak flood levels. At the downstream end of the Code nwarra Levee, the peak flood flow increases by about 5% from 438.3 to 458.6 m^3/s and the corresponding peak flood level increases 0.066m

The im pact at Duckponds GS indicates that whilst the peak flood fl ow increases 0.8% the associated peak flood level actually falls by 0.024m.

The re-distribution of flood flow and consequent changes to peak flood levels is a direct response to the variation in roughness coefficients that have been adopted.

Table 2.4: Peak River Heights and Flows for Northern and Southern Levee Development - January 2008 Flood Event

Levee Chainage	Flood Height	Flow	Levee Chainage	Flood Height	Flow
(m)	(m AHD)	(m^3/s)	(m)	(m AHD)	(m^3/s)
0	164.585 0.	0	3400	165.117 3.	0
100	164.709 0.	0	3500	165.117 3.	0
200	164.852 0.	0	3600	165.117 3.	0
300	164.852 0.	0	3700	165.117 3.	0
400 16	4.842	0.0	3800	164.418	460.2
500 16	4.839	0.0	3900	164.382	459.9
600 16	4.833	0.0	4000	164.367	459.8
700 16	4.827	0.0	4100	164.348	459.6
800 16	4.821	0.0	4200	164.335	459.5
900 16	4.816	0.0	4300	164.321	459.4
1000 16	4.810	0.0	4400	164.321	459.4
1100 16	4.804	0.0	4500	164.321	459.4
1200 16	4.804	0.0	4600	164.321	459.4
1300 16	5.550	3.0	4700	164.310	459.4
1400 16	5.550	3.0	4800	164.296	459.3
1500 16	5.550	3.0	4900	164.284	459.3
1600 16	5.550	3.0	5000	164.272	459.2
1700 16	5.550	3.0	5100	164.177	458.8
1800 16	5.550	3.0	5200	164.159	458.7
1900 16	5.550	3.0	5300	164.146	458.6
2000 16	5.550	3.0	5400	164.121	458.6
2100 16	5.164	1583.3	5500	164.082	458.6
2200 16	5.117	1583.3	5600	164.056	458.6
2300 16	5.116	1458.4	5700	164.027	458.6
2400 16	5.115	1337.0	5800	163.989	458.6

Levee Chainage	Flood Height	Flow	Levee Chainage	Flood Height	Flow
2500 16	5.115	1324.5	5900	163.893	458.6
2600 16	5.115	1315.6	6000	163.874	458.6
2700 16	5.114	1181.7	6100	163.839	458.6
2800 16	5.117	3.0	6200	163.801	458.6
2900 16	5.117	5.1	6300	163.768	458.6
3000 16	5.117	3.0	6400	163.734	458.6
3100 16	5.117	3.0	6500	163.701	458.6
3200 16	5.117	3.0	6600	163.701	458.6
3300 16	5.117	3.0	6620	163.701	458.6
Duckponds GS	155.068	3,032.0			

The comparison between the Sensitivity Base Case and the two development scenarios: Northern Levee and Northern and Southern Levee, shows th at the peak flood flow and levels in Branch BNO_R10 is affected by the presence of the levees. The peak flood level increases by 0.066m in both cases.

2.4.2 Q20 Flood Scenario

The 1 in 20 year AEP design flood event is the flood event that has been adopted as the Designated Design Flood in the Interim Flood Plain Management Plan (DNR 1997). This event has been used to assess development applications as part of the Nogoa River Flood Plain Board's assessment process.

Table 2.5: Peak River Heights and Flows for Sensitivity Base Case Development - Q20 Flood Event

Levee Chainage	Water Height	Water Flow	Levee Chainage	Water Height	Water Flow
(m)	(m AHD)	(m^3/s)	(m)	(m AHD)	(m^3/s)
0	164.585 0.	0	3400	164.386 3.	0
100	164.709 0.	0	3500	164.386 3.	0
200	164.852 0.	0	3600	164.386 3.	0
300	164.852 0.	0	3700	164.386 3.	0
400 16	4.842	0.0	3800	163.433	164.0
500 16	4.839	0.0	3900	163.374	163.9
600 16	4.833	0.0	4000	163.350	163.8
700 16	4.827	0.0	4100	163.320	163.8
800 16	4.821	0.0	4200	163.299	163.8
900 16	4.816	0.0	4300	163.276	163.7
1000 16	4.810	0.0	4400	163.276	163.7
1100 16	4.804	0.0	4500	163.276	163.7
1200 16	4.804	0.0	4600	163.276	163.7
1300 16	4.727	3.0	4700	163.253	163.7
1400 16	4.727	3.0	4800	163.224	163.7
1500 16	4.727	3.0	4900	163.199	163.7
1600 16	4.727	3.0	5000	163.172	163.6
1700 16	4.727	3.0	5100	162.969	163.5
1800 16	4.727	3.0	5200	162.930	163.5
1900 16	4.727	3.0	5300	162.901	163.5
2000 16	4.727	3.0	5400	162.877	163.5
2100 16	4.423	836.3	5500	162.839	163.5
2200 16	4.386	836.3	5600	162.814	163.5
2300 16	4.383	788.6	5700	162.792	163.5
2400 16	4.380	742.2	5800	162.769	163.5
2500 16	4.380	737.4	5900	162.710	163.5
2600 16	4.380	734.0	6000	162.699	163.5
2700 16	4.376	682.9	6100	162.677	163.5
2800 16	4.386	3.0	6200	162.654	163.5

Levee Chainage	Water Height	Water Flow	Levee Chainage	Water Height	Water Flow
2900 16	4.386	3.4	6300	162.634	163.5
3000 16	4.386	3.0	6400	162.613	163.5
3100 16	4.386	3.0	6500	162.593	163.5
3200 16	4.386	3.0	6600	162.593	163.5
3300 16	4.386	3.0	6620	162.593	163.5
Duckponds GS	154.476	2,710.9			

The 1 in 20 Year AEP flood levels are lower than the January 2008 flood event flood levels as is evidenced by the difference in peak flood levels modelled at the Duckponds GS. The 1 in 20 year AEP event is 0.61m lower than the January 2008 flood event values and there is a corresponding lower peak flood flow, (2,711 compared to 3,018 m^3/s.)

By comparison, the levels for the 1 in 20 year AEP event for the Base Case at Duckponds GS is 154.49m (SunWater, 2007), whilst the corresponding value for the 1 in 20 year AEP Sensitivity Case is 154.476m. This indicates a reduction of 0.014m at this location due to the difference in roughness coefficients. Comparisons at other key locations, such as Bridge Flats, Parkers and Lochlees, suggest the peak flood levels shown in the Sensitivity Case are up to 0.13m less than the corresponding values in the original Base Case.

Table 2.6: Peak River Heights and Flows for Northern Levee Development -Q20 Flood Event

Levee Chainage	Water Height	Water Flow	Levee Chainage	Water Height	Water Flow
(m)	(m AHD)	(m^3/s)	(m)	(m AHD)	(m^3/s)
0	164.585 0.	0	3400	164.438 3.	0
100	164.709 0.	0	3500	164.438 3.	0
200	164.852 0.	0	3600	164.438 3.	0
300	164.852 0.	0	3700	164.438 3.	0
400 16	4.842	0.0	3800	163.503	182.6
500 16	4.839	0.0	3900	163.447	182.5
600 16	4.833	0.0	4000	163.423	182.5
700 16	4.827	0.0	4100	163.395	182.4
800 16	4.821	0.0	4200	163.374	182.4
900 16	4.816	0.0	4300	163.352	182.4

Levee Chainage	Water Height	Water Flow	Levee Chainage	Water Height	Water Flow
1000 16	4.810	0.0	4400	163.352	182.4
1100 16	4.804	0.0	4500	163.352	182.4
1200 16	4.804	0.0	4600	163.352	182.4
1300 16	4.765	3.0	4700	163.330	182.3
1400 16	4.765	3.0	4800	163.303	182.3
1500 16	4.765	3.0	4900	163.279	182.3
1600 16	4.765	3.0	5000	163.254	182.3
1700 16	4.765	3.0	5100	163.063	182.1
1800 16	4.765	3.0	5200	163.026	182.1
1900 16	4.765	3.0	5300	162.999	182.1
2000 16	4.765	3.0	5400	162.975	182.1
2100 16	4.474	846.0	5500	162.936	182.1
2200 16	4.438	846.0	5600	162.911	182.1
2300 16	4.436	795.1	5700	162.889	182.1
2400 16	4.434	745.7	5800	162.864	182.1
2500 16	4.434	740.6	5900	162.801	182.1
2600 16	4.434	737.0	6000	162.789	182.1
2700 16	4.431	682.5	6100	162.766	182.1
2800 16	4.438	3.0	6200	162.741	182.1
2900 16	4.438	3.5	6300	162.720	182.1
3000 16	4.438	3.0	6400	162.697	182.1
3100 16	4.438	3.0	6500	162.676	182.1
3200 16	4.438	3.0	6600	162.676	182.1
3300 16	4.438	3.0	6620	162.676	182.1
Duckponds GS	154.487	2,772.9			

The introduction of the northern levee results in the peak flood level at Duckponds GS increasing by 0.011m. The peak flow also increases by 2.3% or 62 m^3/s. At the downstream end of the Codenwarra Levee this increase is 0.083m.

Table 2.7: Peak River Heights and Flows for Northern and Southern Levee Development - Q20 Flood Event

Levee Chainage	Water Height	Water Flow	Levee Chainage	Water Height	Water Flow
(m)	(m AHD)	(m^3/s)	(m)	(m AHD)	(m^3/s)
0	164.585 0.	0	3400	164.438 3.	0
100	164.709 0.	0	3500	164.438 3.	0
200	164.852 0.	0	3600	164.438 3.	0
300	164.852 0.	0	3700	164.438 3.	0
400 16	4.842	0.0	3800	163.503	182.6
500 16	4.839	0.0	3900	163.447	182.5
600 16	4.833	0.0	4000	163.423	182.5
700 16	4.827	0.0	4100	163.395	182.4
800 16	4.821	0.0	4200	163.374	182.4
900 16	4.816	0.0	4300	163.352	182.4
1000 16	4.810	0.0	4400	163.352	182.4
1100 16	4.804	0.0	4500	163.352	182.4
1200 16	4.804	0.0	4600	163.352	182.4
1300 16	4.765	3.0	4700	163.330	182.3
1400 16	4.765	3.0	4800	163.303	182.3
1500 16	4.765	3.0	4900	163.279	182.3
1600 16	4.765	3.0	5000	163.254	182.3
1700 16	4.765	3.0	5100	163.063	182.1
1800 16	4.765	3.0	5200	163.026	182.1
1900 16	4.765	3.0	5300	162.999	182.1
2000 16	4.765	3.0	5400	162.975	182.1
2100 16	4.474	846.0	5500	162.936	182.1
2200 16	4.438	846.0	5600	162.911	182.1
2300 16	4.436	795.1	5700	162.889	182.1
2400 16	4.434	745.7	5800	162.864	182.1
2500 16	4.434	740.6	5900	162.801	182.1
2600 16	4.434	737.0	6000	162.789	182.1
2700 16	4.431	682.5	6100	162.766	182.1
2800 16	4.438	3.0	6200	162.741	182.1
2900 16	4.438	3.5	6300	162.720	182.1
3000 16	4.438	3.0	6400	162.697	182.1
3100 16	4.438	3.0	6500	162.676	182.1
3200 16	4.438	3.0	6600	162.676	182.1
3300 16	4.438	3.0	6620	162.676	182.1
Duckponds GS	154.479	2,769.7			

The inclusion of both the Northern and Southern Levees indicates that the increase is 0.083m at the downstream end of the Codenwarra Levee, whilst the increase at Duckponds GS is only 0.003m. The peak flow is again only around 2.2% greater than the Sensitivity Base Case scenario. This highlights the fact that with the new roughness coefficients, there appears to be quite a significant re-distribution of the flood flow between the main Nogoa River channel and the flood plain flow paths.

2.4.3 Q50 Flood Scenario

Table 2.8: Peak River Heights and Flows for Base Case Development -Q50 Flood Event

Levee Chainage	Water Height	Water Flow	Levee Chainage	Water Height	Water Flow
(m)	(m AHD)	(m^3/s)	(m)	(m AHD)	(m^3/s)
0	164.585 0.	0	3400	164.870 3.	0
100	164.709 0.	0	3500	164.870 3.	0
200	164.852 0.	0	3600	164.870 3.	0
300	164.852 0.	0	3700	164.870 3.	0
400 16	4.842	0.0	3800	164.087	354.5
500 16	4.839	0.0	3900	164.045	354.4
600 16	4.833	0.0	4000	164.028	354.3
700 16	4.827	0.0	4100	164.006	354.3
800 16	4.821	0.0	4200	163.991	354.2
900 16	4.816	0.0	4300	163.974	354.2
1000 16	4.810	0.0	4400	163.974	354.2
1100 16	4.804	0.0	4500	163.974	354.2
1200 16	4.804	0.0	4600	163.974	354.2
1300 16	5.293	3.0	4700	163.960	354.1
1400 16	5.293	3.0	4800	163.944	354.1
1500 16	5.293	3.0	4900	163.930	354.1
1600 16	5.293	3.0	5000	163.914	354.1
1700 16	5.293	3.0	5100	163.799	353.9
1800 16	5.293	3.0	5200	163.777	353.8
1900 16	5.293	3.0	5300	163.761	353.8
2000 16	5.293	3.0	5400	163.736	353.8
2100 16	4.916	1339.7	5500	163.698	353.8
2200 16	4.870	1339.7	5600	163.672	353.8
2300 16	4.869	1243.4	5700	163.645	353.8
2400 16	4.867	1149.8	5800	163.610	353.8
2500 16	4.867	1140.2	5900	163.524	353.8
2600 16	4.867	1133.3	6000	163.507	353.8
2700 16	4.866	1030.1	6100	163.475	353.8
2800 16	4.870	3.0	6200	163.441	353.8
2900 16	4.870	4.1	6300	163.411	353.8
3000 16	4.870	3.0	6400	163.380	353.8
3100 16	4.870	3.0	6500	163.351	353.8
3200 16	4.870	3.0	6600	163.351	353.8
3300 16	4.870	3.0	6620	163.351	353.8
Duckponds GS	155.141	3,042.1			

Table 2.9: Peak River Heights and Flows for Northern Levee Development -Q50 Flood Event

Levee Chainage	Water Height	Water Flow	Levee Chainage	Water Height	Water Flow
(m)	(m AHD)	(m^3/s)	(m)	(m AHD)	(m^3/s)
0	164.585 0.	0	3400	164.916 3.	0
100	164.709 0.	0	3500	164.916 3.	0
200	164.852 0.	0	3600	164.916 3.	0
300	164.852 0.	0	3700	164.916 3.	0
400 16	4.842	0.0	3800	164.149	373.8
500 16	4.839	0.0	3900	164.108	373.7
600 16	4.833	0.0	4000	164.091	373.7
700 16	4.827	0.0	4100	164.070	373.6
800 16	4.821	0.0	4200	164.055	373.6
900 16	4.816	0.0	4300	164.039	373.5
1000 16	4.810	0.0	4400	164.039	373.5
1100 16	4.804	0.0	4500	164.039	373.5
1200 16	4.804	0.0	4600	164.039	373.5
1300 16	5.324	3.0	4700	164.026	373.5
1400 16	5.324	3.0	4800	164.010	373.5
1500 16	5.324	3.0	4900	163.997	373.4
1600 16	5.324	3.0	5000	163.982	373.4
1700 16	5.324	3.0	5100	163.872	373.2
1800 16	5.324	3.0	5200	163.851	373.2
1900 16	5.324	3.0	5300	163.835	373.2
2000 16	5.324	3.0	5400	163.810	373.2
2100 16	4.960	1339.7	5500	163.772	373.1
2200 16	4.916	1339.7	5600	163.746	373.1
2300 16	4.915	1243.4	5700	163.718	373.1
2400 16	4.914	1149.8	5800	163.683	373.1
2500 16	4.914	1140.2	5900	163.594	373.1
2600 16	4.914	1133.3	6000	163.577	373.2
2700 16	4.912	1030.1	6100	163.545	373.2
2800 16	4.916	3.0	6200	163.509	373.2
2900 16	4.916	4.3	6300	163.479	373.2
3000 16	4.916	3.0	6400	163.447	373.2
3100 16	4.916	3.0	6500	163.417	373.2
3200 16	4.916	3.0	6600	163.417	373.2
3300 16	4.916	3.0	6620	163.417	373.2
Duckponds GS	155.135	3,090.3			

Table 2.10: Peak River Heights and Flows for Northern and Southern Levee Development - Q50 Flood Event

Levee Chainage	Water Height	Water Flow	Levee Chainage	Water Height	Water Flow
(m)	(m AHD)	(m^3/s)	(m)	(m AHD)	(m^3/s)
0	164.585 0.	0	3400	164.936 3.	0
100	164.709 0.	0	3500	164.936 3.	0
200	164.852 0.	0	3600	164.936 3.	0
300	164.852 0.	0	3700	164.936 3.	0
400 16	4.842	0.0	3800	164.176	378.3
500 16	4.839	0.0	3900	164.135	378.2
600 16	4.833	0.0	4000	164.119	378.2
700 16	4.827	0.0	4100	164.098	378.1
800 16	4.822	0.0	4200	164.084	378.0
900 16	4.816	0.0	4300	164.068	378.0
1000 16	4.810	0.0	4400	164.068	378.0
1100 16	4.804	0.0	4500	164.068	378.0
1200 16	4.804	0.0	4600	164.068	378.0
1300 16	5.348	3.0	4700	164.055	378.0
1400 16	5.348	3.0	4800	164.040	377.9
1500 16	5.348	3.0	4900	164.026	377.9
1600 16	5.348	3.0	5000	164.012	377.9
1700 16	5.348	3.0	5100	163.903	377.7
1800 16	5.348	3.0	5200	163.882	377.7
1900 16	5.348	3.0	5300	163.867	377.6
2000 16	5.348	3.0	5400	163.842	377.6
2100 16	4.981	1357.3	5500	163.804	377.6
2200 16	4.936	1357.3	5600	163.778	377.6
2300 16	4.935	1257.0	5700	163.750	377.6
2400 16	4.934	1159.6	5800	163.715	377.6
2500 16	4.934	1149.6	5900	163.625	377.6
2600 16	4.934	1142.4	6000	163.608	377.6
2700 16	4.933	1035.0	6100	163.575	377.6
2800 16	4.936	3.0	6200	163.540	377.6
2900 16	4.936	4.3	6300	163.509	377.6
3000 16	4.936	3.0	6400	163.477	377.6
3100 16	4.936	3.0	6500	163.447	377.6
3200 16	4.936	3.0	6600	163.447	377.6
3300 16	4.936	3.0	6620	163.447	377.6
Duckponds GS	155.132	3073.5			

2.4.3 Q100 Flood Scenario

Table 2.11: Peak River Heights and Flows for Base Case Development - Q100 Flood Event

Levee Chainage	Water Height	Water Flow	Levee Chainage	Water Height	Water Flow
(m)	(m AHD)	(m^3/s)	(m)	(m AHD)	(m^3/s)
0	164.585 0.	0	3400	165.236 3.	0
100	164.709 0.	0	3500	165.236 3.	0
200	164.852 0.	0	3600	165.236 3.	0
300	164.852 0.	0	3700	165.236 3.	0
400 16	4.842	0.0	3800	164.577	511.5
500 16	4.839	0.0	3900	164.543	511.4
600 16	4.833	0.0	4000	164.529	511.4
700 16	4.827	0.0	4100	164.511	511.3
800 16	4.821	0.0	4200	164.498	511.2
900 16	4.816	0.0	4300	164.485	511.2
1000 16	4.810	0.0	4400	164.485	511.2
1100 16	4.804	0.0	4500	164.485	511.2
1200 16	4.804	0.0	4600	164.485	511.2
1300 16	5.701	3.0	4700	164.474	511.2
1400 16	5.701	3.0	4800	164.462	511.1
1500 16	5.701	3.0	4900	164.451	511.1
1600 16	5.701	3.0	5000	164.439	511.1
1700 16	5.701	3.0	5100	164.352	510.9
1800 16	5.701	3.0	5200	164.335	510.9
1900 16	5.701	3.0	5300	164.323	510.8
2000 16	5.701	3.0	5400	164.298	510.8
2100 16	5.287	1772.6	5500	164.258	510.8
2200 16	5.236	1772.6	5600	164.232	510.8
2300 16	5.235	1634.2	5700	164.202	510.8
2400 16	5.234	1499.7	5800	164.162	510.8
2500 16	5.234	1485.9	5900	164.062	510.8
2600 16	5.234	1476.0	6000	164.042	510.8
2700 16	5.233	1327.7	6100	164.005	510.8
2800 16	5.236	3.0	6200	163.965	510.8
2900 16	5.236	4.5	6300	163.931	510.8
3000 16	5.236	3.0	6400	163.895	510.8
3100 16	5.236	3.0	6500	163.861	510.8
3200 16	5.236	3.0	6600	163.861	510.8
3300 16	5.236	3.0	6620	163.861	510.8
Duckponds GS	155.595	3,473.2			

Table 2.12: Peak River Heights and Flows for Northern Levee Development - Q100 Flood Event

Levee Chainage	Water Height	Water Flow	Levee Chainage	Water Height	Water Flow
(m)	(m AHD)	(m^3/s)	(m)	(m AHD)	(m^3/s)
0	164.585 0.	0	3400	165.267 3.	0
100	164.709 0.	0	3500	165.267 3.	0
200	164.852 0.	0	3600	165.267 3.	0
300	164.852 0.	0	3700	165.267 3.	0
400 16	4.842	0.0	3800	164.617	524.6
500 16	4.839	0.0	3900	164.583	524.5
600 16	4.833	0.0	4000	164.569	524.4
700 16	4.827	0.0	4100	164.552	524.4
800 16	4.821	0.0	4200	164.540	524.3
900 16	4.816	0.0	4300	164.527	524.3
1000 16	4.810	0.0	4400	164.527	524.3
1100 16	4.804	0.0	4500	164.527	524.3
1200 16	4.804	0.0	4600	164.527	524.3
1300 16	5.721	3.0	4700	164.516	524.2
1400 16	5.721	3.0	4800	164.504	524.2
1500 16	5.721	3.0	4900	164.494	524.2
1600 16	5.721	3.0	5000	164.482	524.2
1700 16	5.721	3.0	5100	164.397	524.0
1800 16	5.721	3.0	5200	164.380	523.9
1900 16	5.721	3.0	5300	164.368	523.9
2000 16	5.721	3.0	5400	164.343	523.9
2100 16	5.316	1778.8	5500	164.303	523.9
2200 16	5.267	1778.8	5600	164.277	523.9
2300 16	5.266	1637.5	5700	164.247	523.9
2400 16	5.265	1500.1	5800	164.207	523.9
2500 16	5.265	1486.0	5900	164.106	523.9
2600 16	5.265	1475.9	6000	164.086	523.9
2700 16	5.264	1324.4	6100	164.049	523.9
2800 16	5.267	3.0	6200	164.009	523.9
2900 16	5.267	4.7	6300	163.975	523.9
3000 16	5.267	3.0	6400	163.938	523.9
3100 16	5.267	3.0	6500	163.904	523.9
3200 16	5.267	3.0	6600	163.904	523.9
3300 16	5.267	3.0	6620	163.904	523.9
Duckponds GS	155.535	3552.6			

Table 2.13: Peak River Heights and Flows for Northern and Southern Levee Development - Q100 Flood Event

Levee Chainage	Water Height	Water Flow	Levee Chainage	Water Height	Water Flow
(m)	(m AHD)	(m^3/s)	(m)	(m AHD)	(m^3/s)
0	164.585 0.	0	3400	165.267 3.	0
100	164.709 0.	0	3500	165.267 3.	0
200	164.852 0.	0	3600	165.267 3.	0
300	164.852 0.	0	3700	165.267 3.	0
400 16	4.842	0.0	3800	164.617	524.6
500 16	4.839	0.0	3900	164.583	524.5
600 16	4.833	0.0	4000	164.569	524.4
700 16	4.827	0.0	4100	164.552	524.4
800 16	4.821	0.0	4200	164.540	524.3
900 16	4.816	0.0	4300	164.527	524.3
1000 16	4.810	0.0	4400	164.527	524.3
1100 16	4.804	0.0	4500	164.527	524.3
1200 16	4.804	0.0	4600	164.527	524.3
1300 16	5.721	3.0	4700	164.516	524.2
1400 16	5.721	3.0	4800	164.504	524.2
1500 16	5.721	3.0	4900	164.494	524.2
1600 16	5.721	3.0	5000	164.482	524.2
1700 16	5.721	3.0	5100	164.397	524.0
1800 16	5.721	3.0	5200	164.380	523.9
1900 16	5.721	3.0	5300	164.368	523.9
2000 16	5.721	3.0	5400	164.343	523.9
2100 16	5.316	1778.8	5500	164.303	523.9
2200 16	5.267	1778.8	5600	164.277	523.9
2300 16	5.266	1637.5	5700	164.247	523.9
2400 16	5.265	1500.1	5800	164.207	523.9
2500 16	5.265	1486.0	5900	164.106	523.9
2600 16	5.265	1475.9	6000	164.086	523.9
2700 16	5.264	1324.4	6100	164.049	523.9
2800 16	5.267	3.0	6200	164.009	523.9
2900 16	5.267	4.7	6300	163.975	523.9
3000 16	5.267	3.0	6400	163.938	523.9
3100 16	5.267	3.0	6500	163.904	523.9
3200 16	5.267	3.0	6600	163.904	523.9
3300 16	5.267	3.0	6620	163.904	523.9
Duckponds GS	155.536	3553.6			

Figures depicting the peak flood heights compared to the ground and levee levels can be found in Appendix A.

2.5 PARKER DEVELOPMENT SUPPLY CHANNEL

2.5.1 Q20 Flood Scenario

The removal of the Parker Developm ent Supply Channel reduces the upstream peak flood level by up to 800mm . In the imm ediate vicinity of the Supply Channel the im pacts are m ost noticeable, with both increases and decreases to flood levels wh ich occur in response to the altered flood flow patterns over the flood plain. Additional flow traverses the floo d runners o n the southern flood plain due to the removal of the Supply Channel resulting in increased levels in these areas, includ ing 790mm at Lochless, and 100mm at Braylands . The f low re-distribu tion lowers level by up to 150mm in the main Nogoa River reach between Bridge Flats and Wyuna.

Adjacent to the Coden warra Levee, peak floo d levels are reduced by between 8 00mm at the downstream end of the levee (C hainage 6,620m) and 120mm at the upstream end of the levee (Chainage 2,000m).

3.0 SUMMARY

A sensitivity assessment has been conducted on the Nogoa River Flood Plain Board's numerical model. This sensitivity assessment is predicated on the basis that there was a peak flood flow of around 3,000 m^3/s at Duckponds Gauging Station during the January 2008 flood event. The adopted Base Case Manning's roughness coefficients were then adjusted to ensure that a peak flood level was attained based upon this assumed flow rate.

The proposed Ensham Resources Pty Ltd Ensham Mine levees (Northern and Southern Levees) have been incorporated into the Sensitivity Base Case and various design flood event scenarios have been examined using the MIKE11 hydrodynamic model. Comparisons between the various model configurations have been made.

The sensitivity testing indicates that with the incorporation of the Northern and Southern Levees flood levels are raised by up to 72mm at the Codenwarra Levee for the January 2008 flood event. The absolute levels however are less that the peak flood levels predicted under the original Base Case simulation. The corresponding increases for the design events are as follows:

- Q20 increases of up to 98 mm
- Q50 increase of up to 75 mm
- Q100 increases of up to 45 mm

The modifications indicate that the MIKE-11 model is sensitive to changes in roughness coefficients and that both peak flood levels and flood flows are impacted by such changes.

The absolute levels derived from the Sensitivity Base Case are less that the peak flood levels predicted under the original Base Case simulation. For example, comparisons of the peak flood level at Bridge Flats under the original Base Case calibration for the Q20 event was EL 164.43 m compared with the Sensitivity Case peak level of EL 164.36 m. These results indicate that the Sensitivity Base Case produces absolute flood levels that are lower than the corresponding Adopted Topographical Base Case for the range of design floods investigated. Similar values were noted for the inclusion of only the Northern Levee.

In all cases examined, the peak flood levels were significantly less than the Codenwarra Levee crest level indicating that the levee provides substantial protection against the design flood event scenarios considered.

The removal of the Parker Development Supply Channel significantly impacts peak flood levels and flow patterns in the immediate vicinity of the Supply Channel. Adjacent to the Codenwarra Levee, peak flood levels are reduced by between 800mm at the downstream end of the levee (Chainage 6,620m) and 120mm at the upstream end of the levee (Chainage 2,000m). Additional flow traverses the flood runners on the southern flood plain due to the removal of the Supply Channel resulting in increased levels in these areas, including 790mm at Lochless, and 100mm at Braylands.

4.0 REFERENCES

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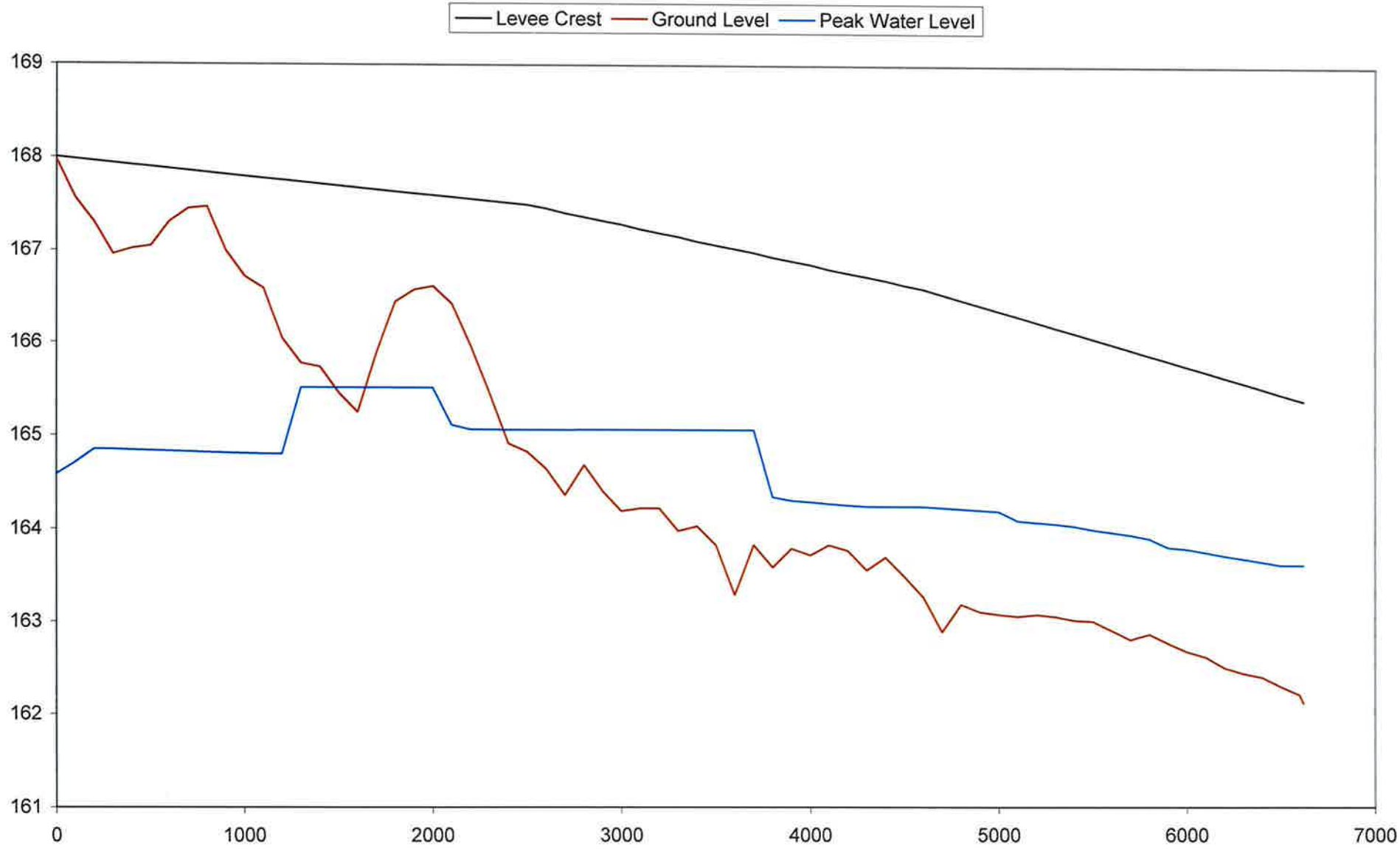
APPENDIX A

PEAK WATER HEIGHT GRAPHICS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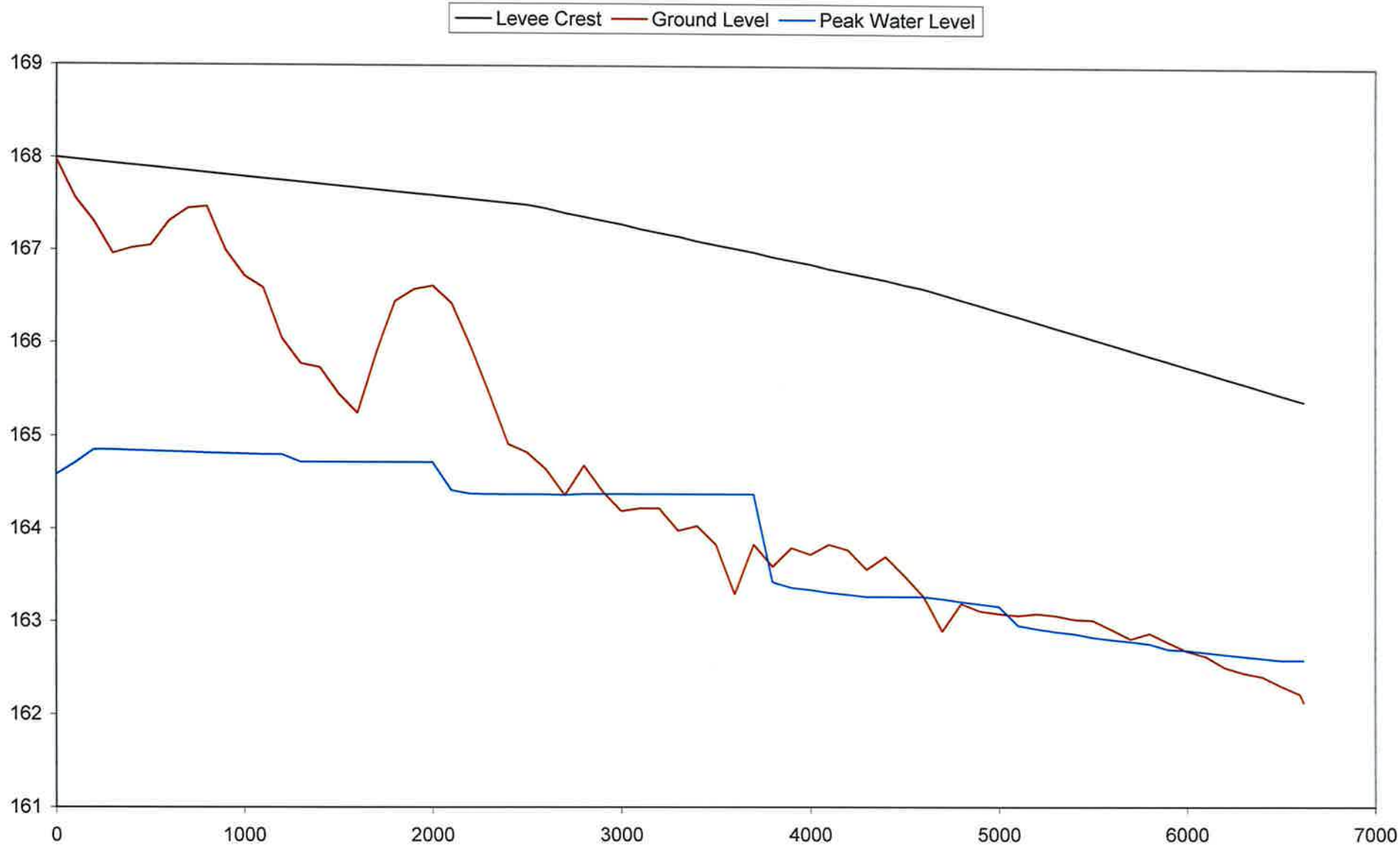
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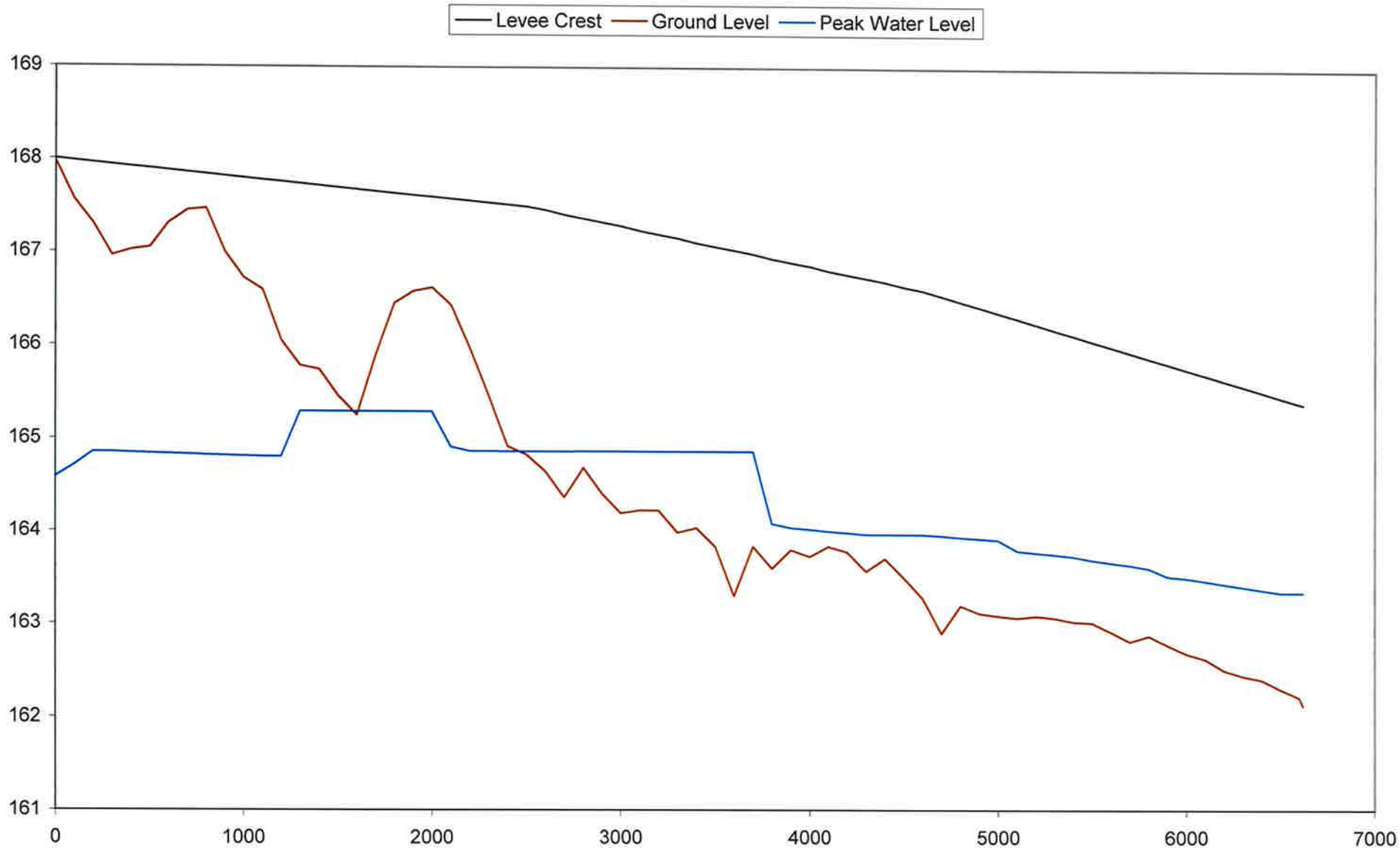
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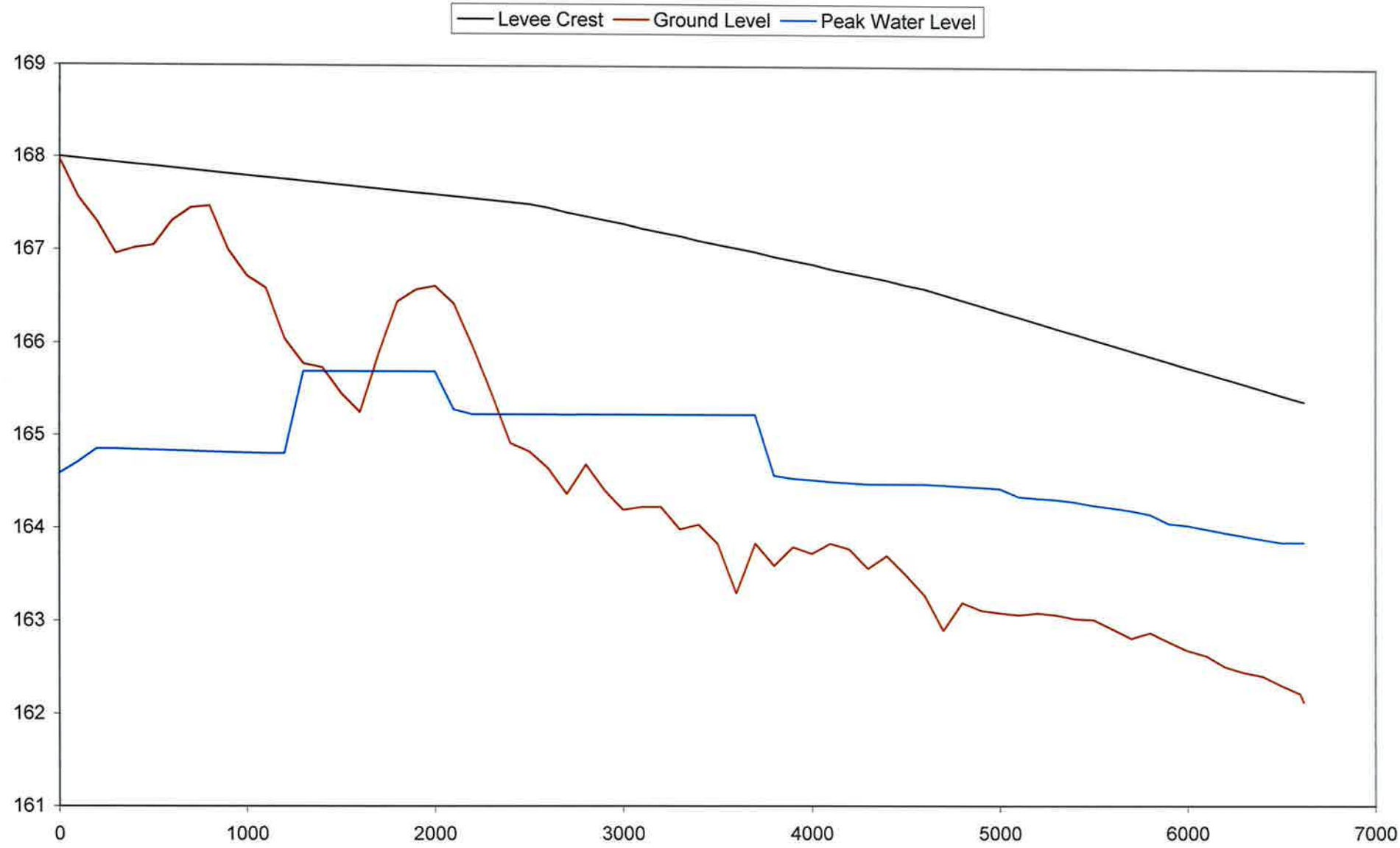
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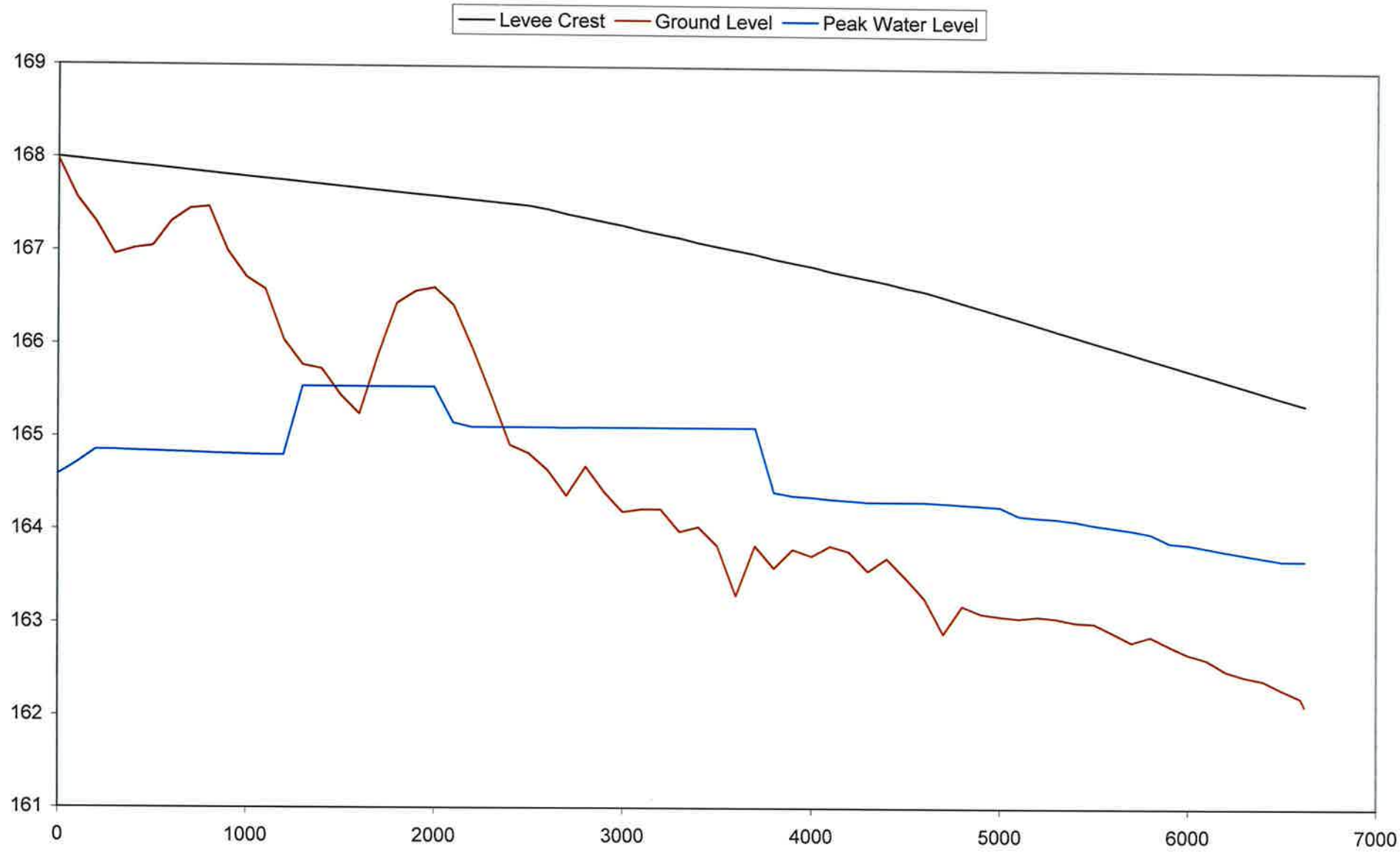
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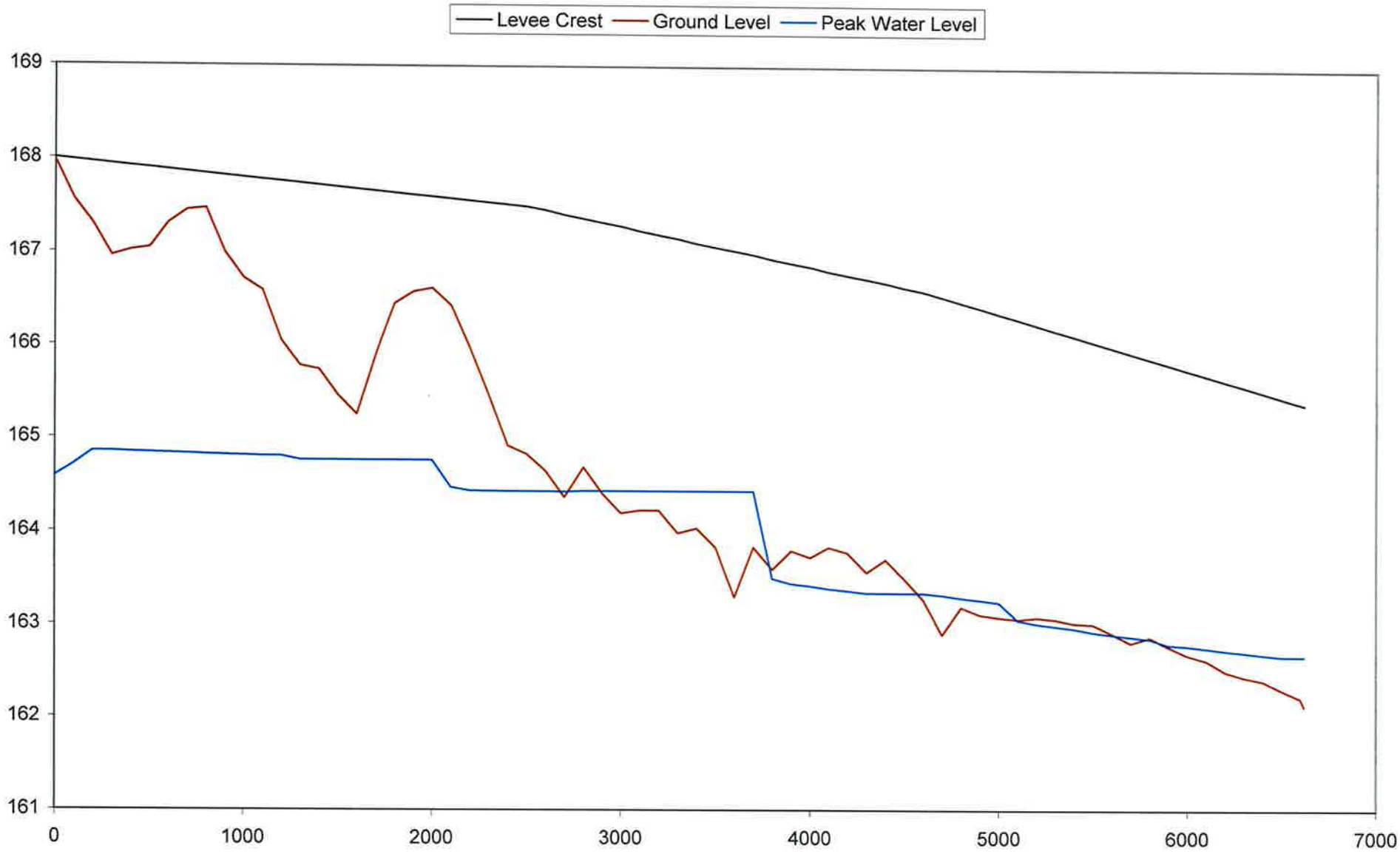
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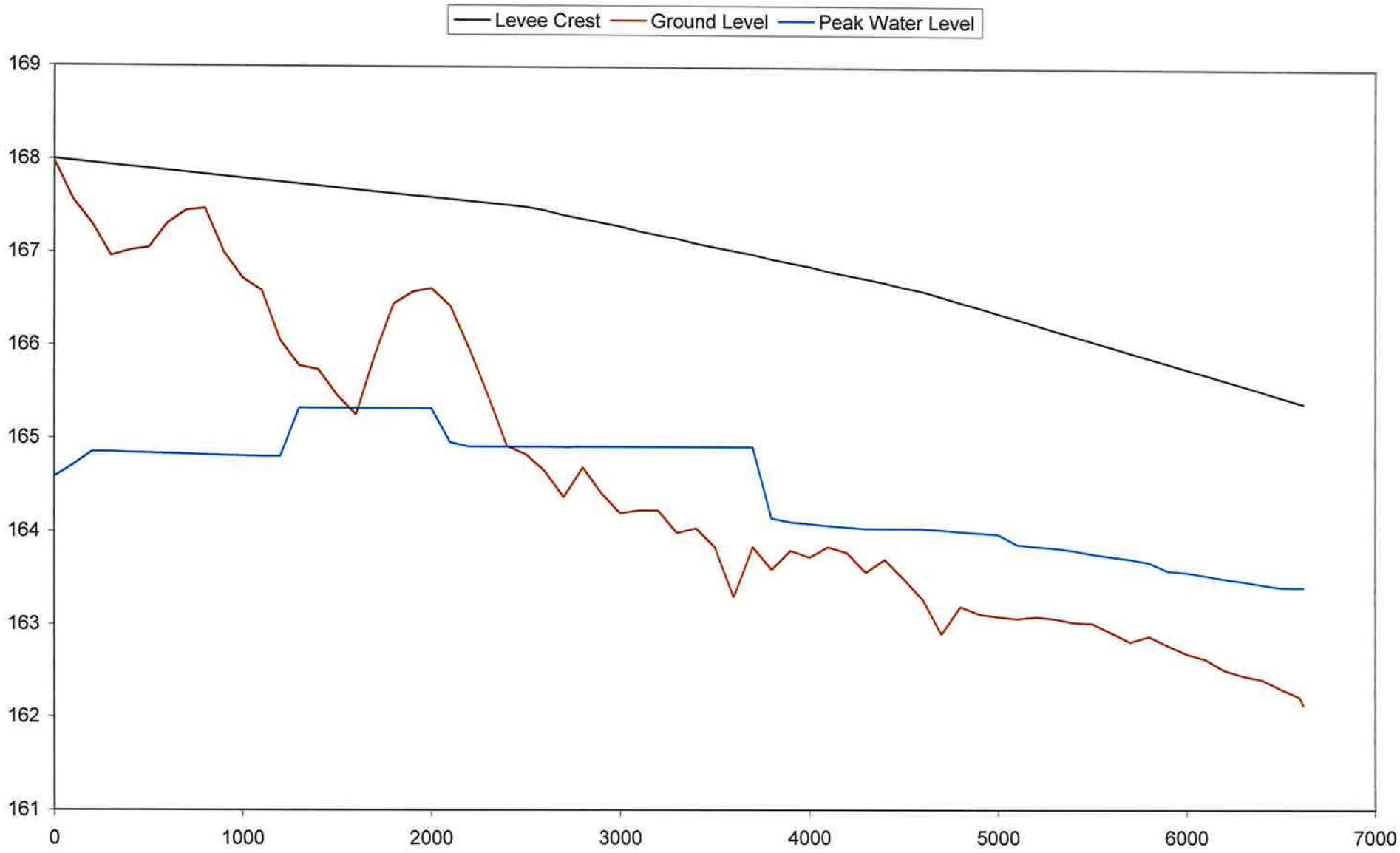
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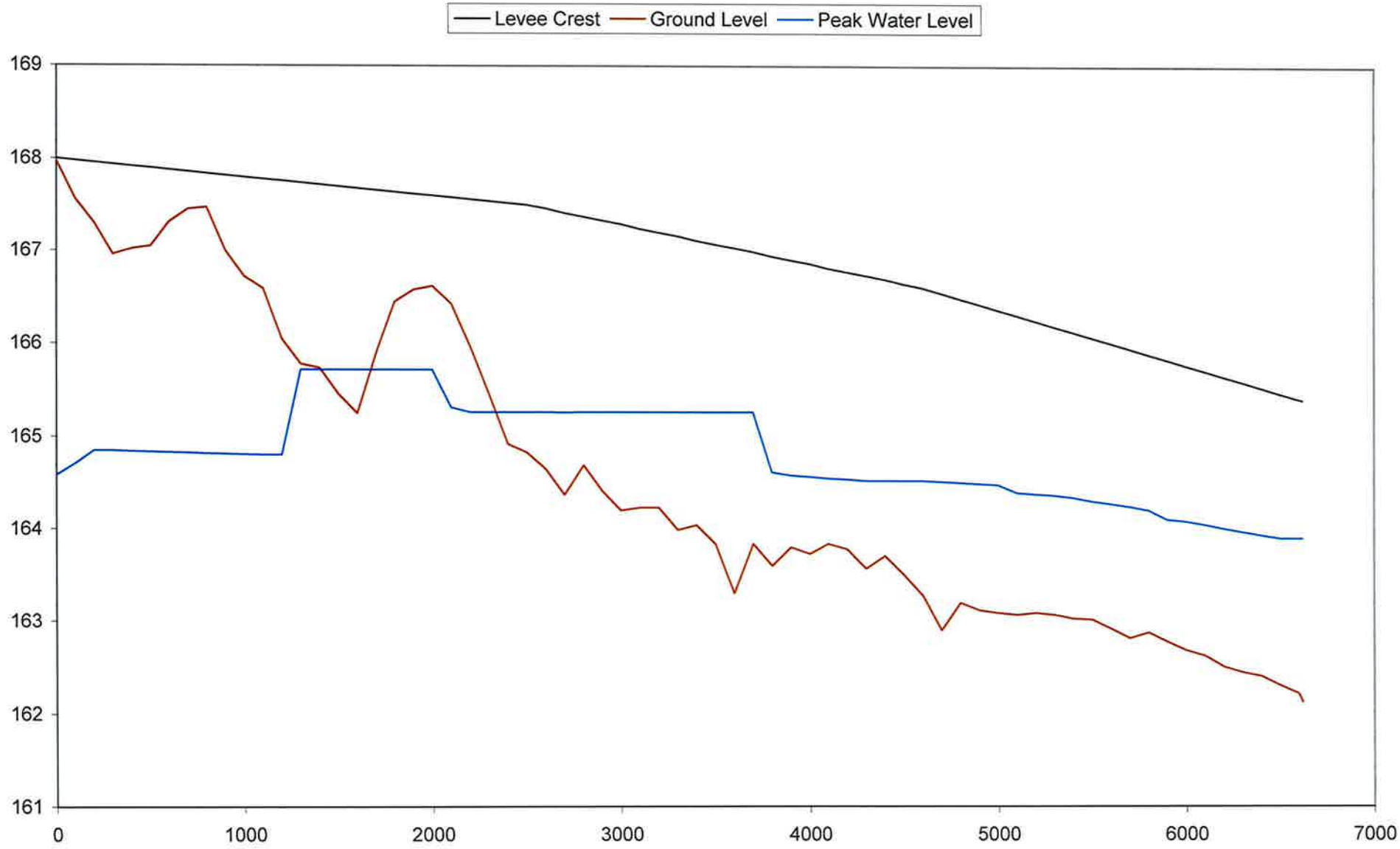
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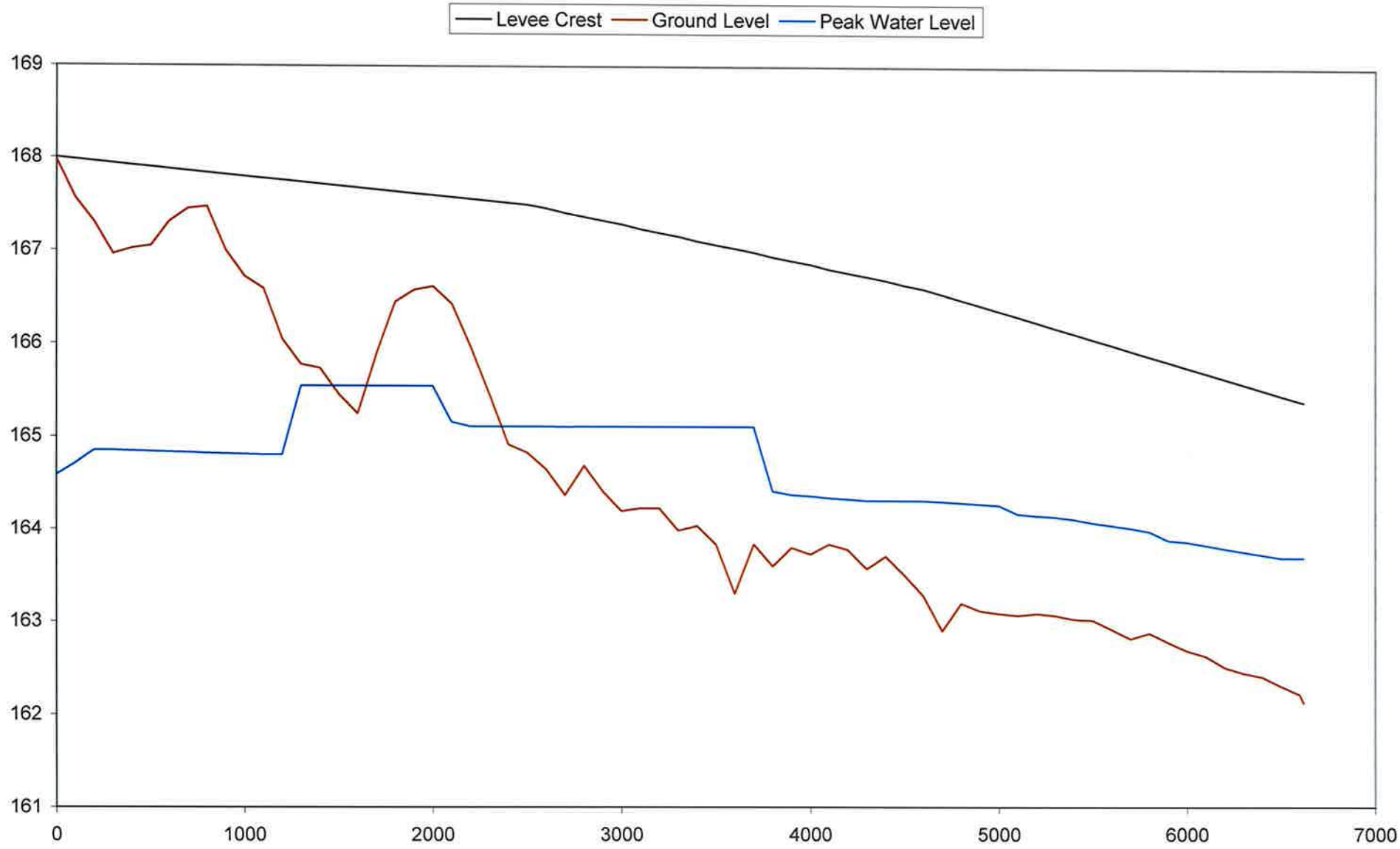
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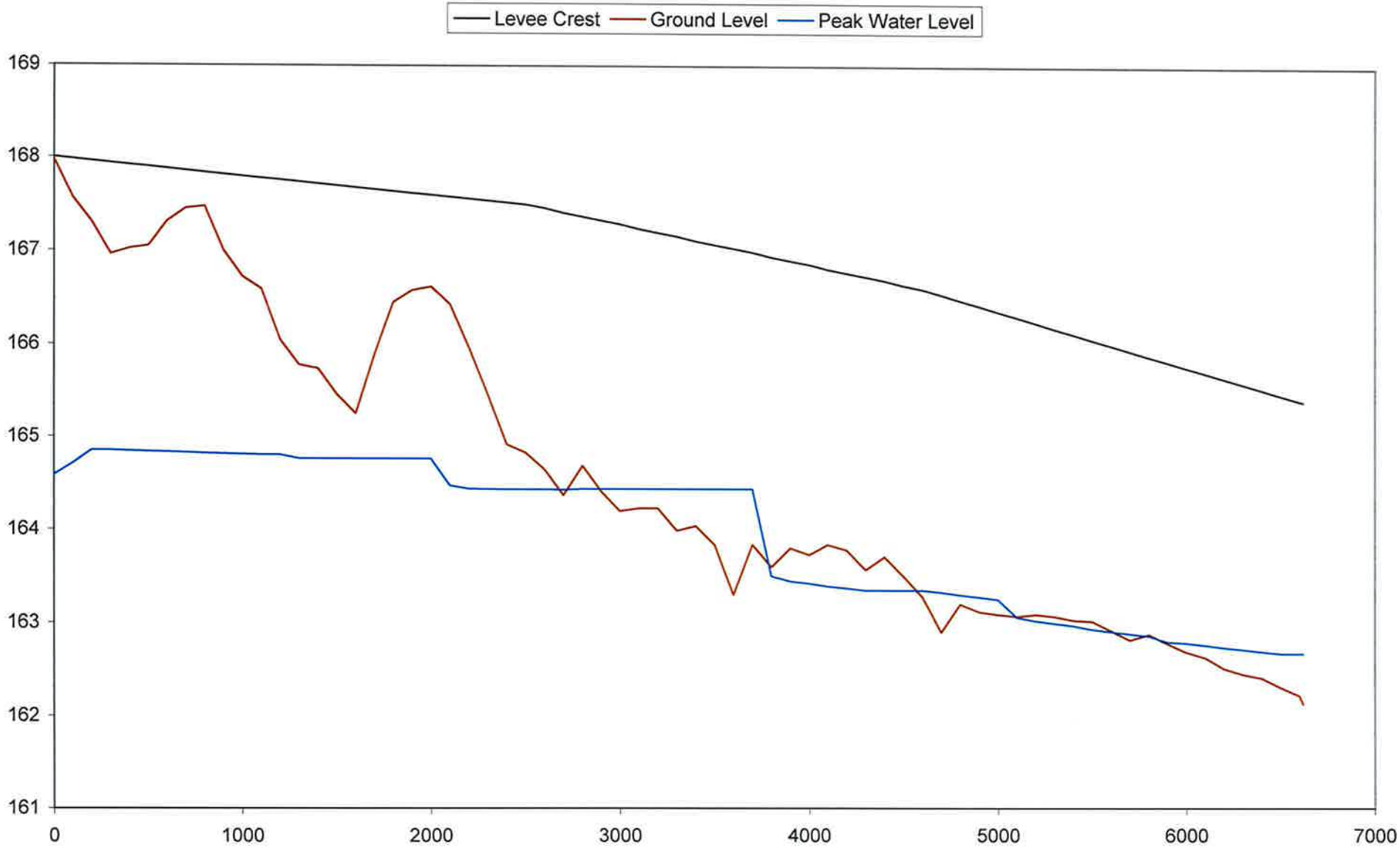
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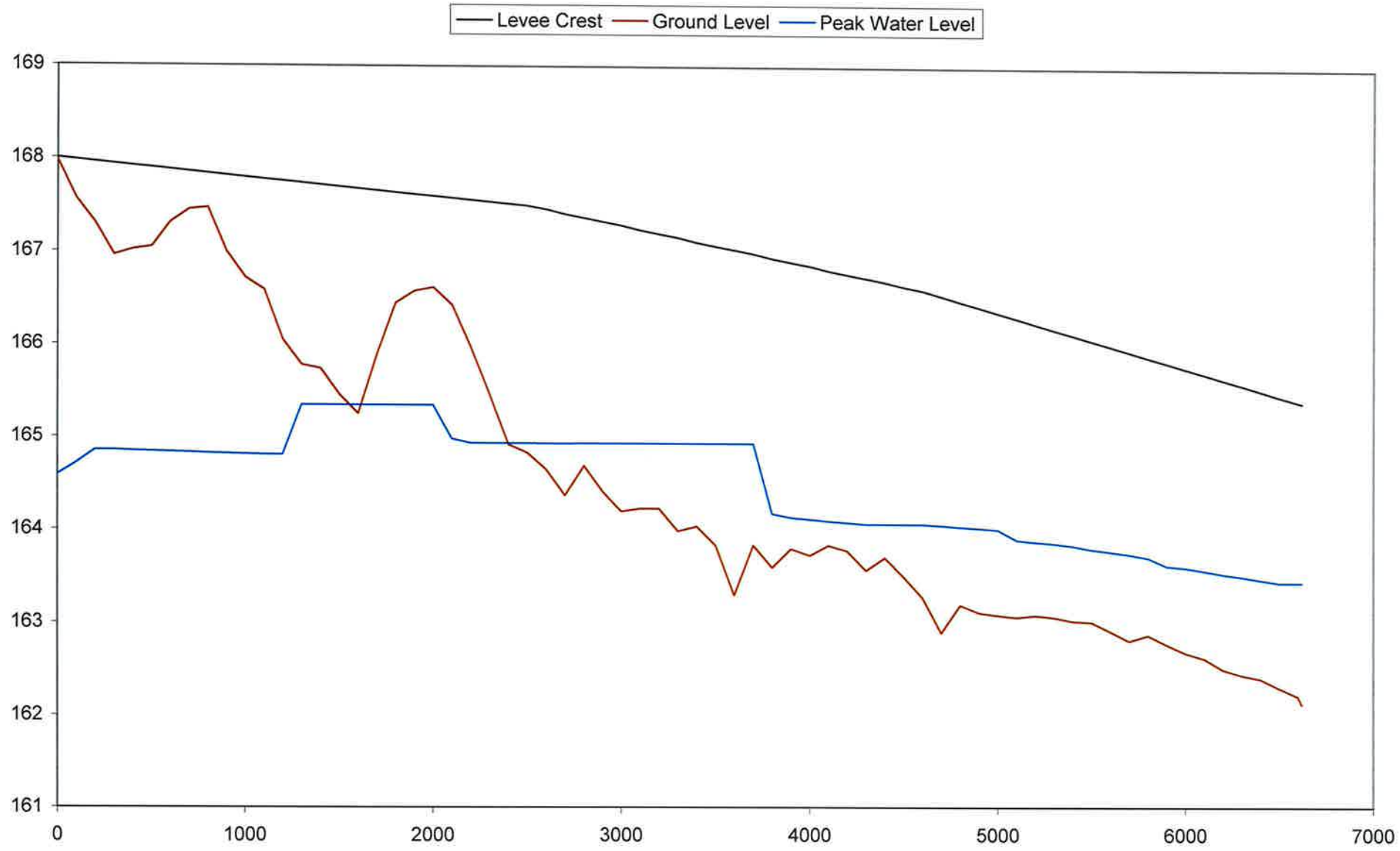
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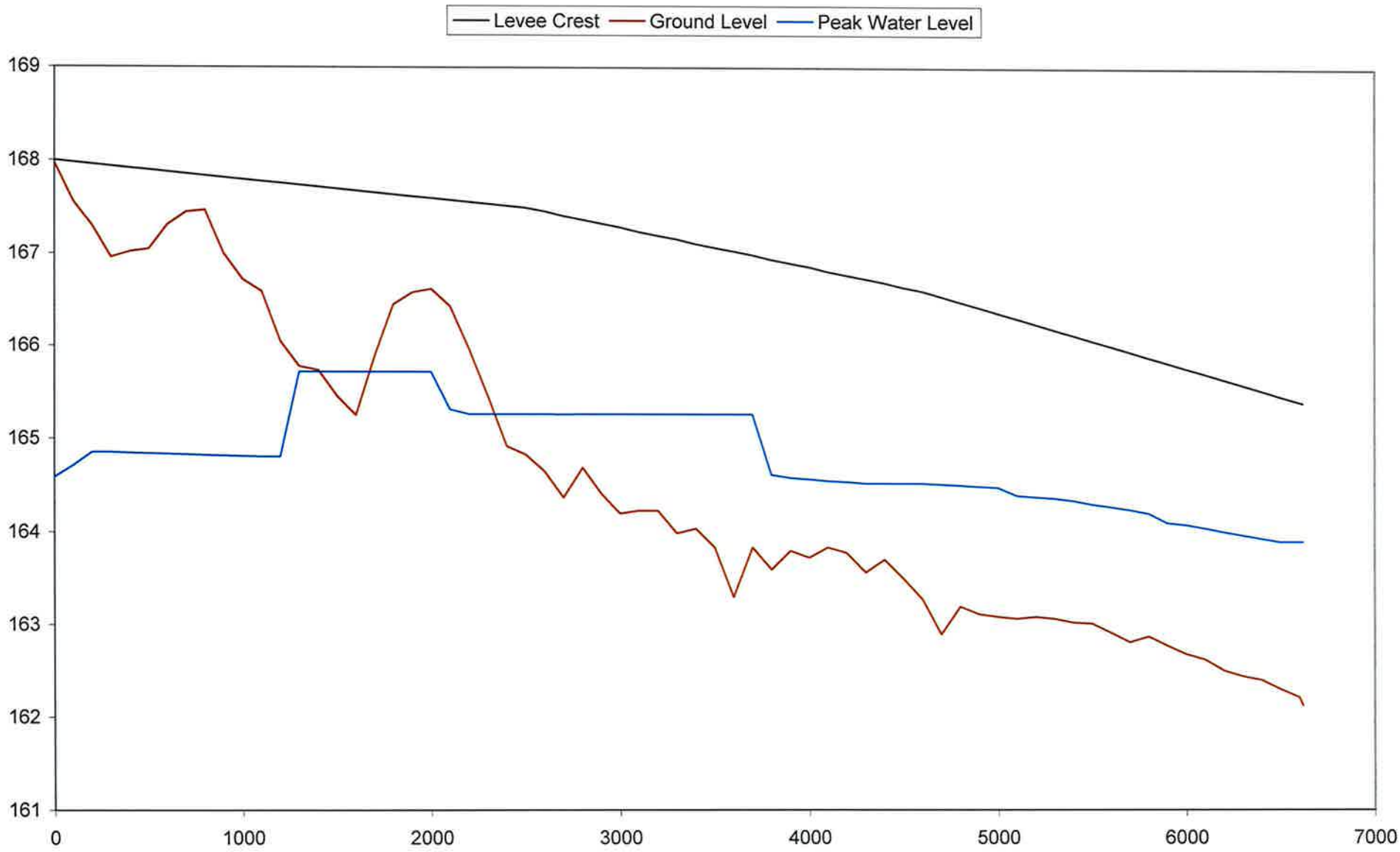
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SunWater
Website: www.sunwater.com.au

SunWater Limited ACN 131 034 985

Level 10, 179 Turbot Street PO Box 15536 City East Qld 4002 www.sunwater.com.au

Our ref: 08-004766/001
Contact Name: Rob Ayre
Telephone: [redacted]

22 September 2009

[redacted]
Manager Technical
Ensham Resources
GPO Box 814
BRISBANE QLD 4001

Dear Lloyd

ENSHAM CENTRAL PROJECT – RAISING OF ORIGINAL DOWNSTREAM LEVEES

SunWater was commissioned by Ensham Resources to review a report prepared by KBR, BEW801-W-REP-007 Rev.1, dated 10 August 2009, which underpins the application to the Nogoa River Flood Plain Board and the Department of Environment and Resource Management (DERM), of the upgrade to the original levee sections.

The original levees were approved by the Board in March 1998, refer to DNR Hydrology report 130213.PR/6. Another approval was issued for Ensham Mine Haul Road berm in April 2004, (SunWater report G-80405-02-01).

A subsequent application was submitted in December 2007 to extend the original levees. This application was assessed and reported in February 2008, refer to SunWater report 07-007593/001. However, in light of the January 2008 flood event which resulted in damage to some sections of the original levee, further applications were submitted for the rehabilitation and extension of the original levee in June 2008. (Refer to SunWater report 08-004766/001 and KBR report BEW801-W-REP-001 Rev. 0).

SunWater conducted a review of this proposal on behalf of the Coordinator General's Department in July 2008, (SunWater Report 08-004766/002 and associated covering letter). This resulted in the upstream levee banks being raised to provide a 1 in 1,000 year Annual Exceedence Probability (AEP) protection. It is understood that construction of the upstream levees was completed in July 2009.

The current KBR report concerns the application to raise the original levee sections to provide the same level of flood protection to the entire mine site. The standard of the flood protection has been defined as a requirement of DERM.

SunWater has been commissioned to review the hydraulic model impact assessment conducted by KBR to ensure that the modelling complies with the requirements of the Interim Flood Plain Management Plan (May 1997).

The report provides details of two cases:

- Base Case (R26 Levee)
- Mine Operations Case (A102 Levee)

The Base Case (R26 Levee) contains the approved upstream levee bank extensions as well as the recently approved Prime Ag (August 2008) levees that are situated on the Braylands property located immediately upstream of the Ensham Resources property boundary. The Mine Operations Case includes the Base Case with the proposed upgraded original downstream levees sections. The model cases were tested against a range of design flood events ranging from 1 in 2 year AEP up to 1 in 1,000 year AEP.

Of particular interest to the Nogoa River Flood Plain Board is the 1 in 20 year AEP design flood event, which has been adopted as the Designated Design Flood Event in the Interim Flood Plain Management Plan. Figure B3 and Table 4.2 summarise the 'afflux' that results from the inclusion of the upgraded levee sections under the 1 in 20 year AEP event. The tabulated results indicate a maximum increase in flood level at Ensham Resources property boundary of 0.01 m.

The Interim Flood Plain Management Plan (May 1997) states that the total permissible increase in peak water elevation at the property boundary is nil but this requirement may be varied at the absolute discretion of the Board. However, the Plan also indicates that irrespective of the above, the total cumulative effect of all works on the flood plain should not exceed 0.3 m at any property boundary over and above that occurring under the Adopted Base Case.

The KBR Base Case (R26 Levee) corresponds to the Nogoa River Flood Plain Board model run known as '*Case086AD*'. This is the Adopted Topographic Base Case (Case 086) including all Approved Developments. This model is used to determine the cumulative effect of all works on the flood plain. The KBR modelling therefore demonstrates the cumulative effect scenario.

The Interim Flood Plain Management Plan (May 1997) also has a requirement that the development within the flood plain should result in the maintenance of a series of flood-ways generally conforming to the natural drainage pattern. The modelling demonstrates that there has been no major change to the flow pattern post development.

Overall the modelling undertaken by KBR demonstrates that the raising of the original levees to the new flood protection standard consistent with the upstream is in general compliance with the measures outlined in the Interim Flood Plain Management Plan (May 1997).

It is noted that in the Appeal ruling of 23 February 2009, it was suggested that the Nogoa River Flood Plain Board needs to consider the appropriateness of the use of the 1 in 20 year AEP design flood event for assessing the level of risk the flood plain community is willing to be exposed to, given the experience of the January 2008 flood event.

This has been covered to some extent in the KBR model by the presentation of a range of design flood scenarios that are larger than the 1 in 20 year AEP event. Results presented in the KBR report for such events confirm that the overall impacts remain within the criteria specified in the Plan.

SunWater endorses the modelling that has been undertaken to substantiate the determination of the level of impact that is likely to arise due to the proposed raising of the original levee.

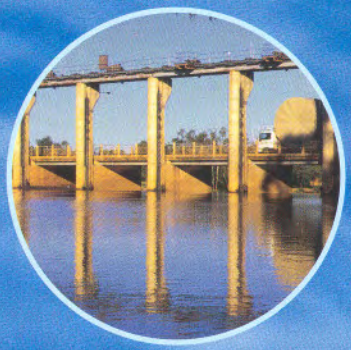
If any aspects of the report require clarification, please do not hesitate to contact the author on the phone number indicated.

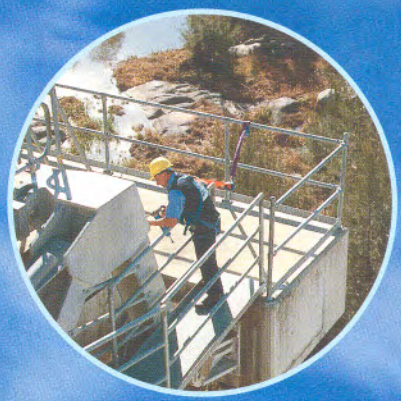
Yours faithfully

[redacted]

Rob Ayre[redacted]

ENGINEERING DESIGN MANAGER





Final Report

Nogoa River Flood Plain

Hydraulic Impacts Assessment

PrimeAG Australia Ltd Proposed Levee Banks

Date: August 2008
File: 08-006274

SunWater

Prepared by:

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Asset Solutions

Final Report

Nogoa River Flood Plain

Hydraulic Impacts Assessment

PrimeAG Australia Ltd Proposed Levee Banks

Date: August 2008
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Prepared for:
Nogoa River Flood Plain Board

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EXECUTIVE SUMMARY

The Nogoa River Flood Plain Board submitted a request to SunWater Asset Solutions in July 2008 to perform a hydraulic assessment of the likely impacts that would arise from a development proposal for PrimeAG Australia Pty Ltd, located on the Nogoa River. The development proposal was for the extension of levees along the southern banks of the Nogoa River in order to mitigate flooding of agricultural land.

The proposed levee assessment required the modification of twenty one cross sections to simulate the reduction in flow area that would be caused by the proposed development.

Two existing hydraulic models were used to assess the impacts on the Nogoa River flood plain caused by the levees. The first model used was the "1994 Topographic Base – Revised" (Case086) model. This model has been used to investigate all of the developments in the Nogoa Flood Plain in the past ten years. This scenario is comparable with all other proposal investigations undertaken by SunWater on behalf of the Nogoa Flood Plain Board over the past ten years as it has none of the approved developments included in the model. The second model used to assess the proposed development was the "Case 086 Approved Development model', (Case086AD) which was built in 2007, incorporating all approved developments in the Nogoa River Flood Plain between 1997 and 2007.

The proposed levee was then incorporated into the model and compared to the base case for the Designated Flood Event (the 20 year Annual Exceedence Probability 168 hour design flood event for the entire floodplain). The study found that there is significant impact on the Nogoa Flood Plain by the proposed levee in both Case 086 and Case086AD. Overland flow that runs between the proposed levees on the PrimeAG site during a 1 in 20 year AEP has an afflux of up to 0.72 and 0.73 meters in one channel and up to 0.66 and 0.69 meters in the other in Case 086 and Case086AD respectively. The high afflux is located within the boundaries of PrimeAG property, however it does also have a minor affect, less than 0.2 meters, on the downstream property owned by Ensham.

TABLE OF CONTENTS

1.0 INTRODUCTION 1
2.0 HYDRAULIC ANALYSIS 2
2.1 PROPOSED WORKS 2
2.2 HYDRAULIC MODEL MODIFICATIONS 2
2.2.1 Base Case Models 2
2.2.2 Proposed Development Case Model 3
2.3 HYDRAULIC MODEL RESULTS: 20 YEAR AEP 4
3.0 SUMMARY 6

LIST OF TABLES

Table 1: Modified Cross Sections 3
Table 2: Peak Flood Levels 4

LIST OF FIGURES

Figure 1: Hydraulic Impact Assessment Case 086 (Base Case) 7
Figure 2: Hydraulic Impact Assessment Case 086AD (Approved Development) 8

LIST OF ABBREVIATIONS

AEP Annual Exceedance Probability

AHD Australian Height Datum

DHI Danish Hydraulics Institute

1.0 INTRODUCTION

In July 2008, the Nogoa River Flood Plain Boar d submitted a request to SunWater Asset Solutions to perform a hydrauli c assessm ent of the likely im pacts that would arise from a development proposal by PrimeAG Australia Ltd.

The developm ent proposal is shown in Figure 1. The proposed works are for the extension of levees around the agricultural land on the southe rn banks of the Nogoa River and associated flood plains.

This report describes the results of the hydrau lic assessm ent of the proposed works. The proposed w orks have been incorporated into the Danish Hydraulics In stitute (D HI) MIKE11 Model. The analysis conducted was an assessm ent on a Designated Flood Event with a 20 year Annual Exceedence Probability (AEP) 168 hour design flood on the entire floodplain.

2.0 HYDRAULIC ANALYSIS

An assessment of the likely hydraulic impacts of the proposed works for PrimeAG Ltd were undertaken using the 20 year AEP 168 hour design flood event. The proposed works were incorporated into the existing hydrodynamic (MIKE11) model. The results of this model were compared with those of the Base Case and are summarised below.

2.1 PROPOSED WORKS

The proposed works are shown in Figure 1. The works comprise building levees along the southern banks of the Nogoa River to complement the existing levees on the site.

2.2 HYDRAULIC MODEL MODIFICATIONS

2.2.1 Base Case Models

Two models were used as base cases in this investigation. The first model used to assess the proposed development was the "1994 Adopted Topographic Base Case – Revised" (Run 086) model. This model has been used to investigate all developments in the Nogoa Flood Plain in the past ten years. This scenario is comparable with all other proposal investigations undertaken by SunWater on behalf of the Nogoa Flood Plain Board over the past ten years as it has none of the approved developments included in the model. This model is referred to as *Case086* in this report. For further information regarding the base case, please refer to the *Nogoa River Flood Plain Study – Hydraulic Model Design Flood Simulation Report, Department of Natural Resources, June 1996*

The second model used to assess the proposed development was the "Case 086 Approved Development model', which was built in 2007, incorporating all approved developments in the Nogoa River Flood Plain between 1997 and 2007. This model is referred to as *Case086AD* in this report.

The proposed works were incorporated into the two Nogoa River MIKE11 hydrodynamic models by modifying the appropriate cross sections affected by the construction of the levees.

2.2.2 Proposed Development Case Model

In order to simulate the construction of the levee, a number of cross sections along the Nogoa River were modified to simulate the narrowing effect on the flow cause by the proposed levee. The modified cross sections are shown in Table 1.

Table 2: Modified Cross Sections

Model Branch	Model Cross-section
Nogoa River	XNO_006545
X	NO_006532
X	NO_006522
X	NO_006510
Nogoa River	XNOR12_065
Right X	NOR12_061
X	NOR12_053
X	NOR12_044
X	NOR12_035
X	NOR17_105
X	NOR17_098
X	NOR17_090
X	NOR17_085
X	NOR17_080
X	NOR17_073
X	NOR17_068
X	NOR18_060
X	NOR18_053
X	NOR20_043
X	NOR20_039
X	NOR20_032

It was assumed that the storage embankment was constructed to a height in excess of the 20 year AEP design flood event. This is consistent with the manner in which existing developments were investigated in the formulation of the Base Case. This assumption results in estimated peak flood levels and consequent impacts that are conservative i.e. higher than would arise if the structures could be overtopped.

2.3 HYDRAULIC MODEL RESULTS: 20 YEAR AEP

A summary of the impacts of the proposed works is provided in Tables 1 and Figure 1.

Table 2: Peak Flood Levels

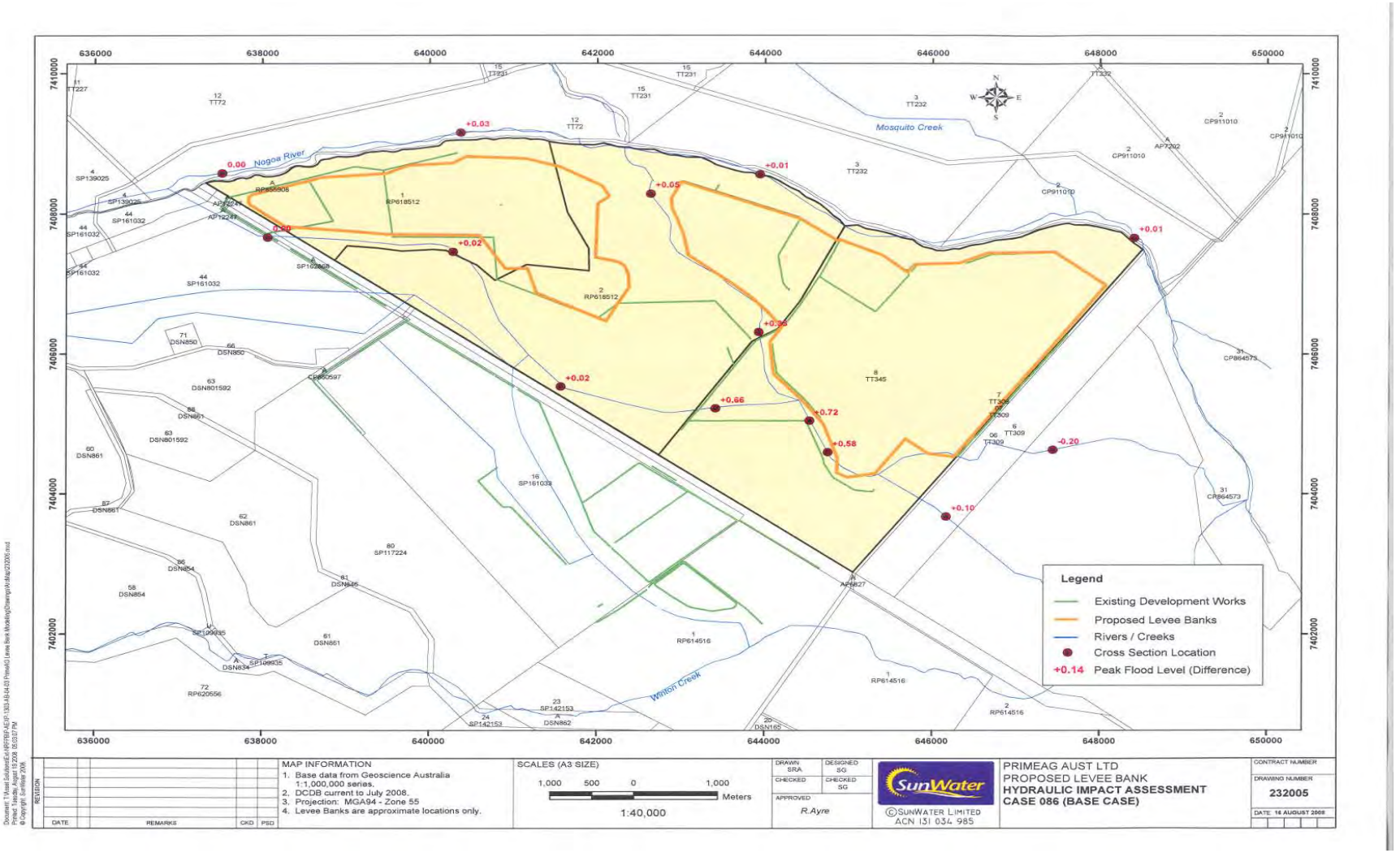
Model Branch	Model Cross-section	Peak Flood Level Case086			Peak Flood Level Case086AD		
		Base Case	PrimeAG Proposed Levee Case	Change in Peak Flood Level	Base Case	PrimeAG Proposed Levee Case	Change in Peak Flood Level
		(m AHD)	(m AHD)	(mm)	(m AHD)	(m AHD)	(mm)
Nogoa River	XNO_006545	163.52	163.51	-0.01	163.34	163.27	-0.07
	XNO_006537	162.94	162.98 0	.04	162.70	162.69 -	0.01
	XNO_006532	162.57	162.61 0	.03	162.36	162.34 -	0.02
X	NO_006522	161.45	161.48	0.03	161.56	161.57	0.01
X	NO_006510	160.94	161.00	0.05	161.16	161.21	0.05
X	NO_006503	160.59	160.64	0.05	160.84	161.94	0.10
X	NO_006496	160.27	160.29	0.02	160.56	160.67	0.11
X	NO_006492	159.99	160.00	0.02	160.23	160.35	0.12
X	NO_006485	159.37	159.38	0.01	159.58	159.70	0.11
X	NO_006480	159.08	159.08	0.01	159.27	159.37	0.10
X	NO_006470	158.67	158.68	0.01	158.81	158.87	0.06
X	NO_006465	158.42	158.43	0.01	158.55	158.58	0.03
X	NO_006460	158.06	158.06	0.01	158.16	158.19	0.04
X	NO_006450	157.43	157.44	0.01	157.47	157.51	0.04
X	NO_006440	157.06	157.07	0.01	157.05	157.08	0.03
X	NO_006420	156.80	156.81	0.01	156.77	156.80	0.03
Nogoa River	XNOR12_081	163.96	163.94	-0.02	163.85	163.78	-0.07
Right X	NOR12_074	162.65	162.64	-0.01	162.59	162.56	-0.03
X	NOR12_065	160.60	160.59	-0.01	160.54	160.50	-0.04
	XNOR12_061	160.08	160.08 0	.00	159.99	159.97 -	0.02
X	NOR12_053	159.86	159.88	0.02	159.78	159.80	0.02
X	NOR12_044	159.83	159.85	0.02	159.74	159.77	0.02
X	NOR12_035	159.81	159.83	0.02	159.73	159.75	0.02
X	NOR13_030	159.81	159.83	0.02	159.73	159.75	0.03
X	NOR13_030	159.81	159.83	0.02	159.73	159.75	0.03
X	NOR13_021	159.28	159.44	0.15	159.06	159.36	0.30
X	NOR13_016	159.01	159.24	0.23	158.83	159.27	0.43
X	NOR13_010	158.48	159.15	0.66 15	8.52	159.21	0.69
X	NOR17_105	160.59	160.64	0.05	160.84	160.94	0.10
X	NOR17_098	160.33	160.37	0.04	160.59	160.69	0.10

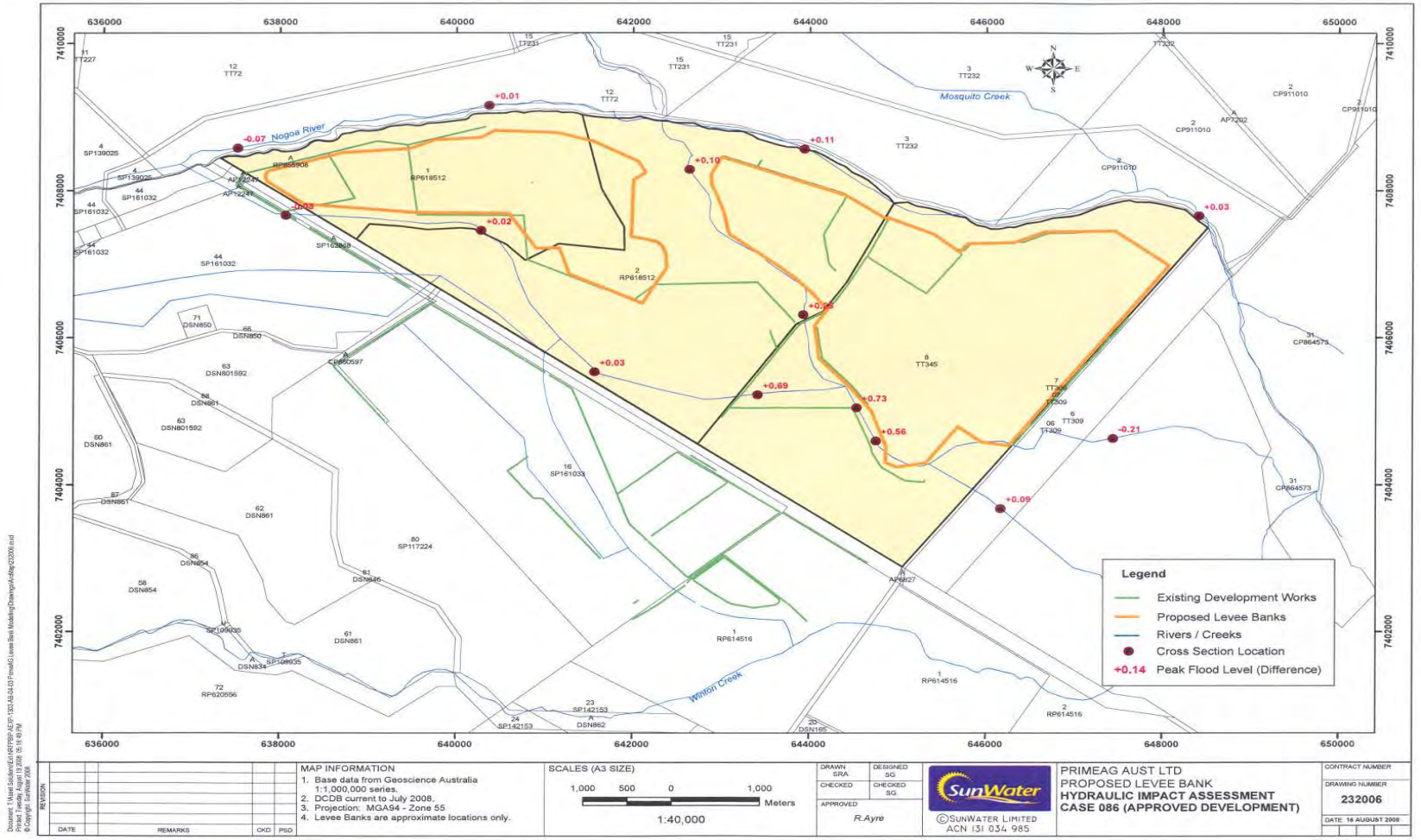
Model Branch	Model Cross-section	Peak Flood Level Case086			Peak Flood Level Case086AD		
		Base Case	PrimeAG Proposed Levee Case	Change in Peak Flood Level	Base Case	PrimeAG Proposed Levee Case	Change in Peak Flood Level
X	NOR17_090	160.11	160.14	0.03	160.39	160.48	0.08
X	NOR17_085	159.66	159.75	0.09	159.99	160.06	0.07
X	NOR17_080	158.96	159.31	0.35 15	9.24	159.49	0.25
X	NOR17_073	158.78	159.21	0.43 15	9.04	159.36	0.32
X	NOR17_068	158.34	159.06	0.72 15	8.42	159.15	0.73
X	NOR18_067	158.34	159.06	0.72 15	8.42	159.15	0.73
X	NOR18_060	156.90	157.12	0.21	156.97	157.21	0.23
X	NOR18_053	156.68	156.79	0.11	156.75	156.86	0.12
X	NOR19_040	156.17	165.27	0.10	156.22	156.32	0.09
X	NOR19_031	155.57	155.69	0.13	155.64	155.75	0.11
X	NOR19_026	155.28	155.42	0.14	155.36	155.48	0.12
X	NOR19_018	154.55	154.71	0.15	154.65	154.79	0.13
X	NOR19_012	153.76	153.86	0.09	154.19	154.24	0.05
X	NOR19_002	153.53	153.53	0.00	154.09	154.10	0.01
X	NOR20_050	156.53	156.50	-0.03	156.59	156.56	-0.03
X	NOR20_043	156.20	155.96	-0.24	156.27	156.03	-0.24
X	NOR20_039	156.00	155.80	-0.20	156.09	155.88	-0.21
X	NOR20_032	155.86	155.66	-0.19	155.95	155.75	-0.20
X	NOR20_025	155.41	155.18	-0.24	155.57	155.38	-0.20
X	NOR20_016	154.84	154.71	-0.13	155.11	155.00	-0.11
X	NOR20_007	156.90	157.12	0.21	156.97	157.21	0.23
X	NOR20_000	156.68	156.79	0.11	156.75	156.86	0.12

The above table highlights that there is significant impact on the Nogoa Flood Plain by the proposed levee in both Case086 and Case086AD. Overland flow that runs between the proposed levees on the PrimeAG site during a 1 in 20 year AEP has an afflux of up to 0.72 and 0.73 meters in one channel and up to 0.66 and 0.69 meters in the other in Case 086 and Case086AD respectively. The high afflux is located within the boundaries of PrimeAG property, however it does also have a minor affect, less than 0.2 meters, on the downstream property owned by Ensham.

3.0 SUMMARY

The proposed works have been tested using the Nogoa River MIKE11 hydrodynamic model for the 20 year AEP Designated Flood Event. The proposed levee to caused significant impact on peak flood levels when compared to both the "1994 Topographic Base – Revised" (Run 086) model" and "Case086AD Approved Development model". The study found that there is significant impact on the Nogoa Flood Plain by the proposed levee in both Case086 and Case086AD. Overland flow that runs between the proposed levees on the PrimeAG site during a 1 in 20 year AEP has an afflux of up to 0.72 and 0.73 meters in one channel and up to 0.66 and 0.69 meters in the other in Case 086 and Case086 AD respectively. The high afflux is located within the boundaries of PrimeAG property, however it does also have a minor affect, less than 0.2 meters, on the downstream property owned by Ensham.


Nogoa River
Mosquito Creek
Wilton Creek
+0.03
0.00
+0.01
+0.05
+0.02
-0.20
+0.01
+0.02
+0.66
+0.72
+0.58
-0.20
+0.10
Legend
Existing Development Works
Proposed Levee Banks
Rivers / Creeks
Cross Section Location
+0.14 Peak Flood Level (Difference)
MAP INFORMATION
1. Base data from Geoscience Australia 1:1,000,000 series.
2. DCDB current to July 2008.
3. Projection: MGA94 - Zone 55
4. Levee Banks are approximate locations only.
SCALES (A3 SIZE)
1,000 500 0 1,000 Meters
1:40,000
PRIMEAG AUST LTD
PROPOSED LEVEE BANK
HYDRAULIC IMPACT ASSESSMENT
CASE 086 (BASE CASE)
CONTRACT NUMBER
DRAWING NUMBER
232005
DATE 18 AUGUST 2008
©SUNWATER LIMITED
ACN 131 034 985


Nogoa River
Mosquito Creek
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+0.01
-0.07
+0.10
+0.11
+0.02
+0.03
+0.03
+0.03
+0.69
+0.73
+0.56
-0.21
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+0.14 Peak Flood Level (Difference)
MAP INFORMATION
1. Base data from Geoscience Australia 1:1,000,000 series.
2. DCDB current to July 2008.
3. Projection: MGA94 - Zone 55
4. Levee Banks are approximate locations only.
SCALES (A3 SIZE)
1,000 500 0 1,000 Meters
1:40,000
PRIMEAG AUST LTD
PROPOSED LEVEE BANK
HYDRAULIC IMPACT ASSESSMENT
CASE 086 (APPROVED DEVELOPMENT)
©SUNWATER LIMITED ACN 131 034 985
CONTRACT NUMBER
DRAWING NUMBER
232006
DATE 16 AUGUST 2008

SunWater
Website: www.sunwater.com.au

Final Report

Ensham Mine Rehabilitation of Flood Levees

Date: July 2008
Ref: P-AEXP-0405-AB-02-03
File: 08-004766

SunWater

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Final Report

Ensham Mine Rehabilitation of Flood Levees

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Prepared for:
Department of Infrastructure & Planning

This report has been produced by SunWater, to provide information for client use only.
The information contained in this report is limited by the scope and the purpose of the engineering study, and should not be regarded as completely exhaustive.
Permission to use or quote information from this report in studies external to the Corporation must first be obtained from the Chief Executive, SunWater.

EXECUTIVE SUMMARY

SunWater were requested by the De partment of Infrastructure and Planning to provide a report on the application subm itted by Ensham Resour ces Pty Ltd to the Nogoa River Flood Plain Board regarding the rehabilitati on and reinstatem ent of fl ood leve es associated with Ensham Mine. SunWater have effectively been requested to act as the Board's Engineer on this matter in addition to its usual role of hydraulic impact assessor for the Board.

Based upon hydraulic assessments undertaken by SunWater and KBR (Ensham Resources technical advisor) and additional information supplied by the Department of Infrastructure and Planning, SunWater has concluded that the level of impact created by the proposed extensions to the levees and the design standards applied to the proposed works conform to the requirements of the Local Law Policy No. 1.

SunWater therefore recomm end that the Coordi nator-General g rant a levee b ank perm it to Ensham Re sources Pty Ltd for the northern and southern levee bank extensions subject to conditions outlined in this report.

TABLE OF CONTENTS

1.0 ENSHAM RESOURCE PTY LTD APPLICATION 1
1.1 BACKGROUND 1
2.0 APPLICATION ASSESSMENT 3
2.1 REHABILITATION OF EXISTING LEVEES 3
2.2 REVIEW OUTCOMES 5
2.2.1 Criteria 1 Local Law Policy No. 1 6
2.2.2 Criteria 2 Local Law Policy No. 1 7
2.2.3 Criteria 3 and 4 Local Law Policy No. 1 7
2.2.4 Criteria 5 Local Law Policy No. 1 9
3.0 RECOMMENDATIONS 10
3.1 ENSHAM MINE SOUTHERN LEVEE BANK 10
3.2 ENSHAM MINE NORTHERN LEVEE BANK 12
4.0 REFERENCES 14

LIST OF APPENDICES

APPENDIX A SunWater Review – Ensham Mine Rehabilitation of Levees

1.0 ENSHAM RESOURCE PTY LTD APPLICATION

1.1 BACKGROUND

Ensham Resources Pty Ltd submitted an application on 15 November 2007 to the Nogoa River Flood Plain Board (NRFB) seeking to extend the levee banks that protect Ensham Mine from river flooding. These structures are situated on the Nogoa River (northern and southern sides of the river) and through the land commonly referred to as "Duckponds". The existing levees were previously approved by the Board in March 1998.

The proposed levee extensions were described in the application and also shown on accompanying drawings as listed below:

Location of work: County – Talbot, Parish – Middarra

Real Property Description: Lot 30 CP864574, Lot 31 CP864573 and Lot 32 RP908643

Drawings:

- Ensham Resources – Nogoa North and South Levee (Overview)
- Ensham Resources – Nogoa South Levee (Overview)
- Ensham Resources – Nogoa South Levee (Detail)
- Ensham Resources – Nogoa North Levee (Overview)
- Ensham Resources – Nogoa North Levee (Detail)

SunWater were commissioned by the Nogoa River Flood Plain Board on 17 December 2007 to assess the proposed levee extensions and prepare a report on the likely flood impacts of the works. This report was completed in February 2008 (Report 07-007593/001). The investigation concluded that the proposed works resulted in negligible impact on the northern flood plain of the Nogoa River and only minor increases in peak levels on the southern flood plain. This assessment was conducted using the Designated Design Flood Event nominated in the Local Law Policy No. 1 (NRFB, 1997) and compared against both the Adopted Topographic Base Case and the Approved Development Topographic Base Case.

In the meanwhile, a significant flood event occurred in the Nogoa River catchment during mid to late January 2008 that resulted in the partial failure of both the existing northern and southern levees which protect Ensham Mine.

The Nogoa River Flood Plain Board has not been able to process the November 2007 Ensham Resources application in accordance with Section 11 of the *Nogoa River Flood Plain Board Local Law No. 1* (Local Law No. 1) because "*The Board must not determine an application until it is in receipt of all relevant information including a report from the Director of Engineering Services.*" Section 3(5) of Local Law No.1 provides that the Director of Engineering Services means the Director of Engineering Services for the NRFB. Due to the reform of local authorities which occurred in early 2008, the newly formed Central Highlands Regional Council had not yet appointed a Director of Engineering Services for the NRFB and so therefore it could not comply with the requirements of the Local Law No.1.

Failure of the NRFB to comply with the proposed progression notices and notices to decide has allowed the Coordinator-General to issue a 'Step In' notice. The 'Step In' notice empowers the Coordinator-General to:

(a) Cause a report to be prepared in lieu of the Director of Engineering Services' report; and

(b) Rely on the report when determining the Ensham Resources applications under Section 11 of Local law No.1.

In June 2008, SunWater were then requested to prepare a technical report for the purposes of informing the Coordinator-General's decision. SunWater have relied upon previous investigations (SunWater, February 2008, June 2008) and (KBR, July 2007 and June 2008) and also information provided to [redacted], Department of Infrastructure and Planning in emails from Ed Donohue, Department of Natural Resources and Water (2 July 2008), Jon Womersley, Environmental Protection Agency (4 July 2008) and Bryan Ottone, Central Highlands Regional Council (3 and 4 July 2008).

2.0 APPLI CATION ASSESSMENT

2.1 REHABILITATION OF EXISTING LEVEES

In light of the significant flood event of January 2008, Ensham Re sources Pty Ltd, have a renewed re quirement for the prop osed works. Rehabilitation of the m ine needs to progres s through the dewatering of the open cut pits which were flooded as a cons equence of the partial failure of the existing levees. The existing levees also need to be rehabilitated and extended and possibly heightened to provide an appropriate level of risk to the ongoing m ine operations. In the current state, th e partially failed levees do n ot provide adequate protection of the mine and Ensham Res ources are seeking to complete the rehabilitation prior to the onset of the 2008/09 wet season. In its present state, E nsham Mine is effectively m ore exposed to flood risk than prior to the January 2008 event.

To achieve the required outcom e of obtaining a pproval for the rehabilitated levee extension, Ensham Resources Pty Ltd consulted with variou s approval authorities a nd technical advisors. Further, in discussion with vari ous authorities includ ing the Departm ent of Natural Resources and W ater (NRW) and the Environm ental Prot ection Agency (EPA), the Departm ent of Infrastructure and Planning considered that ad opting a process of assessm ent that includes an analysis of the January 2008 event was required.

Therefore, based upon this inclusion of this requirement a methodology was devised to provide a two-fold outcome:

1. The impacts of the proposed levees are assessed against the January 2008 event.
    - This was conducted by SunW ater on th e NRFB m odel to satisfy the NRFB requirements
2. The flood i mmunity of the existin g and proposed levees will be assessed again st th e January 2008 event.
    - This was conducted by KBR on the Delft- FLS model to determ ine appropriate levee design heights

The proposed methodology applies the January 2008 event as additional synthetic design flood event.

The results of the analyses showed the effect the proposed levee has on flood levels and afflux on nearby land for the January 2008 rainfall with design initial conditions (Fairbairn Dam full and design losses), compared to the previously computed values for design floods. This will possibly be a significantly rarer flood than actually occurred in January 2008.

The tasks outlined below, summarise the procedure to adopted:

1. KBR provided SunWater with the locations of the upstream and downstream boundary conditions in the Delft-FLS model.
2. SunWater reviewed/ran the hydrologic model (URBS) based on the following assumptions:
   (a) Recorded rainfall from the January 2008 event
   (b) Fairbairn Dam starting full
   (c) Design Rainfall Losses
3. SunWater provided URBS results to KBR at indicated locations, along with a draft short modelling report (covering data, assumptions, methodology, results).
4. KBR completed preliminary modelling using URBS flows
5. SunWater extracted URBS results for input to NRFB model and ran the NRFB model. Two cases were modelled:
   (a) Ensham Year 0 case, which represents the pre-January 2008 levees
   (b) Ensham Year 1 case, which is the same as the Year 0 case, but includes the proposed levees.
6. SunWater provided NRFB results to KBR at indicated locations along with an updated short modelling report.
7. KBR ran Delft-FLS model based on the boundary conditions from NRFB, for the same two cases (Year 0 and Year 1)

8. KBR drafted a report on the modelling covering data, assumptions, methodology, and results. Results included the flood levels and affluxes from the modelled event, and comparison of these to previously run design floods.
9. SunWater reviewed the final report, and prepared a review letter for submission to the regulator.
10. Provision of the report and review letter to the regulator for approval.

The outcome of these investigations was reported in the KBR report dated June 2008, which incorporated the SunWater investigation findings. A review of the report was then conducted by SunWater and reported in a letter to the Department of Infrastructure and Planning, dated 20 June 2008. A copy of this report is included as Appendix A of this report and details are explained in the following sections.

2.2 REVIEW OUTCOMES

The review of the KBR report entitled "Ensham Mine Proposed Levee Banks, January 2008 Flood Event Assessment", report number BEW801-W-REP-001 Rev.0 dated 17 June 2008 has been completed. The KBR report was assessed against the requirements of the Nogoa River Flood Plain Board's Local Law Policy No. 1 – Levee Banks and the "Interim Flood Plain Management Plan" dated May 1997.

The criteria and measures set out in the Local Law Policy No. 1 are:

1. Development in the Floodplain must be designed and constructed to standards appropriate to the level of risk of failure of those works and the hazards such failures represent.
2. Development within the Floodplain should result in the maintenance of a series of floodways generally conforming to the natural drainage pattern.
3. Development proposals must incorporate consideration and allowance for environmental, cultural and social impacts.
4. Development on the Floodplain must comply with any requirements under any other relevant legislation.

5. Changes to flow rates, flow distribution, flood timing and depth of flow, as a result of the proposed development should be within the specified acceptable limits.

The review of the KBR report considered each of the criteria. However, additional information provided by Department of Infrastructure and Planning has now been incorporated into the review as outlined in the following sections.

2.2.1 Criteria 1 Local Law Policy No. 1

The SunWater review did not consider the measure in Criteria 1 that requires a Design Report to be prepared by suitably qualified individuals or companies. However, reference was made to design reports prepared by KBR (23 June 2008) entitled, '*Ensham Mine Flood Levees, Proposed Levees Design Report'*, BEE603-W-REP-005 Rev 0, and KBR report (23 June 2008) entitled, '*Ensham Mine Proposed Flood Levees, Technical Specification for Civil Works'*, BEE603-Z-SPEC-001 Rev 5 and associated technical drawings. SunWater advises that the design standards adopted are those recommended by the Environmental Protection Agency and current best practice.

A Statutory Declaration from Golder and Associates dated 26 June 2008 indicates that 'the design and specification…for the proposed Ensham Levees meet the relevant engineering standards required for such structures'.

SunWater also indicated that conformity with the Local Authority Strategic Plan and By-Laws would need to be considered. The northern and southern levees are to be constructed almost entirely within the Ensham Mining Lease. Mining Lease approvals are dealt with through an Environmental Authority (mining activities) under the *Environmental Protection Act 1994*. Approvals for the extension and repair of levee banks are covered by a replacement Plan of Operations submitted by Ensham Resources and have been granted by the Environmental Protection Agency (letter of 3 July 2008).

A small section of the southern levee (120 metres) lies outside the Mining Lease. Mr Bryan Ottone, CEO Central Highlands Regional Council advises that 'under the superseded planning scheme (in force until January, 2009) an operational works permit for the construction of a levee bank on private land can be issued without making application for an MCU.

Council has received such an application but has not processed it to date. Once a decision to proceed is given, Council will process the operational works permit quickly'.

Based upon the information provided, it would appear that Criteria 1 has been satisfied.

2.2.2 Criteria 2 Local Law Policy No. 1

SunWater indicated that 'the proposed levees do not impact significantly on the flow distribution across the floodplain…as the discharge pattern from the developers property is similar to the pre-development pattern'. In SunWater's view Criteria 2 has been adequately addressed in the KBR report.

2.2.3 Criteria 3 and 4 Local Law Policy No. 1

SunWater indicated that Criteria 3and 4 were not addressed directly in the KBR Report. Consequently, the Department of Infrastructure and Planning asked The Department of Natural Resources and Water (DNRW) and the Environmental Protection Agency (EPA) to provide comment in relation to these criteria. The responses from each of the agencies are summarised as follows:

With respect to the levee bank applications, Mr Jon Womersley, Director, Partnerships, Practice and Business, Environmental Services Division, EPA advises 'that it is understood that the levee repair and extension works are to restore flood immunity for the Ensham Mine. The EPA requires the approval of this work to be based on:

- certified hydrology and hydraulic flood studies that identify the height the levees need to be constructed to in order to achieve protection in the event of a 1:1000 year ARI event;
- certified levee design plans that meet the 1:1000 year ARI design height requirement; and
- operational plans for the levees in a revised Plan of Operations for the mine.

Ensham Resources has provided to the EPA the three items listed above, and on 3 July 2008 the EPA issued Ensham Resources a letter allowing it to proceed with the construction of the levees, subject to lodging the required amount of financial assurance with the Mining Registrar of the Department of Mines and Energy.

Ensham Resources has agreed to lodge an Environmental Authority (EA) amendment application proposing levee management and maintenance conditions, for assessment and inclusion in the EA (mining activities) for the mine during the course of the construction of the levees. This will ensure that the operational requirements of the EPA for the levees are incorporated appropriately in the regulatory instruments applying to the mine.

As a result of the flooding in January 2008, a comprehensive review of the required levee height for the whole site and consequential impacts (afflux impacts on surrounding properties) will now need to be conducted prior to granting a draft EA for the Ensham Central Project which has been subject to review through an EIS process.

A decision on the draft EA has been extended until 30 January 2009. This extension will allow Ensham Resources time to undertake a full recalibration of the flood hydrology and hydraulic models for the January 2008 flood event, and assess the extent of upstream and downstream afflux and potential impacts of the levees on neighbours and surrounds. The new information that would result from this review may be required to be publicly advertised under s556 of the Environmental Protection Act, prior to finalising the conditions of the draft EA.

Mr Ed Donohue, Regional Manager, Water Services, Central West Region, Department of Natural Resources and Water has advised that, 'in respect of the levee bank applications for the Southern and Northern levees at Ensham Mine, no authorisations are required under the Water Act 2000 or Integrated Planning Act 1997 for operational works for the taking of or interfering with the flow of water. Ensham Resources Pty Ltd previously held water licence 0426497F and development permit 109171 for the Southern Levee to authorise the interference with the flow of water within Old Winton Creek. Under the provisions of the Water Act 2000 and the Water Regulation 2002 an upstream limit was declared for Old Winton Creek at the Southern Boundary of Lot 32/RP908643. Old Winton Creek upstream of this limit is no longer considered to be a watercourse. Therefore the water licence and development permit associated with the Southern Levee were repealed and no further authorisations in respect of the levee application is required.

In addition there is no requirement for the applicant to obtain any approvals under the Vegetation Management Act 1999 for the levee applications.

The Northern levee from the diagrams provided to the Department will be contained within the Mining Lease and hence a VMA permit for vegetation clearing is not required. The Southern levee is partly located off lease however is within non-remnant vegetation on Freehold land and does therefore not require a permit.

Therefore we have no issues in respect of the applications or matters that need to be addressed as a condition.'

Based on the information from EPA, DNRW and CHRC it would appear that Criteria 3 and 4 are satisfied.

2.2.4 Criteria 5 Local Law Policy No. 1

With respect to Criteria 5, the KBR report summarises the calculated afflux at the property boundary due to the proposed levees. The maximum increase of 50mm is greater that the nil increase specified in the measure, but well below the 300mm upper limit nominated for the ultimate development case. SunWater 'considered that the proposed development satisfies the intent of this measure and therefore is considered acceptable'.

In summary, SunWater concluded 'that the proposed works generally conform to the requirements of the Local Law Policy No. 1'.

3.0 RECOMMENDATIONS

That the Coordinator-General grant a levee bank permit to Ensham Resources Pty Ltd subject to the following conditions:

3.1 ENSHAM MINE SOUTHERN LEVEE BANK

Application submitted 15 November 2007

Owner:Ensham Resources Pty Ltd

Address:

PO Box 1565
Emerald Qld 4720

Property Description:

Lot 30 CP864574 & Lot 32 RP908643, Parish of Middarra, County of Talbott.

Reference Document:

Prescribed Project assessment and decision – Ensham Mine Flood Recovery Project, Southern and Northern Levee Banks, July 2008

Reference Map:

Ensham Coal Project – Existing and Proposed Flood Protection Levee Locations, July 2008

Conditions:

(a) the proposed works are to be undertaken in accordance with the details included in the application, referred to above;

(b) construction of the levee bank shall comply with the following reports: Kellogg Brown & Root Pty Ltd (23.6.2008) Ensham Mine Flood Levees, Proposed Levees Design Report, BEE603-W-REP-005 Rev 0, and Kellogg Brown & Root Pty Ltd (23.6.2008) Ensham Mine Proposed Flood Levees, Technical Specification for Civil Works, BEE603-Z-SPEC-001 Rev 5 and associated technical drawings;

(c) the work is to be undertaken under the supervision of a Registered Professional Engineer, Queensland (RPEQ) and certified accordingly upon completion.

(d) advice, in writing, shall be given of commencement of the works, and expected duration of works;

(e) the works proposed are to be completed within six (6) months of the date of issue of this permit;

(f) the permit is issued for a period of ten (10) years, expiry date being …/7/2018;

(g) "as constructed" details of the works shall be provided including coordinates of the structures, upon completion, together with a certification that all works are in accordance with the approved plans. This certification shall be signed by a Registered Professional Engineer, Queensland;

(h) the provisions of the Nogoa River Floodplain Board Local Law (Levee Banks) No. 1, 1997 shall be complied with at all times;

(i) the owner shall advise any proposed purchaser that the property is the subject of a levee bank permit;

(j) the owner shall identify any proposed subdivisional application of the property as being subject to a levee bank permit.

3.2 ENSHAM MINE NORTHERN LEVEE BANK

Application submitted 15 November 2007

Owner:Ensham Resources Pty Ltd

Address:

PO Box 1565
Emerald Qld 4720.

Property Description:

Lot 31 CP864573, Parish of Middarra, County of Talbott.

Reference Document:

Prescribed Project assessment and decision – Ensham Mine Flood Recovery Project, Southern and Northern Levee Banks, July 2008

Reference Map:

Ensham Coal Project – Existing and Proposed Flood Protection Levee Locations, July 2008

Conditions:

(a) the proposed works are to be undertaken in accordance with the details included in the application, referred to above;

(b) construction of the levee bank shall comply with the following reports: Kellogg Brown & Root Pty Ltd (23.6.2008) Ensham Mine Flood Levees, Proposed Levees Design Report, BEE603-W-REP-005 Rev 0, and Kellogg Brown & Root Pty Ltd (23.6.2008) Ensham Mine Proposed Flood Levees, Technical Specification for Civil Works, BEE603-Z-SPEC-001 Rev 5 and associated technical drawings;

(c) the work is to be undertaken under the supervision of a Registered Professional Engineer, Queensland (RPEQ) and certified accordingly upon completion.

(d) advice, in writing, shall be given of commencement of the works, and expected duration of works;

(e) the works proposed are to be completed within six (6) months of the date of issue of this permit;

(f) the permit is issued for a period of ten (10) years, expiry date being …/7/2018;

(g) "as constructed" details of the works shall be provided including coordinates of the structures, upon completion, together with a certification that all works are in accordance with the approved plans. This certification shall be signed by a Registered Professional Engineer, Queensland;

(h) the provisions of the Nogoa River Floodplain Board Local Law (Levee Banks) No. 1, 1997 shall be complied with at all times;

(i) the owner shall advise any proposed purchaser that the property is the subject of a levee bank permit;

(j) the owner shall identify any proposed subdivisional application of the property as being subject to a levee bank permit.

4.0 REFERENCES

KBR, (July 2007), *Ensham Mine Study – Hydraulic Assessment of the Proposed D-pit Levee and B-pit Levee*, BEE603-C-REP-003 Rev 0.

KBR, (June 2008), *Ensham Mine Proposed Levee Banks – January 2008 Flood Event Assessment*. BEW801-W-REP-001 Rev 0.

Nogoa River Flood Plain Board, (May 1997), *Interim Flood Plain Management Plan*. Nogoa River Flood Plain Steering Committee and Department of Natural Resources.

SunWater, (February 2008), *Hydraulic Impact Assessment – Ensham Resources Pty Ltd Proposed Levee Bank Extension*, 07-0077593/001.

SunWater, (June 2008), *Ensham Mine Flood Modelling,* 08-004766/001.

APPENDIX A

SUNWATER REVIEW – ENSHAM MINE REHABILITATION OF LEVEES

www.sunwater.com.au ABN 17 020 276 523

Level 9, 120 Edward Street PO Box 15536 City East Qld 4002

Our ref: 08-004766/001 #675680
Contact Name: Rob Ayre
Telephone: [redacted]

20 June 2008

[redacted]
Director, Significant Projects Coordination Branch
Department of Infrastructure and Planning
PO Box 15009
CITY EAST Q 4002

Dear [redacted]

re ENSHAM MINE – REHABILITATION OF LEVEES

I am writing to you in regard to our review of the Kellogg Brown & Root (KBR) Pty Ltd report entitled, "Ensham Mine Proposed Levee Banks, January 2008 Flood Event Assessment", Report number BEW801-W-REP-001 Rev.0 dated 17 June 2008.

SunWater has completed a review of this report in accordance with the requirements of the Nogoa River Flood Plain Board's "Interim Flood Plain Management Plan" dated May 1997. The interim criteria and measures specified in the Management Plan for which development proposals are to be assessed are stated as follows:

1. Development in the Floodplain must be designed and constructed to standards appropriate to the level of risk of failure of those works and the hazards such failure represents.
2. Development within the Floodplain should result in the maintenance of a series of floodways generally conforming to the natural drainage pattern.
3. Development proposals must incorporate consideration and allowance for environmental, cultural and social impacts.
4. Developments on the Floodplain must comply with any requirements under any other relevant legislation.
5. Changes to flow rates, flow distribution, flood timing and depth of flow, as a result of the proposed development should be within the specified acceptable limits.

In accordance with criteria (1), the Interim Floodplain Management Plan requires that, *a Design Report of the proposed development works, including plans and specifications, be prepared by suitably qualified individuals or companies.* This criteria has not been considered as part of the review as such plans and specifications have not been provided to SunWater. It is understood that a Design Report of the proposed levees is in preparation by KBR and being reviewed by Golder and Associates. The Coordinator General would need to ensure that such documentation is submitted and conforms to the requirement of the Interim Flood Plain Management Plan, Shire Strategic Plan and By-Laws.

In terms of standards being applied to the proposed levees, SunWater understands that the Environmental Protection Agency has recommended that the levees be sized to provide flood immunity commensurate with the hazard category and hydrological design criteria specified Table 1 and Table 2 of the Site Water Management Guidelines (DME, 1995). SunWater understands that a 1 in 1000 year AEP design standard has been nominated and that KBR have adopted this event magnitude to establish the proposed levee heights, (Refer Tables 4.6 and 4.7). KBR have also adopted a freeboard allowance of 1 m in accordance with current best practice guidelines and investigated a controlled failure strategy for the proposed works.

Criteria (2) has been adequately addressed in the KBR report. The Interim Floodplain Management Plan requires that, *in general, development proposals must cause minimal change to the distribution of flood flows across the floodplain.* The proposed levee's do not impact significantly on the flow distribution across the floodplain as evidenced by Figures 4.6 and 4.9 of the KBR report, as the discharge pattern from the developers property is similar to the pre-development pattern. It should be noted that the existing levees were approved by the Board in February 1998 and that the comparison of flow distribution has been made against this scenario.

Criteria (3) and (4) are not addressed directly by the KBR report. Under criteria (3), *the Board may require the proponent to undertake other studies as necessary including a suitably detailed Impact Assessment Study and Environmental Management Plan in order for it to properly assess the application.* Likewise, in order to satisfy Criteria (4), *all other approvals, permits and authorities required of the proponent under any other Act must be obtained and a copy provided to the Board.* SunWater has not been provided with any additional information of this nature and are therefore unable to assess the fulfilment of these criteria.

Criteria (5) of the Interim Floodplain Management Plan requires that, *The total permissible increase in peak water elevation at or outside a property boundary arising from all development subject to the local law, on that property compared with that which would occur for the Adopted Base Case will be nil. However, this requirement may be varied at the absolute discretion of the Board subject to further information being provided by the proponent as the Board deems necessary in order for it to properly assess and determine the application. Irrespective, the total cumulative effect of all works (under an ultimate development scenario) on the floodplain shall not exceed 300 mm at any property boundary, over and above that occurring under the Adopted Base Case.*

The KBR report summarises in Table 4.3 and Table 4.4 the calculated afflux at the property boundary due to the proposed levees for the January 2008 Design Flood Event and the 1 in 20 year AEP Design Flood Event (also known as the Designated Flood Event, DFE). The maximum increase indicated for both events is 50 mm at the upstream property boundary on Winton Creek (Point 5) and the main Nogoa River channel (Point 2). The magnitude of the increases indicated is consistent with SunWater's assessment of the likely impacts using the Board's numerical hydraulic model.

Whilst the afflux indicated for these events is greater than the nil increase specified in the criteria, the afflux for both cases is well below the 300 mm upper limit nominated in the measure. As the January 2008 Design Flood Event is significantly larger event than the DFE, and the impacts for both events are of a similar magnitude, it is considered that the proposed development satisfies the intent of this measure and therefore is considered acceptable.

In summary, SunWater has reviewed the KBR report concerning the proposed levees for Ensham Mine, with a focus on the likely hydraulic impacts on the flood plain. SunWater concludes that the proposed works generally conform to the requirements of the Interim Flood Plain Management Plan. It is acknowledged that the proposed works do result in some increase in peak flood levels at locations upstream of the Ensham Resources property boundary, but these increases are well below the 300 mm upper limit specified in the criteria. It is also noted that the proposed levees are designed to the required standard specified by the Environmental Protection Agency and include both a freeboard allowance and a controlled failure strategy.

It is recommended that copies of the Design Report and any other associated approvals be obtained from Ensham Resources Pty Ltd before final approval of the proposed works.

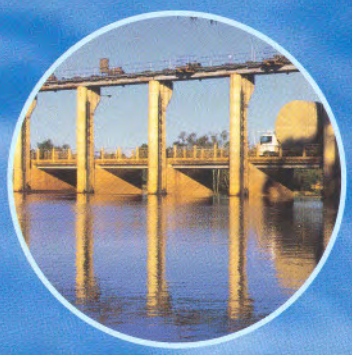
If any aspect of this letter requires clarification, please contact Mr Rob Ayre on [redacted]

Yours faithfully

[redacted]

Rob Ayre
ENGINEERING DESIGN MANAGER

SunWater
Website: www.sunwater.com.au



Draft Report

Ensham Mine Rehabilitation of Flood Levees

Date: July 2008
Ref: P-AEXP-0405-AB-02-03
File: 08-004766

SunWater

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Draft Report

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Prepared for:
Department of Infrastructure & Planning

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EXECUTIVE SUMMARY

SunWater were requested by the Department of Infrastructure and Planning to provide a report on the application submitted by Ensham Resources Pty Ltd to the Nogoa River Flood Plain Board regarding the rehabilitation and reinstatement of flood leves associated with Ensham Mine. SunWater have effectively been requested to act as the Board's Engineer on this matter in addition to its usual role of hydraulic impact assessor for the Board.

Based upon hydraulic assessments undertaken by SunWater and KBR (Ensham Resources technical advisor) and additional information supplied by the Department of Infrastructure and Planning, SunWater have concluded that the level of impact created by the proposed extensions to the levees and the design standards applied to the proposed works conform to the requirements of the Interim Flood Plain Management Plan.

SunWater therefore recommend that the Coordinator-General grant a levee bank permit to Ensham Resources Pty Ltd for the northern and southern levee bank extensions subject to conditions outlined in this report.

TABLE OF CONTENTS

1.0 ENSHAM RESOURCE PTY LTD APPLICATION 1
1.1 BACKGROUND 1
2.0 APPLICATION ASSESSMENT 3
2.1 REHABILITATION OF EXISTING LEVEES 3
2.2 REVIEW OUTCOMES 5
2.2.1 Criteria 1 Interim Flood Plain Management Plan 6
2.2.2 Criteria 2 Interim Flood Plain Management Plan 6
2.2.3 Criteria 3 and 4 Interim Flood Plain Management Plan 7
2.2.4 Criteria 5 Interim Flood Plain Management Plan 9
3.0 RECOMMENDATIONS 10
3.1 ENSHAM MINE SOUTHERN LEVEE BANK 10
3.2 ENSHAM MINE NORTHERN LEVEE BANK 12
4.0 REFERENCES 14

LIST OF APPENDICES

APPENDIX A SunWater Review – Ensham Mine Rehabilitation of Levees

1.0 ENSHAM RESOURCE PTY LTD APPLICATION

1.1 BACKGROUND

Ensham Resources Pty Ltd submitted an application on 15 November 2007 to the Nogoa River Flood Plain Board (NRFB) seeking to extend the levee banks that protect Ensham Mine from river flooding. These structures are situated on the Nogoa River (northern and southern sides of the river) and through the land commonly referred to as "Duckponds". The existing levees were previously approved by the Board in March 1998.

The proposed levee extensions were described in the application and also shown on accompanying drawings as listed below:

Location of work: County – Talbot, Parish – Middarra

Real Property Description: Lot 30 CP864574, Lot 31 CP864573 and Lot 32 RP908643

Drawings:

- Ensham Resources – Nogoa North and South Levee (Overview)
- Ensham Resources – Nogoa South Levee (Overview)
- Ensham Resources – Nogoa South Levee (Detail)
- Ensham Resources – Nogoa North Levee (Overview)
- Ensham Resources – Nogoa North Levee (Detail)

SunWater were commissioned by the Nogoa River Flood Plain Board on 17 December 2007 to assess the proposed levee extensions and prepare a report on the likely flood impacts of the works. This report was completed in February 2008 (Report 07-007593/001). The investigation concluded that the proposed works resulted in negligible impact on the northern flood plain of the Nogoa River and only minor increases in peak levels on the southern flood plain. This assessment was conducted using the Designated Design Flood Event nominated in the Interim Flood Plain Management Plan (NRFB, 1997) and compared against both the Adopted Topographic Base Case and the Approved Development Topographic Base Case.

In the meanwhile, a significant flood event occurred in the Nogoa River catchment during mid to late January 2008 that resulted in the partial failure of both the existing northern and southern levees which protect Ensham Mine.

The Nogoa River Flood Plain Board has not been able to process the November 2007 Ensham Resources application in accordance with Section 11 of the *Nogoa River Flood Plain Board Local Law No. 1* (Local Law No. 1) because "*The Board must not determine an application until it is in receipt of all relevant information including a report from the Director of Engineering Services.*" Section 3(5) of Local Law No.1 provides that the Director of Engineering Services means the Director of Engineering Services for the NRFB. Due to the reform of local authorities which occurred in early 2008, the newly formed Central Highlands Regional Council had not yet appointed a Director of Engineering Services for the NRFB and so therefore it could not comply with the requirements of the Local Law No.1.

Failure of the NRFB to comply with the proposed progression notices and notices to decide has allowed the Coordinator-General to issue a 'Step In' notice. The 'Step In' notice empowers the Coordinator-General to:

(a) Cause a report to be prepared in lieu of the Director of Engineering Services' report; and

(b) Rely on the report when determining the Ensham Resources applications under Section 11 of Local law No.1.

In June 2008, SunWater were then requested to prepare a technical report for the purposes of informing the Coordinator-General's decision. SunWater have relied upon previous investigations (SunWater, February 2008, June 2008) and (KBR, July 2007 and June 2008) and also information provided by Mr Russel Davie, Department of Infrastructure and Planning in his email of 10 July 2008 to formulate the report.

2.0 APPLI CATION ASSESSMENT

2.1 REHABILITATION OF EXISTING LEVEES

In light of the significant flood event of January 2008, Ensham Re sources Pty Ltd, have a renewed re quirement for the prop osed works. Rehabilitation of the m ine needs to progres s through the dewatering of the open cut pits which were flooded as a cons equence of the partial failure of the existing levees. The existing levees also need to be rehabilitated and extended and possibly heightened to provide an appropriate level of risk to the ongoing m ine operations. In the current state, th e partially failed levees do n ot provide adequate protection of the mine and Ensham Res ources are seeking to complete the rehabilitation prior to the onset of the 2008/09 wet season. In its present state, E nsham Mine is effectively m ore exposed to flood risk than prior to the January 2008 event.

To achieve the required outcom e of obtaining a pproval for the rehabilitated levee extension, Ensham Resources Pty Ltd consulted with variou s approval authorities a nd technical advisors. Further, in discussion with vari ous authorities includ ing the Departm ent of Natural Resources and W ater (NRW) and the Environm ental Prot ection Agency (EPA), the Departm ent of Infrastructure and Planning considered that ado pting a process of assessm ent that includes an analysis of the January 2008 event was required.

Therefore, based upon this inclusion of this requirement a methodology was devised to provide a two-fold outcome:

1. The impacts of the proposed levees are assessed against the January 2008 event.
    - This was conducted by SunW ater on th e NRFB m odel to satisfy the NRFB requirements
2. The flood i mmunity of the existin g and proposed levees will be assessed again st th e January 2008 event.
    - This was conducted by KBR on the Delft- FLS model to determ ine appropriate levee design heights

The proposed methodology applies the January 2008 event as additional synthetic design flood event.

The results of the analyses showed the effect the proposed levee has on flood levels and afflux on nearby land for the January 2008 rainfall with design initial conditions (Fairbairn Dam full and design losses), compared to the previously computed values for design floods. This will possibly be a significantly rarer flood than actually occurred in January 2008.

The tasks outlined below, summarise the procedure adopted:

1. KBR provided SunWater with the locations of the upstream and downstream boundary conditions in the Delft-FLS model.
2. SunWater reviewed/ran the hydrologic model (URBS) based on the following assumptions:
   (a) Recorded rainfall from the January 2008 event
   (b) Fairbairn Dam starting full
   (c) Design Rainfall Losses
3. SunWater provided URBS results to KBR at indicated locations, along with a draft short modelling report (covering data, assumptions, methodology, results).
4. KBR completed preliminary modelling using URBS flows
5. SunWater extracted URBS results for input to NRFB model and ran the NRFB model. Two cases were modelled:
   (a) Ensham Year 0 case, which represents the pre-January 2008 levees
   (b) Ensham Year 1 case, which is the same as the Year 0 case, but includes the proposed levees.
6. SunWater provided NRFB results to KBR at indicated locations along with an updated short modelling report.
7. KBR ran Delft-FLS model based on the boundary conditions from NRFB, for the same two cases (Year 0 and Year 1)

8. KBR drafted a report on the modelling covering data, assumptions, methodology, and results. Results included the flood levels and affluxes from the modelled event, and comparison of these to previously run design floods.
9. SunWater reviewed the final report, and prepared a review letter for submission to the regulator.
10. Provision of the report and review letter to the regulator for approval.

The outcome of these investigations was reported in the KBR report dated June 2008, which incorporated the SunWater investigation findings. A review of the report was then conducted by SunWater and reported in a letter to the Department of Infrastructure and Planning, dated 20 June 2008. A copy of this report is included as Appendix A of this report and details are explained in the following sections.

2.2 REVIEW OUTCOMES

The review of the KBR report entitled "Ensham Mine Proposed Levee Banks, January 2008 Flood Event Assessment", report number BEW801-W-REP-001 Rev.0 dated 17 June 2008 has been completed. The KBR report was assessed against the requirements of the Nogoa River Flood Plain Board's Local Law Policy No. 1 – Levee Banks and the "Interim Flood Plain Management Plan" dated May 1997.

The criteria and measures set out in the Interim Flood Plain Management Plan are:

1. Development in the Floodplain must be designed and constructed to standards appropriate to the level of risk of failure of those works and the hazards such failures represent.
2. Development within the Floodplain should result in the maintenance of a series of floodways generally conforming to the natural drainage pattern.
3. Development proposals must incorporate consideration and allowance for environmental, cultural and social impacts.
4. Development on the Floodplain must comply with any requirements under any other relevant legislation.

5. Changes to flow rates, flow distribution, flood timing and depth of flow, as a result of the proposed development should be within the specified acceptable limits.

The review of the KBR report considered each of the criteria. However, additional information provided by Department of Infrastructure and Planning has now been incorporated into the review as outlined in the following sections.

2.2.1 Criteria 1 Interim Flood Plain Management Plan

The SunWater review did not consider the measure in Criteria 1 that requires a Design Report to be prepared by suitably qualified individuals or companies. However, reference was made to design reports prepared by KBR (23 June 2008) entitled, '*Ensham Mine Flood Levees, Proposed Levees Design Report'*, BEE603-W-REP-005 Rev 0, and KBR report (23 June 2008) entitled, '*Ensham Mine Proposed Flood Levees, Technical Specification for Civil Works'*, BEE603-Z-SPEC-001 Rev 5 and associated technical drawings. SunWater advises that the design standards adopted are those recommended by the Environmental Protection Agency and current best practice.

A Statutory Declaration from Golder and Associates dated 26 June 2008 indicates that 'the design and specification…for the proposed Ensham Levees meet the relevant engineering standards required for such structures'.

SunWater also indicated that conformity with the Local Authority Strategic Plan and By-Laws would need to be considered. Mr Bryan Ottone, CEO Central Highlands Regional Council has advised that 'the strategic plan and local by-laws are not applicable to this application'.

Based upon the information provided, it would appear that Criteria 1 has been satisfied.

2.2.2 Criteria 2 Interim Flood Plain Management Plan

SunWater indicated that 'the proposed levees do not impact significantly on the flow distribution across the floodplain…as the discharge pattern from the developers property is similar to the pre-development pattern'. In SunWater's view Criteria 2 has been adequately addressed in the KBR report.

2.2.3 Criteria 3 and 4 Interim Flood Plain Management Plan

SunWater indicated that Criteria 3and 4 were not addressed directly in the KBR Report. Consequently, the Department of Infrastructure and Planning asked The Department of Natural Resources and Water (DNRW) and the Environmental Protection Agency (EPA) to provide comment in relation to these criteria. The responses from each of the agencies are summarised as follows:

With respect to the levee bank applications, Mr Jon Womersley, Director, Partnerships, Practice and Business, Environmental Services Division, EPA advises 'that it is understood that the levee repair and extension works are to restore flood immunity for the Ensham Mine. The EPA requires the approval of this work to be based on:

- certified hydrology and hydraulic flood studies that identify the height the levees need to be constructed to in order to achieve protection in the event of a 1:1000 year ARI event;
- certified levee design plans that meet the 1:1000 year ARI design height requirement; and
- operational plans for the levees in a revised Plan of Operations for the mine.

Ensham Resources has provided to the EPA the three items listed above, and on 3 July 2008 the EPA issued Ensham Resources a letter allowing it to proceed with the construction of the levees, subject to lodging the required amount of financial assurance with the Mining Registrar of the Department of Mines and Energy.

Ensham Resources has agreed to lodge an Environmental Authority (EA) amendment application proposing levee management and maintenance conditions, for assessment and inclusion in the EA (mining activities) for the mine during the course of the construction of the levees. This will ensure that the operational requirements of the EPA for the levees are incorporated appropriately in the regulatory instruments applying to the mine.

As a result of the flooding in January 2008, a comprehensive review of the required levee height for the whole site and consequential impacts (afflux impacts on surrounding properties) will now need to be conducted prior to granting a draft EA for the Ensham Central Project which has been subject to review through an EIS process.

A decision on the draft EA has been extended until 30 January 2009. This extension will allow Ensham Resources time to undertake a full recalibration of the flood hydrology and hydraulic models for the January 2008 flood event, and assess the extent of upstream and downstream afflux and potential impacts of the levees on neighbours and surrounds. The new information that would result from this review may be required to be publicly advertised under s556 of the Environmental Protection Act, prior to finalising the conditions of the draft EA.

[redacted] Regional Manager, Water Services, Central West Region, Department of Natural Resources and Water has advised that, 'in respect of the levee bank applications for the Southern and Northern levees at Ensham Mine, no authorisations are required under the Water Act 2000 or Integrated Planning Act 1997 for operational works for the taking of or interfering with the flow of water. Ensham Resources Pty Ltd previously held water licence 0426497F and development permit 109171 for the Southern Levee to authorise the interference with the flow of water within Old Winton Creek. Under the provisions of the Water Act 2000 and the Water Regulation 2002 an upstream limit was declared for Old Winton Creek at the Southern Boundary of Lot 32/RP908643. Old Winton Creek upstream of this limit is no longer considered to be a watercourse. Therefore the water licence and development permit associated with the Southern Levee were repealed and no further authorisations in respect of the levee application is required.

In addition there is no requirement for the applicant to obtain any approvals under the Vegetation Management Act 1999 for the levee applications. The Northern levee from the diagrams provided to the Department will be contained within the Mining Lease and hence a VMA permit for vegetation clearing is not required. The Southern levee is partly located off lease however is within non-remnant vegetation on Freehold land and does therefore not require a permit.

Therefore we have no issues in respect of the applications or matters that need to be addressed as a condition.'

Based on the information from EPA, DNRW and CHRC it would appear that Criteria 3 and 4 are satisfied.

2.2.4 Criteria 5 Interim Flood Plain Management Plan

With respect to Crite ria 5, the KBR report su mmarises th e calcu lated af flux at the property boundary due to the proposed levees. The m aximum increase of 50mm is greater that the nil increase specified in the m easure, but we ll below the 300mm upper lim it nom inated for the ultimate dev elopment case. SunW ater 'cons idered that the proposed developm ent satisfies the intent of this measure and therefore is considered acceptable'.

In summ ary, SunW ater concluded 'that the proposed works generally conform to the requirements of the Interim Flood Plain Management Plan'.

3.0 RECOMMENDATIONS

That the Coordinator-General grant a levee bank permit to Ensham Resources Pty Ltd subject to the following conditions:

3.1 ENSHAM MINE SOUTHERN LEVEE BANK

Application submitted 15 November 2007

Owner:Ensham Resources Pty Ltd

Address:

PO Box 1565
Emerald Qld 4720

Property Description:

Lot 30 CP864574 & Lot 32 RP908643, Parish of Middarra, County of Talbott.

Reference Document:

Prescribed Project assessment and decision – Ensham Mine Flood Recovery Project, Southern and Northern Levee Banks, July 2008

Reference Map:

Ensham Coal Project – Existing and Proposed Flood Protection Levee Locations, July 2008

Conditions:

(a) the proposed works are to be undertaken in accordance with the details included in the application, referred to above;

(b) construction of the levee bank shall comply with the following reports: Kellogg Brown & Root Pty Ltd (23.6.2008) Ensham Mine Flood Levees, Proposed Levees Design Report, BEE603-W-REP-005 Rev 0, and Kellogg Brown & Root Pty Ltd (23.6.2008) Ensham Mine Proposed Flood Levees, Technical Specification for Civil Works, BEE603-Z-SPEC-001 Rev 5 and associated technical drawings;

(c) the work is to be undertaken under the supervision of a Registered Professional Engineer, Queensland (RPEQ) and certified accordingly upon completion.

(d) advice, in writing, shall be given of commencement of the works, and expected duration of works;

(e) the works proposed are to be completed within eighteen (18) months of the date of issue of this permit;

(f) the permit is issued for a period of ten (10) years, expiry date being …/7/2018;

(g) "as constructed" details of the works shall be provided including coordinates of the structures, upon completion, together with a certification that all works are in accordance with the approved plans. This certification shall be signed by a Registered Professional Engineer, Queensland;

(h) the provisions of the Nogoa River Floodplain Board Local Law (Levee Banks) No. 1, 1997 shall be complied with at all times;

(i) the owner shall advise any proposed purchaser that the property is the subject of a levee bank permit;

(j) the owner shall identify any proposed subdivisional application of the property as being subject to a levee bank permit.

Furthermore, that Central Highlands Regional Council be advised of the levee bank permit to enable the records of the affected property to be duly noted.

Permit issued pursuant to section 76O of the State Development and Public Works Organisation Act 1971.

3.2 ENSHAM MINE NORTHERN LEVEE BANK

Application submitted 15 November 2007

Owner:Ensham Resources Pty Ltd

Address:

PO Box 1565
Emerald Qld 4720.

Property Description:

Lot 31 CP864573, Parish of Middarra, County of Talbott.

Reference Document:

Prescribed Project assessment and decision – Ensham Mine Flood Recovery Project, Southern and Northern Levee Banks, July 2008

Reference Map:

Ensham Coal Project – Existing and Proposed Flood Protection Levee Locations, July 2008

Conditions:

(a) the proposed works are to be undertaken in accordance with the details included in the application, referred to above;

(b) construction of the levee bank shall comply with the following reports: Kellogg Brown & Root Pty Ltd (23.6.2008) Ensham Mine Flood Levees, Proposed Levees Design Report, BEE603-W-REP-005 Rev 0, and Kellogg Brown & Root Pty Ltd (23.6.2008) Ensham Mine Proposed Flood Levees, Technical Specification for Civil Works, BEE603-Z-SPEC-001 Rev 5 and associated technical drawings;

(c) the work is to be undertaken under the supervision of a Registered Professional Engineer, Queensland (RPEQ) and certified accordingly upon completion.

(d) advice, in writing, shall be given of commencement of the works, and expected duration of works;

(e) the works proposed are to be completed within eighteen (18) months of the date of issue of this permit;

(f) the permit is issued for a period of ten (10) years, expiry date being …/7/2018;

(g) "as constructed" details of the works shall be provided including coordinates of the structures, upon completion, together with a certification that all works are in accordance with the approved plans. This certification shall be signed by a Registered Professional Engineer, Queensland;

(h) the provisions of the Nogoa River Floodplain Board Local Law (Levee Banks) No. 1, 1997 shall be complied with at all times;

(i) the owner shall advise any proposed purchaser that the property is the subject of a levee bank permit;

(j) the owner shall identify any proposed subdivisional application of the property as being subject to a levee bank permit.

Furthermore, that Central Highlands Regional Council be advised of the levee bank permit to enable the records of the affected property to be duly noted.

Permit issued pursuant to section 76O of the State Development and Public Works Organisation Act 1971.

4.0 REFERENCES

KBR, (July 2007), *Ensham Mine Study – Hydraulic Assessment of the Proposed D-pit Levee and B-pit Levee*, BEE603-C-REP-003 Rev 0.

KBR, (June 2008), *Ensham Mine Proposed Levee Banks – January 2008 Flood Event Assessment*. BEW801-W-REP-001 Rev 0.

Nogoa River Flood Plain Board, (May 1997), *Interim Flood Plain Management Plan*. Nogoa River Flood Plain Steering Committee and Department of Natural Resources.

SunWater, (February 2008), *Hydraulic Impact Assessment – Ensham Resources Pty Ltd Proposed Levee Bank Extension*, 07-0077593/001.

SunWater, (June 2008), *Ensham Mine Flood Modelling,* 08-004766/001.

APPENDIX A

SUNWATER REVIEW – ENSHAM MINE REHABILITATION OF LEVEES

www.sunwater.com.au ABN 17 020 276 523

Level 9, 120 Edward Street PO Box 15536 City East Qld 4002

Our ref: 08-004766/001 #675680
Contact Name: Rob Ayre
Telephone: [redacted]

20 June 2008

[redacted]
Director, Significant Projects Coordination Branch
Department of Infrastructure and Planning
PO Box 15009
CITY EAST Q 4002

Dear [redacted]

re ENSHAM MINE – REHABILITATION OF LEVEES

I am writing to you in regard to our review of the Kellogg Brown & Root (KBR) Pty Ltd report entitled, "Ensham Mine Proposed Levee Banks, January 2008 Flood Event Assessment", Report number BEW801-W-REP-001 Rev.0 dated 17 June 2008.

SunWater has completed a review of this report in accordance with the requirements of the Nogoa River Flood Plain Board's "Interim Flood Plain Management Plan" dated May 1997. The interim criteria and measures specified in the Management Plan for which development proposals are to be assessed are stated as follows:

1. Development in the Floodplain must be designed and constructed to standards appropriate to the level of risk of failure of those works and the hazards such failure represents.
2. Development within the Floodplain should result in the maintenance of a series of floodways generally conforming to the natural drainage pattern.
3. Development proposals must incorporate consideration and allowance for environmental, cultural and social impacts.
4. Developments on the Floodplain must comply with any requirements under any other relevant legislation.
5. Changes to flow rates, flow distribution, flood timing and depth of flow, as a result of the proposed development should be within the specified acceptable limits.

In accordance with criteria (1), the Interim Floodplain Management Plan requires that, *a Design Report of the proposed development works, including plans and specifications, be prepared by suitably qualified individuals or companies.* This criteria has not been considered as part of the review as such plans and specifications have not been provided to SunWater. It is understood that a Design Report of the proposed levees is in preparation by KBR and being reviewed by Golder and Associates. The Coordinator General would need to ensure that such documentation is submitted and conforms to the requirement of the Interim Flood Plain Management Plan, Shire Strategic Plan and By-Laws.

In terms of standards being applied to the proposed levees, SunWater understands that the Environmental Protection Agency has recommended that the levees be sized to provide flood immunity commensurate with the hazard category and hydrological design criteria specified Table 1 and Table 2 of the Site Water Management Guidelines (DME, 1995). SunWater understands that a 1 in 1000 year AEP design standard has been nominated and that KBR have adopted this event magnitude to establish the proposed levee heights, (Refer Tables 4.6 and 4.7). KBR have also adopted a freeboard allowance of 1 m in accordance with current best practice guidelines and investigated a controlled failure strategy for the proposed works.

Criteria (2) has been adequately addressed in the KBR report. The Interim Floodplain Management Plan requires that, *in general, development proposals must cause minimal change to the distribution of flood flows across the floodplain.* The proposed levee's do not impact significantly on the flow distribution across the floodplain as evidenced by Figures 4.6 and 4.9 of the KBR report, as the discharge pattern from the developers property is similar to the pre-development pattern. It should be noted that the existing levees were approved by the Board in February 1998 and that the comparison of flow distribution has been made against this scenario.

Criteria (3) and (4) are not addressed directly by the KBR report. Under criteria (3), *the Board may require the proponent to undertake other studies as necessary including a suitably detailed Impact Assessment Study and Environmental Management Plan in order for it to properly assess the application.* Likewise, in order to satisfy Criteria (4), *all other approvals, permits and authorities required of the proponent under any other Act must be obtained and a copy provided to the Board.* SunWater has not been provided with any additional information of this nature and are therefore unable to assess the fulfilment of these criteria.

Criteria (5) of the Interim Floodplain Management Plan requires that, *The total permissible increase in peak water elevation at or outside a property boundary arising from all development subject to the local law, on that property compared with that which would occur for the Adopted Base Case will be nil. However, this requirement may be varied at the absolute discretion of the Board subject to further information being provided by the proponent as the Board deems necessary in order for it to properly assess and determine the application. Irrespective, the total cumulative effect of all works (under an ultimate development scenario) on the floodplain shall not exceed 300 mm at any property boundary, over and above that occurring under the Adopted Base Case.*

The KBR report summarises in Table 4.3 and Table 4.4 the calculated afflux at the property boundary due to the proposed levees for the January 2008 Design Flood Event and the 1 in 20 year AEP Design Flood Event (also known as the Designated Flood Event, DFE). The maximum increase indicated for both events is 50 mm at the upstream property boundary on Winton Creek (Point 5) and the main Nogoa River channel (Point 2). The magnitude of the increases indicated is consistent with SunWater's assessment of the likely impacts using the Board's numerical hydraulic model.

Whilst the afflux indicated for these events is greater than the nil increase specified in the criteria, the afflux for both cases is well below the 300 mm upper limit nominated in the measure. As the January 2008 Design Flood Event is significantly larger event than the DFE, and the impacts for both events are of a similar magnitude, it is considered that the proposed development satisfies the intent of this measure and therefore is considered acceptable.

In summary, SunWater has reviewed the KBR report concerning the proposed levees for Ensham Mine, with a focus on the likely hydraulic impacts on the flood plain. SunWater concludes that the proposed works generally conform to the requirements of the Interim Flood Plain Management Plan. It is acknowledged that the proposed works do result in some increase in peak flood levels at locations upstream of the Ensham Resources property boundary, but these increases are well below the 300 mm upper limit specified in the criteria. It is also noted that the proposed levees are designed to the required standard specified by the Environmental Protection Agency and include both a freeboard allowance and a controlled failure strategy.

It is recommended that copies of the Design Report and any other associated approvals be obtained from Ensham Resources Pty Ltd before final approval of the proposed works.

If any aspect of this letter requires clarification, please contact Mr Rob Ayre on [redacted]

Yours faithfully

[redacted]

Rob Ayre
ENGINEERING DESIGN MANAGER

SunWater
Website: www.sunwater.com.au

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Level 9, 120 Edward Street PO Box 15536 City East Qld 4002

Our ref: 08-004766/001 #675680
Contact Name: Rob Ayre
Telephone: [redacted]

20 June 2008

[redacted]
Director, Significant Projects Coordination Branch
Department of Infrastructure and Planning
PO Box 15009
CITY EAST Q 4002

Dear [redacted]

re ENSHAM MINE – REHABILITATION OF LEVEES

I am writing to you in regard to our review of the Kellogg Brown & Root (KBR) Pty Ltd report entitled, "Ensham Mine Proposed Levee Banks, January 2008 Flood Event Assessment", Report number BEW801-W-REP-001 Rev.0 dated 17 June 2008.

SunWater has completed a review of this report in accordance with the requirements of the Nogoa River Flood Plain Board's "Interim Flood Plain Management Plan" dated May 1997. The interim criteria and measures specified in the Management Plan for which development proposals are to be assessed are stated as follows:

1. Development in the Floodplain must be designed and constructed to standards appropriate to the level of risk of failure of those works and the hazards such failure represents.
2. Development within the Floodplain should result in the maintenance of a series of floodways generally conforming to the natural drainage pattern.
3. Development proposals must incorporate consideration and allowance for environmental, cultural and social impacts.
4. Developments on the Floodplain must comply with any requirements under any other relevant legislation.
5. Changes to flow rates, flow distribution, flood timing and depth of flow, as a result of the proposed development should be within the specified acceptable limits.

In accordance with criteria (1), the Interim Floodplain Management Plan requires that, *a Design Report of the proposed development works, including plans and specifications, be prepared by suitably qualified individuals or companies.* This criteria has not been considered as part of the review as such plans and specifications have not been provided to SunWater. It is understood that a Design Report of the proposed levees is in preparation by KBR and being reviewed by Golder and Associates. The Coordinator General would need to ensure that such documentation is submitted and conforms to the requirement of the Interim Flood Plain Management Plan, Shire Strategic Plan and By-Laws.

In terms of standards being applied to the proposed levees, SunWater understands that the Environmental Protection Agency has recommended that the levees be sized to provide flood immunity commensurate with the hazard category and hydrological design criteria specified Table 1 and Table 2 of the Site Water Management Guidelines (DME, 1995). SunWater understands that a 1 in 1000 year AEP design standard has been nominated and that KBR have adopted this event magnitude to establish the proposed levee heights, (Refer Tables 4.6 and 4.7). KBR have also adopted a freeboard allowance of 1 m in accordance with current best practice guidelines and investigated a controlled failure strategy for the proposed works.

Criteria (2) has been adequately addressed in the KBR report. The Interim Floodplain Management Plan requires that, *in general, development proposals must cause minimal change to the distribution of flood flows across the floodplain.* The proposed levee's do not impact significantly on the flow distribution across the floodplain as evidenced by Figures 4.6 and 4.9 of the KBR report, as the discharge pattern from the developers property is similar to the pre-development pattern. It should be noted that the existing levees were approved by the Board in February 1998 and that the comparison of flow distribution has been made against this scenario.

Criteria (3) and (4) are not addressed directly by the KBR report. Under criteria (3), *the Board may require the proponent to undertake other studies as necessary including a suitably detailed Impact Assessment Study and Environmental Management Plan in order for it to properly assess the application.* Likewise, in order to satisfy Criteria (4), *all other approvals, permits and authorities required of the proponent under any other Act must be obtained and a copy provided to the Board.* SunWater has not been provided with any additional information of this nature and are therefore unable to assess the fulfilment of these criteria.

Criteria (5) of the Interim Floodplain Management Plan requires that, *The total permissible increase in peak water elevation at or outside a property boundary arising from all development subject to the local law, on that property compared with that which would occur for the Adopted Base Case will be nil. However, this requirement may be varied at the absolute discretion of the Board subject to further information being provided by the proponent as the Board deems necessary in order for it to properly assess and determine the application. Irrespective, the total cumulative effect of all works (under an ultimate development scenario) on the floodplain shall not exceed 300 mm at any property boundary, over and above that occurring under the Adopted Base Case.*

The KBR report summarises in Table 4.3 and Table 4.4 the calculated afflux at the property boundary due to the proposed levees for the January 2008 Design Flood Event and the 1 in 20 year AEP Design Flood Event (also known as the Designated Flood Event, DFE). The maximum increase indicated for both events is 50 mm at the upstream property boundary on Winton Creek (Point 5) and the main Nogoa River channel (Point 2). The magnitude of the increases indicated is consistent with SunWater's assessment of the likely impacts using the Board's numerical hydraulic model.

Whilst the afflux indicated for these events is greater than the nil increase specified in the criteria, the afflux for both cases is well below the 300 mm upper limit nominated in the measure. As the January 2008 Design Flood Event is significantly larger event than the DFE, and the impacts for both events are of a similar magnitude, it is considered that the proposed development satisfies the intent of this measure and therefore is considered acceptable.

In summary, SunWater has reviewed the KBR report concerning the proposed levees for Ensham Mine, with a focus on the likely hydraulic impacts on the flood plain. SunWater concludes that the proposed works generally conform to the requirements of the Interim Flood Plain Management Plan. It is acknowledged that the proposed works do result in some increase in peak flood levels at locations upstream of the Ensham Resources property boundary, but these increases are well below the 300 mm upper limit specified in the criteria. It is also noted that the proposed levees are designed to the required standard specified by the Environmental Protection Agency and include both a freeboard allowance and a controlled failure strategy.

It is recommended that copies of the Design Report and any other associated approvals be obtained from Ensham Resources Pty Ltd before final approval of the proposed works.

If any aspect of this letter requires clarification, please contact Mr Rob Ayre on [redacted]

Yours faithfully

[redacted]

Rob Ayre
ENGINEERING DESIGN MANAGER

Certification for Ensham Coal Mine Levee Hydrologic/Hydraulic Study

Name of Professional Engineer Providing Certification

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Statement of Relevant Experience

I am a qualified Civil Engineer who has developed specialist skills in hydrology and hydraulic engineering. I have over twenty-four years experience in water engineering projects related to Queensland's surface water resources. My main area of interest includes flood estimation and hydraulic modeling of flood plain flows. I have developed expertise in the areas of flood forecasting and flood operation of dams with gated spillways. I am familiar with water resource planning, management and dam safety provisions of the current Water Act (2000).

I am also very familiar with the use of many different hydrologic and hydraulic modeling systems ranging from databases such as HYDSYS and TimeStudio, to runoff-routing models such as RORB and URBS and water resource simulation models such as WAM, WT16 and IQQM. I am very experienced in the use of one-dimensional and two-dimensional hydraulic models including RUBICON, MIKE-11 and FESWMS, a finite element depth averaged hydrodynamic model. I pioneered the use of the US National Weather Service DAMBRK model in the QWRC for the conduct of dam failure analyses in the late 1980's.

Over the last five years, I have held the role of project manager of the water studies, special projects and engineering design profit centres within the consultancy arm of SunWater. I have been responsible for the management of a range of project studies during that time. I have undertaken project management courses to enhance my ability to manage project teams to achieve business and quality objectives. I have experience in managing multi-disciplinary teams in the delivery of water resource projects in a commercial environment.

Significant projects with which I have been involved include:

Hinze Dam Stage III Raising (Technical Advisory Team)

I am the nominated Project Leader for this project in which SunWater has been commissioned by the Gold Coast City Council to act as Technical Advisors and Owner's Engineer for an Alliance delivery of the design and construction of Stage III of Hinze Dam. This has involved coordinating a team of specialist practioners from within SunWater to provide advice to Council in firstly assisting the selection of the Alliance proponent and then assisting the chosen Alliance team complete options studies and arrive at a preferred design for the raised dam. The team has been retained through the Turn-out Cost and Works Delivery phases of the project to assist the Alliance refine the design and determine the cost for delivery of the overall project.

The preferred design consists of a raised embankment and increased Full Supply Level with an extension of the primary spillway to enable the raised dam to satisfy both flood mitigation and dam safety requirements.

Western Corridor Recycled Water Scheme

I am the nominated Project Leader for the SunWater design team that is a sub-alliance member of the Western Corridor Recycled Water Scheme – Eastern Pipeline Alliance. In this capacity I am responsible for the administration of the project including coordinating all staff, system and financial requirements of the project, including weekly and monthly invoicing and alliance reporting.

This project involves the design and construction of pipe and pump systems that will convey treated wastewater from five existing wastewater treatment plants located in Brisbane and enable this water to be either used by industrial users such as Swanbank and Tarong power stations or be utilised in an indirect potable reuse scheme involving Wivenhoe Dam.

South East Queensland Water Corporation Flood Operations

I am the Senior Duty Flood Operations Engineer for the SEQWater facility management project, which includes the operation and maintenance of Somerset, Wivenhoe and North Pine Dams. I am one of three officers responsible for the direction of flood operations for these storages to maximise the flood mitigation capability of the reservoirs and to minimise the damage to downstream communities.

In the role of Senior Flood Operations Engineer, I am responsible for the ongoing training of flood response team members and supervision of the ongoing monitoring of the real time flood operations modelling system. This includes maintaining rosters and ensuring the ongoing performance of the system is to an appropriate standard. I am also responsible for the preparation and submission of routine and event reports to the regulator of dam safety.

I was also the project leader for the implementation and commissioning phase of the Brisbane River and Pine River Flood Study, which involved the finalisation of the development of a real time flood operations model (known as FLOOD) for the dams owned and operated by the SEQWater. This entailed supervision of the establishment of the flood control centre and the training of operators in the use of the system.

Dam Failure Analyses – SunWater Dams

I was Project Leader and technical reviewer of a reassessment of all of the dam failure analyses for the portfolio of dams owned and operated by SunWater. This program of studies was undertaken in response to changes to the dam safety provisions of the Water Act 2000, which places greater emphasis on the consequence of failure downstream of the dam. As technical reviewer I was responsible for the ensuring the technical standard of each study and that it complies with the relevant ANCOLD and NRW guidelines.

Studies completed under my direction include: Borumba Dam, Cania Dam, Peter Faust Dam, Teemburra Dam, Kinchant Dam, Burdekin Falls Dam, Tinaroo Falls Dam, Fairbairn Dam, Callide Dam, Fred Haigh Dam, Bill Gunn Dam, Leslie Dam, Maroon Dam, Moogerah Dam, Coolmunda Dam, Bjekle-Petersen Dam, Atkinson Dam, and Julius Dam.

Design Flood Revisions – SunWater Dams

Project Leader for a study that involved the revision of design flood estimates using the latest techniques in storm rainfall estimation for storages owned and operated by SunWater. As project leader I was responsible for the ensuring the delivery of the revised design flood estimates to an appropriate technical standard and within budget and on schedule.

Studies completed include: Borumba Dam, Teemburra Dam, Burdekin Falls Dam, Tinaroo Falls Dam, Fairbairn Dam, Callide Dam, Fred Haigh Dam, Moogerah Dam, Coolmunda Dam, Bjekle-Petersen Dam, Atkinson Dam, Julius Dam, Wuruma Dam, Cedar Pocket Dam, and Boondoomba Dam.

Burnett River Dam Design Flood Revision

Technical reviewer for a study that involved the revision of design flood estimates of the proposed Burnett River Dam using the latest techniques in storm rainfall estimation, including Bureau of Meteorology's PMP the Generalised Tropical Storm Method (Revised) and CRC-Forge. I was responsible for ensuring the revised design flood estimates were derived in accordance with the recommended procedures described in Australian Rainfall and Runoff Book VI.

Burrum River Flow Management Plan

I supervised the development of a flow management plan of the Burrum River as part of a submission to the Department of Natural Resources and Water (NRW) on behalf of Wide Bay Water. The flow management plan supplements an earlier Interim Resource Operation License application, which is based upon the findings of a generalized water resource simulation model known as IQQM, (Integrated Quantity Quality Model). The plan outlines the operational strategy required to enable the water management infrastructure to comply with environmental flow objectives for the river basin.

Lenthalls Dam - Dam Failure Analysis

I was involved in the investigation of the possible consequences of the failure of Lenthalls Dam located in the Burrum River. This study involved the assessment of both the existing dam and a proposed 2m raising of the dam on behalf of Wide Bay Water.

The study included the development and calibration of a one-dimensional MIKE-11 hydraulic model of the downstream valley and the determination of population at risk based upon inundation mapping generated from the hydraulic model. The investigation is based upon the latest NRW guidelines for dam failure impact assessment. I was responsible for overseeing the hydraulic modeling and the production of the inundation mapping.

Splityard Creek Dam Failure Analysis

I supervised the investigation of Splityard Creek dam failure analysis on behalf of Tarong Energy. This study involved the establishment of a hydraulic model for the assessment of the likely extent of inundation of the stream system located below the dam and an assessment of the likely failure modes of the dam. The hydraulic modeling was undertaken using the one-dimensional hydraulic model, MIKE-11. Results from the hydraulic modeling were incorporated in digital mapping for use in determining the likely population at risk.

Scrivener Dam Flood Operations

As the Senior Flood Operations Engineer for SunWater, Asset Solutions, I provide advice on flood operations for Scrivener Dam, which is located in the ACT. This project involves the management of flood operations of the dam during flood events. This included the establishment of a real-time flood operations model of the dam and a remote flood operations centre designed to be on alert at all times. A spreadsheet model has been developed to enable the prediction of flood levels based on spillway gate openings. I am responsible for supervising the development of the model, training of duty flood operation engineers, and the establishment and continuing operation of the remote flood operations centre.

Coomera River Flood Study

Project supervisor for a hydraulic model study that involved the assessment of flood impacts of proposed developments in the rapidly developing urban environment within the Coomera River flood plain within Gold Coast City. This study included the estimation of design flood hydrology using the RORB runoff-routing model together with hydrodynamic modelling using the one-dimensional branch network model, MIKE-11. The project also involved the development of an innovative mapping technique for the production of electronic maps for display in a GIS environment (MAPINFO). These plans are used by the Council for public consultation, flood damage assessment and emergency management planning.

Nogoa River Flood Study

Project supervisor for a hydrologic and hydraulic model study undertaken for the Department of Natural Resources and the Nogoa River Flood Plain Board. The study involves the hydraulic assessment of proposed rural developments on the Nogoa River flood plain. Runoff-routing techniques were used to estimate design flood hydrographs whilst the hydraulic modelling was undertaken using the RUBICON one-dimensional branched network hydraulic model. The model assessment is used to test if the proposed developments conform to the plan of management adopted by the Board.

Nerang-Broadbeach Road Flood Impact Assessment Study

A hydraulic assessment of the likely flood impact of the proposed upgrading of the Nerang-Broadbeach Road was undertaken on behalf of the Department of Main Roads. I acted in the capacity of project leader and chief hydraulic modeller in this study that utilised a two-dimensional finite element hydraulic model (FESWMS) to simulate the complex flood effects of the proposed road design on the Nerang River flood plain. Due to the location of the proposed road upgrade the hydraulic impacts could potentially affect a considerable number of adjacent properties on the flood plain.

Emerald Town Flood Study

Project supervisor of a flood study to help define the flooding characteristics of the town of Emerald on behalf of Emerald Shire Council for input into future town planning. The study involved the development of hydrologic and hydraulic models of the town area including the adjacent Nogoa River and its associated flood plains. This study complimented the formulation of a plan of management of the Nogoa river flood plain.

Ingham Bypass Flood Impact Assessment Study

A hydraulic assessment of the likely flood impact of the proposed upgrading of the Pacific Highway south of the town of Ingham was undertaken on behalf of the Department of Main Roads. I acted in the capacity of project leader and chief hydraulic modeller in this study that utilised a two-dimensional finite element hydraulic model (FESWMS) to simulate the complex flood effects of the proposed road design on the Herbert River flood plain.

Bundaberg City Council Detention Basin Design

Responsible for the hydraulic design of a proposed detention basin located on Saltwater Creek in Bundaberg. The design included sizing of the spillway and hydraulic design of the energy dissipator. Hydraulic analyses also included a dam failure analysis of the detention basin due to its proximity to urban development.

Brisbane River and Pine River Flood Study

Project leader of the hydrologic and hydraulic modelling team associated with a review of the design flood hydrology and conduct of a dam failure analysis of Somerset Dam, Wivenhoe Dam and North Pine Dam. In this role I was responsible for the revision of the design flood hydrology of each of the dams using runoff-routing and flood frequency techniques. In addition dam failure analyses were undertaken using DAMBRK and RUBICON hydraulic models for input into Emergency Action Plans of the reservoirs.

Nerang River Flood Study

Project leader for the hydraulic modelling team that provided technical advice to the Albert Shire Council and Gold Coast City Council concerning flood plain management issues of the Nerang River system. Studies included investigation of possible mitigation options such as impacts of detention basins, river dredging, and second opening to ocean and additional flood ways.

Statement of Certification

The hydrologic/hydraulic analysis has been conducted having regard to the 1 in 1000 year AEP using Tables 1 and 2 of the Site Management Technical Guideline for Environmental Management of Exploration and Mining in Queensland (DME, 1995). It is acknowledged that the levees are not designed for the purpose of water retention, but moreover for the purpose of water exclusion.

The minimum reduced level of the crest to be applied in the design of the levee was estimated using hydrologic and hydraulic modelling as set out in the attached report entitled, "Ensham Mine Proposed Levee Banks, January 2008 Flood Event Assessment", report number BEW801-W-REP-001 Rev 0, dated 17 June 2008.

All relevant material relied upon is attached to this certification in a form such that another suitably qualified and experienced person could perform an independent review without seeking further information.

I herby certify that the minimum reduced level of the crest of this levee has been estimated in accordance with best engineering practice.

I Robert Arnold Ayre, of SunWater, PO Box 15536 City East, Brisbane, Q, 4001, being aware that it is an offence under Section 480 of the Environmental Protection Act 1984 to provide false or misleading information state that:

1. I am authorised to sign on behalf of the corporate entity or entities holding the Environmental Authority for the purposes of providing certification above.
2. I do solemnly and sincerely declare that the information is true and correct to the best of my knowledge and I make this solemn declaration conscientiously believing the same to be true, and by virtue of the provisions of the Oaths Act 1867.

Signed

[redacted].....

Robert ~~Arnold~~ Ayre RPEQ 4987

Taken and declared before me at...BRISBANE.....

This 24th.....day of.....JUNE.....2008.....

[redacted].....

Witness (~~A Justice of the Peace~~/Commissioner for Declarations, ~~Barrister or Solicitor~~)

[redacted]

Final Report

Nogoa River Flood Plain

Ensham Mine Flood Modelling

Date: June, 2008
Ref: P-AEXP-0405-AB-02-03
File: 08-004766

SunWater

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Final Report

Nogoa River Flood Plain

Ensham Mine Flood Modelling

Date: June, 2008
Ref: P-AEXP-0405-AB-02-03
File: 08-004766

Prepared for:
Ensham Resources

This report has been produced by SunWater, to provide information for client use only.
The information contained in this report is limited by the scope and the purpose of the engineering study, and should not be regarded as completely exhaustive.
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EXECUTIVE SUMMARY

In January 2008, heavy rainfall up to 700mm was recorded in the five days to 20th January 2008 in the Nogoa/Mackenzie River system in central Queensland. Resultant floods were the some of the largest on record in Theresa Creek and the Nogoa River. At the start of the event, Fairbairn Dam was only 35% of full capacity. The combined flood waters had a significant impact on the open cut Ensham Mine, located just upstream of the confluence of the Nogoa and Comet Rivers.

SunWater was commissioned by Ensham Resources in conjunction with Kellogg, Brown and Root Pty Ltd, Ensham Resources's technical advisors, to provide modelling support services for hydrologic and some hydraulic aspects of the flooding.

A series of hydrologic models were developed and calibrated using the rainfall and water level data compiled from several agencies including the Bureau of Meteorology, the Department of Natural Resources, SunWater and Emerald Shire Council. Critical to the estimation of flows in this modelling was the flow measurements undertaken by the Department on Theresa Creek at Gregory Highway and the Nogoa River at Emerald. Model parameters were adjusted to obtain consistency with these measurements and recorded water levels at key locations.

Hydrologic modelling derived a set of flow hydrographs at numerous locations within the system. The modelling showed that a peak discharge of 4,020 m^3/s in Theresa Creek at the Gregory Highway occurred at 2200 on Friday 18th January. At the start of the event, Fairbairn Dam was only 35% full and the modelled peak outflow was 3,200 m^3/s and occurred at 1500 on Tuesday 22nd January. Runoff from local creeks in the vicinity of Ensham Mine was relatively low due to the lower catchment rainfall and high initial losses.

A second set of flow hydrographs were derived assuming Fairbairn was full at the start of the event.

The MIKE 11 hydraulic model of the Nogoa River floodplain for the Approved Developments Case was used as the base model for this study. That part of the hydraulic model located upstream of Ensham Mine was first re-calibrated for the January 2008 flood event using the flows derived from the hydrologic models.

It was necessary to increase the Manning's *n* roughness along a reach of the main Nogoa River upstream of Duck Ponds Gauging Station and along a parallel flood runner for the model to adequately reproduce the observed flood levels.

The re-calibrated hydraulic model was then used to analyse the January 2008 event assuming that Fairbairn Dam was full at the start of the event and these results were compared to the case of Fairbairn Dam starting at the actual 35% capacity. Peak flood levels were generally found to increase by approximately 0.4m to 1.0m along the Nogoa River as a result of the storage being full at the start of the event.

The re-calibrated model was used to assess the likely impacts that would arise from the extension of the Ensham Mine levees around the mine area on both the northern and southern banks of the Nogoa River. The impact of the extended levees was assessed for both the Designated Design Event, set at the 1:20 AEP event by the Nogoa River Flood Plain Board, and for the January 2008 flood with Fairbairn Dam assumed full at the start of the event.

For both events, the proposed extensions of Ensham Mine levees cause affluxes of up to 25 mm at any location, either within the Ensham Mine holdings or at any neighbouring properties. This is well below the acceptable afflux of 300 mm set by the Nogoa Flood Plain Board.

TABLE OF CONTENTS

1.0 INTRODUCTION 1
2.0 HYDROLOGY 3
2.1 RUNOFF ROUTING MODEL 3
2.2 RATINGS 4
2.3 MODEL CALIBRATION 6
2.3.1 Nogoa River to Fairbairn Dam 9
2.3.2 Theresa Ck to Gregory Highway 10
2.3.3 Comet River to Comet Weir 11
2.3.4 Mackenzie River 11
2.3.5 Summary of Peak Flows 13
3.0 HYDRAULICS 16
3.1 BACKGROUND 16
3.2 HYDRAULIC MODEL INPUT 17
3.2.1 Boundary Conditions 17
3.2.2 Initial Conditions 17
3.2.3 Computational Parameters 17
3.3 HYDRAULIC MODEL RECALIBRATION 19
3.4 HYDRAULIC MODEL – FAIRBAIRN DAM FULL SCENARIO 22
3.5 PROPOSED EXTENSION OF ENSHAM MINE LEVEES 24
3.5.1 Proposed Works 24
3.5.2 Hydraulic Model Results 25
4.0 REFERENCES 33

LIST OF TABLES

Table 2-1: January 2008 Gaugings 4
Table 2-2: Calibration Parameters 8
Table 2-3: Peak Flows and Volumes - Actual Dam Conditions 14
Table 2-4: Peak Flows and Volumes - Assuming Dam Full 15
Table 3-1: Selected Manning's *n* 19
Table 3-2: Peak Flood Levels for January 2008 Recalibration Event 22
Table 3-3: Peak Flood Levels Upstream of Ensham Mine for January 2008 Event 23
Table 3-4: Peak Flood Levels for Northern Levee 26
Table 3-5: Peak Flood Levels for Southern Levee 27

LIST OF FIGURES

Figure 2-1: Rating Theresa Ck at Gregory Highway 5
Figure 2-2: Rating Nogoa River at Emerald.....6
Figure 2-3: Nogoa River Rainfall (Source: BoM 2008).....7
Figure 2-4: Fairbairn Dam Inflow Calibration 9
Figure 2-5: Fairbairn Dam Outflow.....10
Figure 2-6: Theresa Ck at Gregory Highway Calibration 11
Figure 2-7: Emerald Calibration.....12
Figure 2-8: Duck Ponds Calibration.....13
Figure 3-1: Hydraulic Model Layout and Proposed Ensham Levee Extension 18
Figure 3-2: Theresa Creek at the Gregory Highway, January 2008 Re-calibration Event.....20
Figure 3-3: Nogoa River at Emerald Town Gauge, January 2008 Re-calibration Event.....20
Figure 3-4: Nogoa River at Duck Ponds, January 2008 Re-calibration Event.....21
Figure 3-5: Long Profile – Nogoa River, 1:20 AEP Designated Design Event 28
Figure 3-6: Long Profile – Nogoa River, January 2008 Event – Fairbairn Dam Full.....28
Figure 3-7: Long Profile – Winton Creek, 1:20 AEP Designated Design Event 29
Figure 3-8: Long Profile – Winton Creek, January 2008 Event – Fairbairn Dam Full.....29
Figure 3-9: Long Profile – Flood Runner BNO_R22-23-24-25, 1:20 AEP Designated Design Event 30
Figure 3-10: Long Profile – Flood Runner BNO_R22-23-24-25, January 2008 Event – Fairbairn Dam Full 30
Figure 3-11: Long Profile – Flood Runner BNO_R12-13-18-19, 1:20 AEP Designated Design Event 31
Figure 3-12: Long Profile – Flood Runner BNO_R12-13-18-19, January 2008 Event – Fairbairn Dam Full 31

1.0 INTRODUCTION

In January 2008, heavy rainfall was recorded in the five days to 20th January 2008 in the Nogoa River system in central Queensland. Near-record flooding occurred in the Theresa Creek system, peaking at the Gregory Highway on 19th January. On the Nogoa River, Fairbairn Dam which was 35% full or some 832,000 ML below full supply at the start of the event, recorded it's highest ever inflow. Outflow from the dam resulted in significant flooding of Emerald, 19 km downstream. The two drainage systems joined on the Nogoa flood plain just downstream of Emerald.

The flood waters had a significant impact on the open cut Ensham Mine, located just upstream of the confluence of the Nogoa and Comet Rivers, with filling of the open cut pits.

As a result, SunWater was commissioned by Ensham Resources in conjunction with Kellogg, Brown and Root Pty Ltd, Ensham Resources's technical advisors, to provide modelling support services for an assessment of the hydrologic and some hydraulic aspects of the flooding.

These support services included:

- Development and calibration of a hydrological model of the Nogoa system to the January 2008 flood to the main gauging stations. Inflow hydrographs of the local watercourses were also required.
- Re-calibration of the existing MIKE11 model of the Nogoa flood plain to the January 2008. This calibration was limited to the gauging stations upstream of the mine.
- Re-running the hydrologic and hydraulic models assuming Fairbairn Dam full at the start of the rainfall.

Available data for this flood hydrology investigation included:

- Daily and pluviograph rainfall data from the Bureau of Meteorology, Department of Natural Resources and Water and Emerald Shire Council for various locations in and around the Nogoa/Mackenzie basin.

- River height records, ratings and gaugings from stations op erated by the Departm ent of Natural Resources and Water and from Bureau of Meteorology flood warning stations.
- DEM data in the form of the files from the NASA Shuttle Radar Topography Mission.

2.0 HYDROLOGY

2.1 RUNOFF ROUTING MODEL

The conceptual runoff routing model URBS (Carroll 2007) was used to model the behaviour of the Nogoa/Mackenzie River. URBS is a computer based, hydrologic modelling program that enables the simulation of catchment storage and runoff response by a network of conceptual storages representing the stream network and reservoirs.

The URBS model in the split mode was adopted in this study. In this mode, the model identifies the catchment and channel routing in each sub-catchment and calculates their effects separately. First, the excess rainfall on a sub-catchment is routed to the creek channel. This inflow from the sub-catchment into the channel is assumed to occur at the centroid of the sub-catchment. The lag of the sub-catchment storage is assumed proportional to the square root of the sub-catchment area. Next, the inflow is routed along a reach using a linear Muskingum method, whose lag time is assumed proportional to the length (or derivative) of the reach.

The program CatchmentSIM (Ryan 2004) was used to develop the URBS runoff-routing model of the catchment. The program develops a DEM based upon the hgt files from the NASA SRTM site and sub divides the catchment at selected points of interest such as gauging stations and inflow locations.

The river system was divided into 4 linked models:

- Nogoa River to Fairbairn Dam model represents 16,167 km2 and consists of 105 sub-catchments;
- Theresa Creek to Gregory Highway model represents 8,448 km2 and consists of 59 sub-catchments;
- Comet River to Comet Weir model represents 16,136 km2 and consists of 106 sub-catchments, and;
- Mackenzie River to Bingegang model represents 16,136 km2 and consists of 106 sub-catchments. This model takes the outflow from the 4 above models.

For this study, the estimation of flows was limited to the area upstream of the confluence of the Nogoa and Comet Rivers but the areas downstream are included in the modelling for completeness.

2.2 RATINGS

Calibration of the hydrologic model is carried out by comparing modelled flows with the estimated recorded flows. In turn, these recorded flows are estimated from the recorded height and the appropriate rating. Thus rating curves are critical to the modelling process and it is important that there is an appreciation of the reliability of the rating at each site.

Table 2-1: January 2008 Gaugings

AWRC	Stream	AMTD	Location	Date/Time	Mean Gauge Height	Gauged Flow
		km			m	m3/s
130206a	Theresa Creek	14.5	Gregory Highway	19/01/2008 12:00	10.64	3840
130911	Nogoa River	681.0	Emerald	22/01/2008 14:30	15.30	3110
				27/01/2008 14:30	11.48	830
130113a	Mackenzie River	591.0	Rileys Crossing	21/01/2008 11:30	19.70	3340
				22/01/2008 10:45	20.16	3643
				23/01/2008 09:30	20.44	3854
				28/01/2008 11:15	16.81	1773
				31/01/2008 11:15	11.99	668

During the January 2008 event, NRW undertook flow measurements at several key locations along the Nogoa\Mackenzie system. The gaugings, summarised in Table 2-1, form the basis for the estimation of the high stage ratings and are critical in model calibration.

The critical ratings are at Fairbairn Dam, Emerald and the Gregory Highway. The latter two locations were actually gauged during the event while the Fairbairn Dam rating was determined by physical model study. These ratings are shown in the figures below.

The Gregory Highway rating is particularly critical to the estimation of the peak flow and flood volume estimation, critical for estimating the volume of flood water diverted into the open cut mine. The estimation of the Gregory Highway rating above 10 metres gauge height is largely based upon the January 2008 gauging.

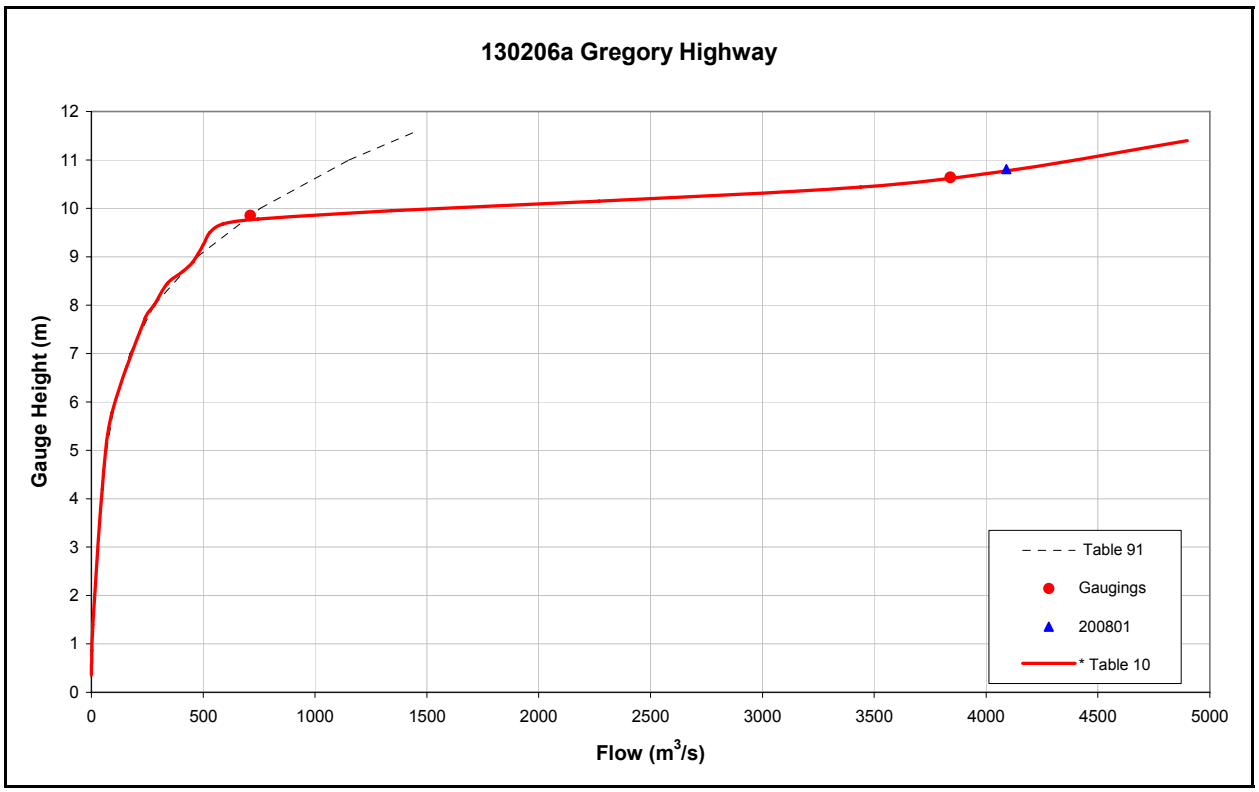

Figure 2-1: Rating Theresa Ck at Gregory Highway

The Emerald rating was found to be consistent with the rating for the Fairbairn Dam spillway.

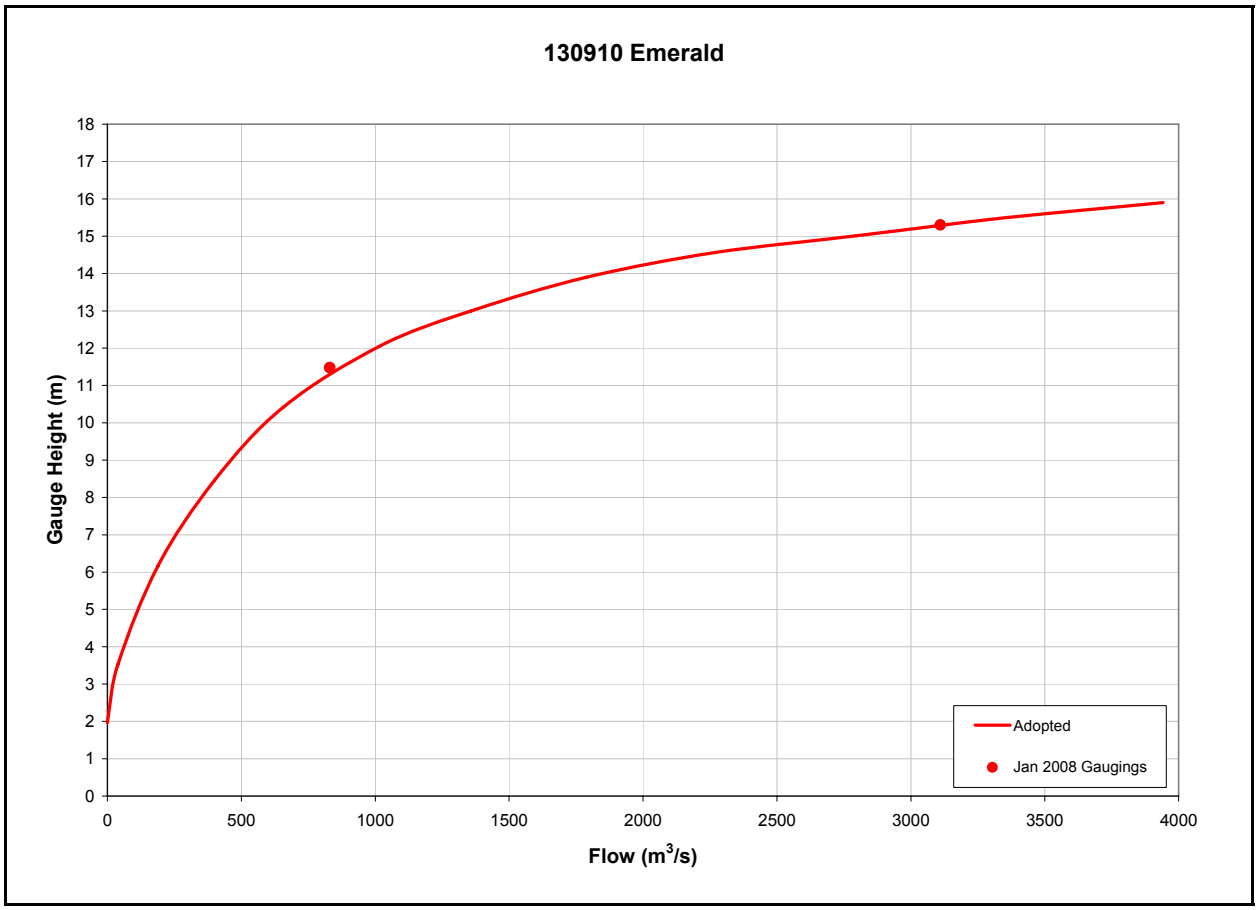

Figure 2-2: Rating Nogoa River at Emerald

2.3 MODEL CALIBRATION

The first step in calibrating the hydrologic model is to define the rainfall depth and pattern for each sub-area in the model.

The data set compiled by BoM following the event (BoM 2008) contains daily rainfall (official and unofficial), pluviograph data and water level data from several agencies with network in the study area. These include the Bureau, the Department of Natural Resources and Water and Emerald Shire Council. The map showing the rainfall in and around the Nogoa/Mackenzie system, Figure 2-3, can be found in the BoM report (BoM 2008).

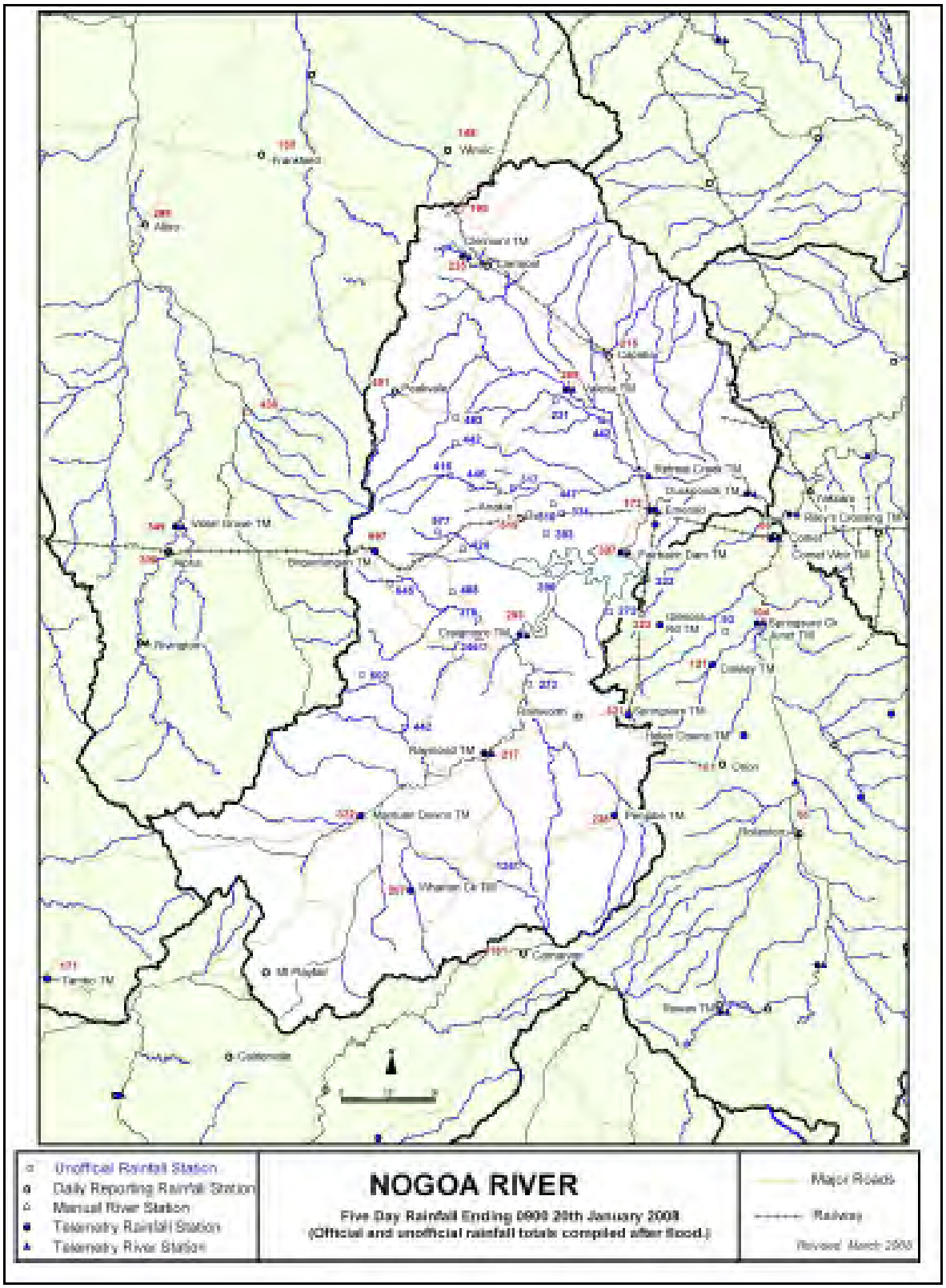

Figure 2-3: Nogoa River Rainfall (Source: BoM 2008)

It should be noted that the heaviest falls in the system were recorded upstream of Emerald and Gregory Highway with 5 day totals in excess of 200 to 700mm. Rainfall totals downstream of these locations were substantially less ranging from 215mm at Capella, 145mm at Emerald Airport and 92mm at the Duck Ponds gauging station. This lower rainfall has implications for the estimation of peak flows and runoff volumes in the local creeks around the mine.

A technique adopted by BoM for flood forecasting (Malone 2000) was used to estimate the rainfall on each sub-catchment in each flood event. The method utilises all available rainfall data, pluviograph and daily, and estimates a rainfall depth for each sub area using weightings based on the inverse distance squared from the centroid of each sub area to the nearest four rainfall stations. The pattern of the nearest pluviograph is then assigned to this estimated depth.

Two sets of calibration parameters were derived for each event to give the best fit to the observed data:

- Rainfall-runoff parameters; initial loss (IL), continuing loss (CL) and;
- Runoff-routing parameters; channel lag parameter (alpha α), catchment lag parameter (beta β) and catchment non-linearity parameter (m).

The calibration parameters adopted for the models are listed in Table 2-1 and discussed further below.

Table 2-2: Calibration Parameters

Model	Calibration Location	IL	CL	Alpha	Beta	m	Volume to Spill	DC	Volume GL		
		mm	mm/hr				ML		Cal	Rec	%
Nogoa R	Inflow	75	2.6	0.33	2.5	0.8	832,000	0.976	2,410	2,370	2
	Fairbairn Dam							0.994	1,410	1,350	4
Theresa Ck	Gregory Hwy	90	4.0	0.27	3.0	0.8	na	0.897	890	1,190	-25
Mackenzie R	Duck Ponds	90	3.5	0.35	2.5	0.8	na				

2.3.1 Nogoa River to Fairbairn Dam

At the commencement of the event, Fairbairn Dam was only 35% full with a volume deficit of 832,000 ML. An initial loss of 75mm matches the modelled hydrograph of the inflow to the dam, indicating that the catchment was reasonably dry.

The continuing loss rate was adjusted to match the estimated inflow and outflow hydrographs and good agreement was obtained between the modelled and recorded hydrographs at the inflow and outflow as shown in Figure 2-4 and Figure 2-5.

The peak of the modelled outflow is slightly higher than the estimated recorded outflow so as to obtain good agreement with the gauged flows at Emerald.

The modelled peak outflow was 3,200 m3/s, occurring at 1500 on 22nd January.

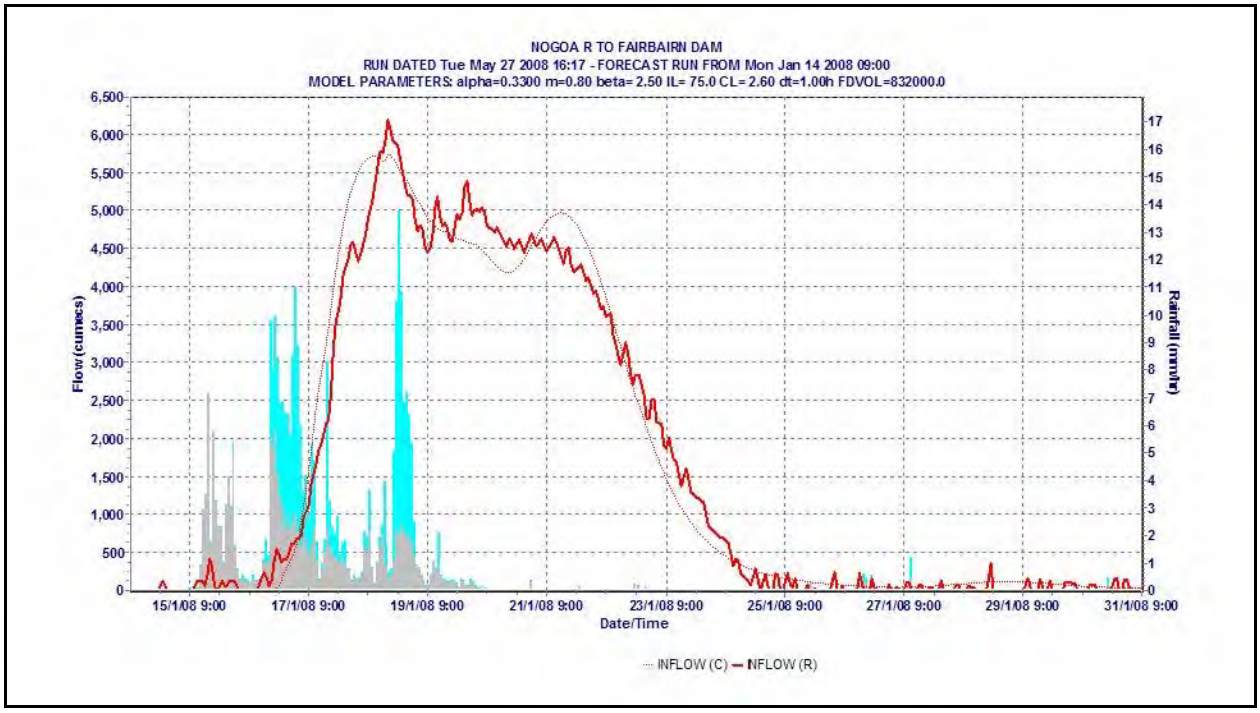

Figure 2-4: Fairbairn Dam Inflow Calibration

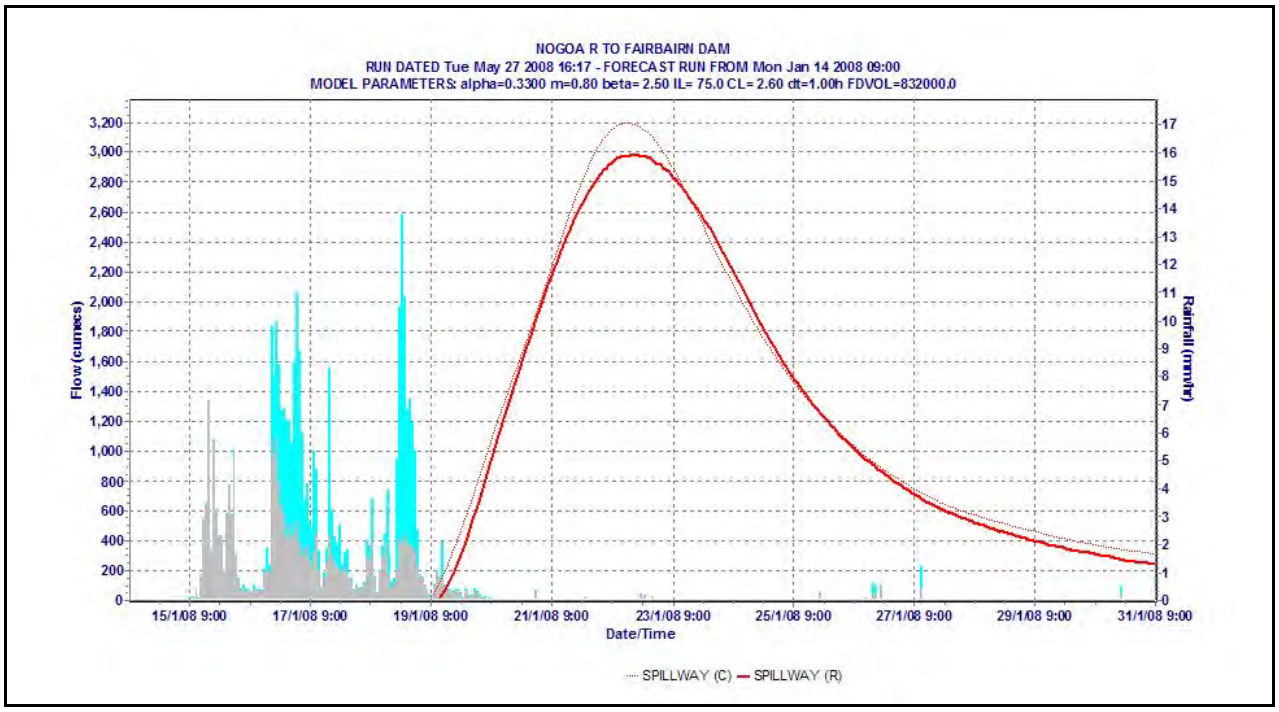

Figure 2-5: Fairbairn Dam Outflow

2.3.2 Theresa Ck to Gregory Highway

An initial loss of 90mm matches the start of the rising limb at the Valeria and Gregory Highway gauges, again indicating that the catchment was reasonably dry.

The continuing loss rate was adjusted to match the estimated peak flow of the hydrograph at Gregory highway. Good agreement was obtained with the flow and timing of the peak at this location although the volume of the flood was underestimated, as shown in Figure 2-6.

The modelled peak flow at the Gregory Highway was 4,020 m3/s, occurring at 2200 on Friday 18th January.

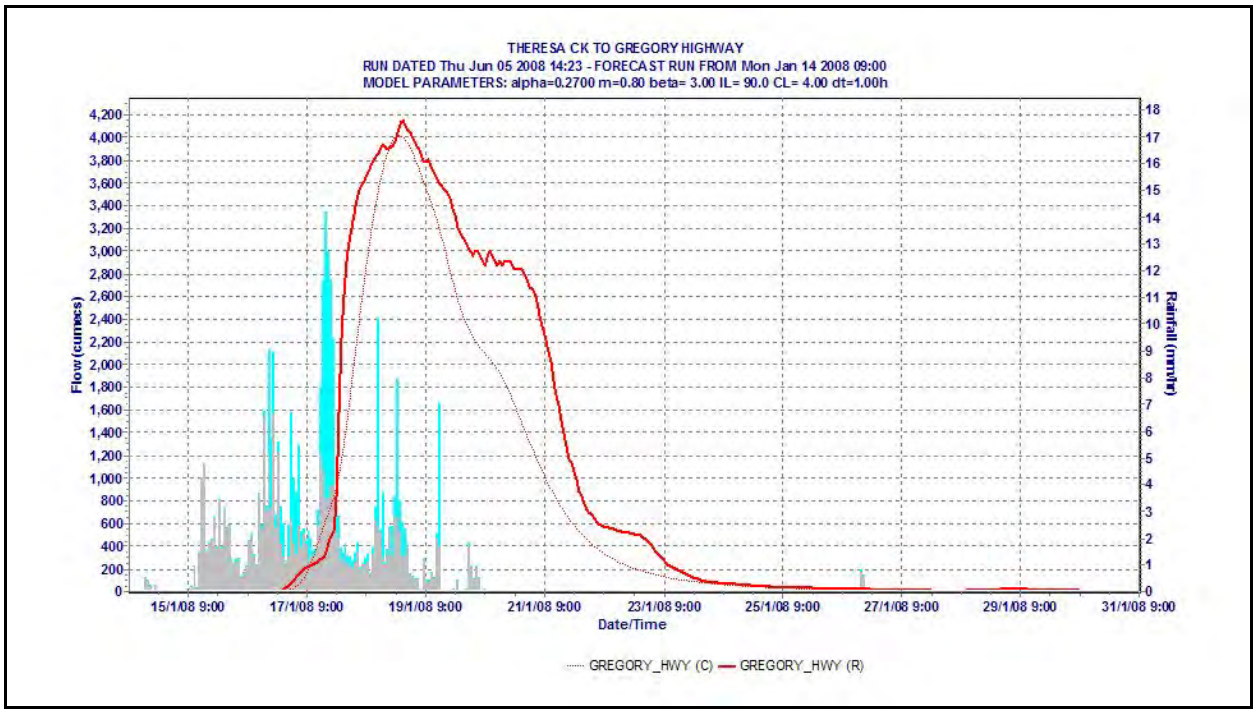

Figure 2-6: Theresa Ck at Gregory Highway Calibration

2.3.3 Comet River to Comet Weir

The Comet River model was not calibrated in this study and the estimated recorded flow at Comet Weir was included in the Mackenzie model for completeness. However, this will not affect model results since Ensham Mine is located upstream of the confluence with the Comet River.

2.3.4 Mackenzie River

The calibration of the Mackenzie model posed a problem as it was not possible to directly calibrate against a particular gauging station.

As shown in Figure 2-7, the model gives good agreement with the recorded data at Emerald but it should be noted that there is a breakout to the west of the town gauge upstream of Selma Weir which is not included in the hydrologic model.

The hydrologic model assumes single flow path for the mainstream between the junction of the Nogoa River and Theresa Creek to the confluence with the Comet River.

The gauging station at Duck Ponds is indicative of only of the flow in that channel. However, as shown in Figure 2-8, the height hydrograph is useful in ge tting the m odel tim ing right. Similarly, due to large diversion of flows into the ope n pit, calibration against gauging stations downstream of the Nogoa-Com et confluence is not possible with specific knowledge of the ne t flow into the pit.

Therefore, the selection of loss a nd model parameters is more subj ective, and more critical, than for the othe r models. In particula r, the select ion of initia l loss has a signif icant impact on the estimation of flows. As stated earlier, rainfall in the local ar ea around the mines was only of the order of 100 to 150mm. Subjective infor mation on the state of the local creeks from Chris Grieg (personal comm s) proves useful in this resp ect. Chris advised that Crinum , W inton and Gordonstone Creeks were flowing overbank wh ile there was significant flow in Boggy and Corkscrew Creeks. Mosquito Ck was flowing 'slowly but with good level'. There was no information on the state of Sandhurst or Bellcong Creeks.

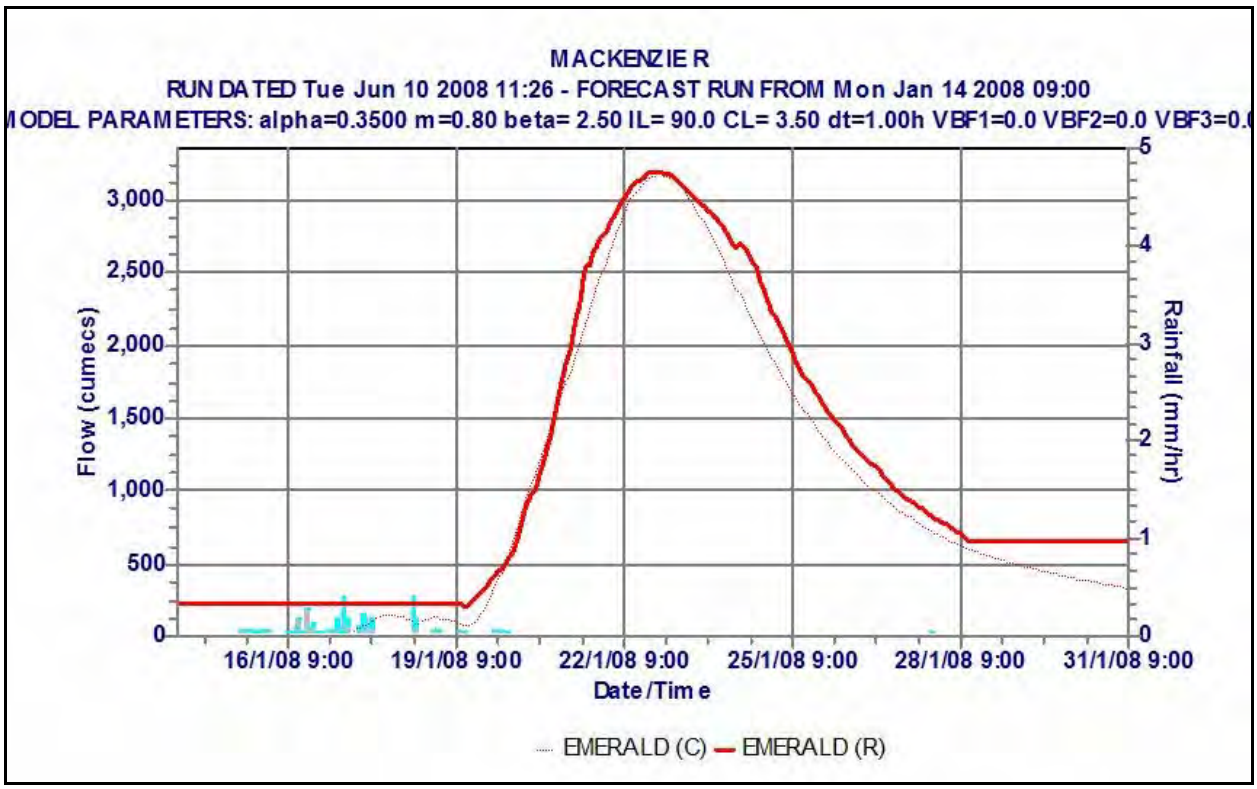

Figure 2-7: Emerald Calibration

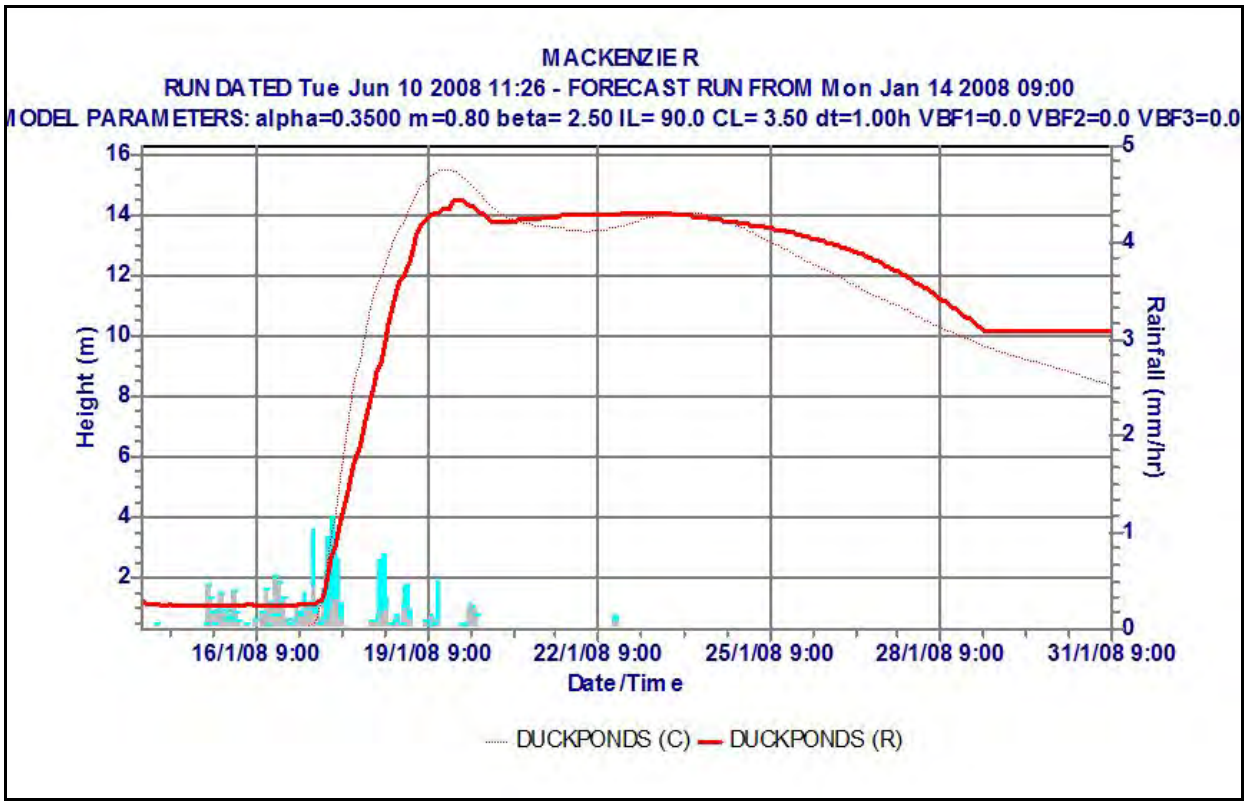

Figure 2-8: Duck Ponds Calibration

Loss parameters, similar to those calibrated for the Nogoa River and Theresa Creek catchments, were adopted for the Mackenzie model. Routing parameters were adjusted to try to match the timing of the peaks at Duck Ponds.

The modelled flows in Crinum, Gordonstone and Mosquito Creeks are consistent with the anecdotal advice. The modelled flows in Boggy and Corkscrew Creeks may be a little low. The modelled flow in Winton Creek is difficult to assess due to its interactivity with flows in the main channels.

2.3.5 Summary of Peak Flows

A summary of the modelled peak flows in the study area is given in Table 2-3. Where indicated by an asterisk, the modelled height and/or flow have been calibrated against recorded data and is considered satisfactory.

The combined flows in the main channels downstream of the Nogoa River and Theresa Creek are represented by the label NO+ANA1+ANA2.

Table 2-3: Peak Flows and Volumes - Actual Dam Conditions

Location	Time of Peak	Peak Height	Peak Discharge	Calculated Volume
		m	m3/s	GL
SPILLWAY*	Tue Jan 22 2008 15:00	4.62	3197 1	411
KOOAROO_CK	Thu Jan 17 2008 23:00		144 20	
ST_HELENS_CK	Fri Jan 18 2008 19:00		21 2	
EMERALD*	Wed Jan 23 2008 00:00	15.35	3177 1	425
EMERALD_CK	Fri Jan 18 2008 20:00		19 2	
GREGORY_HWY*	Fri Jan 18 2008 22:00	10.74	4022 89	1
CODENWARRA_CK	Fri Jan 18 2008 19:00		31 4	
LOCHLESS_CK	Sat Jan 19 2008 06:00		5 <1	
NO+ANA1+ANA2	Sat Jan 19 2008 13:00		3877 2	300
CRINUM_CK	Fri Jan 18 2008 09:00		573 10	7
MOSQUITO_CK	Sat Jan 19 2008 07:00		15 1	
GORDONSTONE_CK	Fri Jan 18 2008 02:00		153 29	
UN_NAMED_CK1	Sat Jan 19 2008 06:00		8 1	
DUCK PONDS*	Sat Jan 19 2008 17:00	14.54	4543 2	455
WINTON_CK	Sat Jan 19 2008 07:00		15 2	
BOGGY_CK	Sat Jan 19 2008 08:00		11 1	
MARIA_CK	Sat Jan 19 2008 04:00		5 <1	
SANDHURST_CK	Fri Jan 18 2008 22:00		86 16	
CORKSCREW_CK	Sat Jan 19 2008 09:00		1 <1	

Overall, the volume of the local inflows account for only a relatively small percentage of the total flow in the Nogoa River system.

The peak flows and volumes were also estimated assuming Fairbairn full at the commencement of the event. Under these circumstances, only estimates at the spillway, Emerald and the main channels will be affected, as summarised in Table 2-4.

Table 2-4: Peak Flows and Volumes - Assuming Dam Full

Location	Time of Peak	Peak Height	Peak Discharge	Calculated Volume
		m	m3/s	GL
SPILLWAY*	Tue Jan 22 2008 07:00	5.41	4112 2	236
EMERALD*	Tue Jan 22 2008 15:00	NA	4098 2	250
NO+ANA1+ANA2	Sun Jan 20 2008 00:00	NA	5276 3	123
DUCK PONDS*	Sun Jan 20 2008 01:00	NA	5799 3	278

It was not possible to estimate the peak height at Emerald, the combined anabranch flow or Duck Ponds in the hydrologic model due to a lack of a suitable high stage rating. Besides the increase in peak flows and volumes, it should also be noted that timing of the estimated peaks changes.

3.0 HYDRAULICS

3.1 BACKGROUND

The Nogoa River Floodplain Study was undertaken in 1996 by the then Department of Natural Resources on behalf of the Nogoa River Floodplain Steering Committee. The study involved the development and calibration of hydrologic and hydraulic models of the Nogoa-Mackenzie River floodplain downstream of Fairbairn Dam. The hydraulic modelling package Rubicon (Haskoning 1992) was employed to model the floodplain.

The hydraulic model extended from Fairbairn Dam located at AMTD 685.6 km on the Nogoa River to Carnangarra (GS 130103a) located at AMTD 585.5 km on the Mackenzie River. The hydraulic model also incorporated the lower reaches of the Comet River, Retreat and Theresa Creeks and a number of smaller tributaries such as Gordonstone, Crinum, Mosquito, Boggy, Maria, Winton and Sandhurst Creek. In total, approximately 180 km of stream length was modelled.

The hydraulic model was primarily calibrated to the February 1978 flood event. Additional verification of model parameters was undertaken against other historical flood events using the February 1984 flood event and the May 1983 flood event, which were both far smaller in magnitude than the February 1978 flood event. Full details of the model construction and calibration can be found in the report *Nogoa River Flood Plain Study, Hydraulic Model Design Simulation Report* (DNR June 1996). This report also stated that it would be "desirable to further verify the model against larger flood events, which may occur in the future."

In 2007, at the request of the Nogoa River Flood Plain Board, SunWater – Asset Solutions converted the existing hydraulic model in Rubicon to the hydraulic model software MIKE 11 (DHI 2005).

The Revised Adopted Topographic Base Case (RATBC) (Case 086) was extracted from the Rubicon model, converted to MIKE 11 format and run with the model parameters adjusted until the MIKE 11 output satisfactorily matched the Rubicon model.

The converted RATBC model was then updated to an Approved Developments case that included the sanctioned developments in the Nogoa River Flood Plain since May 1997 up to the time of the report.

Refer to the report *Nogoa River Flood Plain Board, Model Conversion Report* (SunWater 2007) for full details of the conversion of the model.

The layout of the hydraulic model, the bounds of the Ensham Mine property and the proposed levee extensions are given in Figure 3-1.

3.2 HYDRAULIC MODEL INPUT

The MIKE 11 model of the Nogoa River for the Approved Developments as per SunWater's Model Conversion Study was the base model used in this study.

3.2.1 Boundary Conditions

The calibrated URBS model was used to derive inflow hydrographs for the January 2008 flood event. These hydrographs were used at the upstream boundary of the Nogoa River and of each model tributary, as well as for point inflows along the length of the modelled reaches.

The rating curve at Carnangarra gauging station was retained as the downstream boundary condition at the model outlet.

3.2.2 Initial Conditions

Nogoa River and each tributary were applied until a steady state was achieved throughout the model. These flows were required for model stability and are insignificant compared to storm event flows.

3.2.3 Computational Parameters

Simulations were run for the period from 14th January to 31st January 2008, to cover the period of high flows in the Nogoa River system resulting from the heavy rainfall in the Nogoa River system in the five days to 20th January. The simulations used a 30 second time step and saved every 30 minutes.

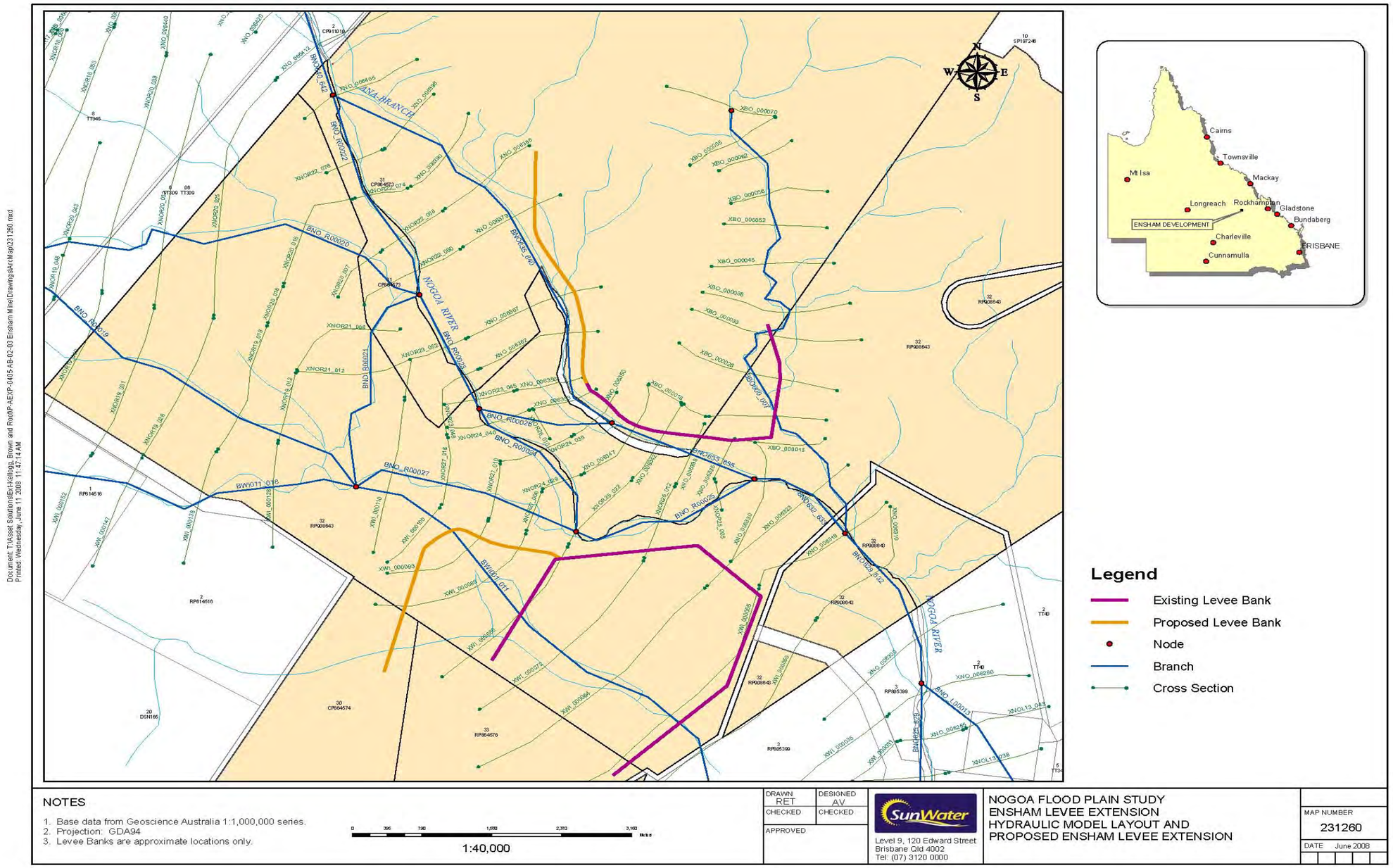

Figure 3-1: Hydraulic Model Layout and Proposed Ensham Levee Extension

3.3 HYDRAULIC MODEL RECALIBRATION

Re-calibration was carried out only for the part of the hydraulic model located upstream of the open cut Ensham Mine. Re-calibration of the model downstream of the mine was not undertaken, owing to uncertainties associated with the volume of water that flowed into the open cut pits. The hydraulic model was re-calibrated using the flows from the URBS hydrologic model for the flood of January 2008. This is the largest flood since the construction of Fairbairn Dam in 1972. The model was re-calibrated against measured flood levels at the gauge sites listed in Table 2-1 previously.

Values of Manning's *n* from the Approved Development Case were adjusted to fit the recorded water levels. It was found that it was only necessary to change certain values along the main Nogoa River and in the flood runner BNO_R22-23-24-25. These final Manning's *n* values are compared them with the values in the Approved Development Case in Table 3-1 below.

Table 3-1: Selected Manning's *n*

Stream	Model Chainages (m)	Manning's *n* value	
		AD Case	Final Re-calibration
Nogoa River	0 – 10000	0.072	0.072
	10800 – 22800	0.068	0.068
	23800 – 26900	0.051	0.051
	27600 – 34100	0.060	0.060
	34500 – 36900	0.063	0.063
	37600 – 45000	0.084	0.084
	45700 – 51800	0.063	0.072
	52800 – 60400	0.059	0.068
	60700 – 61600	0.046	0.053
	62400 – 63600	0.059	0.068
BNO_R22-23-24-25	0 – 8600	0.054	0.062

The measured and modelled hydrographs at the gauging stations are compared from Figure 3-2 to Figure 3-4.

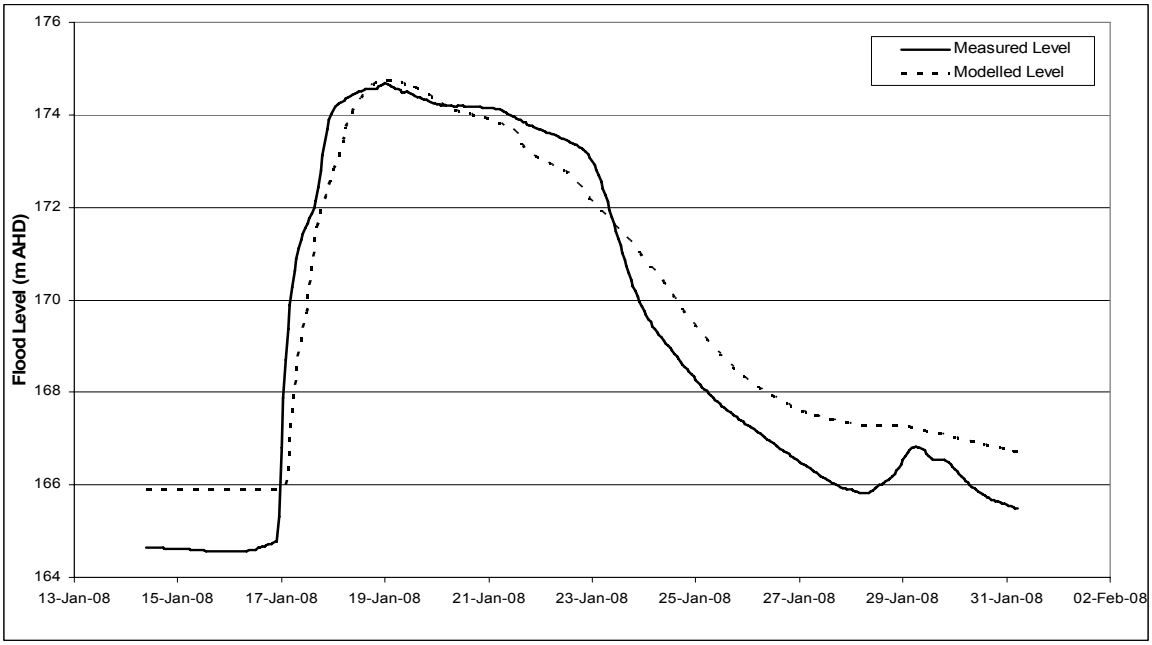

Figure 3-2: Theresa Creek at the Gregory Highway, January 2008 Re-calibration Event

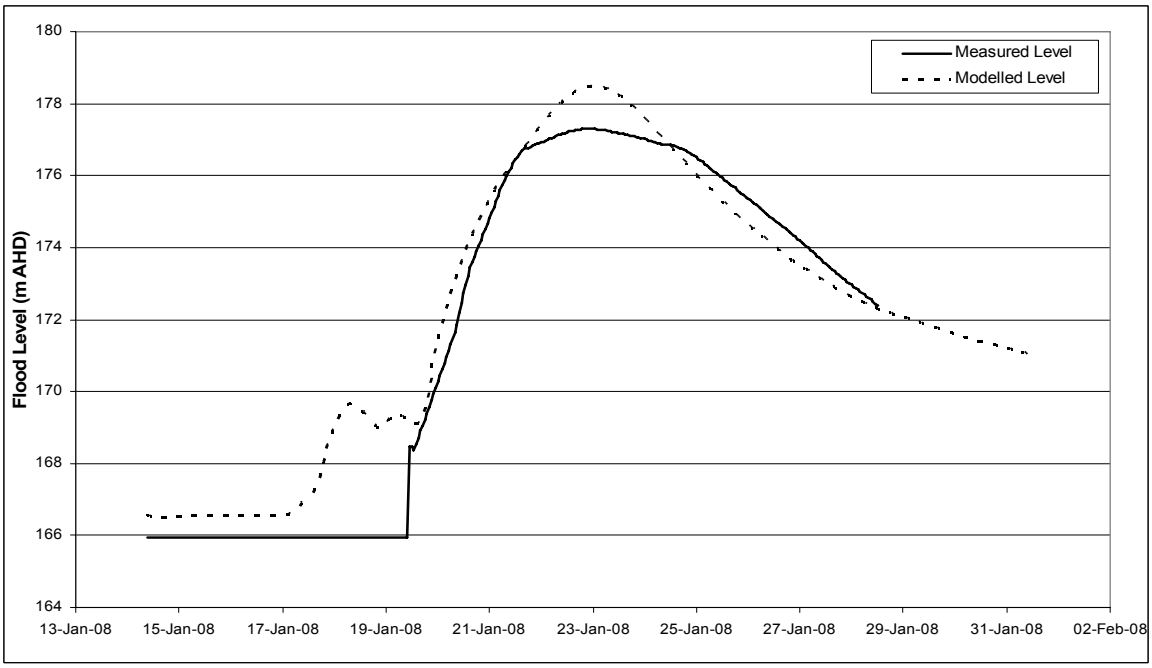

Figure 3-3: Nogoa River at Emerald Town Gauge, January 2008 Re-calibration Event

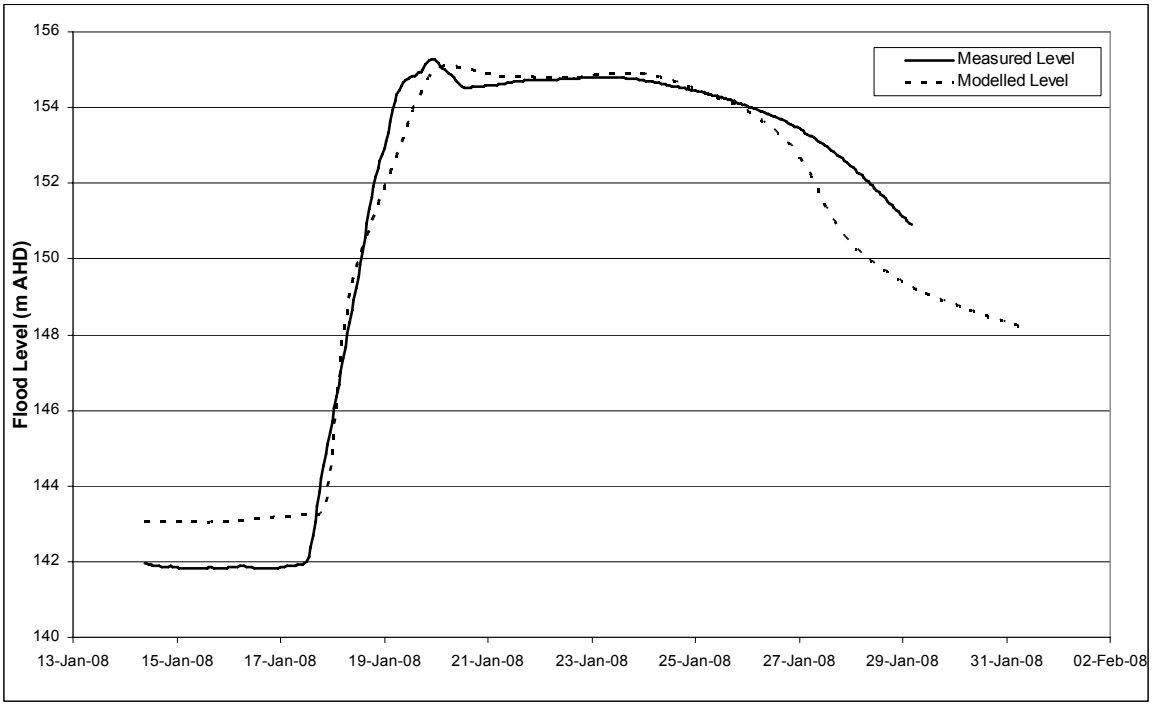

Figure 3-4: Nogoa River at Duck Ponds, January 2008 Re-calibration Event

At Theresa Creek on the Gregory Highway and at Duck Ponds on the Nogoa River, the modelled hydrographs show satisfactory agreement with the measured hydrographs in terms of the magnitude and timing of the peak and the rising limb of the hydrograph. The falling limb of the hydrograph however is poorly reproduced in the model at both locations and it is recommended that this be investigated further in a future study.

At the Emerald Town Gauge, the modelled peak is well in excess of the measured peak flood level. This is because in the hydrodynamic model, flow in the Nogoa River from Selma Weir (Model Chainage 16200, Section XNO_006840) to the Emerald Town Weir (Model Chainage 22200, Section XNO_006778) is represented by a single channel. In reality, during flood events a considerable proportion of flow breaks out of the Nogoa River a short distance downstream of Selma Weir and flows in a drain west of the main channel through the Emerald township before rejoining the system downstream of the town weir.

Due to this model limitation, it was recognised that it would not be possible to obtain agreement with peak water levels at the Emerald Town Gauge.

Therefore, model parameters were adjusted in order to obtain agreement with the rising and falling limbs of the hydrograph at this location only.

For the purposes required in this study, the model was considered to give satisfactory agreement with observed flood levels. A summary of the measured and modelled peak flood levels at the gauging stations for the January 2008 re-calibration event is presented in Table 3-2.

Table 3-2: Peak Flood Levels for January 2008 Recalibration Event

Stream	AMTD (km)	Location	Peak Flood Level		
			January 2008		
			Measured (m AHD)	Modelled (m AHD)	Difference (mm)
Theresa Creek	14.5	Gregory Highway	174.68	174.75	70
Nogoa River	681.0	Emerald Town Gauge	177.31	178.48	1180
Nogoa River	625.4	Duck Ponds	155.28	155.11	-170

Note: Whilst differences are quoted to the nearest millimetre, it should be noted that in absolute terms, the model is only considered accurate to the nearest 0.5 of a metre. Differences in this report are shown to the nearest millimetre to emphasise the relative impacts on design flood levels as a result of changes to the flood plain.

3.4 HYDRAULIC MODEL – FAIRBAIRN DAM FULL SCENARIO

The re-calibrated hydraulic model was used to analyse the January 2008 flood event assuming that Fairbairn Dam was full at the start of the event. Inflow hydrographs calculated by the URBS hydrologic model for this case were input to the MIKE 11 model.

In Table 3.3, peak flood levels for the Key Locations in the study area upstream of Ensham Mine are given for both the January 2008 re-calibration case (Fairbairn Dam was 35% full at the start of the event) and for the January 2008 flood event assuming Fairbairn Dam was full at the start of the event.

Table 3-3: Peak Flood Levels Upstream of Ensham Mine for January 2008 Event

Location	Branch Name	Model Chainage	January 2008 Event Peak Flood Level		Difference (mm)
			Fairbairn Dam @ 35%	Fairbairn Dam @ 100%	
Fairbairn Dam	Nogoa_Mackenzie	0	189.094	190.037	943
Selma Weir	Nogoa_Mackenzie	16,200	180.022	181.048	1026
Emerald – Capricorn Hwy	Nogoa_Mackenzie	18,800	178.484	179.606	1122
Emerald Town Weir	Nogoa_Mackenzie	22,200	174.233	174.728	495
Bellmah No	goa_Mackenzie	26,900	170.773	171.256	483
McCoskers Weir	Nogoa_Mackenzie	31,500	168.870	169.258	388
Retreat Ck Junction	Nogoa_Mackenzie	34,100	167.673	168.520	847
Bridge Flats Crossing	Nogoa_Mackenzie	39,100	164.866	165.763	897
Crinum Ck Junction	Nogoa_Mackenzie	45,700	161.434	161.917	483
Wyuna No	goa_Mackenzie	47,300	160.350	160.809	459
Dunckpond Homestead	BNO_R22-23-24-25	4,700	155.105	156.123	1018
Lochlees B	NO_R12-13-18-19	3,700	160.162	160.842	680
Parker Developments	BNO_R10A	3,000	163.763	165.021	1258
Braylands B	NO_R20	1,100	156.941	157.352	411
Kingower Billabong	Theresa Creek	0	180.833	180.833	0
Blair Athol Railway Line	Theresa Creek	7,400	177.687	177.687	0
Trafalgar R	etreat Creek	0	178.153	178.153	0
Blair Athol Railway Line	Retreat Creek	3,600	175.832	175.832	0
Gregory Highway	Retreat Creek	6,500	174.752	174.752	0
Washpool Waterhole	BRE_R02-4-6-7-13-14	2,600	171.555	171.556	1
Codenwatta Pump Site	BRE_L02-04	2,000	169.993	170.048	55
Langley Downs	Gordonstone Creek	0	164.406	164.406	0
Belcong Ck Junction	Crinum Creek	0	165.441	165.441	0

Location	Branch Name	Model Chainage	January 2008 Event Peak Flood Level		Difference (mm)
			Fairbairn Dam @ 35%	Fairbairn Dam @ 100%	
Wyuna Road	Crinum Creek	4,500	162.862	162.862	0
Colorada C	rinum Creek	12,300	161.856	162.335	479
Fenceline M	osquito Creek	4,200	161.872	162.342	470
Lochabor W	inton Creek	0	167.037	167.037	0
Bauhinias Road	Winton Creek	16,300	156.312	157.008	696
Ensham B	oggy Creek	4,400	153.036	154.165	1129

3.5 PROPOSED EXTENSION OF ENSHAM MINE LEVEES

The re-calibrated hydraulic m odel was used to analyse the im pact of proposed extension of Ensham Mine Levees.

3.5.1 Proposed Works

In February 2008, at the request of the Nogoa River Flood Plain Board, SunW ater - Engineering Services perform ed a hydraulic assessm ent of the likely im pacts that would arise from a development proposal by Ensha m Resources Pty Ltd, namely the extension of levees around the mine area on both the northern and southern banks of the Nogoa River and associated flood plains.

To sim ulate the constru ction of the northern le vee, the narrowing effect on the flow caused by the proposed levee, the cross sections XNO_006 350, XNO_006353, XNO_0063 53, XNO_006362, XNO_0 06367 and XNO_0063 79 along the N ogoa River were modified. To simulate the construction of the southern levee, two sections along W inton Creek A (XWI_000080 and XWI_00086) were removed as their flow was blocked by the proposed levee. The downstream boundary was moved to cross section XWI_000093. Refer to the report *Nogoa River Flood Plain, Ensham Resources Pty Ltd Proposed Levee Bank Extension* (SunWater 2008) for full details of this study.

Before undertaking this assessment, SunWater made a request to Kellogg, Brown & Root Pty Ltd (KBR), to confirm that the model modifications made in the February 2008 study were consistent with the latest levee configuration. In response, KBR sent a layout and locality plan of the Ensham Mine flood levees (Drawing No. BEE603-C-DWG-500).

Examination of this plan indicated that the assumed location of the northern levee in SunWater's 2008 report was satisfactory. However, the location of the southern levee was a distance to the north and west of that assumed in SunWater's 2008 study, meaning that the levee cut Winton Creek approximately 700m further upstream.

Hence, an additional section along Winton Creek A (XWI_000093) was removed from the model and the cross section XWI_000100 was moved 400m upstream (from model chainage 22800 to model chainage 22400) to the location of the proposed levee. The downstream boundary condition for Winton Creek A was placed at this cross section.

3.5.2 Hydraulic Model Results

The hydraulic model with the proposed extended Ensham levees was run for the 1:20 AEP Designated Design Event, as well as the January 2008 flood event with Fairbairn Dam assumed full at the start of the event.

A summary of the impacts of the proposed works for both events is provided below in Table 3.4, and Table 3.5 summarises the peak flood levels and the increase in peak flood levels caused by the proposed levees for both events.

Table 3-4: Peak Flood Levels for Northern Levee

Model Branch	Model Cross-section	Peak Flood Level Designated Design Event (AEP 1:20)			Peak Flood Level January 2008 Event (Fairbairn Dam Full at Start)		
		Approved Developments Case (m AHD)	Ensham Proposed Levee Case (m AHD)	Change in Peak Flood Level (mm)	Approved Developments Case (m AHD)	Ensham Proposed Levee Case (m AHD)	Change in Peak Flood Level (mm)
Nogoa River	XNO_006350	154.208	154.226 1	8 1	55.768	155.778	10
	XNO_006353	154.313	154.329 1	6 1	55.824	155.833	9
	XNO_006356	154.501	154.515 1	4 1	55.908	155.917	9
	XNO_006362	154.688	154.701 1	3 1	56.029	156.038	9
	XNO_006367	154.797	154.808 1	1 1	56.104	156.112	8
	XNO_006379	155.499	155.503 4	1	56.399	156.406	7

Table 3-5: Peak Flood Levels for Southern Levee

Model Branch	Model Cross-section	Peak Flood Level Designated Design Event (AEP 1:20)			Peak Flood Level January 2008 Event (Fairbairn Dam Full at Start)		
		Approved Developments Case (m AHD)	Ensham Proposed Levee Case (m AHD)	Change in Peak Flood Level (mm)	Approved Developments Case (m AHD)	Ensham Proposed Levee Case (m AHD)	Change in Peak Flood Level (mm)
Winton Creek	XWI_000100	154.393 15	4.415	22	156.321 15	6.332	11
	XWI_000110	154.393 15	4.415	22	156.321 15	6.332	11
	XWI_000128	145.419 15	4.441	22	156.341 15	6.351	10
	XWI_000138	154.452 15	4.474	22	156.361 15	6.371	10
	XWI_000147	154.601 15	4.621	20	156.413 15	6.422	9
Nogoa River	XNO_006323	152.783 1	52.802	19	154.544 1	54.552	8
	XNO_006335	153.607 1	53.627	20	155.267 1	55.277	10
	XNO_006338	153.915 1	53.935	20	155.526 1	55.535	9
	XNO_006342	154.088 1	54.106	18	155.660 1	55.670	10
	XNO_006350	154.208 1	54.226	18	155.768 1	55.778	10
Nogoa River Flood Runner R27	XNOR27_006	154.270 1	54.289	19	156.080 1	56.090	10
	XNOR27_010	154.291 1	54.311	20	156.128 1	56.138	10
	XNOR27_018	154.393 1	54.415	22	156.321 1	56.332	11
Nogoa River Flood Runner R25	XNOR25_005	153.709 1	53.730	21	154.453 1	54.463	10
	XNOR25_012	153.927 1	53.947	20	155.734 1	55.744	10
	XNOR25_022	154.255 1	54.275	20	156.029 1	56.039	10

Longitudinal profiles of peak flood levels ar e provided in Figure 3- 5 to Figure 3-12 along various sections of the river for both flood events. The afflux caused by the proposed levees is plotted on the minor y-axis.

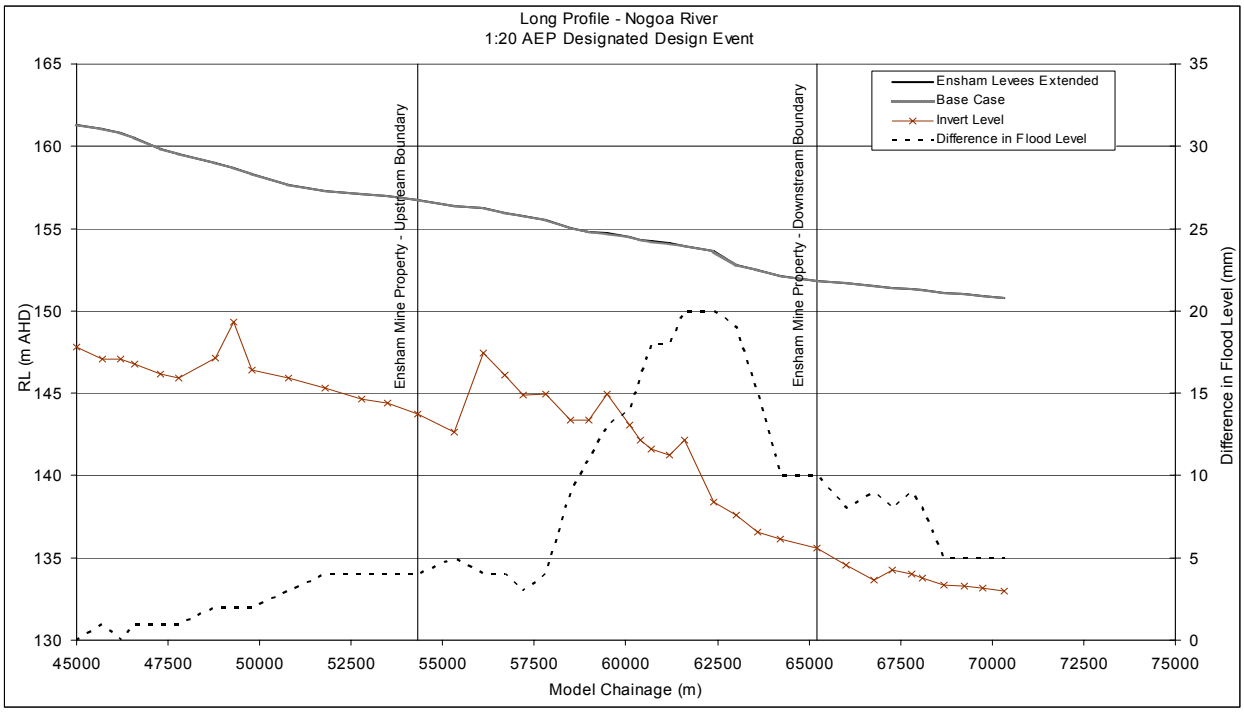

Figure 3-5: Long Profile – Nogoa River, 1:20 AEP Designated Design Event

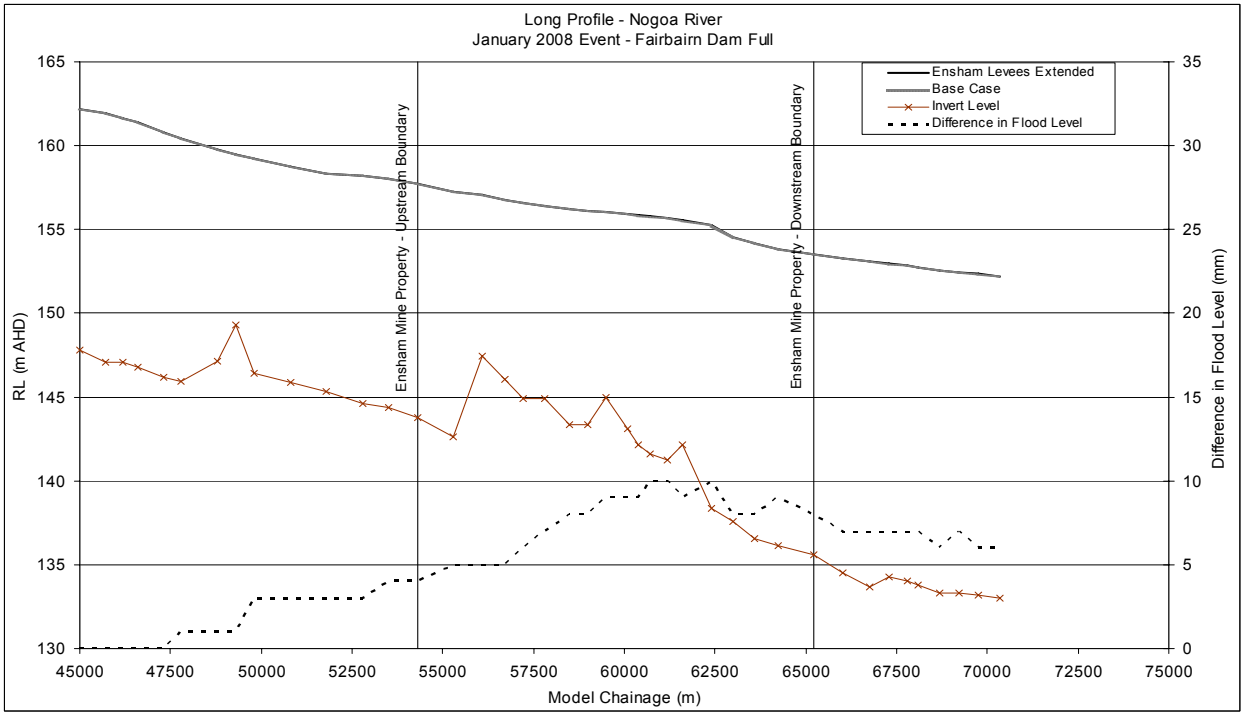

Figure 3-6: Long Profile – Nogoa River, January 2008 Event – Fairbairn Dam Full

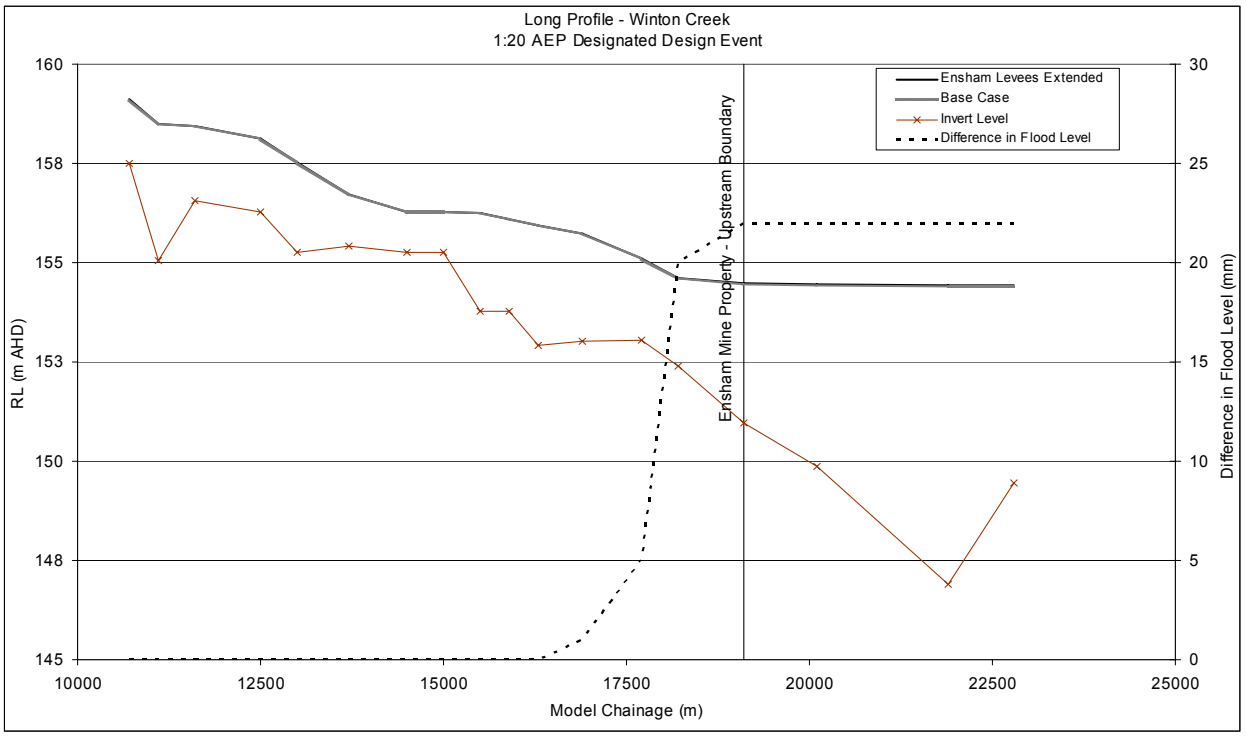

Figure 3-7: Long Profile – Winton Creek, 1:20 AEP Designated Design Event

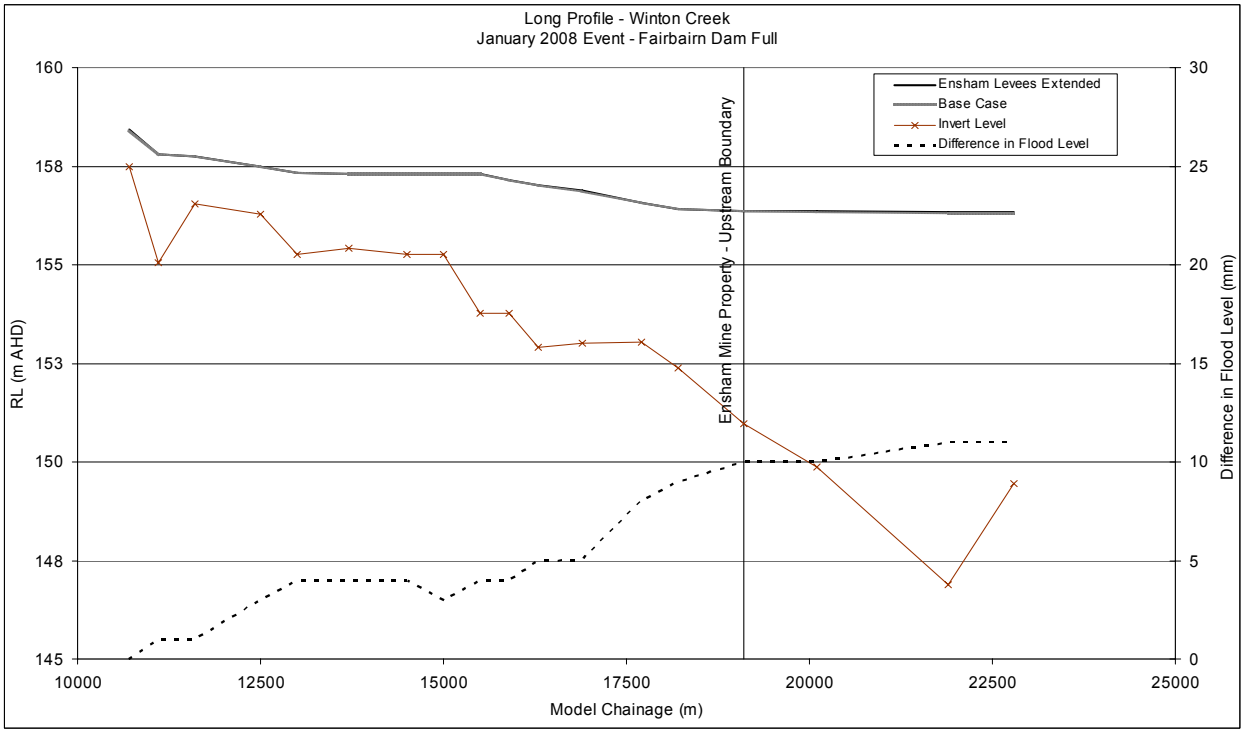

Figure 3-8: Long Profile – Winton Creek, January 2008 Event – Fairbairn Dam Full

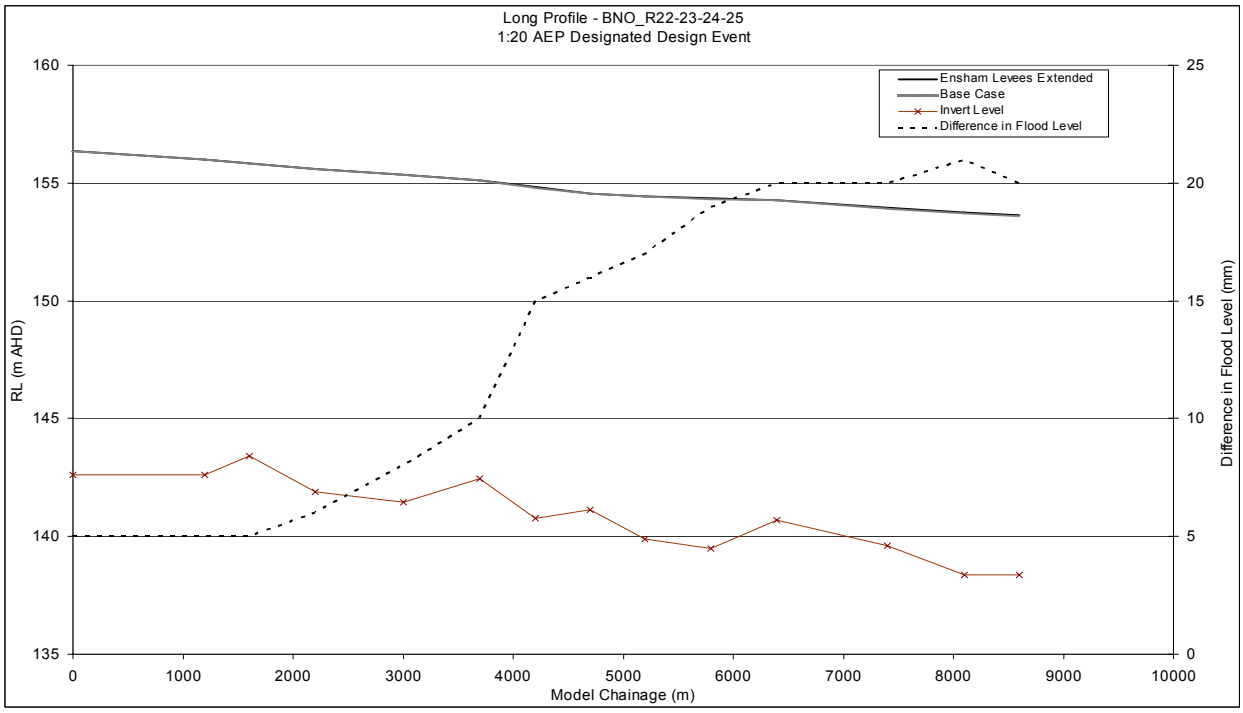

Figure 3-9: Long Profile – Flood Runner BNO_R22-23-24-25, 1:20 AEP Designated Design Event

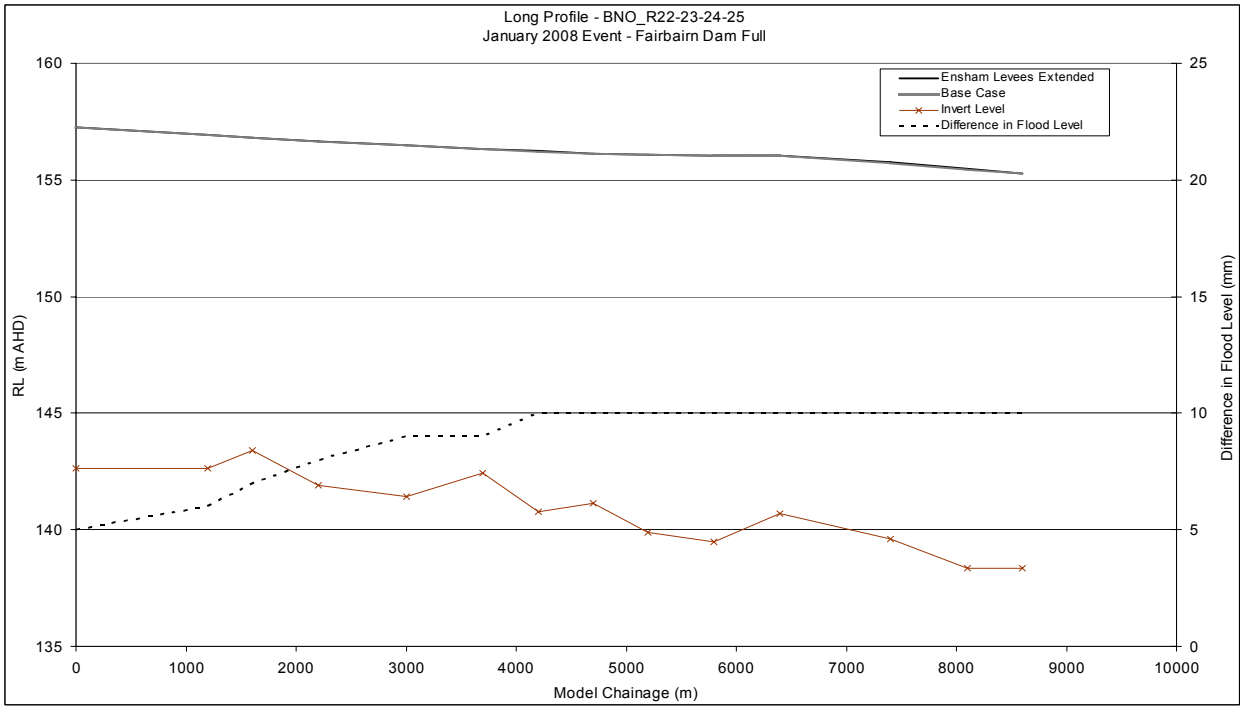

Figure 3-10: Long Profile – Flood Runner BNO_R22-23-24-25, January 2008 Event – Fairbairn Dam Full

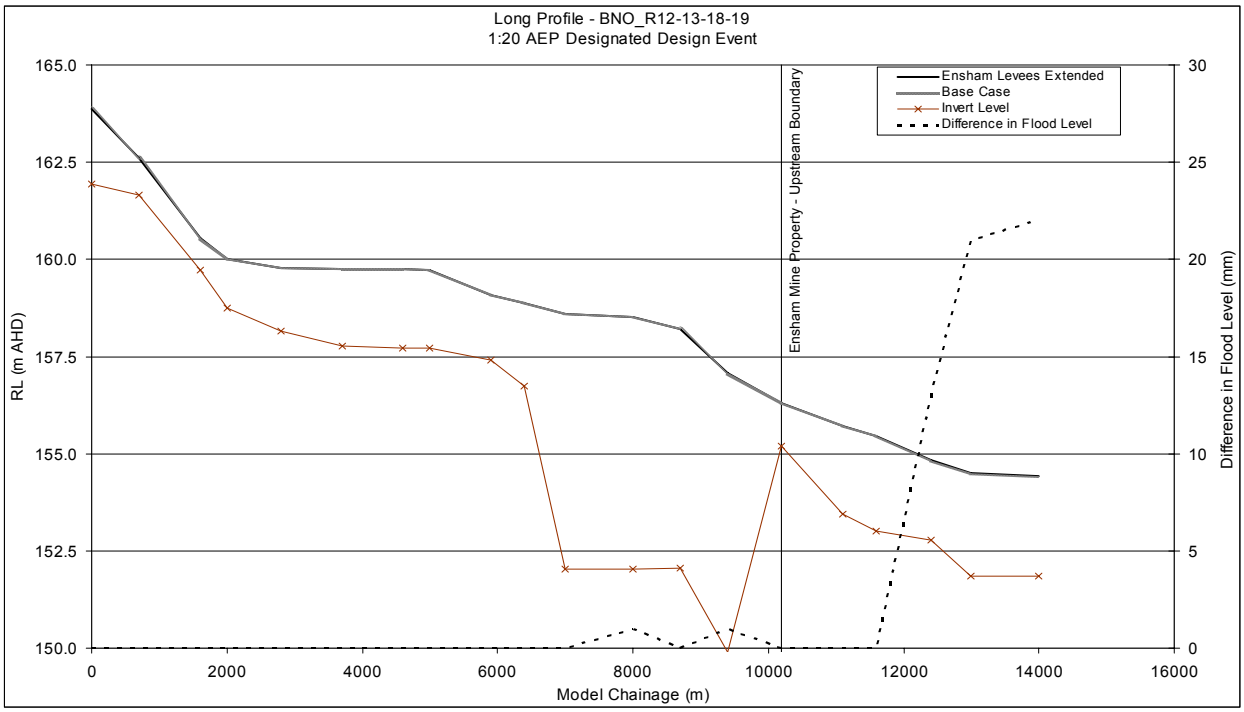

Figure 3-11: Long Profile – Flood Runner BNO_R12-13-18-19, 1:20 AEP Designated Design Event

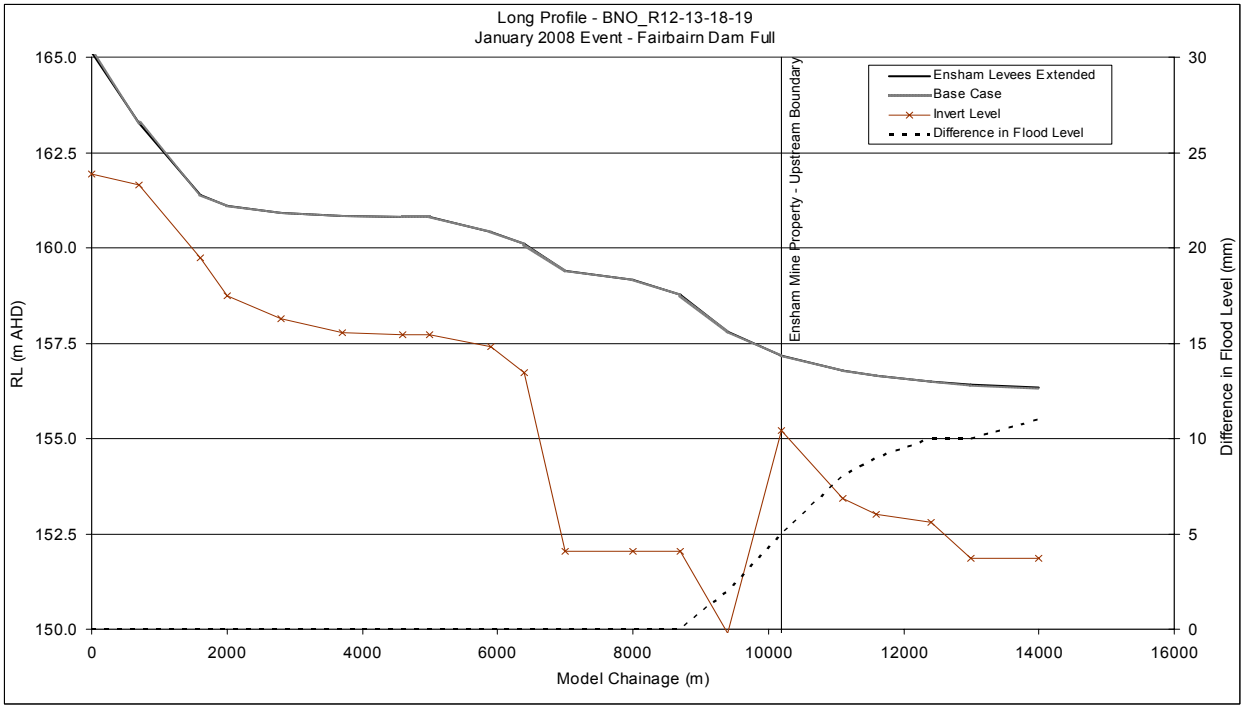

Figure 3-12: Long Profile – Flood Runner BNO_R12-13-18-19, January 2008 Event – Fairbairn Dam Full

The plots in Figure 3-5 to Figure 3-12 show clearly that for both the 1:20 AEP Designated Design Event, as well as for the January 2008 Event with Fairbairn Dam assumed full, the proposed extensions of Ensham Mine levees cause affluxes of up to 25 mm at any location, either within the Ensham Mine holdings or at any neighbouring properties. This is well below the acceptable afflux of 300 mm set by the Nogoa Flood Plain Board.

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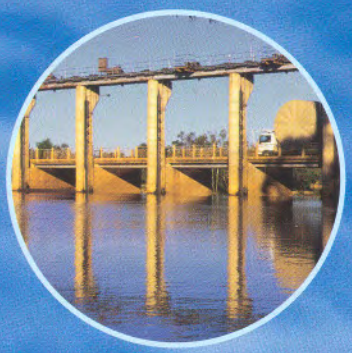

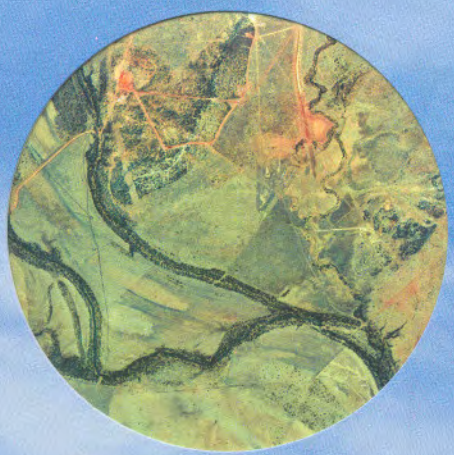

Final Report

Nogoa River Flood Plain

Hydraulic Impacts Assessment

Ensham Resources Pty Ltd
Proposed Levee Bank Extension

Date: February 2008
File: 07-007593/001

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Final Report

Nogoa River Flood Plain

Hydraulic Impacts Assessment

Ensham Resources Pty Ltd Proposed Levee Bank Extension

Date: February 2008
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Prepared for:
Nogoa River Flood Plain Board

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EXECUTIVE SUMMARY

The Nogoa River Flood Plain Board submitted a request to SunWater Engineering Services in December 2007 to perform a hydraulic assessment of the likely impacts that would arise from a development proposal for Ensham Resources Pty Ltd, located on the Nogoa River. The development proposal was for the extension of levees along both the northern and southern banks of the Nogoa River in order to mitigate flooding of a mine site.

For the extension of the levee on the northern bank of the Nogoa River, the assessment required the modification of six cross sections to simulate the reduction in flow area that would be caused by the proposed development. The extension of the levee on the southern bank of the river required the removal of two cross sections to simulate the blocking of Winton Creek, a tributary of the Nogoa River.

Two existing hydraulic models were used to assess the impacts on the Nogoa River flood plain caused by the extension of the levees. The first model used was the "1994 Topographic Base – Revised" (Run 086) model. This model has been used to investigate all of the developments in the Nogoa Flood Plain in the past ten years. This scenario is comparable with all other proposal investigations undertaken by SunWater on behalf of the Nogoa Flood Plain Board over the past ten years as it has none of the approved developments included in the model. The second model used to assess the proposed development was the "Case 086 Approved Development model', which was built in 2007, incorporating all approved developments in the Nogoa River Flood Plain between 1997 and 2007.

The proposed extension of each levee was then incorporated into the model and compared to the base case for the Designated Flood Event (the 20 year Annual Exceedence Probability 168 hour design flood event for the entire floodplain). The proposed levee resulted in a negligible impact on the northern banks of the Nogoa River. The proposed extension to the southern levee resulted in an increase in peak flood levels of up to 50 mm in Winton Creek when compared to the "1994 Topographic Base – Revised" (Run 086) model". When compared to the approved development model, the increase in flood levels was only 14mm.

This is because in the approved development model, a levee that cuts off Winton Creek already exists and the proposed levee is an extension. The extension results in minimal afflux to upstream and downstream properties.

TABLE OF CONTENTS

1.0 INTRODUCTION 1
2.0 HYDRAULIC ANALYSIS 2
2.1 PROPOSED WORKS 2
2.2 HYDRAULIC MODEL MODIFICATIONS 2
2.2.1 Base Case Models 2
2.2.2 Proposed Development Case Model 3
2.3 HYDRAULIC MODEL RESULTS: 20 YEAR AEP 4
3.0 SUMMARY 7

LIST OF TABLES

Table 1: Peak Flood Levels for Northern Levee 4
Table 2: Peak Flood Levels for Southern Levee 5

LIST OF FIGURES

Figure 1: Nogoa Flood Plain Study 8

LIST OF ABBREVIATIONS

AEP	Annual Exceedance Probability
AHD Australian	Height Datum
AMTD	Adopted Middle Thread Distance
ATBC	Adopted Topographic Base Case
DHI	Danish Hydraulics Institute
DTM	Digital Terrain Model

1.0 INTRODUCTION

In December 2007, the Nogoa River Flood Plain Board submitted a request to SunWater Engineering Services to perform a hydraulic assessment of the likely impacts that would arise from a development proposal by Ensham Resources Pty Ltd.

The development proposal is shown in Figure 1. The proposed works are for the extension of levees around the mine area on both the northern and southern banks of the Nogoa River and associated flood plains.

This report describes the results of the hydraulic assessment of the proposed works. The proposed works have been incorporated into the MIKE11 Model. The analysis conducted was an assessment on a Designated Flood Event with a 20 year Annual Exceedence Probability (AEP) 168 hour design flood on the entire floodplain.

2.0 HYDRAULIC ANALYSIS

An assessment of the likely hydraulic impacts of the proposed works for Ensham Resources Pty Ltd were undertaken using the 20 year AEP 168 hour design flood event. The proposed works were incorporated into the existing hydrodynamic (MIKE11) model. The results of this model were compared with those of the Base Case and are summarised below.

2.1 PROPOSED WORKS

The proposed works are shown in Figure 1. The works comprise northern and southern levee to complement the existing levees around the mine site.

2.2 HYDRAULIC MODEL MODIFICATIONS

2.2.1 Base Case Models

Two models were used as base cases in this investigation. The first model used to assess the proposed development was the "1994 Topographic Base – Revised" (Run 086) model. This model has been used to investigate all developments in the Nogoa Flood Plain in the past ten years. This scenario is comparable with all other proposal investigations undertaken by SunWater on behalf of the Nogoa Flood Plain Board over the past ten years as it has none of the approved developments included in the model. This model is referred to as *Case086* in this report.

The second model used to assess the proposed development was the "Case 086 Approved Development model', which was built in 2007, incorporating all approved developments in the Nogoa River Flood Plain between 1997 and 2007. This model is referred to as *Case086AD* in this report.

The proposed works were incorporated into the two Nogoa River MIKE11 hydrodynamic models by modifying the appropriate cross sections affected by the construction of the levees.

2.2.2 Proposed Development Case Model

In order to simulate the construction of the northern levee, a number of cross sections along the Nogoa River were modified to simulate the narrowing effect on the flow cause by the proposed levee. The modified cross sections were XNO_006350, XNO_006353, XNO_006356, XNO_006362, XNO_006367 and XNO_006379.

To simulate the effects of the southern levee, two cross sections along Winton Creek A had to be removed as their flow was blocked by the proposed levee. The removed cross sections were XWI_000080 and XWI_000086. This required the downstream boundary condition to be moved to cross section XWI_000093.

It was assumed that the storage embankment was constructed to a height in excess of the 20 year AEP design flood event. This is consistent with the manner in which existing developments were investigated in the formulation of the Base Case. This assumption results in estimated peak flood levels and consequent impacts that are conservative i.e. higher than would arise if the structures could be overtopped.

2.3 HYDRAULIC MODEL RESULTS: 20 YEAR AEP

A summary of the impacts of the proposed works is provided in Tables 1-2 and Figure 1.

Table 1: Peak Flood Levels for Northern Levee

Model Branch	Model Cross-section	Peak Flood Level Case086			Peak Flood Level Case086AD		
		Base Case	Ensham Proposed Levee Case	Change in Peak Flood Level	Base Case	Ensham Proposed Levee Case	Change in Peak Flood Level
		(m AHD)	(m AHD)	(mm)	(m AHD)	(m AHD)	(mm)
Nogoa River	XNO_006350	153.761	153.759	2	153.969	153.969	0
	XNO_006353	153.890	153.887	3	154.082	154.082	0
	XNO_006356	154.137	154.134	3	154.296	154.296	0
	XNO_006362	154.367	154.365	2	154.490	154.490	0
	XNO_006367	154.493	154.490	3	154.599	154.599	0
	XNO_006379	155.353	155.352	1	155.380	155.380	0

The proposed northern levee made negligible change to the Case 086 model and made no change at all to the approved development Case 086AD model.

Table 2: Peak Flood Levels for Southern Levee

Model Branch	Model Cross-section	Peak Flood Level Case086			Peak Flood Level Case086AD		
		Base Case	Ensham Proposed Levee Case	Change in Peak Flood Level	Base Case	Ensham Proposed Levee Case	Change in Peak Flood Level
		(m AHD)	(m AHD)	(mm)	(m AHD)	(m AHD)	(mm)
Winton Creek	XWI_000093	152.671	152.720	+49	154.091	154.105	+14
	XWI_000100	153.303	153.315	+12	154.091	154.105	+14
	XWI_000110	153.528	153.534	+6	154.091	154.105	+14
	XWI_000128	153.622	153.628	+6	154.127	154.141	+14
	XWI_000138	153.771	153.776	+5	154.177	154.191	+14
	XWI_000147	154.321	154.322	+1	154.416	154.428	+12
Nogoa River	XNO_006323	152.210	152.214	+4	152.651	152.662	+11
	XNO_006335	152.946	152.950	+4	153.374	153.386	+12
	XNO_006338	153.356	153.360	+4	153.664	153.675	+11
	XNO_006342	153.593	153.596	+3	153.843	153.853	+10
	XNO_006350	153.759	153.761	+2	153.969	153.979	+10
Nogoa River Right	XNOR27_006	153.519	153.525	+6	153.997	154.008	+11
	XNOR27_010	153.521	153.526	+5	154.015	154.026	+11
	XNOR27_018	153.528	153.534	+6	154.091	154.105	+14
Nogoa River Right	XNOR25_005	153.016	153.021	+5	153.461	153.473	+12
	XNOR25_012	153.190	153.195	+5	153.661	153.673	+12
	XNOR25_022	153.518	153.524	+6	153.987	153.998	+11

In Case086, the major impact on the Nogoa Flood Plain by the proposed southern levee occurs at Winton Creek where the levee cuts off Winton Cree k. At this location, an increase in peak flood levels of up to 50mm occurred. In Case086AD, the change to the flood levels at the location due to the leve e is only 14 mm in Winton Creek. This is becaus e in the approved developm ent model, a levee that cuts off Wi nton Creek already exists and the proposed levee is an extension. At all other locations, no signif icant increase in flood levels occurred. The extension poses minimal afflux to upstream and downstream properties.

3.0 SUMMARY

The proposed works have been tested using the Nogoa River MIKE11 hydrodynamic model for the 20 year AEP Designated Flood Event. The introduction of the northern levee to the model caused negligible impact on peak flood levels. The introduction of the southern levee resulted in an increase of up to 50mm in peak flood levels in Winton Creek when compared to the "1994 Topographic Base – Revised" (Run 086) model". However, when compared to the approved development model, the increase in flood levels was only 14mm. This is because in the approved development model, a levee that cuts off Winton Creek already exists and the proposed levee is an extension. At all other locations, no significant increase in flood levels occurred. No peak level increases extended significantly upstream or downstream of the property.

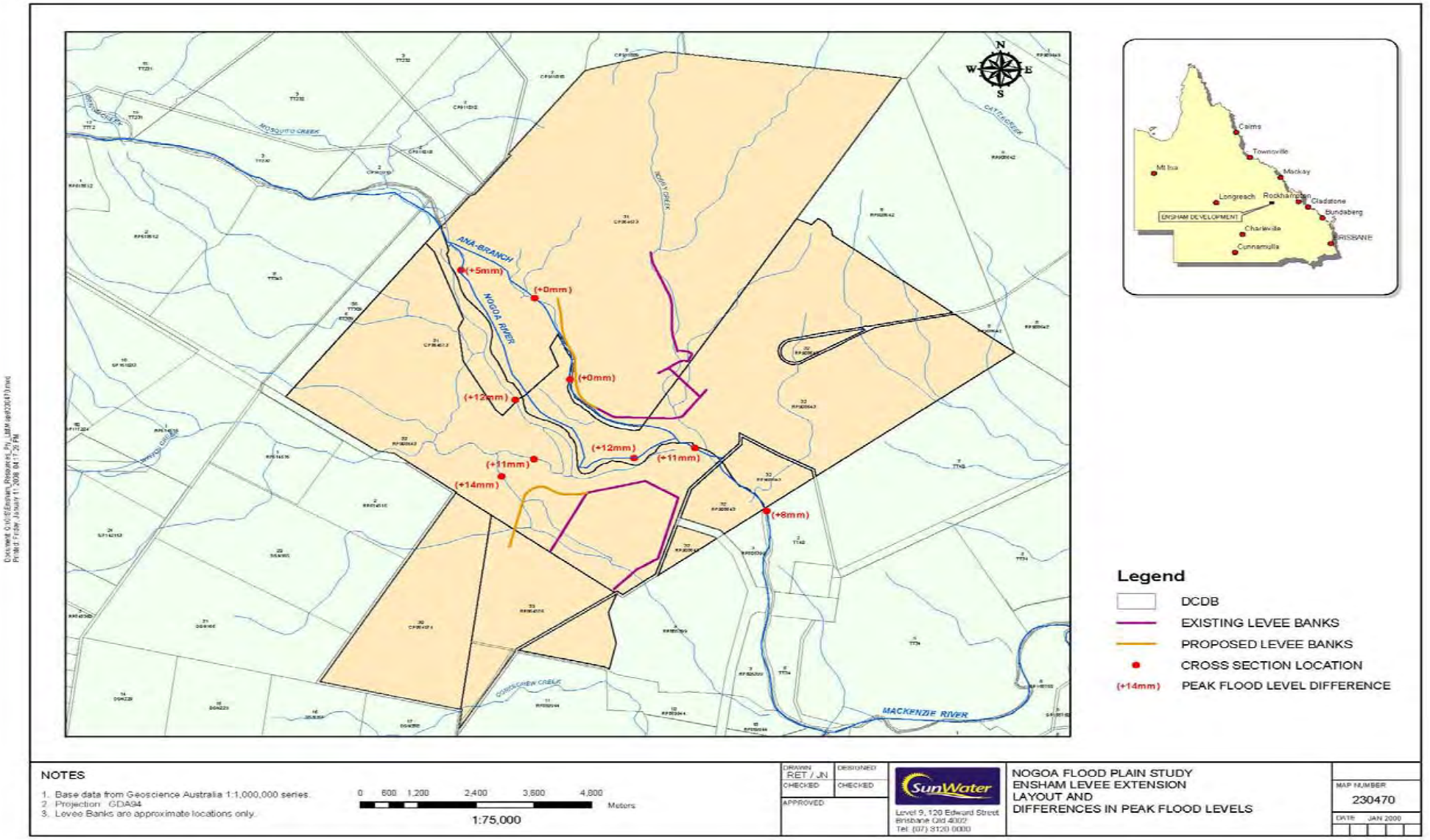

Figure 1: Nogoa Flood Plain Study

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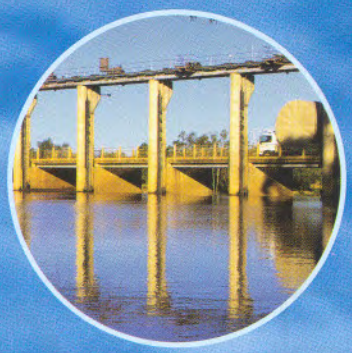

Final Report

Nogoa Flood Plain Board

Model Conversion Report

Date: September 2007
Ref: P-AEXP-1303
File: 07-/008329/001

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Final Report

Nogoa Flood Plain Board

Model Conversion Report

Date: September 2007
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File: 07-/008329/001

Prepared for:
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TABLE OF CONTENTS

1.0 INTRODUCTION 1
1.1 PREVIOUS INVESTIGATIONS 2
1.1.1 Emerald Flood Plain Scoping Study, 1994 2
1.1.2 Hydraulic Model Design Flood Simulation Report, 1996 2
1.1.3 Interim Flood Plain Management Plan Report, 1997 3
1.1.4 Flood Plain Development Studies 3
2.0 GENERAL DESCRIPTION OF NOGOA FLOOD PLAIN 5
3.0 MODELLING METHODOLOGY 7
4.0 MIKE11 MODEL BUILD 8
4.1 HYDRAULIC MODEL CONVERSION 8
4.1.1 Existing Model from Previous Study 8
4.1.2 Topographic Data 8
4.1.3 Model Layout 8
4.1.4 Cross Sections 9
4.1.5 Additional Storages 9
4.1.6 Structures & Key Locations 10
4.1.7 Boundary Conditions 11
4.1.8 Initial Conditions 12
4.1.9 Computational Parameters 12
4.1.10 Model Scenarios 12
5.0 MODEL VERIFICATION 13
5.1 MODEL CONVERSION RESULTS 14
5.1.1 Results Discussion 15
5.2 DESIGN FLOOD PEAK LEVELS 15
6.0 APPROVED DEVELOPMENT CASE 23
7.0 CONCLUSIONS 24
8.0 REFERENCES 25

LIST OF FIGURES

Figure 1: Nogoa Mackenzie River Long Profile 19
Figure 2: Winton Creek Long Profile.....20
Figure 3: Retreat Creek Long Profile 21
Figure 4: Comet Creek Long Profile 22

LIST OF TABLES

Table 2.1: Fairbairn Dam Characteristics.....5
Table 4.1: Key Locations in Study Area 10
Table 4.2: Model Input and Output Files 12
Table 5.1: Adopted Manning's 'n' Values 14
Table 5.2: Key Location 1 in 20 year Results Summary.....16

LIST OF APPENDICES

APPENDIX A – Model Schematic and Key Locations

APPENDIX B – RUBICON Results Plan 1 in 20 ARI

APPENDIX C – MIKE11 Results

LIST OF ABBREVIATIONS

AEP	Annual Exceedence Probability
AHD Australian	Height Datum
AMTD	Adopted Middle Thread Distance
BOM	Bureau of Meteorology
DEM	Digital Elevation Model
DHI	Danish Hydraulics Institute
DEM	Digital Elevation Model
EL	Elevation
FSL Full	Supply Level
FSV	Full Supply Volume
km	Kilometre
m	Metre
ML	Megalitres
mm/h	Millimetres/hour
m^3/s	Cubic metres per second (cumecs)
n Manning's	Roughness Coefficient
NRM	Department of Natural Resources and Mines (Queensland)

1.0 INTRODUCTION

SunWater – Asset Solutions was requested by the Nogoa River Flood Plain Board to undertake a hydraulic analysis of the Nogoa-Mackenzie River flood plain. This involved updating an existing hydraulic model in RUBICON, to the hydraulic model software, MIKE11. This report summarises the conversion of the RUBICON model to MIKE11 and compares the updated results.

In 1996 a hydraulic assessment of the Nogoa-Mackenzie River flood plain was undertaken using the hydraulic software RUBICON. The RUBICON model is unfortunately no longer sustainable in its current form as it is not supported by its developer (Haskoning Consulting Engineers). Additionally, it runs on the outdated platform of HP Unix, which was decommissioned by the Queensland Government Department of Natural Resources (DNR) in late 2003. In 2003, the model data was transferred to a SEQWater HP Workstation that is operated & maintained by SunWater. However, this workstation is nearing the end of its functional life and is in need of replacement, which will be a PC based system.

Since the hydraulic assessment of the Nogoa-Mackenzie River flood plain in 1994, many developments have happened on the flood plain. These additional developments have been included in the updated MIKE11 model. In the long term, it is hoped that this model will be integrated with the recent 2D hydraulic modelling undertaken by KBR for Ensham Mine so that the township of Emerald will be refined in the model and also to assist with disaster management. Other future upgrade work proposed is re-deriving the design rainfalls and floods based on AR&R techniques (CRC Forge) and the consideration of a joint probability approach for the starting level of Fairbairn Dam.

1.1 PREVIOUS INVESTIGATIONS

1.1.1 Emerald Flood Plain Scoping Study, 1994

A scoping study was undertaken by Connell Wagner and Lawson and Treloar to assess the survey, hydrologic and hydraulic modelling requirements of the Emerald Flood Plain Study including a cost benefit analysis of the various combinations of options.

In October 1994, an aerial survey of the Nogoa-Mackenzie River flood plain was undertaken as a result of the scoping study, and a digital terrain model (DTM) was completed. A ground survey of the river channel was also undertaken to provide better definition & to check the photogrammetric survey. The photogrammetric survey data was quoted to have an accuracy of +/- 0.5m on spot heights; however the ground survey highlighted some errors of more than +/- 1.0m.

In 1995 the Queensland Government Department of Natural Resources (DNR) was appointed to undertake the development of a numerical model of the flood plain and prepare a flood plain management plan.

1.1.2 Hydraulic Model Design Flood Simulation Report, 1996

The 1994 aerial survey data was used by DNR to assess the Nogoa River using the hydraulic modelling software RUBICON. The model was created to establish a topographic base against which future development proposals for the flood plain would be compared and assessed by. The model was intended to be used to assess the impacts of major flood events emanating from contributing catchments. It does not assess localised flooding produced by rainfall over small areas.

Historical flood events in the catchment were assessed to understand the impact of flooding in the system. Design flood hydrographs were derived for a range of events and design flood estimates were derived for the various catchments in the flood plain. A base flood or Design Flood Event (DFE) of 1 in 20 year ARI, 168 hour duration was adopted to use for assessing developments.

This event was based on the following requirements:

- It was representative of the typical flood immunity for a large number of works existing on the flood plain at the time;
- It was consistent with the level of immunity adopted for rural enterprises on other Queensland flood plains;
- The February 1978 flood event, which was the primary calibration event used to calibrate the RUBICON model, seems to be the base height used to establish the river bank heights. This was approximately a 1 in 25 year event.
- Consistency with current literature & the draft national best practise guidelines.

The report also assessed a series of case studies that determined the impact of the DFE on the flood plain for developments that occurred between 1978 and 1994.

1.1.3 Interim Flood Plain Management Plan Report, 1997

The Interim Flood Plain Management Plan was created by DNR to control rapid growth in development on the flood plain. It details the basis on which decisions are made by the Nogoa River Flood Plain Board relating to the development and use of the flood plain including management principles and objectives along with specific criteria and measure for allowable development. The Interim Flood Plain Management Plan uses the RUBICON numerical model developed in 1996 to assess the hydraulic impacts of any development proposal on the flood plain to assist the Board in its decision making process.

1.1.4 Flood Plain Development Studies

Various development studies have been undertaken since the Interim Flood Plain Management Plan was developed. Hydraulic assessments of the impact of flooding on the developments and surrounding flood plain were undertaken separately using the RUBICON numerical model.

Each of the studies listed below were approved for development under the plan:

- Millar Farms Ring Tanks (February 1998)
- Ensham Resources Levees and Haul Road (February 1998)
- Parker Development Supply Channel and Developments (April and December 1999)
- McIntosh – Lurline Levees (September 2000)
- Rileys Crossing Bridge (March 2001)
- Braylands Ring Tank and Supply Channel (September 2001)
- Burnetts – Colorada Levees (January 2003)
- Wilsons – Currimundi Levees (January 2003)
- Morawitz Levee (August 2002)
- Burnetts – Wyuna Levees (January 2003)
- Ensham Mine Haul Road Berm (April 2004)
- Citricorp Pty Ltd – Proposed Storage 4 (August 2006)

2.0 GENERAL DESCRIPTION OF NOGOA FLOOD PLAIN

The Nogoa River starts in the relatively steep Great Dividing Range and drains in a north-easterly direction to the Fairbairn Dam. From the Dam, the Nogoa River drains to the flat topography surrounding Emerald, and becomes the Mackenzie River just north of the town of Comet, and then later becomes the Fitzroy River draining into Keppel Bay at Rockhampton in Central Queensland.

Table 2.1: Fairbairn Dam Characteristics

Principle Feature	Attribute
Dam Type	Zoned earth and rock fill embankment
Full Supply Level (FSL)	EL 204.23 m AHD
Storage Capacity at FSL	1,301,133 ML
Dam Crest Level	EL 218.86 m AHD
Spillway Type	Chute with uncontrolled reinforced concrete ogee crest
Year Built	1973
Catchment Area	16,320 kms^2

The area of the Nogoa-Mackenzie River flood plain studied is from Fairbairn Dam, located at 685.6km AMTD on the Nogoa River, to Carnarngarra gauging station (130103A) located at 585.5km AMTD on the Mackenzie River. This is a river distance of approximately 100kms. The study area includes the township of Emerald, which has an existing population of approximately 14,000. The study area includes the lower reaches of the Comet River, Retreat and Theresa Creeks, and a number of smaller tributaries including Gordonstone, Crinum, Mosquito, Boggy, Maria, Winton and Sandhurst Creeks. In total, the study area covers around 180kms of streams. Reach descriptions can be found in the DNR Nogoa River Flood Plain Study, Hydraulic Model Design Flood Simulation Report, 1996.

The Nogoa River from Fairbairn Dam to Emerald is well defined, although often has multi-channelled stream with few overbank flow paths. The river channel is heavily timbered and littered with debris from previous flood events. Selma Weir is located at AMTD 669.3 km.

The weir is owned by D NR and it was originally used as a regulating weir for irrigators until Fairbairn D am was completed. It is now used as a water supply for various coal m ining enterprises.

Appendix A shows the general layout of the river system.

3.0 MODELLING METHODOLOGY

The assessment, updating and operation of the MIKE11 model for the Nogoa River Flood Plain study required collation of information and the application of various modelling assumptions and techniques in order to obtain the required level of accuracy of results. The methodology used in this study was as follows:

- A review and conversion of the hydraulic model:
- Convert Revised Adopted Topographic Base Case (RATBC) (Run 086) from the Rubicon model on the HP workstation to MIKE11 format to operate on a Windows based PC;
- Re-extract & process the raw cross sections from the Digital Terrain Model (DTM) as the existing cross sections from the original study are no longer available.
- Update model information:
- Run the RATBC case and adjust the model parameters until the MIKE11 output matches the RUBICON model;
- Match water levels for all three design floods events (1:100, 1:50 and 1:20 AEP) to best available fit, with the priority being given to achieving a match in water levels for the 1:20 AEP event, since this is the event which is used to sanction proposals for flood plain development.
- Create approved development case:
- Update the converted MIKE11 model to an existing conditions case that includes the approved developments in the Nogoa River Flood Plain since May 1997 up to the present time.

4.0 MIKE11 MODEL BUILD

MIKE11 is one package from a suite of software that enables the production of a one-dimensional branched network model capable of simulating unsteady open channel flow in natural stream systems, including the effects of structures such as culverts, bridges and weirs. The 2005 version of MIKE11 was used to undertake the hydraulic modelling for this study.

4.1 HYDRAULIC MODEL CONVERSION

4.1.1 Existing Model from Previous Study

Certain data from the Rubicon model input files, such as inflow hydrographs and values of Mannings n roughness, were copied directly into the corresponding MIKE11 files.

4.1.2 Topographic Data

As discussed previously in Section 2, the DTM and a ground survey of the Nogoa-Mackenzie River flood plain was completed in 1994. The photogrammetric survey data was quoted to have an accuracy of +/- 0.5m on spot heights; however the ground survey highlighted some errors of more than +/- 1.0m.

4.1.3 Model Layout

The model bounds of the MIKE11 model followed that of the RUBICON model.

In the schematisation of branches, MIKE11 allows greater flexibility than RUBICON in that it allows a branch to be connected not only at the beginning or the end of another branch, but also along its length. Therefore, branches in the RUBICON model which were joined sequentially are represented by a single branch in the MIKE 11 model. All major watercourses, such as the Nogoa and Comet Rivers, Retreat Creek, Crinum Creek, Winton Creek etc were represented as single branches. A number of sequentially joined flood runners were also represented as single branches and the naming convention was adjusted to reflect this. For example, the branches BTH_R00001 and BTH_R00003 in the RUBICON model correspond to the branch BTH_R01-3 in the MIKE11 model.

4.1.4 Cross Sections

The raw cross sections were input to the MIKE11 model at the same grid points and spacing as the RUBICON model. Cross section labels used in the RUBICON model were included in the Cross Section ID of the MIKE11 model.

The levels at which data were processed for each cross section were retained in the MIKE11 model. Care was taken to place the left and right channel markers in the correct locations and in some cases, minor manipulations to the cross sections were made to ensure the cross sectional properties such as area and flow width corresponded as closely as possible to those in the RUBICON model.

The RUBICON model represented non active flow areas by differences in the Breadth of Storage (BS) and the Breadth of Flow (BF) in the processed cross section data. For cross sections with non-active flow areas, the storage area at each level was calculated by multiplying the difference in breadths by half of the distance to the next upstream and downstream cross section. This gave an additional storage area suitable for input to the MIKE11 model.

As stated above, branches in the RUBICON model which were joined sequentially are represented by a single branch in the MIKE11 model. In the RUBICON model, it was noted that there were a number of instances where, due to poor schematisation, the last cross section of the upstream branch was different to the first cross section of the downstream branch. When these branches were joined to form a single branch for the MIKE11 model, it was necessary to select one of these cross sections for use at the branch junction and discard the other. This resulted in a more stable, robust model.

4.1.5 Additional Storages

In addition to the non-active flow areas included in the processed cross sectional data mentioned above, the RUBICON model also contained additional storage in the form of height-area relationships at four locations in the model. These were also incorporated into the additional storage area of the processed data tables of the appropriate cross sections of the MIKE11 model.

4.1.6 Structures & Key Locations

The study area contains a single structure, Selma Weir, located on the Nogoa River at AMTD 668.7 km (MIKE11 Chainage 16,200). Results from the RUBICON model indicated that the peak water level for the AEP 1:20 year event was approximately 7 m above the crest. Hence, for the purpose of this study, it was assumed that the weir would be completely drowned and the weir was modelled as cross section.

The key locations, which have been adopted from the previous study, are listed in Table 4.1.

Table 4.1: Key Locations in Study Area

Location	Branch Name	Mike11 Model Chainage
1. Fairbairn Dam	Nogoa_Mackenzie	0
2. Selma Weir	Nogoa_Mackenzie	16,200
3.Emerald – Capricorn Highway	Nogoa_Mackenzie	18,800
4. Emerald Town Weir	Nogoa_Mackenzie	22,200
5. Bellmah	Nogoa_Mackenzie	26,900
6. McCoskers Weir	Nogoa_Mackenzie	31,500
7. Retreat Ck Junction	Nogoa_Mackenzie	34,100
8. Bridge Flats Crossing	Nogoa_Mackenzie	39,100
9. Crinum Ck Junction	Nogoa_Mackenzie	45,700
10.Wyuna	Nogoa_Mackenzie	47,300
11. Dunckpond Homestead	BNO_R22-23-24-25	4,700
12. Currimundi	Nogoa_Mackenzie	65,220
13. Lochlees	BNO_R12-13-18-19	3,700
14. Parker Developments	BNO_R10A	3,000
15. Braylands	BNO_R20	1,100
16. St Aubins	Nogoa_Mackenzie	71,780
17. Rileys Crossing	Nogoa_Mackenzie	79,490
18. Yackam	Nogoa_Mackenzie	89,710
19. Carnangarra	Nogoa_Mackenzie	95,910
20. Myrtle Park	Comet River	0

Location	Branch Name	Mike11 Model Chainage
21. Comet Town Weir	Comet River	5,100
22. Comet – Capricorn Highway	Comet River	9,400
23. Kingower Billabong	Theresa Creek	0
24. Blair Athol Railway Line	Theresa Creek	7,400
25. Trafalgar	Retreat Creek	0
26. Blair Athol Railway Line	Retreat Creek	3,600
27. Gregory Highway	Retreat Creek	6,500
28. Washpool Waterhole	BRE_R02-4-6-7-13-14	2,600
29. Codenwatta Pump Site	BRE_L02-04	2,000
30. Langley Downs	Gordonstone Creek	0
31. Belcong Ck Junction	Crinum Creek	0
32. Wyuna Road	Crinum Creek	4,500
33. Colorada	Crinum Creek	12,300
34. Fenceline	Mosquito Creek	4,200
35. Lochabor	Winton Creek	0
36. Bauhinias Road	Winton Creek	16,300
37. Duckponds Lagoon	Winton Creek	25,600
38. Ensham	Boggy Creek	4,400
39. Karvella	Sandhurst Creek	0
40. Capricorn Highway	Sandhurst Creek	5,600

4.1.7 Boundar y Conditions

Inflow hydrographs, copied directly from the RUBICON model, were used at the upstrea m boundary of the Nogoa River and each m odel tr ibutary and as point inflows along m odelled reaches as per the RUBICON model. The rating curv e at Carnangarra gau ging station (130103A), also copied directly from the RU BICON model, was used as the downstream boundary condition at the model outlet.

4.1.8 Initial Conditions

A model "hotstart" file was set up to establish pre-existing conditions in the system. Constant, nominal flows in the Nogoa River and each tributary were applied, based on the initial 'lead-in' flows in the RUBICON model. These flows were applied until a steady state was achieved throughout the model. These flows were required for model stability and are insignificant compared to storm event flows.

4.1.9 Computational Parameters

Simulations were run for an 18 day period, using a 30 second time step and saving every 60 timesteps (30 minutes).

4.1.10 Model Scenarios

The model input files for each scenario, and the associated result files, are summarised in Table 4.2.

Table 4.2: Model Input and Output Files

File	Verification Run	Approved Development
Simulation	Case 086 Q20.sim11	Case 086AD1.sim11
Network	Case 086.nwk11	Case 086AD1.nwk11
Cross Section	Case 086.xns11	Case 086AD1.xns11
H'dynamic Parameters	Case 086.HD11	Case 086AD1.HD11
Boundary	Case 086 Q20.bnd11	Case 086AD1.bnd11
Result	Case 086 Q20.RES11	Case 086AD1.RES11

In the above table, the model input and output files listed for the Verification Run are for the 1:20 AEP event, which was the event primarily used. The file names for the 1:50 AEP and 1:100 AEP events follow the same format.

5.0 MODEL VERIFICATION

Results of the MIKE11 model were verified against the results of the RUBICON model. The 1 in 20 year ARI, 168 hour duration flood event was used for the verification, using the "1994 Topographic Base – Revised" (Run 086) model.

The existing values of Mannings *n* roughness in the RUBICON model were used as initial estimates of roughness in the MIKE11 model. Using these values, peak water levels from the MIKE11 model generally exceeded those of the RUBICON model throughout the study area by approximately 0.7 m.

It was not expected that the same values of relative roughness would result in the same peak water levels in both models, since Mannings *n* is model dependent, and there are differences in the way the system was schematised in each model and the way each model calculates certain parameters.

It was therefore necessary to adjust the relative roughness until the peak water levels from the MIKE11 model showed satisfactory agreement with those of the RUBICON model. The relative roughness in the MIKE11 model was first globally reduced, and then locally adjusted in appropriate river reaches until peak water levels throughout the study area generally agreed to those of the RUBICON model to within 300 mm. The values of Mannings n used in the RUBICON model, and a general overview of the final values used in the MIKE11 model are summarised in Table 5-1 below.

Table 5.1: Adopted Manning's 'n' Values

Branch Name	MIKE 11 Chainage	Adopted Mannings n Value	
		RUBICON Model	MIKE 11 Model
Nogoa - Mackenzie	0 - 34,100	0.085	0.072
Nogoa - Mackenzie	34,100 - 71,780	0.09	0.063
Nogoa - Mackenzie	71,780 - 95,910	0.100	0.080
Boggy Creek	0 – 7,000	0.07	0.042
Comet River	0 – 16,100	0.100	0.07
Crinum Creek	0 – 15,100	0.07	0.042
Gordonstone Creek	0 – 9,200	0.07	0.042
Mosquito Creek	0 – 5,200	0.07	0.042
Retreat Creek	0 – 20,600	0.100	0.07
Sandhurst Creek	0 – 16,100	0.07	0.056
Theresa Creek	0 – 10,700	0.100	0.07
Unnamed Creek	0 – 5,600	0.07	0.042
Winton Creek	0 – 32,700	0.07	0.07

The values listed in Table 5-1 are an indica tion only, as values m ay differ along the Nogoa – Mackenzie River and the tributaries due to localised changes. However, with th e exception on Winton Creek, in all cases, the MIKE11 m odel are all les s than the RUBICON model. These values are all within the industry standard r ecommended Mannings 'n' values. Additionally, in many cases, the resistance factor has been increased in the model ain the low flow channel.

5.1 MODEL CONVERSION RESULTS

The inflows for three design floods events (1:1 00, 1:50 and 1:20 AEP) we re run in the MIKE11 model. The model was verified against the water levels for the 1:20 AEP event, sin ce this is the event which is used to sanction proposals fo r flood plain developm ent. The larger 1:100, 1:50 AEP events were run to ensure the capability of the model to simulate large floods.

5.1.1 Results Discussion

It was anticipated that the MIKE11 model would not exactly match the RUBICON model results, as they use different calculation methodologies. Levels that are not within the tolerance level are generally be explained by the difference in model branch and model cross-section conceptualisation due to different solution algorithms. Additionally, there are differences in the models in the determination of hydraulic characteristics of cross-sections. These factors are expected to lead to a different flow distribution through the model. As the model is a one dimensional representation of a two dimensional flow, even relatively moderate differences in flow can lead to relatively large differences in level in the areas of the model with shallow flows.

A band of tolerance of 0.3 meters was applied across the model to verify the MIKE11 peak water level results against the RUBICON model. The results show a good fit with the RUBICON model as generally the water levels are within the tolerance level.

5.2 DESIGN FLOOD PEAK LEVELS

The results of the simulation of the 1 in 20 year ARI, 168 hour duration flood event for each key location are presented in Table 5.2. The results show a good fit with the RUBICON model as generally the water levels are within a tolerance level of 0.3 meters.

Table 5.2: Key Location 1 in 20 year Results Summary

Location	RUBICON Peak WSL (m AHD)	MIKE11 Peak WSL (m AHD)	Difference +/- m
1. Fairbairn Dam	187.19	187.37	0.18
2. Selma Weir	177.39	177.26	-0.13
3.Emerald – Capricorn Highway	176.08	176.17	0.09
4. Emerald Town Weir	173.33	173.06	-0.27
5. Bellmah	169.73	169.73	0.00
6. McCoskers Weir	168.11	168.17	0.06
7. Retreat Ck Junction	167.33	167.22	-0.11
8. Bridge Flats Crossing	164.54	164.43	-0.11
9. Crinum Ck Junction	160.45	160.59	0.14
10.Wyuna	159.62	159.37	-0.25
11. Dunckpond Homestead	154.10	154.09	-0.01
12. Currimundi	151.51	151.57	0.06
13. Lochlees	159.54	159.83	0.28
14. Parker Developments	163.43	163.03	-0.40
15. Braylands	156.20	156.53	0.33
16. St Aubins	150.61	150.51	-0.10
17. Rileys Crossing	148.33	148.12	-0.20
18. Yackam	145.14	145.32	0.18
19. Carnangarra	143.13	143.03	-0.10
20. Myrtle Park	154.28	154.36	0.08
21. Comet Town Weir	152.95	152.86	-0.09
22. Comet – Capricorn Highway	151.41	151.64	0.23
23. Kingower Billabong	180.36	180.27	-0.09
24. Blair Athol Railway Line	177.13	177.11	-0.02
25. Trafalgar	177.48	177.44	-0.04
26. Blair Athol Railway Line	175.33	174.95	-0.38
27. Gregory Highway	174.85	174.10	-0.75
28. Washpool Waterhole	170.80	171.15	0.35
29. Codenwatta Pump Site	169.87	169.37	-0.50
30. Langley Downs	164.07	163.91	-0.16
31. Belcong Ck Junction	164.96	165.05	0.09
32. Wyuna Road	162.31	162.40	0.09
33. Colorada	160.99	161.11	0.11
34. Fenceline	161.02	161.13	0.11
35. Lochabor	167.10	167.06	-0.04
36. Bauhinias Road	156.45	156.01	-0.44
37. Duckponds Lagoon	151.83	151.93	0.10
38. Ensham	151.60	152.01	0.41
39. Karvella	154.89	154.95	0.06
40. Capricorn Highway	151.22	151.70	0.48

At the key locations, the sites that do not m atch the RUBICON model can be explained as follows:

- Parker Developments –The peak water level caused by the reduction of effective waterway from constructing the Codenwarra Levee & the Parker Development Supply channel across the flood runner has been overestimated in the RUBICON model.
- Braylands – the peak water level caused by the Braylands Ring Tank and channels has been underestimated by the RUBICON model.
- The junction where Theresa Creek meets Retreat Creek is constricted. The RUBICON model found that the much of the 1 in 20 year flows follow Retreat Creek, however the MIKE11 model results indicate that much of the flow detracts right along the flood runner. Close examination of the cross sections and conveyance curves indicates that flows would prefer the path of least resistance along the flood runner. Hence the MIKE11 results have been adopted. This change in flow path has an impact on the RUBICON peak water level results for Blair Athol Railway Line, Gregory Highway, Washpool Waterhole and Codenwatta Pump Site, which are all reduced in the MIKE11 model.
- Bauhinias Road – the peak water level at this is location is less than the RUBICON model due to the changes made to the flood plain by the Parker Levees. Therefore there is less flow and lower peak water levels in Winton Creek in this constricted section.
- Ensham Mine – The peak water level at this location is caused by backflow from the Nogoa River. It was found on review of the RUBICON model that there was a minor occurrence where the peak water level at a junction did not match the peak water levels downstream. At this location, the RUBICON model results were 151.6m AHD and immediately downstream at the Nogoa River junction, the peak water levels were 151.92 m AHD. As this is not realistic, the correct level reported in the RUBICON model should have been the Nogoa River peak water level of 151.92, which is within 0.1 meters of the MIKE11 result.
- Capricorn Highway – The peak water level at this location was underestimated by the RUBICON model.

The results of the Nogoa River and several main tributaries are shown in Figures 1 to 4. The figures highlight the band of tolerance of 0.3 meters applied to verify the MIKE11 peak water level results against the RUBICON model. The results show a good fit with the RUBICON model as generally the water levels are within the tolerance level.

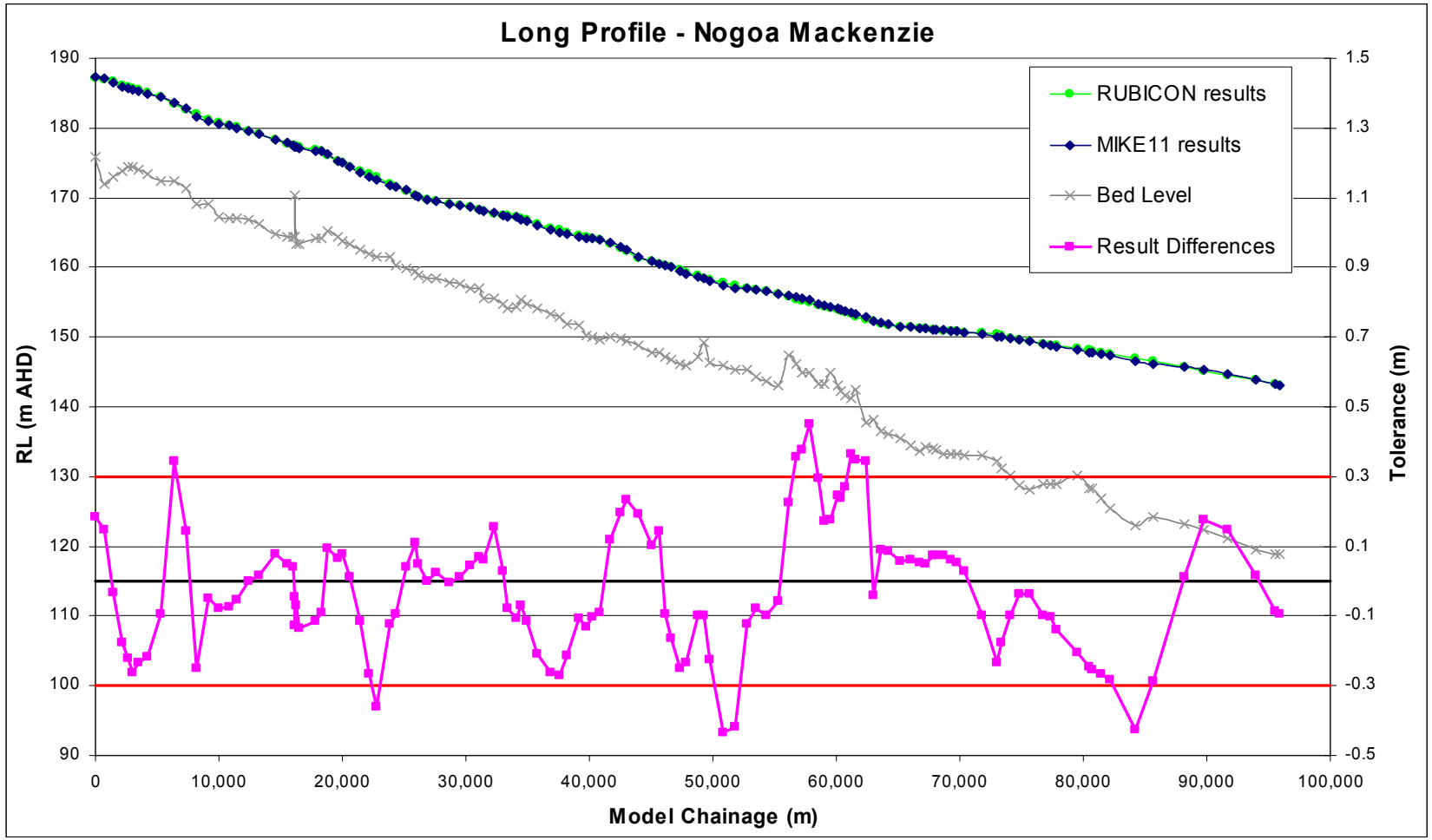

Figure 1: Nogoa Mackenzie River Long Profile

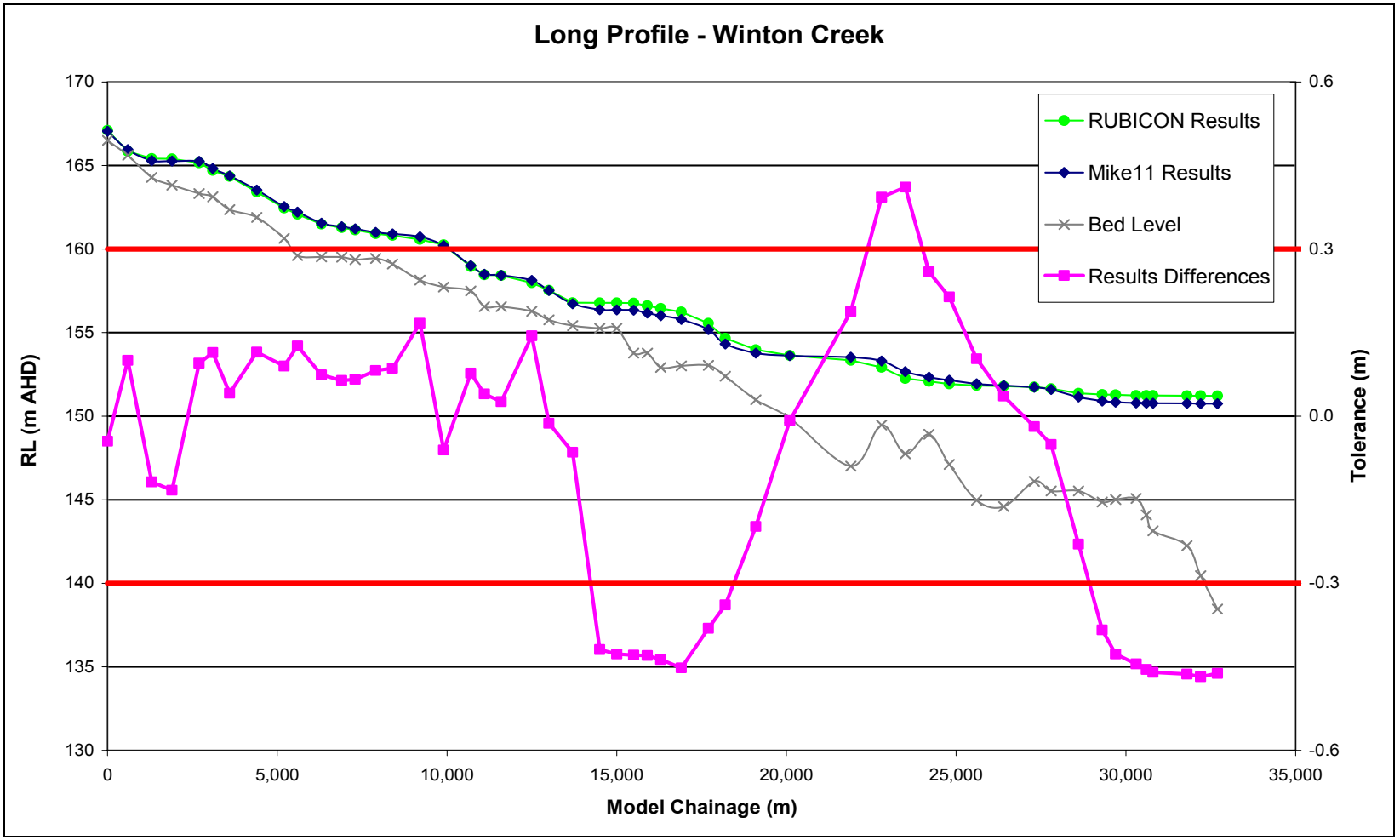

Figure 2: Winton Creek Long Profile

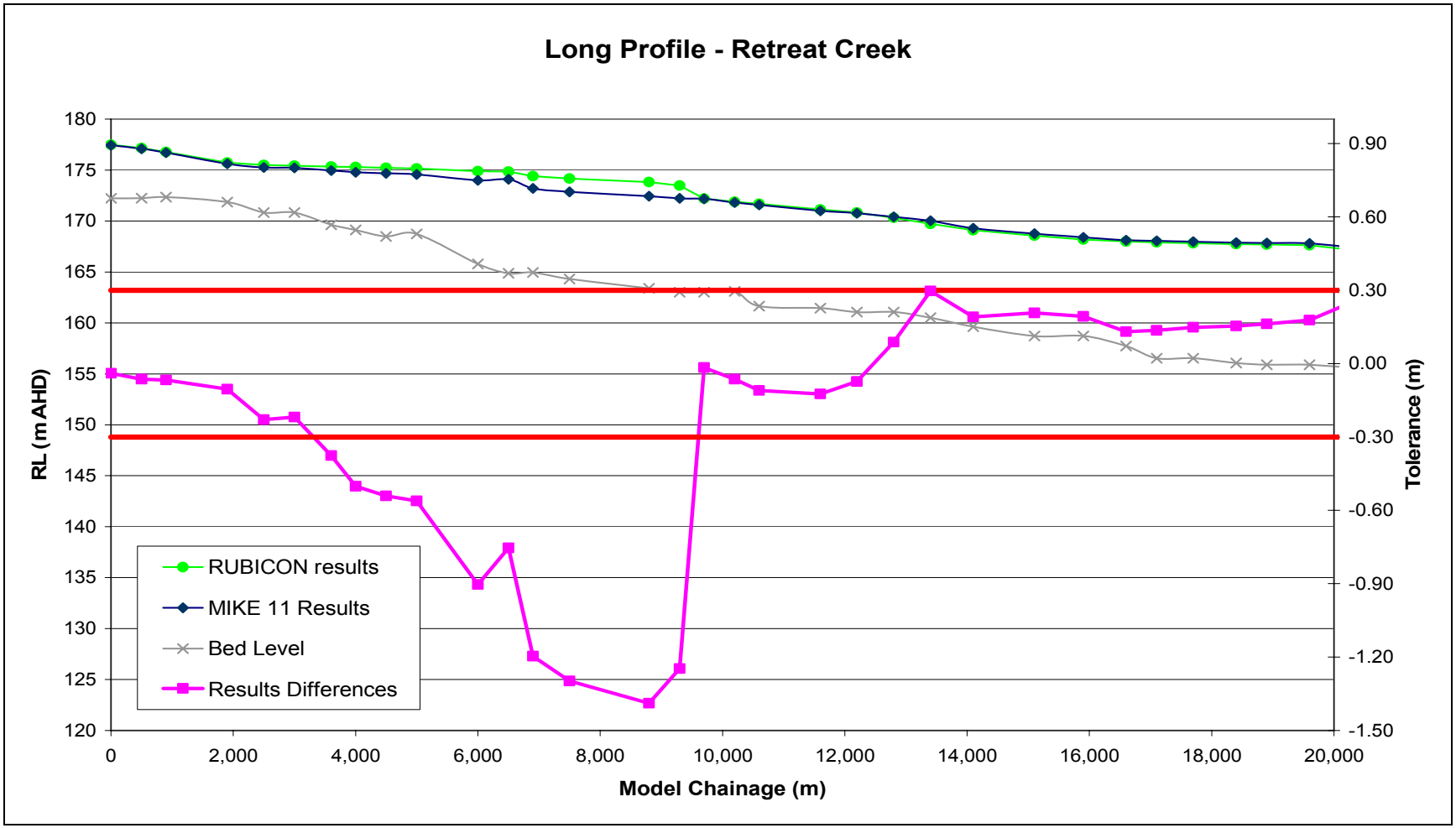

Figure 3: Retreat Creek Long Profile

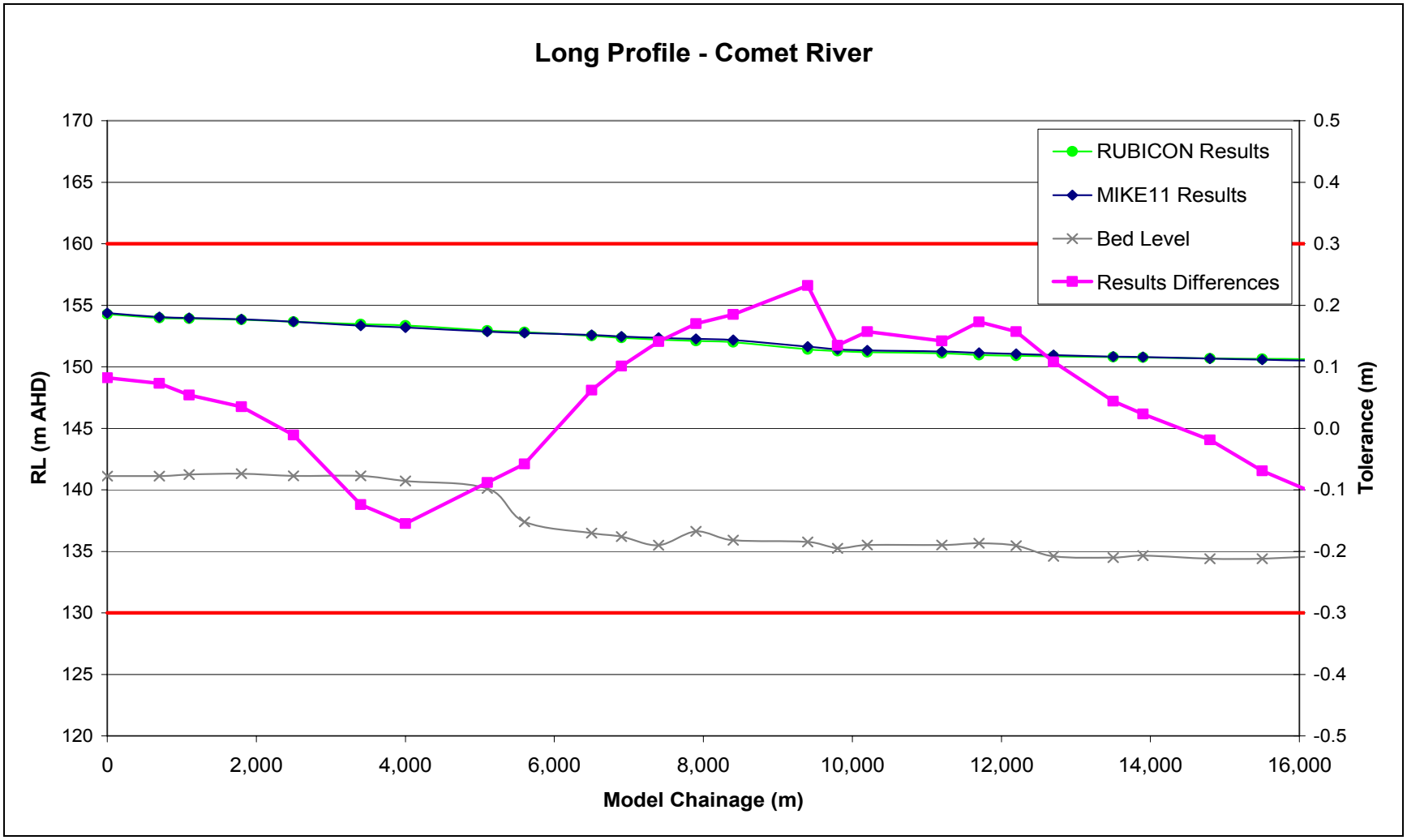

Figure 4: Comet Creek Long Profile

6.0 APPROVED DEVELOPMENT CASE

Each of the following approved developments in the Nogoa River Flood Plain between 1997 to present, have been included in the verified MIKE11 model. These analyses were previously undertaken separately in RUBICON.

- Millar Farms Ring Tanks (February 1998)
- Ensham Resources Levees and Haul Road (February 1998)
- Parker Development Supply Channel and Developments (April and December 1999)
- McIntosh – Lurline Levees (September 2000)
- Rileys Crossing Bridge (March 2001)
- Braylands Ring Tank and Supply Channel (September 2001)
- Morawitz Levee (August 2002)
- Burnetts – Colorada Levees (January 2003)
- Wilsons – Currimundi Levees (January 2003)
- Burnetts – Wyuna Levees (January 2003)
- Ensham Mine Haul Road Berm (April 2004)
- Citricorp Pty Ltd – Proposed Storage 4 (August 2006)

The model results showed that the developments made some impact to the peak water levels in the flood plain. The major increase in peak water levels occurs in Winton Creek where the Ensham Mine Levee blocks flow along the creek. It is expected that during a 1 in 20 year ARI flood, the water levels will continue to rise until backwater effects cause overflow into the flood runner to Nogoa River.

7.0 CONCLUSIONS

In early 2007 SunWater – Asset Solutions was requested by the Nogoa River Flood Plain Board to undertake a hydraulic analysis of the Nogoa-Mackenzie River flood plain. This involved updating an existing hydraulic model in RUBICON, to the hydraulic model software, MIKE11. The MIKE11 results were then verified with the RUBICON results to produce the new adopted Nogoa-Mackenzie River Flood Plain model. The verified model was then updated with the approved developments undertaken on the flood plain since May 1997.

The conclusion of this study is that the MIKE11 model satisfactorily simulates the conditions in the Nogoa-Mackenzie River Flood Plain. The updated model results are within an acceptable band of tolerance and the Nogoa River Flood Plain Board may use the new model with confidence to assess future development within the flood plain.

8.0 REFERENCES

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APPENDIX A

MODEL SCHEMATIC
AND
KEY LOCATIONS

Figure 6

Legend

- Extent of Hydrological Model
- Extent of Hydraulic Model
- Principal Road
- Model Branches

Theresa Ck
Gregory
Retreat
Ck
Hwy
Capricorn
Hwy
EMERALD
Capricorn
Nogoa
Hwy
Gregory
R
Mackenzie
R
Ck
R
Comet
Hwy
Sandhurst
Comet
N

1. Fairbairn Dam Tailwater
2. Selma Weir
3. Emerald –Capricorn Highway
4. Emerald Town Weir
5. Bellmah
6. McCoskers Weir
7. Retreat Creek Junction
8. Bridge Flats Crossing
9. Crinum Creek Junction
10. Wyuna
11. Duckponds Homestead
12. Currimundi
13. Lochlees
14. Parker
15. Braylands
16. St. Aubins
17. Rileys Crossing
18. Yackam
19. Carnangarra
20. Myrtle Park
21. Comet Town Weir
22. Comet –Capricorn Hwy
23. Kingower Billabong
24. Blair Athol Railway
25. Trafalgar
26. Blair Athol Railway
27. Gregory Highway
28. Washpool Waterhole
29. Codenwarra Pump Site
30. Langley Downs
31. Belcong Creek Junction
32. Wyuna Road
33. Colorada
34. Fenceline
35. Locharbor
36. Bauhinias Road
37. Duckponds Lagoon
38. Ensham
39. Karvella
40. Capricorn Highway

KILOMETRES

0 10

1:200000

RESOURCE SCIENCES CENTRE

NATURAL RESOURCES

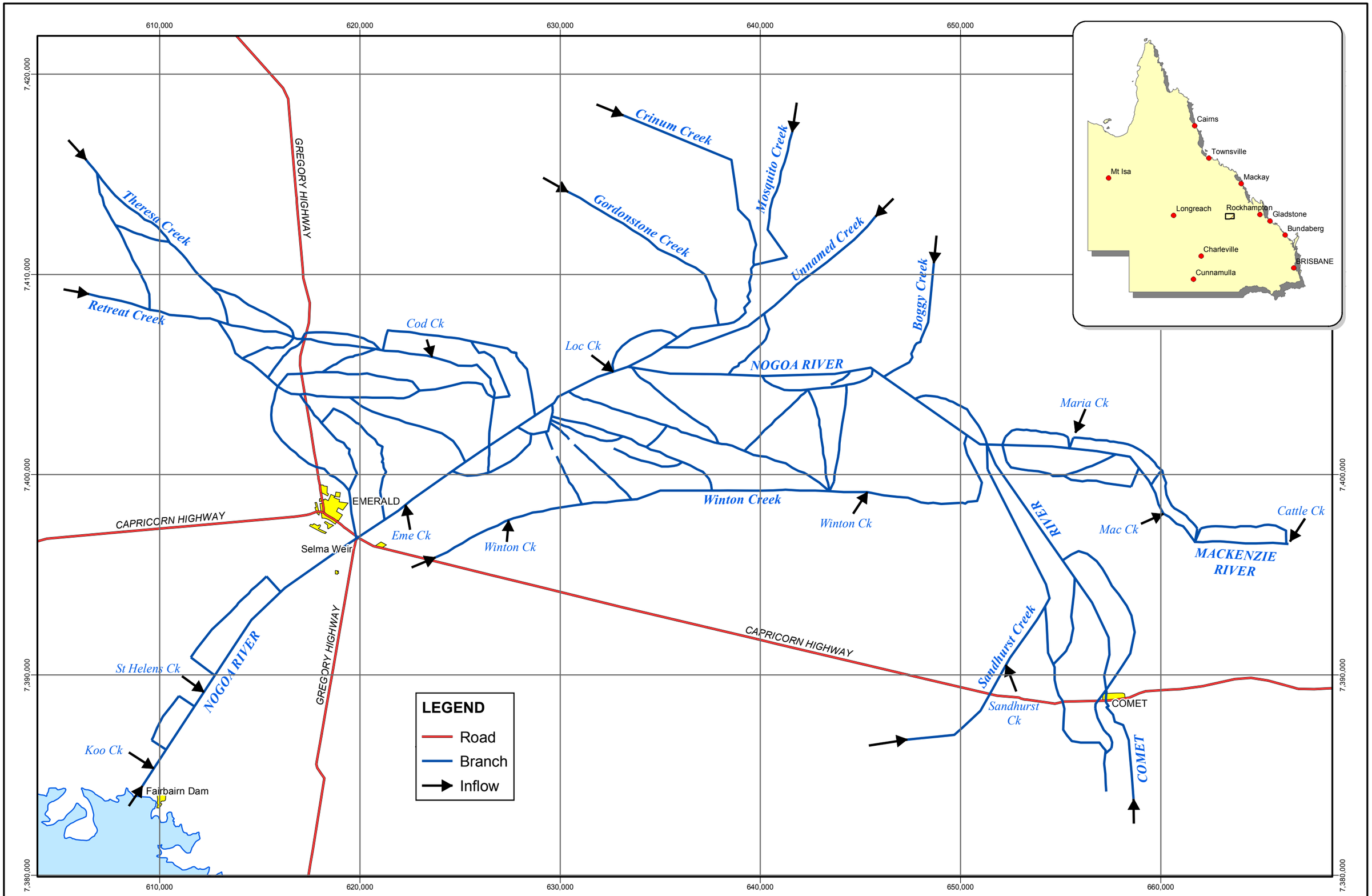
QUEENSLAND GOVERNMENT

Nogoa Flood Plain Study

Key Locations

04/06/96

A3-500331 RSC



Document: Q:\GIS\Nogoa Flood Plain Study\Maps\229707.mxd
Printed: Thursday, September 27 2007 12:45:52 PM

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W E
S

NOTES

1. Base data from Geoscience Australia 1:1,000,000 series.
2. Projection: GDA94

0 2 4 6 8 10 km

1:175,000

DRAWN RET	[redacted]	
CHECKED	CHECKED	
APPROVED	[redacted]	

SunWater
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Brisbane Qld 4002
Tel: (07) 3120 0000

NOGOA RIVER FLOODPLAIN BOARD MIKE 11 HYDRAULIC MODEL SCHEMATIC

MAP NUMBER 229707

DATE SEPT 2007

APPENDIX B

RUBICON FLOOD DEPTH PLAN

1 IN 20 ARI

Figure 6.3

1 501106
2 501107
3 501108
4 501109
5 501110
6 501111
7 501112
8 501113
9 501114
10 501115
11 501419
12 501420

Legend:

- 0m – 1m
- 1m – 2m
- 2m – 3m
- 3m – 4m
- > 4m
- Peak 1978 Flood Line
- Extent of 'RUBICON' Hydraulic Model

Notes:

1. Cadastral blocks shown > 1 hectare.
2. The data from which this plan has been developed is of limited accuracy. Consequently, this plan shows general flooding only and should not be used to access flooding of individual blocks.
3. This map shows the effect of Nogoa River flooding but not the effect of local flooding in creeks.

KILOMETRES
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NATURAL RESOURCES

QUEENSLAND GOVERNMENT

Nogoa Flood Plain Study
Hydraulic Model
Case 1b (1:20) – Depth of Inundation
Key to Sheets

15/01/97

A3-501094 RSC

Printed:-02 Jun 97 Current Workspace:-/PROJECTS1/ML1872/REPD

Produced at the Resource Sciences Centre of the Department of Natural Resources by the Spatial Information and Mapping Group.

APPENDIX C

MIKE11 RESULTS

Water Level

Name of Watercourse	X-SECT Name	MIKE 11 Chainage	Bed EL	1 in 20 year ARI MIKE11 CASE 086	1 in 50 year ARI MIKE11 CASE 086	1 in 100 year ARI MIKE11 CASE 086
NOGOA_MACKENZIE	GNO_007005	0	175.81	187.37	188.83	189.73
NOGOA_MACKENZIE	GNO_006998	700	171.87	187.12	188.56	189.46
NOGOA_MACKENZIE	GNO_006991	1400	172.99	186.61	188.14	189.05
NOGOA_MACKENZIE	GNO_006983	2200	173.73	185.97	187.50	188.44
NOGOA_MACKENZIE	GNO_006978	2600	174.39	185.73	187.27	188.22
NOGOA_MACKENZIE	GNO_006975	3000	174.39	185.49	187.09	188.04
NOGOA_MACKENZIE	GNO_006975	3000	174.39	185.49	187.09	188.04
NOGOA_MACKENZIE	GNO_006972	3500	173.92	185.20	186.88	187.87
NOGOA_MACKENZIE	GNO_006962	4200	173.42	184.86	186.54	187.53
NOGOA_MACKENZIE	GNO_006951	5300	172.35	184.37	186.13	186.97
NOGOA_MACKENZIE	GNO_006940	6400	172.35	183.75	185.73	186.60
NOGOA_MACKENZIE	GNO_006940	6400	172.35	183.75	185.73	186.60
NOGOA_MACKENZIE	GNO_006930	7300	171.26	182.82	185.02	185.91
NOGOA_MACKENZIE	GNO_006919	8200	169.07	181.69	184.07	184.89
NOGOA_MACKENZIE	GNO_006910	9100	169.07	181.06	183.51	184.22
NOGOA_MACKENZIE	GNO_006910	9100	169.07	181.06	183.51	184.22
NOGOA_MACKENZIE	GNO_006900	10000	167.16	180.63	183.15	183.86
NOGOA_MACKENZIE	GNO_006892	10800	167.01	180.28	182.71	183.48
NOGOA_MACKENZIE	GNO_006886	11400	166.99	180.05	182.35	183.19
NOGOA_MACKENZIE	GNO_006876	12400	166.85	179.57	181.75	182.62
NOGOA_MACKENZIE	GNO_006868	13200	166.15	179.17	181.35	182.15
NOGOA_MACKENZIE	GNO_006854	14600	164.84	178.37	180.67	181.54
NOGOA_MACKENZIE	GNO_006845	15500	164.40	177.82	180.07	181.17
NOGOA_MACKENZIE	GNO_006840	16000	164.31	177.49	179.72	180.97
NOGOA_MACKENZIE	GNO_006840	16000	164.31	177.49	179.72	180.97
NOGOA_MACKENZIE	N/A	16150	164.31	177.37	179.60	180.88
NOGOA_MACKENZIE	N/A	16200	170.39	177.26	179.52	180.85
NOGOA_MACKENZIE	N/A	16250	163.46	177.28	179.49	180.83
NOGOA_MACKENZIE	GNO_006835	16500	163.46	177.19	179.32	180.68
NOGOA_MACKENZIE	GNO_006822	17800	164.18	176.76	178.67	180.02
NOGOA_MACKENZIE	GNO_006817	18300	164.18	176.60	178.50	179.84
NOGOA_MACKENZIE	GNO_006810	18800	165.16	176.17	178.08	179.45
NOGOA_MACKENZIE	GNO_006802	19600	164.38	175.30	176.90	178.23
NOGOA_MACKENZIE	GNO_006798	20000	163.84	175.04	176.67	178.02
NOGOA_MACKENZIE	GNO_006792	20600	163.45	174.43	176.11	177.33
NOGOA_MACKENZIE	GNO_006784	21400	162.56	173.60	175.00	175.82
NOGOA_MACKENZIE	GNO_006778	22200	162.02	173.06	174.10	174.59
NOGOA_MACKENZIE	GNO_006778	22200	162.02	173.06	174.10	174.59
NOGOA_MACKENZIE	GNO_006769	22800	161.43	172.57	173.52	173.96
NOGOA_MACKENZIE	GNO_006759	23800	161.43	171.76	172.71	173.10
NOGOA_MACKENZIE	GNO_006759	23800	161.43	171.76	172.71	173.10
NOGOA_MACKENZIE	GNO_006753	24300	160.25	171.56	172.48	172.84
NOGOA_MACKENZIE	GNO_006744	25200	159.78	171.07	171.93	172.25
NOGOA_MACKENZIE	GNO_006737	25900	159.43	170.41	171.22	171.62
NOGOA_MACKENZIE	GNO_006734	26200	158.85	170.11	170.98	171.41
NOGOA_MACKENZIE	GNO_006727	26900	158.39	169.73	170.65	171.10
NOGOA_MACKENZIE	GNO_006720	27600	158.39	169.47	170.38	170.84
NOGOA_MACKENZIE	GNO_006709	28700	157.78	169.01	169.90	170.36
NOGOA_MACKENZIE	GNO_006701	29500	157.54	168.85	169.71	170.17
NOGOA_MACKENZIE	GNO_006692	30400	157.08	168.66	169.46	169.89
NOGOA_MACKENZIE	GNO_006685	31100	157.08	168.35	169.01	169.39
NOGOA_MACKENZIE	GNO_006685	31100	157.08	168.35	169.01	169.39
NOGOA_MACKENZIE	GNO_006678	31500	155.58	168.17	168.78	169.13
NOGOA_MACKENZIE	GNO_006670	32300	155.58	167.78	168.34	168.71
NOGOA_MACKENZIE	GNO_006670	32300	155.58	167.78	168.34	168.71
NOGOA_MACKENZIE	GNO_006661	33000	154.67	167.46	168.01	168.40
NOGOA_MACKENZIE	GNO_006657	33400	154.20	167.30	167.84	168.23
NOGOA_MACKENZIE	GNO_006650	34100	154.29	167.22	167.76	168.15
NOGOA_MACKENZIE	GNO_006641	34100	154.29	167.22	167.76	168.15
NOGOA_MACKENZIE	GNO_006641	34500	155.39	166.91	167.49	167.91
NOGOA_MACKENZIE	GNO_006630	34900	154.83	166.64	167.25	167.69
NOGOA_MACKENZIE	GNO_006621	35800	154.14	166.01	166.68	167.15
NOGOA_MACKENZIE	GNO_006610	36900	153.33	165.34	165.99	166.45
NOGOA_MACKENZIE	GNO_006610	36900	153.33	165.34	165.99	166.45
NOGOA_MACKENZIE	GNO_006598	37600	152.82	165.07	165.69	166.14
NOGOA_MACKENZIE	GNO_006592	38200	151.96	164.75	165.35	165.78
NOGOA_MACKENZIE	GNO_006583	39100	151.75	164.37	164.96	165.38
NOGOA_MACKENZIE	GNO_006583	39100	151.75	164.37	164.96	165.38
NOGOA_MACKENZIE	GNO_006570	39800	150.16	164.17	164.74	165.15
NOGOA_MACKENZIE	GNO_006565	40300	149.96	164.03	164.58	164.98
NOGOA_MACKENZIE	GNO_006560	40800	149.71	163.85	164.39	164.77
NOGOA_MACKENZIE	GNO_006560	40800	149.71	163.85	164.39	164.77
NOGOA_MACKENZIE	GNO_006545	41700	150.01	163.34	163.86	164.23
NOGOA_MACKENZIE	GNO_006537	42500	149.80	162.70	163.22	163.58
NOGOA_MACKENZIE	GNO_006532	43000	149.51	162.36	162.87	163.21
NOGOA_MACKENZIE	GNO_006522	44000	148.73	161.56	162.01	162.29
NOGOA_MACKENZIE	GNO_006522	44000	148.73	161.56	162.01	162.29
NOGOA_MACKENZIE	GNO_006510	45000	147.83	161.16	161.64	161.92
NOGOA_MACKENZIE	GNO_006503	45700	147.83	160.84	161.36	161.64
NOGOA_MACKENZIE	GNO_006503	45700	147.83	160.84	161.36	161.64
NOGOA_MACKENZIE	GNO_006496	46200	147.10	160.56	161.11	161.39
NOGOA_MACKENZIE	GNO_006492	46600	146.79	160.23	160.84	161.11
NOGOA_MACKENZIE	GNO_006485	47300	146.19	159.58	160.28	160.54
NOGOA_MACKENZIE	GNO_006480	47800	145.92	159.27	159.92	160.18
NOGOA_MACKENZIE	GNO_006470	48800	147.16	158.81	159.22	159.48
NOGOA_MACKENZIE	GNO_006465	49300	149.31	158.55	158.91	159.20
NOGOA_MACKENZIE	GNO_006460	49800	146.41	158.16	158.58	158.90
NOGOA_MACKENZIE	GNO_006450	50800	145.90	157.47	157.98	158.36
NOGOA_MACKENZIE	GNO_006440	51800	145.33	157.05	157.58	157.97
NOGOA_MACKENZIE	GNO_006430	52800	145.33	156.90	157.44	157.83
NOGOA_MACKENZIE	GNO_006430	52800	145.33	156.90	157.44	157.83
NOGOA_MACKENZIE	GNO_006420	53500	144.39	156.77	157.31	157.69
NOGOA_MACKENZIE	GNO_006412	54300	143.76	156.51	157.02	157.39
NOGOA_MACKENZIE	GNO_006405	55300	143.01	156.15	156.60	156.92
NOGOA_MACKENZIE	GNO_006405	55300	143.01	156.15	156.60	156.92
NOGOA_MACKENZIE	GNO_006396	56100	147.46	156.04	156.44	156.74

Water Level

Name of Watercourse	X-SECT Name	MIKE 11 Chainage	Bed EL	1 in 20 year ARI MIKE11 CASE 086	1 in 50 year ARI MIKE11 CASE 086	1 in 100 year ARI MIKE11 CASE 086
NOGOA_MACKENZIE	GNO_006390	56700	146.10	155.80	156.14	156.42
NOGOA_MACKENZIE	GNO_006385	57200	144.90	155.62	155.95	156.23
NOGOA_MACKENZIE	GNO_006379	57800	144.95	155.38	155.71	156.01
NOGOA_MACKENZIE	GNO_006372	58500	143.36	154.84	155.35	155.75
NOGOA_MACKENZIE	GNO_006367	59000	143.36	154.60	155.19	155.64
NOGOA_MACKENZIE	GNO_006362	59500	144.95	154.49	155.10	155.56
NOGOA_MACKENZIE	GNO_006356	60100	143.09	154.30	154.95	155.43
NOGOA_MACKENZIE	GNO_006353	60400	142.16	154.08	154.83	155.33
NOGOA_MACKENZIE	GNO_006350	60700	141.63	153.97	154.75	155.27
NOGOA_MACKENZIE	GNO_006350	60700	141.63	153.97	154.75	155.27
NOGOA_MACKENZIE	GNO_006342	61200	141.28	153.84	154.66	155.18
NOGOA_MACKENZIE	GNO_006338	61600	142.49	153.66	154.53	155.06
NOGOA_MACKENZIE	GNO_006330	62400	137.72	153.37	154.30	154.85
NOGOA_MACKENZIE	GNO_006330	62400	137.72	153.37	154.30	154.85
NOGOA_MACKENZIE	GNO_006323	63000	138.11	152.65	153.74	154.33
NOGOA_MACKENZIE	GNO_006319	63600	136.56	152.41	153.47	154.09
NOGOA_MACKENZIE	GNO_006319	63600	136.56	152.41	153.47	154.09
NOGOA_MACKENZIE	GNO_006310	64230	136.16	152.13	153.21	153.85
NOGOA_MACKENZIE	GNO_006300	65220	135.59	151.83	152.95	153.60
NOGOA_MACKENZIE	GNO_006290	66020	134.54	151.69	152.81	153.44
NOGOA_MACKENZIE	GNO_006290	66020	134.54	151.69	152.81	153.44
NOGOA_MACKENZIE	GNO_006285	66770	133.66	151.54	152.70	153.34
NOGOA_MACKENZIE	GNO_006280	67280	134.24	151.41	152.59	153.23
NOGOA_MACKENZIE	GNO_006275	67790	134.03	151.32	152.52	153.17
NOGOA_MACKENZIE	GNO_006270	68090	133.76	151.25	152.47	153.12
NOGOA_MACKENZIE	GNO_006265	68690	133.32	151.10	152.34	153.00
NOGOA_MACKENZIE	GNO_006260	69230	133.29	151.01	152.28	152.94
NOGOA_MACKENZIE	GNO_006256	69740	133.19	150.92	152.22	152.89
NOGOA_MACKENZIE	GNO_006250	70340	133.01	150.81	152.14	152.82
NOGOA_MACKENZIE	GNO_006250	70340	133.01	150.81	152.14	152.82
NOGOA_MACKENZIE	GNO_006263	71780	133.01	150.61	151.96	152.67
NOGOA_MACKENZIE	GNO_006263	71780	133.01	150.61	151.96	152.67
NOGOA_MACKENZIE	GMK_006226	72980	132.16	150.27	151.46	152.16
NOGOA_MACKENZIE	GMK_006226	72980	132.16	150.27	151.46	152.16
NOGOA_MACKENZIE	GMK_006220	73400	131.23	150.18	151.37	152.06
NOGOA_MACKENZIE	GMK_006212	74120	130.24	149.95	151.11	151.82
NOGOA_MACKENZIE	GMK_006205	74780	128.63	149.73	150.87	151.59
NOGOA_MACKENZIE	GMK_006198	75710	128.11	149.43	150.61	151.35
NOGOA_MACKENZIE	GMK_006187	76730	128.89	149.06	150.33	151.09
NOGOA_MACKENZIE	GMK_006180	77330	129.00	148.85	150.19	150.96
NOGOA_MACKENZIE	GMK_006180	77330	129.00	148.85	150.19	150.96
NOGOA_MACKENZIE	GMK_006176	77810	129.00	148.65	150.07	150.86
NOGOA_MACKENZIE	GMK_006160	79490	130.10	148.08	149.70	150.57
NOGOA_MACKENZIE	GMK_006149	80490	128.23	147.79	149.44	150.39
NOGOA_MACKENZIE	GMK_006149	80490	128.23	147.79	149.44	150.39
NOGOA_MACKENZIE	GMK_006147	80670	128.23	147.71	149.37	150.35
NOGOA_MACKENZIE	GMK_006140	81390	126.91	147.49	149.15	150.21
NOGOA_MACKENZIE	GMK_006132	82110	125.50	147.32	149.00	150.10
NOGOA_MACKENZIE	GMK_006132	82110	125.50	147.32	149.00	150.10
NOGOA_MACKENZIE	GMK_006107	84210	122.90	146.50	148.29	149.46
NOGOA_MACKENZIE	GMK_006107	84210	122.90	146.50	148.29	149.46
NOGOA_MACKENZIE	GMK_006085	85710	124.26	146.14	147.96	149.16
NOGOA_MACKENZIE	GMK_006060	88210	123.23	145.63	147.51	148.75
NOGOA_MACKENZIE	GMK_006045	89710	122.45	145.26	147.22	148.52
NOGOA_MACKENZIE	GMK_006045	89710	122.45	145.26	147.22	148.52
NOGOA_MACKENZIE	GMK_006020	91710	121.21	144.68	146.69	148.05
NOGOA_MACKENZIE	GMK_005997	94010	119.56	143.85	145.97	147.41
NOGOA_MACKENZIE	GMK_005982	95510	118.83	143.17	145.34	146.82
NOGOA_MACKENZIE	GMK_005982	95510	118.83	143.17	145.34	146.82
NOGOA_MACKENZIE	GMK_005976	95910	118.83	142.97	145.12	146.59
BNO_L14	GNOL14_020	0	181.65	185.49	187.09	188.04
BNO_L14	GNOL14_012	800	181.29	184.86	186.68	187.59
BNO_L14	GNOL14_004	1600	182.53	183.75	185.73	186.60
BNO_L01	GNOL01_085	0	182.03	181.06	183.51	184.22
BNO_L01	GNOL01_077	800	182.03	182.03	183.15	183.90
BNO_L01	GNOL01_068	1700	179.94	179.94	182.70	183.52
BNO_L01	GNOL01_060	2500	179.94	179.94	182.54	183.25
BNO_L01	GNOL01_051	3400	180.38	180.39	182.20	182.71
BNO_L01	GNOL01_045	4000	179.50	180.46	181.42	181.79
BNO_L01	GNOL01_032	5300	176.22	177.49	179.75	180.98
BNO_L01	GNOL01_024	6100	174.32	177.49	179.73	180.97
BNO_L01	GNOL01_018	6700	172.70	177.49	179.72	180.97
BNO_L01	GNOL01_010	7500	170.48	177.49	179.72	180.97
BOGGY CREEK	GBO_000070	0	161.24	161.24	161.24	161.24
BOGGY CREEK	GBO_000065	500	159.25	159.24	159.24	159.24
BOGGY CREEK	GBO_000062	800	158.46	158.45	158.45	158.45
BOGGY CREEK	GBO_000056	1400	156.69	156.69	156.69	156.69
BOGGY CREEK	GBO_000052	1800	154.81	154.81	154.81	154.81
BOGGY CREEK	GBO_000045	2500	153.36	153.36	153.47	154.09
BOGGY CREEK	GBO_000038	3200	149.88	152.41	153.47	154.09
BOGGY CREEK	GBO_000033	3700	148.19	152.41	153.47	154.09
BOGGY CREEK	GBO_000026	4400	146.30	152.41	153.47	154.09
BOGGY CREEK	GBO_000018	5200	145.25	152.41	153.47	154.09
BOGGY CREEK	GBO_000013	5700	143.29	152.41	153.47	154.09
BOGGY CREEK	GBO_000000	7000	143.29	152.41	153.47	154.09
COMET RIVER	GCO_000168	0	141.12	154.38	155.29	155.78
COMET RIVER	GCO_000161	700	141.12	154.07	155.06	155.54
COMET RIVER	GCO_000161	700	141.12	154.07	155.06	155.54
COMET RIVER	GCO_000157	1100	141.24	154.00	155.00	155.49
COMET RIVER	GCO_000150	1800	141.31	153.90	154.91	155.39
COMET RIVER	GCO_000143	2500	141.14	153.70	154.73	155.19
COMET RIVER	GCO_000135	3400	141.14	153.40	154.43	154.89
COMET RIVER	GCO_000128	4000	140.72	153.26	154.31	154.75
COMET RIVER	GCO_000117	5100	140.10	152.93	153.91	154.33
COMET RIVER	GCO_000112	5600	137.39	152.83	153.64	154.08
COMET RIVER	GCO_000112	5600	137.39	152.83	153.64	154.08

Water Level

Name of Watercourse	X-SECT Name	MIKE 11 Chainage	Bed EL	1 in 20 year ARI MIKE11 CASE 086	1 in 50 year ARI MIKE11 CASE 086	1 in 100 year ARI MIKE11 CASE 086
COMET RIVER	GCO_000104	6500	136.49	152.67	153.49	153.94
COMET RIVER	GCO_000099	6900	136.19	152.56	153.37	153.83
COMET RIVER	GCO_000094	7400	135.49	152.45	153.25	153.71
COMET RIVER	GCO_000089	7900	136.62	152.37	153.15	153.63
COMET RIVER	GCO_000084	8400	135.90	152.28	153.06	153.55
COMET RIVER	GCO_000074	9400	135.76	151.79	152.66	153.21
COMET RIVER	GCO_000070	9800	135.25	151.60	152.50	153.07
COMET RIVER	GCO_000065	10200	135.52	151.53	152.45	153.03
COMET RIVER	GCO_000065	10200	135.52	151.53	152.45	153.03
COMET RIVER	GCO_000058	11200	135.52	151.42	152.39	152.99
COMET RIVER	GCO_000058	11200	135.52	151.42	152.39	152.99
COMET RIVER	GCO_000051	11700	135.65	151.31	152.30	152.92
COMET RIVER	GCO_000046	12200	135.45	151.21	152.22	152.87
COMET RIVER	GCO_000041	12700	134.60	151.11	152.19	152.85
COMET RIVER	GCO_000033	13500	134.49	150.99	152.15	152.82
COMET RIVER	GCO_000028	13900	134.65	150.94	152.13	152.80
COMET RIVER	GCO_000020	14800	134.40	150.80	152.06	152.76
COMET RIVER	GCO_000013	15500	134.40	150.69	152.00	152.70
COMET RIVER	GCO_000006	16100	134.56	150.61	151.96	152.67
SANDHURST CREEK	GSA_000160	0	151.64	154.95	155.19	155.36
SANDHURST CREEK	GSA_000155	500	151.18	154.50	154.72	154.88
SANDHURST CREEK	GSA_000150	1000	150.74	153.86	154.11	154.29
SANDHURST CREEK	GSA_000146	1400	150.72	153.67	153.89	154.07
SANDHURST CREEK	GSA_000141	1900	149.40	153.23	153.42	153.67
SANDHURST CREEK	GSA_000136	2400	148.79	152.54	152.87	153.39
SANDHURST CREEK	GSA_000128	3200	148.96	151.91	152.58	153.28
SANDHURST CREEK	GSA_000121	3900	147.98	151.81	152.54	153.26
SANDHURST CREEK	GSA_000117	4300	147.04	151.80	152.54	153.25
SANDHURST CREEK	GSA_000111	4900	146.52	151.80	152.53	153.24
SANDHURST CREEK	GSA_000104	5600	146.53	151.70	152.43	153.16
SANDHURST CREEK	GSA_000096	6400	145.52	150.67	152.03	152.74
SANDHURST CREEK	GSA_000089	7100	145.29	150.67	152.03	152.74
SANDHURST CREEK	GSA_000084	7600	144.51	150.67	152.03	152.74
SANDHURST CREEK	GSA_000076	8400	143.41	150.67	152.03	152.74
SANDHURST CREEK	GSA_000065	9500	143.13	150.67	152.03	152.74
SANDHURST CREEK	GSA_000065	9500	143.13	150.67	152.03	152.74
SANDHURST CREEK	GSA_000052	10700	142.46	150.66	152.01	152.73
SANDHURST CREEK	GSA_000041	11700	141.07	150.65	152.01	152.72
SANDHURST CREEK	GSA_000035	12300	140.95	150.64	152.00	152.71
SANDHURST CREEK	GSA_000027	13100	140.65	150.63	151.99	152.70
SANDHURST CREEK	GSA_000015	14600	139.34	150.62	151.98	152.69
SANDHURST CREEK	GSA_000010	15100	138.19	150.62	151.97	152.69
SANDHURST CREEK	GSA_000000	16100	138.19	150.61	151.96	152.67
BCO_L01-02-04	GCOL01_026	0	150.37	154.07	155.06	155.54
BCO_L01-02-04	GCOL01_020	600	149.72	153.66	154.60	155.04
BCO_L01-02-04	GCOL01_014	1200	149.40	153.27	154.14	154.58
BCO_L01-02-04	GCOL01_010	1600	149.30	153.12	153.94	154.37
BCO_L01-02-04	GCOL01_002	2600	148.54	152.95	153.70	154.11
BCO_L01-02-04	GCOL01_002	2600	148.54	152.95	153.70	154.11
BCO_L01-02-04	GCOL02_069	3400	151.49	152.92	153.60	153.97
BCO_L01-02-04	GCOL02_062	4100	151.38	152.59	153.22	153.52
BCO_L01-02-04	GCOL02_057	4600	150.87	152.04	152.68	153.14
BCO_L01-02-04	XCOL02_050	5300	n/a	151.53	152.40	152.99
BCO_L01-02-04	GCOL02_045	5800	150.05	151.41	152.37	152.97
BCO_L01-02-04	GCOL02_040	6300	149.17	151.40	152.36	152.97
BCO_L01-02-04	GCOL02_030	7300	148.42	151.40	152.36	152.96
BCO_L01-02-04	GCOL02_020	8300	147.83	151.40	152.35	152.96
BCO_L01-02-04	GCOL02_016	8700	146.43	151.40	152.35	152.96
BCO_L01-02-04	GCOL02_008	9500	146.34	151.40	152.35	152.96
BCO_L01-02-04	GCOL02_002	10100	145.47	151.39	152.35	152.96
BCO_L01-02-04	GCOL02_002	10100	145.47	151.39	152.35	152.96
BCO_L01-02-04	GCOL04_018	10600	145.95	151.38	152.34	152.95
BCO_L01-02-04	GCOL04_009	11500	145.96	151.28	152.28	152.90
BCO_L01-02-04	GCOL04_000	12400	145.96	150.67	152.03	152.74
CRINUM CK	GCR_000155	0	160.89	165.05	165.46	165.74
CRINUM CK	GCR_000150	500	160.72	164.83	165.26	165.55
CRINUM CK	GCR_000145	1000	159.12	164.69	165.08	165.35
CRINUM CK	GCR_000140	1500	159.32	164.36	164.70	164.94
CRINUM CK	GCR_000135	2000	158.23	163.57	164.03	164.37
CRINUM CK	GCR_000130	2500	158.11	163.18	163.71	164.11
CRINUM CK	GCR_000120	3500	157.10	162.85	163.40	163.81
CRINUM CK	GCR_000115	4000	156.73	162.57	163.09	163.47
CRINUM CK	GCR_000110	4500	157.45	162.40	162.89	163.19
CRINUM CK	GCR_000103	5200	155.38	162.23	162.71	162.99
CRINUM CK	GCR_000095	6000	153.69	162.13	162.58	162.84
CRINUM CK	GCR_000088	6700	154.88	162.04	162.48	162.74
CRINUM CK	GCR_000078	7700	154.98	161.78	162.18	162.45
CRINUM CK	GCR_000070	8500	154.83	161.51	161.96	162.26
CRINUM CK	GCR_000060	9500	154.40	161.37	161.88	162.19
CRINUM CK	GCR_000053	10200	154.40	161.33	161.85	162.16
CRINUM CK	GCR_000053	10200	154.40	161.33	161.85	162.16
CRINUM CK	GCR_000045	10900	153.91	161.32	161.84	162.14
CRINUM CK	GCR_000040	11400	153.13	161.32	161.83	162.14
CRINUM CK	GCR_000034	12000	153.13	161.31	161.83	162.13
CRINUM CK	GCR_000034	12000	153.13	161.31	161.83	162.13
CRINUM CK	GCR_000030	12300	153.00	161.31	161.83	162.13
CRINUM CK	GCR_000020	13300	151.68	161.31	161.82	162.12
CRINUM CK	GCR_000015	13800	151.68	161.30	161.81	162.11
CRINUM CK	GCR_000015	13800	151.68	161.30	161.81	162.11
CRINUM CK	GCR_000008	14400	150.39	161.02	161.56	161.86
CRINUM CK	GCR_000006	14500	149.84	160.97	161.51	161.80
CRINUM CK	GCR_000006	14500	149.84	160.97	161.51	161.80
CRINUM CK	GCR_000000	15100	149.84	160.84	161.36	161.64
MOSQUITO CK	GMO_000052	0	166.31	166.31	166.31	166.31
MOSQUITO CK	GMO_000048	400	165.17	165.17	165.17	165.17
MOSQUITO CK	GMO_000042	1000	163.79	163.79	163.79	163.79

Water Level

Name of Watercourse	X-SECT Name	MIKE 11 Chainage	Bed EL	1 in 20 year ARI MIKE11 CASE 086	1 in 50 year ARI MIKE11 CASE 086	1 in 100 year ARI MIKE11 CASE 086
MOSQUITO CK	GMO_000033	1900	162.98	162.97	162.97	162.97
MOSQUITO CK	GMO_000028	2400	162.25	162.25	162.25	162.25
MOSQUITO CK	GMO_000020	3200	160.97	161.33	161.85	162.16
MOSQUITO CK	GMO_000010	4200	158.36	161.33	161.85	162.16
MOSQUITO CK	GMO_000000	5200	156.36	161.33	161.85	162.16
GORDONSTONE CK	GGO_000092	0	161.52	163.91	164.24	164.47
GORDONSTONE CK	GGO_000080	1200	160.63	162.89	163.22	163.45
GORDONSTONE CK	GGO_000074	1800	160.00	162.52	162.84	162.95
GORDONSTONE CK	GGO_000062	3000	159.57	161.52	161.94	162.18
GORDONSTONE CK	GGO_000055	3700	157.92	161.32	161.83	162.14
GORDONSTONE CK	GGO_000045	4700	157.33	161.32	161.83	162.13
GORDONSTONE CK	GGO_000033	5900	157.07	161.32	161.83	162.13
GORDONSTONE CK	GGO_000023	6900	156.31	161.32	161.83	162.13
GORDONSTONE CK	GGO_000016	7600	155.94	161.32	161.83	162.13
GORDONSTONE CK	GGO_000012	8000	155.75	161.32	161.83	162.13
GORDONSTONE CK	GGO_000008	8400	155.14	161.31	161.83	162.13
GORDONSTONE CK	GGO_000000	9200	153.14	161.31	161.83	162.13
UNNAMED CK	GUN_000056	0	162.55	162.55	162.55	162.55
UNNAMED CK	GUN_000050	600	161.77	161.77	161.77	161.77
UNNAMED CK	GUN_000042	1400	159.15	159.14	159.29	159.53
UNNAMED CK	GUN_000034	2200	157.87	159.04	159.29	159.53
UNNAMED CK	GUN_000020	3600	155.73	159.04	159.29	159.53
UNNAMED CK	GUN_000020	3600	155.73	159.04	159.29	159.53
UNNAMED CK	GUN_000000	5600	155.73	160.97	161.51	161.80
BCO_L03	GCOL03_008	0	148.43	152.83	153.64	154.08
BCO_L03	GCOL03_000	800	148.43	152.95	153.70	154.11
BCO_L05	GCOL05_010	0	143.91	151.53	152.45	153.03
BCO_L05	GCOL05_000	1000	143.91	151.39	152.35	152.96
BNO_L02	GNOL02_050	0	155.46	159.04	159.29	159.53
BNO_L02	GNOL02_046	400	155.46	158.79	159.04	159.26
BNO_L02	GNOL02_038	1200	154.08	158.13	158.50	158.72
BNO_L02	GNOL02_030	2000	153.86	157.63	158.12	158.33
BNO_L02	GNOL02_022	2800	152.81	157.24	157.71	158.01
BNO_L02	GNOL02_016	3400	152.21	157.02	157.51	157.89
BNO_L02	GNOL02_010	4000	149.77	156.94	157.47	157.86
BNO_L02	GNOL02_000	5000	149.77	156.90	157.44	157.83
WINTON CK	GWI_000332	0	166.5	167.06	167.05	167.06
WINTON CK	GWI_000326	600	165.61	165.95	165.95	165.95
WINTON CK	GWI_000319	1300	164.29	165.29	165.22	165.29
WINTON CK	GWI_000313	1900	163.83	165.27	165.18	165.26
WINTON CK	GWI_000305	2700	163.32	165.26	165.16	165.25
WINTON CK	GWI_000301	3100	163.12	164.81	164.73	164.81
WINTON CK	GWI_000296	3600	162.36	164.38	164.31	164.38
WINTON CK	GWI_000288	4400	161.89	163.53	163.44	163.53
WINTON CK	GWI_000280	5200	160.64	162.56	162.47	162.55
WINTON CK	GWI_000276	5600	159.61	162.27	162.18	162.26
WINTON CK	GWI_000269	6300	159.53	161.68	161.58	161.67
WINTON CK	GWI_000263	6900	159.52	161.37	161.29	161.36
WINTON CK	GWI_000259	7300	159.37	161.21	161.12	161.20
WINTON CK	GWI_000253	7900	159.44	160.99	160.89	160.98
WINTON CK	GWI_000247	8400	159.10	160.89	160.79	160.88
WINTON CK	GWI_000247	8400	159.10	160.89	160.79	160.88
WINTON CK	GWI_000239	9200	158.14	160.73	160.64	160.72
WINTON CK	GWI_000232	9900	157.73	160.22	160.17	160.22
WINTON CK	GWI_000224	10700	157.49	159.12	159.06	159.11
WINTON CK	GWI_000220	11100	156.55	158.50	158.41	158.49
WINTON CK	GWI_000220	11100	156.55	158.50	158.41	158.49
WINTON CK	GWI_000214	11600	156.55	158.44	158.35	158.43
WINTON CK	GWI_000205	12500	156.27	158.13	158.05	158.12
WINTON CK	GWI_000200	13000	155.76	157.52	157.41	157.51
WINTON CK	GWI_000193	13700	155.41	156.73	156.80	157.09
WINTON CK	GWI_000185	14500	155.25	156.28	156.79	157.08
WINTON CK	GWI_000180	15000	155.25	156.27	156.78	157.08
WINTON CK	GWI_000175	15500	153.78	156.25	156.78	157.08
WINTON CK	GWI_000175	15500	153.78	156.25	156.78	157.08
WINTON CK	GWI_000170	15900	153.78	156.09	156.59	156.89
WINTON CK	GWI_000166	16300	152.91	155.93	156.40	156.72
WINTON CK	GWI_000160	16900	153.01	155.71	156.17	156.53
WINTON CK	GWI_000152	17700	153.04	155.10	155.66	156.12
WINTON CK	GWI_000147	18200	152.39	154.42	155.34	155.89
WINTON CK	GWI_000138	19100	150.97	154.18	155.22	155.81
WINTON CK	GWI_000128	20100	149.88	154.13	155.19	155.78
WINTON CK	GWI_000110	21900	147.01	154.09	155.16	155.76
WINTON CK	GWI_000110	21900	147.01	154.09	155.16	155.76
WINTON CK	GWI_000100	22800	149.46	154.09	155.16	155.76
WINTON CK	GWI_000093	23500	147.74	154.09	155.16	155.76
WINTON CK	GWI_000086	24200	148.91	154.09	155.16	155.76
WINTON CK	GWI_000080	24800	147.11	154.09	155.16	155.76
WINTON CK	GWI_000072	25600	144.97	n/a	n/a	n/a
WINTON CK	GWI_000064	26400	144.58	n/a	n/a	n/a
WINTON CK	GWI_000055	27300	146.09	n/a	n/a	n/a
WINTON CK	GWI_000050	27800	145.53	n/a	n/a	n/a
WINTON CK	GWI_000042	28600	145.53	n/a	n/a	n/a
WINTON CK	GWI_000035	29300	144.86	n/a	n/a	n/a
WINTON CK	GWI_000031	29700	145.01	n/a	n/a	n/a
WINTON CK	GWI_000025	30300	145.08	150.81	152.14	152.82
WINTON CK	GWI_000022	30600	144.08	150.81	152.14	152.82
WINTON CK	GWI_000020	30800	143.13	150.81	152.14	152.82
WINTON CK	GWI_000010	31800	142.24	150.81	152.14	152.82
WINTON CK	GWI_000005	32200	140.45	150.81	152.14	152.82
WINTON CK	GWI_000000	32700	138.45	150.81	152.14	152.82
RETREAT CK	GRE_000215	0	172.21	177.44	177.74	177.96
RETREAT CK	GRE_000210	500	172.24	177.10	177.37	177.58
RETREAT CK	GRE_000206	900	172.34	176.70	176.96	177.15
RETREAT CK	GRE_000196	1900	171.85	175.63	175.92	176.17
RETREAT CK	GRE_000190	2500	170.83	175.26	175.61	175.89

Water Level

Name of Watercourse	X-SECT Name	MIKE 11 Chainage	Bed EL	1 in 20 year ARI MIKE11 CASE 086	1 in 50 year ARI MIKE11 CASE 086	1 in 100 year ARI MIKE11 CASE 086
RETREAT CK	GRE_000185	3000	170.83	175.20	175.56	175.83
RETREAT CK	GRE_000185	3000	170.83	175.20	175.56	175.83
RETREAT CK	GRE_000174	3600	169.63	174.95	175.34	175.63
RETREAT CK	GRE_000170	4000	169.13	174.79	175.22	175.53
RETREAT CK	GRE_000165	4500	168.47	174.68	175.13	175.43
RETREAT CK	GRE_000160	5000	168.73	174.58	175.02	175.32
RETREAT CK	GRE_000149	6000	165.78	173.99	174.37	174.61
RETREAT CK	GRE_000149	6000	165.78	173.99	174.37	174.61
RETREAT CK	GRE_000145	6500	164.87	174.10	174.39	174.61
RETREAT CK	GRE_000145	6500	164.87	174.10	174.39	174.61
RETREAT CK	GRE_000141	6900	164.96	173.20	173.56	173.77
RETREAT CK	GRE_000135	7500	164.31	172.86	173.14	173.37
RETREAT CK	GRE_000122	8800	163.40	172.43	172.69	172.90
RETREAT CK	GRE_000117	9300	163.01	172.22	172.45	172.61
RETREAT CK	GRE_000112	9700	163.01	172.17	172.39	172.54
RETREAT CK	GRE_000112	9700	163.01	172.17	172.39	172.54
RETREAT CK	GRE_000109	10200	163.10	171.82	172.04	172.19
RETREAT CK	GRE_000109	10200	163.10	171.82	172.04	172.19
RETREAT CK	GRE_000105	10600	161.64	171.58	171.80	171.97
RETREAT CK	GRE_000095	11600	161.45	171.01	171.24	171.42
RETREAT CK	GRE_000089	12200	161.06	170.77	170.99	171.17
RETREAT CK	GRE_000084	12800	161.06	170.41	170.62	170.79
RETREAT CK	GRE_000084	12800	161.06	170.41	170.62	170.79
RETREAT CK	GRE_000076	13400	160.50	170.02	170.24	170.42
RETREAT CK	GRE_000076	13400	160.50	170.02	170.24	170.42
RETREAT CK	GRE_000068	14100	159.62	169.28	169.55	169.77
RETREAT CK	GRE_000058	15100	158.71	168.77	169.08	169.35
RETREAT CK	GRE_000050	15900	158.71	168.38	168.77	169.10
RETREAT CK	GRE_000043	16600	157.72	168.11	168.58	168.95
RETREAT CK	GRE_000038	17100	156.54	168.05	168.53	168.90
RETREAT CK	GRE_000032	17700	156.54	167.97	168.46	168.84
RETREAT CK	GRE_000025	18400	156.07	167.88	168.38	168.76
RETREAT CK	GRE_000020	18900	155.88	167.84	168.34	168.72
RETREAT CK	GRE_000013	19600	155.88	167.80	168.29	168.67
RETREAT CK	GRE_000013	19600	155.46	167.80	168.29	168.67
RETREAT CK	GRE_000001	20600	155.46	167.22	167.76	168.15
THERESA CK	GTH_000130	0	172.04	180.27	180.50	180.67
THERESA CK	GTH_000112	1000	172.04	179.89	180.09	180.25
THERESA CK	GTH_000112	1000	172.04	179.89	180.09	180.25
THERESA CK	GTH_000105	1700	171.18	179.80	180.01	180.16
THERESA CK	GTH_000095	2700	170.82	179.53	179.73	179.87
THERESA CK	GTH_000080	4200	170.42	178.80	178.97	179.11
THERESA CK	GTH_000073	4900	169.80	178.30	178.49	178.64
THERESA CK	GTH_000063	5900	168.71	177.79	178.01	178.17
THERESA CK	GTH_000063	5900	168.71	177.79	178.01	178.17
THERESA CK	GTH_000052	6400	167.42	177.50	177.73	177.90
THERESA CK	GTH_000042	7400	166.83	177.11	177.34	177.52
THERESA CK	GTH_000035	8100	166.56	176.80	177.03	177.20
THERESA CK	GTH_000030	8600	166.04	176.35	176.55	176.69
THERESA CK	GTH_000023	9200	166.28	175.45	175.57	175.66
THERESA CK	GTH_000023	9200	166.28	175.45	175.57	175.66
THERESA CK	GTH_000014	9800	166.01	175.04	175.19	175.30
THERESA CK	GTH_000005	10700	166.18	174.10	174.39	174.61
BTH_L01	GTHL01_048	0	172.09	175.45	175.57	175.66
BTH_L01	GTHL01_045	300	172.03	174.96	175.07	175.14
BTH_L01	GTHL01_040	800	171.09	174.00	174.14	174.26
BTH_L01	GTHL01_036	1200	170.36	173.71	173.88	174.01
BTH_L01	GTHL01_028	2000	170.11	173.25	173.44	173.58
BTH_L01	GTHL01_017	2900	169.37	172.91	173.10	173.24
BTH_L01	GTHL01_012	3400	169.35	172.75	172.94	173.07
BTH_L01	GTHL01_005	4100	169.15	172.17	172.39	172.54
BTH_R01-R03	GTHR01_023	0	174.31	179.89	180.09	180.25
BTH_R01-R03	GTHR01_020	500	174.31	179.61	179.78	179.91
BTH_R01-R03	GTHR01_010	1500	174.31	179.15	179.25	179.35
BTH_R01-R03	GTHR01_000	2500	173.30	177.82	178.04	178.21
BTH_R01-R03	GTHR01_000	2500	173.30	177.82	178.04	178.21
BTH_R01-R03	GTHR03_042	3800	173.30	177.27	177.52	177.71
BTH_R01-R03	GTHR03_034	4600	175.05	176.82	177.15	177.38
BTH_R01-R03	GTHR03_028	5200	174.36	176.69	177.03	177.26
BTH_R01-R03	GTHR03_020	6000	174.08	176.57	176.89	177.10
BTH_R01-R03	GTHR03_010	7000	174.08	176.15	176.44	176.61
BTH_R01-R03	GTHR03_000	8000	172.26	175.20	175.56	175.83
BNO_L07-08-09	GNOL07_010	0	171.35	173.06	174.10	174.59
BNO_L07-08-09	GNOL08_023	1000	171.35	172.64	173.70	174.15
BNO_L07-08-09	GNOL08_023	1000	171.35	172.64	173.70	174.15
BNO_L07-08-09	GNOL08_014	1900	171.00	172.36	173.35	173.84
BNO_L07-08-09	GNOL08_005	2800	170.42	172.18	173.12	173.53
BNO_L07-08-09	GNOL09_045	3300	170.42	172.09	173.01	173.35
BNO_L07-08-09	GNOL09_045	3300	170.42	172.09	173.01	173.35
BNO_L07-08-09	GNOL09_040	3800	170.58	172.00	172.95	173.29
BNO_L07-08-09	GNOL09_031	4700	169.99	171.89	172.85	173.21
BNO_L07-08-09	GNOL09_025	5300	168.99	171.87	172.82	173.18
BNO_L07-08-09	GNOL09_015	6300	169.06	171.84	172.78	173.15
BNO_L07-08-09	GNOL09_010	7000	169.34	171.79	172.74	173.12
BNO_L07-08-09	GNOL09_005	7800	167.24	171.76	172.71	173.10
BRE_R02-4-6-7-13-14	GRER02_010	0	168.53	173.99	174.37	174.61
BRE_R02-4-6-7-13-14	GRER04_018	1000	168.55	173.26	173.61	173.83
BRE_R02-4-6-7-13-14	GRER04_018	1000	168.55	173.26	173.61	173.83
BRE_R02-4-6-7-13-14	GRER04_012	1600	169.50	173.00	173.31	173.49
BRE_R02-4-6-7-13-14	GRER04_007	2100	169.38	172.23	172.45	172.58
BRE_R02-4-6-7-13-14	GRER04_007	2100	169.38	172.23	172.45	172.58
BRE_R02-4-6-7-13-14	GRER07_018	2600	169.36	171.15	171.31	171.45
BRE_R02-4-6-7-13-14	GRER07_018	2600	169.36	171.15	171.31	171.45
BRE_R02-4-6-7-13-14	GRER07_008	3600	168.09	170.52	170.77	170.96
BRE_R02-4-6-7-13-14	GRER07_000	4400	167.35	170.39	170.60	170.76
BRE_R02-4-6-7-13-14	GRER07_000	4400	167.35	170.39	170.60	170.76

Water Level

Name of Watercourse	X-SECT Name	MIKE 11 Chainage	Bed EL	1 in 20 year ARI MIKE11 CASE 086	1 in 50 year ARI MIKE11 CASE 086	1 in 100 year ARI MIKE11 CASE 086
BRE_R02-4-6-7-13-14	GRER13_029	5500	168.55	169.76	169.97	170.14
BRE_R02-4-6-7-13-14	GRER13_020	6400	167.91	169.39	169.60	169.76
BRE_R02-4-6-7-13-14	GRER13_010	7400	165.97	168.57	168.82	169.06
BRE_R02-4-6-7-13-14	GRER14_032	7900	164.52	168.04	168.49	168.85
BRE_R02-4-6-7-13-14	GRER14_032	7900	164.52	168.04	168.49	168.85
BRE_R02-4-6-7-13-14	GRER14_020	9100	163.09	167.88	168.37	168.74
BRE_R02-4-6-7-13-14	GRER14_010	10100	161.98	167.82	168.31	168.69
BRE_R02-4-6-7-13-14	GRER14_005	10600	160.11	167.80	168.29	168.67
BRE_R09-10-12	GRER09_010	0	169.36	171.15	171.31	171.45
BRE_R09-10-12	GRER09_007	250	170.46	171.12	171.26	171.39
BRE_R09-10-12	GRER10_019	500	169.64	170.77	170.97	171.11
BRE_R09-10-12	GRER10_019	500	169.64	170.77	170.97	171.11
BRE_R09-10-12	GRER10_010	1400	168.52	170.20	170.37	170.46
BRE_R09-10-12	GRER12_020	1900	167.40	169.07	169.28	169.42
BRE_R09-10-12	GRER12_020	1900	167.40	169.07	169.28	169.42
BRE_R09-10-12	GRER12_010	2900	165.96	168.12	168.54	168.89
BRE_R09-10-12	GRER12_002	3700	164.52	168.04	168.49	168.85
BNO_L10	GNOL10_010	0	170.71	170.77	170.97	171.11
BNO_L10	GNOL10_005	1000	172.54	172.09	173.01	173.35
BNO_L06-4	GNOL06_010	0	171.35	172.64	173.70	174.15
BNO_L06-4	GNOL04_043	1000	172.69	172.69	173.24	173.38
BNO_L06-4	GNOL04_038	1500	172.24	172.19	172.84	172.98
BNO_L06-4	GNOL04_029	2400	171.62	171.62	172.11	172.22
BNO_L06-4	GNOL04_021	3200	170.81	171.15	171.48	171.62
BNO_L06-4	GNOL04_014	3900	170.60	171.15	171.31	171.45
BNO_L06-4	GNOL04_007	4600	169.36	171.15	171.31	171.45
BRE_R08	GRER08_010	0	167.35	170.39	170.60	170.76
BRE_R08	GRER08_000	1000	161.06	170.41	170.62	170.79
BRE_R05	GRER05_012	0	169.38	172.23	172.45	172.58
BRE_R05	GRER05_004	800	168.36	172.17	172.39	172.54
BRE_R03	GRER03_026	0	168.55	173.26	173.61	173.83
BRE_R03	GRER03_021	500	167.69	173.16	173.52	173.74
BRE_R03	GRER03_012	1400	167.41	172.89	173.26	173.47
BRE_R03	GRER03_001	2600	166.55	172.17	172.39	172.54
BRE_L01	GREL01_030	0	164.67	171.82	172.04	172.19
BRE_L01	GREL01_019	1100	165.73	171.17	171.38	171.52
BRE_L01	GREL01_014	1600	165.50	170.67	170.91	171.06
BRE_L01	GREL01_005	2500	162.74	170.11	170.35	170.53
BRE_L01	GREL01_000	3000	162.74	170.02	170.24	170.42
BRE_L02-04	GREL02_050	0	162.74	170.02	170.24	170.42
BRE_L02-04	GREL02_042	800	162.65	169.75	169.99	170.18
BRE_L02-04	GREL02_030	2000	162.12	169.37	169.65	169.87
BRE_L02-04	GREL02_020	3000	161.44	169.09	169.39	169.63
BRE_L02-04	GREL02_010	4000	160.60	168.89	169.20	169.45
BRE_L02-04	GREL04_048	4700	160.50	168.51	168.84	169.11
BRE_L02-04	GREL04_048	4700	160.50	168.51	168.84	169.11
BRE_L02-04	GREL04_040	5500	164.51	167.80	168.00	168.17
BRE_L02-04	GREL04_035	6000	164.39	166.93	167.12	167.30
BRE_L02-04	GREL04_030	6500	163.89	166.42	166.67	166.92
BRE_L02-04	GREL04_025	7000	163.89	166.14	166.45	166.77
BRE_L02-04	GREL04_020	7500	163.38	165.73	166.22	166.62
BRE_L02-04	GREL04_010	8500	161.36	165.44	166.06	166.51
BRE_L02-04	GREL04_000	9500	161.36	165.34	165.99	166.45
BRE_L03	GREL03_016	0	160.50	168.51	168.84	169.11
BRE_L03	GREL03_008	800	160.53	168.27	168.64	168.94
BRE_L03	GREL03_000	1600	160.53	167.80	168.29	168.67
BTH_R02	GTHR02_020	0	173.3	177.82	178.04	178.21
BTH_R02	GTHR02_010	1000	171.07	177.79	178.01	178.18
BTH_R02	GTHR02_000	2000	168.5	177.79	178.01	178.17
BMK_L05	GMKL05_070	0	140.08	145.26	147.22	148.52
BMK_L05	GMKL05_060	1000	140.08	143.35	145.76	147.33
BMK_L05	GMKL05_050	2000	140.08	143.17	145.45	147.00
BMK_L05	GMKL05_040	3000	140.24	143.17	145.36	146.86
BMK_L05	GMKL05_025	4500	132.40	143.17	145.34	146.82
BMK_L05	GMKL05_015	5500	129.87	143.17	145.34	146.82
BMK_L05	GMKL05_000	7000	129.87	143.17	145.34	146.82
BMK_R01-02	GMKR01_038	0	144.75	150.27	151.46	152.16
BMK_R01-02	GMKR01_029	900	141.17	148.90	150.02	150.76
BMK_R01-02	GMKR01_020	1800	144.13	148.45	149.79	150.61
BMK_R01-02	GMKR01_010	2800	143.28	148.13	149.62	150.50
BMK_R01-02	GMKR02_031	3500	136.00	147.79	149.44	150.39
BMK_R01-02	GMKR02_031	3500	136.00	147.79	149.44	150.39
BMK_R01-02	GMKR02_027	4000	145.18	147.56	149.23	150.24
BMK_R01-02	GMKR02_020	5100	143.07	147.33	149.01	150.11
BMK_R01-02	GMKR02_010	6100	133.07	147.32	149.00	150.10
BMK_R01-02	GMKR02_000	7100	123.07	147.32	149.00	150.10
BMK_R03	GMKR03_080	0	136.00	147.79	149.44	150.39
BMK_R03	GMKR03_000	800	136.00	147.79	149.44	150.39
BMK_L02	GMKL02_030	0	147.62	150.27	151.46	152.16
BMK_L02	GMKL02_022	800	147.28	149.53	150.62	151.39
BMK_L02	GMKL02_014	1600	145.65	148.93	150.27	151.07
BMK_L02	GMKL02_009	2100	142.20	148.86	150.21	151.01
BMK_L02	GMKL02_000	3000	142.20	148.85	150.19	150.96
BMK_L01-04	GMKL01_092	0	143.66	148.85	150.19	150.96
BMK_L01-04	GMKL01_082	1000	147.00	148.75	149.87	150.61
BMK_L01-04	GMKL01_073	1900	146.26	148.36	149.51	150.29
BMK_L01-04	GMKL01_063	2900	145.94	147.74	149.05	149.99
BMK_L01-04	GMKL01_055	3700	144.87	147.38	148.79	149.82
BMK_L01-04	GMKL01_049	4300	145.40	147.09	148.64	149.72
BMK_L01-04	GMKL01_040	5200	144.81	146.78	148.51	149.65
BMK_L01-04	GMKL04_050	6200	142.55	146.49	148.29	149.46
BMK_L01-04	GMKL04_050	6200	142.55	146.49	148.29	149.46
BMK_L01-04	GMKL04_043	6800	142.63	145.92	147.75	149.03
BMK_L01-04	GMKL04_037	7500	142.63	145.70	147.63	148.95
BMK_L01-04	GMKL04_028	8400	139.80	145.52	147.51	148.84
BMK_L01-04	GMKL04_020	9200	139.80	145.46	147.44	148.76

Water Level

Name of Watercourse	X-SECT Name	MIKE 11 Chainage	Bed EL	1 in 20 year ARI MIKE11 CASE 086	1 in 50 year ARI MIKE11 CASE 086	1 in 100 year ARI MIKE11 CASE 086
BMK_L01-04	GMKL04_010	10200	139.80	145.38	147.34	148.64
BMK_L01-04	GMKL04_004	10800	140.08	145.26	147.22	148.52
BMK_L03	GMKL03_008	0	135.05	146.49	148.29	149.46
BMK_L03	GMKL03_004	400	130.05	146.49	148.29	149.46
BMK_L03	GMKL03_000	800	125.05	146.50	148.29	149.46
BNO_L13	GNOL13_050	0	144.31	151.69	152.81	153.44
BNO_L13	GNOL13_043	700	144.31	151.48	152.60	153.23
BNO_L13	GNOL13_038	1200	142.42	151.29	152.42	153.05
BNO_L13	GNOL13_033	1700	143.91	151.00	152.24	152.91
BNO_L13	GNOL13_030	2000	141.90	150.90	152.17	152.86
BNO_L13	GNOL13_023	2700	141.84	150.76	152.07	152.77
BNO_L13	GNOL13_020	3000	141.10	150.72	152.04	152.74
BNO_L13	GNOL13_016	3400	142.41	150.67	152.01	152.71
BNO_L13	GNOL13_010	4000	141.46	150.64	151.99	152.70
BNO_L13	GNOL13_000	5000	141.46	150.61	151.96	152.67
BNO_R22-23-24-25	GNOR22_090	0	142.64	156.15	156.60	156.92
BNO_R22-23-24-25	GNOR22_078	1200	142.64	155.80	156.24	156.55
BNO_R22-23-24-25	GNOR22_074	1600	143.42	155.64	156.08	156.40
BNO_R22-23-24-25	GNOR22_068	2200	141.94	155.38	155.87	156.22
BNO_R22-23-24-25	GNOR23_058	3000	141.46	155.11	155.67	156.04
BNO_R22-23-24-25	GNOR23_058	3000	141.46	155.11	155.67	156.04
BNO_R22-23-24-25	GNOR23_051	3700	142.45	154.87	155.47	155.87
BNO_R22-23-24-25	GNOR23_046	4200	140.83	154.58	155.27	155.73
BNO_R22-23-24-25	GNOR24_040	4700	140.55	154.34	155.10	155.61
BNO_R22-23-24-25	GNOR24_040	4700	140.55	154.34	155.10	155.61
BNO_R22-23-24-25	GNOR24_035	5200	139.91	154.21	155.03	155.57
BNO_R22-23-24-25	GNOR24_029	5800	139.48	154.06	154.95	155.51
BNO_R22-23-24-25	GNOR25_022	6400	140.68	153.99	154.92	155.48
BNO_R22-23-24-25	GNOR25_022	6400	140.68	153.99	154.92	155.48
BNO_R22-23-24-25	GNOR25_012	7400	139.61	153.66	154.63	155.22
BNO_R22-23-24-25	GNOR25_005	8100	138.37	153.46	154.41	154.98
BNO_R22-23-24-25	GNOR25_000	8600	138.37	153.37	154.30	154.85
BNO_R21	GNOR21_000	0	150.55	155.11	155.67	156.04
BNO_R21	GNOR21_008	800	152.55	155.09	155.64	156.01
BNO_R21	GNOR21_012	1200	151.44	154.85	155.50	155.92
BNO_R21	GNOR21_020	2000	147.01	154.09	155.16	155.76
BNO_R27	GNOR27_018	0	147.01	154.09	155.16	155.76
BNO_R27	GNOR27_010	800	146.07	154.02	154.98	155.57
BNO_R27	GNOR27_006	1200	144.54	154.00	154.95	155.52
BNO_R27	GNOR27_000	1800	144.54	153.99	154.92	155.48
BNO_R12-13-18-19	GNOR12_081	0	161.96	163.85	164.39	164.77
BNO_R12-13-18-19	GNOR12_074	700	161.66	162.59	162.88	163.10
BNO_R12-13-18-19	GNOR12_065	1600	159.73	160.54	160.90	161.16
BNO_R12-13-18-19	GNOR12_061	2000	158.75	159.99	160.48	160.81
BNO_R12-13-18-19	GNOR12_053	2800	158.15	159.78	160.29	160.64
BNO_R12-13-18-19	GNOR12_044	3700	157.78	159.74	160.24	160.57
BNO_R12-13-18-19	GNOR12_035	4600	157.73	159.73	160.22	160.54
BNO_R12-13-18-19	GNOR13_030	5000	157.73	159.73	160.22	160.54
BNO_R12-13-18-19	GNOR13_030	5000	157.73	159.73	160.22	160.54
BNO_R12-13-18-19	GNOR13_021	5900	157.42	159.06	159.71	160.10
BNO_R12-13-18-19	GNOR13_016	6400	156.75	158.83	159.45	159.81
BNO_R12-13-18-19	GNOR13_010	7000	154.96	158.52	158.95	159.20
BNO_R12-13-18-19	GNOR18_067	8000	152.05	158.42	158.79	158.98
BNO_R12-13-18-19	GNOR18_067	8000	152.05	158.42	158.79	158.98
BNO_R12-13-18-19	GNOR18_060	8700	152.05	158.11	158.46	158.63
BNO_R12-13-18-19	GNOR18_053	9400	149.89	156.97	157.40	157.62
BNO_R12-13-18-19	GNOR18_053	9400	149.89	156.97	157.40	157.62
BNO_R12-13-18-19	GNOR19_040	10200	155.21	156.22	156.61	156.87
BNO_R12-13-18-19	GNOR19_031	11100	153.44	155.64	156.05	156.37
BNO_R12-13-18-19	GNOR19_026	11600	153.02	155.36	155.82	156.19
BNO_R12-13-18-19	GNOR19_018	12400	152.79	154.65	155.44	155.96
BNO_R12-13-18-19	GNOR19_012	13000	151.86	154.19	155.24	155.83
BNO_R12-13-18-19	GNOR19_002	14000	147.01	154.09	155.16	155.76
BNO_R17	GNOR17_105	0	154.02	160.84	161.36	161.64
BNO_R17	GNOR17_098	700	154.05	160.59	161.14	161.45
BNO_R17	GNOR17_090	1500	154.25	160.39	160.96	161.27
BNO_R17	GNOR17_085	2000	153.88	159.99	160.63	160.97
BNO_R17	GNOR17_080	2500	153.60	159.24	159.88	160.19
BNO_R17	GNOR17_073	3200	152.66	159.04	159.61	159.88
BNO_R17	GNOR17_068	3700	152.05	158.42	158.79	158.98
BNO_R20	GNOR20_050	0	149.89	156.97	157.40	157.62
BNO_R20	GNOR20_043	700	149.89	156.75	157.13	157.33
BNO_R20	GNOR20_039	1100	149.20	156.59	156.95	157.15
BNO_R20	GNOR20_032	1800	149.12	156.27	156.69	156.92
BNO_R20	GNOR20_025	2500	148.83	156.09	156.56	156.81
BNO_R20	GNOR20_016	3400	149.20	155.95	156.42	156.68
BNO_R20	GNOR20_007	4300	149.04	155.57	156.08	156.39
BNO_R20	GNOR20_000	5000	149.04	155.11	155.67	156.04
BNO_R04-5-6-7	GNOR04_005	0	158.89	165.34	165.99	166.45
BNO_R04-5-6-7	GNOR05_007	500	160.06	165.20	165.89	166.37
BNO_R04-5-6-7	GNOR05_007	500	160.06	165.20	165.89	166.37
BNO_R04-5-6-7	GNOR06_013	1200	159.05	164.75	165.42	165.88
BNO_R04-5-6-7	GNOR06_013	1200	159.05	164.75	165.42	165.88
BNO_R04-5-6-7	GNOR06_005	2000	159.14	164.40	164.97	165.39
BNO_R04-5-6-7	GNOR06_005	2000	159.14	164.40	164.97	165.39
BNO_R04-5-6-7	GNOR07_000	2700	157.96	164.37	164.96	165.38
BNO_R01-3	GNOR01_029	0	164.73	168.35	169.01	169.39
BNO_R01-3	GNOR01_021	800	165.80	167.87	168.29	168.57
BNO_R01-3	GNOR01_018	1300	164.94	167.33	167.78	168.09
BNO_R01-3	GNOR01_013	1800	164.06	167.08	167.60	167.94
BNO_R01-3	GNOR03_058	2800	164.03	166.72	167.29	167.68
BNO_R01-3		2800	164.03	166.72	167.29	167.68
BNO_R01-3	GNOR03_050	3600	162.94	166.11	166.80	167.25
BNO_R01-3	GNOR03_041	4500	162.40	165.82	166.57	167.03
BNO_R01-3	GNOR03_035	5100	162.17	165.71	166.47	166.94
BNO_R01-3	GNOR03_028	5800	162.10	165.62	166.36	166.82

Water Level

Name of Watercourse	X-SECT Name	MIKE 11 Chainage	Bed EL	1 in 20 year ARI MIKE11 CASE 086	1 in 50 year ARI MIKE11 CASE 086	1 in 100 year ARI MIKE11 CASE 086
BNO_R01-3	GNOR03_019	6700	162.41	165.47	166.16	166.63
BNO_R01-3	GNOR03_012	7400	162.51	165.36	166.04	166.52
BNO_R01-3	GNOR03_005	8100	161.21	165.20	165.89	166.37
BNO_R02	GNOR02_029	0	163.62	166.72	167.29	167.68
BNO_R02	GNOR02_024	500	163.62	166.75	167.36	167.77
BNO_R02	GNOR02_015	1400	164.30	166.82	167.43	167.84
BNO_R02	GNOR02_010	1900	164.51	166.96	167.51	167.92
BNO_R02	GNOR02_000	2900	164.03	167.22	167.76	168.15
BNO_R08-15-16	GNOR08_090	0	161.54	164.40	164.97	165.39
BNO_R08-15-16	GNOR08_087	300	161.68	164.01	164.63	165.09
BNO_R08-15-16	GNOR08_080	1000	162.10	163.49	164.24	164.76
BNO_R08-15-16	GNOR08_075	1500	161.52	163.37	164.13	164.66
BNO_R08-15-16	GNOR08_070	2000	161.08	163.26	164.03	164.57
BNO_R08-15-16	GNOR08_056	3400	160.24	162.89	163.76	164.33
BNO_R08-15-16	GNOR08_050	4000	158.99	162.63	163.50	164.05
BNO_R08-15-16	GNOR08_050	4000	158.99	162.63	163.50	164.05
BNO_R08-15-16	GNOR08_040	5000	158.99	161.70	162.35	162.77
BNO_R08-15-16	GNOR08_036	5400	159.22	161.28	161.93	162.33
BNO_R08-15-16	GNOR08_030	6000	157.73	159.77	160.30	160.61
BNO_R08-15-16	GNOR08_030	6000	157.73	159.77	160.30	160.61
BNO_R08-15-16	GNOR15_025	6160	157.92	159.53	159.99	160.23
BNO_R08-15-16	GNOR15_018	6700	157.01	159.17	159.69	159.96
BNO_R08-15-16	GNOR15_008	7700	156.00	158.71	159.26	159.57
BNO_R08-15-16	GNOR15_000	8500	155.46	158.35	158.87	159.14
BNO_R08-15-16	GNOR15_000	8500	155.46	158.35	158.87	159.14
BNO_R08-15-16	GNOR16_020	9200	155.39	157.88	158.34	158.54
BNO_R08-15-16	GNOR16_015	9700	155.33	157.54	157.99	158.22
BNO_R08-15-16	GNOR16_007	10500	154.25	156.90	157.49	157.80
BNO_R08-15-16	GNOR16_000	11200	153.78	156.25	156.78	157.08
BNO_R11A	GNOR11_075	0	161.41	164.40	164.97	165.39
BNO_R11A	GNOR11_075	250	N/A	164.40	164.97	165.39
BNO_R11A	GNOR11_070	500	162.47	164.40	164.97	165.39
BNO_R11B	GNOR11_060	0	162.47	162.59	162.59	162.59
BNO_R11B	GNOR11_054	600	161.99	162.13	162.13	162.13
BNO_R11B	GNOR11_049	1100	160.99	161.12	161.12	161.12
BNO_R11B	GNOR11_042	1800	160.27	160.38	160.38	160.38
BNO_R11B	GNOR11_035	2500	158.56	159.10	159.10	159.10
BNO_R11B	GNOR11_024	3600	158.95	159.07	159.06	159.06
BNO_R11B	GNOR11_018	4200	158.16	158.50	158.41	158.50
BNO_R11B	GNOR11_009	5100	157.44	158.50	158.41	158.49
BNO_R11B	GNOR11_004	5600	156.55	158.50	158.41	158.49
BNO_R09A	GNOR09_060	0	162.36	164.75	165.42	165.88
BNO_R09A	GNOR09_060	250	N/A	164.75	165.42	165.88
BNO_R09A	GNOR09_055	500	162.36	164.75	165.42	165.88
BNO_R09B	GNOR09_041	0	164.85	164.85	164.85	164.85
BNO_R09B	GNOR09_034	700	163.50	163.60	163.60	163.60
BNO_R09B	GNOR09_026	1500	162.34	162.50	162.50	162.50
BNO_R09B	GNOR09_021	2000	161.50	161.74	161.74	161.74
BNO_R09B	GNOR09_015	2600	161.13	161.13	161.13	161.13
BNO_R09B	GNOR09_005	3600	159.10	160.89	160.79	160.88
BNO_R10A	GNOR10_109	0	162.47	164.40	164.97	165.39
BNO_R10A	GNOR10_101	800	161.89	163.64	164.35	164.86
BNO_R10A	GNOR10_094	1500	159.71	163.40	164.18	164.73
BNO_R10A	GNOR10_090	1900	160.46	163.30	164.11	164.67
BNO_R10A	GNOR10_079	3000	160.19	162.93	163.92	164.52
BNO_R10A	GNOR10_074	3500	160.29	162.84	163.82	164.42
BNO_R10A	GNOR10_065	4400	158.99	162.63	163.50	164.05
BNO_R10B	GNOR10_072	0	160.19	160.34	160.35	160.35
BNO_R10B	GNOR10_062	1000	158.90	159.11	159.11	159.19
BNO_R10B	GNOR10_044	1800	157.32	158.46	158.88	159.15
BNO_R10B	GNOR10_036	2600	157.07	158.36	158.87	159.14
BNO_R10B	GNOR10_030	3200	155.46	158.35	158.87	159.14
BNO_R14	GNOR14_005	0	157.73	159.77	160.30	160.61
BNO_R14	GNOR14_000	20	157.73	159.73	160.22	160.54
BNO_L11	GNOL11_008	0	150.60	161.56	162.01	162.29
BNO_L11	GNOL11_000	800	150.60	161.30	161.81	162.11
BRE_R11	GRER11_040	0	168.05	169.07	169.28	169.42
BRE_R11	GRER11_032	800	168.05	168.93	169.09	169.27
BRE_R11	GRER11_021	1900	166.85	167.78	168.34	168.74
BRE_R11	GRER11_012	2800	160.69	167.78	168.34	168.72
BRE_R11	GRER11_004	3600	160.69	167.78	168.34	168.71
BNO_R26	GNOR26_010	0	152.26	154.34	155.10	155.61
BNO_R26	GNOR26_000	1000	152.26	153.97	154.75	155.27
BCO_R01	GCOR01_030	0	149.65	152.83	153.64	154.08
BCO_R01	GCOR01_022	800	149.65	152.41	153.21	153.64
BCO_R01	GCOR01_019	1200	149.68	152.09	152.83	153.34
BCO_R01	GCOR01_011	1900	147.93	151.57	152.48	153.07
BCO_R01	GCOR01_007	2300	147.09	151.44	152.41	153.00
BCO_R01	GCOR01_003	2700	141.07	151.42	152.39	152.99

Nogoa River Model Conversion
Case 086 1 in 20, 1 in 50 and 1 in 100 year Results

Water Level				1 in 20 year ARI Results (mAHD)			1 in 50 year ARI Results (mAHD)			1 in 100 year ARI Results (mAHD)		
Name of Watercourse	X-SECT Name	MIKE 11 Chainage	Bed EL	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)
NOGOA_MACKENZIE	GNO_007005	0	175.81	187.19	187.37	0.18	188.66	188.83	0.17	189.56	189.73	0.17
NOGOA_MACKENZIE	GNO_006998	700	171.87	186.97	187.12	0.15	188.40	188.56	0.16	189.27	189.46	0.19
NOGOA_MACKENZIE	GNO_006991	1400	172.99	186.64	186.61	-0.03	188.04	188.14	0.10	188.90	189.05	0.15
NOGOA_MACKENZIE	GNO_006983	2200	173.73	186.14	185.97	-0.17	187.49	187.50	0.01	188.32	188.44	0.12
NOGOA_MACKENZIE	GNO_006978	2600	174.39	185.95	185.73	-0.22	187.29	187.27	-0.02	188.11	188.22	0.10
NOGOA_MACKENZIE	GNO_006975	3000	174.39	185.75	185.49	-0.26	187.10	187.09	-0.01	187.91	188.04	0.13
NOGOA_MACKENZIE	GNO_006975	3000	174.39	185.75	185.49	-0.26	187.10	187.09	-0.01	187.91	188.04	0.13
NOGOA_MACKENZIE	GNO_006972	3500	173.92	185.43	185.20	-0.24	186.81	186.88	0.06	187.64	187.87	0.23
NOGOA_MACKENZIE	GNO_006962	4200	173.42	185.08	184.86	-0.22	186.46	186.54	0.08	187.30	187.53	0.23
NOGOA_MACKENZIE	GNO_006951	5300	172.35	184.46	184.37	-0.09	185.88	186.13	0.25	186.74	186.97	0.23
NOGOA_MACKENZIE	GNO_006940	6400	172.35	183.40	183.75	0.35	185.02	185.73	0.71	185.94	186.60	0.66
NOGOA_MACKENZIE	GNO_006940	6400	172.35	183.40	183.75	0.35	185.02	185.73	0.71	185.94	186.60	0.66
NOGOA_MACKENZIE	GNO_006930	7300	171.26	182.67	182.82	0.15	184.33	185.02	0.69	185.25	185.91	0.66
NOGOA_MACKENZIE	GNO_006919	8200	169.07	181.94	181.69	-0.25	183.60	184.07	0.47	184.52	184.89	0.37
NOGOA_MACKENZIE	GNO_006910	9100	169.07	181.11	181.06	-0.05	182.79	183.51	0.72	183.72	184.22	0.50
NOGOA_MACKENZIE	GNO_006910	9100	169.07	181.11	181.06	-0.05	182.79	183.51	0.72	183.72	184.22	0.50
NOGOA_MACKENZIE	GNO_006900	10000	167.16	180.71	180.63	-0.08	182.37	183.15	0.78	183.27	183.86	0.58
NOGOA_MACKENZIE	GNO_006892	10800	167.01	180.35	180.28	-0.07	181.99	182.71	0.72	182.87	183.48	0.61
NOGOA_MACKENZIE	GNO_006886	11400	166.99	180.10	180.05	-0.05	181.73	182.35	0.62	182.61	183.19	0.58
NOGOA_MACKENZIE	GNO_006876	12400	166.85	179.57	179.57	0.00	181.22	181.75	0.53	182.12	182.62	0.50
NOGOA_MACKENZIE	GNO_006868	13200	166.15	179.15	179.17	0.02	180.78	181.35	0.57	181.65	182.15	0.50
NOGOA_MACKENZIE	GNO_006854	14600	164.84	178.29	178.37	0.08	179.98	180.67	0.69	180.89	181.54	0.65
NOGOA_MACKENZIE	GNO_006845	15500	164.40	177.77	177.82	0.05	179.48	180.07	0.59	180.47	181.17	0.70
NOGOA_MACKENZIE	GNO_006840	16000	164.31	177.45	177.49	0.04	179.19	179.72	0.53	180.21	180.97	0.75
NOGOA_MACKENZIE	GNO_006840	16000	164.31	177.45	177.49	0.04	179.19	179.72	0.53	180.21	180.97	0.75
NOGOA_MACKENZIE	N/A	16150	164.31	177.42	177.37	-0.04	179.15	179.60	0.45	180.15	180.88	0.73
NOGOA_MACKENZIE	N/A	16200	170.39	177.39	177.26	-0.13	179.10	179.52	0.42	180.10	180.85	0.75
NOGOA_MACKENZIE	N/A	16250	163.46	177.35	177.28	-0.07	179.06	179.49	0.44	180.04	180.83	0.79
NOGOA_MACKENZIE	GNO_006835	16500	163.46	177.32	177.19	-0.13	179.01	179.32	0.31	179.98	180.68	0.70
NOGOA_MACKENZIE	GNO_006822	17800	164.18	176.87	176.76	-0.11	178.49	178.67	0.18	179.41	180.02	0.61
NOGOA_MACKENZIE	GNO_006817	18300	164.18	176.69	176.60	-0.09	178.27	178.50	0.23	179.16	179.84	0.68
NOGOA_MACKENZIE	GNO_006810	18800	165.16	176.08	176.17	0.09	177.58	178.08	0.50	178.46	179.45	0.99
NOGOA_MACKENZIE	GNO_006802	19600	164.38	175.23	175.30	0.07	176.59	176.90	0.31	177.34	178.23	0.89
NOGOA_MACKENZIE	GNO_006798	20000	163.84	174.96	175.04	0.08	176.29	176.67	0.38	177.01	178.02	1.01
NOGOA_MACKENZIE	GNO_006792	20600	163.45	174.42	174.43	0.01	175.69	176.11	0.42	176.35	177.33	0.98
NOGOA_MACKENZIE	GNO_006784	21400	162.56	173.71	173.60	-0.12	174.87	175.00	0.13	175.47	175.82	0.35
NOGOA_MACKENZIE	GNO_006778	22200	162.02	173.33	173.06	-0.27	174.41	174.10	-0.31	174.94	174.59	-0.35
NOGOA_MACKENZIE	GNO_006778	22200	162.02	173.33	173.06	-0.27	174.41	174.10	-0.31	174.94	174.59	-0.35
NOGOA_MACKENZIE	GNO_006769	22800	161.43	172.93	172.57	-0.36	174.03	173.52	-0.51	174.57	173.96	-0.61
NOGOA_MACKENZIE	GNO_006759	23800	161.43	171.88	171.76	-0.12	172.95	172.71	-0.24	173.54	173.10	-0.44
NOGOA_MACKENZIE	GNO_006759	23800	161.43	171.88	171.76	-0.12	172.95	172.71	-0.24	173.54	173.10	-0.44
NOGOA_MACKENZIE	GNO_006753	24300	160.25	171.65	171.56	-0.09	172.71	172.48	-0.23	173.29	172.84	-0.45
NOGOA_MACKENZIE	GNO_006744	25200	159.78	171.03	171.07	0.04	172.02	171.93	-0.09	172.55	172.25	-0.30
NOGOA_MACKENZIE	GNO_006737	25900	159.43	170.30	170.41	0.11	171.33	171.22	-0.12	171.89	171.62	-0.27
NOGOA_MACKENZIE	GNO_006734	26200	158.85	170.06	170.11	0.05	171.15	170.98	-0.17	171.73	171.41	-0.32
NOGOA_MACKENZIE	GNO_006727	26900	158.39	169.73	169.73	0.00	170.85	170.65	-0.20	171.44	171.10	-0.34
NOGOA_MACKENZIE	GNO_006720	27600	158.39	169.45	169.47	0.02	170.55	170.38	-0.17	171.14	170.84	-0.30

Water Level				1 in 20 year ARI Results (mAHD)			1 in 50 year ARI Results (mAHD)			1 in 100 year ARI Results (mAHD)		
Name of Watercourse	X-SECT Name	MIKE 11 Chainage	Bed EL	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)
NOGOA_MACKENZIE	GNO_006709	28700	157.78	169.01	169.01	0.00	170.03	169.90	-0.13	170.58	170.36	-0.22
NOGOA_MACKENZIE	GNO_006701	29500	157.54	168.84	168.85	0.01	169.83	169.71	-0.12	170.36	170.17	-0.19
NOGOA_MACKENZIE	GNO_006692	30400	157.08	168.61	168.66	0.04	169.56	169.46	-0.10	170.09	169.89	-0.20
NOGOA_MACKENZIE	GNO_006685	31100	157.08	168.28	168.35	0.07	169.18	169.01	-0.17	169.72	169.39	-0.33
NOGOA_MACKENZIE	GNO_006685	31100	157.08	168.28	168.35	0.07	169.18	169.01	-0.17	169.72	169.39	-0.33
NOGOA_MACKENZIE	GNO_006678	31500	155.58	168.11	168.17	0.06	168.99	168.78	-0.21	169.53	169.14	-0.40
NOGOA_MACKENZIE	GNO_006670	32300	155.58	167.63	167.78	0.15	168.43	168.34	-0.09	168.94	168.72	-0.22
NOGOA_MACKENZIE	GNO_006670	32300	155.58	167.63	167.78	0.15	168.43	168.34	-0.09	168.94	168.72	-0.22
NOGOA_MACKENZIE	GNO_006661	33000	154.67	167.43	167.46	0.03	168.17	168.02	-0.15	168.71	168.40	-0.31
NOGOA_MACKENZIE	GNO_006657	33400	154.20	167.38	167.30	-0.08	168.10	167.84	-0.26	168.63	168.24	-0.39
NOGOA_MACKENZIE	GNO_006650	34100	154.29	167.33	167.22	-0.11	168.02	167.76	-0.26	168.54	168.16	-0.38
NOGOA_MACKENZIE	GNO_006641	34100	154.29	167.33	167.22	-0.11	167.72	167.76	0.04	168.54	168.16	-0.38
NOGOA_MACKENZIE	GNO_006641	34500	155.39	166.98	166.91	-0.07	167.72	167.49	-0.23	168.27	167.92	-0.36
NOGOA_MACKENZIE	GNO_006630	34900	154.83	166.76	166.64	-0.12	167.53	167.25	-0.28	168.09	167.69	-0.40
NOGOA_MACKENZIE	GNO_006621	35800	154.14	166.23	166.02	-0.21	167.02	166.69	-0.33	167.61	167.16	-0.45
NOGOA_MACKENZIE	GNO_006610	36900	153.33	165.63	165.37	-0.26	166.42	166.01	-0.41	167.02	166.47	-0.55
NOGOA_MACKENZIE	GNO_006610	36900	153.33	165.63	165.37	-0.26	166.42	166.01	-0.41	167.02	166.47	-0.55
NOGOA_MACKENZIE	GNO_006598	37600	152.82	165.37	165.10	-0.27	166.15	165.72	-0.43	166.74	166.16	-0.58
NOGOA_MACKENZIE	GNO_006592	38200	151.96	165.01	164.80	-0.22	165.79	165.39	-0.41	166.38	165.81	-0.57
NOGOA_MACKENZIE	GNO_006583	39100	151.75	164.54	164.43	-0.11	165.30	165.01	-0.29	165.90	165.41	-0.49
NOGOA_MACKENZIE	GNO_006583	39100	151.75	164.54	164.43	-0.11	165.30	165.01	-0.29	165.90	165.41	-0.49
NOGOA_MACKENZIE	GNO_006570	39800	150.16	164.38	164.25	-0.13	165.12	164.81	-0.31	165.71	165.20	-0.51
NOGOA_MACKENZIE	GNO_006565	40300	149.96	164.22	164.12	-0.10	164.94	164.66	-0.28	165.51	165.03	-0.48
NOGOA_MACKENZIE	GNO_006560	40800	149.71	164.05	163.96	-0.09	164.74	164.48	-0.26	165.29	164.83	-0.46
NOGOA_MACKENZIE	GNO_006560	40800	149.71	164.05	163.96	-0.09	164.74	164.48	-0.26	165.29	164.83	-0.46
NOGOA_MACKENZIE	GNO_006545	41700	150.01	163.40	163.52	0.12	164.04	164.02	-0.02	164.52	164.33	-0.19
NOGOA_MACKENZIE	GNO_006537	42500	149.80	162.74	162.94	0.19	163.34	163.38	0.04	163.79	163.67	-0.12
NOGOA_MACKENZIE	GNO_006532	43000	149.51	162.34	162.57	0.23	162.92	162.98	0.06	163.36	163.25	-0.11
NOGOA_MACKENZIE	GNO_006522	44000	148.73	161.26	161.45	0.19	161.75	161.90	0.15	162.12	162.13	0.01
NOGOA_MACKENZIE	GNO_006522	44000	148.73	161.26	161.45	0.19	161.75	161.90	0.15	162.12	162.13	0.01
NOGOA_MACKENZIE	GNO_006510	45000	147.83	160.84	160.94	0.10	161.32	161.44	0.12	161.68	161.66	-0.02
NOGOA_MACKENZIE	GNO_006503	45700	147.83	160.45	160.59	0.14	160.92	161.08	0.16	161.26	161.31	0.05
NOGOA_MACKENZIE	GNO_006503	45700	147.83	160.45	160.59	0.14	160.92	161.08	0.16	161.26	161.31	0.05
NOGOA_MACKENZIE	GNO_006496	46200	147.10	160.36	160.27	-0.09	160.82	160.73	-0.09	161.17	161.03	-0.14
NOGOA_MACKENZIE	GNO_006492	46600	146.79	160.15	159.99	-0.16	160.62	160.29	-0.33	160.98	160.69	-0.29
NOGOA_MACKENZIE	GNO_006485	47300	146.19	159.62	159.37	-0.25	160.14	159.53	-0.61	160.52	159.94	-0.58
NOGOA_MACKENZIE	GNO_006480	47800	145.92	159.31	159.08	-0.23	159.84	159.21	-0.63	160.22	159.55	-0.67
NOGOA_MACKENZIE	GNO_006470	48800	147.16	158.77	158.67	-0.10	159.28	158.82	-0.46	159.66	159.08	-0.58
NOGOA_MACKENZIE	GNO_006465	49300	149.31	158.52	158.42	-0.10	159.05	158.61	-0.44	159.44	158.84	-0.60
NOGOA_MACKENZIE	GNO_006460	49800	146.41	158.28	158.06	-0.22	158.84	158.32	-0.52	159.25	158.60	-0.65
NOGOA_MACKENZIE	GNO_006450	50800	145.90	157.86	157.43	-0.43	158.45	157.87	-0.58	158.88	158.21	-0.67
NOGOA_MACKENZIE	GNO_006440	51800	145.33	157.48	157.06	-0.42	158.08	157.61	-0.47	158.51	157.98	-0.53
NOGOA_MACKENZIE	GNO_006430	52800	145.33	157.06	156.94	-0.12	157.66	157.53	-0.13	158.09	157.90	-0.19
NOGOA_MACKENZIE	GNO_006430	52800	145.33	157.06	156.94	-0.12	157.66	157.53	-0.13	158.09	157.90	-0.19
NOGOA_MACKENZIE	GNO_006420	53500	144.39	156.88	156.80	-0.08	157.47	157.39	-0.08	157.89	157.76	-0.13
NOGOA_MACKENZIE	GNO_006412	54300	143.76	156.63	156.53	-0.10	157.21	157.09	-0.12	157.62	157.44	-0.18
NOGOA_MACKENZIE	GNO_006405	55300	143.01	156.20	156.14	-0.06	156.75	156.64	-0.11	157.13	156.93	-0.20

Water Level				1 in 20 year ARI Results (mAHD)			1 in 50 year ARI Results (mAHD)			1 in 100 year ARI Results (mAHD)		
Name of Watercourse	X-SECT Name	MIKE 11 Chainage	Bed EL	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)
NOGOA_MACKENZIE	GNO_006405	55300	143.01	156.20	156.14	-0.06	156.75	156.64	-0.11	157.13	156.93	-0.20
NOGOA_MACKENZIE	GNO_006396	56100	147.46	155.80	156.03	0.23	156.29	156.47	0.18	156.64	156.74	0.10
NOGOA_MACKENZIE	GNO_006390	56700	146.10	155.43	155.79	0.35	155.92	156.15	0.23	156.26	156.39	0.13
NOGOA_MACKENZIE	GNO_006385	57200	144.90	155.22	155.60	0.38	155.71	155.95	0.24	156.05	156.18	0.13
NOGOA_MACKENZIE	GNO_006379	57800	144.95	154.90	155.35	0.45	155.42	155.69	0.27	155.79	155.93	0.14
NOGOA_MACKENZIE	GNO_006372	58500	143.36	154.47	154.76	0.29	155.09	155.27	0.18	155.52	155.58	0.06
NOGOA_MACKENZIE	GNO_006367	59000	143.36	154.32	154.49	0.17	154.96	155.08	0.12	155.40	155.42	0.02
NOGOA_MACKENZIE	GNO_006362	59500	144.95	154.19	154.37	0.18	154.83	154.97	0.14	155.27	155.32	0.05
NOGOA_MACKENZIE	GNO_006356	60100	143.09	153.89	154.13	0.24	154.58	154.78	0.20	155.05	155.14	0.09
NOGOA_MACKENZIE	GNO_006353	60400	142.16	153.65	153.89	0.24	154.40	154.60	0.20	154.91	154.99	0.08
NOGOA_MACKENZIE	GNO_006350	60700	141.63	153.49	153.76	0.27	154.27	154.50	0.23	154.80	154.90	0.10
NOGOA_MACKENZIE	GNO_006350	60700	141.63	153.49	153.76	0.27	154.27	154.50	0.23	154.80	154.90	0.10
NOGOA_MACKENZIE	GNO_006342	61200	141.28	153.23	153.59	0.36	154.05	154.38	0.33	154.60	154.78	0.18
NOGOA_MACKENZIE	GNO_006338	61600	142.49	153.01	153.36	0.35	153.85	154.20	0.35	154.42	154.62	0.20
NOGOA_MACKENZIE	GNO_006330	62400	137.72	152.60	152.95	0.35	153.52	153.88	0.36	154.12	154.33	0.21
NOGOA_MACKENZIE	GNO_006330	62400	137.72	152.60	152.95	0.35	153.52	153.88	0.36	154.12	154.33	0.21
NOGOA_MACKENZIE	GNO_006323	63000	138.11	152.25	152.21	-0.04	153.20	153.37	0.17	153.85	153.89	0.04
NOGOA_MACKENZIE	GNO_006319	63600	136.56	151.92	152.01	0.09	152.88	153.12	0.24	153.57	153.67	0.10
NOGOA_MACKENZIE	GNO_006319	63600	136.56	151.92	152.01	0.09	152.88	153.12	0.24	153.57	153.67	0.10
NOGOA_MACKENZIE	GNO_006310	64230	136.16	151.70	151.79	0.09	152.68	152.87	0.19	153.40	153.45	0.05
NOGOA_MACKENZIE	GNO_006300	65220	135.59	151.51	151.57	0.06	152.49	152.64	0.15	153.22	153.23	0.01
NOGOA_MACKENZIE	GNO_006290	66020	134.54	151.38	151.44	0.06	152.36	152.53	0.16	153.11	153.10	-0.01
NOGOA_MACKENZIE	GNO_006290	66020	134.54	151.38	151.44	0.06	152.36	152.53	0.16	153.11	153.10	-0.01
NOGOA_MACKENZIE	GNO_006285	66770	133.66	151.27	151.32	0.05	152.29	152.44	0.15	153.05	153.02	-0.03
NOGOA_MACKENZIE	GNO_006280	67280	134.24	151.17	151.22	0.05	152.21	152.36	0.15	152.99	152.94	-0.05
NOGOA_MACKENZIE	GNO_006275	67790	134.03	151.08	151.15	0.07	152.14	152.31	0.17	152.95	152.89	-0.06
NOGOA_MACKENZIE	GNO_006270	68090	133.76	151.03	151.10	0.07	152.10	152.26	0.16	152.92	152.86	-0.06
NOGOA_MACKENZIE	GNO_006265	68690	133.32	150.91	150.99	0.08	152.01	152.16	0.15	152.86	152.76	-0.10
NOGOA_MACKENZIE	GNO_006260	69230	133.29	150.85	150.91	0.06	151.97	152.12	0.15	152.83	152.72	-0.11
NOGOA_MACKENZIE	GNO_006256	69740	133.19	150.78	150.84	0.06	151.93	152.07	0.14	152.80	152.68	-0.12
NOGOA_MACKENZIE	GNO_006250	70340	133.01	150.72	150.75	0.03	151.89	152.01	0.12	152.78	152.64	-0.15
NOGOA_MACKENZIE	GNO_006250	70340	133.01	150.72	150.75	0.03	151.89	152.01	0.12	152.78	152.64	-0.15
NOGOA_MACKENZIE	GNO_006263	71780	133.01	150.61	150.51	-0.10	151.80	151.75	-0.05	152.70	152.40	-0.30
NOGOA_MACKENZIE	GNO_006263	71780	133.01	150.61	150.51	-0.10	151.80	151.75	-0.05	152.70	152.40	-0.30
NOGOA_MACKENZIE	GMK_006226	72980	132.16	150.35	150.12	-0.23	151.49	151.19	-0.30	152.38	151.85	-0.53
NOGOA_MACKENZIE	GMK_006226	72980	132.16	150.35	150.12	-0.23	151.49	151.19	-0.30	152.38	151.85	-0.53
NOGOA_MACKENZIE	GMK_006220	73400	131.23	150.20	150.02	-0.18	151.37	151.10	-0.27	152.28	151.77	-0.51
NOGOA_MACKENZIE	GMK_006212	74120	130.24	149.91	149.81	-0.10	151.14	150.87	-0.27	152.08	151.55	-0.53
NOGOA_MACKENZIE	GMK_006205	74780	128.63	149.65	149.61	-0.04	150.92	150.66	-0.26	151.90	151.36	-0.54
NOGOA_MACKENZIE	GMK_006198	75710	128.11	149.38	149.34	-0.04	150.72	150.43	-0.29	151.75	151.15	-0.60
NOGOA_MACKENZIE	GMK_006187	76730	128.89	149.10	149.00	-0.10	150.52	150.18	-0.34	151.59	150.93	-0.66
NOGOA_MACKENZIE	GMK_006180	77330	129.00	148.91	148.81	-0.10	150.39	150.06	-0.33	151.48	150.83	-0.65
NOGOA_MACKENZIE	GMK_006180	77330	129.00	148.91	148.81	-0.10	150.39	150.06	-0.33	151.48	150.83	-0.65
NOGOA_MACKENZIE	GMK_006176	77810	129.00	148.76	148.62	-0.14	150.30	149.96	-0.34	151.42	150.75	-0.67
NOGOA_MACKENZIE	GMK_006160	79490	130.10	148.33	148.13	-0.20	150.05	149.67	-0.38	151.26	150.54	-0.72
NOGOA_MACKENZIE	GMK_006149	80490	128.23	148.12	147.87	-0.25	149.94	149.47	-0.47	151.18	150.41	-0.77
NOGOA_MACKENZIE	GMK_006149	80490	128.23	148.12	147.87	-0.25	149.94	149.47	-0.47	151.18	150.41	-0.77

Water Level				1 in 20 year ARI Results (mAHD)			1 in 50 year ARI Results (mAHD)			1 in 100 year ARI Results (mAHD)		
Name of Watercourse	X-SECT Name	MIKE 11 Chainage	Bed EL	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)
NOGOA_MACKENZIE	GMK_006147	80670	128.23	148.05	147.79	-0.26	149.90	149.40	-0.50	151.16	150.37	-0.79
NOGOA_MACKENZIE	GMK_006140	81390	126.91	147.83	147.56	-0.27	149.78	149.18	-0.60	151.08	150.23	-0.85
NOGOA_MACKENZIE	GMK_006132	82110	125.50	147.67	147.39	-0.28	149.68	149.03	-0.66	151.01	150.12	-0.89
NOGOA_MACKENZIE	GMK_006132	82110	125.50	147.67	147.39	-0.28	149.68	149.03	-0.66	151.01	150.12	-0.89
NOGOA_MACKENZIE	GMK_006107	84210	122.90	146.98	146.55	-0.43	149.11	148.29	-0.82	150.47	149.46	-1.01
NOGOA_MACKENZIE	GMK_006107	84210	122.90	146.98	146.55	-0.43	149.11	148.29	-0.82	150.47	149.46	-1.01
NOGOA_MACKENZIE	GMK_006085	85710	124.26	146.48	146.19	-0.29	148.55	147.97	-0.59	149.88	149.16	-0.72
NOGOA_MACKENZIE	GMK_006060	88210	123.23	145.68	145.69	0.01	147.60	147.52	-0.08	148.88	148.75	-0.13
NOGOA_MACKENZIE	GMK_006045	89710	122.45	145.14	145.32	0.18	147.00	147.23	0.23	148.30	148.52	0.22
NOGOA_MACKENZIE	GMK_006045	89710	122.45	145.14	145.32	0.18	147.00	147.23	0.23	148.30	148.52	0.22
NOGOA_MACKENZIE	GMK_006020	91710	121.21	144.60	144.75	0.15	146.52	146.70	0.17	147.87	148.05	0.18
NOGOA_MACKENZIE	GMK_005997	94010	119.56	143.90	143.92	0.01	145.89	145.97	0.08	147.30	147.40	0.10
NOGOA_MACKENZIE	GMK_005982	95510	118.83	143.32	143.23	-0.09	145.36	145.35	-0.02	146.80	146.81	0.01
NOGOA_MACKENZIE	GMK_005982	95510	118.83	143.32	143.23	-0.09	145.36	145.35	-0.02	146.80	146.81	0.01
NOGOA_MACKENZIE	GMK_005976	95910	118.83	143.13	143.03	-0.10	145.14	145.13	-0.01	146.56	146.59	0.03
BNO_L14	GNOL14_020	0	181.65	185.75	185.49	-0.26	187.10	187.09	-0.01	187.91	188.04	0.13
BNO_L14	GNOL14_012	800	181.29	185.73	184.86	-0.87	186.91	186.68	-0.23	187.59	187.59	0.00
BNO_L14	GNOL14_004	1600	182.53	183.40	183.75	0.35	185.02	185.73	0.71	185.94	186.60	0.66
BNO_L01	GNOL01_085	0	182.03	182.03	182.03	0.00	N/A	183.51	N/A	N/A	184.22	N/A
BNO_L01	GNOL01_077	800	182.03	182.03	182.03	0.00	N/A	183.15	N/A	N/A	183.90	N/A
BNO_L01	GNOL01_068	1700	179.94	179.94	179.94	0.00	N/A	182.70	N/A	N/A	183.52	N/A
BNO_L01	GNOL01_060	2500	179.94	179.94	179.94	0.00	N/A	182.54	N/A	N/A	183.25	N/A
BNO_L01	GNOL01_051	3400	180.38	180.38	180.39	0.00	N/A	182.20	N/A	N/A	182.71	N/A
BNO_L01	GNOL01_045	4000	179.50	179.5	180.46	0.96	N/A	181.42	N/A	N/A	181.79	N/A
BNO_L01	GNOL01_032	5300	176.22	177.45	177.49	0.04	179.19	179.75	0.56	N/A	180.98	N/A
BNO_L01	GNOL01_024	6100	174.32	177.45	177.49	0.04	179.19	179.73	0.54	N/A	180.97	N/A
BNO_L01	GNOL01_018	6700	172.70	177.45	177.49	0.04	179.19	179.72	0.53	N/A	180.97	N/A
BNO_L01	GNOL01_010	7500	170.48	177.45	177.49	0.04	179.19	179.72	0.53	N/A	180.97	N/A
BOGGY CREEK	GBO_000070	0	161.24	161.24	161.24	0.00	N/A	161.24	N/A	N/A	161.24	N/A
BOGGY CREEK	GBO_000065	500	159.25	159.25	159.24	-0.01	N/A	159.24	N/A	N/A	159.24	N/A
BOGGY CREEK	GBO_000062	800	158.46	158.46	158.45	-0.01	N/A	158.45	N/A	N/A	158.45	N/A
BOGGY CREEK	GBO_000056	1400	156.69	156.69	156.69	0.00	N/A	156.69	N/A	N/A	156.69	N/A
BOGGY CREEK	GBO_000052	1800	154.81	154.81	154.81	0.00	N/A	154.81	N/A	N/A	154.81	N/A
BOGGY CREEK	GBO_000045	2500	153.36	153.36	153.36	0.00	N/A	153.36	N/A	N/A	153.67	N/A
BOGGY CREEK	GBO_000038	3200	149.88	151.6	152.01	0.41	152.56	153.12	0.56	153.25	153.67	0.42
BOGGY CREEK	GBO_000033	3700	148.19	151.6	152.01	0.41	152.56	153.12	0.56	153.25	153.67	0.42
BOGGY CREEK	GBO_000026	4400	146.30	151.6	152.01	0.41	152.56	153.12	0.56	153.25	153.67	0.42
BOGGY CREEK	GBO_000018	5200	145.25	151.6	152.01	0.41	152.56	153.12	0.56	153.25	153.67	0.42
BOGGY CREEK	GBO_000013	5700	143.29	151.6	152.01	0.41	152.56	153.12	0.56	153.25	153.67	0.42
BOGGY CREEK	GBO_000000	7000	143.29	151.6	152.01	0.41	152.56	153.12	0.56	153.25	153.67	0.42
COMET RIVER	GCO_000168	0	141.12	154.28	154.36	0.08	155.12	155.27	0.15	155.67	155.76	0.09
COMET RIVER	GCO_000161	700	141.12	153.97	154.04	0.07	154.88	155.04	0.16	155.45	155.52	0.07
COMET RIVER	GCO_000161	700	141.12	153.97	154.04	0.07	154.88	155.04	0.16	155.45	155.52	0.07
COMET RIVER	GCO_000157	1100	141.24	153.92	153.97	0.05	154.83	154.98	0.15	155.40	155.46	0.06
COMET RIVER	GCO_000150	1800	141.31	153.83	153.87	0.03	154.75	154.89	0.14	155.32	155.37	0.05
COMET RIVER	GCO_000143	2500	141.14	153.67	153.66	-0.01	154.59	154.70	0.11	155.17	155.16	-0.01
COMET RIVER	GCO_000135	3400	141.14	153.47	153.35	-0.12	154.40	154.40	0.00	154.98	154.85	-0.13

Water Level				1 in 20 year ARI Results (mAHD)			1 in 50 year ARI Results (mAHD)			1 in 100 year ARI Results (mAHD)		
Name of Watercourse	X-SECT Name	MIKE 11 Chainage	Bed EL	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)
COMET RIVER	GCO_000128	4000	140.72	153.35	153.20	-0.16	154.27	154.27	0.00	154.85	154.71	-0.14
COMET RIVER	GCO_000117	5100	140.10	152.95	152.86	-0.09	153.84	153.85	0.01	154.41	154.27	-0.14
COMET RIVER	GCO_000112	5600	137.39	152.81	152.75	-0.06	153.66	153.57	-0.09	154.22	154.00	-0.22
COMET RIVER	GCO_000112	5600	137.39	152.81	152.75	-0.06	153.66	153.57	-0.09	154.22	154.00	-0.22
COMET RIVER	GCO_000104	6500	136.49	152.52	152.58	0.06	153.39	153.41	0.02	153.97	153.84	-0.13
COMET RIVER	GCO_000099	6900	136.19	152.36	152.46	0.10	153.23	153.28	0.05	153.83	153.71	-0.12
COMET RIVER	GCO_000094	7400	135.49	152.21	152.35	0.14	153.09	153.14	0.05	153.71	153.57	-0.14
COMET RIVER	GCO_000089	7900	136.62	152.1	152.27	0.17	152.99	153.04	0.05	153.62	153.48	-0.14
COMET RIVER	GCO_000084	8400	135.90	151.99	152.18	0.19	152.88	152.93	0.05	153.52	153.38	-0.14
COMET RIVER	GCO_000074	9400	135.76	151.41	151.64	0.23	152.37	152.47	0.10	153.11	152.97	-0.14
COMET RIVER	GCO_000070	9800	135.25	151.28	151.42	0.13	152.26	152.28	0.02	153.02	152.80	-0.23
COMET RIVER	GCO_000065	10200	135.52	151.18	151.34	0.16	152.18	152.22	0.04	152.96	152.74	-0.22
COMET RIVER	GCO_000065	10200	135.52	151.18	151.34	0.16	152.18	152.22	0.04	152.96	152.74	-0.22
COMET RIVER	GCO_000058	11200	135.52	151.09	151.23	0.14	152.12	152.16	0.04	152.92	152.69	-0.23
COMET RIVER	GCO_000058	11200	135.52	151.09	151.23	0.14	152.12	152.16	0.04	152.92	152.69	-0.23
COMET RIVER	GCO_000051	11700	135.65	150.96	151.13	0.17	151.99	152.06	0.07	152.83	152.61	-0.22
COMET RIVER	GCO_000046	12200	135.45	150.89	151.05	0.16	151.94	151.95	0.01	152.79	152.54	-0.25
COMET RIVER	GCO_000041	12700	134.60	150.85	150.96	0.11	151.92	151.92	0.00	152.78	152.52	-0.26
COMET RIVER	GCO_000033	13500	134.49	150.79	150.83	0.04	151.89	151.88	-0.01	152.76	152.49	-0.27
COMET RIVER	GCO_000028	13900	134.65	150.76	150.78	0.02	151.88	151.86	-0.02	152.75	152.48	-0.27
COMET RIVER	GCO_000020	14800	134.40	150.69	150.67	-0.02	151.84	151.82	-0.02	152.73	152.45	-0.28
COMET RIVER	GCO_000013	15500	134.40	150.64	150.57	-0.07	151.81	151.77	-0.04	152.71	152.42	-0.30
COMET RIVER	GCO_000006	16100	134.56	150.61	150.51	-0.10	151.80	151.75	-0.05	152.70	152.40	-0.30
SANDHURST CREEK	GSA_000160	0	151.64	154.89	154.95	0.06	155.09	155.19	0.10	155.25	155.36	0.11
SANDHURST CREEK	GSA_000155	500	151.18	154.27	154.50	0.23	154.47	154.72	0.25	154.62	154.88	0.26
SANDHURST CREEK	GSA_000150	1000	150.74	153.66	153.86	0.20	153.89	154.11	0.22	154.04	154.29	0.25
SANDHURST CREEK	GSA_000146	1400	150.72	153.47	153.67	0.19	153.69	153.89	0.20	153.83	154.07	0.24
SANDHURST CREEK	GSA_000141	1900	149.40	152.96	153.23	0.27	153.18	153.42	0.23	153.34	153.67	0.33
SANDHURST CREEK	GSA_000136	2400	148.79	152.27	152.54	0.27	152.67	152.86	0.19	152.96	153.39	0.43
SANDHURST CREEK	GSA_000128	3200	148.96	151.83	151.91	0.08	152.44	152.58	0.14	152.81	153.28	0.47
SANDHURST CREEK	GSA_000121	3900	147.98	151.78	151.81	0.03	152.41	152.54	0.13	152.79	153.26	0.47
SANDHURST CREEK	GSA_000117	4300	147.04	151.77	151.80	0.03	152.41	152.54	0.13	152.79	153.25	0.46
SANDHURST CREEK	GSA_000111	4900	146.52	151.77	151.80	0.03	152.4	152.53	0.13	152.78	153.24	0.46
SANDHURST CREEK	GSA_000104	5600	146.53	151.22	151.70	0.48	151.84	152.43	0.59	152.74	153.16	0.42
SANDHURST CREEK	GSA_000096	6400	145.52	150.65	150.60	-0.05	151.84	151.86	0.02	152.74	152.50	-0.24
SANDHURST CREEK	GSA_000089	7100	145.29	150.65	150.60	-0.05	151.84	151.86	0.02	152.74	152.50	-0.24
SANDHURST CREEK	GSA_000084	7600	144.51	150.65	150.60	-0.05	151.84	151.86	0.01	152.74	152.50	-0.24
SANDHURST CREEK	GSA_000076	8400	143.41	150.65	150.60	-0.05	151.84	151.86	0.01	152.74	152.50	-0.24
SANDHURST CREEK	GSA_000065	9500	143.13	150.65	150.60	-0.05	151.84	151.86	0.01	152.74	152.50	-0.24
SANDHURST CREEK	GSA_000065	9500	143.13	150.65	150.60	-0.05	151.84	151.86	0.01	152.74	152.50	-0.24
SANDHURST CREEK	GSA_000052	10700	142.46	150.64	150.58	-0.06	151.83	151.83	0.00	152.73	152.48	-0.25
SANDHURST CREEK	GSA_000041	11700	141.07	150.64	150.57	-0.07	151.83	151.82	-0.01	152.73	152.47	-0.26
SANDHURST CREEK	GSA_000035	12300	140.95	150.63	150.56	-0.07	151.82	151.81	-0.01	152.72	152.46	-0.26
SANDHURST CREEK	GSA_000027	13100	140.65	150.63	150.55	-0.08	151.82	151.80	-0.02	152.72	152.45	-0.28
SANDHURST CREEK	GSA_000015	14600	139.34	150.62	150.53	-0.09	151.81	151.78	-0.03	152.71	152.43	-0.28
SANDHURST CREEK	GSA_000010	15100	138.19	150.62	150.52	-0.10	151.81	151.77	-0.04	152.71	152.42	-0.29
SANDHURST CREEK	GSA_000000	16100	138.19	150.61	150.51	-0.10	151.8	151.75	-0.05	152.70	152.40	-0.30

Water Level				1 in 20 year ARI Results (mAHD)			1 in 50 year ARI Results (mAHD)			1 in 100 year ARI Results (mAHD)		
Name of Watercourse	X-SECT Name	MIKE 11 Chainage	Bed EL	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)
BCO_L01-02-04	GCOL01_026	0	150.37	153.97	154.04	0.07	154.88	155.04	0.16	155.45	155.52	0.07
BCO_L01-02-04	GCOL01_020	600	149.72	153.57	153.62	0.05	154.46	154.57	0.11	155.01	155.02	0.01
BCO_L01-02-04	GCOL01_014	1200	149.40	153.22	153.22	0.00	154.07	154.10	0.03	154.61	154.54	-0.07
BCO_L01-02-04	GCOL01_010	1600	149.30	153.09	153.07	-0.02	153.92	153.90	-0.02	154.45	154.32	-0.13
BCO_L01-02-04	GCOL01_002	2600	148.54	152.93	152.89	-0.04	153.72	153.64	-0.08	154.25	154.04	-0.21
BCO_L01-02-04	GCOL01_002	2600	148.54	152.93	152.89	-0.04	153.72	153.64	-0.08	154.25	154.04	-0.21
BCO_L01-02-04	GCOL02_069	3400	151.49	152.86	152.87	0.01	153.72	153.55	-0.17	154.25	153.90	-0.35
BCO_L01-02-04	GCOL02_062	4100	151.38	152.49	152.53	0.04	153.57	153.18	-0.39	154.03	153.46	-0.57
BCO_L01-02-04	GCOL02_057	4600	150.87	151.92	152.05	0.13	153.12	152.59	-0.53	153.52	152.94	-0.58
BCO_L01-02-04	XCOL02_050	5300	n/a	n/a	151.38	n/a	152.48	152.11	-0.37	153.09	152.66	-0.43
BCO_L01-02-04	GCOL02_045	5800	150.05	151.00	151.01	0.01	152.03	152.04	0.00	152.87	152.63	-0.24
BCO_L01-02-04	GCOL02_040	6300	149.17	150.97	150.97	0.00	152.02	152.02	0.00	152.86	152.62	-0.24
BCO_L01-02-04	GCOL02_030	7300	148.42	150.97	150.96	-0.01	152.01	152.02	0.01	152.85	152.61	-0.24
BCO_L01-02-04	GCOL02_020	8300	147.83	150.97	150.96	-0.01	152.01	152.01	0.00	152.85	152.61	-0.24
BCO_L01-02-04	GCOL02_016	8700	146.43	150.97	150.96	-0.01	152.01	152.01	0.00	152.85	152.61	-0.24
BCO_L01-02-04	GCOL02_008	9500	146.34	150.96	150.96	0.00	152.00	152.01	0.01	152.85	152.61	-0.24
BCO_L01-02-04	GCOL02_002	10100	145.47	150.96	150.96	0.00	152.00	152.01	0.01	152.84	152.60	-0.24
BCO_L01-02-04	GCOL02_002	10100	145.47	150.96	150.96	0.00	152.00	152.01	0.01	152.84	152.60	-0.24
BCO_L01-02-04	GCOL04_018	10600	145.95	150.90	150.90	0.00	151.97	151.98	0.01	152.84	152.58	-0.26
BCO_L01-02-04	GCOL04_009	11500	145.96	150.77	150.74	-0.03	151.91	151.92	0.01	152.84	152.54	-0.30
BCO_L01-02-04	GCOL04_000	12400	145.96	150.65	150.60	-0.05	151.84	151.86	0.01	152.82	152.50	-0.32
CRINUM CK	GCR_000155	0	160.89	164.96	165.05	0.09	165.37	165.46	0.09	165.63	165.74	0.11
CRINUM CK	GCR_000150	500	160.72	164.80	164.83	0.03	165.21	165.26	0.04	165.46	165.55	0.09
CRINUM CK	GCR_000145	1000	159.12	164.66	164.69	0.03	165.03	165.08	0.05	165.27	165.35	0.08
CRINUM CK	GCR_000140	1500	159.32	164.27	164.36	0.09	164.62	164.70	0.07	164.84	164.94	0.10
CRINUM CK	GCR_000135	2000	158.23	163.50	163.57	0.07	163.97	164.03	0.06	164.27	164.37	0.10
CRINUM CK	GCR_000130	2500	158.11	163.18	163.18	0.00	163.68	163.71	0.03	164.01	164.11	0.10
CRINUM CK	GCR_000120	3500	157.10	162.77	162.85	0.08	163.27	163.40	0.13	163.59	163.81	0.22
CRINUM CK	GCR_000115	4000	156.73	162.46	162.57	0.10	162.96	163.09	0.13	163.28	163.47	0.19
CRINUM CK	GCR_000110	4500	157.45	162.31	162.40	0.09	162.81	162.89	0.08	163.14	163.19	0.05
CRINUM CK	GCR_000103	5200	155.38	162.15	162.23	0.08	162.65	162.70	0.05	162.97	162.99	0.02
CRINUM CK	GCR_000095	6000	153.69	162.05	162.13	0.08	162.53	162.58	0.05	162.84	162.84	0.00
CRINUM CK	GCR_000088	6700	154.88	161.97	162.04	0.07	162.44	162.48	0.04	162.74	162.74	0.00
CRINUM CK	GCR_000078	7700	154.98	161.66	161.78	0.12	162.08	162.18	0.10	162.36	162.42	0.06
CRINUM CK	GCR_000070	8500	154.83	161.40	161.51	0.11	161.78	161.85	0.07	162.05	162.13	0.08
CRINUM CK	GCR_000060	9500	154.40	161.11	161.19	0.08	161.58	161.73	0.14	161.92	161.98	0.06
CRINUM CK	GCR_000053	10200	154.40	161.02	161.13	0.11	161.58	161.68	0.10	161.88	161.92	0.04
CRINUM CK	GCR_000053	10200	154.40	161.02	161.13	0.11	161.53	161.68	0.15	161.88	161.92	0.04
CRINUM CK	GCR_000045	10900	153.91	161.00	161.11	0.11	161.52	161.66	0.14	161.88	161.90	0.02
CRINUM CK	GCR_000040	11400	153.13	161.00	161.11	0.11	161.51	161.65	0.14	161.87	161.89	0.02
CRINUM CK	GCR_000034	12000	153.13	160.99	161.11	0.12	161.50	161.65	0.15	161.86	161.88	0.02
CRINUM CK	GCR_000034	12000	153.13	160.99	161.11	0.12	161.50	161.65	0.15	161.86	161.88	0.02
CRINUM CK	GCR_000030	12300	153.00	160.99	161.11	0.11	161.50	161.65	0.15	161.86	161.88	0.02
CRINUM CK	GCR_000020	13300	151.68	160.98	161.10	0.12	161.49	161.64	0.15	161.86	161.86	0.00
CRINUM CK	GCR_000015	13800	151.68	160.97	161.09	0.12	161.49	161.63	0.13	161.85	161.85	0.00
CRINUM CK	GCR_000015	13800	151.68	160.97	161.09	0.12	161.49	161.63	0.13	161.85	161.85	0.00
CRINUM CK	GCR_000008	14400	150.39	160.66	160.76	0.10	161.15	161.26	0.11	161.50	161.48	-0.02

Water Level				1 in 20 year ARI Results (mAHD)			1 in 50 year ARI Results (mAHD)			1 in 100 year ARI Results (mAHD)		
Name of Watercourse	**X-SECT Name**	**MIKE 11 Chainage**	**Bed EL**	**RUBICON CASE 086**	**MIKE11 CASE 086**	**difference** (mAHD)	**RUBICON CASE 086**	**MIKE11 CASE 086**	**difference** (mAHD)	**RUBICON CASE 086**	**MIKE11 CASE 086**	**difference** (mAHD)
CRINUM CK	GCR_000006	14500	149.84	160.59	160.69	0.10	161.07	161.17	0.10	161.42	161.39	-0.03
CRINUM CK	GCR_000006	14500	149.84	160.59	160.69	0.10	161.07	161.17	0.10	161.42	161.39	-0.03
CRINUM CK	GCR_000000	15100	149.84	160.46	160.59	0.13	160.92	161.08	0.16	161.42	161.31	-0.11
MOSQUITO CK	GMO_000052	0	166.31	166.31	166.31	0.00	N/A	166.31	N/A	N/A	166.31	N/A
MOSQUITO CK	GMO_000048	400	165.17	165.17	165.17	0.00	N/A	165.17	N/A	N/A	165.17	N/A
MOSQUITO CK	GMO_000042	1000	163.79	163.79	163.79	0.00	N/A	163.79	N/A	N/A	163.79	N/A
MOSQUITO CK	GMO_000033	1900	162.98	162.98	162.97	-0.01	N/A	162.97	N/A	N/A	162.97	N/A
MOSQUITO CK	GMO_000028	2400	162.25	162.25	162.25	0.00	N/A	162.25	N/A	N/A	162.25	N/A
MOSQUITO CK	GMO_000020	3200	160.97	161.02	161.13	0.11	161.53	161.68	0.15	161.88	161.92	0.04
MOSQUITO CK	GMO_000010	4200	158.36	161.02	161.13	0.11	161.53	161.68	0.15	161.88	161.92	0.04
MOSQUITO CK	GMO_000000	5200	156.36	161.02	161.13	0.11	161.53	161.68	0.15	161.88	161.92	0.04
GORDONSTONE CK	GGO_000092	0	161.52	164.07	163.91	-0.16	164.38	164.24	-0.14	164.59	164.47	-0.12
GORDONSTONE CK	GGO_000080	1200	160.63	163.04	162.89	-0.15	163.29	163.22	-0.07	163.47	163.45	-0.02
GORDONSTONE CK	GGO_000074	1800	160.00	162.71	162.52	-0.19	162.98	162.84	-0.14	163.17	162.95	-0.22
GORDONSTONE CK	GGO_000062	3000	159.57	161.70	161.52	-0.18	162.05	161.94	-0.12	162.19	162.08	-0.11
GORDONSTONE CK	GGO_000055	3700	157.92	161.00	161.12	0.12	161.51	161.66	0.15	161.87	161.89	0.02
GORDONSTONE CK	GGO_000045	4700	157.33	160.99	161.11	0.12	161.51	161.65	0.14	161.86	161.88	0.02
GORDONSTONE CK	GGO_000033	5900	157.07	160.99	161.11	0.12	161.51	161.65	0.14	161.86	161.88	0.02
GORDONSTONE CK	GGO_000023	6900	156.31	160.99	161.11	0.12	161.50	161.65	0.15	161.86	161.88	0.02
GORDONSTONE CK	GGO_000016	7600	155.94	160.99	161.11	0.12	161.50	161.65	0.15	161.86	161.88	0.02
GORDONSTONE CK	GGO_000012	8000	155.75	160.99	161.11	0.12	161.50	161.65	0.15	161.86	161.88	0.02
GORDONSTONE CK	GGO_000008	8400	155.14	160.99	161.11	0.12	161.50	161.65	0.15	161.86	161.88	0.02
GORDONSTONE CK	GGO_000000	9200	153.14	160.99	161.11	0.12	161.50	161.65	0.15	161.86	161.88	0.02
UNNAMED CK	GUN_000056	0	162.55	162.55	162.55	0.00	N/A	162.55	N/A	N/A	162.55	N/A
UNNAMED CK	GUN_000050	600	161.77	161.77	161.77	0.00	N/A	161.77	N/A	N/A	161.77	N/A
UNNAMED CK	GUN_000042	1400	159.15	160.22	159.53	-0.69	160.59	160.15	-0.44	160.88	160.44	-0.44
UNNAMED CK	GUN_000034	2200	157.87	160.22	159.53	-0.69	160.59	160.15	-0.44	160.88	160.44	-0.44
UNNAMED CK	GUN_000020	3600	155.73	160.22	159.53	-0.69	160.59	160.15	-0.44	160.88	160.44	-0.44
UNNAMED CK	GUN_000020	3600	155.73	160.59	159.53	-1.06	160.59	160.15	-0.44	161.42	160.44	-0.98
UNNAMED CK	GUN_000000	5600	155.73	160.59	160.69	0.10	161.07	161.17	0.10	161.42	161.39	-0.03
BCO_L03	GCOL03_008	0	148.43	152.93	152.75	-0.18	N/A	153.57	N/A	N/A	154.00	N/A
BCO_L03	GCOL03_000	800	148.43	152.81	152.89	0.08	N/A	153.64	N/A	N/A	154.04	N/A
BCO_L05	GCOL05_010	0	143.91	150.96	151.34	0.38	152.00	152.22	0.22	152.78	152.74	-0.04
BCO_L05	GCOL05_000	1000	143.91	151.18	150.96	-0.22	152.18	152.01	-0.17	152.74	152.60	-0.14
BNO_L02	GNOL02_050	0	155.46	159.02	159.53	0.51	N/A	160.15	N/A	N/A	160.44	N/A
BNO_L02	GNOL02_046	400	155.46	158.75	159.26	0.51	N/A	159.89	N/A	N/A	160.17	N/A
BNO_L02	GNOL02_038	1200	154.08	158.10	158.70	0.60	N/A	159.25	N/A	N/A	159.51	N/A
BNO_L02	GNOL02_030	2000	153.86	157.63	158.26	0.63	158.09	158.70	0.61	158.44	158.95	0.51
BNO_L02	GNOL02_022	2800	152.81	157.27	157.70	0.43	157.82	158.15	0.33	158.23	158.45	0.22
BNO_L02	GNOL02_016	3400	152.21	157.14	157.21	0.07	157.73	157.81	0.08	158.16	158.19	0.03
BNO_L02	GNOL02_010	4000	149.77	157.1	157.04	-0.06	157.70	157.67	-0.03	158.13	158.06	-0.07
BNO_L02	GNOL02_000	5000	149.77	157.06	156.94	-0.12	157.66	157.53	-0.13	158.09	157.90	-0.19
WINTON CK	GWI_000332	0	166.5	167.10	167.06	-0.04	167.11	167.05	-0.06	167.11	167.06	-0.06
WINTON CK	GWI_000326	600	165.61	165.85	165.95	0.10	165.99	165.95	-0.04	165.99	165.95	-0.04
WINTON CK	GWI_000319	1300	164.29	165.41	165.29	-0.12	165.55	165.22	-0.33	165.66	165.29	-0.38
WINTON CK	GWI_000313	1900	163.83	165.40	165.27	-0.13	165.55	165.18	-0.37	165.65	165.26	-0.39
WINTON CK	GWI_000305	2700	163.32	165.16	165.26	0.09	165.31	165.16	-0.15	165.43	165.25	-0.18

Water Level				1 in 20 year ARI Results (mAHD)			1 in 50 year ARI Results (mAHD)			1 in 100 year ARI Results (mAHD)		
Name of Watercourse	X-SECT Name	MIKE 11 Chainage	Bed EL	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)
WINTON CK	GWI_000301	3100	163.12	164.70	164.81	0.11	164.87	164.73	-0.15	164.98	164.81	-0.17
WINTON CK	GWI_000296	3600	162.36	164.34	164.38	0.04	164.48	164.31	-0.17	164.58	164.37	-0.21
WINTON CK	GWI_000288	4400	161.89	163.42	163.54	0.12	163.57	163.45	-0.13	163.67	163.53	-0.14
WINTON CK	GWI_000280	5200	160.64	162.45	162.54	0.09	162.62	162.46	-0.16	162.72	162.53	-0.19
WINTON CK	GWI_000276	5600	159.61	162.08	162.21	0.13	162.25	162.13	-0.13	162.36	162.20	-0.16
WINTON CK	GWI_000269	6300	159.53	161.48	161.55	0.07	161.65	161.46	-0.19	161.78	161.55	-0.23
WINTON CK	GWI_000263	6900	159.52	161.27	161.33	0.06	161.44	161.25	-0.19	161.56	161.33	-0.23
WINTON CK	GWI_000259	7300	159.37	161.14	161.21	0.07	161.31	161.12	-0.19	161.43	161.20	-0.23
WINTON CK	GWI_000253	7900	159.44	160.91	160.99	0.08	161.08	160.90	-0.18	161.21	160.98	-0.23
WINTON CK	GWI_000247	8400	159.10	160.81	160.90	0.09	160.98	160.80	-0.18	161.10	160.89	-0.21
WINTON CK	GWI_000247	8400	159.10	160.81	160.90	0.09	160.98	160.80	-0.18	161.10	160.89	-0.21
WINTON CK	GWI_000239	9200	158.14	160.57	160.74	0.17	160.71	160.65	-0.06	160.81	160.73	-0.08
WINTON CK	GWI_000232	9900	157.73	160.26	160.20	-0.06	160.33	160.15	-0.18	160.38	160.19	-0.19
WINTON CK	GWI_000224	10700	157.49	158.94	159.02	0.08	159.05	158.97	-0.08	159.12	159.01	-0.11
WINTON CK	GWI_000220	11100	156.55	158.46	158.50	0.04	158.63	158.41	-0.22	158.72	158.49	-0.23
WINTON CK	GWI_000220	11100	156.55	158.46	158.50	0.04	158.63	158.41	-0.22	158.72	158.49	-0.23
WINTON CK	GWI_000214	11600	156.55	158.41	158.44	0.03	158.57	158.35	-0.22	158.66	158.43	-0.23
WINTON CK	GWI_000205	12500	156.27	157.98	158.12	0.14	158.15	158.05	-0.10	158.25	158.12	-0.13
WINTON CK	GWI_000200	13000	155.76	157.53	157.52	-0.01	157.69	157.41	-0.28	157.96	157.51	-0.45
WINTON CK	GWI_000193	13700	155.41	156.79	156.73	-0.06	157.64	156.90	-0.74	157.95	157.21	-0.74
WINTON CK	GWI_000185	14500	155.25	156.78	156.36	-0.42	157.63	156.89	-0.74	157.95	157.21	-0.74
WINTON CK	GWI_000180	15000	155.25	156.78	156.35	-0.43	157.63	156.89	-0.74	157.95	157.21	-0.74
WINTON CK	GWI_000175	15500	153.78	156.77	156.34	-0.43	157.63	156.89	-0.74	157.95	157.21	-0.74
WINTON CK	GWI_000175	15500	153.78	156.77	156.34	-0.43	157.63	156.89	-0.74	157.95	157.21	-0.74
WINTON CK	GWI_000170	15900	153.78	156.60	156.17	-0.43	157.47	156.69	-0.78	157.80	157.00	-0.80
WINTON CK	GWI_000166	16300	152.91	156.45	156.01	-0.44	157.32	156.49	-0.83	157.65	156.81	-0.84
WINTON CK	GWI_000160	16900	153.01	156.24	155.79	-0.45	157.11	156.24	-0.87	157.43	156.59	-0.84
WINTON CK	GWI_000152	17700	153.04	155.56	155.18	-0.38	156.40	155.63	-0.77	156.72	156.02	-0.70
WINTON CK	GWI_000147	18200	152.39	154.66	154.32	-0.34	155.62	155.01	-0.61	156.03	155.49	-0.54
WINTON CK	GWI_000138	19100	150.97	153.97	153.77	-0.20	155.04	154.70	-0.34	155.54	155.21	-0.33
WINTON CK	GWI_000128	20100	149.88	153.63	153.62	-0.01	154.69	154.59	-0.10	155.24	155.11	-0.13
WINTON CK	GWI_000110	21900	147.01	153.34	153.53	0.19	154.30	154.50	0.20	154.93	155.02	0.09
WINTON CK	GWI_000110	21900	147.01	153.34	153.53	0.19	154.30	154.50	0.20	154.93	155.02	0.09
WINTON CK	GWI_000100	22800	149.46	152.91	153.30	0.39	153.86	154.20	0.34	154.54	154.72	0.18
WINTON CK	GWI_000093	23500	147.74	152.26	152.67	0.41	153.25	153.47	0.22	154.01	153.98	-0.03
WINTON CK	GWI_000086	24200	148.91	152.08	152.34	0.26	153.14	153.19	0.05	153.94	153.73	-0.21
WINTON CK	GWI_000080	24800	147.11	151.93	152.14	0.21	153.07	153.07	0.00	153.90	153.65	-0.25
WINTON CK	GWI_000072	25600	144.97	151.83	151.93	0.10	153.03	152.95	-0.08	153.88	153.56	-0.32
WINTON CK	GWI_000064	26400	144.58	151.79	151.83	0.04	153.01	152.89	-0.12	153.86	153.51	-0.35
WINTON CK	GWI_000055	27300	146.09	151.74	151.72	-0.02	152.97	152.82	-0.15	153.83	153.44	-0.39
WINTON CK	GWI_000050	27800	145.53	151.65	151.60	-0.05	152.88	152.72	-0.16	153.74	153.34	-0.40
WINTON CK	GWI_000042	28600	145.53	151.37	151.14	-0.23	152.57	152.34	-0.23	153.44	152.96	-0.48
WINTON CK	GWI_000035	29300	144.86	151.29	150.91	-0.38	152.49	152.18	-0.31	153.37	152.81	-0.56
WINTON CK	GWI_000031	29700	145.01	151.27	150.84	-0.43	152.45	152.12	-0.33	153.34	152.75	-0.59
WINTON CK	GWI_000025	30300	145.08	151.23	150.79	-0.44	152.42	152.06	-0.36	153.30	152.69	-0.61
WINTON CK	GWI_000022	30600	144.08	151.23	150.78	-0.45	152.41	152.05	-0.36	153.29	152.68	-0.61
WINTON CK	GWI_000020	30800	143.13	151.23	150.77	-0.46	152.41	152.04	-0.37	153.29	152.67	-0.62

Water Level				1 in 20 year ARI Results (mAHD)			1 in 50 year ARI Results (mAHD)			1 in 100 year ARI Results (mAHD)		
Name of Watercourse	**X-SECT Name**	**MIKE 11 Chainage**	**Bed EL**	**RUBICON CASE 086**	**MIKE11 CASE 086**	**difference** (mAHD)	**RUBICON CASE 086**	**MIKE11 CASE 086**	**difference** (mAHD)	**RUBICON CASE 086**	**MIKE11 CASE 086**	**difference** (mAHD)
WINTON CK	GWI_000010	31800	142.24	151.22	150.76	-0.46	152.39	152.03	-0.36	153.28	152.65	-0.63
WINTON CK	GWI_000005	32200	140.45	151.22	150.75	-0.47	152.39	152.02	-0.37	153.27	152.64	-0.63
WINTON CK	GWI_000000	32700	138.45	151	150.75	-0.46	152.38	152.01	-0.37	153.27	152.64	-0.64
RETREAT CK	GRE_000215	0	172.21	177.48	177.44	-0.04	177.80	177.74	-0.06	178.05	177.96	-0.09
RETREAT CK	GRE_000210	500	172.24	177.16	177.10	-0.06	177.48	177.37	-0.11	177.72	177.58	-0.14
RETREAT CK	GRE_000206	900	172.34	176.77	176.70	-0.07	177.07	176.96	-0.11	177.31	177.15	-0.16
RETREAT CK	GRE_000196	1900	171.85	175.73	175.63	-0.10	176.14	175.92	-0.22	176.48	176.17	-0.31
RETREAT CK	GRE_000190	2500	170.83	175.49	175.26	-0.23	175.96	175.61	-0.35	176.30	175.89	-0.42
RETREAT CK	GRE_000185	3000	170.83	175.42	175.20	-0.22	175.88	175.56	-0.32	176.23	175.83	-0.40
RETREAT CK	GRE_000185	3000	170.83	175.42	175.20	-0.22	175.88	175.56	-0.32	176.23	175.83	-0.40
RETREAT CK	GRE_000174	3600	169.63	175.33	174.95	-0.38	175.80	175.34	-0.46	176.15	175.63	-0.52
RETREAT CK	GRE_000170	4000	169.13	175.29	174.79	-0.50	175.77	175.22	-0.55	176.12	175.53	-0.59
RETREAT CK	GRE_000165	4500	168.47	175.22	174.68	-0.54	175.69	175.13	-0.56	176.04	175.43	-0.61
RETREAT CK	GRE_000160	5000	168.73	175.14	174.58	-0.56	175.59	175.02	-0.57	175.92	175.32	-0.60
RETREAT CK	GRE_000149	6000	165.78	174.89	173.99	-0.90	175.27	174.37	-0.90	175.53	174.61	-0.92
RETREAT CK	GRE_000149	6000	165.78	174.89	173.99	-0.90	175.27	174.37	-0.90	175.53	174.61	-0.92
RETREAT CK	GRE_000145	6500	164.87	174.85	174.10	-0.75	175.20	174.39	-0.81	175.43	174.61	-0.82
RETREAT CK	GRE_000145	6500	164.87	174.85	174.10	-0.75	175.20	174.39	-0.81	175.43	174.61	-0.82
RETREAT CK	GRE_000141	6900	164.96	174.40	173.20	-1.20	174.83	173.56	-1.28	175.10	173.77	-1.33
RETREAT CK	GRE_000135	7500	164.31	174.16	172.86	-1.30	174.61	173.14	-1.47	174.89	173.37	-1.52
RETREAT CK	GRE_000122	8800	163.40	173.82	172.43	-1.39	174.29	172.69	-1.60	174.59	172.90	-1.69
RETREAT CK	GRE_000117	9300	163.01	173.47	172.22	-1.25	173.92	172.45	-1.47	174.19	172.61	-1.58
RETREAT CK	GRE_000112	9700	163.01	172.19	172.17	-0.02	N/A	172.39	N/A	172.34	172.54	0.20
RETREAT CK	GRE_000112	9700	163.01	172.19	172.17	-0.02	N/A	172.39	N/A	172.34	172.54	0.20
RETREAT CK	GRE_000109	10200	163.10	171.88	171.82	-0.06	172.14	172.04	-0.10	N/A	172.19	N/A
RETREAT CK	GRE_000109	10200	163.10	171.88	171.82	-0.06	172.14	172.04	-0.10	N/A	172.19	N/A
RETREAT CK	GRE_000105	10600	161.64	171.69	171.58	-0.11	171.96	171.80	-0.16	172.16	171.97	-0.19
RETREAT CK	GRE_000095	11600	161.45	171.13	171.01	-0.12	171.42	171.24	-0.18	171.64	171.42	-0.22
RETREAT CK	GRE_000089	12200	161.06	170.84	170.77	-0.07	171.13	170.99	-0.14	171.34	171.17	-0.18
RETREAT CK	GRE_000084	12800	161.06	170.32	170.41	0.09	170.58	170.62	0.04	170.77	170.79	0.02
RETREAT CK	GRE_000084	12800	161.06	170.32	170.41	0.09	170.58	170.62	0.04	170.77	170.79	0.02
RETREAT CK	GRE_000076	13400	160.50	169.72	170.02	0.30	170.58	170.24	-0.34	170.77	170.42	-0.36
RETREAT CK	GRE_000076	13400	160.50	169.72	170.02	0.30	170.58	170.24	-0.34	170.77	170.42	-0.36
RETREAT CK	GRE_000068	14100	159.62	169.09	169.28	0.19	169.44	169.55	0.11	169.73	169.77	0.03
RETREAT CK	GRE_000058	15100	158.71	168.56	168.77	0.21	168.97	169.08	0.11	169.32	169.35	0.03
RETREAT CK	GRE_000050	15900	158.71	168.19	168.38	0.19	168.69	168.77	0.08	169.09	169.10	0.01
RETREAT CK	GRE_000043	16600	157.72	167.98	168.11	0.13	168.53	168.58	0.05	168.96	168.95	-0.01
RETREAT CK	GRE_000038	17100	156.54	167.91	168.05	0.14	168.47	168.53	0.06	168.90	168.90	0.00
RETREAT CK	GRE_000032	17700	156.54	167.82	167.97	0.15	168.39	168.46	0.07	168.83	168.84	0.01
RETREAT CK	GRE_000025	18400	156.07	167.73	167.88	0.15	168.29	168.38	0.09	168.74	168.76	0.02
RETREAT CK	GRE_000020	18900	155.88	167.68	167.84	0.16	168.24	168.34	0.10	168.68	168.72	0.04
RETREAT CK	GRE_000013	19600	155.88	167.62	167.80	0.18	168.17	168.29	0.12	168.61	168.67	0.06
RETREAT CK	GRE_000013	19600	155.46	167.62	167.80	0.18	168.17	168.29	0.12	168.61	168.67	0.06
RETREAT CK	GRE_000001	20600	155.46	166.94	167.22	0.28	167.64	167.76	0.12	168.16	168.16	0.00
THERESA CK	GTH_000130	0	172.04	180.36	180.27	-0.09	180.63	180.50	-0.13	180.83	180.67	-0.16
THERESA CK	GTH_000112	1000	172.04	179.75	179.89	0.14	179.96	180.09	0.13	180.11	180.25	0.13
THERESA CK	GTH_000112	1000	172.04	179.75	179.89	0.14	179.96	180.09	0.13	180.11	180.25	0.13

Water Level				1 in 20 year ARI Results (mAHD)			1 in 50 year ARI Results (mAHD)			1 in 100 year ARI Results (mAHD)		
Name of Watercourse	X-SECT Name	MIKE 11 Chainage	Bed EL	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)
THERESA CK	GTH_000105	1700	171.18	179.65	179.80	0.15	179.86	180.01	0.15	180.01	180.16	0.15
THERESA CK	GTH_000095	2700	170.82	179.37	179.53	0.16	179.57	179.73	0.16	179.71	179.87	0.16
THERESA CK	GTH_000080	4200	170.42	178.73	178.80	0.07	178.93	178.97	0.04	179.07	179.11	0.04
THERESA CK	GTH_000073	4900	169.80	178.24	178.30	0.06	178.47	178.49	0.02	178.63	178.64	0.01
THERESA CK	GTH_000063	5900	168.71	177.76	177.79	0.03	178.02	178.01	-0.01	178.22	178.17	-0.05
THERESA CK	GTH_000063	5900	168.71	177.76	177.79	0.03	178.02	178.01	-0.01	178.22	178.17	-0.05
THERESA CK	GTH_000052	6400	167.42	177.45	177.50	0.05	177.72	177.73	0.01	177.93	177.90	-0.03
THERESA CK	GTH_000042	7400	166.83	177.13	177.11	-0.02	177.40	177.34	-0.06	177.61	177.52	-0.10
THERESA CK	GTH_000035	8100	166.56	176.87	176.80	-0.07	177.14	177.03	-0.11	177.34	177.20	-0.14
THERESA CK	GTH_000030	8600	166.04	176.48	176.35	-0.13	176.71	176.55	-0.17	176.89	176.69	-0.20
THERESA CK	GTH_000023	9200	166.28	175.43	175.45	0.02	175.58	175.57	-0.01	175.70	175.66	-0.04
THERESA CK	GTH_000023	9200	166.28	175.43	175.45	0.02	175.58	175.57	-0.01	175.70	175.66	-0.04
THERESA CK	GTH_000014	9800	166.01	175.24	175.04	-0.20	175.44	175.19	-0.25	175.60	175.30	-0.31
THERESA CK	GTH_000005	10700	166.18	174.85	174.10	-0.75	175.20	174.39	-0.81	175.43	174.61	-0.82
BTH_L01	GTHL01_048	0	172.09	175.43	175.45	0.02	175.58	175.57	-0.01	175.70	175.66	-0.04
BTH_L01	GTHL01_045	300	172.03	174.82	174.96	0.14	174.99	175.07	0.08	175.15	175.14	-0.01
BTH_L01	GTHL01_040	800	171.09	174.02	174.00	-0.02	174.32	174.14	-0.18	174.58	174.26	-0.33
BTH_L01	GTHL01_036	1200	170.36	173.85	173.71	-0.14	174.18	173.88	-0.30	174.46	174.01	-0.45
BTH_L01	GTHL01_028	2000	170.11	173.42	173.25	-0.17	173.78	173.44	-0.34	174.06	173.58	-0.48
BTH_L01	GTHL01_017	2900	169.37	173.12	172.91	-0.21	173.47	173.10	-0.37	173.74	173.24	-0.50
BTH_L01	GTHL01_012	3400	169.35	172.98	172.75	-0.23	173.31	172.94	-0.37	173.58	173.07	-0.51
BTH_L01	GTHL01_005	4100	169.15	172.19	172.17	-0.02	172.44	172.39	-0.05	172.63	172.54	-0.09
BTH_R01-R03	GTHR01_023	0	174.31	179.75	179.89	0.14	179.96	180.09	0.13	180.11	180.25	0.13
BTH_R01-R03	GTHR01_020	500	174.31	179.54	179.61	0.07	179.72	179.78	0.06	179.85	179.91	0.06
BTH_R01-R03	GTHR01_010	1500	174.31	179.05	179.15	0.09	179.17	179.25	0.08	179.28	179.35	0.07
BTH_R01-R03	GTHR01_000	2500	173.30	177.82	177.82	0.00	178.09	178.04	-0.05	178.29	178.21	-0.08
BTH_R01-R03	GTHR01_000	2500	173.30	177.82	177.82	0.00	178.09	178.04	-0.05	178.29	178.21	-0.08
BTH_R01-R03	GTHR03_042	3800	173.30	177.28	177.27	-0.01	177.60	177.52	-0.08	177.85	177.71	-0.14
BTH_R01-R03	GTHR03_034	4600	175.05	176.93	176.82	-0.11	177.29	177.15	-0.14	177.56	177.38	-0.18
BTH_R01-R03	GTHR03_028	5200	174.36	176.82	176.69	-0.13	177.19	177.03	-0.16	177.45	177.26	-0.19
BTH_R01-R03	GTHR03_020	6000	174.08	176.70	176.57	-0.13	177.04	176.89	-0.15	177.29	177.10	-0.19
BTH_R01-R03	GTHR03_010	7000	174.08	176.15	176.15	0.00	176.48	176.44	-0.04	176.74	176.61	-0.13
BTH_R01-R03	GTHR03_000	8000	172.26	175.42	175.20	-0.22	175.88	175.56	-0.32	176.23	175.83	-0.40
BNO_L07-08-09	GNOL07_010	0	171.35	173.33	173.06	-0.27	174.41	174.10	-0.31	174.94	174.59	-0.35
BNO_L07-08-09	GNOL08_023	1000	171.35	172.58	172.64	0.06	173.73	173.70	-0.03	174.46	174.15	-0.31
BNO_L07-08-09	GNOL08_023	1000	171.35	172.58	172.64	0.06	173.73	173.70	-0.03	174.46	174.15	-0.31
BNO_L07-08-09	GNOL08_014	1900	171.00	172.37	172.36	-0.01	173.55	173.35	-0.20	174.32	173.84	-0.48
BNO_L07-08-09	GNOL08_005	2800	170.42	172.27	172.18	-0.09	173.41	173.12	-0.29	174.14	173.53	-0.61
BNO_L07-08-09	GNOL09_045	3300	170.42	172.22	172.09	-0.13	173.33	173.01	-0.32	174.02	173.35	-0.67
BNO_L07-08-09	GNOL09_045	3300	170.42	172.22	172.09	-0.13	173.33	173.01	-0.32	174.02	173.35	-0.67
BNO_L07-08-09	GNOL09_040	3800	170.58	172.18	172.00	-0.18	173.28	172.95	-0.34	173.94	173.29	-0.65
BNO_L07-08-09	GNOL09_031	4700	169.99	172.15	171.89	-0.26	173.21	172.85	-0.36	173.85	173.21	-0.64
BNO_L07-08-09	GNOL09_025	5300	168.99	172.05	171.87	-0.19	173.12	172.82	-0.30	173.75	173.18	-0.57
BNO_L07-08-09	GNOL09_015	6300	169.06	171.90	171.84	-0.06	173.00	172.78	-0.22	173.61	173.15	-0.46
BNO_L07-08-09	GNOL09_010	7000	169.34	171.89	171.79	-0.10	172.97	172.74	-0.23	173.56	173.12	-0.44
BNO_L07-08-09	GNOL09_005	7800	167.24	171.88	171.76	-0.12	172.95	172.71	-0.24	173.54	173.10	-0.44
BRE_R02-4-6-7-13-14	GRER02_010	0	168.53	174.89	173.99	-0.90	175.27	174.37	-0.90	175.53	174.61	-0.92

Water Level				1 in 20 year ARI Results (mAHD)			1 in 50 year ARI Results (mAHD)			1 in 100 year ARI Results (mAHD)		
Name of Watercourse	X-SECT Name	MIKE 11 Chainage	Bed EL	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)
BRE_R02-4-6-7-13-14	GRER04_018	1000	168.55	172.77	173.26	0.49	173.05	173.61	0.56	173.27	173.83	0.55
BRE_R02-4-6-7-13-14	GRER04_018	1000	168.55	172.77	173.26	0.49	173.05	173.61	0.56	173.27	173.83	0.55
BRE_R02-4-6-7-13-14	GRER04_012	1600	169.50	172.54	173.00	0.46	172.8	173.31	0.51	173.00	173.49	0.49
BRE_R02-4-6-7-13-14	GRER04_007	2100	169.38	172.21	172.23	0.01	172.45	172.45	0.00	172.64	172.58	-0.06
BRE_R02-4-6-7-13-14	GRER04_007	2100	169.38	172.21	172.23	0.01	172.45	172.45	0.00	172.64	172.58	-0.06
BRE_R02-4-6-7-13-14	GRER07_018	2600	169.36	170.80	171.15	0.35	171.15	171.31	0.16	171.29	171.45	0.16
BRE_R02-4-6-7-13-14	GRER07_018	2600	169.36	170.80	171.15	0.35	171.15	171.31	0.16	171.29	171.45	0.16
BRE_R02-4-6-7-13-14	GRER07_008	3600	168.09	170.16	170.52	0.36	170.51	170.77	0.26	170.70	170.96	0.26
BRE_R02-4-6-7-13-14	GRER07_000	4400	167.35	170.01	170.39	0.38	170.28	170.60	0.31	170.46	170.76	0.30
BRE_R02-4-6-7-13-14	GRER07_000	4400	167.35	170.01	170.39	0.38	170.28	170.60	0.31	170.46	170.76	0.30
BRE_R02-4-6-7-13-14	GRER13_029	5500	168.55	169.88	169.76	-0.12	N/A	169.97	N/A	N/A	170.14	N/A
BRE_R02-4-6-7-13-14	GRER13_020	6400	167.91	169.60	169.39	-0.21	N/A	169.60	N/A	N/A	169.76	N/A
BRE_R02-4-6-7-13-14	GRER13_010	7400	165.97	168.44	168.57	0.13	N/A	168.82	N/A	N/A	169.06	N/A
BRE_R02-4-6-7-13-14	GRER14_032	7900	164.52	167.85	168.04	0.19	N/A	168.49	N/A	N/A	168.85	N/A
BRE_R02-4-6-7-13-14	GRER14_032	7900	164.52	167.85	168.04	0.19	N/A	168.49	N/A	N/A	168.85	N/A
BRE_R02-4-6-7-13-14	GRER14_020	9100	163.09	167.69	167.88	0.19	N/A	168.37	N/A	N/A	168.75	N/A
BRE_R02-4-6-7-13-14	GRER14_010	10100	161.98	167.63	167.82	0.19	N/A	168.31	N/A	N/A	168.69	N/A
BRE_R02-4-6-7-13-14	GRER14_005	10600	160.11	167.62	167.80	0.18	N/A	168.29	N/A	N/A	168.67	N/A
BRE_R09-10-12	GRER09_010	0	169.36	170.80	171.15	0.35	171.15	171.31	0.16	171.29	171.45	0.16
BRE_R09-10-12	GRER09_007	250	170.46	170.46	171.12	0.66	N/A	171.26	N/A	N/A	171.39	N/A
BRE_R09-10-12	GRER10_019	500	169.64	169.92	170.77	0.85	170.51	170.97	0.46	170.79	171.11	0.32
BRE_R09-10-12	GRER10_019	500	169.64	169.92	170.77	0.85	170.51	170.97	0.46	170.79	171.11	0.32
BRE_R09-10-12	GRER10_010	1400	168.52	169.52	170.20	0.68	170.08	170.37	0.29	170.03	170.46	0.43
BRE_R09-10-12	GRER12_020	1900	167.40	168.05	169.07	1.02	N/A	169.28	N/A	169.02	169.42	0.40
BRE_R09-10-12	GRER12_020	1900	167.40	168.05	169.07	1.02	N/A	169.28	N/A	169.02	169.42	0.40
BRE_R09-10-12	GRER12_010	2900	165.96	167.85	168.12	0.27	N/A	168.54	N/A	168.78	168.89	0.11
BRE_R09-10-12	GRER12_002	3700	164.52	167.85	168.04	0.19	N/A	168.49	N/A	168.78	168.85	0.07
BNO_L10	GNOL10_010	0	170.71	170.71	170.77	0.06	170.51	170.97	0.46	170.79	171.11	0.32
BNO_L10	GNOL10_005	1000	172.54	172.54	172.09	-0.45	173.33	173.01	-0.32	174.02	173.35	-0.67
BNO_L06-4	GNOL06_010	0	171.35	172.58	172.64	0.06	173.73	173.70	-0.03	174.46	174.15	-0.31
BNO_L06-4	GNOL04_043	1000	172.69	172.69	172.69	0.00	173.17	173.24	0.07	173.53	173.38	-0.15
BNO_L06-4	GNOL04_038	1500	172.24	172.24	172.19	-0.05	172.95	172.84	-0.11	173.24	172.98	-0.26
BNO_L06-4	GNOL04_029	2400	171.62	171.62	171.62	0.00	172.22	172.11	-0.11	172.33	172.22	-0.12
BNO_L06-4	GNOL04_021	3200	170.81	170.81	171.15	0.34	171.67	171.48	-0.19	171.84	171.62	-0.22
BNO_L06-4	GNOL04_014	3900	170.60	170.8	171.15	0.35	171.18	171.31	0.13	171.29	171.45	0.16
BNO_L06-4	GNOL04_007	4600	169.36	170.80	171.15	0.35	171.15	171.31	0.16	171.29	171.45	0.16
BRE_R08	GRER08_010	0	167.35	170.01	170.39	0.38	170.28	170.60	0.31	170.46	170.76	0.30
BRE_R08	GRER08_000	1000	161.06	170.32	170.41	0.09	170.58	170.62	0.04	170.77	170.79	0.02
BRE_R05	GRER05_012	0	169.38	172.21	172.23	0.01	172.45	172.45	0.00	172.64	172.58	-0.06
BRE_R05	GRER05_004	800	168.36	172.20	172.17	-0.03	172.45	172.39	-0.06	172.64	172.54	-0.10
BRE_R03	GRER03_026	0	168.55	172.77	173.26	0.49	173.05	173.61	0.56	173.27	173.83	0.55
BRE_R03	GRER03_021	500	167.69	172.69	173.16	0.47	172.98	173.52	0.54	173.20	173.74	0.54
BRE_R03	GRER03_012	1400	167.41	172.49	172.89	0.40	172.78	173.26	0.48	173.00	173.47	0.47
BRE_R03	GRER03_001	2600	166.55	172.20	172.17	-0.03	172.45	172.39	-0.06	172.64	172.54	-0.10
BRE_L01	GREL01_030	0	164.67	171.90	171.82	-0.08	172.16	172.04	-0.12	172.36	172.19	-0.17
BRE_L01	GREL01_019	1100	165.73	171.20	171.17	-0.03	171.44	171.38	-0.06	171.63	171.52	-0.11
BRE_L01	GREL01_014	1600	165.50	170.73	170.67	-0.06	171.01	170.91	-0.10	171.24	171.06	-0.18

Water Level				1 in 20 year ARI Results (mAHD)			1 in 50 year ARI Results (mAHD)			1 in 100 year ARI Results (mAHD)		
Name of Watercourse	X-SECT Name	MIKE 11 Chainage	Bed EL	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)
BRE_L01	GREL01_005	2500	162.74	170.40	170.11	-0.29	170.71	170.35	-0.37	170.97	170.53	-0.44
BRE_L01	GREL01_000	3000	162.74	170.36	170.02	-0.34	170.67	170.24	-0.43	170.92	170.42	-0.50
BRE_L02-04	GREL02_050	0	162.74	170.36	170.02	-0.34	170.67	170.24	-0.43	170.92	170.42	-0.50
BRE_L02-04	GREL02_042	800	162.65	170.11	169.75	-0.36	170.46	169.99	-0.47	170.75	170.18	-0.57
BRE_L02-04	GREL02_030	2000	162.12	169.87	169.37	-0.50	170.26	169.65	-0.61	170.59	169.87	-0.72
BRE_L02-04	GREL02_020	3000	161.44	169.67	169.09	-0.58	170.11	169.39	-0.72	170.46	169.63	-0.83
BRE_L02-04	GREL02_010	4000	160.60	169.54	168.89	-0.66	170.00	169.20	-0.80	170.38	169.45	-0.93
BRE_L02-04	GREL04_048	4700	160.50	169.46	168.51	-0.95	169.94	168.84	-1.10	170.32	169.11	-1.21
BRE_L02-04	GREL04_048	4700	160.50	169.46	168.51	-0.95	169.94	168.84	-1.10	170.32	169.11	-1.21
BRE_L02-04	GREL04_040	5500	164.51	168.38	167.80	-0.58	168.72	168.00	-0.72	169.07	168.17	-0.90
BRE_L02-04	GREL04_035	6000	164.39	168.05	166.93	-1.12	168.05	167.12	-0.93	168.44	167.30	-1.14
BRE_L02-04	GREL04_030	6500	163.89	168.04	166.42	-1.62	168.02	166.67	-1.35	168.30	166.93	-1.37
BRE_L02-04	GREL04_025	7000	163.89	167.19	166.14	-1.05	167.62	166.45	-1.17	168.18	166.78	-1.40
BRE_L02-04	GREL04_020	7500	163.38	166.76	165.73	-1.03	167.53	166.24	-1.29	168.11	166.64	-1.47
BRE_L02-04	GREL04_010	8500	161.36	166.64	165.46	-1.18	167.44	166.08	-1.36	168.03	166.53	-1.51
BRE_L02-04	GREL04_000	9500	161.36	166.58	165.37	-1.21	167.39	166.01	-1.38	167.99	166.47	-1.52
BRE_L03	GREL03_016	0	160.50	169.46	168.51	-0.95	169.94	168.84	-1.10	170.32	169.11	-1.21
BRE_L03	GREL03_008	800	160.53	169.37	168.27	-1.11	169.88	168.64	-1.24	170.29	168.94	-1.35
BRE_L03	GREL03_000	1600	160.53	169.26	167.80	-1.46	169.81	168.29	-1.52	170.25	168.67	-1.58
BTH_R02	GTHR02_020	0	173.3	177.82	177.82	0.00	178.03	178.04	0.01	178.23	178.21	-0.02
BTH_R02	GTHR02_010	1000	171.07	177.76	177.79	0.03	178.03	178.01	-0.02	178.23	178.18	-0.05
BTH_R02	GTHR02_000	2000	168.5	177.76	177.79	0.03	178.02	178.01	-0.01	178.22	178.17	-0.05
BMK_L05	GMKL05_070	0	140.08	147.34	145.32	-2.02	149.20	147.23	-1.97	150.50	148.52	-1.98
BMK_L05	GMKL05_060	1000	140.08	145.26	143.42	-1.84	147.42	145.77	-1.65	148.77	147.33	-1.44
BMK_L05	GMKL05_050	2000	140.08	144.20	143.24	-0.96	146.41	145.46	-0.95	147.78	146.99	-0.79
BMK_L05	GMKL05_040	3000	140.24	143.47	143.23	-0.24	145.64	145.37	-0.27	147.11	146.86	-0.25
BMK_L05	GMKL05_025	4500	132.40	143.33	143.23	-0.10	145.39	145.35	-0.04	146.85	146.82	-0.03
BMK_L05	GMKL05_015	5500	129.87	143.32	143.23	-0.09	145.38	145.35	-0.03	146.83	146.82	-0.01
BMK_L05	GMKL05_000	7000	129.87	143.32	143.23	-0.09	145.36	145.35	-0.02	146.80	146.81	0.01
BMK_R01-02	GMKR01_038	0	144.75	150.35	150.12	-0.23	151.49	151.19	-0.30	152.38	151.85	-0.53
BMK_R01-02	GMKR01_029	900	141.17	149.78	149.54	-0.24	151.09	150.82	-0.28	152.07	151.55	-0.52
BMK_R01-02	GMKR01_020	1800	144.13	149.20	148.99	-0.21	150.62	150.40	-0.22	151.70	151.20	-0.50
BMK_R01-02	GMKR01_010	2800	143.28	148.43	148.42	-0.01	150.11	149.99	-0.12	151.31	150.86	-0.45
BMK_R01-02	GMKR02_031	3500	136.00	148.14	147.90	-0.24	149.95	149.48	-0.47	151.19	150.42	-0.77
BMK_R01-02	GMKR02_031	3500	136.00	148.14	147.90	-0.24	149.95	149.48	-0.47	151.19	150.42	-0.77
BMK_R01-02	GMKR02_027	4000	145.18	147.84	147.66	-0.18	149.78	149.26	-0.52	151.07	150.27	-0.80
BMK_R01-02	GMKR02_020	5100	143.07	147.68	147.39	-0.29	149.69	149.04	-0.66	151.01	150.13	-0.88
BMK_R01-02	GMKR02_010	6100	133.07	147.67	147.39	-0.28	149.68	149.03	-0.66	151.01	150.12	-0.89
BMK_R01-02	GMKR02_000	7100	123.07	147.67	147.39	-0.28	149.68	149.03	-0.66	151.01	150.12	-0.89
BMK_R03	GMKR03_080	0	136.00	148.14	147.90	-0.24	149.95	149.48	-0.47	151.19	150.42	-0.77
BMK_R03	GMKR03_000	800	136.00	148.12	147.87	-0.25	149.94	149.47	-0.47	151.18	150.41	-0.77
BMK_L02	GMKL02_030	0	147.62	150.35	150.12	-0.23	151.49	151.19	-0.30	152.38	151.85	-0.53
BMK_L02	GMKL02_022	800	147.28	149.54	149.41	-0.13	150.78	150.43	-0.35	151.80	151.16	-0.64
BMK_L02	GMKL02_014	1600	145.65	148.96	148.86	-0.10	150.46	150.12	-0.34	151.57	150.90	-0.67
BMK_L02	GMKL02_009	2100	142.20	148.92	148.82	-0.10	150.42	150.08	-0.34	151.52	150.86	-0.66
BMK_L02	GMKL02_000	3000	142.20	148.91	148.81	-0.10	150.39	150.06	-0.33	151.48	150.83	-0.65
BMK_L01-04	GMKL01_092	0	143.66	148.91	148.81	-0.10	150.39	150.06	-0.33	151.48	150.83	-0.65

Water Level				1 in 20 year ARI Results (mAHD)			1 in 50 year ARI Results (mAHD)			1 in 100 year ARI Results (mAHD)		
Name of Watercourse	X-SECT Name	MIKE 11 Chainage	Bed EL	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)
BMK_L01-04	GMKL01_082	1000	147.00	148.72	148.71	-0.01	150.09	149.76	-0.33	151.19	150.49	-0.70
BMK_L01-04	GMKL01_073	1900	146.26	148.32	148.32	0.00	149.78	149.41	-0.37	150.96	150.19	-0.77
BMK_L01-04	GMKL01_063	2900	145.94	147.73	147.69	-0.04	149.46	148.97	-0.49	150.74	149.91	-0.83
BMK_L01-04	GMKL01_055	3700	144.87	147.72	147.33	-0.39	149.29	148.72	-0.57	150.62	149.76	-0.86
BMK_L01-04	GMKL01_049	4300	145.40	147.72	147.06	-0.66	149.21	148.59	-0.62	150.56	149.68	-0.88
BMK_L01-04	GMKL01_040	5200	144.81	147.72	146.79	-0.93	149.15	148.48	-0.67	150.51	149.61	-0.90
BMK_L01-04	GMKL04_050	6200	142.55	146.99	146.55	-0.44	149.12	148.29	-0.83	150.49	149.45	-1.04
BMK_L01-04	GMKL04_050	6200	142.55	146.99	146.55	-0.44	149.12	148.29	-0.83	150.49	149.45	-1.04
BMK_L01-04	GMKL04_043	6800	142.63	N/A	145.98	N/A	N/A	147.75	N/A	N/A	149.03	N/A
BMK_L01-04	GMKL04_037	7500	142.63	147.26	145.76	-1.50	149.18	147.64	-1.54	150.49	148.94	-1.55
BMK_L01-04	GMKL04_028	8400	139.80	N/A	145.59	N/A	N/A	147.52	N/A	N/A	148.84	N/A
BMK_L01-04	GMKL04_020	9200	139.80	147.30	145.53	-1.77	149.19	147.44	-1.75	150.49	148.75	-1.74
BMK_L01-04	GMKL04_010	10200	139.80	N/A	145.44	N/A	N/A	147.35	N/A	N/A	148.63	N/A
BMK_L01-04	GMKL04_004	10800	140.08	147.34	145.32	-2.02	149.20	147.23	-1.97	150.50	148.52	-1.98
BMK_L03	GMKL03_008	0	135.05	146.99	146.55	-0.44	149.12	148.29	-0.83	150.49	149.45	-1.04
BMK_L03	GMKL03_004	400	130.05	146.98	146.55	-0.43	149.11	148.29	-0.82	150.48	149.46	-1.02
BMK_L03	GMKL03_000	800	125.05	146.98	146.55	-0.43	149.11	148.29	-0.82	150.47	149.46	-1.01
BNO_L13	GNOL13_050	0	144.31	151.38	151.44	0.06	152.36	152.53	0.16	153.11	153.10	-0.01
BNO_L13	GNOL13_043	700	144.31	151.11	151.23	0.12	152.12	152.34	0.22	152.88	152.91	0.03
BNO_L13	GNOL13_038	1200	142.42	150.89	151.06	0.17	151.91	152.18	0.27	152.68	152.75	0.07
BNO_L13	GNOL13_033	1700	143.91	150.62	150.86	0.24	151.70	152.00	0.30	152.53	152.62	0.09
BNO_L13	GNOL13_030	2000	141.90	150.53	150.77	0.24	151.63	151.94	0.31	152.48	152.57	0.09
BNO_L13	GNOL13_023	2700	141.84	150.39	150.65	0.26	151.52	151.85	0.33	152.39	152.49	0.10
BNO_L13	GNOL13_020	3000	141.10	150.34	150.61	0.27	151.48	151.82	0.34	152.36	152.46	0.10
BNO_L13	GNOL13_016	3400	142.41	150.29	150.57	0.28	151.44	151.79	0.35	152.33	152.44	0.11
BNO_L13	GNOL13_010	4000	141.46	150.25	150.54	0.29	151.42	151.77	0.35	152.31	152.42	0.11
BNO_L13	GNOL13_000	5000	141.46	150.20	150.51	0.31	151.39	151.75	0.36	152.29	152.40	0.11
BNO_R22-23-24-25	GNOR22_090	0	142.64	156.20	156.14	-0.06	156.75	156.64	-0.11	157.13	156.93	-0.20
BNO_R22-23-24-25	GNOR22_078	1200	142.64	155.73	155.73	0.00	156.25	156.23	-0.02	156.61	156.50	-0.11
BNO_R22-23-24-25	GNOR22_074	1600	143.42	155.53	155.55	0.02	156.04	156.05	0.01	156.39	156.30	-0.09
BNO_R22-23-24-25	GNOR22_068	2200	141.94	155.30	155.22	-0.08	155.79	155.79	0.00	156.12	156.06	-0.06
BNO_R22-23-24-25	GNOR23_058	3000	141.46	154.96	154.84	-0.12	155.45	155.55	0.10	155.77	155.81	0.04
BNO_R22-23-24-25	GNOR23_058	3000	141.46	154.96	154.84	-0.12	155.45	155.55	0.10	155.77	155.81	0.04
BNO_R22-23-24-25	GNOR23_051	3700	142.45	154.63	154.57	-0.06	155.16	155.30	0.14	155.77	155.57	-0.20
BNO_R22-23-24-25	GNOR23_046	4200	140.83	154.36	154.34	-0.02	154.95	155.01	0.06	155.52	155.34	-0.18
BNO_R22-23-24-25	GNOR24_040	4700	140.55	154.10	154.09	-0.01	154.75	154.75	0.00	155.35	155.14	-0.21
BNO_R22-23-24-25	GNOR24_040	4700	140.55	154.10	154.09	-0.01	154.75	154.75	0.00	155.35	155.14	-0.21
BNO_R22-23-24-25	GNOR24_035	5200	139.91	153.92	153.90	-0.02	154.63	154.62	-0.01	155.10	155.04	-0.06
BNO_R22-23-24-25	GNOR24_029	5800	139.48	153.64	153.67	0.03	154.43	154.48	0.05	154.95	154.93	-0.02
BNO_R22-23-24-25	GNOR25_022	6400	140.68	153.28	153.52	0.24	154.17	154.41	0.24	154.75	154.88	0.13
BNO_R22-23-24-25	GNOR25_022	6400	140.68	153.28	153.52	0.24	154.17	154.41	0.24	154.75	154.88	0.13
BNO_R22-23-24-25	GNOR25_012	7400	139.61	152.94	153.19	0.25	153.88	154.15	0.27	154.49	154.62	0.13
BNO_R22-23-24-25	GNOR25_005	8100	138.37	152.73	153.02	0.29	153.66	153.96	0.30	154.27	154.43	0.16
BNO_R22-23-24-25	GNOR25_000	8600	138.37	152.60	152.95	0.35	153.52	153.88	0.36	154.27	154.33	0.06
BNO_R21	GNOR21_000	0	150.55	154.96	154.84	-0.12	155.45	155.55	0.10	155.77	155.81	0.04
BNO_R21	GNOR21_008	800	152.55	154.91	154.83	-0.08	155.37	155.52	0.14	155.65	155.77	0.11
BNO_R21	GNOR21_012	1200	151.44	154.81	154.51	-0.30	155.26	155.30	0.04	155.50	155.59	0.09

Water Level				1 in 20 year ARI Results (mAHD)			1 in 50 year ARI Results (mAHD)			1 in 100 year ARI Results (mAHD)		
Name of Watercourse	X-SECT Name	MIKE 11 Chainage	Bed EL	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)
BNO_R21	GNOR21_020	2000	147.01	153.34	153.53	0.19	154.30	154.50	0.20	154.93	155.02	0.09
BNO_R27	GNOR27_018	0	147.01	153.34	153.53	0.19	154.30	154.50	0.20	154.93	155.02	0.09
BNO_R27	GNOR27_010	800	146.07	153.33	153.52	0.19	154.24	154.43	0.19	154.84	154.91	0.07
BNO_R27	GNOR27_006	1200	144.54	153.32	153.52	0.20	154.22	154.42	0.20	154.81	154.89	0.08
BNO_R27	GNOR27_000	1800	144.54	153.32	153.52	0.20	154.21	154.41	0.20	154.79	154.88	0.09
BNO_R12-13-18-19	GNOR12_081	0	161.96	164.05	163.96	-0.09	164.74	164.48	-0.26	165.29	164.83	-0.46
BNO_R12-13-18-19	GNOR12_074	700	161.66	162.76	162.65	-0.11	163.14	162.93	-0.21	163.42	163.11	-0.31
BNO_R12-13-18-19	GNOR12_065	1600	159.73	160.76	160.60	-0.16	161.15	160.96	-0.19	161.46	161.22	-0.24
BNO_R12-13-18-19	GNOR12_061	2000	158.75	160.13	160.08	-0.05	160.60	160.58	-0.02	160.98	160.95	-0.03
BNO_R12-13-18-19	GNOR12_053	2800	158.15	159.69	159.86	0.17	160.10	160.41	0.31	160.49	160.82	0.33
BNO_R12-13-18-19	GNOR12_044	3700	157.78	159.54	159.83	0.28	159.80	160.36	0.56	160.11	160.77	0.66
BNO_R12-13-18-19	GNOR12_035	4600	157.73	159.45	159.81	0.36	159.52	160.34	0.82	159.80	160.75	0.95
BNO_R12-13-18-19	GNOR13_030	5000	157.73	159.40	159.81	0.41	159.19	160.34	1.15	159.45	160.75	1.30
BNO_R12-13-18-19	GNOR13_030	5000	157.73	159.40	159.81	0.41	159.19	160.34	1.15	159.45	160.75	1.30
BNO_R12-13-18-19	GNOR13_021	5900	157.42	159.06	159.28	0.22	158.79	160.03	1.24	159.10	160.54	1.44
BNO_R12-13-18-19	GNOR13_016	6400	156.75	158.89	159.01	0.12	158.64	159.88	1.24	158.91	160.45	1.54
BNO_R12-13-18-19	GNOR13_010	7000	154.96	158.75	158.48	-0.27	158.49	158.93	0.44	158.73	159.15	0.42
BNO_R12-13-18-19	GNOR18_067	8000	152.05	158.04	158.34	0.30	158.28	158.73	0.45	158.49	158.92	0.43
BNO_R12-13-18-19	GNOR18_067	8000	152.05	158.04	158.34	0.30	158.28	158.73	0.45	158.49	158.92	0.43
BNO_R12-13-18-19	GNOR18_060	8700	152.05	157.76	158.02	0.25	158.01	158.41	0.40	158.22	158.57	0.35
BNO_R12-13-18-19	GNOR18_053	9400	149.89	156.58	156.90	0.32	156.80	157.34	0.54	157.01	157.55	0.54
BNO_R12-13-18-19	GNOR18_053	9400	149.89	156.58	156.90	0.32	156.80	157.34	0.54	157.01	157.55	0.54
BNO_R12-13-18-19	GNOR19_040	10200	155.21	156.03	156.17	0.14	156.26	156.54	0.28	156.66	156.77	0.11
BNO_R12-13-18-19	GNOR19_031	11100	153.44	155.36	155.57	0.20	155.64	155.99	0.35	156.22	156.21	-0.01
BNO_R12-13-18-19	GNOR19_026	11600	153.02	155.10	155.28	0.18	155.37	155.75	0.38	155.78	155.97	0.19
BNO_R12-13-18-19	GNOR19_018	12400	152.79	154.33	154.55	0.22	154.74	155.18	0.44	155.22	155.50	0.28
BNO_R12-13-18-19	GNOR19_012	13000	151.86	153.53	153.76	0.23	154.39	154.68	0.29	155.01	155.17	0.16
BNO_R12-13-18-19	GNOR19_002	14000	147.01	153.34	153.53	0.19	154.30	154.50	0.20	154.93	155.02	0.09
BNO_R17	GNOR17_105	0	154.02	160.45	160.59	0.14	160.92	161.08	0.16	161.26	161.31	0.05
BNO_R17	GNOR17_098	700	154.05	160.27	160.33	0.06	160.72	160.79	0.07	161.07	161.03	-0.04
BNO_R17	GNOR17_090	1500	154.25	159.99	160.11	0.12	160.45	160.52	0.07	160.83	160.76	-0.08
BNO_R17	GNOR17_085	2000	153.88	159.60	159.66	0.06	160.20	160.18	-0.02	160.64	160.47	-0.17
BNO_R17	GNOR17_080	2500	153.60	159.17	158.96	-0.21	159.84	159.72	-0.12	160.29	160.04	-0.25
BNO_R17	GNOR17_073	3200	152.66	158.87	158.78	-0.09	159.45	159.43	-0.02	159.81	159.71	-0.10
BNO_R17	GNOR17_068	3700	152.05	158.04	158.34	0.30	158.28	158.73	0.45	158.49	158.92	0.43
BNO_R20	GNOR20_050	0	149.89	156.58	156.90	0.32	156.80	157.34	0.54	157.01	157.55	0.54
BNO_R20	GNOR20_043	700	149.89	156.34	156.68	0.34	156.56	157.08	0.52	156.77	157.27	0.50
BNO_R20	GNOR20_039	1100	149.20	156.20	156.53	0.33	156.42	156.90	0.48	156.64	157.08	0.44
BNO_R20	GNOR20_032	1800	149.12	155.96	156.20	0.24	156.21	156.62	0.41	156.46	156.83	0.37
BNO_R20	GNOR20_025	2500	148.83	155.85	156.00	0.15	156.12	156.49	0.37	156.38	156.71	0.33
BNO_R20	GNOR20_016	3400	149.20	155.69	155.86	0.17	155.99	156.35	0.36	156.27	156.57	0.30
BNO_R20	GNOR20_007	4300	149.04	155.35	155.41	0.06	155.72	156.00	0.28	156.03	156.24	0.21
BNO_R20	GNOR20_000	5000	149.04	154.96	154.84	-0.12	155.45	155.55	0.10	155.77	155.81	0.04
BNO_R04-5-6-7	GNOR04_005	0	158.89	165.63	165.37	-0.26	166.37	166.01	-0.36	166.98	166.47	-0.51
BNO_R04-5-6-7	GNOR05_007	500	160.06	165.54	165.23	-0.31	166.37	165.91	-0.46	166.98	166.38	-0.60
BNO_R04-5-6-7	GNOR05_007	500	160.06	165.54	165.23	-0.31	166.37	165.91	-0.46	166.98	166.38	-0.60
BNO_R04-5-6-7	GNOR06_013	1200	159.05	164.98	164.79	-0.19	165.87	165.45	-0.42	166.51	165.90	-0.61

Water Level				1 in 20 year ARI Results (mAHD)			1 in 50 year ARI Results (mAHD)			1 in 100 year ARI Results (mAHD)		
Name of Watercourse	**X-SECT Name**	**MIKE 11 Chainage**	**Bed EL**	**RUBICON CASE 086**	**MIKE11 CASE 086**	**difference** (mAHD)	**RUBICON CASE 086**	**MIKE11 CASE 086**	**difference** (mAHD)	**RUBICON CASE 086**	**MIKE11 CASE 086**	**difference** (mAHD)
BNO_R04-5-6-7	GNOR06_013	1200	159.05	164.98	164.79	-0.19	165.87	165.45	-0.42	166.51	165.90	-0.61
BNO_R04-5-6-7	GNOR06_005	2000	159.14	164.58	164.46	-0.12	165.35	165.02	-0.33	165.95	165.42	-0.53
BNO_R04-5-6-7	GNOR06_005	2000	159.14	164.58	164.46	-0.12	165.35	165.02	-0.33	165.95	165.42	-0.53
BNO_R04-5-6-7	GNOR07_000	2700	157.96	164.54	164.43	-0.11	165.30	165.01	-0.29	165.90	165.41	-0.49
BNO_R01-3	GNOR01_029	0	164.73	168.28	168.35	0.07	169.18	169.01	-0.17	169.72	169.39	-0.33
BNO_R01-3	GNOR01_021	800	165.80	167.70	167.87	0.17	168.29	168.30	0.00	168.71	168.57	-0.14
BNO_R01-3	GNOR01_018	1300	164.94	167.43	167.33	-0.10	167.71	167.78	0.07	168.19	168.09	-0.10
BNO_R01-3	GNOR01_013	1800	164.06	166.99	167.08	0.09	167.46	167.60	0.14	168.02	167.94	-0.08
BNO_R01-3	GNOR03_058	2800	164.03	167.00	166.72	-0.28	N/A	167.30	N/A	167.97	167.68	-0.29
BNO_R01-3		2800	164.03	167.00	166.72	-0.28	N/A	167.30	N/A	167.97	167.68	-0.29
BNO_R01-3	GNOR03_050	3600	162.94	166.02	166.11	0.09	166.98	166.80	-0.18	167.62	167.25	-0.37
BNO_R01-3	GNOR03_041	4500	162.40	165.84	165.83	-0.01	166.79	166.58	-0.21	167.43	167.04	-0.39
BNO_R01-3	GNOR03_035	5100	162.17	165.79	165.73	-0.06	166.72	166.48	-0.24	167.35	166.94	-0.41
BNO_R01-3	GNOR03_028	5800	162.10	165.73	165.63	-0.10	166.64	166.37	-0.27	167.28	166.83	-0.45
BNO_R01-3	GNOR03_019	6700	162.41	165.66	165.49	-0.17	166.55	166.18	-0.37	167.19	166.65	-0.54
BNO_R01-3	GNOR03_012	7400	162.51	165.61	165.38	-0.23	166.48	166.06	-0.42	167.11	166.53	-0.58
BNO_R01-3	GNOR03_005	8100	161.21	165.54	165.23	-0.31	166.37	165.91	-0.46	166.98	166.38	-0.60
BNO_R02	GNOR02_029	0	163.62	167.00	166.72	-0.28	167.38	167.30	-0.08	167.97	167.68	-0.29
BNO_R02	GNOR02_024	500	163.62	167.17	166.76	-0.41	167.48	167.36	-0.12	168.08	167.77	-0.31
BNO_R02	GNOR02_015	1400	164.30	167.18	166.82	-0.36	167.57	167.43	-0.14	168.17	167.85	-0.32
BNO_R02	GNOR02_010	1900	164.51	167.18	166.96	-0.22	167.67	167.51	-0.16	168.25	167.92	-0.33
BNO_R02	GNOR02_000	2900	164.03	167.33	167.22	-0.11	168.02	167.76	-0.26	168.54	168.16	-0.38
BNO_R08-15-16	GNOR08_090	0	161.54	164.58	164.46	-0.12	165.35	165.02	-0.33	165.95	165.42	-0.53
BNO_R08-15-16	GNOR08_087	300	161.68	164.28	164.07	-0.21	165.17	164.68	-0.49	165.83	165.12	-0.71
BNO_R08-15-16	GNOR08_080	1000	162.10	163.89	163.56	-0.33	164.95	164.30	-0.65	165.68	164.80	-0.88
BNO_R08-15-16	GNOR08_075	1500	161.52	163.76	163.44	-0.32	164.88	164.19	-0.69	165.62	164.70	-0.92
BNO_R08-15-16	GNOR08_070	2000	161.08	163.65	163.33	-0.33	164.81	164.10	-0.71	165.57	164.61	-0.96
BNO_R08-15-16	GNOR08_056	3400	160.24	163.39	162.97	-0.42	164.67	163.83	-0.84	165.46	164.37	-1.09
BNO_R08-15-16	GNOR08_050	4000	158.99	163.13	162.71	-0.42	164.48	163.56	-0.92	165.29	164.09	-1.20
BNO_R08-15-16	GNOR08_050	4000	158.99	163.13	162.71	-0.42	164.48	163.56	-0.92	165.29	164.09	-1.20
BNO_R08-15-16	GNOR08_040	5000	158.99	162.95	161.76	-1.19	164.33	162.41	-1.92	165.15	162.83	-2.33
BNO_R08-15-16	GNOR08_036	5400	159.22	162.89	161.35	-1.54	164.27	162.00	-2.28	165.09	162.40	-2.69
BNO_R08-15-16	GNOR08_030	6000	157.73	160.81	159.86	-0.95	161.83	160.40	-1.43	162.20	160.79	-1.41
BNO_R08-15-16	GNOR08_030	6000	157.73	160.81	159.86	-0.95	161.83	160.40	-1.43	162.20	160.79	-1.41
BNO_R08-15-16	GNOR15_025	6160	157.92	160.81	159.59	-1.22	161.83	160.02	-1.81	162.20	160.29	-1.91
BNO_R08-15-16	GNOR15_018	6700	157.01	159.84	159.05	-0.79	160.88	159.48	-1.40	161.33	159.75	-1.58
BNO_R08-15-16	GNOR15_008	7700	156.00	159.34	158.57	-0.77	160.42	158.97	-1.45	160.87	159.24	-1.63
BNO_R08-15-16	GNOR15_000	8500	155.46	159.07	158.35	-0.72	160.14	158.75	-1.39	160.59	159.00	-1.59
BNO_R08-15-16	GNOR15_000	8500	155.46	159.07	158.35	-0.72	160.14	158.75	-1.39	160.59	159.00	-1.59
BNO_R08-15-16	GNOR16_020	9200	155.39	158.78	157.94	-0.84	159.92	158.37	-1.55	160.38	158.63	-1.75
BNO_R08-15-16	GNOR16_015	9700	155.33	158.68	157.63	-1.05	159.86	158.08	-1.78	160.31	158.37	-1.94
BNO_R08-15-16	GNOR16_007	10500	154.25	158.55	157.01	-1.54	159.69	157.62	-2.07	160.13	157.98	-2.15
BNO_R08-15-16	GNOR16_000	11200	153.78	156.77	156.34	-0.43	157.63	156.89	-0.74	157.95	157.21	-0.74
BNO_R11A	GNOR11_075	0	161.41	164.58	164.46	-0.12	165.35	165.02	-0.33	165.95	165.42	-0.53
BNO_R11A	GNOR11_075	250	N/A	N/A	164.46	N/A	165.35	165.02	-0.33	165.95	165.42	-0.53
BNO_R11A	GNOR11_070	500	162.47	164.58	164.46	-0.12	165.35	165.02	-0.33	165.95	165.42	-0.53
BNO_R11B	GNOR11_060	0	162.47	162.47	162.95	0.47	N/A	162.95	N/A	N/A	162.95	N/A

Water Level				1 in 20 year ARI Results (mAHD)			1 in 50 year ARI Results (mAHD)			1 in 100 year ARI Results (mAHD)		
Name of Watercourse	**X-SECT Name**	**MIKE 11 Chainage**	**Bed EL**	**RUBICON CASE 086**	**MIKE11 CASE 086**	**difference** (mAHD)	**RUBICON CASE 086**	**MIKE11 CASE 086**	**difference** (mAHD)	**RUBICON CASE 086**	**MIKE11 CASE 086**	**difference** (mAHD)
BNO_R11B	GNOR11_054	600	161.99	161.99	162.52	0.53	N/A	162.52	N/A	N/A	162.52	N/A
BNO_R11B	GNOR11_049	1100	160.99	160.99	161.56	0.57	N/A	161.56	N/A	N/A	161.56	N/A
BNO_R11B	GNOR11_042	1800	160.27	160.27	160.66	0.39	N/A	160.66	N/A	N/A	160.66	N/A
BNO_R11B	GNOR11_035	2500	158.56	158.56	159.52	0.96	N/A	159.52	N/A	N/A	159.52	N/A
BNO_R11B	GNOR11_024	3600	158.95	158.95	159.31	0.36	N/A	159.31	N/A	N/A	159.31	N/A
BNO_R11B	GNOR11_018	4200	158.16	158.46	158.50	0.04	158.63	158.41	-0.22	158.72	158.49	-0.23
BNO_R11B	GNOR11_009	5100	157.44	158.46	158.50	0.04	158.63	158.41	-0.22	158.72	158.49	-0.23
BNO_R11B	GNOR11_004	5600	156.55	158.46	158.50	0.04	158.63	158.41	-0.22	158.72	158.49	-0.23
BNO_R09A	GNOR09_060	0	162.36	164.98	164.79	-0.19	165.87	165.45	-0.42	166.51	165.90	-0.61
BNO_R09A	GNOR09_060	250	N/A	N/A	164.79	N/A	165.87	165.45	-0.42	166.51	165.90	-0.61
BNO_R09A	GNOR09_055	500	162.36	164.98	164.79	-0.19	165.87	165.45	-0.42	166.51	165.90	-0.61
BNO_R09B	GNOR09_041	0	164.85	164.85	164.87	0.02	N/A	164.87	N/A	N/A	164.87	N/A
BNO_R09B	GNOR09_034	700	163.50	163.50	163.98	0.48	N/A	163.98	N/A	N/A	163.98	N/A
BNO_R09B	GNOR09_026	1500	162.34	162.34	163.08	0.74	N/A	163.08	N/A	N/A	163.08	N/A
BNO_R09B	GNOR09_021	2000	161.50	161.50	162.52	1.02	N/A	162.52	N/A	N/A	162.52	N/A
BNO_R09B	GNOR09_015	2600	161.13	161.13	161.36	0.23	N/A	161.36	N/A	N/A	161.36	N/A
BNO_R09B	GNOR09_005	3600	159.10	160.81	160.90	0.09	N/A	160.80	N/A	N/A	160.89	N/A
BNO_R10A	GNOR10_109	0	162.47	164.58	164.46	-0.12	165.35	165.02	-0.33	165.95	165.42	-0.53
BNO_R10A	GNOR10_101	800	161.89	163.88	163.70	-0.18	164.96	164.41	-0.56	165.69	164.90	-0.79
BNO_R10A	GNOR10_094	1500	159.71	163.70	163.48	-0.22	164.88	164.25	-0.63	165.63	164.77	-0.86
BNO_R10A	GNOR10_090	1900	160.46	163.62	163.38	-0.24	164.84	164.18	-0.66	165.61	164.72	-0.90
BNO_R10A	GNOR10_079	3000	160.19	163.43	163.03	-0.40	164.75	163.99	-0.76	165.54	164.57	-0.97
BNO_R10A	GNOR10_074	3500	160.29	163.36	162.94	-0.42	164.70	163.89	-0.81	165.49	164.47	-1.02
BNO_R10A	GNOR10_065	4400	158.99	163.13	162.71	-0.42	164.48	163.56	-0.92	165.29	164.09	-1.20
BNO_R10B	GNOR10_072	0	160.19	160.19	160.37	0.18	160.13	160.37	0.24	160.58	160.37	-0.21
BNO_R10B	GNOR10_062	1000	158.90	159.06	159.13	0.07	160.13	159.13	-1.00	160.58	159.13	-1.45
BNO_R10B	GNOR10_044	1800	157.32	159.06	158.53	-0.53	160.13	158.75	-1.38	160.58	159.01	-1.58
BNO_R10B	GNOR10_036	2600	157.07	159.06	158.35	-0.71	160.13	158.75	-1.38	160.58	159.00	-1.58
BNO_R10B	GNOR10_030	3200	155.46	159.06	158.35	-0.71	160.13	158.75	-1.38	160.58	159.00	-1.58
BNO_R14	GNOR14_005	0	157.73	160.81	159.86	-0.95	161.83	160.40	-1.43	162.20	160.79	-1.41
BNO_R14	GNOR14_000	20	157.73	159.40	159.81	0.41	159.19	160.34	1.15	159.45	160.75	1.30
BNO_L11	GNOL11_008	0	150.60	161.26	161.45	0.19	161.75	161.90	0.15	162.12	162.13	0.01
BNO_L11	GNOL11_000	800	150.60	160.97	161.09	0.12	161.49	161.63	0.13	161.84	161.85	0.01
BRE_R11	GRER11_040	0	168.05	168.05	169.07	1.02	N/A	169.28	N/A	168.94	169.42	0.48
BRE_R11	GRER11_032	800	168.05	168.05	168.93	0.88	N/A	169.09	N/A	168.94	169.27	0.33
BRE_R11	GRER11_021	1900	166.85	167.68	167.78	0.10	N/A	168.34	N/A	168.94	168.74	-0.20
BRE_R11	GRER11_012	2800	160.69	167.63	167.78	0.15	N/A	168.34	N/A	168.94	168.72	-0.22
BRE_R11	GRER11_004	3600	160.69	167.63	167.78	0.15	N/A	168.34	N/A	168.94	168.72	-0.22
BNO_R26	GNOR26_010	0	152.26	154.10	154.09	-0.01	154.75	154.75	0.00	155.18	155.14	-0.04
BNO_R26	GNOR26_000	1000	152.26	153.49	153.76	0.27	154.27	154.50	0.23	154.80	154.90	0.10
BCO_R01	GCOR01_030	0	149.65	152.81	152.75	-0.06	153.66	153.57	-0.09	154.22	154.00	-0.22
BCO_R01	GCOR01_022	800	149.65	152.35	152.33	-0.02	153.17	153.12	-0.05	153.73	153.53	-0.20
BCO_R01	GCOR01_019	1200	149.68	151.93	151.99	0.06	152.76	152.71	-0.05	153.40	153.16	-0.24
BCO_R01	GCOR01_011	1900	147.93	151.28	151.40	0.12	152.28	152.28	0.00	153.05	152.80	-0.25
BCO_R01	GCOR01_007	2300	147.09	151.11	151.25	0.14	152.15	152.18	0.03	152.94	152.71	-0.23
BCO_R01	GCOR01_003	2700	141.07	151.09	151.23	0.14	152.12	152.16	0.04	152.92	152.69	-0.23

Water Level				1 in 20 year ARI Results (mAHD)	1 in 20 year ARI Results (mAHD)		1 in 20 year ARI Results (mAHD)	
Name of Watercourse	**X-SECT Name**	**MIKE 11 Chainage**	**Bed EL**	**RUBICON CASE 086**	**MIKE11 CASE 086**	**difference** (mAHD)	**MIKE11 AD Case**	**difference** (mAHD)
NOGOA_MACKENZIE	GNO_007005	0	175.81	187.19	187.37	0.18	187.37	0.00
NOGOA_MACKENZIE	GNO_006998	700	171.87	186.97	187.12	0.15	187.12	0.00
NOGOA_MACKENZIE	GNO_006991	1400	172.99	186.64	186.61	-0.03	186.61	0.00
NOGOA_MACKENZIE	GNO_006983	2200	173.73	186.14	185.97	-0.17	185.97	0.00
NOGOA_MACKENZIE	GNO_006978	2600	174.39	185.95	185.73	-0.22	185.73	0.00
NOGOA_MACKENZIE	GNO_006975	3000	174.39	185.75	185.49	-0.26	185.49	0.00
NOGOA_MACKENZIE	GNO_006975	3000	174.39	185.75	185.49	-0.26	185.49	0.00
NOGOA_MACKENZIE	GNO_006972	3500	173.92	185.43	185.20	-0.24	185.20	0.00
NOGOA_MACKENZIE	GNO_006962	4200	173.42	185.08	184.86	-0.22	184.86	0.00
NOGOA_MACKENZIE	GNO_006951	5300	172.35	184.46	184.37	-0.09	184.37	0.00
NOGOA_MACKENZIE	GNO_006940	6400	172.35	183.40	183.75	**0.35**	183.75	0.00
NOGOA_MACKENZIE	GNO_006940	6400	172.35	183.40	183.75	**0.35**	183.75	0.00
NOGOA_MACKENZIE	GNO_006930	7300	171.26	182.67	182.82	0.15	182.82	0.00
NOGOA_MACKENZIE	GNO_006919	8200	169.07	181.94	181.69	-0.25	181.69	0.00
NOGOA_MACKENZIE	GNO_006910	9100	169.07	181.11	181.06	-0.05	181.06	0.00
NOGOA_MACKENZIE	GNO_006910	9100	169.07	181.11	181.06	-0.05	181.06	0.00
NOGOA_MACKENZIE	GNO_006900	10000	167.16	180.71	180.63	-0.08	180.63	0.00
NOGOA_MACKENZIE	GNO_006892	10800	167.01	180.35	180.28	-0.07	180.28	0.00
NOGOA_MACKENZIE	GNO_006886	11400	166.99	180.10	180.05	-0.05	180.05	0.00
NOGOA_MACKENZIE	GNO_006876	12400	166.85	179.57	179.57	0.00	179.57	0.00
NOGOA_MACKENZIE	GNO_006868	13200	166.15	179.15	179.17	0.02	179.17	0.00
NOGOA_MACKENZIE	GNO_006854	14600	164.84	178.29	178.37	0.08	178.37	0.00
NOGOA_MACKENZIE	GNO_006845	15500	164.40	177.77	177.82	0.05	177.82	0.00
NOGOA_MACKENZIE	GNO_006840	16000	164.31	177.45	177.49	0.04	177.49	0.00
NOGOA_MACKENZIE	GNO_006840	16000	164.31	177.45	177.49	0.04	177.49	0.00
NOGOA_MACKENZIE	N/A	16150	164.31	177.42	177.37	-0.04	177.37	0.00
NOGOA_MACKENZIE	N/A	16200	170.39	177.39	177.26	-0.13	177.26	0.00
NOGOA_MACKENZIE	N/A	16250	163.46	177.35	177.28	-0.07	177.28	0.00
NOGOA_MACKENZIE	GNO_006835	16500	163.46	177.32	177.19	-0.13	177.19	0.00
NOGOA_MACKENZIE	GNO_006822	17800	164.18	176.87	176.76	-0.11	176.76	0.00
NOGOA_MACKENZIE	GNO_006817	18300	164.18	176.69	176.60	-0.09	176.60	0.00
NOGOA_MACKENZIE	GNO_006810	18800	165.16	176.08	176.17	0.09	176.17	0.00
NOGOA_MACKENZIE	GNO_006802	19600	164.38	175.23	175.30	0.07	175.30	0.00
NOGOA_MACKENZIE	GNO_006798	20000	163.84	174.96	175.04	0.08	175.04	0.00
NOGOA_MACKENZIE	GNO_006792	20600	163.45	174.42	174.43	0.01	174.43	0.00
NOGOA_MACKENZIE	GNO_006784	21400	162.56	173.71	173.60	-0.12	173.60	0.00
NOGOA_MACKENZIE	GNO_006778	22200	162.02	173.33	173.06	-0.27	173.06	0.00
NOGOA_MACKENZIE	GNO_006778	22200	162.02	173.33	173.06	-0.27	173.06	0.00
NOGOA_MACKENZIE	GNO_006769	22800	161.43	172.93	172.57	**-0.36**	172.57	0.00
NOGOA_MACKENZIE	GNO_006759	23800	161.43	171.88	171.76	-0.12	171.76	0.00
NOGOA_MACKENZIE	GNO_006759	23800	161.43	171.88	171.76	-0.12	171.76	0.00
NOGOA_MACKENZIE	GNO_006753	24300	160.25	171.65	171.56	-0.09	171.56	0.00
NOGOA_MACKENZIE	GNO_006744	25200	159.78	171.03	171.07	0.04	171.07	0.00
NOGOA_MACKENZIE	GNO_006737	25900	159.43	170.30	170.41	0.11	170.41	0.00
NOGOA_MACKENZIE	GNO_006734	26200	158.85	170.06	170.11	0.05	170.11	0.00
NOGOA_MACKENZIE	GNO_006727	26900	158.39	169.73	169.73	0.00	169.73	0.00
NOGOA_MACKENZIE	GNO_006720	27600	158.39	169.45	169.47	0.02	169.47	0.00
NOGOA_MACKENZIE	GNO_006709	28700	157.78	169.01	169.01	0.00	169.01	0.00
NOGOA_MACKENZIE	GNO_006701	29500	157.54	168.84	168.85	0.01	168.85	0.00
NOGOA_MACKENZIE	GNO_006692	30400	157.08	168.61	168.66	0.04	168.66	0.00
NOGOA_MACKENZIE	GNO_006685	31100	157.08	168.28	168.35	0.07	168.35	0.00
NOGOA_MACKENZIE	GNO_006685	31100	157.08	168.28	168.35	0.07	168.35	0.00
NOGOA_MACKENZIE	GNO_006678	31500	155.58	168.11	168.17	0.06	168.17	0.00
NOGOA_MACKENZIE	GNO_006670	32300	155.58	167.63	167.78	0.15	167.78	0.00
NOGOA_MACKENZIE	GNO_006670	32300	155.58	167.63	167.78	0.15	167.78	0.00
NOGOA_MACKENZIE	GNO_006661	33000	154.67	167.43	167.46	0.03	167.46	0.00
NOGOA_MACKENZIE	GNO_006657	33400	154.20	167.38	167.30	-0.08	167.30	0.00
NOGOA_MACKENZIE	GNO_006650	34100	154.29	167.33	167.22	-0.11	167.22	0.00
NOGOA_MACKENZIE	GNO_006641	34100	154.29	167.33	167.22	-0.11	167.22	0.00
NOGOA_MACKENZIE	GNO_006641	34500	155.39	166.98	166.91	-0.07	166.91	0.00
NOGOA_MACKENZIE	GNO_006630	34900	154.83	166.76	166.64	-0.12	166.64	0.00
NOGOA_MACKENZIE	GNO_006621	35800	154.14	166.23	166.02	-0.21	166.01	-0.01
NOGOA_MACKENZIE	GNO_006610	36900	153.33	165.63	165.37	-0.26	165.34	-0.02
NOGOA_MACKENZIE	GNO_006610	36900	153.33	165.63	165.37	-0.26	165.34	-0.02
NOGOA_MACKENZIE	GNO_006598	37600	152.82	165.37	165.10	-0.27	165.07	-0.03
NOGOA_MACKENZIE	GNO_006592	38200	151.96	165.01	164.80	-0.22	164.75	-0.04
NOGOA_MACKENZIE	GNO_006583	39100	151.75	164.54	164.43	-0.11	164.37	-0.06
NOGOA_MACKENZIE	GNO_006583	39100	151.75	164.54	164.43	-0.11	164.37	-0.06
NOGOA_MACKENZIE	GNO_006570	39800	150.16	164.38	164.25	-0.13	164.17	-0.08
NOGOA_MACKENZIE	GNO_006565	40300	149.96	164.22	164.12	-0.10	164.03	-0.09
NOGOA_MACKENZIE	GNO_006560	40800	149.71	164.05	163.96	-0.09	163.85	-0.11
NOGOA_MACKENZIE	GNO_006560	40800	149.71	164.05	163.96	-0.09	163.85	-0.11
NOGOA_MACKENZIE	GNO_006545	41700	150.01	163.40	163.52	0.12	163.34	-0.18
NOGOA_MACKENZIE	GNO_006537	42500	149.80	162.74	162.94	0.19	162.70	-0.24
NOGOA_MACKENZIE	GNO_006532	43000	149.51	162.34	162.57	0.23	162.36	-0.21
NOGOA_MACKENZIE	GNO_006522	44000	148.73	161.26	161.45	0.19	161.56	0.11
NOGOA_MACKENZIE	GNO_006522	44000	148.73	161.26	161.45	0.19	161.56	0.11
NOGOA_MACKENZIE	GNO_006510	45000	147.83	160.84	160.94	0.10	161.16	0.22
NOGOA_MACKENZIE	GNO_006503	45700	147.83	160.45	160.59	0.14	160.84	0.25
NOGOA_MACKENZIE	GNO_006503	45700	147.83	160.45	160.59	0.14	160.84	0.25
NOGOA_MACKENZIE	GNO_006496	46200	147.10	160.36	160.27	-0.09	160.56	0.29
NOGOA_MACKENZIE	GNO_006492	46600	146.79	160.15	159.99	-0.16	160.23	0.24
NOGOA_MACKENZIE	GNO_006485	47300	146.19	159.62	159.37	-0.25	159.58	0.21
NOGOA_MACKENZIE	GNO_006480	47800	145.92	159.31	159.08	-0.23	159.27	0.20
NOGOA_MACKENZIE	GNO_006470	48800	147.16	158.77	158.67	-0.10	158.81	0.14
NOGOA_MACKENZIE	GNO_006465	49300	149.31	158.52	158.42	-0.10	158.55	0.12
NOGOA_MACKENZIE	GNO_006460	49800	146.41	158.28	158.06	-0.22	158.16	0.10
NOGOA_MACKENZIE	GNO_006450	50800	145.90	157.86	157.43	**-0.43**	157.47	0.05
NOGOA_MACKENZIE	GNO_006440	51800	145.33	157.48	157.06	**-0.42**	157.05	-0.02
NOGOA_MACKENZIE	GNO_006430	52800	145.33	157.06	156.94	-0.12	156.90	-0.04
NOGOA_MACKENZIE	GNO_006430	52800	145.33	157.06	156.94	-0.12	156.90	-0.04
NOGOA_MACKENZIE	GNO_006420	53500	144.39	156.88	156.80	-0.08	156.77	-0.03
NOGOA_MACKENZIE	GNO_006412	54300	143.76	156.63	156.53	-0.10	156.51	-0.02
NOGOA_MACKENZIE	GNO_006405	55300	143.01	156.20	156.14	-0.06	156.15	0.01
NOGOA_MACKENZIE	GNO_006405	55300	143.01	156.20	156.14	-0.06	156.15	0.01

Water Level				1 in 20 year ARI Results (mAHD)	1 in 20 year ARI Results (mAHD)		1 in 20 year ARI Results (mAHD)	
Name of Watercourse	**X-SECT Name**	**MIKE 11 Chainage**	**Bed EL**	**RUBICON CASE 086**	**MIKE11 CASE 086**	**difference** (mAHD)	**MIKE11 AD Case**	**difference** (mAHD)
NOGOA_MACKENZIE	GNO_006396	56100	147.46	155.80	156.03	0.23	156.04	0.01
NOGOA_MACKENZIE	GNO_006390	56700	146.10	155.43	155.79	**0.35**	155.80	0.01
NOGOA_MACKENZIE	GNO_006385	57200	144.90	155.22	155.60	**0.38**	155.62	0.02
NOGOA_MACKENZIE	GNO_006379	57800	144.95	154.90	155.35	**0.45**	155.38	0.03
NOGOA_MACKENZIE	GNO_006372	58500	143.36	154.47	154.76	0.29	154.84	0.08
NOGOA_MACKENZIE	GNO_006367	59000	143.36	154.32	154.49	0.17	154.60	0.11
NOGOA_MACKENZIE	GNO_006362	59500	144.95	154.19	154.37	0.18	154.49	0.13
NOGOA_MACKENZIE	GNO_006356	60100	143.09	153.89	154.13	0.24	154.30	0.16
NOGOA_MACKENZIE	GNO_006353	60400	142.16	153.65	153.89	0.24	154.08	0.19
NOGOA_MACKENZIE	GNO_006350	60700	141.63	153.49	153.76	0.27	153.97	0.21
NOGOA_MACKENZIE	GNO_006350	60700	141.63	153.49	153.76	0.27	153.97	0.21
NOGOA_MACKENZIE	GNO_006342	61200	141.28	153.23	153.59	**0.36**	153.84	0.25
NOGOA_MACKENZIE	GNO_006338	61600	142.49	153.01	153.36	**0.35**	153.66	**0.31**
NOGOA_MACKENZIE	GNO_006330	62400	137.72	152.60	152.95	**0.35**	153.37	**0.43**
NOGOA_MACKENZIE	GNO_006330	62400	137.72	152.60	152.95	**0.35**	153.37	**0.43**
NOGOA_MACKENZIE	GNO_006323	63000	138.11	152.25	152.21	-0.04	152.65	**0.44**
NOGOA_MACKENZIE	GNO_006319	63600	136.56	151.92	152.01	0.09	152.41	**0.40**
NOGOA_MACKENZIE	GNO_006319	63600	136.56	151.92	152.01	0.09	152.41	**0.40**
NOGOA_MACKENZIE	GNO_006310	64230	136.16	151.70	151.79	0.09	152.13	**0.34**
NOGOA_MACKENZIE	GNO_006300	65220	135.59	151.51	151.57	0.06	151.83	0.26
NOGOA_MACKENZIE	GNO_006290	66020	134.54	151.38	151.44	0.06	151.69	0.25
NOGOA_MACKENZIE	GNO_006290	66020	134.54	151.38	151.44	0.06	151.69	0.25
NOGOA_MACKENZIE	GNO_006285	66770	133.66	151.27	151.32	0.05	151.54	0.22
NOGOA_MACKENZIE	GNO_006280	67280	134.24	151.17	151.22	0.05	151.41	0.19
NOGOA_MACKENZIE	GNO_006275	67790	134.03	151.08	151.15	0.07	151.32	0.16
NOGOA_MACKENZIE	GNO_006270	68090	133.76	151.03	151.10	0.07	151.25	0.15
NOGOA_MACKENZIE	GNO_006265	68690	133.32	150.91	150.99	0.08	151.10	0.12
NOGOA_MACKENZIE	GNO_006260	69230	133.29	150.85	150.91	0.06	151.01	0.10
NOGOA_MACKENZIE	GNO_006256	69740	133.19	150.78	150.84	0.06	150.92	0.08
NOGOA_MACKENZIE	GNO_006250	70340	133.01	150.72	150.75	0.03	150.81	0.06
NOGOA_MACKENZIE	GNO_006250	70340	133.01	150.72	150.75	0.03	150.81	0.06
NOGOA_MACKENZIE	GNO_006263	71780	133.01	150.61	150.51	-0.10	150.61	0.10
NOGOA_MACKENZIE	GNO_006263	71780	133.01	150.61	150.51	-0.10	150.61	0.10
NOGOA_MACKENZIE	GMK_006226	72980	132.16	150.35	150.12	-0.23	150.27	0.15
NOGOA_MACKENZIE	GMK_006226	72980	132.16	150.35	150.12	-0.23	150.27	0.15
NOGOA_MACKENZIE	GMK_006220	73400	131.23	150.20	150.02	-0.18	150.18	0.16
NOGOA_MACKENZIE	GMK_006212	74120	130.24	149.91	149.81	-0.10	149.95	0.14
NOGOA_MACKENZIE	GMK_006205	74780	128.63	149.65	149.61	-0.04	149.73	0.12
NOGOA_MACKENZIE	GMK_006198	75710	128.11	149.38	149.34	-0.04	149.43	0.08
NOGOA_MACKENZIE	GMK_006187	76730	128.89	149.10	149.00	-0.10	149.06	0.06
NOGOA_MACKENZIE	GMK_006180	77330	129.00	148.91	148.81	-0.10	148.85	0.05
NOGOA_MACKENZIE	GMK_006180	77330	129.00	148.91	148.81	-0.10	148.85	0.05
NOGOA_MACKENZIE	GMK_006176	77810	129.00	148.76	148.62	-0.14	148.65	0.02
NOGOA_MACKENZIE	GMK_006160	79490	130.10	148.33	148.13	-0.20	148.08	-0.05
NOGOA_MACKENZIE	GMK_006149	80490	128.23	148.12	147.87	-0.25	147.79	-0.09
NOGOA_MACKENZIE	GMK_006149	80490	128.23	148.12	147.87	-0.25	147.79	-0.09
NOGOA_MACKENZIE	GMK_006147	80670	128.23	148.05	147.79	-0.26	147.71	-0.08
NOGOA_MACKENZIE	GMK_006140	81390	126.91	147.83	147.56	-0.27	147.49	-0.07
NOGOA_MACKENZIE	GMK_006132	82110	125.50	147.67	147.39	-0.28	147.32	-0.06
NOGOA_MACKENZIE	GMK_006132	82110	125.50	147.67	147.39	-0.28	147.32	-0.06
NOGOA_MACKENZIE	GMK_006107	84210	122.90	146.98	146.55	**-0.43**	146.50	-0.06
NOGOA_MACKENZIE	GMK_006107	84210	122.90	146.98	146.55	**-0.43**	146.50	-0.06
NOGOA_MACKENZIE	GMK_006085	85710	124.26	146.48	146.19	-0.29	146.14	-0.06
NOGOA_MACKENZIE	GMK_006060	88210	123.23	145.68	145.69	0.01	145.63	-0.06
NOGOA_MACKENZIE	GMK_006045	89710	122.45	145.14	145.32	0.18	145.26	-0.06
NOGOA_MACKENZIE	GMK_006045	89710	122.45	145.14	145.32	0.18	145.26	-0.06
NOGOA_MACKENZIE	GMK_006020	91710	121.21	144.60	144.75	0.15	144.68	-0.06
NOGOA_MACKENZIE	GMK_005997	94010	119.56	143.90	143.92	0.01	143.85	-0.06
NOGOA_MACKENZIE	GMK_005982	95510	118.83	143.32	143.23	-0.09	143.17	-0.06
NOGOA_MACKENZIE	GMK_005982	95510	118.83	143.32	143.23	-0.09	143.17	-0.06
NOGOA_MACKENZIE	GMK_005976	95910	118.83	143.13	143.03	-0.10	142.97	-0.06
BNO_L14	GNOL14_020	0	181.65	185.75	185.49	-0.26	185.49	0.00
BNO_L14	GNOL14_012	800	181.29	185.73	184.86	**-0.87**	184.86	0.00
BNO_L14	GNOL14_004	1600	182.53	183.40	183.75	**0.35**	183.75	0.00
BNO_L01	GNOL01_085	0	182.03	182.03	182.03	0.00	181.06	**-0.96**
BNO_L01	GNOL01_077	800	182.03	182.03	182.03	0.00	182.03	0.00
BNO_L01	GNOL01_068	1700	179.94	179.94	179.94	0.00	179.94	0.00
BNO_L01	GNOL01_060	2500	179.94	179.94	179.94	0.00	179.94	0.00
BNO_L01	GNOL01_051	3400	180.38	180.38	180.39	0.00	180.39	0.00
BNO_L01	GNOL01_045	4000	179.50	179.5	180.46	**0.96**	180.46	0.00
BNO_L01	GNOL01_032	5300	176.22	177.45	177.49	0.04	177.49	0.00
BNO_L01	GNOL01_024	6100	174.32	177.45	177.49	0.04	177.49	0.00
BNO_L01	GNOL01_018	6700	172.70	177.45	177.49	0.04	177.49	0.00
BNO_L01	GNOL01_010	7500	170.48	177.45	177.49	0.04	177.49	0.00
BOGGY CREEK	GBO_000070	0	161.24	161.24	161.24	0.00	161.24	0.00
BOGGY CREEK	GBO_000065	500	159.25	159.25	159.24	-0.01	159.24	0.00
BOGGY CREEK	GBO_000062	800	158.46	158.46	158.45	-0.01	158.45	0.00
BOGGY CREEK	GBO_000056	1400	156.69	156.69	156.69	0.00	156.69	0.00
BOGGY CREEK	GBO_000052	1800	154.81	154.81	154.81	0.00	154.81	0.00
BOGGY CREEK	GBO_000045	2500	153.36	153.36	153.36	0.00	153.36	0.00
BOGGY CREEK	GBO_000038	3200	149.88	151.6	152.01	**0.41**	152.41	**0.40**
BOGGY CREEK	GBO_000033	3700	148.19	151.6	152.01	**0.41**	152.41	**0.40**
BOGGY CREEK	GBO_000026	4400	146.30	151.6	152.01	**0.41**	152.41	**0.40**
BOGGY CREEK	GBO_000018	5200	145.25	151.6	152.01	**0.41**	152.41	**0.40**
BOGGY CREEK	GBO_000013	5700	143.29	151.6	152.01	**0.41**	152.41	**0.40**
BOGGY CREEK	GBO_000000	7000	143.29	151.6	152.01	**0.41**	152.41	**0.40**
COMET RIVER	GCO_000168	0	141.12	154.28	154.36	0.08	154.38	0.02
COMET RIVER	GCO_000161	700	141.12	153.97	154.04	0.07	154.07	0.03
COMET RIVER	GCO_000161	700	141.12	153.97	154.04	0.07	154.07	0.03
COMET RIVER	GCO_000157	1100	141.24	153.92	153.97	0.05	154.00	0.03
COMET RIVER	GCO_000150	1800	141.31	153.83	153.87	0.03	153.90	0.03
COMET RIVER	GCO_000143	2500	141.14	153.67	153.66	-0.01	153.70	0.04
COMET RIVER	GCO_000135	3400	141.14	153.47	153.35	-0.12	153.40	0.05
COMET RIVER	GCO_000128	4000	140.72	153.35	153.20	-0.16	153.26	0.06
COMET RIVER	GCO_000117	5100	140.10	152.95	152.86	-0.09	152.93	0.07

Water Level				1 in 20 year ARI Results (mAHD)	1 in 20 year ARI Results (mAHD)		1 in 20 year ARI Results (mAHD)	
Name of Watercourse	**X-SECT Name**	**MIKE 11 Chainage**	**Bed EL**	**RUBICON CASE 086**	**MIKE11 CASE 086**	**difference** (mAHD)	**MIKE11 AD Case**	**difference** (mAHD)
COMET RIVER	GCO_000112	5600	137.39	152.81	152.75	-0.06	152.83	0.08
COMET RIVER	GCO_000112	5600	137.39	152.81	152.75	-0.06	152.83	0.08
COMET RIVER	GCO_000104	6500	136.49	152.52	152.58	0.06	152.67	0.09
COMET RIVER	GCO_000099	6900	136.19	152.36	152.46	0.10	152.56	0.09
COMET RIVER	GCO_000094	7400	135.49	152.21	152.35	0.14	152.45	0.09
COMET RIVER	GCO_000089	7900	136.62	152.1	152.27	0.17	152.37	0.10
COMET RIVER	GCO_000084	8400	135.90	151.99	152.18	0.19	152.28	0.10
COMET RIVER	GCO_000074	9400	135.76	151.41	151.64	0.23	151.79	0.15
COMET RIVER	GCO_000070	9800	135.25	151.28	151.42	0.13	151.60	0.19
COMET RIVER	GCO_000065	10200	135.52	151.18	151.34	0.16	151.53	0.20
COMET RIVER	GCO_000065	10200	135.52	151.18	151.34	0.16	151.53	0.20
COMET RIVER	GCO_000058	11200	135.52	151.09	151.23	0.14	151.42	0.19
COMET RIVER	GCO_000058	11200	135.52	151.09	151.23	0.14	151.42	0.19
COMET RIVER	GCO_000051	11700	135.65	150.96	151.13	0.17	151.31	0.18
COMET RIVER	GCO_000046	12200	135.45	150.89	151.05	0.16	151.21	0.17
COMET RIVER	GCO_000041	12700	134.60	150.85	150.96	0.11	151.11	0.15
COMET RIVER	GCO_000033	13500	134.49	150.79	150.83	0.04	150.99	0.16
COMET RIVER	GCO_000028	13900	134.65	150.76	150.78	0.02	150.94	0.16
COMET RIVER	GCO_000020	14800	134.40	150.69	150.67	-0.02	150.80	0.13
COMET RIVER	GCO_000013	15500	134.40	150.64	150.57	-0.07	150.69	0.12
COMET RIVER	GCO_000006	16100	134.56	150.61	150.51	-0.10	150.61	0.10
SANDHURST CREEK	GSA_000160	0	151.64	154.89	154.95	0.06	154.95	0.00
SANDHURST CREEK	GSA_000155	500	151.18	154.27	154.50	0.23	154.50	0.00
SANDHURST CREEK	GSA_000150	1000	150.74	153.66	153.86	0.20	153.86	0.00
SANDHURST CREEK	GSA_000146	1400	150.72	153.47	153.67	0.19	153.67	0.00
SANDHURST CREEK	GSA_000141	1900	149.40	152.96	153.23	0.27	153.23	0.00
SANDHURST CREEK	GSA_000136	2400	148.79	152.27	152.54	0.27	152.54	0.00
SANDHURST CREEK	GSA_000128	3200	148.96	151.83	151.91	0.08	151.91	0.00
SANDHURST CREEK	GSA_000121	3900	147.98	151.78	151.81	0.03	151.81	0.00
SANDHURST CREEK	GSA_000117	4300	147.04	151.77	151.80	0.03	151.80	0.00
SANDHURST CREEK	GSA_000111	4900	146.52	151.77	151.80	0.03	151.80	0.00
SANDHURST CREEK	GSA_000104	5600	146.53	151.22	151.70	**0.48**	151.70	0.00
SANDHURST CREEK	GSA_000096	6400	145.52	150.65	150.60	-0.05	150.67	0.07
SANDHURST CREEK	GSA_000089	7100	145.29	150.65	150.60	-0.05	150.67	0.07
SANDHURST CREEK	GSA_000084	7600	144.51	150.65	150.60	-0.05	150.67	0.07
SANDHURST CREEK	GSA_000076	8400	143.41	150.65	150.60	-0.05	150.67	0.07
SANDHURST CREEK	GSA_000065	9500	143.13	150.65	150.60	-0.05	150.67	0.07
SANDHURST CREEK	GSA_000065	9500	143.13	150.65	150.60	-0.05	150.67	0.07
SANDHURST CREEK	GSA_000052	10700	142.46	150.64	150.58	-0.06	150.66	0.08
SANDHURST CREEK	GSA_000041	11700	141.07	150.64	150.57	-0.07	150.65	0.08
SANDHURST CREEK	GSA_000035	12300	140.95	150.63	150.56	-0.07	150.64	0.09
SANDHURST CREEK	GSA_000027	13100	140.65	150.63	150.55	-0.08	150.63	0.09
SANDHURST CREEK	GSA_000015	14600	139.34	150.62	150.53	-0.09	150.62	0.09
SANDHURST CREEK	GSA_000010	15100	138.19	150.62	150.52	-0.10	150.62	0.09
SANDHURST CREEK	GSA_000000	16100	138.19	150.61	150.51	-0.10	150.61	0.10
BCO_L01-02-04	GCOL01_026	0	150.37	153.97	154.04	0.07	154.07	0.03
BCO_L01-02-04	GCOL01_020	600	149.72	153.57	153.62	0.05	153.66	0.03
BCO_L01-02-04	GCOL01_014	1200	149.40	153.22	153.22	0.00	153.27	0.04
BCO_L01-02-04	GCOL01_010	1600	149.30	153.09	153.07	-0.02	153.12	0.05
BCO_L01-02-04	GCOL01_002	2600	148.54	152.93	152.89	-0.04	152.95	0.05
BCO_L01-02-04	GCOL01_002	2600	148.54	152.93	152.89	-0.04	152.95	0.05
BCO_L01-02-04	GCOL02_069	3400	151.49	152.86	152.87	0.01	152.92	0.05
BCO_L01-02-04	GCOL02_062	4100	151.38	152.49	152.53	0.04	152.59	0.05
BCO_L01-02-04	GCOL02_057	4600	150.87	151.92	152.05	0.13	152.04	-0.01
BCO_L01-02-04	XCOL02_050	5300	n/a	n/a	151.38	**n/a**	151.53	0.15
BCO_L01-02-04	GCOL02_045	5800	150.05	151.00	151.01	0.01	151.41	**0.40**
BCO_L01-02-04	GCOL02_040	6300	149.17	150.97	150.97	0.00	151.40	**0.43**
BCO_L01-02-04	GCOL02_030	7300	148.42	150.97	150.96	-0.01	151.40	**0.43**
BCO_L01-02-04	GCOL02_020	8300	147.83	150.97	150.96	-0.01	151.40	**0.43**
BCO_L01-02-04	GCOL02_016	8700	146.43	150.97	150.96	-0.01	151.40	**0.43**
BCO_L01-02-04	GCOL02_008	9500	146.34	150.96	150.96	0.00	151.40	**0.43**
BCO_L01-02-04	GCOL02_002	10100	145.47	150.96	150.96	0.00	151.39	**0.44**
BCO_L01-02-04	GCOL02_002	10100	145.47	150.96	150.96	0.00	151.39	**0.44**
BCO_L01-02-04	GCOL04_018	10600	145.95	150.90	150.90	0.00	151.38	**0.48**
BCO_L01-02-04	GCOL04_009	11500	145.96	150.77	150.74	-0.03	151.28	**0.55**
BCO_L01-02-04	GCOL04_000	12400	145.96	150.65	150.60	-0.05	150.67	0.07
CRINUM CK	GCR_000155	0	160.89	164.96	165.05	0.09	165.05	0.00
CRINUM CK	GCR_000150	500	160.72	164.80	164.83	0.03	164.83	0.00
CRINUM CK	GCR_000145	1000	159.12	164.66	164.69	0.03	164.69	0.00
CRINUM CK	GCR_000140	1500	159.32	164.27	164.36	0.09	164.36	0.00
CRINUM CK	GCR_000135	2000	158.23	163.50	163.57	0.07	163.57	0.00
CRINUM CK	GCR_000130	2500	158.11	163.18	163.18	0.00	163.18	0.00
CRINUM CK	GCR_000120	3500	157.10	162.77	162.85	0.08	162.85	0.00
CRINUM CK	GCR_000115	4000	156.73	162.46	162.57	0.10	162.57	0.00
CRINUM CK	GCR_000110	4500	157.45	162.31	162.40	0.09	162.40	0.00
CRINUM CK	GCR_000103	5200	155.38	162.15	162.23	0.08	162.23	0.00
CRINUM CK	GCR_000095	6000	153.69	162.05	162.13	0.08	162.13	0.00
CRINUM CK	GCR_000088	6700	154.88	161.97	162.04	0.07	162.04	0.00
CRINUM CK	GCR_000078	7700	154.98	161.66	161.78	0.12	161.78	0.00
CRINUM CK	GCR_000070	8500	154.83	161.40	161.51	0.11	161.51	0.00
CRINUM CK	GCR_000060	9500	154.40	161.11	161.19	0.08	161.37	0.18
CRINUM CK	GCR_000053	10200	154.40	161.02	161.13	0.11	161.33	0.20
CRINUM CK	GCR_000053	10200	154.40	161.02	161.13	0.11	161.33	0.20
CRINUM CK	GCR_000045	10900	153.91	161.00	161.11	0.11	161.32	0.21
CRINUM CK	GCR_000040	11400	153.13	161.00	161.11	0.11	161.32	0.21
CRINUM CK	GCR_000034	12000	153.13	160.99	161.11	0.12	161.31	0.21
CRINUM CK	GCR_000034	12000	153.13	160.99	161.11	0.12	161.31	0.21
CRINUM CK	GCR_000030	12300	153.00	160.99	161.11	0.11	161.31	0.21
CRINUM CK	GCR_000020	13300	151.68	160.98	161.10	0.12	161.31	0.21
CRINUM CK	GCR_000015	13800	151.68	160.97	161.09	0.12	161.30	0.21
CRINUM CK	GCR_000015	13800	151.68	160.97	161.09	0.12	161.30	0.21
CRINUM CK	GCR_000008	14400	150.39	160.66	160.76	0.10	161.02	0.27
CRINUM CK	GCR_000006	14500	149.84	160.59	160.69	0.10	160.97	0.28
CRINUM CK	GCR_000006	14500	149.84	160.59	160.69	0.10	160.97	0.28
CRINUM CK	GCR_000000	15100	149.84	160.46	160.59	0.13	160.84	0.25

Water Level				1 in 20 year ARI Results (mAHD)	1 in 20 year ARI Results (mAHD)		1 in 20 year ARI Results (mAHD)	
Name of Watercourse	X-SECT Name	MIKE 11 Chainage	Bed EL	RUBICON CASE 086	MIKE11 CASE 086	difference (mAHD)	MIKE11 AD Case	difference (mAHD)
MOSQUITO CK	GMO_000052	0	166.31	166.31	166.31	0.00	166.31	0.00
MOSQUITO CK	GMO_000048	400	165.17	165.17	165.17	0.00	165.17	0.00
MOSQUITO CK	GMO_000042	1000	163.79	163.79	163.79	0.00	163.79	0.00
MOSQUITO CK	GMO_000033	1900	162.98	162.98	162.97	-0.01	162.97	0.00
MOSQUITO CK	GMO_000028	2400	162.25	162.25	162.25	0.00	162.25	0.00
MOSQUITO CK	GMO_000020	3200	160.97	161.02	161.13	0.11	161.33	0.20
MOSQUITO CK	GMO_000010	4200	158.36	161.02	161.13	0.11	161.33	0.20
MOSQUITO CK	GMO_000000	5200	156.36	161.02	161.13	0.11	161.33	0.20
GORDONSTONE CK	GGO_000092	0	161.52	164.07	163.91	-0.16	163.91	0.00
GORDONSTONE CK	GGO_000080	1200	160.63	163.04	162.89	-0.15	162.89	0.00
GORDONSTONE CK	GGO_000074	1800	160.00	162.71	162.52	-0.19	162.52	0.00
GORDONSTONE CK	GGO_000062	3000	159.57	161.70	161.52	-0.18	161.52	0.00
GORDONSTONE CK	GGO_000055	3700	157.92	161.00	161.12	0.12	161.32	0.20
GORDONSTONE CK	GGO_000045	4700	157.33	160.99	161.11	0.12	161.32	0.21
GORDONSTONE CK	GGO_000033	5900	157.07	160.99	161.11	0.12	161.32	0.21
GORDONSTONE CK	GGO_000023	6900	156.31	160.99	161.11	0.12	161.32	0.21
GORDONSTONE CK	GGO_000016	7600	155.94	160.99	161.11	0.12	161.32	0.21
GORDONSTONE CK	GGO_000012	8000	155.75	160.99	161.11	0.12	161.32	0.21
GORDONSTONE CK	GGO_000008	8400	155.14	160.99	161.11	0.12	161.31	0.21
GORDONSTONE CK	GGO_000000	9200	153.14	160.99	161.11	0.12	161.31	0.21
UNNAMED CK	GUN_000056	0	162.55	162.55	162.55	0.00	162.55	0.00
UNNAMED CK	GUN_000050	600	161.77	161.77	161.77	0.00	161.77	0.00
UNNAMED CK	GUN_000042	1400	159.15	160.22	159.53	**-0.69**	159.14	**-0.39**
UNNAMED CK	GUN_000034	2200	157.87	160.22	159.53	**-0.69**	159.04	**-0.49**
UNNAMED CK	GUN_000020	3600	155.73	160.22	159.53	**-0.69**	159.04	**-0.49**
UNNAMED CK	GUN_000020	3600	155.73	160.59	159.53	**-1.06**	159.04	**-0.49**
UNNAMED CK	GUN_000000	5600	155.73	160.59	160.69	0.10	160.97	0.28
BCO_L03	GCOL03_008	0	148.43	152.93	152.75	-0.18	152.83	0.08
BCO_L03	GCOL03_000	800	148.43	152.81	152.89	0.08	152.95	0.05
BCO_L05	GCOL05_010	0	143.91	150.96	151.34	**0.38**	151.53	0.20
BCO_L05	GCOL05_000	1000	143.91	151.18	150.96	-0.22	151.39	**0.44**
BNO_L02	GNOL02_050	0	155.46	159.02	159.53	**0.51**	159.04	**-0.49**
BNO_L02	GNOL02_046	400	155.46	158.75	159.26	**0.51**	158.79	**-0.46**
BNO_L02	GNOL02_038	1200	154.08	158.10	158.70	**0.60**	158.13	**-0.56**
BNO_L02	GNOL02_030	2000	153.86	157.63	158.26	**0.63**	157.63	**-0.63**
BNO_L02	GNOL02_022	2800	152.81	157.27	157.70	**0.43**	157.24	**-0.46**
BNO_L02	GNOL02_016	3400	152.21	157.14	157.21	0.07	157.02	-0.19
BNO_L02	GNOL02_010	4000	149.77	157.1	157.04	-0.06	156.94	-0.11
BNO_L02	GNOL02_000	5000	149.77	157.06	156.94	-0.12	156.90	-0.04
WINTON CK	GWI_000332	0	166.5	167.10	167.06	-0.04	167.06	0.00
WINTON CK	GWI_000326	600	165.61	165.85	165.95	0.10	165.95	0.00
WINTON CK	GWI_000319	1300	164.29	165.41	165.29	-0.12	165.29	0.00
WINTON CK	GWI_000313	1900	163.83	165.40	165.27	-0.13	165.27	0.00
WINTON CK	GWI_000305	2700	163.32	165.16	165.26	0.09	165.26	0.00
WINTON CK	GWI_000301	3100	163.12	164.70	164.81	0.11	164.81	0.00
WINTON CK	GWI_000296	3600	162.36	164.34	164.38	0.04	164.38	0.00
WINTON CK	GWI_000288	4400	161.89	163.42	163.54	0.12	163.53	0.00
WINTON CK	GWI_000280	5200	160.64	162.45	162.54	0.09	162.56	0.02
WINTON CK	GWI_000276	5600	159.61	162.08	162.21	0.13	162.27	0.07
WINTON CK	GWI_000269	6300	159.53	161.48	161.55	0.07	161.68	0.13
WINTON CK	GWI_000263	6900	159.52	161.27	161.33	0.06	161.37	0.04
WINTON CK	GWI_000259	7300	159.37	161.14	161.21	0.07	161.21	0.00
WINTON CK	GWI_000253	7900	159.44	160.91	160.99	0.08	160.99	0.00
WINTON CK	GWI_000247	8400	159.10	160.81	160.90	0.09	160.89	-0.01
WINTON CK	GWI_000247	8400	159.10	160.81	160.90	0.09	160.89	-0.01
WINTON CK	GWI_000239	9200	158.14	160.57	160.74	0.17	160.73	-0.01
WINTON CK	GWI_000232	9900	157.73	160.26	160.20	-0.06	160.22	0.02
WINTON CK	GWI_000224	10700	157.49	158.94	159.02	0.08	159.12	0.10
WINTON CK	GWI_000220	11100	156.55	158.46	158.50	0.04	158.50	0.00
WINTON CK	GWI_000220	11100	156.55	158.46	158.50	0.04	158.50	0.00
WINTON CK	GWI_000214	11600	156.55	158.41	158.44	0.03	158.44	0.00
WINTON CK	GWI_000205	12500	156.27	157.98	158.12	0.14	158.13	0.00
WINTON CK	GWI_000200	13000	155.76	157.53	157.52	-0.01	157.52	0.00
WINTON CK	GWI_000193	13700	155.41	156.79	156.73	-0.06	156.73	0.00
WINTON CK	GWI_000185	14500	155.25	156.78	156.36	**-0.42**	156.28	-0.08
WINTON CK	GWI_000180	15000	155.25	156.78	156.35	**-0.43**	156.27	-0.09
WINTON CK	GWI_000175	15500	153.78	156.77	156.34	**-0.43**	156.25	-0.09
WINTON CK	GWI_000175	15500	153.78	156.77	156.34	**-0.43**	156.25	-0.09
WINTON CK	GWI_000170	15900	153.78	156.60	156.17	**-0.43**	156.09	-0.08
WINTON CK	GWI_000166	16300	152.91	156.45	156.01	**-0.44**	155.93	-0.08
WINTON CK	GWI_000160	16900	153.01	156.24	155.79	**-0.45**	155.71	-0.08
WINTON CK	GWI_000152	17700	153.04	155.56	155.18	**-0.38**	155.10	-0.08
WINTON CK	GWI_000147	18200	152.39	154.66	154.32	**-0.34**	154.42	0.09
WINTON CK	GWI_000138	19100	150.97	153.97	153.77	-0.20	154.18	**0.41**
WINTON CK	GWI_000128	20100	149.88	153.63	153.62	-0.01	154.13	**0.50**
WINTON CK	GWI_000110	21900	147.01	153.34	153.53	0.19	154.09	**0.56**
WINTON CK	GWI_000110	21900	147.01	153.34	153.53	0.19	154.09	**0.56**
WINTON CK	GWI_000100	22800	149.46	152.91	153.30	**0.39**	154.09	**0.79**
WINTON CK	GWI_000093	23500	147.74	152.26	152.67	**0.41**	154.09	**1.42**
WINTON CK	GWI_000086	24200	148.91	152.08	152.34	0.26	154.09	**1.75**
WINTON CK	GWI_000080	24800	147.11	151.93	152.14	0.21	154.09	**1.95**
WINTON CK	GWI_000072	25600	144.97	151.83	151.93	0.10	n/a	n/a
WINTON CK	GWI_000064	26400	144.58	151.79	151.83	0.04	n/a	n/a
WINTON CK	GWI_000055	27300	146.09	151.74	151.72	-0.02	n/a	n/a
WINTON CK	GWI_000050	27800	145.53	151.65	151.60	-0.05	n/a	n/a
WINTON CK	GWI_000042	28600	145.53	151.37	151.14	-0.23	n/a	n/a
WINTON CK	GWI_000035	29300	144.86	151.29	150.91	**-0.38**	n/a	n/a
WINTON CK	GWI_000031	29700	145.01	151.27	150.84	**-0.43**	n/a	n/a
WINTON CK	GWI_000025	30300	145.08	151.23	150.79	**-0.44**	150.81	0.02
WINTON CK	GWI_000022	30600	144.08	151.23	150.78	**-0.45**	150.81	0.03
WINTON CK	GWI_000020	30800	143.13	151.23	150.77	**-0.46**	150.81	0.04
WINTON CK	GWI_000010	31800	142.24	151.22	150.76	**-0.46**	150.81	0.05
WINTON CK	GWI_000005	32200	140.45	151.22	150.75	**-0.47**	150.81	0.05
WINTON CK	GWI_000000	32700	138.45	151	150.75	**-0.46**	150.81	0.06
RETREAT CK	GRE_000215	0	172.21	177.48	177.44	-0.04	177.44	0.00

Water Level				1 in 20 year ARI Results (mAHD)	1 in 20 year ARI Results (mAHD)		1 in 20 year ARI Results (mAHD)	
Name of Watercourse	**X-SECT Name**	**MIKE 11 Chainage**	**Bed EL**	**RUBICON CASE 086**	**MIKE11 CASE 086**	**difference** (mAHD)	**MIKE11 AD Case**	**difference** (mAHD)
RETREAT CK	GRE_000210	500	172.24	177.16	177.10	-0.06	177.10	0.00
RETREAT CK	GRE_000206	900	172.34	176.77	176.70	-0.07	176.70	0.00
RETREAT CK	GRE_000196	1900	171.85	175.73	175.63	-0.10	175.63	0.00
RETREAT CK	GRE_000190	2500	170.83	175.49	175.26	-0.23	175.26	0.00
RETREAT CK	GRE_000185	3000	170.83	175.42	175.20	-0.22	175.20	0.00
RETREAT CK	GRE_000185	3000	170.83	175.42	175.20	-0.22	175.20	0.00
RETREAT CK	GRE_000174	3600	169.63	175.33	174.95	**-0.38**	174.95	0.00
RETREAT CK	GRE_000170	4000	169.13	175.29	174.79	**-0.50**	174.79	0.00
RETREAT CK	GRE_000165	4500	168.47	175.22	174.68	**-0.54**	174.68	0.00
RETREAT CK	GRE_000160	5000	168.73	175.14	174.58	**-0.56**	174.58	0.00
RETREAT CK	GRE_000149	6000	165.78	174.89	173.99	**-0.90**	173.99	0.00
RETREAT CK	GRE_000149	6000	165.78	174.89	173.99	**-0.90**	173.99	0.00
RETREAT CK	GRE_000145	6500	164.87	174.85	174.10	**-0.75**	174.10	0.00
RETREAT CK	GRE_000145	6500	164.87	174.85	174.10	**-0.75**	174.10	0.00
RETREAT CK	GRE_000141	6900	164.96	174.40	173.20	**-1.20**	173.20	0.00
RETREAT CK	GRE_000135	7500	164.31	174.16	172.86	**-1.30**	172.86	0.00
RETREAT CK	GRE_000122	8800	163.40	173.82	172.43	**-1.39**	172.43	0.00
RETREAT CK	GRE_000117	9300	163.01	173.47	172.22	**-1.25**	172.22	0.00
RETREAT CK	GRE_000112	9700	163.01	172.19	172.17	-0.02	172.17	0.00
RETREAT CK	GRE_000112	9700	163.01	172.19	172.17	-0.02	172.17	0.00
RETREAT CK	GRE_000109	10200	163.10	171.88	171.82	-0.06	171.82	0.00
RETREAT CK	GRE_000109	10200	163.10	171.88	171.82	-0.06	171.82	0.00
RETREAT CK	GRE_000105	10600	161.64	171.69	171.58	-0.11	171.58	0.00
RETREAT CK	GRE_000095	11600	161.45	171.13	171.01	-0.12	171.01	0.00
RETREAT CK	GRE_000089	12200	161.06	170.84	170.77	-0.07	170.77	0.00
RETREAT CK	GRE_000084	12800	161.06	170.32	170.41	0.09	170.41	0.00
RETREAT CK	GRE_000084	12800	161.06	170.32	170.41	0.09	170.41	0.00
RETREAT CK	GRE_000076	13400	160.50	169.72	170.02	0.30	170.02	0.00
RETREAT CK	GRE_000076	13400	160.50	169.72	170.02	0.30	170.02	0.00
RETREAT CK	GRE_000068	14100	159.62	169.09	169.28	0.19	169.28	0.00
RETREAT CK	GRE_000058	15100	158.71	168.56	168.77	0.21	168.77	0.00
RETREAT CK	GRE_000050	15900	158.71	168.19	168.38	0.19	168.38	0.00
RETREAT CK	GRE_000043	16600	157.72	167.98	168.11	0.13	168.11	0.00
RETREAT CK	GRE_000038	17100	156.54	167.91	168.05	0.14	168.05	0.00
RETREAT CK	GRE_000032	17700	156.54	167.82	167.97	0.15	167.97	0.00
RETREAT CK	GRE_000025	18400	156.07	167.73	167.88	0.15	167.88	0.00
RETREAT CK	GRE_000020	18900	155.88	167.68	167.84	0.16	167.84	0.00
RETREAT CK	GRE_000013	19600	155.88	167.62	167.80	0.18	167.80	0.00
RETREAT CK	GRE_000013	19600	155.46	167.62	167.80	0.18	167.80	0.00
RETREAT CK	GRE_000001	20600	155.46	166.94	167.22	0.28	167.22	0.00
THERESA CK	GTH_000130	0	172.04	180.36	180.27	-0.09	180.27	0.00
THERESA CK	GTH_000112	1000	172.04	179.75	179.89	0.14	179.89	0.00
THERESA CK	GTH_000112	1000	172.04	179.75	179.89	0.14	179.89	0.00
THERESA CK	GTH_000105	1700	171.18	179.65	179.80	0.15	179.80	0.00
THERESA CK	GTH_000095	2700	170.82	179.37	179.53	0.16	179.53	0.00
THERESA CK	GTH_000080	4200	170.42	178.73	178.80	0.07	178.80	0.00
THERESA CK	GTH_000073	4900	169.80	178.24	178.30	0.06	178.30	0.00
THERESA CK	GTH_000063	5900	168.71	177.76	177.79	0.03	177.79	0.00
THERESA CK	GTH_000063	5900	168.71	177.76	177.79	0.03	177.79	0.00
THERESA CK	GTH_000052	6400	167.42	177.45	177.50	0.05	177.50	0.00
THERESA CK	GTH_000042	7400	166.83	177.13	177.11	-0.02	177.11	0.00
THERESA CK	GTH_000035	8100	166.56	176.87	176.80	-0.07	176.80	0.00
THERESA CK	GTH_000030	8600	166.04	176.48	176.35	-0.13	176.35	0.00
THERESA CK	GTH_000023	9200	166.28	175.43	175.45	0.02	175.45	0.00
THERESA CK	GTH_000023	9200	166.28	175.43	175.45	0.02	175.45	0.00
THERESA CK	GTH_000014	9800	166.01	175.24	175.04	-0.20	175.04	0.00
THERESA CK	GTH_000005	10700	166.18	174.85	174.10	**-0.75**	174.10	0.00
BTH_L01	GTHL01_048	0	172.09	175.43	175.45	0.02	175.45	0.00
BTH_L01	GTHL01_045	300	172.03	174.82	174.96	0.14	174.96	0.00
BTH_L01	GTHL01_040	800	171.09	174.02	174.00	-0.02	174.00	0.00
BTH_L01	GTHL01_036	1200	170.36	173.85	173.71	-0.14	173.71	0.00
BTH_L01	GTHL01_028	2000	170.11	173.42	173.25	-0.17	173.25	0.00
BTH_L01	GTHL01_017	2900	169.37	173.12	172.91	-0.21	172.91	0.00
BTH_L01	GTHL01_012	3400	169.35	172.98	172.75	-0.23	172.75	0.00
BTH_L01	GTHL01_005	4100	169.15	172.19	172.17	-0.02	172.17	0.00
BTH_R01-R03	GTHR01_023	0	174.31	179.75	179.89	0.14	179.89	0.00
BTH_R01-R03	GTHR01_020	500	174.31	179.54	179.61	0.07	179.61	0.00
BTH_R01-R03	GTHR01_010	1500	174.31	179.05	179.15	0.09	179.15	0.00
BTH_R01-R03	GTHR01_000	2500	173.30	177.82	177.82	0.00	177.82	0.00
BTH_R01-R03	GTHR01_000	2500	173.30	177.82	177.82	0.00	177.82	0.00
BTH_R01-R03	GTHR03_042	3800	173.30	177.28	177.27	-0.01	177.27	0.00
BTH_R01-R03	GTHR03_034	4600	175.05	176.93	176.82	-0.11	176.82	0.00
BTH_R01-R03	GTHR03_028	5200	174.36	176.82	176.69	-0.13	176.69	0.00
BTH_R01-R03	GTHR03_020	6000	174.08	176.70	176.57	-0.13	176.57	0.00
BTH_R01-R03	GTHR03_010	7000	174.08	176.15	176.15	0.00	176.15	0.00
BTH_R01-R03	GTHR03_000	8000	172.26	175.42	175.20	-0.22	175.20	0.00
BNO_L07-08-09	GNOL07_010	0	171.35	173.33	173.06	-0.27	173.06	0.00
BNO_L07-08-09	GNOL08_023	1000	171.35	172.58	172.64	0.06	172.64	0.00
BNO_L07-08-09	GNOL08_023	1000	171.35	172.58	172.64	0.06	172.64	0.00
BNO_L07-08-09	GNOL08_014	1900	171.00	172.37	172.36	-0.01	172.36	0.00
BNO_L07-08-09	GNOL08_005	2800	170.42	172.27	172.18	-0.09	172.18	0.00
BNO_L07-08-09	GNOL09_045	3300	170.42	172.22	172.09	-0.13	172.09	0.00
BNO_L07-08-09	GNOL09_045	3300	170.42	172.22	172.09	-0.13	172.09	0.00
BNO_L07-08-09	GNOL09_040	3800	170.58	172.18	172.00	-0.18	172.00	0.00
BNO_L07-08-09	GNOL09_031	4700	169.99	172.15	171.89	-0.26	171.89	0.00
BNO_L07-08-09	GNOL09_025	5300	168.99	172.05	171.87	-0.19	171.87	0.00
BNO_L07-08-09	GNOL09_015	6300	169.06	171.90	171.84	-0.06	171.84	0.00
BNO_L07-08-09	GNOL09_010	7000	169.34	171.89	171.79	-0.10	171.79	0.00
BNO_L07-08-09	GNOL09_005	7800	167.24	171.88	171.76	-0.12	171.76	0.00
BRE_R02-4-6-7-13-14	GRER02_010	0	168.53	174.89	173.99	**-0.90**	173.99	0.00
BRE_R02-4-6-7-13-14	GRER04_018	1000	168.55	172.77	173.26	**0.49**	173.26	0.00
BRE_R02-4-6-7-13-14	GRER04_018	1000	168.55	172.77	173.26	**0.49**	173.26	0.00
BRE_R02-4-6-7-13-14	GRER04_012	1600	169.50	172.54	173.00	**0.46**	173.00	0.00
BRE_R02-4-6-7-13-14	GRER04_007	2100	169.38	172.21	172.23	0.01	172.23	0.00
BRE_R02-4-6-7-13-14	GRER04_007	2100	169.38	172.21	172.23	0.01	172.23	0.00

Water Level				1 in 20 year ARI Results (mAHD)	1 in 20 year ARI Results (mAHD)		1 in 20 year ARI Results (mAHD)	
Name of Watercourse	**X-SECT Name**	**MIKE 11 Chainage**	**Bed EL**	**RUBICON CASE 086**	**MIKE11 CASE 086**	**difference** (mAHD)	**MIKE11 AD Case**	**difference** (mAHD)
BRE_R02-4-6-7-13-14	GRER07_018	2600	169.36	170.80	171.15	**0.35**	171.15	0.00
BRE_R02-4-6-7-13-14	GRER07_018	2600	169.36	170.80	171.15	**0.35**	171.15	0.00
BRE_R02-4-6-7-13-14	GRER07_008	3600	168.09	170.16	170.52	**0.36**	170.52	0.00
BRE_R02-4-6-7-13-14	GRER07_000	4400	167.35	170.01	170.39	**0.38**	170.39	0.00
BRE_R02-4-6-7-13-14	GRER07_000	4400	167.35	170.01	170.39	**0.38**	170.39	0.00
BRE_R02-4-6-7-13-14	GRER13_029	5500	168.55	169.88	169.76	-0.12	169.76	0.00
BRE_R02-4-6-7-13-14	GRER13_020	6400	167.91	169.60	169.39	-0.21	169.39	0.00
BRE_R02-4-6-7-13-14	GRER13_010	7400	165.97	168.44	168.57	0.13	168.57	0.00
BRE_R02-4-6-7-13-14	GRER14_032	7900	164.52	167.85	168.04	0.19	168.04	0.00
BRE_R02-4-6-7-13-14	GRER14_032	7900	164.52	167.85	168.04	0.19	168.04	0.00
BRE_R02-4-6-7-13-14	GRER14_020	9100	163.09	167.69	167.88	0.19	167.88	0.00
BRE_R02-4-6-7-13-14	GRER14_010	10100	161.98	167.63	167.82	0.19	167.82	0.00
BRE_R02-4-6-7-13-14	GRER14_005	10600	160.11	167.62	167.80	0.18	167.80	0.00
BRE_R09-10-12	GRER09_010	0	169.36	170.80	171.15	**0.35**	171.15	0.00
BRE_R09-10-12	GRER09_007	250	170.46	170.46	171.12	**0.66**	171.12	0.00
BRE_R09-10-12	GRER10_019	500	169.64	169.92	170.77	**0.85**	170.77	0.00
BRE_R09-10-12	GRER10_019	500	169.64	169.92	170.77	**0.85**	170.77	0.00
BRE_R09-10-12	GRER10_010	1400	168.52	169.52	170.20	**0.68**	170.20	0.00
BRE_R09-10-12	GRER12_020	1900	167.40	168.05	169.07	**1.02**	169.07	0.00
BRE_R09-10-12	GRER12_020	1900	167.40	168.05	169.07	**1.02**	169.07	0.00
BRE_R09-10-12	GRER12_010	2900	165.96	167.85	168.12	0.27	168.12	0.00
BRE_R09-10-12	GRER12_002	3700	164.52	167.85	168.04	0.19	168.04	0.00
BNO_L10	GNOL10_010	0	170.71	170.71	170.77	0.06	170.77	0.00
BNO_L10	GNOL10_005	1000	172.54	172.54	172.09	**-0.45**	172.09	0.00
BNO_L06-4	GNOL06_010	0	171.35	172.58	172.64	0.06	172.64	0.00
BNO_L06-4	GNOL04_043	1000	172.69	172.69	172.69	0.00	172.69	0.00
BNO_L06-4	GNOL04_038	1500	172.24	172.24	172.19	-0.05	172.19	0.00
BNO_L06-4	GNOL04_029	2400	171.62	171.62	171.62	0.00	171.62	0.00
BNO_L06-4	GNOL04_021	3200	170.81	170.81	171.15	**0.34**	171.15	0.00
BNO_L06-4	GNOL04_014	3900	170.60	170.8	171.15	**0.35**	171.15	0.00
BNO_L06-4	GNOL04_007	4600	169.36	170.80	171.15	**0.35**	171.15	0.00
BRE_R08	GRER08_010	0	167.35	170.01	170.39	**0.38**	170.39	0.00
BRE_R08	GRER08_000	1000	161.06	170.32	170.41	0.09	170.41	0.00
BRE_R05	GRER05_012	0	169.38	172.21	172.23	0.01	172.23	0.00
BRE_R05	GRER05_004	800	168.36	172.20	172.17	-0.03	172.17	0.00
BRE_R03	GRER03_026	0	168.55	172.77	173.26	**0.49**	173.26	0.00
BRE_R03	GRER03_021	500	167.69	172.69	173.16	**0.47**	173.16	0.00
BRE_R03	GRER03_012	1400	167.41	172.49	172.89	**0.40**	172.89	0.00
BRE_R03	GRER03_001	2600	166.55	172.20	172.17	-0.03	172.17	0.00
BRE_L01	GREL01_030	0	164.67	171.90	171.82	-0.08	171.82	0.00
BRE_L01	GREL01_019	1100	165.73	171.20	171.17	-0.03	171.17	0.00
BRE_L01	GREL01_014	1600	165.50	170.73	170.67	-0.06	170.67	0.00
BRE_L01	GREL01_005	2500	162.74	170.40	170.11	-0.29	170.11	0.00
BRE_L01	GREL01_000	3000	162.74	170.36	170.02	**-0.34**	170.02	0.00
BRE_L02-04	GREL02_050	0	162.74	170.36	170.02	**-0.34**	170.02	0.00
BRE_L02-04	GREL02_042	800	162.65	170.11	169.75	**-0.36**	169.75	0.00
BRE_L02-04	GREL02_030	2000	162.12	169.87	169.37	**-0.50**	169.37	0.00
BRE_L02-04	GREL02_020	3000	161.44	169.67	169.09	**-0.58**	169.09	0.00
BRE_L02-04	GREL02_010	4000	160.60	169.54	168.89	**-0.66**	168.89	0.00
BRE_L02-04	GREL04_048	4700	160.50	169.46	168.51	**-0.95**	168.51	0.00
BRE_L02-04	GREL04_048	4700	160.50	169.46	168.51	**-0.95**	168.51	0.00
BRE_L02-04	GREL04_040	5500	164.51	168.38	167.80	**-0.58**	167.80	0.00
BRE_L02-04	GREL04_035	6000	164.39	168.05	166.93	**-1.12**	166.93	0.00
BRE_L02-04	GREL04_030	6500	163.89	168.04	166.42	**-1.62**	166.42	0.00
BRE_L02-04	GREL04_025	7000	163.89	167.19	166.14	**-1.05**	166.14	0.00
BRE_L02-04	GREL04_020	7500	163.38	166.76	165.73	**-1.03**	165.73	-0.01
BRE_L02-04	GREL04_010	8500	161.36	166.64	165.46	**-1.18**	165.44	-0.02
BRE_L02-04	GREL04_000	9500	161.36	166.58	165.37	**-1.21**	165.34	-0.02
BRE_L03	GREL03_016	0	160.50	169.46	168.51	**-0.95**	168.51	0.00
BRE_L03	GREL03_008	800	160.53	169.37	168.27	**-1.11**	168.27	0.00
BRE_L03	GREL03_000	1600	160.53	169.26	167.80	**-1.46**	167.80	0.00
BTH_R02	GTHR02_020	0	173.3	177.82	177.82	0.00	177.82	0.00
BTH_R02	GTHR02_010	1000	171.07	177.76	177.79	0.03	177.79	0.00
BTH_R02	GTHR02_000	2000	168.5	177.76	177.79	0.03	177.79	0.00
BMK_L05	GMKL05_070	0	140.08	147.34	145.32	**-2.02**	145.26	-0.06
BMK_L05	GMKL05_060	1000	140.08	145.26	143.42	**-1.84**	143.35	-0.07
BMK_L05	GMKL05_050	2000	140.08	144.20	143.24	**-0.96**	143.17	-0.07
BMK_L05	GMKL05_040	3000	140.24	143.47	143.23	-0.24	143.17	-0.07
BMK_L05	GMKL05_025	4500	132.40	143.33	143.23	-0.10	143.17	-0.06
BMK_L05	GMKL05_015	5500	129.87	143.32	143.23	-0.09	143.17	-0.06
BMK_L05	GMKL05_000	7000	129.87	143.32	143.23	-0.09	143.17	-0.06
BMK_R01-02	GMKR01_038	0	144.75	150.35	150.12	-0.23	150.27	0.15
BMK_R01-02	GMKR01_029	900	141.17	149.78	149.54	-0.24	148.90	**-0.65**
BMK_R01-02	GMKR01_020	1800	144.13	149.20	148.99	-0.21	148.45	**-0.54**
BMK_R01-02	GMKR01_010	2800	143.28	148.43	148.42	-0.01	148.13	-0.28
BMK_R01-02	GMKR02_031	3500	136.00	148.14	147.90	-0.24	147.79	-0.11
BMK_R01-02	GMKR02_031	3500	136.00	148.14	147.90	-0.24	147.79	-0.11
BMK_R01-02	GMKR02_027	4000	145.18	147.84	147.66	-0.18	147.56	-0.10
BMK_R01-02	GMKR02_020	5100	143.07	147.68	147.39	-0.29	147.33	-0.06
BMK_R01-02	GMKR02_010	6100	133.07	147.67	147.39	-0.28	147.32	-0.06
BMK_R01-02	GMKR02_000	7100	123.07	147.67	147.39	-0.28	147.32	-0.06
BMK_R03	GMKR03_080	0	136.00	148.14	147.90	-0.24	147.79	-0.11
BMK_R03	GMKR03_000	800	136.00	148.12	147.87	-0.25	147.79	-0.09
BMK_L02	GMKL02_030	0	147.62	150.35	150.12	-0.23	150.27	0.15
BMK_L02	GMKL02_022	800	147.28	149.54	149.41	-0.13	149.53	0.13
BMK_L02	GMKL02_014	1600	145.65	148.96	148.86	-0.10	148.93	0.07
BMK_L02	GMKL02_009	2100	142.20	148.92	148.82	-0.10	148.86	0.05
BMK_L02	GMKL02_000	3000	142.20	148.91	148.81	-0.10	148.85	0.05
BMK_L01-04	GMKL01_092	0	143.66	148.91	148.81	-0.10	148.85	0.05
BMK_L01-04	GMKL01_082	1000	147.00	148.72	148.71	-0.01	148.75	0.04
BMK_L01-04	GMKL01_073	1900	146.26	148.32	148.32	0.00	148.36	0.04
BMK_L01-04	GMKL01_063	2900	145.94	147.73	147.69	-0.04	147.74	0.05
BMK_L01-04	GMKL01_055	3700	144.87	147.72	147.33	**-0.39**	147.38	0.05
BMK_L01-04	GMKL01_049	4300	145.40	147.72	147.06	**-0.66**	147.09	0.04
BMK_L01-04	GMKL01_040	5200	144.81	147.72	146.79	**-0.93**	146.78	0.00

Water Level				1 in 20 year ARI Results (mAHD)	1 in 20 year ARI Results (mAHD)		1 in 20 year ARI Results (mAHD)	
Name of Watercourse	**X-SECT Name**	**MIKE 11 Chainage**	**Bed EL**	**RUBICON CASE 086**	**MIKE11 CASE 086**	**difference** (mAHD)	**MIKE11 AD Case**	**difference** (mAHD)
BMK_L01-04	GMKL04_050	6200	142.55	146.99	146.55	**-0.44**	146.49	-0.06
BMK_L01-04	GMKL04_050	6200	142.55	146.99	146.55	**-0.44**	146.49	-0.06
BMK_L01-04	GMKL04_043	6800	142.63	N/A	145.98	**N/A**	145.92	-0.06
BMK_L01-04	GMKL04_037	7500	142.63	147.26	145.76	**-1.50**	145.70	-0.06
BMK_L01-04	GMKL04_028	8400	139.80	N/A	145.59	**N/A**	145.52	-0.07
BMK_L01-04	GMKL04_020	9200	139.80	147.30	145.53	**-1.77**	145.46	-0.06
BMK_L01-04	GMKL04_010	10200	139.80	N/A	145.44	**N/A**	145.38	-0.06
BMK_L01-04	GMKL04_004	10800	140.08	147.34	145.32	**-2.02**	145.26	-0.06
BMK_L03	GMKL03_008	0	135.05	146.99	146.55	**-0.44**	146.49	-0.06
BMK_L03	GMKL03_004	400	130.05	146.98	146.55	**-0.43**	146.49	-0.06
BMK_L03	GMKL03_000	800	125.05	146.98	146.55	**-0.43**	146.50	-0.06
BNO_L13	GNOL13_050	0	144.31	151.38	151.44	0.06	151.69	0.25
BNO_L13	GNOL13_043	700	144.31	151.11	151.23	0.12	151.48	0.25
BNO_L13	GNOL13_038	1200	142.42	150.89	151.06	0.17	151.29	0.22
BNO_L13	GNOL13_033	1700	143.91	150.62	150.86	0.24	151.00	0.14
BNO_L13	GNOL13_030	2000	141.90	150.53	150.77	0.24	150.90	0.12
BNO_L13	GNOL13_023	2700	141.84	150.39	150.65	0.26	150.76	0.11
BNO_L13	GNOL13_020	3000	141.10	150.34	150.61	0.27	150.72	0.11
BNO_L13	GNOL13_016	3400	142.41	150.29	150.57	0.28	150.67	0.10
BNO_L13	GNOL13_010	4000	141.46	150.25	150.54	0.29	150.64	0.10
BNO_L13	GNOL13_000	5000	141.46	150.20	150.51	**0.31**	150.61	0.10
BNO_R22-23-24-25	GNOR22_090	0	142.64	156.20	156.14	-0.06	156.15	0.01
BNO_R22-23-24-25	GNOR22_078	1200	142.64	155.73	155.73	0.00	155.80	0.06
BNO_R22-23-24-25	GNOR22_074	1600	143.42	155.53	155.55	0.02	155.64	0.09
BNO_R22-23-24-25	GNOR22_068	2200	141.94	155.30	155.22	-0.08	155.38	0.16
BNO_R22-23-24-25	GNOR23_058	3000	141.46	154.96	154.84	-0.12	155.11	0.27
BNO_R22-23-24-25	GNOR23_058	3000	141.46	154.96	154.84	-0.12	155.11	0.27
BNO_R22-23-24-25	GNOR23_051	3700	142.45	154.63	154.57	-0.06	154.87	0.30
BNO_R22-23-24-25	GNOR23_046	4200	140.83	154.36	154.34	-0.02	154.58	0.24
BNO_R22-23-24-25	GNOR24_040	4700	140.55	154.10	154.09	-0.01	154.34	0.25
BNO_R22-23-24-25	GNOR24_040	4700	140.55	154.10	154.09	-0.01	154.34	0.25
BNO_R22-23-24-25	GNOR24_035	5200	139.91	153.92	153.90	-0.02	154.21	**0.31**
BNO_R22-23-24-25	GNOR24_029	5800	139.48	153.64	153.67	0.03	154.06	**0.40**
BNO_R22-23-24-25	GNOR25_022	6400	140.68	153.28	153.52	0.24	153.99	**0.47**
BNO_R22-23-24-25	GNOR25_022	6400	140.68	153.28	153.52	0.24	153.99	**0.47**
BNO_R22-23-24-25	GNOR25_012	7400	139.61	152.94	153.19	0.25	153.66	**0.47**
BNO_R22-23-24-25	GNOR25_005	8100	138.37	152.73	153.02	0.29	153.46	**0.44**
BNO_R22-23-24-25	GNOR25_000	8600	138.37	152.60	152.95	**0.35**	153.37	**0.43**
BNO_R21	GNOR21_000	0	150.55	154.96	154.84	-0.12	155.11	0.27
BNO_R21	GNOR21_008	800	152.55	154.91	154.83	-0.08	155.09	0.26
BNO_R21	GNOR21_012	1200	151.44	154.81	154.51	**-0.30**	154.85	**0.34**
BNO_R21	GNOR21_020	2000	147.01	153.34	153.53	0.19	154.09	**0.56**
BNO_R27	GNOR27_018	0	147.01	153.34	153.53	0.19	154.09	**0.56**
BNO_R27	GNOR27_010	800	146.07	153.33	153.52	0.19	154.02	**0.49**
BNO_R27	GNOR27_006	1200	144.54	153.32	153.52	0.20	154.00	**0.48**
BNO_R27	GNOR27_000	1800	144.54	153.32	153.52	0.20	153.99	**0.47**
BNO_R12-13-18-19	GNOR12_081	0	161.96	164.05	163.96	-0.09	163.85	-0.11
BNO_R12-13-18-19	GNOR12_074	700	161.66	162.76	162.65	-0.11	162.59	-0.06
BNO_R12-13-18-19	GNOR12_065	1600	159.73	160.76	160.60	-0.16	160.54	-0.06
BNO_R12-13-18-19	GNOR12_061	2000	158.75	160.13	160.08	-0.05	159.99	-0.08
BNO_R12-13-18-19	GNOR12_053	2800	158.15	159.69	159.86	0.17	159.78	-0.09
BNO_R12-13-18-19	GNOR12_044	3700	157.78	159.54	159.83	0.28	159.74	-0.08
BNO_R12-13-18-19	GNOR12_035	4600	157.73	159.45	159.81	**0.36**	159.73	-0.08
BNO_R12-13-18-19	GNOR13_030	5000	157.73	159.40	159.81	**0.41**	159.73	-0.08
BNO_R12-13-18-19	GNOR13_030	5000	157.73	159.40	159.81	**0.41**	159.73	-0.08
BNO_R12-13-18-19	GNOR13_021	5900	157.42	159.06	159.28	0.22	159.06	-0.23
BNO_R12-13-18-19	GNOR13_016	6400	156.75	158.89	159.01	0.12	158.83	-0.18
BNO_R12-13-18-19	GNOR13_010	7000	154.96	158.75	158.48	-0.27	158.52	0.03
BNO_R12-13-18-19	GNOR18_067	8000	152.05	158.04	158.34	0.30	158.42	0.08
BNO_R12-13-18-19	GNOR18_067	8000	152.05	158.04	158.34	0.30	158.42	0.08
BNO_R12-13-18-19	GNOR18_060	8700	152.05	157.76	158.02	0.25	158.11	0.10
BNO_R12-13-18-19	GNOR18_053	9400	149.89	156.58	156.90	**0.32**	156.97	0.07
BNO_R12-13-18-19	GNOR18_053	9400	149.89	156.58	156.90	**0.32**	156.97	0.07
BNO_R12-13-18-19	GNOR19_040	10200	155.21	156.03	156.17	0.14	156.22	0.05
BNO_R12-13-18-19	GNOR19_031	11100	153.44	155.36	155.57	0.20	155.64	0.07
BNO_R12-13-18-19	GNOR19_026	11600	153.02	155.10	155.28	0.18	155.36	0.08
BNO_R12-13-18-19	GNOR19_018	12400	152.79	154.33	154.55	0.22	154.65	0.10
BNO_R12-13-18-19	GNOR19_012	13000	151.86	153.53	153.76	0.23	154.19	**0.43**
BNO_R12-13-18-19	GNOR19_002	14000	147.01	153.34	153.53	0.19	154.09	**0.56**
BNO_R17	GNOR17_105	0	154.02	160.45	160.59	0.14	160.84	0.25
BNO_R17	GNOR17_098	700	154.05	160.27	160.33	0.06	160.59	0.26
BNO_R17	GNOR17_090	1500	154.25	159.99	160.11	0.12	160.39	0.28
BNO_R17	GNOR17_085	2000	153.88	159.60	159.66	0.06	159.99	**0.33**
BNO_R17	GNOR17_080	2500	153.60	159.17	158.96	-0.21	159.24	0.28
BNO_R17	GNOR17_073	3200	152.66	158.87	158.78	-0.09	159.04	0.26
BNO_R17	GNOR17_068	3700	152.05	158.04	158.34	0.30	158.42	0.08
BNO_R20	GNOR20_050	0	149.89	156.58	156.90	**0.32**	156.97	0.07
BNO_R20	GNOR20_043	700	149.89	156.34	156.68	**0.34**	156.75	0.06
BNO_R20	GNOR20_039	1100	149.20	156.20	156.53	**0.33**	156.59	0.06
BNO_R20	GNOR20_032	1800	149.12	155.96	156.20	0.24	156.27	0.07
BNO_R20	GNOR20_025	2500	148.83	155.85	156.00	0.15	156.09	0.09
BNO_R20	GNOR20_016	3400	149.20	155.69	155.86	0.17	155.95	0.10
BNO_R20	GNOR20_007	4300	149.04	155.35	155.41	0.06	155.57	0.16
BNO_R20	GNOR20_000	5000	149.04	154.96	154.84	-0.12	155.11	0.27
BNO_R04-5-6-7	GNOR04_005	0	158.89	165.63	165.37	-0.26	165.34	-0.02
BNO_R04-5-6-7	GNOR05_007	500	160.06	165.54	165.23	**-0.31**	165.20	-0.03
BNO_R04-5-6-7	GNOR05_007	500	160.06	165.54	165.23	**-0.31**	165.20	-0.03
BNO_R04-5-6-7	GNOR06_013	1200	159.05	164.98	164.79	-0.19	164.75	-0.04
BNO_R04-5-6-7	GNOR06_013	1200	159.05	164.98	164.79	-0.19	164.75	-0.04
BNO_R04-5-6-7	GNOR06_005	2000	159.14	164.58	164.46	-0.12	164.40	-0.05
BNO_R04-5-6-7	GNOR06_005	2000	159.14	164.58	164.46	-0.12	164.40	-0.05
BNO_R04-5-6-7	GNOR07_000	2700	157.96	164.54	164.43	-0.11	164.37	-0.06
BNO_R01-3	GNOR01_029	0	164.73	168.28	168.35	0.07	168.35	0.00
BNO_R01-3	GNOR01_021	800	165.80	167.70	167.87	0.17	167.87	0.00
BNO_R01-3	GNOR01_018	1300	164.94	167.43	167.33	-0.10	167.33	0.00

Water Level				1 in 20 year ARI Results (mAHD)	1 in 20 year ARI Results (mAHD)		1 in 20 year ARI Results (mAHD)	
Name of Watercourse	**X-SECT Name**	**MIKE 11 Chainage**	**Bed EL**	**RUBICON CASE 086**	**MIKE11 CASE 086**	**difference** (mAHD)	**MIKE11 AD Case**	**difference** (mAHD)
BNO_R01-3	GNOR01_013	1800	164.06	166.99	167.08	0.09	167.08	0.00
BNO_R01-3	GNOR03_058	2800	164.03	167.00	166.72	-0.28	166.72	0.00
BNO_R01-3		2800	164.03	167.00	166.72	-0.28	166.72	0.00
BNO_R01-3	GNOR03_050	3600	162.94	166.02	166.11	0.09	166.11	0.00
BNO_R01-3	GNOR03_041	4500	162.40	165.84	165.83	-0.01	165.82	-0.01
BNO_R01-3	GNOR03_035	5100	162.17	165.79	165.73	-0.06	165.71	-0.01
BNO_R01-3	GNOR03_028	5800	162.10	165.73	165.63	-0.10	165.62	-0.01
BNO_R01-3	GNOR03_019	6700	162.41	165.66	165.49	-0.17	165.47	-0.02
BNO_R01-3	GNOR03_012	7400	162.51	165.61	165.38	-0.23	165.36	-0.02
BNO_R01-3	GNOR03_005	8100	161.21	165.54	165.23	**-0.31**	165.20	-0.03
BNO_R02	GNOR02_029	0	163.62	167.00	166.72	-0.28	166.72	0.00
BNO_R02	GNOR02_024	500	163.62	167.17	166.76	**-0.41**	166.75	0.00
BNO_R02	GNOR02_015	1400	164.30	167.18	166.82	**-0.36**	166.82	0.00
BNO_R02	GNOR02_010	1900	164.51	167.18	166.96	-0.22	166.96	0.00
BNO_R02	GNOR02_000	2900	164.03	167.33	167.22	-0.11	167.22	0.00
BNO_R08-15-16	GNOR08_090	0	161.54	164.58	164.46	-0.12	164.40	-0.05
BNO_R08-15-16	GNOR08_087	300	161.68	164.28	164.07	-0.21	164.01	-0.06
BNO_R08-15-16	GNOR08_080	1000	162.10	163.89	163.56	**-0.33**	163.49	-0.06
BNO_R08-15-16	GNOR08_075	1500	161.52	163.76	163.44	**-0.32**	163.37	-0.07
BNO_R08-15-16	GNOR08_070	2000	161.08	163.65	163.33	**-0.33**	163.26	-0.07
BNO_R08-15-16	GNOR08_056	3400	160.24	163.39	162.97	**-0.42**	162.89	-0.08
BNO_R08-15-16	GNOR08_050	4000	158.99	163.13	162.71	**-0.42**	162.63	-0.08
BNO_R08-15-16	GNOR08_050	4000	158.99	163.13	162.71	**-0.42**	162.63	-0.08
BNO_R08-15-16	GNOR08_040	5000	158.99	162.95	161.76	**-1.19**	161.70	-0.06
BNO_R08-15-16	GNOR08_036	5400	159.22	162.89	161.35	**-1.54**	161.28	-0.07
BNO_R08-15-16	GNOR08_030	6000	157.73	160.81	159.86	**-0.95**	159.77	-0.08
BNO_R08-15-16	GNOR08_030	6000	157.73	160.81	159.86	**-0.95**	159.77	-0.08
BNO_R08-15-16	GNOR15_025	6160	157.92	160.81	159.59	**-1.22**	159.53	-0.06
BNO_R08-15-16	GNOR15_018	6700	157.01	159.84	159.05	**-0.79**	159.17	0.12
BNO_R08-15-16	GNOR15_008	7700	156.00	159.34	158.57	**-0.77**	158.71	0.14
BNO_R08-15-16	GNOR15_000	8500	155.46	159.07	158.35	**-0.72**	158.35	0.01
BNO_R08-15-16	GNOR15_000	8500	155.46	159.07	158.35	**-0.72**	158.35	0.01
BNO_R08-15-16	GNOR16_020	9200	155.39	158.78	157.94	**-0.84**	157.88	-0.06
BNO_R08-15-16	GNOR16_015	9700	155.33	158.68	157.63	**-1.05**	157.54	-0.09
BNO_R08-15-16	GNOR16_007	10500	154.25	158.55	157.01	**-1.54**	156.90	-0.10
BNO_R08-15-16	GNOR16_000	11200	153.78	156.77	156.34	**-0.43**	156.25	-0.09
BNO_R11A	GNOR11_075	0	161.41	164.58	164.46	-0.12	164.40	-0.05
BNO_R11A	GNOR11_075	250	N/A	N/A	164.46	**N/A**	164.40	-0.05
BNO_R11A	GNOR11_070	500	162.47	164.58	164.46	-0.12	164.40	-0.05
BNO_R11B	GNOR11_060	0	162.47	162.47	162.95	**0.47**	162.59	**-0.36**
BNO_R11B	GNOR11_054	600	161.99	161.99	162.52	**0.53**	162.13	**-0.39**
BNO_R11B	GNOR11_049	1100	160.99	160.99	161.56	**0.57**	161.12	**-0.44**
BNO_R11B	GNOR11_042	1800	160.27	160.27	160.66	**0.39**	160.38	-0.28
BNO_R11B	GNOR11_035	2500	158.56	158.56	159.52	**0.96**	159.10	**-0.42**
BNO_R11B	GNOR11_024	3600	158.95	158.95	159.31	**0.36**	159.07	-0.25
BNO_R11B	GNOR11_018	4200	158.16	158.46	158.50	0.04	158.50	0.00
BNO_R11B	GNOR11_009	5100	157.44	158.46	158.50	0.04	158.50	0.00
BNO_R11B	GNOR11_004	5600	156.55	158.46	158.50	0.04	158.50	0.00
BNO_R09A	GNOR09_060	0	162.36	164.98	164.79	-0.19	164.75	-0.04
BNO_R09A	GNOR09_060	250	N/A	N/A	164.79	**N/A**	164.75	-0.04
BNO_R09A	GNOR09_055	500	162.36	164.98	164.79	-0.19	164.75	-0.04
BNO_R09B	GNOR09_041	0	164.85	164.85	164.87	0.02	164.85	-0.02
BNO_R09B	GNOR09_034	700	163.50	163.50	163.98	**0.48**	163.60	**-0.38**
BNO_R09B	GNOR09_026	1500	162.34	162.34	163.08	**0.74**	162.50	**-0.59**
BNO_R09B	GNOR09_021	2000	161.50	161.50	162.52	**1.02**	161.74	**-0.79**
BNO_R09B	GNOR09_015	2600	161.13	161.13	161.36	0.23	161.13	-0.23
BNO_R09B	GNOR09_005	3600	159.10	160.81	160.90	0.09	160.89	-0.01
BNO_R10A	GNOR10_109	0	162.47	164.58	164.46	-0.12	164.40	-0.05
BNO_R10A	GNOR10_101	800	161.89	163.88	163.70	-0.18	163.64	-0.06
BNO_R10A	GNOR10_094	1500	159.71	163.70	163.48	-0.22	163.40	-0.08
BNO_R10A	GNOR10_090	1900	160.46	163.62	163.38	-0.24	163.30	-0.08
BNO_R10A	GNOR10_079	3000	160.19	163.43	163.03	**-0.40**	162.93	-0.10
BNO_R10A	GNOR10_074	3500	160.29	163.36	162.94	**-0.42**	162.84	-0.10
BNO_R10A	GNOR10_065	4400	158.99	163.13	162.71	**-0.42**	162.63	-0.08
BNO_R10B	GNOR10_072	0	160.19	160.19	160.37	0.18	160.34	-0.02
BNO_R10B	GNOR10_062	1000	158.90	159.06	159.13	0.07	159.11	-0.03
BNO_R10B	GNOR10_044	1800	157.32	159.06	158.53	**-0.53**	158.46	-0.07
BNO_R10B	GNOR10_036	2600	157.07	159.06	158.35	**-0.71**	158.36	0.01
BNO_R10B	GNOR10_030	3200	155.46	159.06	158.35	**-0.71**	158.35	0.01
BNO_R14	GNOR14_005	0	157.73	160.81	159.86	**-0.95**	159.77	-0.08
BNO_R14	GNOR14_000	20	157.73	159.40	159.81	**0.41**	159.73	-0.08
BNO_L11	GNOL11_008	0	150.60	161.26	161.45	0.19	161.56	0.11
BNO_L11	GNOL11_000	800	150.60	160.97	161.09	0.12	161.30	0.21
BRE_R11	GRER11_040	0	168.05	168.05	169.07	**1.02**	169.07	0.00
BRE_R11	GRER11_032	800	168.05	168.05	168.93	**0.88**	168.93	0.00
BRE_R11	GRER11_021	1900	166.85	167.68	167.78	0.10	167.78	0.00
BRE_R11	GRER11_012	2800	160.69	167.63	167.78	0.15	167.78	0.00
BRE_R11	GRER11_004	3600	160.69	167.63	167.78	0.15	167.78	0.00
BNO_R26	GNOR26_010	0	152.26	154.10	154.09	-0.01	154.34	0.25
BNO_R26	GNOR26_000	1000	152.26	153.49	153.76	0.27	153.97	0.21
BCO_R01	GCOR01_030	0	149.65	152.81	152.75	-0.06	152.83	0.08
BCO_R01	GCOR01_022	800	149.65	152.35	152.33	-0.02	152.41	0.08
BCO_R01	GCOR01_019	1200	149.68	151.93	151.99	0.06	152.09	0.10
BCO_R01	GCOR01_011	1900	147.93	151.28	151.40	0.12	151.57	0.17
BCO_R01	GCOR01_007	2300	147.09	151.11	151.25	0.14	151.44	0.19
BCO_R01	GCOR01_003	2700	141.07	151.09	151.23	0.14	151.42	0.19

ROBERT AIRE

QUEENSLAND GOVERNMENT

Nogoa River Flood Plain Board

NATURAL RESOURCES

Nogoa River Flood Plain Board

Interim Flood Plain Management Plan

Nogoa River Flood Plain

May 1997

Nogoa River Flood Plain Board

Interim Flood Plain Management Plan

Prepared for

Nogoa River Flood Plain Board

by
Nogoa River Flood Plain Steering Committee
and
Department of Natural Resources

May 1997

TABLE OF CONTENTS

		PAGE NO
TABLE OF CONTENTS		*ii*
LIST OF APPENDICES		*iii*
LIST OF FIGURES		*iii*
LIST OF TABLES		*iii*
DEFINITIONS		*iv*
ABBREVIATIONS		*viii*
UNITS		*viii*
1.0 Introduction		**1**
1.1	**Background**	**1**
1.2	**Community Consultation**	**2**
2.0 Responsibility for Implementation and Management of Plan		**3**
2.1	**Approvals within the 'Nogoa River Flood Plain' Related to Other Responsible Authorities**	**3**
3.0 Scope of Management Plan		**4**
3.1	**Floodplain Management Process**	**4**
3.2	**Limits of Area**	**4**
3.3	**Requirement to make Application**	**4**
3.3.1	**Works requiring Permit**	**4**
3.3.2	**Exempt Works**	**5**
3.4	**Limits of Investigations**	**5**
3.5	**Emerald Town**	**5**
4.0 Principles of Management and Objectives		**6**
4.1	**Principles of Management**	**6**
4.2	**Objectives**	**6**
5.0 Flood Study		**7**
5.1	**Historical Floods**	**7**
5.2	**Nogoa Floodplain Numerical Model**	**8**
5.3	**Topographic Base**	**9**
5.4	**Designated Flood Event**	**9**
5.5	**Adopted Base Case and Simulation Results**	**11**
6.0 Interim Criteria and Measures for Allowable Development		**12**
6.1	**Introduction**	**12**
6.2	**Interim Criteria**	**12**
6.3	**Interim Measures**	**12**
7.0 Plan Review and Amendment		**15**
8.0 References		**16**

APPENDICES

APPENDIX A	NOGOA RIVER FLOOD PLAIN STEERING COMMITTEE
APPENDIX B	NOGOA RIVER FLOOD PLAIN SCOPING STUDY EXECUTIVE SUMMARY

LIST OF FIGURES

Figure 1	Desired Process for Development of Floodplain Management Plan
Figure 2	Nogoa River Flood Plain
Figure 3	Adopted Topographic Base
Figure 4	Adopted Base Case- Depth and Extent of Inundation
Figure 5	Adopted Base Case- Discharge and Velocity Distribution

LIST OF TABLES

Table 5.1	Historical Flood Events Pre-Fairbairn Dam
Table 5.2	Historical Flood Events Post-Fairbairn Dam
Table 5.3	Designated Flood Event Design Rainfall Depths and Loss Rates(mm)
Table 5.4	Designated Flood Event 1:20 year ARI 168 hour duration contributing hydrographs
Table 5.5	Adopted Base Case Simulation Data Files
Table 6.1	Interim Measures

DEFINITIONS

Adopted Middle Thread Distance (AMTD)	The distance (usually in kilometres) up a stream relative to its mouth or the next downstream significant junction with another stream.
Annual Exceedence Probability (AEP)	The likelihood of a flood of a certain magnitude being exceeded within a finite time frame, which is usually one year. AEP is usually expressed as a percentage. eg 1% AEP flood event is an alternate way of expressing the 1 in 100 year ARI flood event.
Average Recurrence Interval (ARI)	The likelihood of occurrence of flooding expressed in terms of the long-term average number of years between the occurrence of a flood as big as or bigger than the specified event, eg floods with a discharge as big as or larger than the 1 in 100 year ARI flood event will occur on average once every 100 years.
Board	Nogoa River Flood Plain Board. (NRFPB)
Catchment	The area draining to a particular site. It always relates to a specific location and includes the catchments of tributary streams as well as the main stream.
Critical Storm Duration	The duration of the storm event of a nominated AEP or ARI (eg. the 1 in 50 year ARI flood) that produces the largest flood discharge at the location of interest. Critical storm duration depends upon catchment size, topography, land use and the temporal pattern of the rainfall.
Design Report	Report, prepared by suitably qualified individuals or companies, which provides details of the development proposal, including data and design parameters used (including assumptions), Plans and Specifications, and assessments of impacts the works may have and the hazard the works may represent.

Designated Flood Event (DFE)	Flood events selected for planning purposes, as determined in floodplain management studies and incorporated in floodplain management plans. Selection should be based on an understanding of flood behaviour and the associated flood risk. It should also take into account the social, economic and environmental consequences associated with floods of different severities. Different DFE's may be appropriate for different categories of land use, eg residential, commercial, rural etc and for emergency services planning. Note that DFE's do not define the extent of flood prone land, which is defined by the Probable Maximum Flood (PMF).
Discharge	The rate of flow of water, as measured in terms of volume per unit time, eg cubic metres per second, (m^3/s).
Flood	Relatively high stream flow which overtops the natural or artificial banks in any part of a stream, river, estuary, lake or dam.
Floodway	Those areas of the floodplain where significant discharge or storage of waters occur during floods. Floodways are often aligned with naturally defined channels. Floodways are areas which, if filled or even partially blocked, would cause a significant redistribution of flood flow, or a significant increase in flood levels.
Flood Emergency Plan	An agreed set of roles, responsibilities, functions, actions and management arrangements to deal with the prevention, preparation for response to, and recovery from, flood emergencies. A local flood emergency plan forms an essential component of a floodplain management plan.
Flood Liable Land	Land which is inundated by designated flood events. Note that the extent of flood liable land varies with the DFE. (see floodprone land)
Floodplain	Area of a river valley, adjacent to the river channel, which is subject to inundation by the Probable Maximum Flood.

Floodplain Management Plan	The principle means of managing the floodplain. A floodplain management plan describes how the extent of floodprone land is to be developed and managed to achieve defined objectives.
Floodprone Land	Land susceptible to inundation by the Probable Maximum Flood (PMF) event, ie the maximum theoretical extent of flood liable land.
Flood Runners	See Floodway.
Freeboard	Freeboard is a factor of safety (usually expressed as a height) above designated flood levels, typically used in relation to the setting of floor levels or levee crest levels. Freeboard compensates for effects such as wave action, localised hydraulic behaviour and settlement of levees which combine to reduce the level of protection provided by the levee.
Hydraulic	Term given to the study of water flow in waterways. In particular it is used to refer to the evaluation of flow characteristics such as water level, discharge and velocity.
Hydrograph	A plot which shows the variation of discharge (discharge hydrograph) or water level (stage hydrograph) with time during the course of a flood event at any particular location.
Hydrology	The science concerned with the study of water and it's constituents in respect to its movement in relation to the land ie. rainfall, runoff, evaporation and infiltration.
Mathematical/Numerical model	The mathematical representation of the physical processes involved in runoff generation and streamflow. Due to the complex nature of these mathematical relationships, computers are often used to solve the underlying equations.
Nogoa River Flood Plain	Area under control of Nogoa River Flood Plain Board (in relation to its responsibilities only) and defined by drawing No JB1 held by Board. The area approximates the extent of inundation that would be expected to occur for an event similar to the 1978 flood plus an additional 500 mm vertically.

Nogoa River Flood Plain Board (NRFPB)	Joint Local Government established under the Local Government Act responsible for the management and control of the development and use of works on the Nogoa River Flood Plain. Representation on the NRFPB comprises elected representatives of the Emerald and Peak Downs Local Governments.
Nogoa River Flood Plain Steering Committee	Committee formed to oversee the development and implementation of the floodplain management plan. The Committee comprises representatives of stakeholder groups and agencies with an interest in and responsibilities for management of the Nogoa River Flood Plain.
Peak Discharge	The maximum discharge to occur at any specific location during the course of a flood event.
Probable Maximum Flood(PMF)	The flood hydrograph that results from the Probable Maximum Precipitation (PMP) with the worst flood producing catchment conditions that can be realistically expected in the prevailing meteorologic conditions. The PMF defines the extent of flood prone land. Generally, it is not physically or financially possible to provide general protection against this event. For this floodplain, the PMF is assumed to have a nominal probability of 1 in 100 000 years.
Probable Maximum Precipitation (PMP)	The theoretical greatest depth of precipitation for a given duration that is physically possible over a particular drainage basin.
Runoff	The amount of rainfall which actually becomes streamflow, also known as rainfall excess.
Temporal Pattern	The variation of rainfall intensity with time over the course of a storm event.
Velocity	The speed of floodwater, measured in distance per unit time. ie metres per second, (m/sec).

ABBREVIATIONS

AEP	Annual Exceedence Probability
ARI	Average Recurrence Interval
BoM	Bureau of Meteorology
DFE	Designated Flood Event
DNR	Department of Natural Resources. The Department of Natural Resources was formed in February 1996. At the commencement of this study, officers contributing to the Floodplain Management Plan were part of the Department of Primary Industries. Unless otherwise stated, DNR or the Department of Natural Resources is used for simplicity in reference to the involvement of officers in the study.
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation

UNITS

hr	hour (time)
m	metres (distance)
m AHD	metres to Australian Height Datum (Elevation)
m SD	metres to State Datum
ML	megalitres or one million litres (volume)
m/s	metres per second (velocity)
m^3/s	cubic metres per second (discharge)

1.0 Introduction

Of all natural disasters, floods are considered the most manageable, not only because areas of risk can be identified and quantified, but also because of the availability of cost effective measures to reduce damage.

Statewide the average annual cost of flooding has been estimated at about $125 million out of an annual total flood disaster bill of $350 million. Inappropriately located development on floodplains has the potential to further escalate this average annual damages bill.

The need for management control of the Nogoa River Flood Plain gained momentum late in 1993 following concerns being raised from a number of quarters. These concerns included the extent of the collective rapid growth in development on the floodplain, its potential to adversely impact on existing landowners and their use of that land and the potential for future investment dollars in the region being lost, either due to uncertainty in the surety of investments or to expensive litigation cases. This led to the formation of the Nogoa River Flood Plain Steering Committee and subsequently the Nogoa River Flood Plain Board.

This Interim Floodplain Management Plan is the Nogoa River Flood Plain Board's adopted interim Policy document, representing a major component of the Board's overall management framework.

1.1 Background

Significant expansion in irrigated farming adjacent to the regulated section of the Nogoa-Mackenzie Rivers has occurred in recent years, particularly since the major release of additional water allocation in the late 1980s from Fairbairn Dam.

A large proportion of this expansion has occurred along the Nogoa Floodplain downstream of Emerald, and considerable pressure exists for further development. This development, which includes construction of significant levee banks and above ground supply channels and ring tanks has been largely uncoordinated and the influence which the combined effects all development may have on the floodplain is of significant concern.

On 12 December 1993, a meeting was held with representatives from Emerald, Broadsound and Peak Downs Shire Councils, Department of Natural Resources (DNR) and Nogoa floodplain landholders in attendance. This meeting reached comprehensive agreement that control of works on the Central Queensland River System Flood Plains was important and in February 1994 the Nogoa River Flood Plain Steering Committee was formed. The steering committee comprised representatives from landholders, mining, Local Governments and DNR. Membership on the Steering Committee is shown in Appendix A. Its charter was to;

- consider and approve any proposed conceptual plans of the study area for modelling.
- develop guidelines against which the impact of existing and proposed works on natural runoff over the study area could be measured and compared.
- determine future development scenarios to be modelled.
- consider and endorse modifications to existing and proposed developments.

A scoping study (Connell Wagner and Lawson and Treloar (1994)) was undertaken to assess the survey, hydrologic and hydraulic modelling requirements of the Emerald Floodplain Study including a cost benefit analysis of the various combinations of options within and between each of these areas. This study was undertaken by consultants with their report completed in August 1994. Copies of the report are held by the Nogoa River Flood Plain Board. The executive summary of the report is attached as Appendix B.

On 16 February 1995 the Department of Natural Resources was appointed to undertake the development of a Numerical model of the floodplain and prepare a Floodplain Management Plan.

1.2 Community Consultation

Appropriate community involvement in the Nogoa Floodplain study and decision making processes including the development of this Interim Management Plan were considered an integral component of the study from the outset. In particular this was essential if the study was to consider all relevant issues and concerns and appropriately address these. In addition, to be successfully implemented the plan needed to attain general community support, adoption and ownership. Key components of the consultation process included;

- Public meetings as follows;
    - 1993, leading to formation of the Nogoa River Flood Plain Steering Committee.
    - January 1995, to outline progress to that date and seek endorsement to proceed to detailed study.
    - May 1997, to outline outcomes of the study and details of this Interim Management Plan.
- Nogoa River Flood Plain Steering Committee meetings held on a periodic basis, including linkages to strategic milestones in the study to provide;
    - a conduit for the two way transfer of information,
    - input on study progress; and
    - input on project direction.
- Independent scoping study, including consultation with many key stakeholders.
- Interviews with landholders on the floodplain in order to obtain and ratify historical data.
- Distribution of Newsletters to stakeholders during 1995 and 1996.
- Discussions at strategic points with specific owners of existing works on the floodplain during the course of the study to obtain comment on likely decisions and study direction and impacts of those decisions on their enterprise.
- Public presentation of Interim Floodplain Management Plan following its adoption by the Nogoa River Flood Plain Board.
- Periodic review and possible amendment of the plan, including the opportunity for community input.

2.0 Responsibility For Implementation And Management of Plan

The "Nogoa River Flood Plain Board" was created and empowered under the provisions of the Local Government Act on 19 September 1996 (Gazettal Notice S96/0251V06 - see Government Gazette 20.9.96 page 255 re Subordinate Legislation No 245) to manage the Nogoa River Flood Plain.

The Board's primary responsibility is to manage and control the development and use of works on the Nogoa River Flood Plain. Support is provided to the Board in the carriage of its duties by the following;

- Nogoa River Flood Plain Board - Local Law (Levee Banks).
- Nogoa River Flood Plain Board - Interim Floodplain Management Plan.
- Nogoa Floodplain Numerical Model.

The Local Law (Levee Banks), developed under the provisions of the Local Government Act, provides the Board with the mechanism to control the construction, maintenance and use of works on the floodplain and provides the process by which that control will be achieved.

The 'Interim Floodplain Management Plan' is the Board's adopted policy document. It details the basis on which decisions are made by the Nogoa River Flood Plain Board relating to the development and use of the floodplain including management principles and objectives along with specific interim criteria and measures for allowable development.

The 'Nogoa Floodplain Numerical Model' is the tool by which the hydraulic impacts of any development proposal on the floodplain are quantified for the Board to assist decision making processes. Refer to Section 5.2 for more details.

2.1 Approvals within the 'Nogoa River Flood Plain' Related to Other Responsible Authorities

Dealings with a property within the 'Nogoa River Flood Plain' for other approvals should be referred to the Board by the relevant Local Government or responsible authority for advice as to any special conditions that may apply on that property, and any additional information that may be required of the proponent by the Board. Matters of concern may include (but not limited to) the sale of land and subdivision proposals.

3.0 Scope of Management Plan

3.1 Floodplain Management Processes

The desired process for the development of a Floodplain Management Plan is, as presented in the Draft Best Practice Guidelines Floodplain Management in Australia, shown in Figure 1.

The development of this Floodplain Management Plan has been broadly in accordance with this process. However, due to the nature of the floodplain (ie a rural environment), the activities to be controlled (ie structures impacting on flooding characteristics) and the significant pressures which exist for further development requiring control, some components of this process have not been fully addressed as part of this interim management plan. These include a Flood Emergency Management System and Floodplain Management Study including Economic Appraisal to determine the Designated Flood Event. The basis on which the Designated Flood Event for this Interim Plan was determined is discussed in more detail in Section 5.4.

3.2 Limit of Area

This Interim Floodplain Management Plan applies to only those areas contained within the "Nogoa River Flood Plain" as defined by the area designated on Drawing No JB1, the master copy of which is held by the Nogoa River Flood Plain Board. The extent of the floodplain was defined by adding 0.5 metres to the peak water levels recorded or estimated during the February 1978 flood event. The 0.5 metre extension is in recognition of the fact that the February 1978 flood event has an ARI of approximately 1 in 25 years.(ie far smaller than the PMF- refer to definition of floodplain)

A copy of this map is shown as Figure 2. Copies may also be viewed at the Emerald or Peak Downs Shire Offices.

3.3 Requirement to make Application

Under the provisions of the Local Law any person intending to construct or cause to be constructed on land within the 'Nogoa River Flood Plain', any construction, including a levee bank, shall before such construction is commenced make application to the Board for either a permit to construct such levee bank or for an exemption from obtaining a permit.

3.3.1 Works requiring Permit

Works on the Floodplain that may require a permit include;

- above ground storage structures.
- above ground supply channels.
- levee banks on the floodplain.
- above ground drainage channels.
- high profile embankments including roadways and railways.
- formations, bridges and culverts.
- landfill.

3.3.2 Exempt Works

An exemption from the requirement to obtain a permit may be granted for certain works, where those works can, with a high degree of certainty, be expected to have an inconsequential impact on the hydraulic behaviour of the floodplain during floods. These works may include;

- below ground channels (which do not divert floodwater).
- levee banks around domestic residences, farm sheds.
- fences.
- low profile roads.
- low height banks which overtop easily during higher frequency flood events.

Those works exempted from the requirement to obtain a permit are decided by the Board. The Board may modify at any time by resolution any aspect of the type or dimension of works exempted from the requirement to obtain a permit. 'Guidelines on Exempt Works' can be obtained from the Board through the Emerald or Peak Downs Shire Council Offices.

3.4 Limits of Investigations

Considerable technical investigation has been undertaken relating to flood hydrology and river hydraulics on the Nogoa Floodplain and these investigations have formed the major basis on which this Interim Floodplain Management Plan was developed. However it must be recognised that the development of a Floodplain Management Plan involves the consideration of a much wider range of issues, including environmental, economic, cultural and social concerns. These have been given preliminary consideration and general provisions have been incorporated into the Interim Floodplain Management Plan. Future refinement and enhancement of the Management Plan may need to address these issues in more detail.

3.5 Impacts on Emerald Town

Detailed assessments of any impacts arising from developments on the floodplain on areas within the Emerald Township are beyond the scope of this interim management plan. The model has the capacity to be modified to enable such assessments with the provision of more extensive spatial coverage of data within the township boundaries.

4.0 Principles of Management and Objectives

4.1 Principles of Management

Management of Floodplains including control of the development and use of works on floodplains should recognise the following guiding principles.

- The security of existing approved investments in properties and infrastructure should be maintained.
- Any impacts of new developments should be within acceptable limits (physical, economic, environmental, social, etc)
- Decisions on allowable development on the floodplain must be based on the consideration of the cumulative effects of all development approvals (including existing and potential works based on principle of equity).
- All development should adhere to the principles of sustainable development.
- All development on the floodplain should be treated on its merits in relation to the risk of flooding and the benefits such development can provide.

In managing the Nogoa River Floodplain it may not be possible for the Board to simultaneously satisfy all of the above principles . In such cases the Board will give due regard to the relative merits of the proposal, weighed against each principle.

4.2 Objectives

Through establishing and enforcing the provisions of the Local Law and providing management and control to the development and use of works on the Nogoa River Floodplain, the Board's objectives are;

- To optimise the beneficial use of the floodplain and its resources whilst reducing the impact of flooding and flood liability.
- To ensure development on the floodplain occurs in accordance with the principles of sustainable development.(economic, social and environmental).
- To provide a platform on which equitable and logical development of the floodplain can take place so as to ensure a sound basis exists for consistent decision making.

5.0 Flood Study

5.1 Historical Floods

Official records of flood levels on the Nogoa River floodplain date back to 1875. At Emerald, records of flood levels date back to 1890 when the Railways Department monitored flooding that was likely to result in disruptions to rail traffic. Since the 1920's DNR and the Bureau of Meteorology (BoM) have operated stream gauges and flood warning gauges along the Nogoa River and its tributaries. During this time, a number of substantial flood events have occurred, resulting in a good awareness of flood impacts within the affected community.

The largest flood on record occurred in December 1916 when the Mackenzie River at St Aubins reached a gauge height of 23.09 metres. This flood level is some 2.5 metres higher than any other observed flood level at this location. The December 1916 flood event was associated with a cyclone that caused extreme rainfalls to occur over a widespread area, but particularly around the town of Clermont. Daily rainfall records show that for the two day period commencing on the 27th December rainfall depths were in excess of 500 mm around the town. These rainfall totals were assessed as having an Average Recurrence Interval (ARI) of in excess of 1 in 1000 years. However, the overall Retreat/Theresa Creek catchment estimate of the exceedence probability of the storm event was assessed at having an ARI of in excess of 1 in 130 years.

Several large floods have occurred since 1916, with frequent flooding occurring in the 1950's. The flood of November 1950 is recognised as the largest flood to have affected Emerald since the turn of the century. Other notable flood events include February 1922, February 1954, February, April and December 1956 and March 1963. Details concerning these events pre-Fairbairn Dam are shown in Table 5.1.

Table 5.1

Historical Flood Events Pre-Fairbairn Dam

Event	Water Level (m SD)		Discharge (m^3/s)		ARI (Years)	
	Emerald	St Aubins	Emerald	St Aubins	Emerald	St Aubins
December 1916	177.29	155.74	na	na	na	na
February 1922	na	152.74	1900	6550	9.1	20.0
November 1950	177.94	152.33	4420	5890	62.5	13.3
February 1954	176.36	153.17	2640	7210	19.2	26.3
February 1956	176.29	152.31	2780	5790	20.0	13.2
April 1956	176.87	150.81	3000	4600	22.5	8.7
December 1956	176.49	151.70	2780	6370	20.0	16.7
March/April 1963	175.65	148.96	2200	3830	11.1	5.7

Note: na = Not Available

Fairbairn Dam located upstream of Emerald at AMTD 685.6 km, was completed in November 1973. The dam impounds Lake Maraboon which is currently the second largest reservoir in the State. Such a large reservoir has a significant impact on the frequency of flooding for downstream locations. The dam has overflowed eleven times since it was constructed, with the largest overflow occurring in February 1984. The dam first filled and spilled in January 1974 shortly after completion. The dam last overflowed in April 1990. Details concerning events post Fairbairn Dam are shown in Table 5.2.

Table 5.2

Historical Flood Events Post-Fairbairn Dam

Event	Water Levels (m SD)		Discharge (m^3/s)		ARI (Years)	
	Emerald	St Aubins	Emerald	St Aubins	Emerald	St Aubins
December 1975	174.29	na	1000	2420	13.3	9.5
February 1978	175.21	152.52	1410	4550	18.2	40.0
May 1983 (Early)	174.24	149.90	1140	2710	15.4	12.5
February 1984	175.24	146.70	1430	1420	18.2	4.4
April 1990	174.39	na	1120	1660	14.9	5.0

Note: na = Not Available
m SD = metres State Datum

The largest flood to occur on the floodplain since construction of the dam was in February 1978. This event resulted in significant widespread flooding over the floodplain because all of the contributing streams, including the Nogoa River, Retreat/Theresa Creeks and Comet River were in flood simultaneously. The Retreat and Theresa Creek catchments in particular, experienced severe flooding during the course of this event. The February 1978 flood remains significant to landholders on the floodplain as it occurred 'recently' and it also occurred in the period after the construction of Fairbairn Dam. Thus, it was a major flood event that incorporated the mitigating effect of the dam.

5.2 Nogoa Floodplain Numerical Model

The Nogoa Floodplain Numerical Model (NFNM) is a computer based hydrodynamic model that is capable of simulating unsteady flow in natural river systems. The model was developed using the HD-system RUBICON software package developed by HASKONING BV and Delft Engineering Software.

The model can accurately simulate the propagation of flood waves through the Nogoa River and floodplain system. The model is limited to sub-critical flow regimes and quasi-two dimensional representations of the floodplain system. The model is intended to be used to assess the impacts of major flood events emanating from contributing catchments. Localised flooding produced by rainfall over small areas is not addressed by this model.

5.3 Topographic Base

The topographic base adopted by the Board upon which the impacts of development proposals will be assessed is as shown in Figure 3. The numerical model is based on topographic information derived from aerial photography and ground survey obtained in October 1994.

It was decided at an early stage of the study that only those works constructed on the floodplain or with approval (to construct specific works on the floodplain) prior to October 1994 would be considered eligible for inclusion in the topographic base. This decision was made with consideration to the timing of the Gazettal of the Emerald Shire Council Local Law (Levee Banks) and that of the topographic information on which the numerical model was based. Determination of those works to be incorporated into the topographic base entailed a detailed assessment of how well those works, both individually and cumulatively satisfied the general management principles and objectives, as outlined in this document.

It is also important to reiterate that all works on the floodplain, including those works incorporated into the adopted topographic base, are subject to the provisions of the Local Law. This includes the requirement to apply for and be granted a permit (or exemption if the case may be).

5.4 Designated Flood Event

The Designated Flood Event (DFE) against which the impacts of proposed works will be measured and assessed was derived during the numerical model development.

A 1 in 20 year ARI flood event was selected as the DFE for the floodplain. This event was determined by adopting a seven day or 168 hour design storm duration rainfall. This storm duration was adopted after consideration of critical storm durations of contributing catchments and through comparisons with historical storm events. The temporal pattern associated with the seven day design storm is based upon the BoM's Probable Maximum Precipitation temporal pattern. This pattern represents a storm that consists of a four day storm preceded by three days of generalised rainfall.

The design storm rainfall applied to each catchment is summarised in Table 5.3. Rainfall loss rates were also applied so as to ensure the volumetric runoff coefficients of each contributing catchment were consistent with historically observed events. These loss rates are also shown in Table 5.3. Further details can be found in the Design Flood Estimation Report (Reference Ayre and Muncaster 1995b).

Table 5.3

Designated Flood Event Rainfall Depths and Loss Rates (mm)

Catchment	Storm Rainfall (mm)	Initial Loss (mm)	Continuing Loss (mm/hr)
Nogoa River to Fairbairn Dam	267	125	1.5
Retreat Creek to Main Road	267	130	1.5
Comet River to 17.2 km AMTD	267	120	1.5
Residual Area to Mackenzie River at Carnangarra	267	105	1.5

In determining the resultant flood flows it was assumed that Fairbairn Dam was at Full Supply Level prior to the onset of the design storm event.

The resultant design flood hydrograph peaks for the major contributing streams are summarised in Table 5.4.

Table 5.4

Designated Flood Event 1:20 year ARI 168 hour duration contributing hydrographs

Stream	Peak Discharge (m^3/s)	Volume (ML)
Nogoa River @ Fairbairn Outflow	1940	1 109 100
St Helens Creek @ Floodplain boundary	70	13 300
Retreat Creek @ Main Road	2260	549 100
Gordonstone Creek @ Floodplain boundary	90	20 200
Belcong Creek @ Floodplain boundary	230	62 200
Crinum Creek @ Floodplain boundary	170	37 500
Winton Creek @ Floodplain boundary	60	11 100
Sandhurst Creek @ Floodplain boundary	200	43 700
Comet River @ 17.2 km AMTD	1620	1 138 900

This DFE was adopted based on the following;

- it is representative of the typical flood immunity for a large percentage of existing works on the floodplain.
- it is consistent with the level of immunity adopted for rural enterprises on other floodplains in Queensland.
- the 1978 flood event against which the numerical model was calibrated appears to have formed the basis on which many enterprises have established bank heights. This event nominally has an ARI in the order of 1:25 years.
- consideration of many factors and issues affecting the selection of the DFE, consistent with current literature, including the draft national best practice guidelines.

However the Board is conscious of the need for some enterprises to construct works to heights above the level to which the 1:20 year ARI event will flow, either for immunity purposes or for the proper functioning of the proposed works (eg a supply channel or off stream storage). Development of these works on the floodplain may have adverse impacts in terms of the overall management principles and objectives on which the Board shall manage the floodplain. Therefore it may be necessary for the proponent to investigate the impacts of the proposed works under events with larger magnitudes (ie frequencies less than the DFE).

5.5 Adopted Base Case and Simulation Results

The Adopted Base Case incorporates the Topographic Base and Designated Flood Event as defined in Sections 5.3 and 5.4.

The hydraulic characteristics against which the Board will assess the impacts of any proposed or existing works not incorporated into the topographic base were derived through model simulations using the data files shown in Table 5.5.

Table 5.5

Adopted Base Case Simulation Data Files

Model Definition File	Model Computation File	File Type
def-057.dat	comh-057.dat	Height
	comq-057.dat	Discharge
	comv-057.dat	Velocity

The results of comh-057.dat, comq-057.dat and comv-057.dat are presented in Figures 4 and 5. Figure 4 shows the depth and extent of inundation on the Floodplain while Figure 5 shows discharge and velocity distributions over the floodplain.

Additional information is contained in report 'Hydraulic Model Design Flood Simulation Results' (Reference Ayre & Voutsis 1996).

6.0 Interim Criteria and Measures for Allowable Development

6.1 Introduction

Interim Criteria and Measures against which proposals for development of works and the continued use of those works on the Nogoa Floodplain will be assessed have been developed, based on the Principles of Management and Objectives and consideration of information arising from and during the flood study.

6.2 Interim Criteria

Proposals for development of works and the continued use of works on the Nogoa River Flood Plain shall be assessed by the Board on the following interim criteria.

- Developments on the Floodplain must be designed and constructed to standards appropriate to the level of risk of failure of those works and the hazard such failure represents.
- Development within the floodplain should result in the maintenance of a series of floodways generally conforming to the natural drainage pattern.
- Development proposals must incorporate consideration and allowance for environmental, cultural and social impacts.
- Developments on the Floodplain must comply with any requirements under any other Legislation.
- Changes to flow rates, flow distribution, flood timing and depth of flow, as a result of proposed developments should be within the acceptable limits.

6.3 Interim Measures

Table 6.1 contains the interim measures which will be used to assess how well developments on the floodplain meet the interim criteria.

Implementation of the interim criteria and measures will restrict the Board in its ability to apply the principle whereby all development on the floodplain should be treated on its merits in relation to the risk of flooding and the benefits such development can provide. Based on the available information, it was considered that this criteria could not be satisfied without a high risk of compromising the ability to satisfy in the medium to long term other principles, including security of existing investments and equity. This may be addressed in the future, if the need arises, through undertaking relevant studies, including possibly risk-damage assessments and ultimate development scenario assessments.

Table 6.1

Interim Measures

Interim Criteria	Interim Measure
Developments on the Floodplain must be designed and constructed to standards appropriate to the level of risk of failure of those works and the hazard such failure represents.	Proposed developments must comply with relevant Shire Strategic Plan and ByLaws of constituent Local Governments Design Report, including Plans & Specifications, must be prepared by suitably qualified individuals or companies. The Design Report must address the impacts of overtopping or failure of the works, including the hazards such an occurrence presents and appropriate management measures. Works are constructed and maintained in accordance with the approved Design Report (including approved Plans and Specifications) to the satisfaction of the Board. It is the policy of the Board that the full height of works shall be taken into account when assessing impacts and determining an application. ie There shall be no allowance for freeboard. Development proposals should be in accordance with Industry Best Practice.
Development within the floodplain should result in the maintenance of a series of floodways generally conforming to the natural drainage pattern.	In general development proposals must cause minimal change to the distribution of flood flows across the floodplain. Discharge pattern from the developers property is similar to the pre- development pattern. In general flow paths within a property should not be blocked. Provided other criteria are satisfied and in the opinion of Board no reasonable alternative exists, a developer may cause a flow path to be blocked, on the condition that the developer constructs (or provides) and maintains an alternative flow path which is acceptable to the Board (and may be subject to permit).
Development proposals must incorporate consideration and allowance for environmental, cultural and social impacts.	The developer must address these issues as part of the application. The Board may require the proponent to undertake other studies as necessary including suitably detailed Impact Assessment Study and Environmental Management Plan in order for it to properly assess any application.
Developments on the Floodplain must comply with requirements under any other Legislation.	All other approvals, permits, authorities etc required of the proponent under any other Act must be obtained and a copy provided to the Board.

Table 6.1 (continued)

Interim Measures

Criteria	Measure
Changes to flow rates, flow distribution, flood timing and depth of flow, as a result of proposed developments should be within the acceptable limits.	The total permissible increase in peak water elevation at or outside a property boundary arising from all development (including the proposed development and works approved to be constructed) subject to permit under the local law, on that property compared with that which would occur for the Adopted Base Case will be nil. The total permissible increase in peak water elevation at or outside a property boundary arising from all development (including the proposed development and works approved to be constructed) subject to permit under the local law, on the floodplain compared with that which would occur for the Adopted Base Case will be nil. However, this requirement may be varied at the absolute discretion of the Board subject to such further information being provided by the proponent as the Board deems necessary in order for it to properly assess and determine the application. **Irrespective, the total cumulative effect of all works (under an ultimate development scenario) on the floodplain shall not exceed 300 mm at any property boundary, over and above that occurring under the Adopted Base Case.** No significant change in flood timing or flood flow distribution. No significant change in the duration of inundation of lands outside the property boundary such that the normal use or potential use of that land is adversely impacted. Any change in flood velocity arising from the proposed development will not result in increased erosion on the floodplain and watercourses (including localised scour effects). Sufficient pondage must be retained in the floodplain system so that the characteristics of the flood hydrographs, in particular their general shape, timing and peak height are not unduly altered. The Board may at its absolute discretion require the proponent to undertake any other studies and provide such information as it deems necessary in order for it to properly assess and determine the application, including any impacts arising from events less frequent than the designated flood event.

7.0 Plan Review and Amendment

This Management Plan shall be reviewed on a periodic basis. However the Interim Plan shall be subject to continuous review leading up to the adoption of the final Floodplain Management Plan. Amendments as required to this Plan may be made by the Board and will incorporate due consultative process.

8.0 References

Ayre R A, Muncaster S, (1995a), 'Nogoa River Floodplain Study, Runoff-Routing Model Calibration Report'. Department of Natural Resources, Hydrology Report 130213.PR/1 Brisbane, July 1995.

Ayre R A, Muncaster S, (1995b), 'Nogoa River Floodplain Study, Design Flood Estimation Report'. Department of Natural Resources, Hydrology Report 130213.PR/2 Brisbane, October 1995.

Ayre R A, Muncaster S, Voutsis A, (1996a), 'Nogoa River Floodplain Study, Hydraulic Model Calibration Report'. Department of Natural Resources, Hydrology Report 130213.PR/3 Brisbane, February 1996.

Ayre R A, Voutsis A, (1996), 'Nogoa River Floodplain Study, Hydraulic Model Simulation Report'. Department of Natural Resources, Hydrology Report 130213.PR/4 Brisbane, June 1996.

Connell Wagner in association with Lawson and Treloar (1994), 'Scoping Study for the Emerald Floodplain Management'. DPI Water Resources, Emerald Shire Council and Peak Downs Shire Council, August 1994.

Water Studies (1996), 'Best Practice Guidelines Floodplain Management in Australia, Draft Report. Standing Committee on Agriculture and Resource Management, Brisbane, August 1996.

APPENDIX A

NOGOA RIVER FLOOD PLAIN STEERING COMMITTEE

Appendix A

NOGOA RIVER FLOOD PLAIN STEERING COMMITTEE MEMBERS

ORGANISATION	AT FEB 1994	AT MARCH 1997
LANDHOLDERS	[redacted]	[redacted]
BAUHINIA SHIRE COUNCIL	GAIL NIXON [redacted]	[redacted]
PEAK DOWNS SHIRE COUNCIL	[redacted] WAYNE SWEENEY [redacted]	[redacted]
EMERALD SHIRE COUNCIL	[redacted]	[redacted]
DEPARTMENT OF NATURAL RESOURCES	[redacted]	[redacted]

DEPARTMENT OF NATURAL RESOURCES ADVISORS

	AT FEB 1994	AT MARCH 1997
ADVISORS	[redacted]	[redacted] RUSSELL CUEREL
CONSULTANTS		ROB AYRE

APPENDIX B

Nogoa River Flood Plain

Scoping Study Executive Summary

by
Connell Wagner
in association with
Lawson and Treloar

1.0 EXECUTIVE SUMMARY

A scoping study has been completed which has identified the most appropriate methodology, in terms of survey, hydrologic and hydraulic requirements, for the development of a floodplain management plan for the Emerald floodplain system. The Study Area for which floodplain management is required is shown in Figure 1. As well as identifying the methodology, this study has identified the data requirements and the approximate costs for further detailed studies required to address the issued relating to flooding within the study area, leading to the floodplain management plan.

Information used in this scoping study was collected through office research, field interviews and study area inspections. This information formed the basis of identification of methodologies, and the assessment of their benefits and disadvantages, for application to the issues of this study area.

The scoping study and proposed subsequent detailed study have arisen because of concern over recent uncontrolled floodplain development, and the potential for considerable additional future development.

Stakeholders in the floodplain include the grazing industry (including dryland farming), the irrigation industry, Ensham Coal Mine, the Queensland Government (principally through DPI), Emerald Shire Council and Peak Downs Shire Council. These stakeholders are represented on the Steering Committee for this study, and the proposed subsequent detailed study.

Key floodplain management issues identified are:

- the need for clear, overall floodplain development guidelines, to enable responsible development to proceed
- effects on flooding of recently constructed and/or future proposed above ground irrigation supply channels, levee banks and ring dams, particularly in relation to impacts on other properties
- the potential for further rapid, uncontrolled development of leveed irrigation schemes, with the likely sale in the near future of several large grazing/dryland farming properties
- the need for fair and equitable treatment of all stakeholders in the study area
- the requirement for licensing of certain floodplain works.

Priority areas of the floodplain, requiring urgent attention now are:

- existing channels, levees and ring dams on 'Parker' and 'Brayland', on the Nogoa River floodplain, some 20km upstream of the confluence of the Nogoa and Comet Rivers
- existing and proposed future works on Charlie Wilson's property, on the Nogoa River, just upstream of its confluence with the Comet River
- proposed development by Carl Morawitz, on the lower Comet River floodplain
- proposed levee works on 'Colorada' by Ian Burnett, between Crinum Creek and Nogoa River, in the Nogoa River floodplain
- the potential development of a large portion of 'Codenwarra', between Theresa Creek and Nogoa River.

Other areas that do not appear to require immediate attention, but could develop in the next three to five years are:

- [redacted] property, between Retreat and Theresa Creeks
- possible future development in the floodplain of the Nogoa River by Ensham Mine
- other portions of 'Codenwarra', through additional sales of properties held by the McCosker family.

Additional survey data to provide appropriate topographic representation of the floodplain is required. Options available for obtaining survey data are:

- new photogrammetric mapping of the study area, using existing available photography
- new photogrammetric mapping of the study area using customised, new photography
- selected ground surveys; primarily using floodplain cross-sections.

Hydrologic analysis is required to determine flood flows entering the study area. Options available are:

- analysis and use of selected historic events only
- analysis and use of selected historic events and derived theoretical design flood events.

Hydraulic analysis is required to assess the natural network of floodways, and to determine the effects of existing and possible future floodplain development works on flood depths, velocities and flow distributions throughout the study area. Options for hydraulic analysis considered in this scoping study all utilise dynamic, unsteady flow modelling, but vary in density and complexity of their physical representations of the floodplain. Coarse, medium and fine grid models have been examined.

The cost of obtaining appropriate, additional floodplain survey required, varies between $90,000 (for use of existing available survey data, supplemented by ground cross-sectional survey at between 2 to 3 kilometres spacing) and $155,000 (for new photogrammetric survey of the entire study area, using existing photography).

The cost of hydrologic investigations varies between $10,000 for the simplest, and $20,000 for more detailed assessments.

The cost of hydraulic investigations (including provision for field data gathering, overall project management, local liaison and plan drafting) varies between $60,000 for coarse grid modelling, and $100,000 for fine grid modelling.

Various legislative powers that may be relevant to the implementation of the final floodplain management plan are briefly discussed. The most appropriate method for legislative support for a floodplain management plan would appear to be the use of a by-law or local law under the Local Government Act, with administration by Emerald Shire Council and Peak Downs Shire Council.

Possible funding mechanisms for the study have been investigated and are presented. Funding of the study will be required through contributions from DPI (either as capital of by 'work in kind'), Emerald Shire Council and Peak Downs Shire Council. An overall study budget in the range $200,000 to $250,000 may be all that can realistically be funded at present, depending upon the actual level of input from DPI.

Our cost estimate for the preferred option for the detailed floodplain modelling study incorporates:

– a new photogrammetric survey of the base study area, using new photography	$100,000
– a hydrologic investigation, incorporating historic and design flood events	$ 20,000
– medium grid hydraulic modelling	$ 80,000
– detailed report production	$ 20,000
– contingency	$ 30,000
TOTAL	**$250,000**

The Steering Committee require that the study be complete by July 1995.

Recommended Flood Plain Management Process

Note:-
This figure has been copied from the original Figure 3.1 in "Best Practice Guidelines, Flood Plain Management in Australia" draft report by Water Studies Pty Ltd, August 1996.

A4-501498 RSC 07/05/97

Figure 1

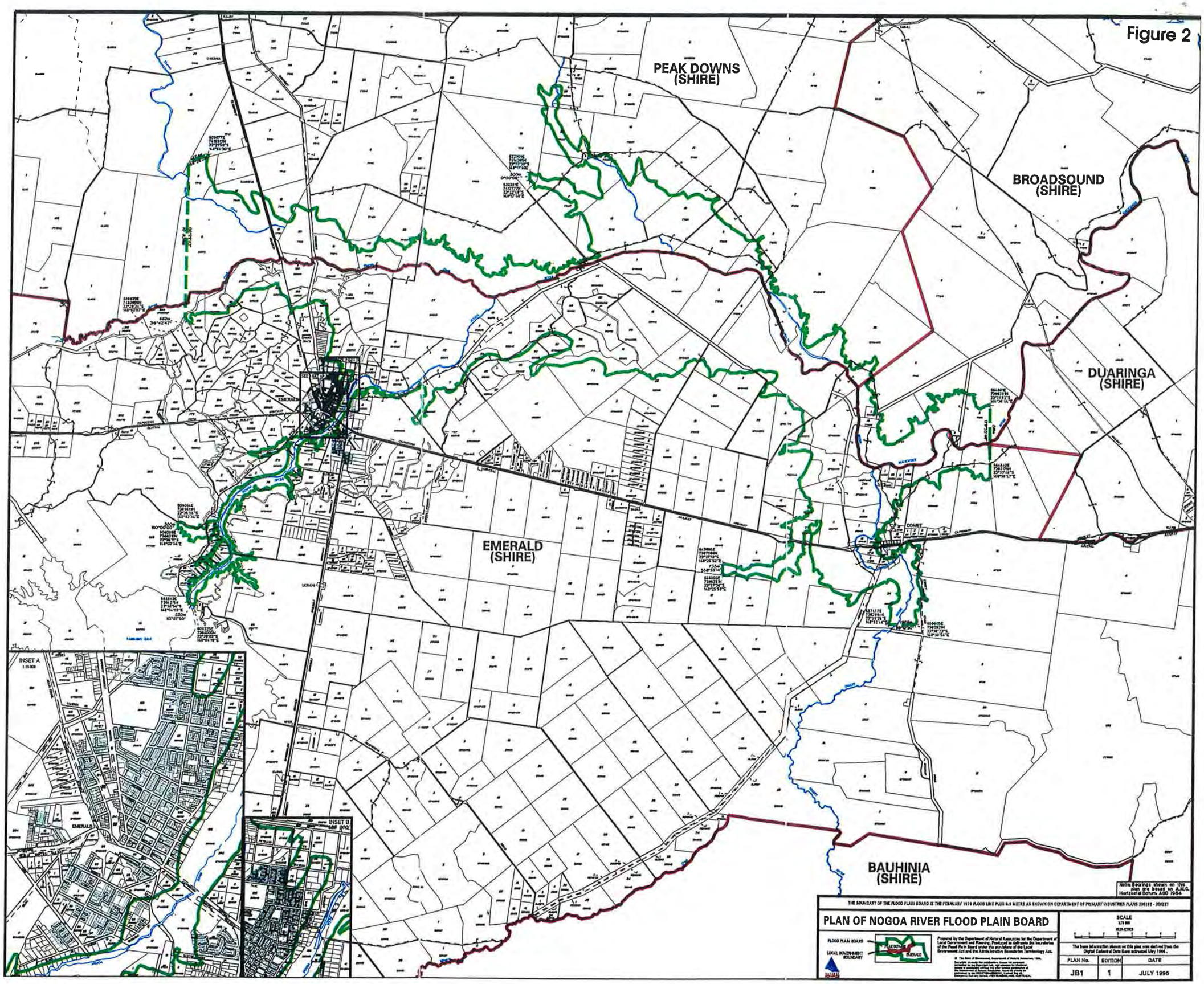
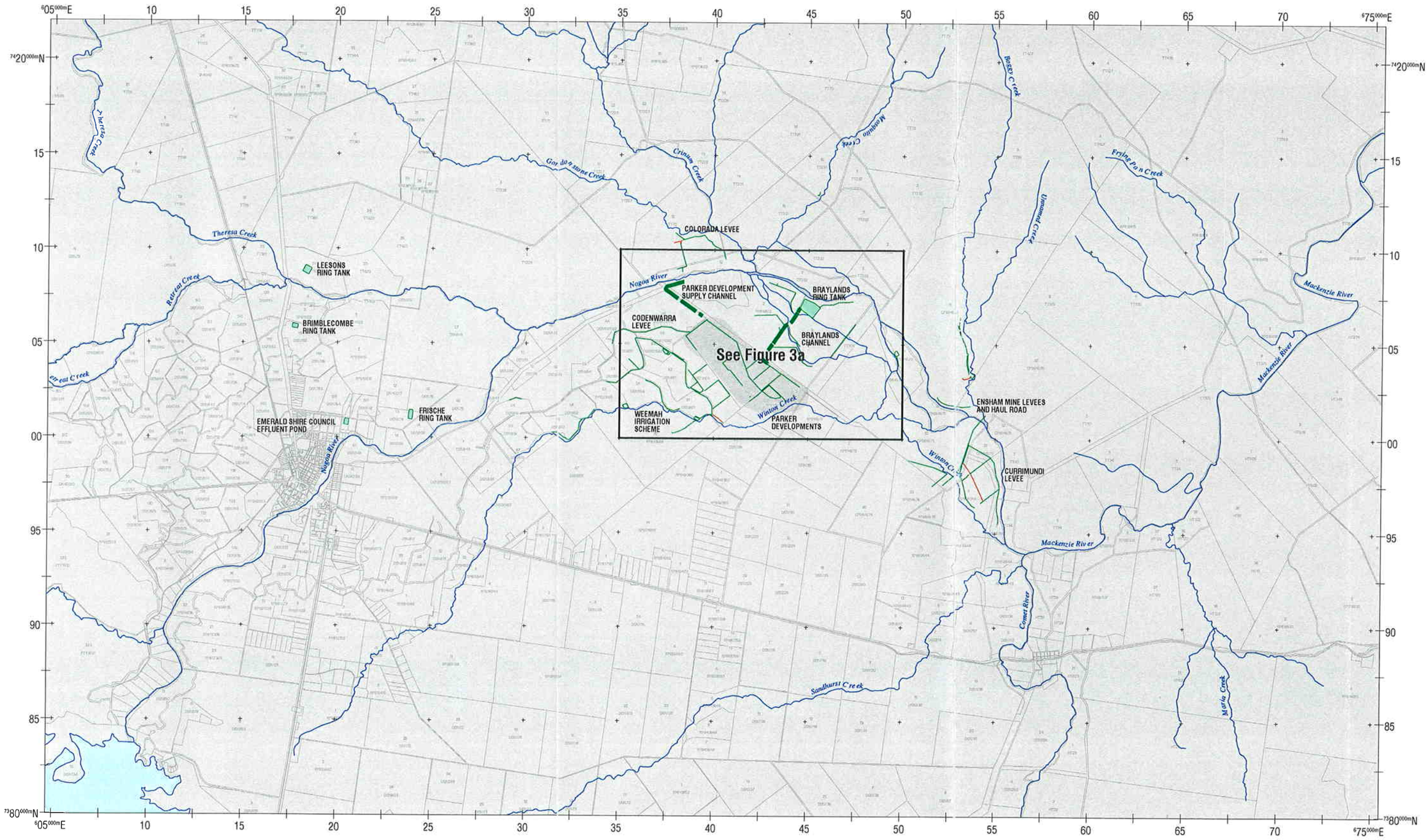


Figure 2
PEAK DOWNS (SHIRE)
BROADSOUND (SHIRE)
DUARINGA (SHIRE)
EMERALD (SHIRE)
BAUHINIA (SHIRE)
INSET A
INSET B
EMERALD
Note: Bearings shown on this plan are based on A.M.G. Horizontal Datum AGD 1984
THE BOUNDARY OF THE FLOOD PLAIN BOARD IS THE FEBRUARY 1978 FLOOD LINE PLUS 0.5 METRE AS SHOWN ON DEPARTMENT OF PRIMARY INDUSTRIES PLANS 200192 - 200227
PLAN OF NOGOA RIVER FLOOD PLAIN BOARD
FLOOD PLAIN BOARD
LOCAL GOVERNMENT BOUNDARY
SCALE
PLAN No.
EDITION
DATE
JB1
1
JULY 1996

Figure 3



Legend:

- Above Ground Development (Levee Bank, Ring Tank etc.)
- Above Ground Development (Levee Bank, Ring Tank etc.) – Modified
- Below Ground Development (Channel)

Notes:

1. Cadastral blocks shown > 1 hectare and labeled > 100 hectares.

KILOMETRES

0 10 20

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RESOURCE SCIENCES CENTRE

NATURAL RESOURCES

QUEENSLAND GOVERNMENT

Nogoa Flood Plain Study
Flood Plain Developments

October 1994

03/06/97

A3-501640 RSC

Printed:-17 Jun 97 Current Workspace:-/PROJECTS/AML1872-TMP/MGT

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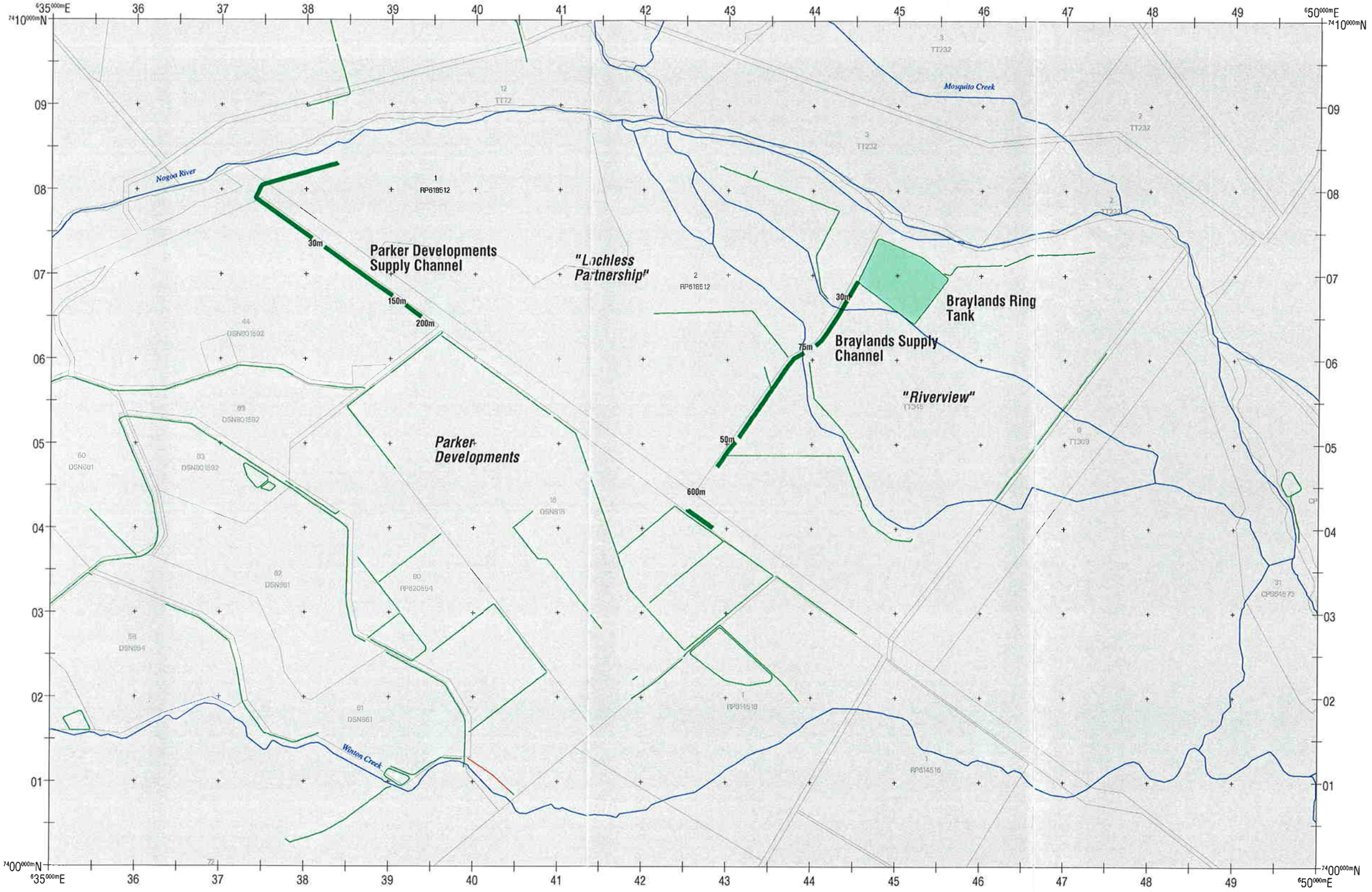
Figure 3a



Legend:

- Above Ground Development (Levee Bank, Ring Tank etc.)
- Above Ground Development (Levee Bank, Ring Tank etc.) – Modified
- Below Ground Development (Channel)

Notes:

1. Cadastral blocks shown > 1 hectare and labeled > 100 hectares.

KILOMETRES
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RESOURCE SCIENCES CENTRE

Nogoa Flood Plain Study
Flood Plain Developments
October 1994
Channel Modifications

02/06/97

A3-501656 RSC

Printed:-17 Jun 97 Current Workspace:-/PROJECTS4/ML1872-FMP/MGT

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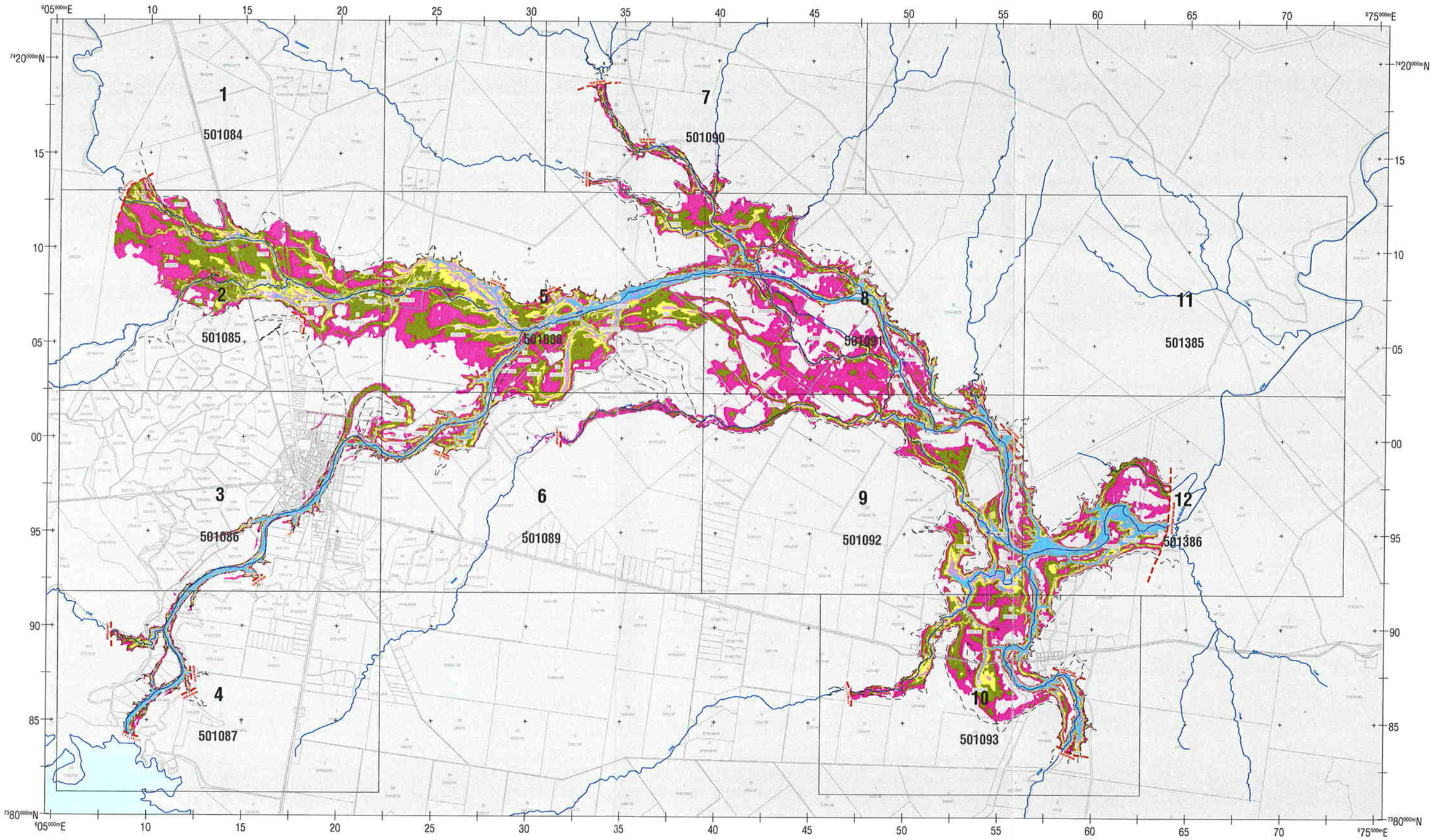
Figure 4



Legend:

- 0m – 1m
- 1m – 2m
- 2m – 3m
- 3m – 4m
- > 4m
- Peak 1978 Flood Line
- Extent of 'RUBICON' Hydraulic Model

Notes:

1. Cadastral blocks shown > 1 hectare and labeled > 100 hectares.
2. The data from which this plan has been developed is of limited accuracy. Consequently, this plan shows general flooding only and should not be used to access flooding of individual blocks.
3. This map shows the effect of Nogoa River flooding but not the effect of local flooding in creeks.

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RESOURCE SCIENCES CENTRE

NATURAL RESOURCES

QUEENSLAND GOVERNMENT

Nogoa Flood Plain Study
Hydraulic Model
Case 14b (1:20) – Depth of Inundation
Key to Sheets

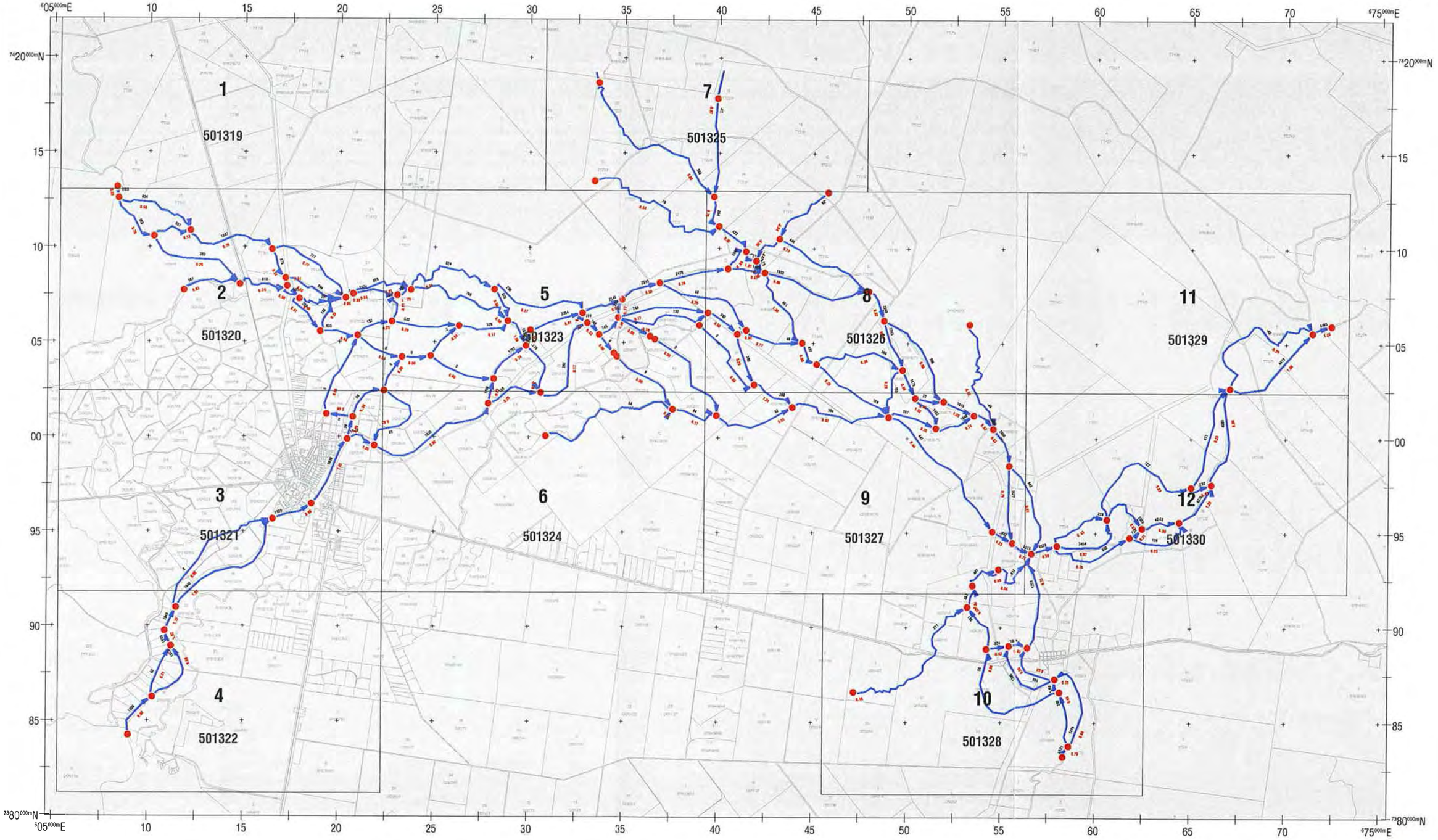
15/01/97

A3-501083 RSC

Printed:-02 Jun 97 Current Workspace:-/PROJECTS1/ML1872/MGT

Produced at the Resource Sciences Centre of the Department of Natural Resources by the Spatial Information and Mapping Group.

Figure 5



Legend:

- Branch
- DCDB Feb-95
- Node
- Values indicate flow in m ^{3}/sec.
- Values indicate velocity in m/s.

Notes:

1. Negative values indicate flow in the **opposite direction** to the arrow.

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RESOURCE SCIENCES CENTRE

NATURAL RESOURCES

QUEENSLAND GOVERNMENT

Nogoa Flood Plain Study
Branch Network
Peak Discharge and Velocity
Case 14b (1:20) – Key to Sheets

01/04/97

A3-501318 RSC

Printed:-02 Jun 97 Current Workspace:-/PROJECTS1/ML1872/MGT

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